ICAR-NBSS&LUP

Annual Report

2015-16

ICAR-National Bureau of Soil Survey and Land Use Planning

Nagpur - 440 033, Maharashtra, India

www.nbsslup.in

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PREFACE

The year 2015-16 has certainly been one of the most productive years in the history of the Bureau and it can look back with pride on what it has achieved in the year. Significant achievements have been, among others, development of protocols for linking soil resource data of 1:250000 scale with the new dataset of land resource inventory (LRI) on 1:10000 scales. Five letters and a numeral based coding system have been designed for delineating landscape ecological units, the base map of LRI. A case study has been taken to develop methodology for up scaling soil resource information of 1:50k to 1:10k using high resolution remote sensing data and digital elevation model in the back end.Protocols have also been set for using land resource inventory data of 1:10000 for fallow and khajan land mapping of Goa; characterisation, and mapping of jhum land in North-Eastern region. The information could also be set for estimating water harvesting potentials with or without use of soil water conservation measures in the watershed. The programme is further set in to use LRI database in monitoring land degradation in a given set of conditions. During the year, web and mobile-based Farmer's advisory for input based land use planning, Mrida Sangrahak (Android based mobile apps for collecting Geo-referenced smart mobile phone aided soil samples), automated land potential evaluation system (ALPES), framework designing of sub-module for Land Evaluation towards development of Decision Support System have been brought out. Substantial progress has also been made towards the development of dedicated geo-portal on soils "Bhumi".

During the year LRI project on 1:10000 scales has made substantial progress with completion of survey and mapping work in 24 blocks across the country. A total of 294 soil series was identified in the programme. For strengthening LRI programme, mineralogical characterization of Vertisols of Agro-ecological region 10 and 6 has been carried out. Genesis of Vertisols in Bemetara block of Chattisgarh involving drainage pattern, geology and clay mineral assemblage has been studied. Soil-physiographic relationship on 1:250000 scale on the sedimentary formation at Bagalkot Bijapur, western ghat of Dakshina Kannada district, basaltic, metamorphic, lateritic and granitic gneissic landforms. The relationship among slope, elevation and soils on 1:10000 scales has been investigated for north eastern region

Land use and management options have been developed for eight watersheds, three blocks of Telangana and one each for Gujarat and Bihar. For making land use planning more practical and objective oriented, study on simulation modelling of organic carbon has been taken under different land use systems. During the year land use planning has been made more practical and farmers oriented by demonstrating its utility in the coastal system of West Bengal (Bali Island), Mysore plateau (H.D.Kote) and in the Brahmaputra valley of north eastern region. The year has also been remarkable in that we reached out to our stakeholders in a more purposeful manner to involve them in planning by delineating the potential areas for growing sesame and safflower in India; medicinal plants in Karnataka; pomegranate in Gujarat; rubber, spices and coconut in Kerala; cotton, sugarcane and paddy in the state of Tamilnadu using soils resource information of 1:250000 scale data. The database of 1:250000 scales are also used to delineate prime agricultural land in the country and the state. Similar set of data are also used to revise agro-ecological region map of the country. During the year, soil health cards have been distributed to 1.5 lacs farmers in the state of Telangna and more than

thousand soil health cards in the other parts of the country have been distributed on international day of soil health. The stage is set to distribute soil health cards for 70 thousand farmers in the state of Maharashtra.

Human resource development through education and training continued to be a major activity. The Bureau organized a number of training programmes in its mandated areas of work. Two scientists visited abroad to attend meetings/ workshops on different NRM issues towards agricultural development. Besides, a number of staff underwent national trainings in varied fields.

The Bureau brought out a total of 206 publications including 74 research papers (63 in national and 11 in international referred journals), 20 Book Chapters, 11 Reports/Bulletins, 33 popular articles and 68 Seminar/Symposia papers. An important publication namely, Vision 2050 was published during the year. Revenue generated during the year through different activities of research touches the mark of two crores.

I am thankful to the Chairman and members of Research Advisory Committee (RAC), the Chairman and members of Institute Management Committee (IMC) and the Member-Secretary of Institute Research Council (IRC) for the guidance and support provided in formulating and pursuing our RD&T programmes.

I am highly grateful to Dr. S. Ayyappan, esteemed Secretary, DARE and Director General, Dr. A.K. Sikka, Deputy Director General (NRM) and Dr. S.K. Chaudhari, Assistant Director General (S&WM), ICAR, New Delhi for the guidance and support provided and also for encouraging new research initiatives.

I appreciate the sincere and dedicated efforts put in by the scientists in the huge task of compiling and editing the report. I am more than contented in placing the Annual Report (2015-16) for public scrutiny. I welcome suggestions and feedback from the readers. The same will provide valuable inputs towards raising the bar in Annual Report writing in years to come.

(S.K. SINGH)

DIRECTOR

Place: Nagpur

Date: June 2016

CONTENTS

Executive Summary

Substantial progress has been made in the Land Resource Inventory (LRI) programme on 1:10000 initiated in a phased manner during 2014-15. Soil survey is largely dependent on soil-landform relationship and the soil map represents the static soil properties, which are acquired after a series of climatic episodes. However, the present Land Resource Inventory (LRI) is basically meant for developing sustainable land use plan, which is dynamic, vibrant and functional. It is basically dependent on present climatic conditions and the prevailing soil forming processes. Therefore, landscape ecological unit (LEU) representing agro-ecosystem as a whole is preferred over landform as the basis of mapping. LEU is the assemblage of landform, slope and land use. For developing landscape ecological unit map as a base of LRI, standard schema has been developed. It involves5 letters and one numeral; first two letters represent physiographic and sub-physiographic regions and third letter with super and subscript indicates broad landforms. Fourth letter is placed for landforms. A numeral in the schema is placed only for slope class and last letter is designed for land use and land cover factors.

Physiographic and sub-physiographic regions and broad landforms are being generated by using legacy data i.e. soil resource information of 1:250000 scale, whereas three secondary layers i.e. landform, slope and land use are integrated through the hierarchical object based segmentation algorithm taking into consideration of the area, morphology of the landform units and its relation with the neighboring objects to develop landscape ecological unit (LEU) map. The segmentation was accomplished in three levels: Level-I: First level segmentation is done based on the landform layer. Level-II: This segmentation runs within the 1st level segment using fuzzy threshold based on slope class. Second level intermediate output gives rise to landform-slope unit. Level-III: The landform-slope segments of 2nd level is further subdivided into landform-slope-land use unit i.e. LEU by incorporating the land use factor. The logic used to incorporate the land use factor is that the minimum overlap with the thematic polygon i.e. level-II segment will be more than or equal to 60%. The criteria ensure the continuity of LEU zone vis-à-vis soil boundary by ignoring negligible change in land use.

LEU developed for twenty four blocks, 6 from western and eastern region each, 5 from northern region, 3 from southern region, 2 each from north-east and central region. LEUs were developed for Ankleshwar taluk, Bharuch district, Khedbramha taluk, Sabarkantha district, Dholka taluk Ahmedabad district, Deesa block, Banaskantha district, Porbandar taluk, Porbandar district, Rapar taluk, Kutch district, Gujarat in Western region; Mushahari block, Muzaffarpur district, Kadwa block, Katihar district from Bihar, Basudevpur block Bhadrak district, Ganjam block, Ganjam district, Titlagarh block, Bolangir district from Odisha and Rajnagar block, Birbhum district, West Bengal in Eastern region; Gajwel mandal, Medak district, Thimmajipet mandal, Mahabubnagar district, Indravelle mandal, Adilabad district from Telangana in Southern region; Jagner block, Agra district, Baragoan block, Varanasi district from Uttar Pradesh, Chamba block, Tehri Garhwal district, Uttarakhand, Odhan block, Sirsa district, Haryana and Rajpura block, Patiala district, Punjab in Northern region; North West Jorhat Development block, Jorhat district, Assam and Medziphema block, Medziphema district, Nagaland from North-Eastern Region; Rahuri block, Ahmednagar district, Maharashtra and Raisen block, Raisen district, Madhya Pradesh from Central Region.

Apart from the schema of LEU, another schema is developed to represent phases of soil series. It contains again letters and numeral. First two/three letters represent name of soil series, first numeral in the scheme is designated for soil depth followed by letters for soil texture and slope, respectively; final numeral indicates severity of soil erosion. Depending upon the situation letters and numerals are kept or deleted. Soil resource map of 1:10K is developed for Ankaleshwar taluka, Bharuch district, Khedbrahma taluka, Sabarkantha district, Dholka taluka, Ahmadabad district, Deesa taluka, Sabarkantha district, Porbandar taluka, Porbandar district, Rapar taluka, Kachchha district of Gujarat in Western region; Basudevpur block, Bhadrak district, Ganjam block, Ganjam district, Titlagarh block, Bolangir district of Odisha, Mushahari block, Muzzafarpur district, Kadwa

block, Katihar district of Bihar in Eastern region; Indervalle mandal, Adilabad district, Thimmajipet mandal, Mahaboobnagar district, Gajwel madal, Medak district of Telangana in Southern Region; Jagner block, Agra district, Uttar Pradesh, Nagrota Bhagwan block, Kangra district, Himachal Pradesh in Northern region and North West Jorhat block, Jorhat, Assam in North-Eastern Region. Apart from this substantial progress has been made in Sujala-III project where information on fields at cadastral level was noted.

Database developed in LRI programme is utilized for delineating LMUs based on the management needs. One or more than one land characteristics, having the influence on agriculture are generally chosen for the delineation. For example, four soil and site characteristics namely slope, depth, texture, gravelliness and erosion have been considered for defining LMUs in the watersheds of Karnataka and the water stressed blocks of Telangana for raising second crop in a year. Comparably in Titalagarh block of Bolangir district, Odisha, apart from moisture, slope and risk of erosion are the factors to be managed for successful agriculture. In contrast, risk of flooding is the main and sole criteria for defining LMUs in Kadwa block of Katihar district, Bihar. Extent and severity of salinity have been considered for delineating LMUs in Ganjam and Basudebpur blocks of Ganjam and Bhadrak districts of Odisha. In the Bali Island of coastal region of West Bengal, apart from salinity, the depth of sulfidic material is the main factor governing agriculture as well as coastal environment of West Bengal.

Database developed in LRI programme is utilized to estimate runoff and the water harvesting potential with existing and proposed structures in the prevailing mean annual rainfall pattern for seven micro-watersheds of Karnataka. Balance runoff water in each micro-watershed is also estimated. Additional storage structures and their dimensions are calculated. On utilizing the expected stored water in the tank, the expected increases in the area of different crops have been prepared. Similar exercise has also been done for the micro-watersheds of Darwha block of Yavatmal district of Maharashtra.

Finally land use and management options have been developed LMU wise in eight watersheds of Karnataka, three blocks of Telangana and one block each from Bihar and Gujarat. In order to link land use options with the socio-economic profiling of the people an automated land evaluation system (ALPES) using MS-Access programme have been developed. Computer based decision support system using modified Requir's method of land evaluation has also been developed during the year. An Android based mobile application for data mining and utilization of land use options for the state of Gujarat has been developed.

Further the protocol has been developed to use LRI database for characterization of Fallow and Khajan land of Goa and jhum land of north eastern region. For mapping of fallow land in Goa, current fallow and the agriculture land use were delineated using R2 LISS-IV. The observations are verified by using Landsat-8 imagery for the Kharif, Rabi and Zaid seasons of the current year i.e. 2015. Similarly land uses other than current fallow and culturable waste are derived by visual check in wasteland polygons of three growing season images from 2011 to 2014; extensive ground truthing has been done for verification. Problem of separating similar spectral response by grass and cropland was done by trend analysis of time series data of NDVI, which have performed well in the region with its linear slope parameter (low value for fallow land and higher value for presently cultivated land). Mapping of area under shifting cultivation or Jhum Land in the north eastern region has been taken as project during the year. Mapping of Jhum land has been done in the Ri-Bhoi district of Meghalaya and Mokokchuk district of Nagaland.

For utilizing LRI database in degradation/desertification monitoring, an extramural project entitled "Mapping and Assessment of Land Degradation in Major Ecosystems of India Using Geospatial Technologies" has been undertaken with the objectives to develop robust methodology for mapping and assessment of type, extent and severity of land degradation using high resolution temporal satellite data, legacy and field data. The base map consisting of fused multi-spectral temporal LANDSAT-8 OLI (30m resolution) data and PAN data (15m resolution) are used.

For quicken the process of LRI mapping by use of high resolution remote sensing database and digital elevation model, an attempt has been made for up scaling soil resource information from 1:50K to 1:10K by using legacy data and geospatial tools in Goa State. Three steps methodology has been followed. In the step I: the hierarchical relation tree was framed showing interrelationships between the physiography, broad landform and landform units. Hence, if we are able to upscale the landform units (represented by the SRM units as such or their combination) of 50k to 10k scale by redrafting its boundary and breaking individual units into multiple ones with the help of high

resolution geospatial data products in the background; the physiography and broad landforms could be updated accordingly by merging the landform units as per the legacy hierarchical relation tree. In the step II: the landform vis-à-vis association of soil series at 10k scale need to be dissociated into monoseries for precise delineation of land management units at this scale. We adopted the digital soil mapping concept at this stage. DSM has evolved for deriving advantage of advancement of computing and geographic data handling, as well as increased availability of environmental covariate data from high resolution digital elevation models (DSM) and remotely sensed imagery. Hypothesis in this case study is that in a given set of conditions (i.e. state factors of climate, time and geology; had been already well taken into consideration while preparing 50k scale soil resource information), the soil type (series in pedological term) variability is largely governed by the remaining state factors. The minimum dataset (MDS) to separate one series from their association state under each landform unit is identified. The "r" factor parameters selected in the MDS are elevation and slope. The "o" factors include land use/land cover that costs variation in spectral response. The "s" factor being known soil attribute is derived from the legacy soil series report to finalize the MDS. It mainly includes soil texture as a function of spectral response ("o" factor); for e.g. the coarse texture soil will have brighter spectral response than the finer one owing to its low water holding capacity. Finally in the step III: accuracy assessment of the 50k soil map with the spatial scale corrected one is also performed. The accuracy of legacy 50k soil map was also assessed.

For strengthening the database of LRI, mineralogical characterization of Vertisols of Agro-ecological region 10 and 6 has been carried out during the year, while genesis of Vertisols in Bemetara block of Chattisgarh involving drainage pattern, geology and clay mineral assemblage has been studied. Soil-physiographic relationship on 1:250000 scale on the sedimentary formation at Bagalkot Bijapur, western ghat of Dakshina Kannada district, basaltic, metamorphic, lateritic and granitic gnessic landforms. The relationship among slope, elevation and soils for north eastern region on 1:10000 scales has been investigated.

During the year substantial information has been generated using legacy data of 1:250000 scale like delineation of potential area for different crops and cropping pattern and also delineation of prime land in the country and the state. For delineation of Potential area for sesame and sunflower in the country, the relative spread index (RSI) and relative yield index (RYI) is used, whereas for delineating potential area for medicinal plant Ashwagandha and fruit plant pomegranate in Karnataka and Gujarat, respectively, is done using soil site suitability criteria. The similar exercise has been done for delineation of potential areas for growing tea and coffee in Kerala, Karnataka and Tamilnadu and tea in Assam and West Bengal. During the year potential areas for rubber, paddy and spices in Kerala has been marked. The soil-site suitability evaluation has also been applied further for delineating potential areas for cotton, sugarcane and paddy in Tamilnadu.

Prime agricultural lands have been delineated for all the states (First Approximations) based on soil resource data of 1:250000 scale of all the states of India. Agriculture land use was derived from LULC map of 2011-12. Double cropped area is considered as irrigated. Criteria for delineation of prime agricultural lands includes soil depth (>75 cm), non sandy, non-gravelly (<15% rock fragments), slope less than 8 percent, soil pH between 6.5 and 8.5 in all horizons within the root zone, water table should not be within one meter depth, non-saline (EC < 2 mmhos/cm), non-alkaline (ESP < 5 per cent), no flooding/water logging. Based on the exercise, we have delineated 58.8 million hectare areas as prime land in the country. Of which 26.7 million hectare belonged to the rainfed and 32.1 million hectare area is classified under irrigated conditions.

AER map was prepared in 1992 based on available data on climate, soil and physiography. In view of the new dataset on soil and climate, bureau has revised agro-ecological region map of the country (2015).

On the base map of 1:50000 scale desertification status mapping (2nd cycle) of Telangana state has been taken up during the year. Three season Resourcesat AWiFS data of 2011-2013 and 2003-2005 were used for delineation of different desertification processes. The results showed that 30.6 % area of state was affected by different desertification processes in 2011-13, whereas it was 31.3% of the state in 2003-05. The dominant processes in 2011-13 were water erosion (82%), vegetal degradation (15%) and salinity (2%). The change detection analysis showed that the area affected by water erosion and forest vegetal degradation in 2011-13 is significantly lower than that of 2003-05.

Base map of 1:50000 are also used for Land use and land cover analysis of Darwha block. It is concluded from the study that more than 10000 ha wasteland

area was brought under cultivation during the period 2001 to 2005. The block lost 1932 ha of forest land and 1401 ha scrub land as well. Analysis of crop history for last 15 years showed a steep decline in cereal crops (mostly sorghum). Soybean crop area jumped from 1107 ha to 20565 ha during the period. Decrease in short duration kharif season crops like sorghum and maize is attributed to increased area under cotton. The loss of area under cereals (mainly sorghum) led to decreased fodder availability. It was reflected in decline in livestock from 110559 in 2001 to 103048 in 2007 in the block. Decline in double cropped area was also noted. Number of functional wells in the district shows a sharp drop from 2976 in 2001 to 276 in 2005. The socio-economic factors leading to choice of crops in Darwha block is also analyzed.

Keeping database on one platform and disseminating to the user agency, Digital Library software is being developed using Visual StudioNET. The software displays all the information of the selected land parcel i.e. soils, current land use, existing hydrological structures, proposed conservation measures, fertility status and suitability to different crops. Software module is developed to display the village wise land parcels with selected soil or fertility status and can also generate reports. The information can be used to prepare village or micro watershed reports. The software also includes the facility to view the Photos and Pedon description from of the selected soil series.

NBSS&LUP further attempted to develop dedicated to Geoportal on soils (BHUMI by collating geo-referenced soil and allied resources database in GIS. It could be used as knowledge gateway to visualize access, query soil data and disseminate the land resource information to the users. The advantages of developing such Geo-portal include elimination of redundancies and duplication of efforts, enforces consistency, standards, and sharable protocols to build a cross-domain soil knowledge base for effective utilization of limited natural resources in the country. The soil maps available on 1:1m and 1:250,000 scales, Agro-ecological regions, Agro-ecological sub-regions, soil loss, degraded and wastelands data were deployed in BHUMI. The schema has been standardized for soil attribute database and ten district soil survey reports have been deployed. The point layer data on soil fertility, rainfall, benchmark soils, raster data on SRTM & ASTER DEM and AWiFS of India have also been deployed. Web Map Services (WMS) services for visualization will be started shortly.

For quick assess of database ICAR has initiated to develop knowledge portal KRISHI. ICAR-NBSS&LUP is one of the core team members of KRISHI project actively involved in conceptualization of theme and development of project proposal entitled "ICAR Research Data Repository for Knowledge Management (KRISHI)" for funding from ICAR. The design and development of front end of ICAR Geoportal has been developed to showcase Indian agricultural research capabilities in various domains. KRISHI Geoportal provides a gateway to explore and discover geospatial databases with specific emphasis on Indian Agriculture. In addition to the spatial data, metadata and services components, building a spatial data infrastructure requires suitable structures for coordination and communication. KRISHI Geo-portal is an initiative to make geo-spatial data related to agriculture to all the stakeholders. This portal makes available geo-referenced data collected by ICAR institutions on climate, soil, cropping systems, land-use pattern etc. During the reporting period, the available basic information on area, production and productivity of major crops; Agro-ecological regions, Agro-ecological sub-regions and soil maps (1:1 million) of NBSS&LUP; Vulnerability map and climate layers of CRIDA; ICAR Institutes/Regional Centres locations etc. have been deployed as WMS.

Thus the year 2015-16 could be considered as the year of promise and performance for NBSS&LUP. During the year the protocols for LRI and LUP is set for application; its performance and coherence have been seen in many parts of the country. New initiatives have been taken to use soil resource information developed on 1:250000 scale. For appraising the information on soils to the user and planners, substantial progress has been made in setting Digital library, dedicated Geo-portal on soils BHUMI, ICAR-knowledge portal KRISHI.

1 NBSS & LUP : A Profile

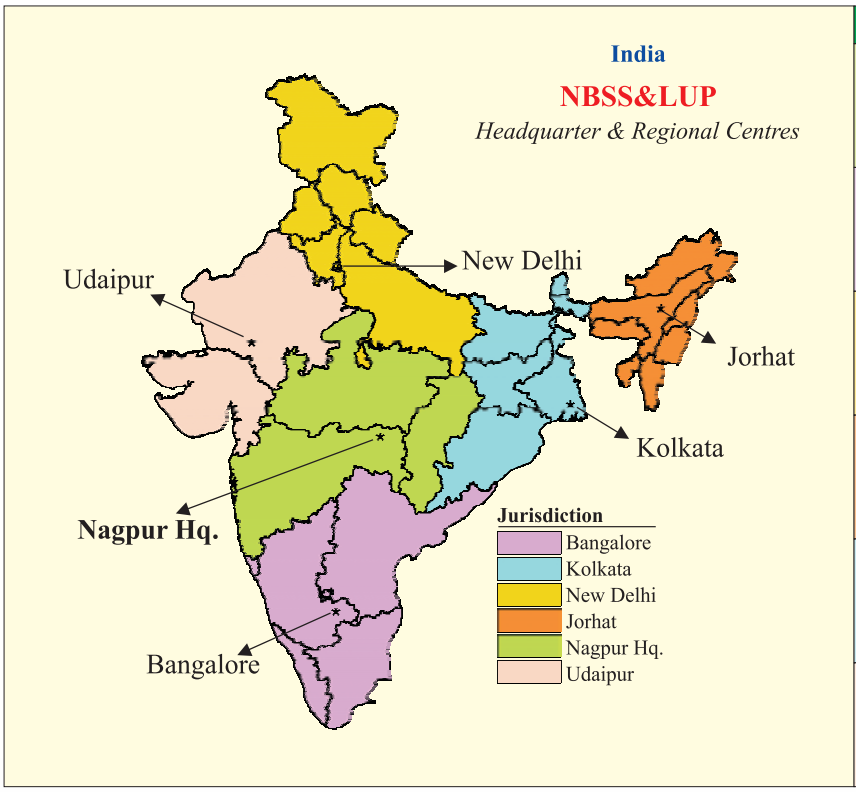
Genesis

Subsequent to the recognition of Soil Survey as a national priority, a need was felt for creating a centralized information warehouse to assimilate, verify and disseminate information on nature, extent and distribution of soils in the country. Consequently, the Indian Council of Agricultural Research (ICAR) established National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) (to be hereafter referred to as Bureau) in 1976, with its Hqrs. at Nagpur. The Hqrs. houses 3 Research Divisions, namely, Division of Remote Sensing Applications, Division of Soil Resource Studies and Division of Land Use Planning. Subsequently, five regional centrescame into existence that are located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur and address regional specific issues in the mandated areas of work. Besides, there are a number of units and sections, which provide scientific and technical support to the research divisions and regional centres in accomplishing varied tasks.

The Bureau is the country's only premier national institute mandated for research, development and training (RD&T) in the field of soil survey, land use planning and allied aspects. Over the years, the Bureau has excelled as a centre of RD&T in Soil Survey and Land Use Planning at national and international level.

Location

The Hqrs. is located on Amravati Road (Kolkata-Mumbai National Highway 6). It has in its close vicinity the ICAR-affiliated National Research Centre for Citrus (NRCC), Ginning Training Centre (GTC) a regional centre of Central Institute for Research on Cotton Technology (CIRCOT), and Regional Remote Sensing Centre (RRSC) (ISRO). The campus of the Bureau is also quite close to Nagpur University. The Hqrs., therefore, has locational advantage which facilitates multidisciplinary studies, inter-institutional interactions and research linkages, etc. A map showing location of the Hqrs and the five regional centres is shown below.



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Mandate

- To conduct soil survey and mapping of the soils of the country to promote scientific and optimal land use programmes in collaboration with relevant institutions and agencies.
- To conduct and promote research in the National Agricultural Research System in the areas of Pedology, Soil survey, Remote sensing applications, Land degradation, Land evaluation and Land use planning.
- To impart training and education to create awareness on soil and land resources and their state of health.

The role of the ICAR-National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS&LUP) becomes all the more important in view of the serious challenges the country faces in terms of shrinking soil and land resource base, soil/land degradation, depleting nutrient stock, deterioration in soil/land quality, changing climate, land use conversion and non-judicious planning of land use.

Major research themes

- Inventorying natural resources
- Remote sensing and GIS applications
- Basic Pedological Research
- Soil Survey Data Interpretation and Applications
- Land Evaluation and Land Use Planning

Training Areas

- Soil Survey and Land Evaluation for Land Use Planning
- Remote Sensing and GIS Applications in Soil Resources Mapping

Management

A high powered Research Advisory Committee (RAC) comprising eminent professionals, mostly from outside the ICAR system guides the Bureau on formulating its research policies and in planning research thrusts and strategies.

The Institute Management Committee (IMC), constituted and mandated by the ICAR, supervises the functioning of the Bureau. Internal Committees, such as, Institute Research Council, Purchase Committee, Library and Publication Committee, Official Language Committee and a Grievance Cell, to name a few, are operating for decentralization of management. The Institute Joint Staff Council promotes healthy interaction and congenial work environment.

Infrastructural Facilities

Laboratories

The Bureau has various state-of-art laboratories. Some of the modern and sophisticated equipments are listed below.

X-ray diffractogram

Scanning Electron Microscope

Inductively coupled Plasma Spectrometre

Atomic Absorption Spectrophotometer

Spectroradiometer

Latest Remote Sensing and GIS softwares

CN Analyzer

The facilities available in micromorphology and GIS laboratories are the best in the country that match international standards.

Library

The Bureau houses a fully computerized library located at the Hqrs. that has a comprehensive collection of books, reports and periodicals. The regional centres also have computerized libraries.

ICAR-NBSS&LUP website

The Bureau posts all important information about its activities, particularly about research projects, publications, linkages, educational trainings, staff and infrastructure on its Website (http://www.nbsslup.in).

Major Achievements

1976-2014

The Bureau, through its journey over last 4 decades, has every reason to feel proud for its tremendous accomplishments in the domains of research and development.

- An outstanding achievement has been in generating the Soil Resource Map of the Country on 1:1 million scale and its different states on 1:250000 scale.
- A 20-Unit Agro-ecological region and a 60-unit Agro-ecological sub-region map of the country were developed for regional planning.
- 316 soil series have been entered into the National Registerupto March 2016.
- A method has been developed for using remote sensing data, namely IRS-1C PAN merged data

for large scale mapping of soils at village and watershed level.

- Soil reflectance properties have been successfully used as a potential tool to provide information on a wide range of soil properties.
- The Bureau has been an active partner in generating harmonized statistics of the degraded lands/wastelands according to which the country has about 121 m ha area under different forms of degradation.
- As per estimates made by the Bureau, the total carbon stocks in Indian soils at 150 cm depth is up to a 64 pentagrams (pg) (1 Pg = 10 to the power of 15 g) with considerable amount of inorganic form. This is the first ever estimate made on SOC stocks at national level.
- The Bureau developed land use options for 5 agro-ecosystems, namely,Rainfed, Irrigated, Arid, Hill, Mountain and Coastal.

Software Solutions

The Bureau has developed software solutions for soil correlation and land evaluation. The softwares have replaced age old, tedious and time-consuming manual methods of undertaking the aforesaid activities.

Development of Farmer's Advisory Services

A Farmer's advisory services has been developed to guide growers of vegetables, rice, fruits and pulses of West Bengal on the soil-fertility management, and has been hosted on www.wbagrisnet.gov.in of the NIC server, and is linked with the mobile cell-phone.

Soil Nutrient Maps

Soil (macro and micro) nutrient mapping has been undertaken by the respective Regional Centres of Kolkata and Jorhat at different levels of priority – districts, blocks, watersheds, villages and farms of the eastern and north-eastern states of the country. This activity has generated high utility soil-nutrient maps and revolutionized soil-fertility management in the states.

Salient achievements in 2 years (2014-2016)

- Methodology for Land Resource Inventory on 1:10000 scale, using high resolution remote sensing data and perfected application of land resource inventory data of 1:10000 scale for Fallow and Khajan land mapping of Goa, salt affected area of coastal region, extent of shifting cultivation in Nagaland and Meghalaya, delineation of degraded land in the different agro-ecological regions and assessment of water harvesting potential and soil-water conservation measures requirement in the watershed**.**
- **Site soil-land use models** for enhancing productivity and improving livelihood for tribal farmers in Bali Island Sundarban (Rice-vegetable cropping system with farm pond technologies), Agro-silvicultural based land use models in the coastal ecosystem of A&N Island, Rice-wheat and Rice-maize cropping systems with conservation technology on coarse loamy soils of middle Gangetic plains; Cotton and wheat based cropping system in command area of desert; alternate land-use systems for non-command area of the desert ecosystem; Pigeonpea-rice-pigeonpea-rice on uplands and Rice+sunhemp-fallow in the low lands, Jharkhand state, paddy-vegetable based cropping system in flood plains of Brahmputra, cotton-finger millet based cropping system on Mysore plateau of Karnataka**.**
- **Land use plans (options)** for enhancing productivity, improving livelihood and arresting land degradation in Bali Island of Sundarbans, West Bengal, H.D. KoteTaluk, Mysore District, Karnataka and Bhomoraguri, Jorhat district, Assam, UparDeurigaon, North West Jorhat Development Block, Jorhat district, Assam, Bahphalagaon, North West Jorhat Development Block, Jorhat district, Assam, NatunChaporigaon, Kakadanga Block, Golaghat district, Assam, rainfed ecosystem of Deccan plateau (Case studies of three Mandals of Telangana) and delineation of potential areas for growing cotton, soybean, sesame, safflower medicinal plants in Karnataka, rubber, spices and coconut in Kerala**.**
- Scale Neutral Database (dedicated Geo-portal on soils, Bhumi), **Web and Mobile based Farmer's advisory for input based land use planning; Mrida Sangrahak** (Android based mobile apps for collecting Geo-referenced smart mobile phone aided soil samples **and automated land evaluation software. Protocols for delineating prime agriculture land in the country.**
- Developed a farmer's advisory service, hosted on www.wbagrisnet.gov.in of the NIC server and linked to mobile phones that guides farmers on soil fertility management of West Bengal for growing vegetables, rice, pulses and fruits.
- Potential area for growing onion has been identified in the selected villages of Aurangabad, Dhule and Gondia districts of Maharashtra and a number

of soil based agro-technologies implemented for livelihood improvement of the farmers.

- Participatory diagnosis exercise was undertaken in selected hamlets of villages of Mysore district, Karnataka, 24 Paraganas (South) district, West Bengal and Jorhat, Assam under the Tribal Sub Plan to identify the needs of the tribal community, prioritize and address them.
- Prepared Soil health cards and distributed 1.5 lakh farmers of Telangana State. Apart from this we prepared the base for issuing 70,000 soil health cards .to the farmers of Maharashtra and 1045 cards to the other parts of the country.

New initiatives

- Land use planning for managing acid sulphate soils
- Application of geo-informatics in land use planning and land degradation studies
- Assessment and monitoring of impact of land use planning on soil system and environment
- Soft computing techniques for land evaluation
- Prime land mapping
- Fallow land mapping of Goa
- Development of National Soil Geoportal.

Linkages

The Bureau maintains close linkages with many national organizations like ICAR institutes, State Agricultural Universities (SAUs), state Departmentsof Agriculture, Soil and Land Use Survey of India (SLUSI), National Remote Sensing Centre (NRSC), Hyderabad, Govt. of Telangana, Govt. of Meghalaya and Govt. of Goa.

It has also maintained close linkages in the past with a number of international organizations like ICRISAT, Hyderabad, CYMMIT, New Delhi, ISRIC, ITC, the Netherlands and APARI, Bangkok.

Thrust areas for XII plan

- Development of land resource inventory for village level planning in India to provide site-specific database and situation specific recommendations.
- Development of demand driven soil resource inventory of disadvantaged districts, command areas, prioritized watersheds, villages and farming systems.
- Conducting basic and strategic research in pedology, remote sensing applications using GIS to soil resource mapping, land evaluation and land use planning using new science and emerging technologies.
- Assessment and monitoring of soil quality including soil carbon stock assessment.
- Assessment of degraded lands in the country at different levels for updating their status.
- Preparation of blue prints for efficient land use planning at different levels.
- Implementation of Tribal Sub Plan programme to provide soil based land use planning and to impart training in the selected tribal areas.

Budget (2015-16)

Plan

Funds Received : 437.21 Lakhs

Funds Utilized : 437.20 Lakhs

Non-Plan

Funds Received : 5468.00 Lakhs

Funds Utilized : 5301.34 Lakhs

Revenue Generation

Research Projects : 20316515

Sales of publications : 337178

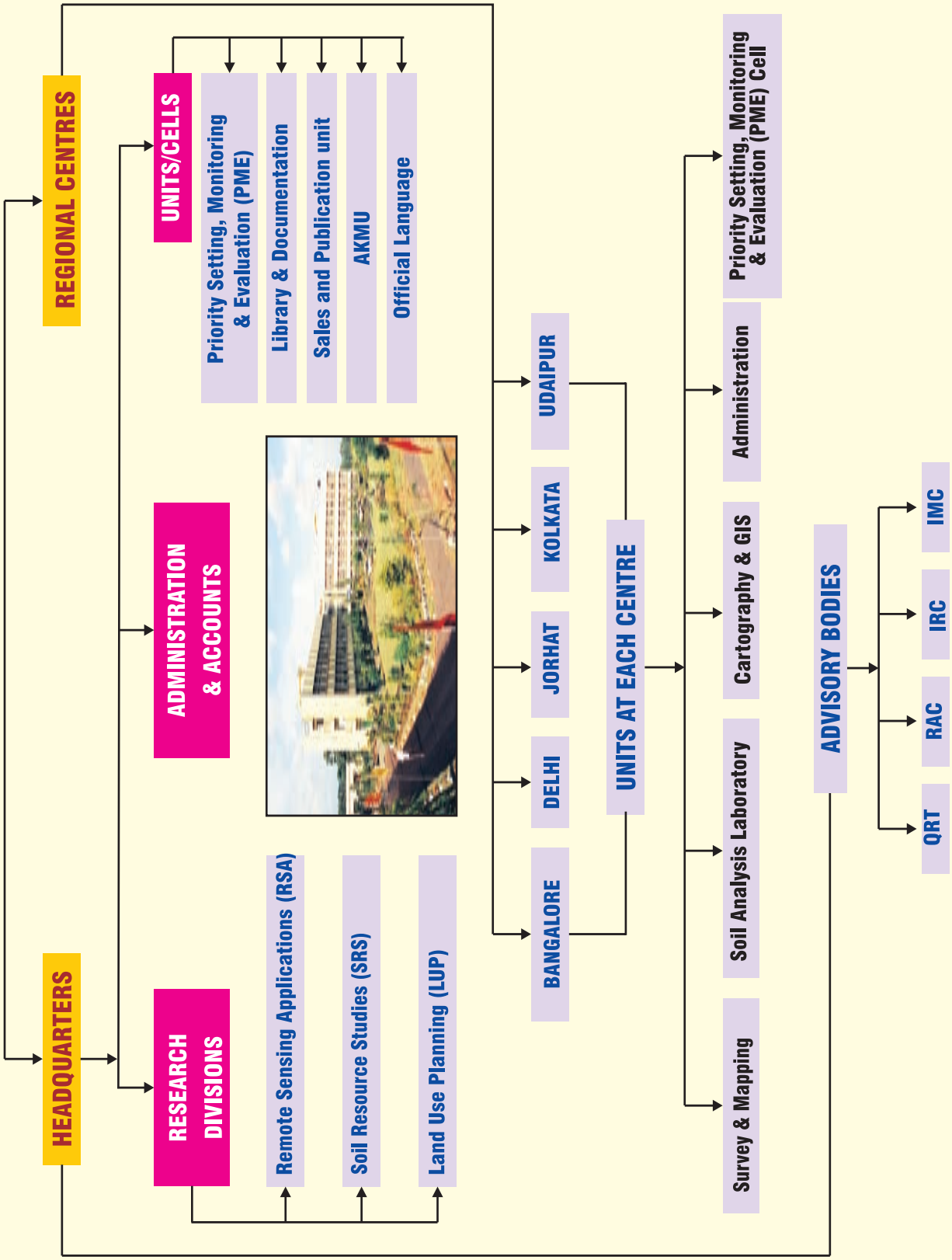
Soil analysis/testing : 22015

Total : 20675708 (Rupees Two crores six lakhs seventy five thousand seven hundred eight only)

Staff strength (as on 31.03.2016)

Category	Sanctioned	Filled	Vacant	% Vacant
Scientific	100	79	21	21
Technical	165	134	31	18
Administrative	67	48	19	28
Supporting	76	51	25	34
Total	408	312	96	23

ORGANOGRAM


HEADQUARTERS
REGIONAL CENTRES
RESEARCH DIVISIONS
Remote Sensing Applications (RSA)
Soil Resource Studies (SRS)
Land Use Planning (LUP)
ADMINISTRATION & ACCOUNTS
UNITS/CELLS
Priority Setting, Monitoring & Evaluation (PME)
Library & Documentation
Sales and Publication unit
AKMU
Official Language
BANGALORE
DELHI
JORHAT
KOLKATA
UDAIPUR
UNITS AT EACH CENTRE
Survey & Mapping
Soil Analysis Laboratory
Cartography & GIS
Administration
Priority Setting, Monitoring & Evaluation (PME) Cell
ADVISORY BODIES
QRT
RAC
IRC
IMC

2 RESEARCH ACHIEVEMENTS

- REMOTE SENSING AND GIS APPLICATIONS
- INVENTORYING NATURAL RESOURCES
- BASIC PEDOLOGICAL RESEARCH
- INTERPRETATION OF SOIL SURVEY DATA
- LAND EVALUATION AND LAND USE PLANNING

2.1 REMOTE SENSING AND GIS APPLICATIONS

Delineation of state-wise physiography, sub-physiography and broad landforms

Three letter symbol scheme with or without super or subscripts developed for linking soil information available on 1:250000 scale and the new information is being evolved during land resource mapping on 1:10000 scale (Table 2.1.1). In the three letter symbols first two letters are devoted to physiography and sub-physiography regions and third letter (with or without super or sub script) is indicative of broad landforms. Information is arranged alphabetically and is given statewise in the Table 2.1.1. Spatial distribution of the above landscape features for the state of Gujarat and Uttar Pradesh is shown in the Fig.2.1.1 & 2.1.2 as an examples.

Table 2.1.1. Symbols used for Physiography and Broad Landforms

State	Physiography	Physiography sub-region	Broad landforms	Symbols
Andhra Pradesh	Deccan plateau	South Deccan plateau	Granite and gneissic complex	DsG_n
			Basaltic complex	DsB_a
			Laterites	DsL
			Gondwana	DsG_w
			Dharwars	DsW_r
			Cuddappa and Kurnool	DsC_k
	Hill ranges (ghats)	Eastern ghats	Granite and granite-gneiss landform	HeG_n
			Dharwar landform	HeW_r
			Cuddappa and Kurnool	HeC_k
	Coastal plain	East coast	Marine landform	PeM_a
			Inland plains	PeP_i
			Krishna delta	PeK_d
			Godavari delta	PeG_d
			Laterite	PeL
			Sandstone	PeS_t
Arunachal Pradesh	North Eastern ranges, Eastern Himalayas	Brahmaputra valley	Upland and flood plains of Brahmaputra valleys	NaUd&NaA
		Purvanchal hills	High and low amplitudinal hills	NcHl&NcHh
		Eastern Himalayas	Eastern Himalayas	NdS^r
		Siwalik hills	Siwalik hills	NeS^r
Assam	Northeastern ranges, Eastern Himalayas	Brahmaputra valley	South Bank (Brahmaputra valley)	NaBr
			North Bank (Brahmaputra valley)	NaBr
			Barak valley	NaBk
		Purvanchal hills	Hill ranges of Central Assam	NcHc
			Purvanchal hill	NcPu
			Interhill basin	NcVb
Bihar	Indo-Gangetic alluvial plain	Piedmont plain	Upper piedmont plain	ApU_u
			Lower piedmont plain	ApL_l
		Alluvial plain	Active alluvial plain	AaA
			Recent alluvial plain	AaY
			Old alluvial plains	AaO
			Old Alluvial Plains with Ox-bow	AaO_x
		Alluvial cone	Kosi river	AcK_s

State	Physiography	Physiography sub-region	Broad landforms	Symbols
Chhattisgarh	Central highlands	Vindhyan ranges and scarpland	Hilly terrain	CvH
			Kaimur plateau	CvK_m
			Alluvial plains	CvA_l
	Eastern plateau	Chotanagpur plateau	Granite gneiss	EcG_n
			Dharwar	EcW_r
		Eastern Himalayas	Hill and side slopes	MeR
	Central highlands	Pathar and Bundelkhand upland	Granite/gneiss	CpG_n
	Deccan plateau	North Deccan plateau	Satpura ranges (Basalt)	DnS_b
			Satpura ranges (Granite)	DnS_g
			Satpura ranges (Sedimentary)	DnS_s
	Eastern plateau	Baghelkhand plateau	Basalt	EbB_a
			Sedimentary gondwana/quartzite	EbS_d
		Chotanagpur plateau	Granite-laterite	EcL_g
			Sedimentary dharwar	EcS_W
			Basalt-laterite	EcL_b
		Dandakaranya	Granite / gneissic	EdG_n
			Laterite	EdL
			Basalt-pre-cambrian	EdB_a
			Sedimentary	EdS_d
		Mahanadi basin	Sedimentary	EmS_d
Gujarat	Central highlands	Aravalli landscape	Hilly terrain	CaH
			Pediment	CaD
			Piedmont	CaP_p
	Gujarat coastal plain	West coast plain	Hilly terrain	GpH
			Plateau	GpP_l
			Interflues	GpI_f
			Alluvial plains	GpA_l
			Coastal plains	GpC_p
			Aeo-fluvial plains	GpE_f
			Aeolian plains	GpE
			Mud flats	GpF_m
		Kutch peninsula	Hilly terrain	GuH
			Pediment	GuD
			Arid plains	GuP_a
			Mud flats	GuF_m
			Coastal plains	GuC_p
		Kathiawar peninsula	Hilly terrain	GwH
			Pediment	GwD
			Coastal plains	GwCp
			Piedmont	GwPp
	Hill ranges (ghats)	Western ghats	Hilly terrain	HwH
Goa	Deccan plateau	South Deccan plateau	Basaltic landform	DsB_a
	Hill ranges (ghats)	Western ghats	Dissected hills and laterite landforms	HwL_e
			Granite and granite-gneisses landforms	HwG_n
			Quartzite and shistoze landform	HwQ_s
	Coastal plain	West coast	West coast	Pw
Himachal Pradesh	Indo-Gangetic alluvial plain	Piedmont plain	Upper alluvial piedmont plains	ApU_u
		Alluvial plain	Active flood plains	AaA

State	Physiography	Physiography sub-region	Broad landforms	Symbols
	Himalayas and other mountain ranges	Greater Himalayas	Summit and ridge top	MhS^r
			Mountain and valley glaciers	MhG
			Side and reposed slopes	MhR
			Fluvio- glacial valley	MhV_g
			Fluvial valley	MhV_f
		Lesser Himalayas	Summit and ridge top	MlS^r
			Side and reposed slope	MlR
			Fluvial valley	MlV_f
		Siwalik hills/outer Himalayas	Summit and ridge tops	MsS^r
			Side and reposed slope	MsR
			Fluvial valleys	MsV_f
			Piedmont plains	MsP
Haryana	Himalayas and other mountain ranges	Siwalik hills/outer Himalayas	Siwalik hills	Ms
	Indo-Gangetic alluvial plain	Piedmont plain	Upper piedmont plain	ApU_u
		Alluvial plain	Old alluvial plains	AaO
			Old alluvial plains with sand dunes	AaD^s
			Recent flood plains	AaY
			Active flood plains	AaA
			Aeo fluvial plain	AaE_f
			Fluvio aeolian plains	AaF_e
			Aeolian plains	WbE
	Central Highlands	Aravalli landscape	Hills	CaH
			Pediment	CaD
Jharkhand	Indo-Gangetic alluvial plain	Alluvial plain	Recent alluvial plains	AaY
			Old alluvial plains	AaO
			Old alluvial plains with ox-bow	AaO_x
		Alluvial cone	Kosi river	AcK_s
	Bengal basin	Undulating plain interspersed with mound	Dissected undulating upland	BbU_e
			Upland with valleys	BbU_v
	Central highlands	Vindhyan ranges and scarpland	Hilly terrain	CvH
			Kaimur plateau	CvK_m
			Alluvial plains	CvA_l
	Eastern plateau	Chotanagpur plateau	Granite gneiss	EcG_n
			Dharwar	EcW_r
			Gondawana	EcG_w
			Rajmahal hills	EcR_j
Jammu and Kashmir	Indo-Gangetic alluvial plain	Piedmont plain	Alluvial piedmont plains	Ap
		Tarai	Tarai region	At
	Himalayas and other mountain ranges	Trans Himalayas	Cryic temperature regime (Trans Himalayas)	MtT_c
		Greater Himalayas	Cryic temperature regime (Grater Himalayas)	MhT_c
			Mesic temperature regime (Grater Himalayas)	MhT_m
		Lesser Himalayas	Mesic temperature regime (Lesser Himalayas)	MlT_m
			Thermic temperature regime	MlT_t
		Siwalik hills / outer Himalayas	Hyperthermic temperature regime	MsT_h

State	Physiography	Physiography sub-region	Broad landforms	Symbols
Karnataka	Deccan plateau	South Deccan plateau	Granite gneiss	DsG_n
			Basalt	DsB_a
			Metamorphic	DsM_t
			Sedimentary	DsS_d
			Laterite plateau	DsL
			Bangalore	DsL_B
			Bidar/belgaon	DsL_{BB}
			Malnad	DsL_M
	Hill ranges (Ghats)	Eastern ghats	South eastern ghats	HeS
		Western ghats	Western ghats –central Sahyadri	HwS_c
	Coastal plain	West coast	West coast-Karnataka	PwK_c
Kerala	Hill ranges (ghats)	Western ghats	Central Sahyadri	HwS_c
			Nilgiri	HwN_g
			South Sahyadri	HwS_s
	Coastal plain	West coast	Low land	PwL_l
Maharashtra	Deccan plateau	Deccan plateau (Upper Maharashtra)	Basalt	DuB_a
		Deccan plateau (Lower Maharashtra)	Metamorphic	DlM_t
	Hill ranges (ghats)	Western ghats	Hilly regions	Hw
	Coastal plain	West coast	Coastal landscape	Pw
Meghalaya	Northeastern ranges / Eastern Himalayas	Meghalaya plateau	Upper plateau	NbP_l
			Hills of middle and lower Plateau (sub montane)	NbS^m
Manipur	North Eastern ranges / Eastern Himalayas	Purvanchal hills (Nagaland)	Low amplitudinal hills	NcH_l
			High amplitudinal hills	NcH_h
			Manipur interhill basin	NcV_b
Madhya Pradesh	Central highlands	Pathar and Bundelkhand upland	Sedimentary vindhyan	CpS_d
			Alluvium	CpA_l
			Granite/gneiss	CpG_n
		Vindhyan ranges and scarpland	Sedimentary	CvS_d
			Alluvium	CvA_l
		Malwa plateau	Basalt	CmB_a
			Granite / gneiss	CmG_n
		Narmada valley	Basalt	CnB_a
			Alluvium	CnA_l
	Deccan plateau	North Deccan plateau	Satpura ranges (basalt)	DnS_b
			Satpura ranges (granite)	DnS_g
			Satpura ranges (sedimentary)	DnS_s
	Eastern plateau	Baghelkhand plateau	Quartzite and schist	EbQ_s
			Laterite	EbL
			Basalt	EbB_a
			Sedimentary gondwana/quartzite	EbS_d
Mizoram	North eastern ranges / eastern Himalayas	Purvanchal hills (Nagaland)	Purvanchal hill ranges	NcH
			Narrow valleys	NcV_n
			Surma valley	NcV_s
Odisha	Bengal basin	Alluvial plain	Lower alluvial plain	BaA_l
			Dissected undulating upland	BaU_e
	Eastern plateau	Dandakaranya	Dandkaranya (metamorphic)	EdD_k
		Garhjat hills	Granite and granite-gneiss	EgG_n

State	Physiography	Physiography sub-region	Broad landforms	Symbols
			Dharwar	EgW_r
			Gondwana	EgG_w
			Lateritic	EgL
		Mahanadi basin	Granite and granite-gneiss	EmG_n
	Hill ranges (ghats)	Eastern ghats	Granite and granite-gneiss	HeG_n
			Dharwar	HeW_r
	Coastal plain	East coast	Utkal plain	PeP_u
			Mahanadi delta	PeM_d
			Andhra Pradesh plains	PeP_A
Punjab	Indo-Gangetic Alluvial plain	Piedmont plain	Upper alluvial piedmont plains	ApU_u
		Alluvial plain	Alluvial plains with sand dunes	AaP^s
			Alluvial plains with occasional sand dunes	AaD_s
			Alluvial plains	AaA_l
			Alluvial plains (partially salt affected)	AaS_l
			Alluvial plains with sand dunes (Aridic)	Aa^aD^s
			Alluvial plains with occasional sand dunes (Aridic)	Aa^aD_s
			Active/recent flood plains	AaA
			Recent flood plains (Aridic)	Aa^aY
			Aeo-fluvial plains (Aridic)	Aa^aE_f
	Himalayas and other mountain ranges	Siwalik hills/outer Himalayas	Siwaliks	Ms
Rajasthan	Central highlands	Aravalli landscape	Hilly terrain	CaH
			Dissected hills pediment	CaH_e
			Aravalli plains	CaP
		East Rajasthan upland	Upland	CeU
			River valley	CeV
			Dissected hills and ridges	CeHe
			Lake margin	CeL_k
			Aeo-fluvial plains with sand dunes and sand cover	CeF_s
			Pediment	CeD
			Plateau	CeP_l
			Alluvial plains	CeA_l
			Mesa and buttes	CeM
			Isolated hillocks with pediments	CeH_d
		Pathar and Bundelkhand upland	Hills with escarpment	CpH
			Residual and isolated hillocks	CpH_r
			Undulated plateau	CpP_l
			Rocky plateau	CpP^r
			Ravines	CpA^r
			Alluvial plains	CpA_l
	Western plains	Sandy arid plain/ Marusthali	Sandy arid plain	WaS_p
		Semiarid transitional plain	Ghaggar aeofluvial plain	WbG_p
			Luni aeo-fluvial plain	WbE_L
			Interior drainage	WbI_d
Sikkim	Himalayas and other mountain ranges	Eastern Himalayas	Summit and ridge	MeS
			Side slope of hills	MeR
			Valley	MeV
			Cliff and precipitous slope	MeC

State	Physiography	Physiography sub-region	Broad landforms	Symbols
Tamil Nadu	Deccan plateau	South Deccan plateau	South Deccan plateau	Ds
	Hill ranges (ghats)	Eastern and Western ghats	Eastern and western ghats	HeS
	Coastal plain	East coast	East coast	HwS_s
			Miscellaneous	
Tripura	Northeastern ranges, eastern Himalayas	Purvanchal hills (Nagaland)	High relief structural hills (sandstone)	NcH
			Medium relief parallel ridges (siltstone)	NcH
			Low relief structural hills (shales)	NcH
Uttar Pradesh	Indo-Gangetic alluvial plain	Piedmont plain	Upper piedmont plain	ApU_u
			Lower piedmont plain	ApL_l
		Tarai	Tarai	At
		Alluvial plain	Old alluvial plains	AaO
			Young alluvial plains	AaY
			Active flood plains	AaA
			Ravinous land	AaR_v
	Central highlands	Aravalli plains	Aravalli plains	CaA
		Eastern Rajasthan upland	Dissected upland	CeU_e
			Undulating land with hillocks	CeU_h
			Land with monadnocks	CeU_m
		Pathar and Bundelkhand upland	Sandstone landscape	CpS_t
			Granite and gneissic landscape	CpG_n
			Alluvial landscape	CpA_l
		Vindhyan ranges and scarpland	Sandstone landscape	CvS_t
			Gneissic complex	CvG_n
	Himalayas and other mountain ranges	Greater Himalayas	Cliff	MtC
		Siwalik hills/outer Himalayas	Summit and ridge top	MsS^r
			Side slopes	MsR
			Fluvial valleys	MsV_f
Uttarakhand	Indo-Gangetic alluvial plain	Piedmont plain	Upper piedmont plain	ApU_u
			Lower piedmont plain	ApL_l
		Tarai	Tarai	At
		Alluvial plain	Old alluvial plains	AaO
			Young alluvial plains	AaY
			Active flood plains	AaA
	Himalayas and other mountain ranges	Greater Himalayas	Summit and ridge top	MtS^r
			Mountain and valley glaciers	MtG
			Side slopes	MtR
			Glacio-fluvial valley	MtV_g
			Cliff	MtC
		Lesser Himalayas	Summit and ridge top	MlS^r
			Side slopes	MlR
			Glacio-fluvial valley	MlV_g
			Fluvial valleys	MlV_f
			Cliffs	MlC
		Siwalik hills/outer Himalayas	Summit and ridge top	MsS^r
			Side slopes	MsR
			Fluvial valleys	MsV_f

State	Physiography	Physiography sub-region	Broad landforms	Symbols
West Bengal	Indo-Gangetic alluvial plain	Piedmont plain	Piedmont plain (upper and Lower)	$ApU_{u\&}$ ApL_{l}
		Alluvial plain (IGP)	Old alluvial plains	AaO
			Young alluvial plains	AaY
			Active flood plains	AaA
	Bengal basin	Alluvial plain (Bengal basin)	Young alluvial plain	BaY
		Undulating plain interspersed with mound	Undulating plain interspersed with mound	BbU_{i}
		Coastal plain	Recent coastal alluvial plains	BcY
		Delta plain	Upper delta plain	BdPu
	Eastern plateau	Chotanagpur plateau	Granite and gneiss landscape	EcG_{n}
			Dharwar landscape	EcW_{r}
			Gondwana landscape	EcG_{w}
	Himalayas and other mountain ranges	Eastern Himalayas	Hill and side slope	MeR

Gujarat

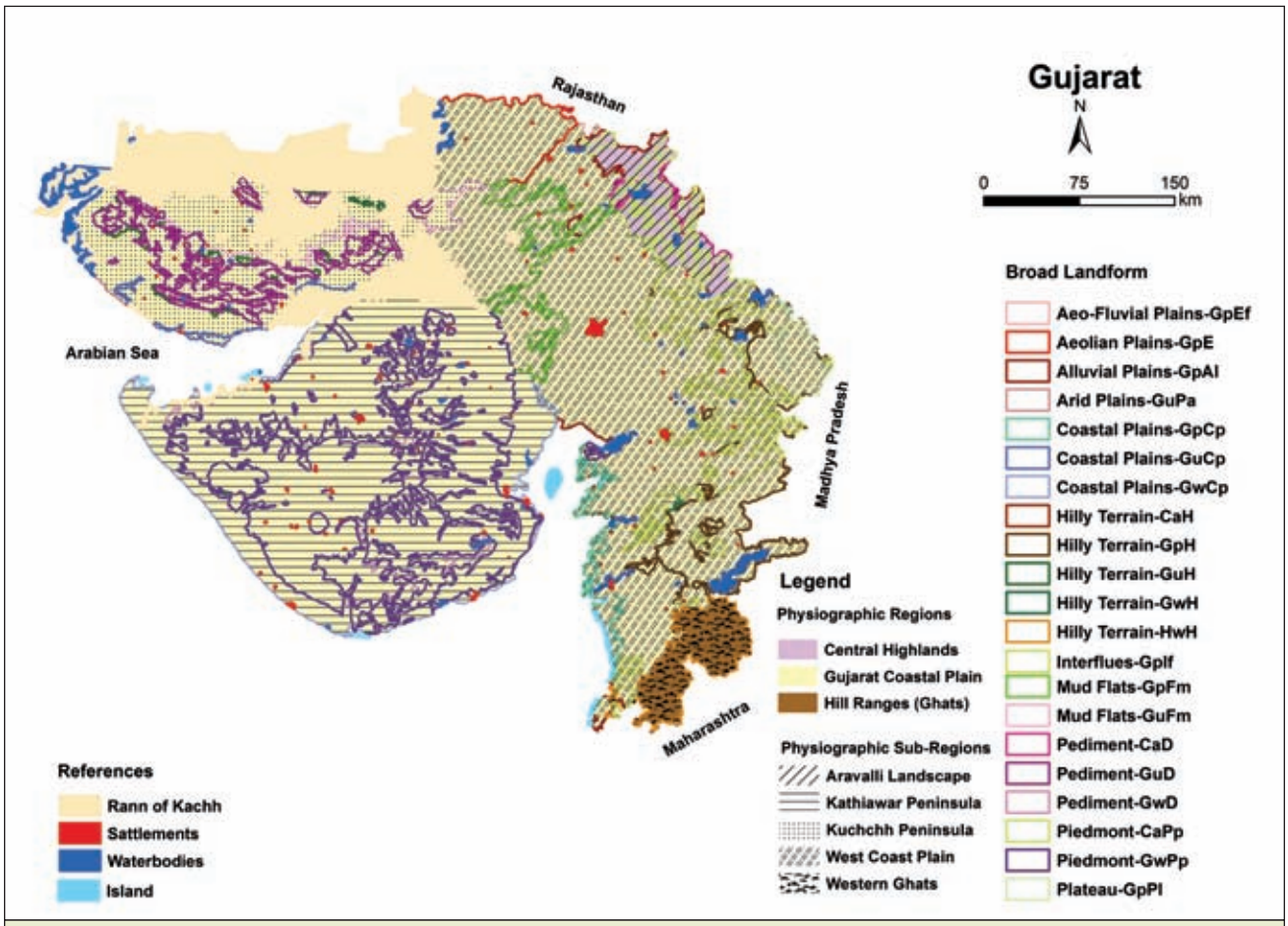


Fig. 2.1.1. Physiographic Regions, Sub-Regions and Broad Landforms, Gujarat

Uttar Pradesh

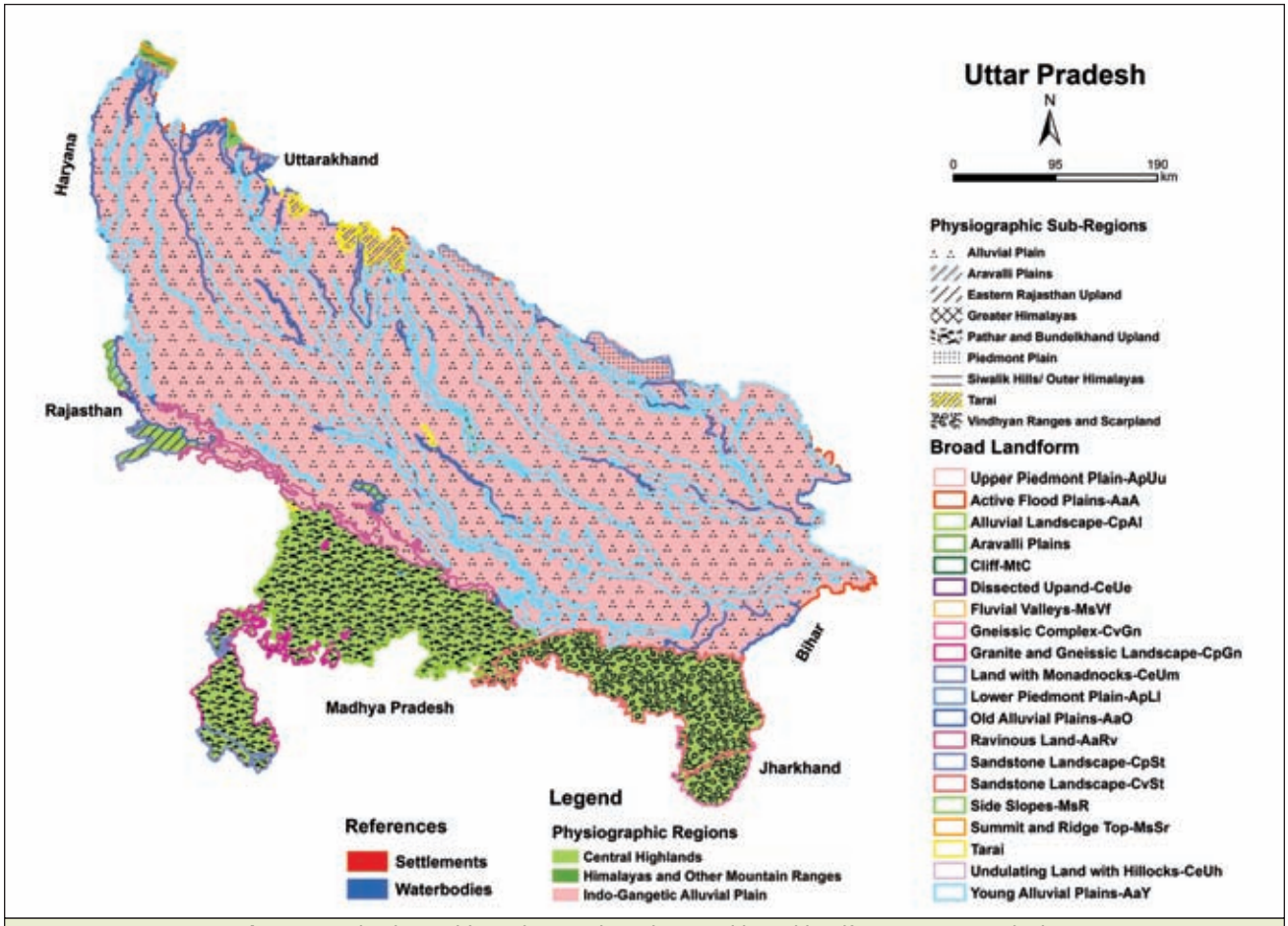


Fig. 2.1.2. Physiographic regions, sub-regions and broad landforms, Uttar Pradesh

Delineation of Landscape Ecological Unit (LEU) : Base map for Land Resource Inventory (LRI)

Soil survey is largely dependent on soil-landform relationship and the soil map represents the static soil properties, which are acquired after a series of climatic episodes. However, the present Land Resource Inventory (LRI) is basically meant for developing sustainable land use plan, which is dynamic and dependent on present climatic conditions and the prevailing soil forming processes. Therefore, landscape ecological unit (LEU) representing agro-ecosystem as a and whole is preferred over landform as the basis of mapping (Fig. 2.1.3). LEU is the assemblage of landform, slope and land use. Landform is the testimony of climatic events, whereas slope and land use represent the influence of present climatic conditions on the soil formation.

Input layer for LEU

Three secondary layers *i.e.* landform, slope and land use were integrated through the hierarchical object based segmentation algorithm taking into consideration the area, morphology of the landform units and its relation with the neighbouring objects to develop landscape ecological unit (LEU) map (Fig. 2.1.4). The segmentation was accomplished at three levels

- Level-I: First level segmentation was done based on the landform layer.
- Level-II: This segmentation was run within each of the 1st level segment based on fuzzy threshold based slope class. Second level intermediate output delineate to landform-slope unit.

Level-III: The landform-slope segments of 2nd level were further subdivided into landform-slope-land use unit *i.e.* LEU by incorporating the land use factor. The logic used to incorporate the land use factor is that the minimum overlap with the thematic polygon *i.e.* level-II segment will be more than or equal to 60%. The criteria ensure the continuity of LEU zone *vis-à-vis* soil boundary by ignoring negligible change in land use. After defining the unit consisting of landform, land use

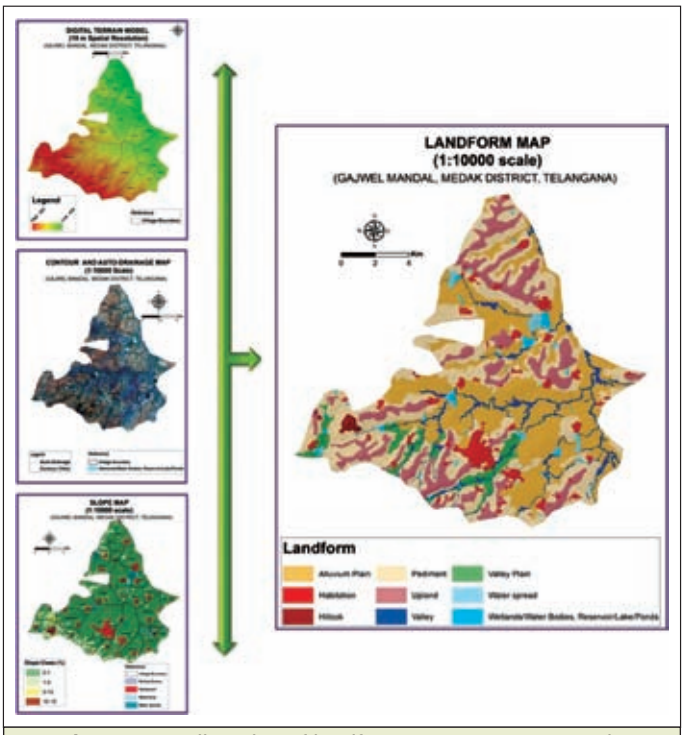


Fig. 2.1.3. Delineation of landform map at 1:10000 scale

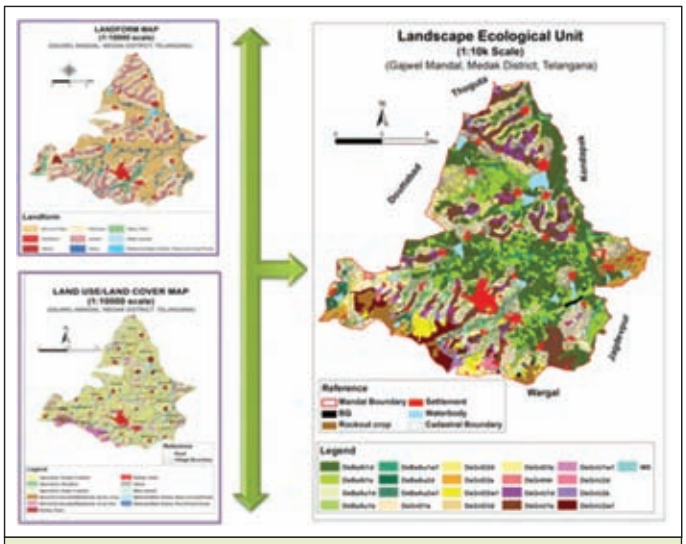


Fig. 2.1.4. Delineation of landscape ecological unit map

and slope, the unit is attached with the physiographic regions, sub-regions and broad landforms which are as defined in para 2.1. Thus LEU is designed using 5 letters and one numeral; first two letters represent physiographic regions and sub regions and third letter with super and subscript is devoted to broad landforms. Fourth letter is placed for landforms. Only numeral in the scheme is placed for slope class and last letter in the scheme is designed for land use and land cover. The complete representation of landscape ecological unit is given in Fig. 2.1.5. The block where the delineation is completed during the calendar year 2015-16, is reported in Fig. 2.1.6 to 2.1.29 and the description of the legend is presented in Tables 2.1.2 to 2.1.25.

Physiographic region	1st Letter
Physiographic sub-region	2nd Letter
Broad Landform	3rd Letter
Landform	4th Letter
Slope	5th Numeric
Land use	6th Letter

Fig. 2.1.5. Interpretation of landscape ecological unit map

(a) Western region:

Ankaleshwar taluk, Bharuch district, Gujarat (21°28' to 21°43' N and 72°50' to 73°8' E, 43600 hectare area, 59 villages)

Nine landscape ecological units (LEUs) have been delineated in the block, covering alluvial plains, interfluves and coastal plains within the physiographic region of Gujarat coastal plain and sub-physiographic region of west coast plain (Fig. 2.1.6 and Table 2.1.2).

Khedbramha taluk, Sabarkantha district, Gujarat (23°57' to 24°30' N and 72°53' to 73°13' E, 83540 hectare area, 135 villages)

Fifteen landscape ecological units (LEUs) representing hills, pediments and piedmont plain within the physiographic region of central highlands and sub-physiographic region of aravalli landscape (Fig. 2.1.7 and Table 2.1.3) have been delineated in the block.

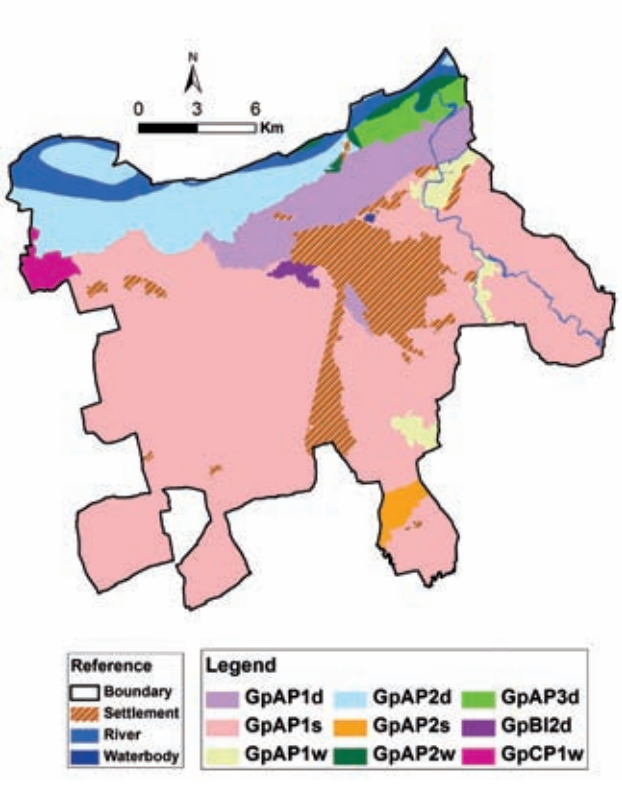


Fig. 2.1.6. Landscape ecological unit map, Ankaleswar taluk, Bharuch district, Gujarat

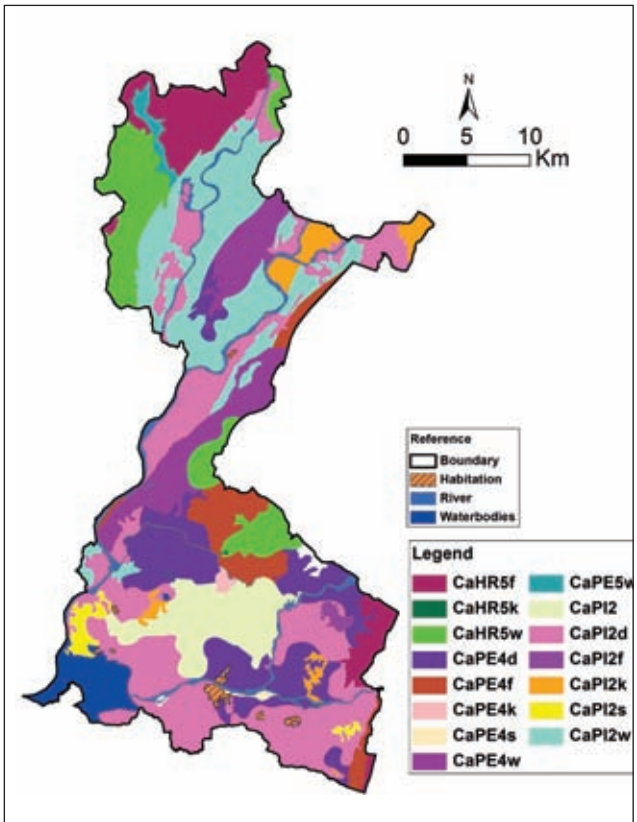


Fig. 2.1.7. Landscape ecological unit map, Khedbrahma taluk, Sabarkantha district, Gujarat

Table 2.1.2. Description of landscape ecological units, Ankaleshwar taluk, Bharuch district, Gujarat

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Gujarat coastal plain	West coast plain	Alluvial plain	GpAP1d	Nearly level alluvial plain (double crop)
			GpAP1s	Nearly level alluvial plain (single crop)
			GpAP1w	Nearly level alluvial plain (wasteland)
			GpAP2d	Very gently sloping alluvial plain (double crop)
			GpAP2s	Very gently sloping alluvial plain (single crop)
			GpAP2w	Very gently sloping alluvial plain (wasteland)
			GpAP3d	Gently sloping alluvial plain (double crop)
		Interflues	GpBI2d	Very gently sloping basaltic interfluves (double crop)
		Coastal plain	GpCP1W	Nearly level coastal Plain (wasteland)

Table 2.1.3. Description of landscape ecological units, Khedbrahma taluk, Sabarkantha district, Gujarat

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Central highlands	Aravalli landscape	Hilly terrain	CaHR5f	Moderately steep sloping hills and ridges (deciduous forest)
			CaHR5k	Moderately steep sloping hills and ridges (*kharif* crop)
			CaHR5w	Moderately steep sloping hills and ridges (wasteland)
		Pediment	CaPE4d	Moderately sloping pediment (double crop)
			CaPE4f	Moderately sloping pediment (deciduous forest)
			CaPE4k	Moderately sloping pediment (single crop)
			CaPE4s	Moderately sloping pediment (single crop)
			CaPE4w	Moderately sloping pediment (wasteland)
			CaPE5w	Moderately steep sloping pediment (wasteland)
		Piedmont	CaPI2s	Very gently sloping piedmont plain/alluvial plains (single crop)
			CaPI2d	Very gently sloping piedmont plain/alluvial plains (double crop)
			CaPI2f	Very gently sloping piedmont plain/alluvial plains (deciduous forest)
			CaPI2k	Very gently sloping piedmont plain/alluvial plains (*kharif* crop)
			CaPI2s	Very gently sloping piedmont plain/alluvial plains (single crop)
			CaPI2w	Very gently sloping piedmont plain/alluvial plains (wasteland)

Dholka taluk Ahmedabad district Gujarat (22⁰23' to 22⁰51' N and 72⁰08' to 72⁰34' E, 101940 ha area, 70 villages)

Deesa taluk, Banaskantha district, Gujarat (24°2'55" to 24°29'8" N and 71°47'47" to 72°18'21" E)

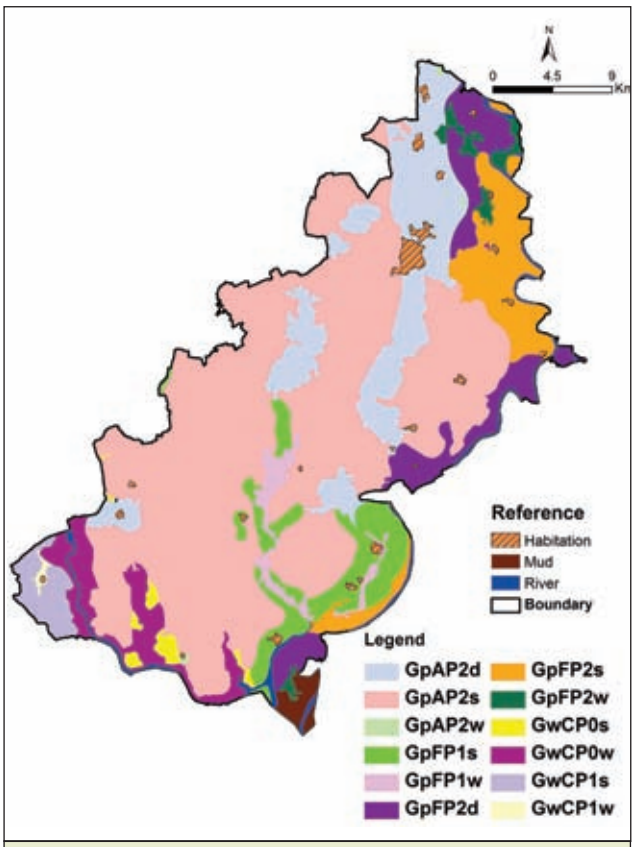


Fig. 2.1.8. Landscape ecological unit map, Dholka taluk, Ahmedabad district, Gujarat

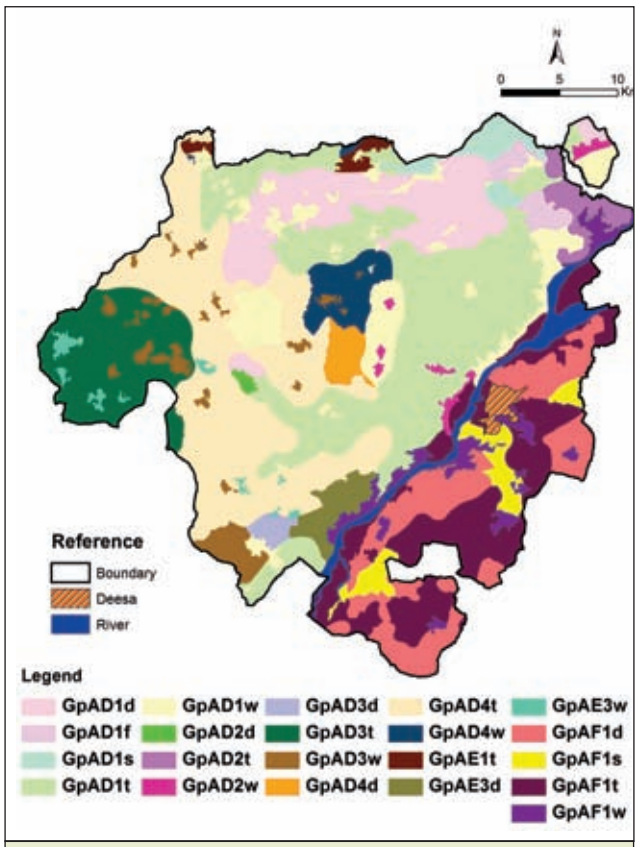


Fig. 2.1.9. Landscape ecological unit map, Deesa taluk, Banaskantha district, Gujarat

Twelve landscape ecological units (LEUs) have been marked within broad landforms of alluvial plains, flood plains and coastal plains, belonging to the physiographic region of Gujarat coastal plain and sub-physiographic region of west coast plain and Kathiawar peninsula (Fig. 2.1.8 and Table 2.1.4).

Twenty one landscape ecological units (LEUs) in aeolian and aeo-fluvial plains have been delineated. Deesa taluk belongs to the physiographic region of Gujarat coastal plain and sub-physiographic region of west coast plain (Fig. 2.1.9 and Table 2.1.5)

Table 2.1.4. Description of landscape ecological units, Dholka taluk, Ahmedabad district, Gujarat

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Gujarat coastal plain	West coast plain	Alluvial plain	GpAP2d	Very gently sloping alluvial plain (double crop)
			GpAP2s	Very gently sloping alluvial plain (single crop)
			GpAP2w	Very gently sloping alluvial plain (waste land)
		Flood plain	GpFP1s	Nearly level flood plain (single crop)
			GpFP1w	Nearly level flood plain (waste land)
			GpFP2d	Very gently sloping flood plain (double crop)
			GpFP2s	Very gently sloping flood plain (single crop)
			GpFP2w	Very gently sloping flood plain (waste land)
	Kathiawar peninsula	Coastal plain	GwCP0s	Low lying nearly level coastal plain (single crop)
			GwCP0w	Low lying nearly level coastal plain (wasteland)
			GwCP1s	Nearly level low lying coastal plain (single crop)
			GwCP1w	Nearly level low lying coastal plain (waste land)

Table 2.1.5. Description of landscape ecological units, Deesa taluk, Banaskantha district, Gujarat

Physiographic region	**Physiographic sub-region**	**Broad land-form**	**LEU**	**Description**
Gujarat coastal plain	West coast plain	Aeolian plain	GpAD1d	Nearly level aeolian plain with stabilized sand dunes (double crop)
			GpAD1f	Nearly level aeolian plain with stabilized sand dunes (fallow)
			GpAD1s	Nearly level aeolian plain with stabilized sand dunes (single crop)
			GpAD1t	Nearly level aeolian plain with stabilized sand dunes (more than two crops)
			GpAD1w	Nearly level aeolian plain with stabilized sand dunes (waste land)
			GpAD2d	Very gently sloping aeolian plain with stabilized sand dunes (double crop)
			GpAD2t	Very gently sloping aeolian plain with stabilized sand dunes (more than two crops)
			GpAD2w	Very gently sloping aeolian plain with stabilized sand dunes (waste land)
			GpAD3d	Gently sloping aeolian plain with stabilized sand dunes (double crop)
			GpAD3t	Gently sloping aeolian plain with stabilized sand dunes (more than two crops)
			GpAD3w	Gently sloping aeolian plain with stabilized sand dunes (waste land)
			GpAD4d	Moderately sloping aeolian plain with stabilized sand dunes (double crop)

Physiographic region	Physiographic sub-region	Broad land-form	LEU	Description
			GpAD4w	Moderately sloping aeolian plain with stabilized sand dunes (waste land)
			GpAE1t	Nearly level aeolian plain (more than two crops)
			GpAE3d	Gently sloping aeolian plain (double Crop)
			GpAE3w	Gently sloping aeolian plain (waste land)
		Aeo-fluvial plain	GpAF1d	Nearly level aeo-fluvial plain (double crop)
			GpAF1s	Nearly level aeo-fluvial plain (single Crop)
			GpAF1t	Nearly level aeo-fluvial plain (more than two crops)
			GpAF1w	Nearly level aeo-fluvial plain (waste land)

Porbandar taluk, Porbandar district, Gujarat (21°13'38" to 21°58'41" N and 69°22'57" to 70°1'43" E, 114330 hectare area)

Thirty five landscape ecological units (LEUs) within the broad landforms of marine ridges, beaches, coastal plains, hilly terrain and piedmont were delineated. The taluk belongs to the physiographic region of Gujarat coastal plain and sub-physiographic region of Kathiawar peninsula (Fig. 2.1.10 and Table 2.1.6).

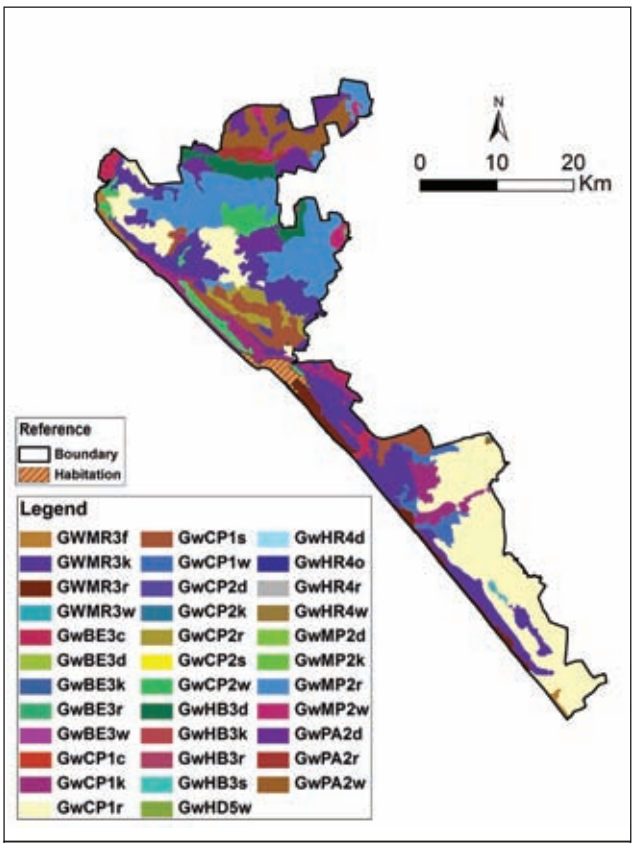


Fig. 2.1.10. Landscape ecological unit map, Porbandar taluk, Porbandar district, Gujarat

Rapar taluk, Kutch district, Gujarat (21°14' to 23°59' N and70°23' to 71°09' E, 2,95,000 ha area)

Twenty two landscape ecological units (LEUs) have been earmarked under the broad landforms of arid plains, arid plain with narrow valley, coastal plains, hilly terrain, mudflats, and pediments. Broad landform further grouped with the physiographic region of Gujarat coastal plain and sub-physiographic region of Kutch peninsula (Fig. 2.1.11 and Table 2.1.7).

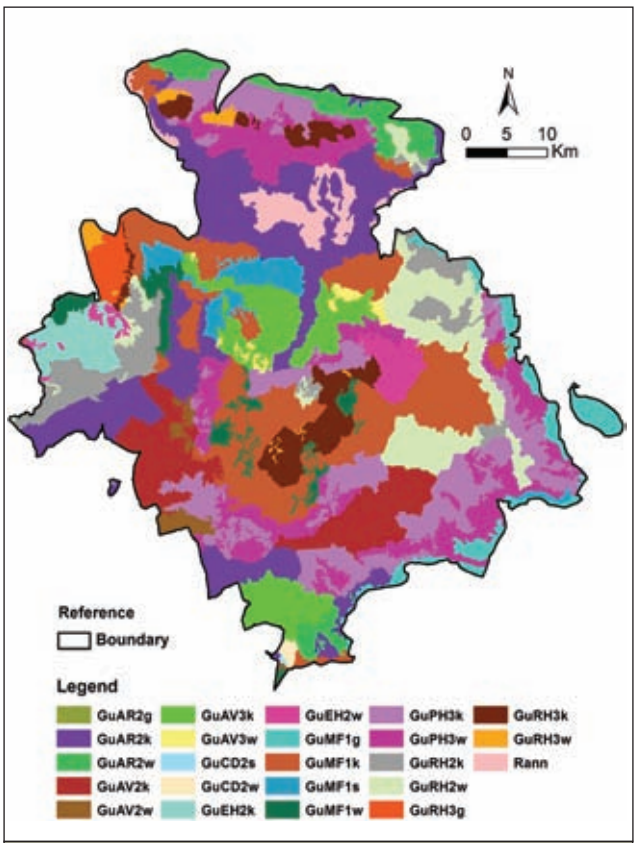


Fig. 2.1.11. Landscape ecological unit map, Rapar taluk, Kutch district, Gujarat

Table 2.1.6. Description of landscape ecological units, Porbandar taluk, Porbandar district, Gujarat

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Gujarat coastal plain	Kathiawar peninsula	Marine ridges	GwMR3f	Gently sloping coastal plain marine ridges (deciduous forest)
			GwMR3k	Gently sloping coastal plain marine ridges (*kharif* crop)
			GwMR3r	Gently sloping coastal plain marine ridges (*rabi* crop)
			GwMR3w	Gently sloping coastal plain marine ridges (waste land)
		Beaches	GwBE3c	Gently sloping beaches (current fallow)
			GwBE3d	Gently sloping beaches (double crop)
			GwBE3k	Gently sloping beaches (*kharif* crop)
			GwBE3r	Gently sloping beaches (*rabi* crop)
			GwBE3w	Gently sloping beaches (waste land)
		Coastal plain	GwCP1c	Nearly level coastal plain (current fallow)
			GwCP1k	Nearly level coastal plain (*kharif* crop)
			GwCP1r	Nearly level coastal plain (*rabi* crop)
			GwCP1s	Nearly level coastal plain (single crop)
			GwCP1w	Nearly level coastal plain (waste land)
			GwCP2d	Very gently coastal plain (double crop)
			GwCP2k	Very gently coastal plain (*kharif* crop)
			GwCP2r	Very gently coastal plain (*rabi* crop)
			GwCP2s	Very gently coastal plain (single crop)
			GwCP2w	Very gently coastal plain (waste land)
		Hilly terrain	GwHB3d	Gently sloping inter hilly basin (double crop)
			GwHB3k	Gently sloping inter hilly basin (*kharif* crop)
			GwHB3r	Gently sloping inter hilly basin (*rabi* crop)
			GwHB3s	Gently sloping inter hilly basin (single crop)
			GwHD5w	Moderately steep sloping domes (waste land)
			GwHR4d	Moderately sloping hills & ridges (double crop)
			GwHR4o	Moderately sloping hills & ridges (open scrub/grazing land)
			GwHR4r	Moderately sloping hills & ridges (*rabi* crop)
			GwHR4w	Moderately sloping hills & ridges (waste land)
		Piedmont	GwMP2d	Very gently sloping piedmont plain with mound (double crop)
			GwMP2k	Very gently sloping piedmont plain with mound (*kharif* crop)
			GwMP2r	Very gently sloping piedmont plain with mound (*rabi* crop)
			GwMP2w	Very gently sloping piedmont plain with mound (wasteland)
			GwPA2d	Very gently sloping piedmont alluvial plain with narrow valley (double crop)
			GwPA2r	Very gently sloping piedmont alluvial plain with narrow valley (*rabi* crop)
			GwPA2w	Very gently sloping piedmont alluvial plain with narrow valley (waste land)

Table 2.1.7. Description of landscape ecological units, Rapar taluk, Kutch district, Gujarat

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Gujarat coastal plain	Kutch peninsula	Arid plains	GuAR2g	Very gently sloping arid Plains (gullied/ravenous)
			GuAR2k	Very gently sloping arid Plains (*kharif* crop)
			GuAR2w	Very gently sloping arid Plains (waste land)
		Arid plains with narrow valley	GuAV2k	Very gently sloping arid plain with narrow valley (*kharif* crop)
			GuAV2w	Very gently sloping arid plain with narrow valley (waste land)
			GuAV3k	Gently sloping arid plain with narrow valley (kharif crop)
			GuAV3w	Gently sloping arid plain with narrow valley (waste land)
		Coastal plain	GuCD2s	Very gently sloping coastal plain with stabilized sand dunes (single crop)
			GuCD2w	Very gently sloping coastal plain with stabilized sand dunes (wasteland)
		Hilly terrain	GuEH2k	Very gently sloping elongated hills and ridges (*kharif* crop)
			GuEH2w	Very gently sloping elongated hills and ridges (waste land)
		Mudflats	GuMF1g	Nearly level mudflats (gullied/ravenous)
			GuMF1k	Nearly level mudflats (*kharif* crop)
			GuMF1s	Nearly level mudflats (single crop)
			GuMF1w	Nearly level mudflats (waste land)
		Pediment	GuPH3k	Gently sloping pediments with isolated hillocks (*kharif* crop)
			GuPH3w	Gently sloping pediments with isolated hillocks (waste land)
		Hilly terrain	GuRH2k	Very gently sloping residual hills (Kharif crop)
			GuRH2w	Very gently sloping residual hills (waste land)
			GuRH3g	Gently sloping residual hills (gullied/ravenous)
			GuRH3k	Gently sloping residual hills (*kharif* crop)
			GuRH3w	Gently sloping residual hills (waste land)
		Rann	Rann	Rann

b) Eastern region

Basudevpur block, Bhadrak district, Odisha (20°56'36" to 21°13'58" N and 86°38'32" to 86°54'47" E, area of 46702 hectare).

In Basudevpur block ten landscape ecological units (LEUs) have been identified within the broad landforms of coastal, old and young alluvial plains. These broad landforms are the part of physiographic region of coastal Plain and sub-physiographic region of east coast (Fig. 2.1.12 and Table 2.1.8).

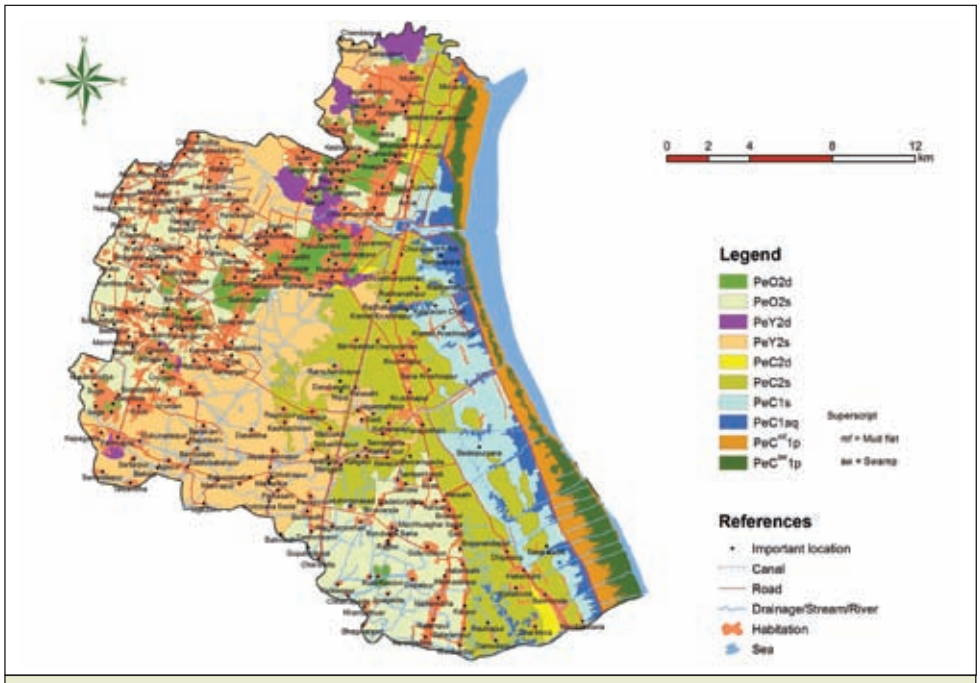


Fig. 2.1.12. Landscape ecological unit map, Basudevpur block, Bhadrak district, Odisha

Table 2.1.8. Description of landscape ecological units, Basudevpur block, Bhadrak, Odisha

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Coastal plain	East coast	Old alluvial plain	PeO2d	Very gently sloping old alluvial plain (double crops)
			PeO2s	Very gently sloping old alluvial plain (single crops)
		Coastal plain	PeC2d	Very gently sloping coastal plains (double crops)
			PeC2s	Very gently sloping coastal plains (single crops)
			PeC1s	Nearly level coastal plains (single crops)
			PeC1aq	Nearly level coastal plains (aqua culture)
			PeC1p	Nearly level coastal plains (plantation)
			PeC1p	Nearly level coastal plains (plantation)
		Young alluvial plain	PeY2d	Very gently sloping young alluvial plain (double crops)
			PeY2s	Very gently sloping young alluvial plain (single crops)

Mushahari block Muzaffarpur district, Bihar (26°02'30" to 26°1258"' N and 85°18'42" to 85°31'20" E, 19610 hectare area)

Thirty four landscape ecological units (LEUs) have been delineated in the block within broad landforms of old, active and young alluvial plains which are the constituents of Indo-Gangetic alluvial plain defined as assemblage of physiographic and sub-physiographic region (Fig. 2.1.13 and Table 2.1.9).

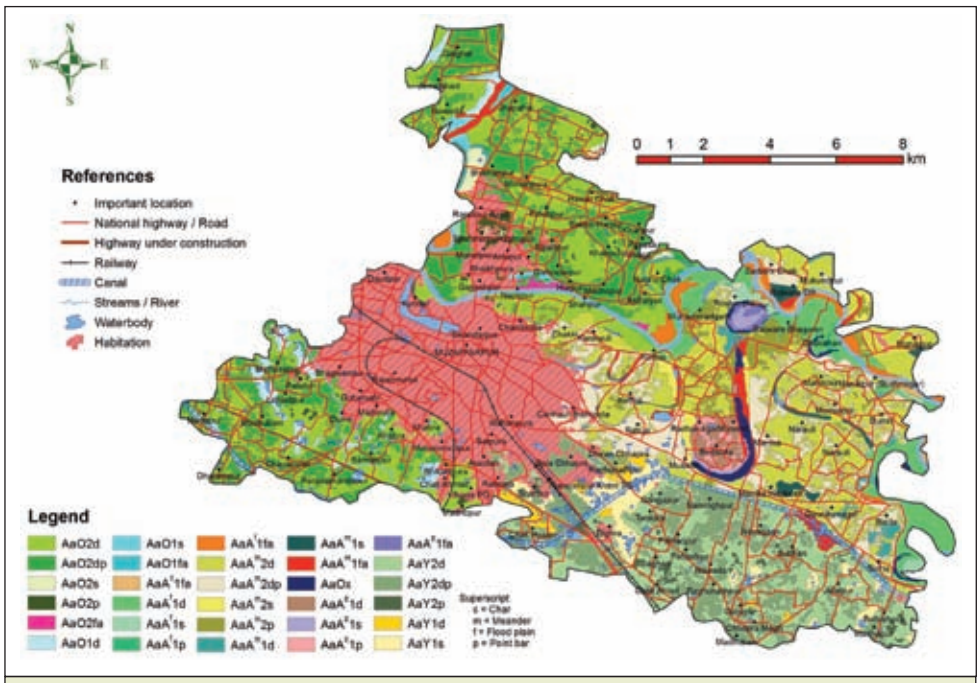


Fig. 2.1.13. Landscape ecological unit map, Mushahari block, Muzaffarpur district, Bihar

Table 2.1.9. Description of landscape ecological units, Mushahari block, Muzaffarpur district, Bihar

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Indo-Gangetic plain	Alluvial plain	Old alluvial plain	AaO2d	Very gently sloping old alluvial plain (double crops)
			AaO2dp	Very gently sloping old alluvial plain (double crop area with parcels of plantation)
			AaO2s	Very gently sloping old alluvial plain (single crops)
			AaO2p	Very gently sloping old alluvial plain (plantation)
			AaO2fa	Very gently sloping old alluvial plain (fallow land)
			AaO1d	Nearly level old alluvial plain (double crops)
			AaO1s	Nearly level old alluvial plain (single crops)
			AaO1fa	Nearly level old alluvial plain (fallow land)
			AaOx	Ox bow lake
		Active alluvial plains	$AaA^{c}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{f}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{m}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{m}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{m}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{p}1fa$	Nearly level active alluvial plains (fallow)
			$AaA^{f}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{m}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{m}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{p}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{f}1s$	Nearly level active alluvial plains (single crops)
			$AaA^{m}1s$	Nearly level active alluvial plains (single crops)
			$AaA^{m}1s$	Nearly level active alluvial plains (single crop)
			$AaA^{p}1s$	Nearly level active alluvial plains (single crop)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
			$AaA^{f}1p$	Nearly level active alluvial plains (plantation)
			$AaA^{m}2d$	Very gently sloping active alluvial plains (double crops)
			$AaA^{m-}2dp$	Very gently sloping active alluvial plains (double crop area with parcels of plantation)
			$AaA^{m}2s$	Very gently sloping active alluvial plains (single crops)
			$AaA^{m}2p$	Very gently sloping active alluvial plains (plantation)
			$AaA^{p}1p$	Nearly level active alluvial plains (plantation)
		Young alluvial plain	AaY2d	Very gently sloping young alluvial plain (double crops)
			AaY2p	Very gently sloping young alluvial plain (plantation)
			AaY2dp	Very gently sloping young alluvial plain (double crop area with parcels of plantation)
			AaY1d	Nearly level young alluvial plain (double crops)
			AaY1s	Nearly level young alluvial plain (single crop)

Note - ^{c}-char land, ^{f}-flood plains, ^{m}-meander plains, ^{p}- point bars

Kadwa block, Katihar district, Bihar (25°30' to 25°47' N and 87°35' to 87°55' E, 34047 hectare, 263 villages)

In Kadwa block, sixteen landscape ecological units (LEUs) are identified covering the broad landforms classified as old, young and active plains. Block represents Indo-Gangetic alluvial plain (Fig. 2.1.14 and Table 2.1.10).

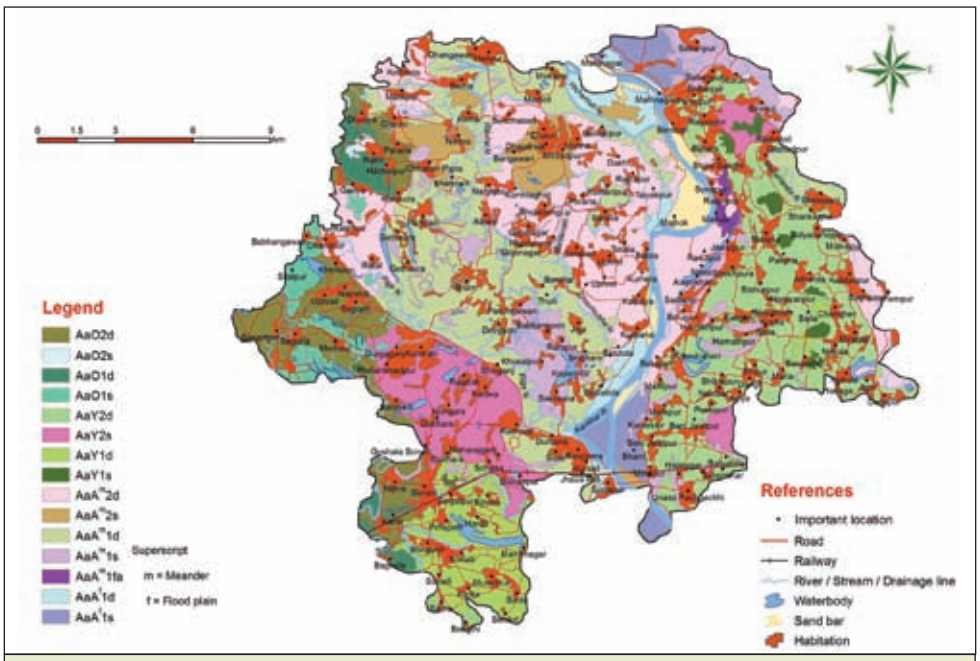


Fig. 2.1.14. Landscape ecological unit map, Kadwa block, Katihar district, Bihar

Table 2.1.10. Description of landscape ecological units, Kadwa block, Katihar district, Bihar

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Indo-Gangetic plain	Alluvial plain	Old alluvial plain	AaO2d	Very gently sloping old alluvial plain (double crops)
			AaO2s	Very gently sloping old alluvial plain (single crops)
			AaO1d	Nearly level old alluvial plain (double crops)
			AaO1s	Nearly level old alluvial plain (single crops)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
		Active alluvial plain	$AaA^{f}1fa$	Nearly level active alluvial plains (fallow land)
			$AaA^{f}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{m}1d$	Nearly level active alluvial plains (double crops)
			$AaA^{f}1s$	Nearly level active alluvial plains (single crops)
			$AaA^{m}1s$	Nearly level active alluvial plains (single crops)
			$AaA^{m}1s$	Nearly level active alluvial plains (single crop)
			$AaA^{m}2d$	Very gently sloping active alluvial plains (double crops)
			$AaA^{m}2s$	Very gently sloping active alluvial plains (single crops)
		Young alluvial plain	AaY2d	Very gently sloping young alluvial plain (double crops)
			AaY2s	Very gently sloping young alluvial plain (single crops)
			AaY1d	Nearly level young alluvial plain (double crops)
			AaY1s	Nearly level young alluvial plain (single)

Note - ^{c}-char land, ^{f}-flood plains, ^{m}-meander plains, ^{p}- point bars

Ganjam block, Ganjam district, Odisha (19°22'07" to 19°32'24" N , 84°58'04" to 85°10'30" E, 21104 hectare area and 114 villages)

Thirty two landscape ecological units (LEUs) have been delineated in the block within nine broad landform units, which are denuded hills, residual hills, foothill, pediments, valley, upland, old and young alluvial plains and coastal plains. LEUs together with broad landforms are the constituents of east coast of Odisha coastal plains (Fig. 2.1.15 and Table 2.1.11).

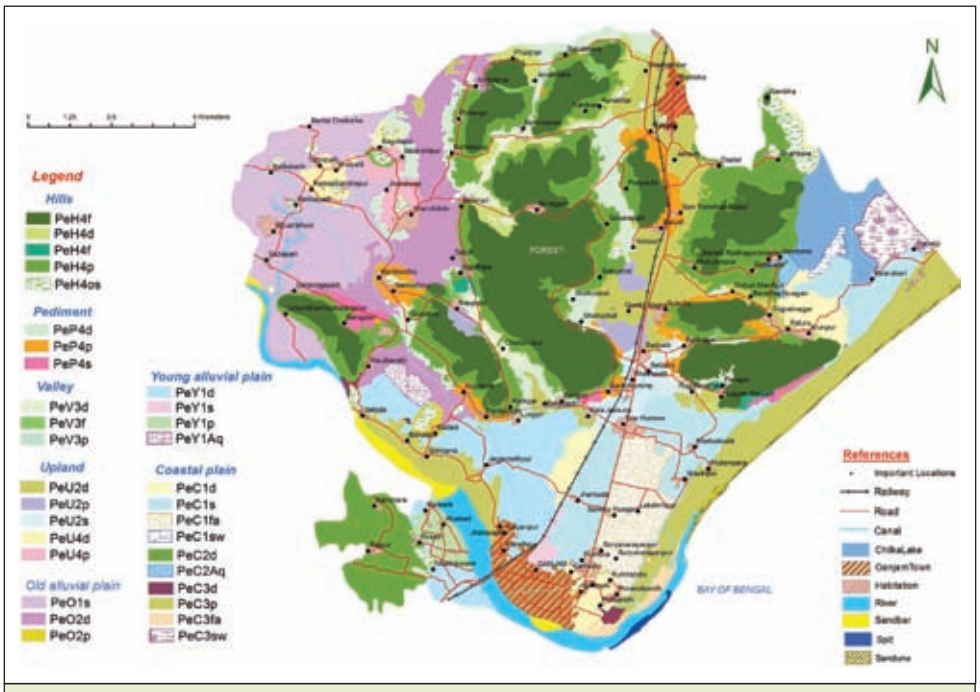


Fig. 2.1.15. Landscape ecological unit map, Ganjam block, Ganjam district, Odisha

Table 2.1.11. Description of landscape ecological units, Ganjam block, Ganjam district, Odisha

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Coastal plain	East coast	Denudational hills	PeH4f	Moderately sloping denudational hills (forest)
		Residual hills	PeH4os	Moderately sloping residual hills(Open scrub)
		Foothills	PeH4f	Moderately sloping foothill (forest)
			PeH4d	Moderately sloping foothill (double crop)
			PeH4p	Moderately sloping foothill (plantation)
		Valley	PeV3f	Gently sloping valley (forest)
			PeV3d	Gently sloping valley (double crop)
			PeV3p	Gently sloping valley (plantation)
		Pediment	PeP4p	Moderately sloping pediment (plantations)
			PeP4s	Moderately sloping pediment (single crop)
			PeP4d	Moderately sloping pediment (double crop)
		Upland	PeU4d	Moderately sloping upland (double crop)
			PeU4P	Moderately sloping upland (plantations)
			PeU2s	Very gently sloping upland (single crop)
			PeU2d	Very gently sloping upland (double crop)
			PeU2p	Very gently sloping upland (plantation)
		Old alluvial plain	PeO2d	Very gently sloping old alluvial plain (double crop)
			PeO2p	Very gently sloping old alluvial plain (plantation)
			PeO1s	Nearly level old alluvial plain (single crop)
		Young alluvial plains	PeY1d	Nearly level young alluvial plains (double crop)
			PeY1s	Nearly level young alluvial plains (single crop)
			PeY1p	Nearly level young alluvial plains (plantation)
		Coastal plain	PeC3d	Gently sloping coastal plain (double crop)
			PeC3p	Gently sloping coastal plain (plantation)
			PeC3fa	Gently sloping coastal plain (fallow)
			PeC3sw	Gently sloping coastal plain (swamp)
			PeC2d	Very gently sloping coastal plain (double crop)
			PeC2Aq	Very gently sloping coastal plain (aquaculture)
			PeC1d	Nearly level coastal plain (double crop)
			PeC1s	Nearly level coastal plain (single crop)
			PeC1fa	Nearly level coastal plain (fallow)
			PeC1sw	Nearly level coastal plain (swamp)

Titlagarh block, Bolangir district, Odisha (20°10'02" to 21°04'38"N, 82°40'52" to 83°40'33"E longitude, 34931 hectare area, 148 villages)

In Titlagarh block, thirty two landscape ecological units (LEUs) have been identified within the broad landforms consisting of denuded hills, residual hills, pediment, upland, valley, young and old alluvial plains. These are the part of eastern plateau and Mahanadi basin, which are classified as physiographic and sub-phsiographic regions, respectively (Fig. 2.1.16 and Table 2.1.12).

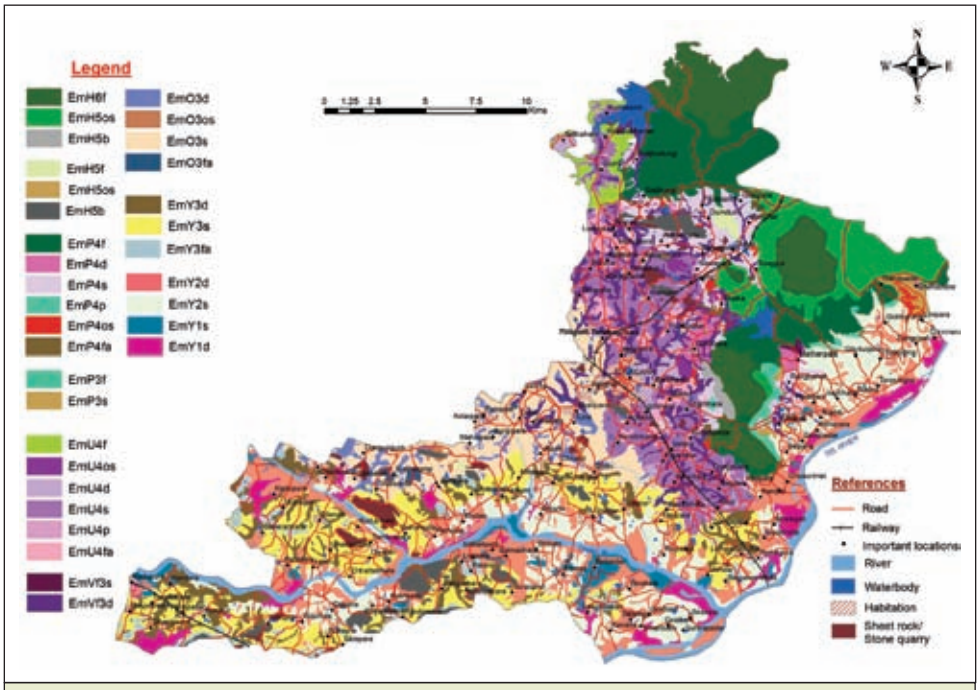


Fig. 2.1.16. Landscape ecological unit map, Titlagarh block, Bolangir district, Odisha

Table 2.1.12. Description of landscape ecological units, Titlagarh block, Bolangir districts, Odisha

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Eastern plateau	Mahanadi basin	Denudational hills	EmH6f	Steeply sloping denudational hills (forest)
			EmH5os	Moderately steeply sloping denudational hills (open scrub)
			EmH5b	Moderately steeply sloping denudational hills (barren)
		Residual hills	EmH5f	Moderately steeply sloping residual hills (forest)
			EmH5b	Moderately steeply sloping residual hills (barren)
			EmH4os	Moderately sloping residual hills (open scrub)
		Pediment	EmP4f	Moderately sloping pediment (forest)
			EmP4p	Moderately sloping pediment (plantation)
			EmP4s	Moderately sloping pediment (single crop)
			EmP4d	Moderately sloping pediment (double crop)
			EmP4os	Moderately sloping pediment (open scrub)
			EmP4fa	Moderately sloping pediment (fallow)
			EmP3f	Gently sloping pediment (forest)
			EmP3s	Gently sloping pediment (single crop)
		Upland	EmU4f	Moderately sloping upland (forest)
			EmU4p	Moderately sloping upland (plantation)
			EmU4fs	Moderately sloping upland (single crop)
			EmU4d	Moderately sloping upland (double crop)
			EmU4os	Moderately sloping upland (open scrub)
			EmU4fa	Moderately sloping upland (fallow)
		Valley	EmUv3d	Gently sloping valley fill (double crop)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
		Old alluvial plain	EmO3s	Gently sloping old alluvial plain (single crop)
			EmO3d	Gently sloping old alluvial plain (double crop)
			EmO3os	Gently sloping old alluvial plain (open scrub)
			EmO3fa	Gently sloping old alluvial plains (fallow)
		Young alluvial plain	EmY3s	Gently sloping young alluvial plain (single crop)
			EmY3d	Gently sloping young alluvial plain (double crop)
			EmY3fa	Gently sloping young alluvial plain (fallow)
			EmY2s	Very gently sloping young alluvial plains (single crop)
			EmY2d	Very gently sloping young alluvial plains (double crop)
			EmY1s	Nearly level young alluvial plains (single crop)
			EmY1d	Nearly level young alluvial plains (double crop)

Rajnagar block, Birbhum district, West Bengal (23°52'12.1' N to 24°02'43.8' N and 87°14'04.6' E to 87°27'46.9' E, 22,147 hectare area, 99 villages)

Rajnagar block belongs to the physiographic region of eastern plateau and sub-physiographic region of Chhotanagpur plateau. Based on the landforms slope and land uses thirty eight landscape ecological units (LEUs) have been delineated within the broad landforms of granitic and granite gneiss complexes (Fig. 2.1.17 and Table 2.1.13).

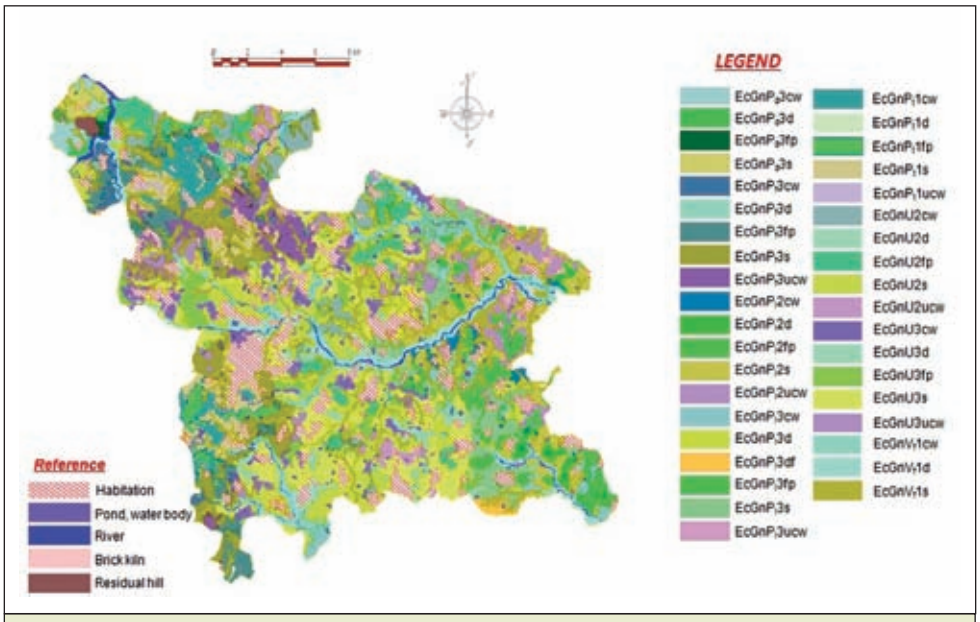


Fig. 2.1.17. Landscape ecological unit map of Rajnagar block, Birbhum district, West Bengal

Table 2.1.13. Description of landscape ecological units, Rajnagar block, Birbhum district, West Bengal

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Eastern plateau	Chhotanagpur plateau	Granite and gneissic complex	EcGnPd2fp	Dissected plateau (forest plantation)
			EcGnPd2s	Dissected plateau (single crop)
			EcGnPd2d	Dissected plateau (double crop)
			EcGnPd2cw	Dissected plateau (culturable waste land)
			EcGnPt1fp	Plateau top (forest plantation)
			EcGnPt1s	Plateau top (single crop)
			EcGnPt1d	Plateau top (double crop)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
			EcGnPt1cw	Plateau top (culturable waste land)
			EcGnPt1ucw	Plateau top (unculturable waste land)
			EcGnPf3fp	Plateau fringe (forest plantation)
			EcGnPf3s	Plateau fringe (single crop)
			EcGnPf3d	Plateau fringe (double crop)
			EcGnPf3cw	Plateau fringe (culturable waste land)
			EcGnPf3ucw	Plateau fringe (unculturable waste land)
			EcGnU3fp	Gently sloping undulating upland (forest plantation)
			EcGnU3s	Gently sloping undulating upland (single crop)
			EcGnU3d	Gently sloping undulating upland (double crop)
			EcGnU3cw	Gently sloping undulating upland (culturable waste land)
			EcGnU3ucw	Gently sloping undulating upland (unculturable waste land)
			EcGnU2fp	Very gently sloping undulating upland (forest plantation)
			EcGnU2s	Very gently sloping undulating upland (single crop)
			EcGnU2d	Very gently sloping undulating upland (double crop)
			EcGnU2cw	Very gently sloping undulating upland (culturable waste land)
			EcGnU2ucw	Very gently sloping undulating upland (unculturable waste land)
			EcGnPl3fp	Gently sloping undulating plain (forest plantation)
			EcGnPl3s	Gently sloping undulating plain (single crop)
			EcGnPl3d	Gently sloping undulating plain (double crop)
			EcGnPl3cw	Gently sloping undulating plain (culturable waste land)
			EcGnPl3ucw	Gently sloping undulating plain (unculturable waste land)
			EcGnPl3df	Very gently sloping undulating plain (degraded forest)
			EcGnPl2fp	Very gently sloping undulating plain (forest plantation)
			EcGnPl2s	Very gently sloping undulating plain (single crop)
			EcGnPl2d	Very gently sloping undulating plain (double crop)
			EcGnPl2cw	Very gently sloping undulating plain (culturable waste land)
			EcGnPl2ucw	Very gently sloping undulating plain (unculturable waste land)
			EcGnVf1s	Valley fill (single crop)
			EcGnVf1d	Valley fill (double crop)
			EcGnVf1cw	Valley fill (culturable waste land)

C) Southern region:

Gajwel mandal, Medak district, Telangana (17°47'21"to17°58'35" N and 78°34'53"to 78°47'23" E, 21168 hectare area)

Gajwel mandal in Medak district of Telangana state is a part of south Deccan plateau, representing basaltic and granitic gneiss landscapes. Mandal is divided into twenty two landscape ecological units (LEUs) based on landforms, slope and land uses (Fig.2.1.18 and Table 2.1.14).

Thimmajipet mandal, Mahabubnagar district, Telangana (16°35'01"to 16°44'38" N, and78°07'38" to 78°18'38" E, 21579 ha area)

Thimmajipet mandal in south Deccan plateau is another representative of basaltic and granitic landscape and is classified into sixteen LEUs depending on landforms, slope and land use (Fig. 2.1.19 and Table 2.1.15).

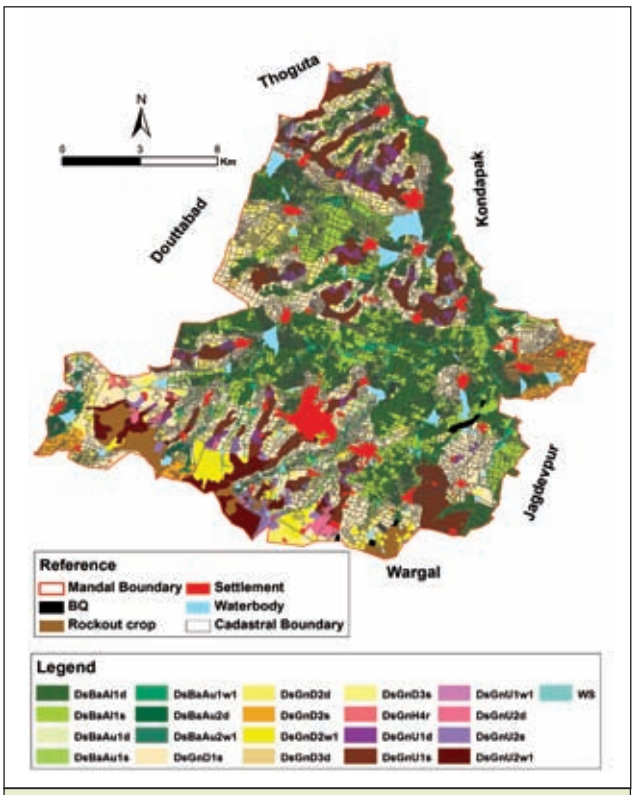


Fig. 2.1.18. Landscape ecological unit map of Gajwel mandal, Medak district, Telangana

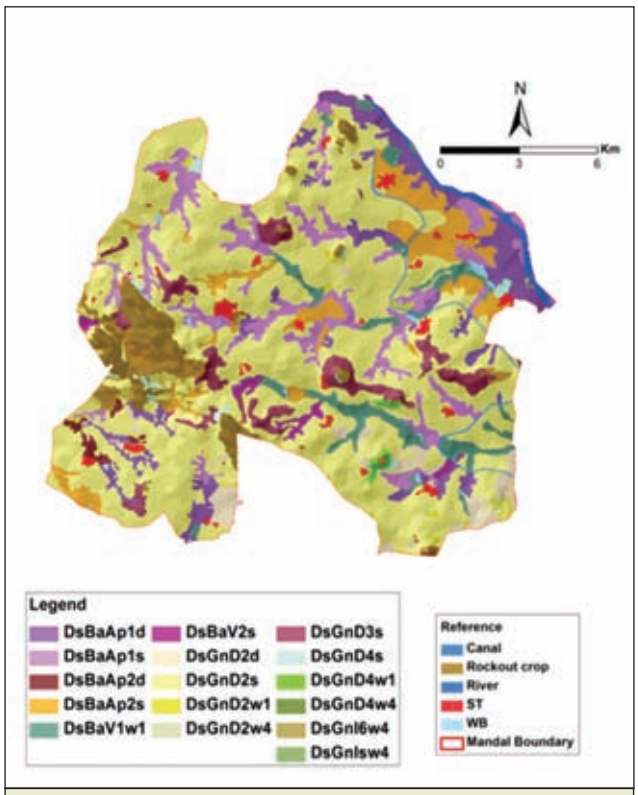


Fig. 2.1.19. Landscape ecological unit map of Thimmajipet mandal, Mahabubnagar district, Telangana

Table 2.1.14. Description of landscape ecological units, Gajwel mandal, Medak district, Telangana

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Deccan plateau	South Deccan plateau	Granite & gneissic complex	DsGnH4r	Isolated Hillock with pediment (rocky)
			DsGnD3s	Gently sloping pediment (single crop)
			DsGnD3d	Gently sloping pediment (double crop)
			DsGnD2s	Very gently sloping pediment (single crop)
			DsGnD2w1	Very gently sloping pediment (waste land /open scrub)
			DsGnD1s	Nearly level pediment (single crop)
			DsGnD2d	Very gently sloping pediment (double crop)
			DsGnU2s	Very gently sloping upland (single crop)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
			DsGnU2w1	Very gently sloping upland (waste land /open scrub)
			DsGnU2d	Very gently sloping upland (double crop)
			DsGnU1s	Nearly level upland (single crop)
			DsGnU1d	Nearly level upland (double crop)
			DsGnU1w1	Nearly level upland (waste land /open scrub)
		Basaltic complex	DsB_aA_u1s	Nearly level upper alluvial plain (single crop)
			DsB_aA_u2w1	Nearly level upper alluvial plain (waste land / open scrub)
			DsB_aA_u1d	Nearly level upper alluvial plain (double crop)
			DsB_aA_u1w1	Nearly level upper alluvial plain (waste land / open scrub)
			DsB_aA_u 2d	Nearly level upper alluvial plain (double crop)
			DsB_aA_l 1d	Nearly level lower alluvial plain (double crop)
			DsB_aA_l 1s	Nearly level lower alluvial plain (single crop)

Table 2.1.15. Description of landscape ecological units, Thimmajipet mandal, Mahabubnagar district, Telangana

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Deccan plateau	South Deccan plateau	Granite and gneissic complex	DsGnI6w4	Isolated hillock (rocky waste land)
			DsGnI5w4	Isolated hillock (rocky waste land)
			DsGnD4w4	Moderately sloping pediment (rocky waste land)
			DsGnD4w1	Moderately sloping pediment (waste land)
			DsGnD4s	Moderately sloping pediment (single crop)
			DsGnD3s	Gently sloping pediment (single crop)
			DsGnD2w4	Very gently sloping pediment (rocky waste land)
			DsGnD2w1	Very gently sloping pediment (waste land)
			DsGnD2s	Very gently sloping pediment (single crop)
			DsGnD2d	Very gently sloping pediment (double crop)
		Basaltic complex	DsBaAp1d	Nearly level alluvial plains (double crop)
			DsBaAp1s	Nearly level alluvial plains (single crop)
			DsBaAp2d	Very gently sloping alluvial plains (double crop)
			DsBaAp2s	Very gently sloping alluvial plains (single crop)
			DsBaV2s	Very gently sloping valley (single crop)
			DsBaV2w1	Very gently sloping valley (waste land)

Indervalle mandal, Adilabad district, Telangana (19°22'36"to 19°34'12" N and 78°32'58"to 78°46'10" E, 23081 hectare area)

Indervalle mandal of Adilabad district in the state of Telangana is representative block of basaltic landscape of south Deccan plateau and is classified into twenty one LEUs (Fig. 2.1.20 and Table 2.1.16).

D) Northern region:

Jagner block, Agra district, Uttar Pradesh ($26^0$44' to $26^0$59' N and $77^0$25' to $77^0$45' E, 29371 hectare area, 52 villages)

Jagner block of Kheragarh tehsil in Agra district, Uttar Pradesh represents fringes of Aravalli landscape in the physiographic region of central highland (Indo-Gangetic alluvial plains). Based on the landforms, slope and land uses, hills, piedmont and old alluvial plains are further classified into eleven landscape ecological units (LEUs) (Fig. 2.1.21 and Table 2.1.17).

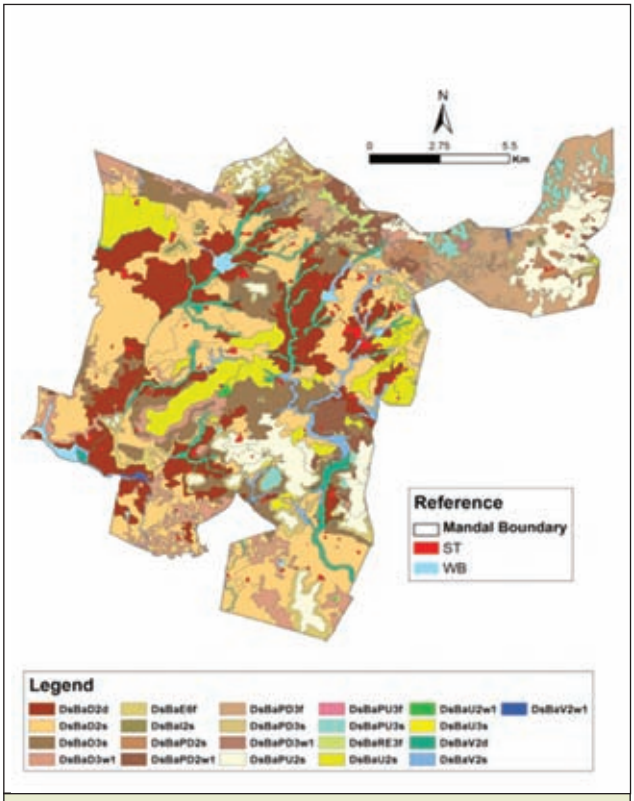


Fig. 2.1.20. Landscape ecological unit map, Indervalle mandal, Adilabad district, Telangana

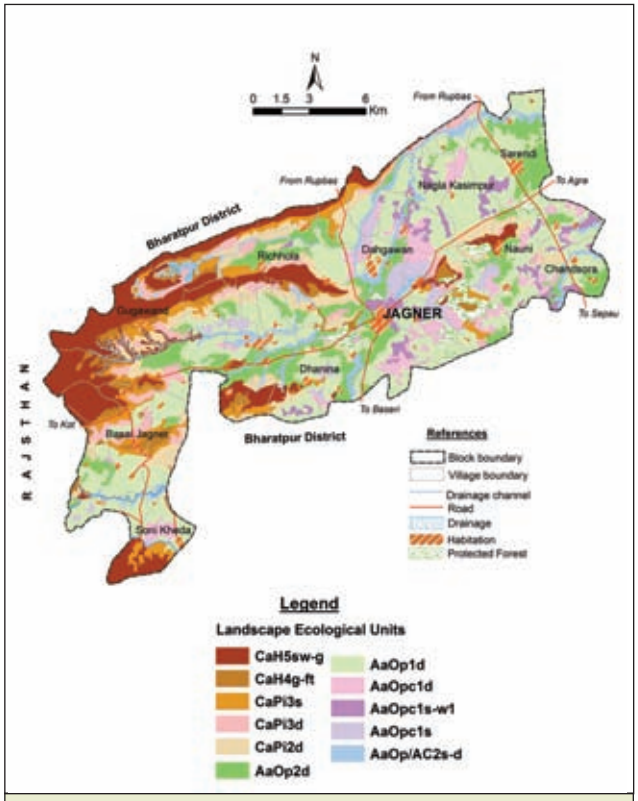


Fig. 2.1.21. Landscape ecological unit map, Jagner block, Agra district, Uttar Pradesh

Table 2.1.16. Description of landscape ecological units, Indervalle mandal, Adilabad district, Telangana

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Deccan plateau	South Deccan plateau	Basaltic complex	DsBaD2d	Very gently sloping pediment (double crop)
			DsBaD2s	Very gently sloping pediment (single crop)
			DsBaD3s	Gently sloping pediment (single crop)
			DsBaD3w1	Gently sloping pediment (waste land)
			DsBaE6f	Strongly sloping escarpment (forest)
			DsBaI2s	Very gently sloping isolated hillocks (single crop)
			DsBaPD2s	Very gently sloping dissected plateau (single crop)
			DsBaPD2w1	Very gently sloping dissected plateau (waste land)
			DsBaPD3f	Gently sloping dissected plateau (forest)
			DsBaPD3s	Gently sloping dissected plateau (single crop)
			DsBaPD3w1	Gently sloping dissected plateau (waste land)
			DsBaPU2s	Very gently sloping undissected plateau (single crop)
			DsBaPU3f	Gently sloping undissected plateau (forest)
			DsBaPU3s	Gently sloping undissected plateau (single crop)
			DsBaRE3f	Gently sloping reposed slope (forest)
			DsBaU2s	Very gently sloping upland (single crop)
			DsBaU2w1	Very gently sloping upland (waste land)
			DsBaU3s	Gently sloping upland (single crop)
			DsBaV2d	Very gently sloping valley (double crop)
			DsBaV2s	Very gently sloping valley (single crop)
			DsBaV2w1	Very gently sloping valley (waste land)

Table 2.1.17. Description of landscape ecological units, Jagner block, Agra district, Uttar Pradesh

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Central highlands	Aravalli plains	Hill slopes	CaH4sw-g	Strongly sloping hill slopes (stony waste/rocky waste and pasture/ grazing land)
			CaH4g-ft	Moderately sloping hill slopes (pasture and grazing land / thin bushy forest)
		Piedmont plain	CaPi3s	Gently sloping upper piedmont plain (single crop)
			CaPi3d	Gently sloping middle piedmont plain (double crop)
			CaPi2d	Very gently sloping lower piedmont plain (double crop)
		Old alluvial plain	AaOp2d	Very gently sloping old alluvial plain (double crop)
			AaOp1d	Level to nearly level old alluvial plain (double crop)
			AaOpc1d	Level old alluvial plain with concave relief (double crop) (with moderate salinity/sodicity)
			AaOpc1s-w1	Level old alluvial plain with concave relief (single crop – cultivation in patches and waste land intermittently)
			AaOpc1s	Level old alluvial plain with concave relief (single crop) (with slight salinity and moderate flooding
			AaOp/Ac3s-d	Gently to very gently sloping old alluvial plain with abandoned channels/fluvial channels (double crop/ single crop)

Baragaon block, Varanasi district, Uttar Pradesh (25°23'0" to 25°34'47"N and 82°39'50" to 82050'15"E, 17433 hectares area)

Baragaon block in Varanasi district of Uttar Pradesh represents of alluvial plains of Indo-Gangetic plains and is classified into three broad landforms namely upland, old alluvial plains and river terraces. Based on landforms, land uses and slope class, the broad landforms further classified into twelve landscape ecological units (LEUs) (Fig. 2.1.22 and Table 2.1.18).

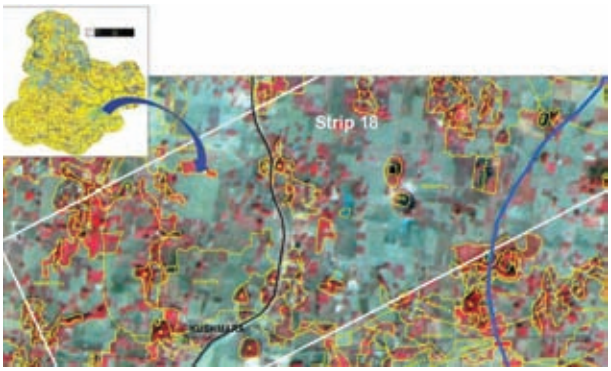


Fig. 2.1.22. Landscape ecological unit map, Baragoan block, Varanasi district , Uttar Pradesh

Chamba block, Tehri Garhwal district, Uttarakhand (30°8'52" to 30°24'32" N and 78°15'22" to 78°36'21" E, 16256 hectare area, 221 villages)

Chamba block, Tehri Garhwal district in the state of Uttarakhand represents side slopes and glacio-fluvial valley in Lesser Himalaya of Himalayan mountainous region of the country. Side slopes and glacio-fluvial valley have been divided into fourteen landscape ecological units (LEUs) depending upon landforms, slope and land uses (Fig. 2.1.23 and Table 2.1.19).

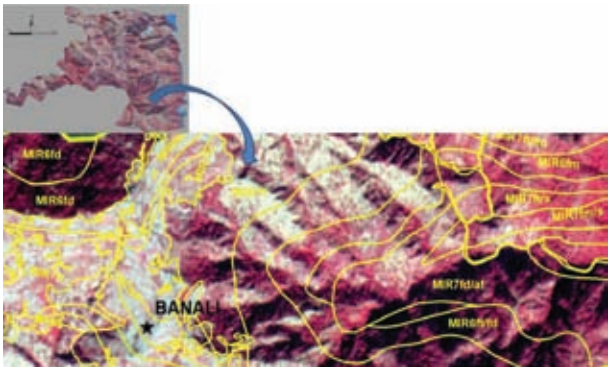


Fig. 2.1.23. Landscape ecological unit map of Chamba block, Tehri Garhwal district, Uttarakhand

Table 2.1.18. Description of landscape ecological units, Baragoan block, Varanasi district, Uttar Pradesh

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Indo-Gangetic plain	Alluvial plain	Upland	AaUp3s	Gently sloping upland plain (single crop)
			AaUp2fa	Very gently sloping lower piedmont plain (fallow land)
			AaUp2d	Very gently sloping upland plain (double crop)
		Old alluvial plain	AaOp2s	Very gently sloping old alluvial plain (single crop)
			AaOp2p	Very gently sloping old alluvial plain (plantation)
			AaOp1d	Level to nearly level old alluvial plain (double crop)
			AaOpc1d	Undulating middle old alluvial plain with concave relief (double crop)
			AaOpc1s	Undulating lower old alluvial plain with concave relief (single crop) (with salt affected soils)
			AaOpc1s-w1	Undulating lower old alluvial plain with concave relief (single crop and waste land intermittently)
		River terraces	AaY2 s/w	Very gently sloping upper river terraces (single crop and waste land intermittently)
			AaY1w	Very gently to nearly level lower river terraces /flood plain area (wasteland/sandy area)

Table 2.1.19. Description of landscape ecological units, Chamba block, Tehri Garhwal district, Uttarakhand

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Himalayas and other mountain ranges	Lesser Himalayas	Side slopes	MIR8fd	Strongly sloping high hill side slopes (thick/dense forest)
			MIR8fm	Strongly sloping high hill side slopes (medium forest)
			MIR7fd	Very steeply sloping high hill side slopes (thick/dense forest)
			MIR7fm-ft	Very steeply sloping high hill side slopes (medium/thin forest)
			MIR7af	Very steeply sloping high hill side slopes (agro-forestry)
			MIR7s/tc	Very steeply sloping high hill side slopes (single crop) (terrace cultivation)
			MIR6fm-ft	Steeply sloping mid hill side slopes (medium/thin forest)
			MIR6 s/tc	Steeply sloping mid hill side slopes (single crop) (terrace cultivation)
			MIR5af	Moderately steeply sloping low hill side slopes (agro-forestry)
			MIR5d/tc	Moderately steeply sloping low hill side slopes (double crop) (terrace cultivation)
			MIR4af	Moderately sloping low hill side slopes (Agro-forestry)
			MIR4d/tc	Moderately sloping low hill side slopes (double crop under terrace cultivation)
		Glacio fluvial valley	MIV_f3d/s	Gently sloping Intermountain valley (double crop/ single crop)
			MIV_f3ah	Gently sloping Intermountain valley (agro-horticulture)

Odhan block, Sirsa district, Haryana (29^{0}42' to 29^0 58' N and 74^0 47' to 75^0 07' E, 45589 hectares area, 40 villages)

Odhan block in Sirsa district, Haryana is the representative of old, aeolian and aeo-fluvial plains of Indo-Gangetic alluvial plains, classified into eleven landscape ecological units (LEUs) for the purpose of LRI on 1: 10000 scales (Fig. 2.1.24 and Table 2.1.20).

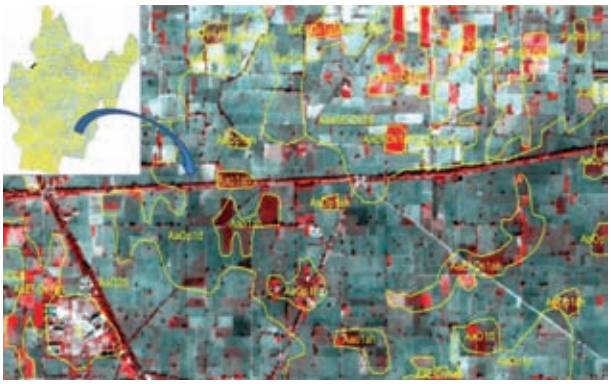


Fig. 2.1.24. Landscape ecological unit map of Odhan block, Sirsa district, Haryana

Rajpura block, Patiala district, Punjab (30°24'50" N to 30°39'16" N and 76°25'56" E to 76°49'14" E, 28315 hectares area and 116 villages)

Rajpura block in Patiala district represents old and young alluvial plains of Indo-Gangetic alluvial plains and the two plains are further classified into ten landscape ecological units (LEUs) based on slope and land uses (Fig. 2.1.25 and Table 2.1.21).

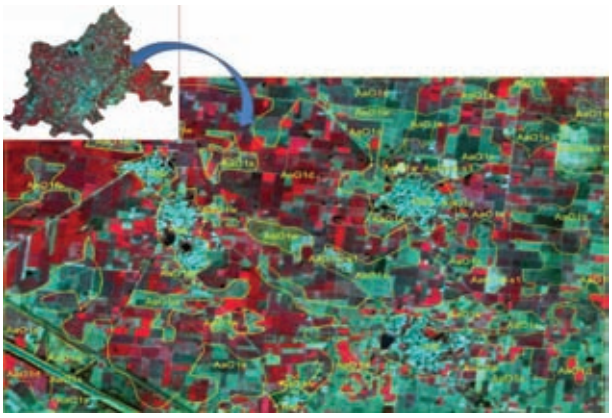


Fig. 2.1.25. Landscape ecological unit map, Rajpura block, Patiala district, Punjab

Table 2.1. 20. Description of landscape ecological units, Odhan block, Sirsa district, Haryana

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Indo-Gangetic plain	Alluvial plain	Old alluvial plains	AaOp2s	Very gently sloping old alluvial plains (single crop)
			AaOp1d	Nearly level to level old alluvial plains (double crop)
			AaOp1p	Nearly level to level old alluvial plains (plantation)
			AaOp1ah	Nearly level to level old alluvial plains (agri-horticulture)
		Aeofluvial plains	AaEf-D^{s}2s	Very gently sloping aeo-fluvial plains with reclaimed sand dunes (single crop)
			AaEf-D^{s}2d	Very gently sloping aeo-fluvial plains with reclaimed sand dunes (double crop)
			AaEf-D^{s}1d	Nearly level to level aeo-fluvial plains with reclaimed sand dunes (double crop)
			AaEf-D^{s}1ah	Nearly level to level aeo-fluvial plains with reclaimed sand dunes (agri-horticulture)
		Aeolian plains	AaWbE-D^{s}3s	Gently sloping aeolian plains with reclaimed sand dunes (single crop)
			AaWbE-D^{s}2d	Very gently sloping aeolian plains with reclaimed sand dunes (double crop)
			AaWbE-D^{s}2s	Very gently sloping aeolian plains with reclaimed sand dunes (single crop)
			AaWbE-D^{s}2w	Very gently sloping aeolian plains with reclaimed sand dunes (culturable waste))

Table 2.1.21. Description of landscape ecological units, Rajpura block, Patiala, Punjab

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Indo-Gangetic plains	Alluvial plain	Old alluvial plain	AaO1w	Nearly level old alluvial plain (culturable waste - saline)
			AaO1fb	Nearly level old alluvial plain (fallow land other than current fallow -saline)
			AaO1s	Nearly level old alluvial plain (single crop)
			AaOld-w	Nearly level old alluvial plain (double crops -waste land in patches)
			Aao1d	Nearly level old alluvial plain (double/ triple crops)
		Young alluvial plain	AaY2w	Very gently sloping young alluvial plain (culturable waste-saline)
			AaY2fb	Very gently sloping young alluvial plain (fallow land other than current fallow -saline)
			AaY2s	Very gently sloping young alluvial plain (single crop)
			AaY2d	Very gently sloping young alluvial plain (double crops)
			AaY2d- s1	Very gently sloping young alluvial plain (double crops -partially salt affected)

E) North-eastern region

North West Jorhat block, Jorhat district, Assam (26°35' to 26°55'N and 93°55' to 94°15'E 94°13'E, 30700 hectare area)

North West Jorhat block in Jorhat district, Assam is the representative of old, young and active flood plains of Brahmaputra valley of eastern Himalaya. For the purpose of LRI on 1:10000 scale, three landforms were further divided into twenty landscape ecological units (LEUs). (Fig. 2.1.26 and Table 2.1.22).

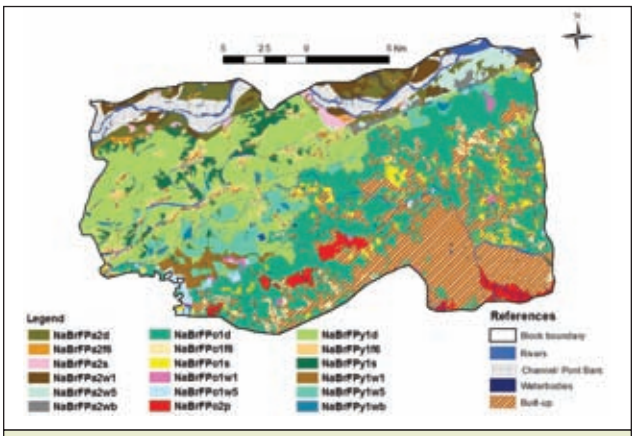


Fig. 2.1.26. Landscape ecological unit map, North West Jorhat Block, Jorhat district, Assam

Table 2.1.22. Description of landscape ecological units, North West Jorhat block, Jorhat, Assam

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
North Eastern ranges, eastern Himalayas Brahmaputra valley		Active flood plains	$NaBrFP_a2d$	Very gently sloping active flood plains (double-crop)
			$NaBrF_aP2s$	Very gently sloping active flood plains (single-crop)
			$NaBrFP_a2f6$	Very gently sloping active flood plains (home stead vegetation)
			$NaBrFP_a2w1$	Very gently sloping active flood plains (barren/ scrub-lands)
			$NaBrFP_a2w5$	Very gently sloping active flood plains (marshes & swamps/ waste-lands)
			$NaBrFP_a2wb$	Very gently sloping active flood plains (wet-lands/ water-bodies)
		Younger flood plains	$NaBrFP_y1d$	Nearly level younger flood plains (double-crop)
			$NaBrFP_y1s$	Nearly level younger flood plains (single-crop)
			$NaBrFP_y1f6$	Nearly level younger flood plains (home stead vegetation)
			$NaBrFP_y1w1$	Nearly level younger flood plains (barren/ scrub-lands)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
			$NaBrFP_y1w5$	Nearly level younger flood plains (marshes & swamps/ waste lands)
			$NaBrFP_y1wb$	Nearly level younger flood plains (wet-lands/ water bodies)
		Older flood plains	$NaBrFP_o1d$	Nearly level older flood plains (double-crop)
			$NaBrFP_o1s$	Nearly level older flood plains (single-crop)
			$NaBrFP_o1f6$	Nearly level older flood plains (home stead vegetation)
			$NaBrFP_o1w1$	Nearly level older flood plains (barren/ scrub-lands)
			$NaBrFP_o1w5$	Nearly level older flood plains (marshes & swamps/ waste lands)
			$NaBrFP_o2p$	Very gently sloping older flood plains (plantation-tea)

Medziphema block, Dimapur district, Nagaland (25.62^0 to 25.98^0 N and 93.63^0 to 94.0^0 E, 63,262 hectare area)

Medziphema block represent low, high and foot hills of Purvanchal hills in North eastern ranges of Eastern Himalaya. Based on the landforms, slope and land uses, the block is further sub-divided into thirty two landscape ecological units (LEUs) (Table 2.1.23).

Table 2.1.23. Description of landscape ecological units, Medziphema block, Dimapur district, Nagaland

Physiographic region	**Physiographic sub-region**	**Broad landform**	**LEU**	**Description**
Northeastern ranges, eastern Himalayas	Purvanchal hills	High hills	NcH_h6p	Moderately steep to steeply sloping highly dissected ampitudinal high hills (plantation/ horticulture)
			NcH_h6f6	Moderately steep to steeply sloping highly dissected ampitudinal high hills (village plantation/ vegetation)
			NcH_h6ft	Moderately steep to steeply sloping highly dissected ampitudinal high hills (open mixed jungle)
			NcH_h6fm	Moderately steep to steeply sloping highly dissected ampitudinal high hills (moderately dense mixed jungle)
			NcH_h6fd	Moderately steep to steeply sloping highly dissected ampitudinal high hills (fairly dense mixed jungle)
		Low hills	NcH_l6p	Moderately steep to steeply sloping highly dissected ampitudinal low hills (plantation/ horticulture)
			NcH_l6f6	Moderately steep to steeply sloping highly dissected ampitudinal low hills (village plantation/ vegetation)
			NcH_l6ft	Moderately steep to steeply sloping highly dissected ampitudinal low hills (open mixed jungle)
			NcH_l6fm	Moderately steep to steeply sloping highly dissected ampitudinal low hills (moderately dense mixed jungle)
			NcH_l6fd	Moderately steep to steeply sloping highly dissected ampitudinal low hills (fairly dense mixed jungle)
		Foot hills	NcH_o5ft	Strongly sloping rolling foot hills (open mixed jungle)
			NcH_o5fm	Strongly sloping rolling foot hills (moderately dense mixed jungle)
			NcH_o5p	Strongly sloping rolling foot hills (plantation/ horticulture)
			NcH_o5f6	Strongly sloping rolling foot hills (village plantation/ vegetation)
		Upper piedmont	NcX_u4s	Gently sloping upper piedmont (single crop)
			NcX_u4d	Gently sloping upper piedmont (double crop)
			NcX_u4f6	Gently sloping upper piedmont (village plantation/ vegetation)
			NcX_u4p	Gently sloping upper piedmont (plantation/ horticulture)
			NcX_u4ft	Gently sloping upper piedmont (open mixed jungle)
			NcX_u4fb	Gently sloping upper piedmont (fallow land)

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
		Middle piedmont	NcX_m4s	Gently sloping middle piedmont (single crop)
			NcX_m4d	Gently sloping middle piedmont (double crop)
			NcX_m4f6	Gently sloping middle piedmont (village plantation/ vegetation)
			NcX_m4p	Gently sloping middle piedmont (plantation/ horticulture)
			NcX_m4ft	Gently sloping middle piedmont (open mixed jungle)
			NcX_m4fb	Gently sloping middle piedmont (fallow land)
		Lower piedmont	NcX_l4s	Gently sloping lower piedmont (single crop)
			NcX_l4d	Gently sloping lower piedmont (double crop)
			NcX_l4f6	Gently sloping lower piedmont (village plantation/ vegetation)
			NcX_l4p	Gently sloping lower piedmont (plantation/ horticulture)
			NcX_l4ft	Gently sloping lower piedmont (open mixed jungle)
			NcX_l4fb	Gently sloping lower piedmont (fallow land)
		Interhill valleys	NcV^d4s	Gently sloping interhill valleys (single crop)
			NcV^d4d	Gently sloping interhill valleys (double crop)
			NcV^d4fb	Gently sloping interhill valleys (fallow land)
			NcV^J4s	Gently sloping interhill valleys (single crop)
			NcV^J4d	Gently sloping interhill valleys (double crop)
			NcV^J4fb	Gently sloping interhill valleys (fallow land)
			NcV^t4s	Gently sloping interhill valleys of Tehai Reuriver (single crop)
			NcV^t4d	Gently sloping interhill valleys (double crop)
			NcV^t4fb	Gently sloping interhill valleys (fallow land)
		Flood plains	$NcFP_u1s$	Nearly level upper terrace of flood plains (single crop)
			$NcFP_u1d$	Nearly level upper terrace of flood plains (double crop)
			$NcFP_u1f6$	Nearly level upper terrace of flood plains (village plantation/ vegetation)
			$NcFP_u1p$	Nearly level upper terrace of flood plains (plantation/ horticulture)
			$NcFP_u1fb$	Nearly level upper terrace of flood plains (fallow land)
			$NcFP_l1s$	Nearly level lower terrace of flood plains (single crop)
			$NcFP_l1d$	Nearly level lower terrace of flood plains (double crop)
			$NcFP_l1f6$	Nearly level lower terrace of flood plains (village plantation/ vegetation)
			$NcFP_l1p$	Nearly level lower terrace of flood plains (plantation/ horticulture)
			$NcFP_l1fb$	Nearly level lower terrace of flood plains (fallow land)
		Meander plains	$NcFP_m^d1s$	Nearly level meander plains (single crop)
			$NcFP_m^d1d$	Nearly level meander plains (double crop)
			Miscella-neous	Built-up (ST) / river (RIV)/ waterbody (WB)/ point bars (PB)

f) Central region

Rahuri block, Ahmednagar district, Maharashtra

Rahuri block belong to the basaltic landscape within the region of north Deccan plateau defined as physiographic and sub-physiographic region of the central region. The block is further divided into 20 landscape ecological units (LEUs) depending on landform, slope and land uses (Fig.2.1.27 and Table 2.1.24).

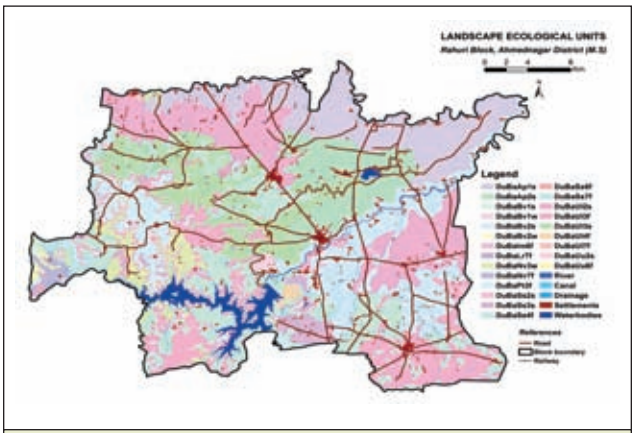


Fig. 2.1.27. Landscape ecological unit map of Rahuri block, Ahmednagar district, Maharashtra

Table 2.1.24. Description of landscape ecological units, Rahuri block, Ahmednagar district, Maharashtra

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Deccan plateau	Deccan plateau (upper Maharashtra)	Basalt landscape	DuB_aAp1s	Level to nearly level alluvial plains (single crop)
			DuB_aAp2s	Very gently sloping alluvial plains (single crop)
			DuB_aBv1s	Level to nearly level broad valley floor (single crop)
			DuB_aBv1w	Level to nearly level broad valley floor (waste lands)
			DuB_aBv2s	Very gently sloping broad valley floor (single crop)
			DuB_aBv2w	Very gently sloping broad valley floor (waste lands)
			DuB_aIm6f	Steeply sloping lands, isolated mounds (forest)
			DuB_aLr7f	Very steeply sloping lands, linear ridges (forest)
			DuB_aNv3w	Gently sloping lands, narrow valleys (waste lands)
			DuB_aNv7f	Very steeply sloping lands, narrow valleys (forest)
			DuB_aPt3f	Gently sloping lands, plateau top (forest)
			DuB_aSs2s	Very gently sloping plains, scarp slopes (single crop)
			DuB_aSs3s	Gently sloping lands, scarp slopes (single crop)
			DuB_aSs4f	Moderately sloping lands, scarp slopes (forest)
			DuB_aSs6f	Steeply sloping lands, scarp slopes (forest)
			DuB_aSs7f	Very steeply sloping lands, scarp slopes (forest)
			DuB_aUl2s	Very gently sloping plains, undulating lowlands (single crop)
			DuB_aUl3f	Gently sloping lands, undulating lowlands (forest)
			DuB_aUl3s	Gently sloping lands, undulating lowlands (single crop)
			DuB_aUl4f	Moderately sloping lands, undulating lowlands (forest)
			DuB_aUl7f	Very steeply sloping lands, undulating lowlands (forest)
			DuB_aUu2s	Very gently sloping plains, undulating uplands (single crop)
			DuB_aUu6f	Steeply sloping lands, undulating uplands (single crop)

Raisen block, Raisen district, Madhya Pradesh

Raisen block represents Vindhyan ranges and scarp land in the physiographic region of central region. The block is divided into 24 landscape ecological units (LEUs) within the broad landform classified as sedimentary landscape (Fig.2.1.28 and Table 2.1.25).

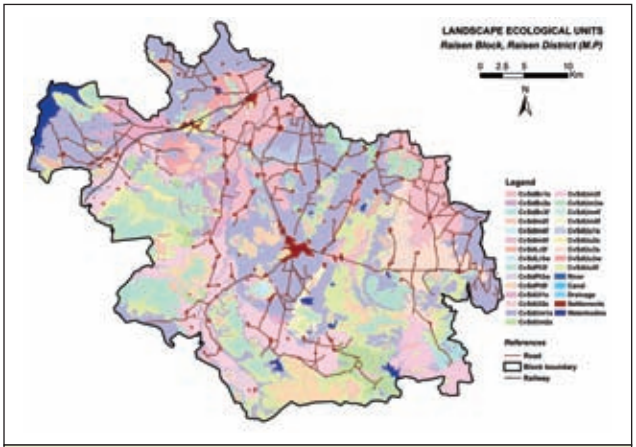


Fig. 2.1.28. Landscape ecological unit map of Raisen block, Raisen district, Madhya Pradesh

Fallow land mapping in Goa

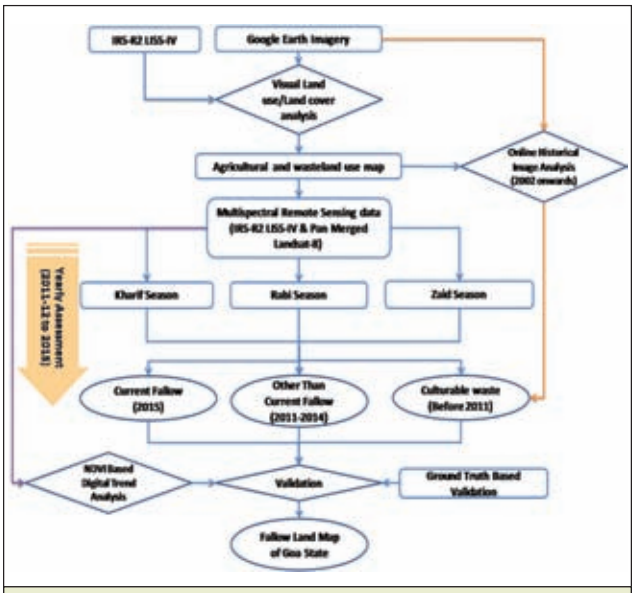


Fig. 2.1.29. Methodology framework for fallow land mapping

Table 2.1.25. Description of landscape ecological units, Raisen block, Raisen district, Madhya Pradesh

Physiographic region	Physiographic sub-region	Broad landform	LEU	Description
Central highlands	Vindhyan ranges and scarplands	Sedimentary landscape	CvS_dBv1s	Level to nearly level broad valley floor (single crop)
			CvS_dBv2s	Very gently sloping broad valley floor (single crop)
			CvS_dBv3f	Gently sloping broad valley floor (forest)
			CvS_dIm2f	Very gently sloping isolated mounds (forest)
			CvS_dIm4f	Moderately sloping isolated mounds (forest)
			CvS_dIm5f	Moderately steep sloping isolated mounds (forest)
			CvS_dLr2f	Very gently sloping linear ridges (forest)
			CvS_dLr3w	Gently sloping linear ridges (waste lands)
			CvS_dPt3f	Gently sloping plateau top (forest)
			CvS_dPt3w	Gently sloping plateau top (waste lands)
			CvS_dPt5f	Moderately steep sloping plateau top (forest)
			CvS_dUl1s	Level to nearly level undulating lowlands (single crop)
			CvS_dUl2s	Very gently sloping undulating lowlands (single crop)
			CvS_dUm1s	Level to nearly level undulating midlands (single crop)
			CvS_dUm2s	Very gently sloping undulating midlands (single crop)
			CvS_dUm3f	Gently sloping undulating midlands (forest)
			CvS_dUm3w	Gently sloping undulating midlands (waste lands)
			CvS_dUm4f	Moderately sloping undulating midlands (forest)
			CvS_dUm5f	Moderately steep sloping undulating midlands (forest)
			CvS_dUu1s	Level to nearly level undulating uplands (single crop)
			CvS_dUu2s	Very gently sloping undulating uplands (single crop)
			CvS_dUu3s	Gently sloping undulating uplands (single crop)
			CvS_dUu3s	Gently sloping undulating uplands (forest)
			CvS_dUu5f	Moderately steep sloping undulating uplands (forest)

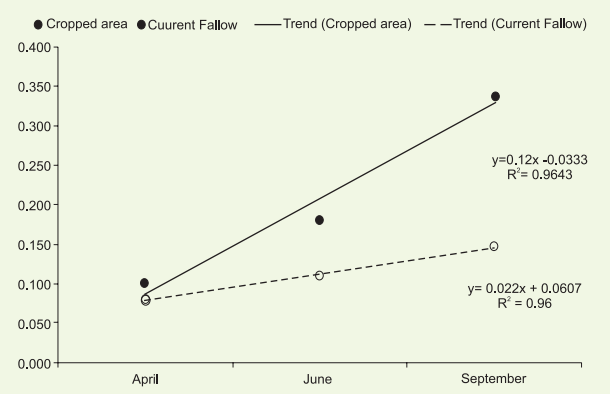


Fig. 2.1.30. NDVI based digital trend analysis for identification of fallow lands.

The flow chart (Fig.2.1.29) explains the overall methodology for mapping of fallow lands in Goa (Fig. 2.1.31). Current fallow and the agriculture land use were delineated using R2 LISS-IV. The observations were verified by using Landsat-8 imagery for *Kharif, Rabi* and *Zaid* seasons of the current year *i.e.* 2015. Similarly, land uses other than current fallow and culturable waste were derived by visual check in waste land polygons of three growing season images from 2011 to 2014; Extensive ground truthing was done for verification. Similar spectral responses of current fallow and cropland were separated by trend analysis of time series data of NDVI, which have performed well in the region with its linear slope parameter (low value for fallow land and higher value for presently cultivated land) (Fig. 2.1.30). Distribution of fallow land in the state (1st approximation) is given in Fig. 2.1.32.

Fig. 2.1.31. Appearance of a typical fallow land of Goa

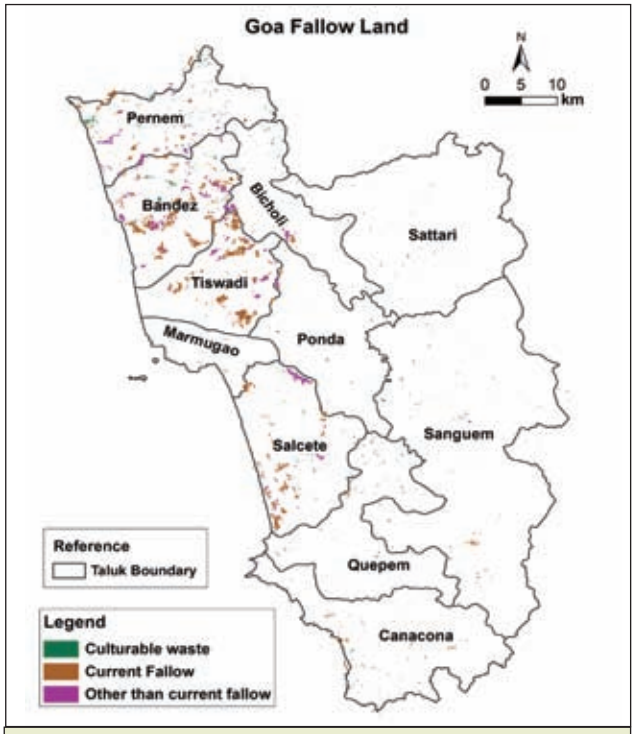


Fig.2.1.32. Distribution of fallow land in the state (1st approximation)

Shifting cultivation or *Jhum* land mapping of NE region

Mapping of area under *Jhum* cultivation in the north eastern region has been initiated during the year.

a. Ri-Bhoi district, Meghalaya

Illustrative examples of LULC analysis for Ri-Bhoi district of Meghalaya is shown in Fig.2.1.33 while Fig. 2.1.34 shows spread of *Jhum* land in Mokokchuk district of Nagaland.

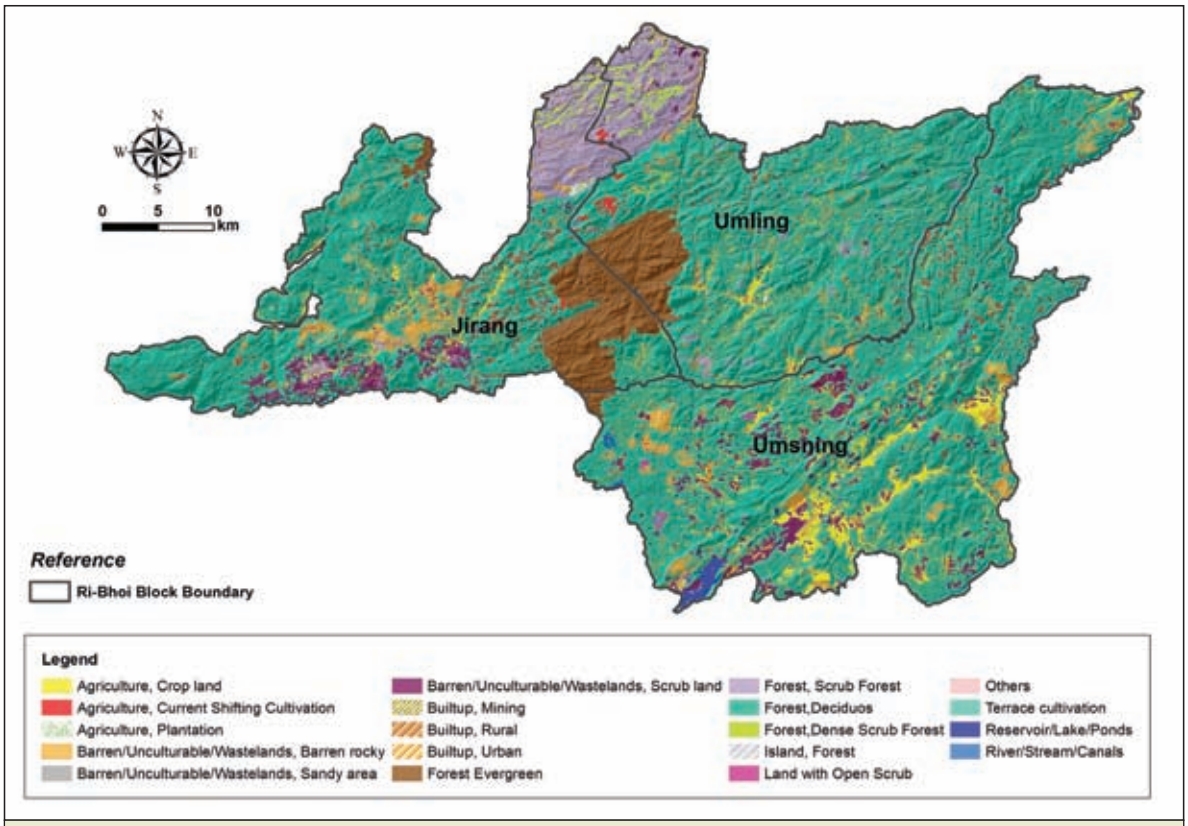


Fig. 2.1.33. *Jhum* area in Ri-Bhoi district, Meghalaya

b. Mokokchung district, Nagaland

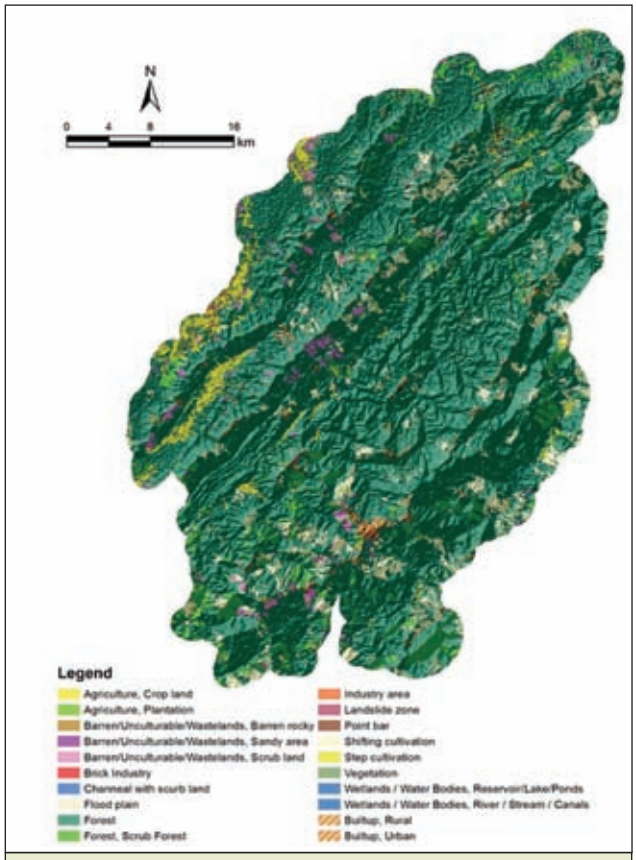


Fig. 2.1.34. *Jhum* area in Mokokchuk district, Nagaland

Desertification status mapping (2nd cycle) – Telangana state

Three season Resourcesat AWiFS data of 2011-2013 and 2003-2005 are used for delineation of different desertification processes and change detection analysis at 1:50000 scale. The results shows that 30.6 % area of the state is affected by different processes of desertification in 2011-13, whereas the area affected under desertification in 2003-05 was 31.3% of the state. The dominant processes in 2011-13 were water erosion (82%) vegetal degradation (15%) and salinity (2%). The change detection analysis showed that area affected by water erosion and forest vegetal degradation in 2014-13 (Fig. 2.1.35) is significantly lower than that of 2003-05 (Fig. 2.1.36).

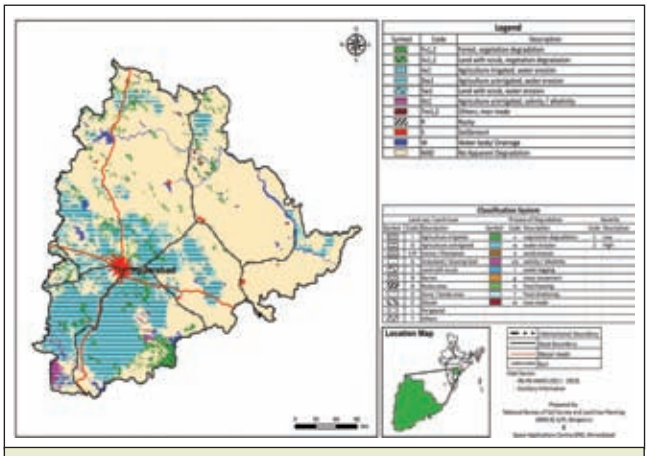


Fig. 2.1.35. Desertification status map of Telangana state- 2nd cycle (2011-13)

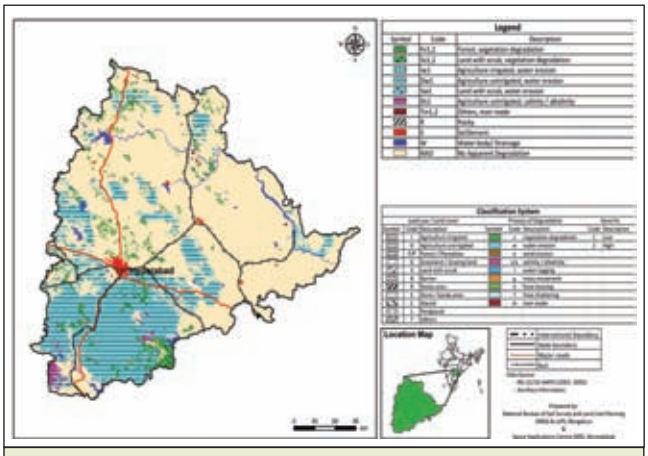


Fig. 2.1.36. Desertification status map of Telangana state- 1st cycle (2003-05)

Combined use of Legacy data and geospatial tools for upscaling soil resource information- A case study in Goa state

Methodology framework

The modeling workflow of upscaling soil information from 50k to 10k scale is depicted in Fig. 2.1.37. This a three step methodology described below:

Step I: Up scaling of legacy information to 10k scale: All the maps of 1:250000 and 1:50000 scales are of very good quality while viewing at their respective scale; but the large scale view apparently reveals boundary distortion from the actual feature existing on the high resolution satellite imagery. This is obviously due to the scale limitation factor. Therefore first objective is to bring all the legacy information into one scale *i.e.* of 10k. To achieve this, we begin with framing a hierarchical relation tree through the legacy soil report of Goa state. The hierarchical

relation tree (Fig. 2.1.38) reveals interrelationships between the physiography, broad landform and landform units. Hence, if we are able to upscale the landform units (represented by the SRM units as such or their combination) of 50k to 10k scale by redrafting boundary and breaking individual units into multiple ones with the help of high resolution geospatial data products in the background; the physiography and broad landforms will be updated accordingly by merging the landform units as per the legacy hierarchical relation tree.

The hillshade (shaded relief), contour, drainage and slope layers are used in the backdrop for redrafting the boundaries of 50k units to 10k. Individual Soil Resource Mapping (SRM) unit of 50k is found to be associated with other SRM units. While viewing at larger scale of 10k; which is being disintegrated within the spatial domain of 50k units. Once the spatial scaling correction is done, the landform map at 10k scale is developed by mining the interrelation of landform.

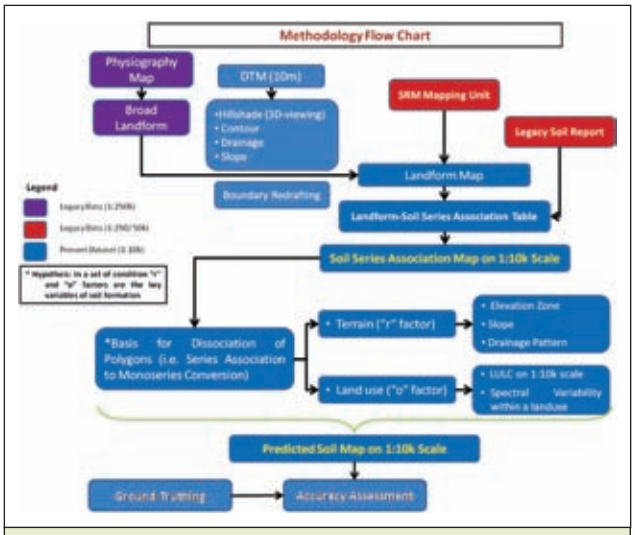


Fig.2.1.37. Methodology flow chart

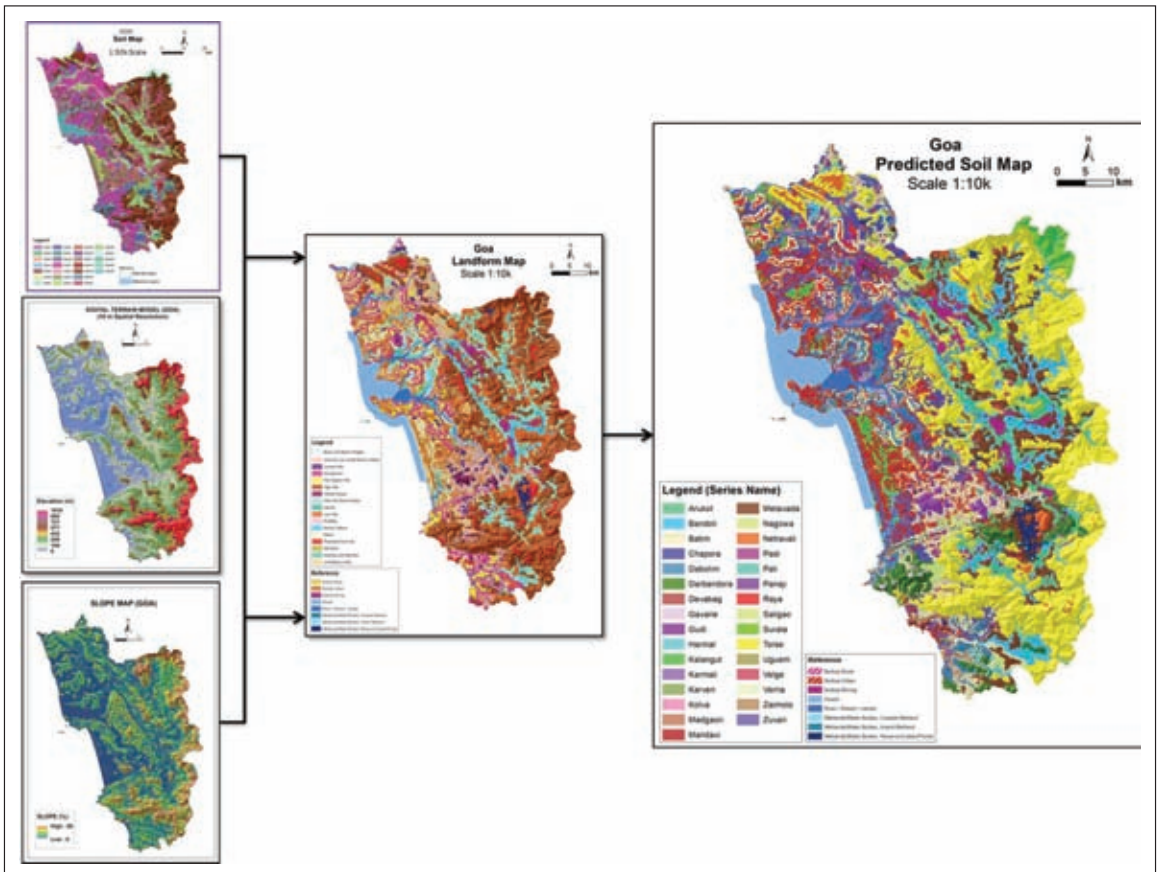


Fig. 2.1.38. Predicted soil map of Goa using hierarchical relation tree

Step II: Monoseries mapping through DSM on 10k scale: The landform *vis-à-vis* association of soil series at 10k scale need to be dissociated into monoseries for precise delineation of land management units at this scale. We adopt the digital soil mapping (DSM) concept at this stage. DSM has evolved for deriving advantage of advancement of computing and geographic data handling, as well as increased availability of environmental covariate data from high resolution digital elevation models and remotely sensed imagery. McBratney *et al*., 2003 had offered a revised formalization of the state factor model *i.e.* CORPT model (Jenny, 1941). This revised formula is expressed by the following equation:

$$S = f\,(s,c,o,r,p,a,n) + e = f\,(Q) + e$$

where S, a set of soil attributes (Sa) or classes (Sc), is considered a function of other known soil attributes or classes (s), climate (c), organisms (o), relief (r), parent materials (p), age or time (a), and spatial location or position (n) and e is residuals. Q represents the set of pedologically meaningful predictor variables.

Hypothesis in this case study is that in a given set of conditions (*i.e.* state factors of climate, time and geology; had been already well taken into consideration while preparing 50k scale soil resource information), the soil type (series in pedological term) variability is largely governed by the remaining state factors. The minimum dataset (MDS) to separate one series from another from their association state under each landform unit is identified. The "r" factor parameters selected in the MDS are elevation and slope. The "o" factors include land use/land cover and variation in spectral response. The "s" factor being known soil attribute is derived from the legacy soil series report to finalize the MDS. It mainly includes soil texture as a function of spectral response ("o" factor); for *e.g.* the coarse texture soil will have brighter spectral response than the finer one owing to its low water holding capacity.

Step III: Accuracy assessment: Accuracy assessment of the 50k soil map with the spatial scale corrected one is also performed. The accuracy of legacy 50k soil map was assessed based on the following three measures (Oleire-Oltmanns *et al.* 2013):

User's accuracy (UA), the percentage of correctly classified area from the total classified area;

Producer's accuracy (PA), the percentage of correctly classified area from the total reference;

Detection rate, the percentage of reference data that have been detected by the classification (also including partial detection).

Elevation Basis **Slope Basis**

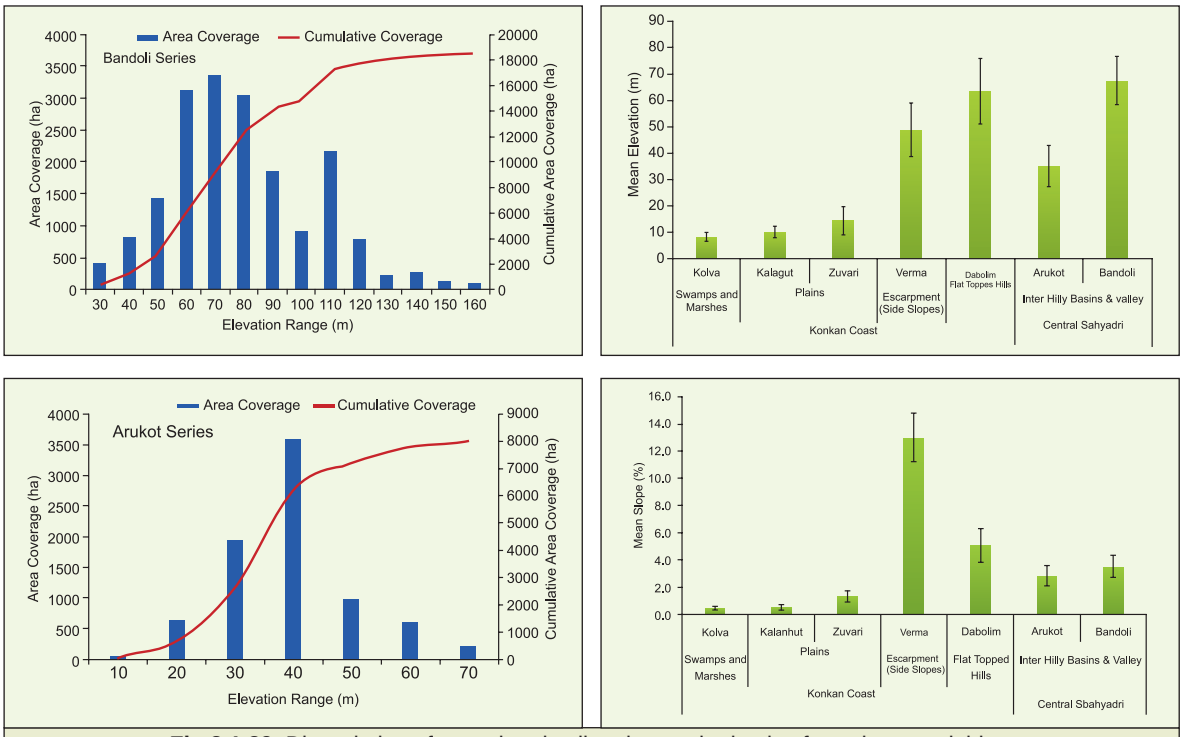


Fig.2.1.39. Dissociation of associated soil series on the basis of terrain co-variables

Fig.2.1.39 depicts the use of digital elevation database in separating Bandoli and Arukote series association. Further, the figure also reveals that Verna and Dabolim series have insignificant elevation difference; both the series are thus separated through their mean slope difference (significant difference is noted through error bar).

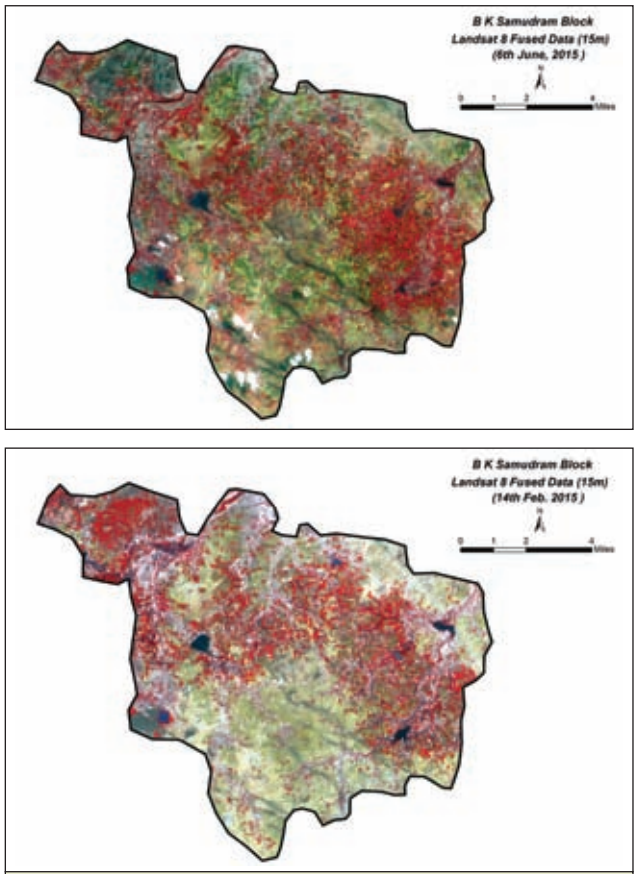


Fig. 2.1.40. LANDSAT-8 OLI (30m) data fused with PAN data (15m) of Bukkarayasamudram block of Anantpur district

Land Degradation in Major Ecosystems of India

The availability of precise information on kind and spatial extent under various categories of degraded lands play an important role in sustainable management of land resources in the country. During the reporting period, extramural project entitled "Mapping and Assessment of Land Degradation in Major Ecosystems of India Using Geospatial Technologies" has been undertaken with the objective of developing robust methodology for mapping and assessment of type, extent and severity of land degradation using high resolution temporal satellite data, legacy and field data. Other objectives are to develop land degradation information system in GIS and composite Land Degradation Index for the selected blocks in different AER's of India. The base map consisting of fused multi-spectral temporal LANDSAT-8 OLI (30m) data and PAN data (15m) were used. The base map for Bukkarayasamudram block is given in this report as an example (Fig. 2.1.40).

Conceptual approach towards Digital Library (DL) for development of land resource information

Soil phase level digital LRI database of 60 watersheds was generated. The thematic maps for depth, LCC, slope, texture, erosion, gravelliness and suitability maps for 11 horticultural crops *i.e.* Amla, Cashew, Custard Apple, Guava, Jackfruit, Black berry (Jamun), Lime, Mango, Orange (moosambi), Sapota sapota (Chikoo), and Tamarind were generated. Soil fertility maps were generated for 20 watersheds. The spatial data is being created in File Geo-database format in ArcGIS environment and the Digital Library (DL) software is being developed using Visual Studio. NET. Fig. 2.1.41 shows the opening screen of the DL software where the user has to select the micro watershed and Fig. 2.1.42 shows the soil map selected watershed. The software displays all the information of the selected land parcel *i.e.* soils, current land use, existing hydrological structures, proposed conservation measures, fertility status and suitability to different crops (Fig. 2.1.43 and Fig. 2.1.44). Software module is developed to display the village wise land parcels with selected soil or fertility status. For example, Fig 2.1.45 shows the village wise land parcels of boron status. Using the software, one can also generate reports and Excel file with properties of all the land parcels for the selected village (Fig. 2.1.46). The information can be used to prepare village or micro watershed reports. The software also includes the facility to view the photos and pedon description forms of the selected soil series (Fig. 2.1.47 and Fig. 2.1.48).

Fig. 2.1.41. Opening screen of the Digital Library software

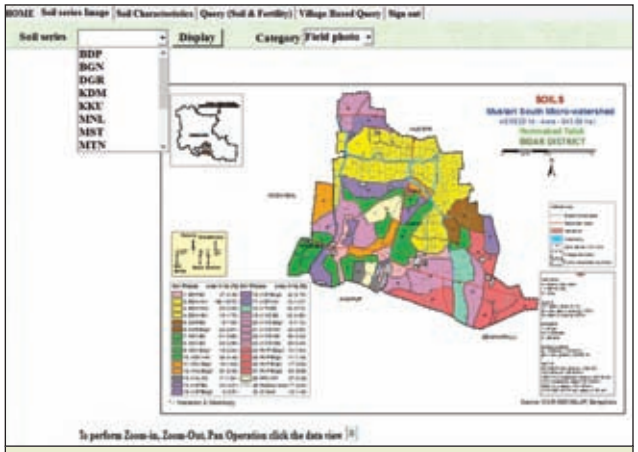


Fig. 2.1.42. Computear screen showing the soil map of selected watershed

Fig. 2.1.43. Computer screen showing all the properties of selected land parcel

Fig. 2.1.44. Computer screen showing the suitability status for different crops

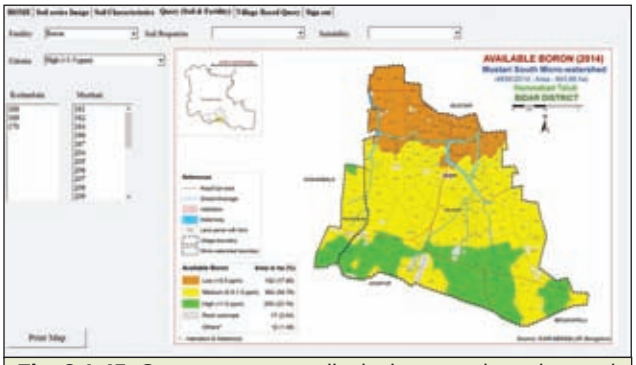


Fig. 2.1.45. Computer screen displaying parcel number and fertility status in the selected village

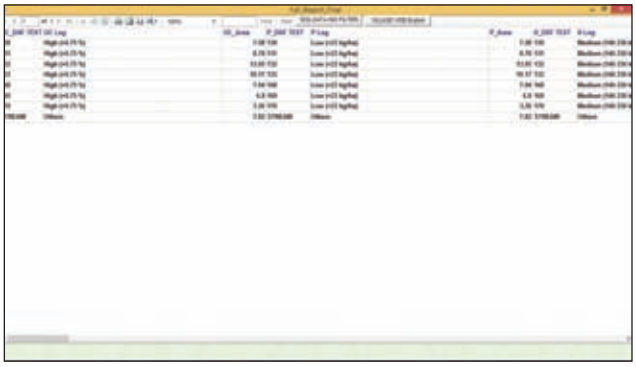


Fig. 2.1.46. Computer screen with the results of the selected village

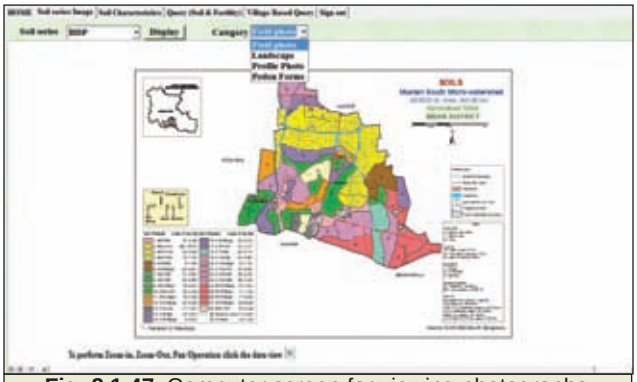


Fig. 2.1.47. Computer screen for viewing photographs and pedon forms of soil series.

Fig. 2.1.48. Computer screen showing the soil profile photo of the selected soil series.

Design and Development of Land Resource Information System and NBSS Geoportal for Geospatial Database Management and Dissemination

The importance of spatial databases in management and optimum utilization of natural resources is well recognized. Information on several soil parameters are available in the country and these have been scattered at various places in form of research paper and reports. Keeping this in view, development of Geoportal dedicated to soil information by collating geo-referenced soil and allied resources database in Geographic Information System (GIS) to provide a knowledge gateway to visualize, access, query soil

data and disseminate the land resource information to the users is initiated. The advantage of developing such Geo-portal is to eliminate redundancies and duplication of efforts, and enforcing consistency, standards, and sharable protocols to build a cross-domain soil knowledge base for effective utilization of limited natural resources in the country.

The user interface of NBSS Geo-portal has been developed (Fig. 2.1.49) to visualize thematic layers. The soil maps available on 1.1m and 1:250,000 scales, Agro-ecological regions, Agro-ecological sub-regions, soil loss, degraded and wastelands data are deployed in NBSS Geo-portal (BHUMI).The schema has been standardized for soil attribute database and ten district soil survey reports have been deployed. The point layer data on soil fertility, rainfall, benchmark soils, raster data on SRTM & ASTER DEM and AWiFS of India have also been deployed. WMS services for visualization will be started shortly.

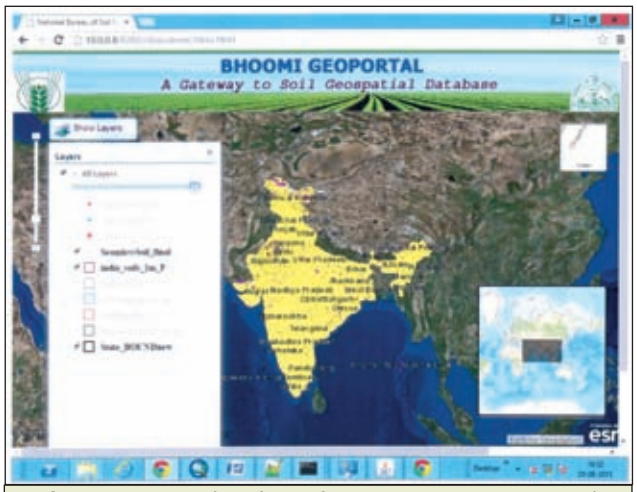


Fig. 2.1.49. User interface of NBSS BHOOMI Geoportal

ICAR Research Data Repository for Knowledge Management (KRISHI)

ICAR-NBSS&LUP as one of the core team members of KRISHI project is actively involved in conceptualization of theme and development of project proposal entitled "ICAR Research Data Repository for Knowledge Management (KRISHI)" for funding from ICAR. The design and development of front end of ICAR Geoportal has been developed to showcase Indian agricultural research capabilities in various domains. KRISHI Geoportal provides a gateway to explore and discover geospatial databases with specific emphasis on Indian Agriculture. In addition to the spatial data, metadata and services components, building a spatial data infrastructure requires suitable structures for coordination and communication. KRISHI Geo-portal is an initiative to make geo-spatial data related to Agriculture to all the stakeholders. This portal makes available geo-referenced data collected by ICAR institutions on climate, soil, cropping systems, land-use pattern *etc*. During the reporting period, the available basic information on area, production and productivity of major crops; agro-ecological regions, agro-ecological sub-regions and soil maps (1:1 million) of NBSS&LUP; Vulnerability map and climate layers of CRIDA; ICAR Institutes/Regional Centres locations *etc*. have been deployed as Web Map Services. Front end and thematic services developed in ICAR KRISHI Geoportal are shown in Fig.2.1.50.

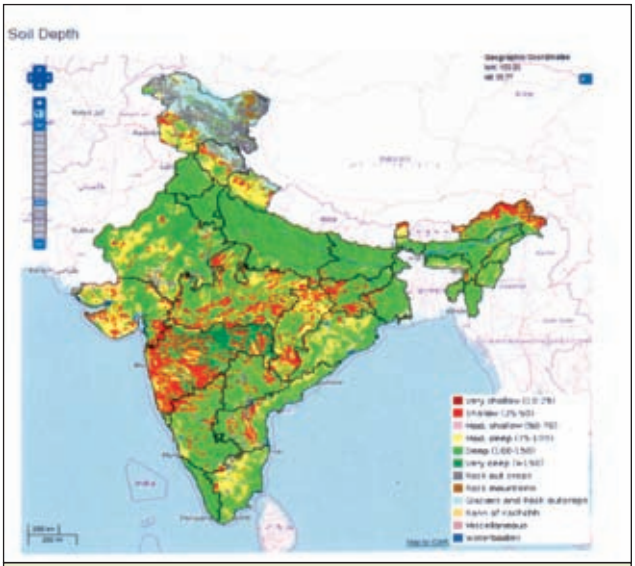


Fig. 2.1.50. Front end and thematic services developed in ICAR KRISHI Geoportal

In order to increase the awareness on KRISHI Geoportal, two day 'ICAR KRISHI Geoportal Workshop-Experts' and three-day's User's Training Workshop were organized at ICAR-NBSS&LUP, Nagpur during 11-12 March, 2016 and 28-30 March, 2016, respectively to showcase the functionalities

and utilities of KRISHI Geoportal for the benefit of Scientists/Technical Officers at various institutes across the NARS. Glimpse of ICAR KRISHI Geoportal Workshop-Experts' and three-day's User's Training Workshops organized at ICAR-NBSS&LUP, Nagpur are shown in Fig. 2.1.51.

Fig. 2.1.51. Glimpse of ICAR KRISHI Geoportal workshops organized at NBSS&LUP, Nagpur

2.2 INVENTORYING NATURAL RESOURCES

Delineation of Prime Agricultural Land – First Approximations

Prime farmland is the land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It is capable of producing economically sustained yield with proper management under acceptable farming methods (NRCS-USDA, 1980). In general, prime agriculture lands have an adequate and dependable water supply from precipitation or irrigation, a favourable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime agriculture lands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

The first approximation is carried out using soil resource data of 1:250000 scale of all the states of India. First of all, the agriculture land of the country was delineated from land use and land cover map of 2011-12. Criteria for delineation of prime agricultural lands includes soil depth (>75 cm), non sandy, non gravelly (<15% rock fragments), slope less than 8 percent, soil pH between 6.5 and 8.5 in all horizons within the root zone, water table should not be within one meter depth, non saline (EC < 2 mmhos/cm), non-alkaline (ESP < 5 per cent), no flooding/water logging. In the study, the area under double cropped is considered as irrigated area. The state wise distribution of prime land in rainfed and irrigated system of agriculture is shown in Table 2.2.1 and spatial distribution is elucidated in Figure 1. Statewise distribution of irrigated prime agricultural lands is shown in Table 2.2.2.

Table 2.2.1. Distribution of prime agricultural lands in states of India

State Name	Prime Agriculture Land					
	Irrigated (ha)	Rainfed (ha)	Total (ha)	NSA (including Current Fallow)	% of NSA of the state	Per cent contribution to the country
Andhra Pradesh	614707	1097913	1712619	9426764	18	3
Arunachal Pradesh	42787	9240	52027	253699.4	21	<1
Assam	858081	362733	1220814	4279008	29	2
Bihar	2115177	1446612	3561789	8625507	41	6
Chhattisgarh	256285	605985	862269	6950037	12	1
Delhi	27656	20621	48276	63904.96	76	<1
Gujrat	1870433	955202	2825635	10545022	27	5
Haryana	1319743	249613	1569356	3950947	40	3
Himachal Pradesh	21147	27590	48737	523615.7	9	<1
Jammu & Kashmir	216807	100894	317700	1161771	27	1
Jharkhand	118018	724116	842134	5382791	16	1
Karnataka	981437	2378811	3360248	12957698	26	6
Kerala	37079	35900	72979	2367329	3	<1
Madhya Pradesh	2983452	2198317	5181769	18381386	28	9
Maharashtra	2277782	3469119	5746901	20510464	28	10
Meghalaya	7621	20467	28088	198725.4	14	<1
Mizoram	904	1082	1986	36526.52	5	<1

Nagaland	2561	237	2798	61056.76	5	<1
Odisha	619057	2250289	2869345	8077283	36	5
Punjab	2459016	197749	2656764	4533197	59	5
Rajasthan	1342538	2589883	3932421	21336770	18	7
Tamilnadu	2144635	1782560	3927196	8319052	47	7
Telangana	600876	1476542	2077418	7124727	29	4
Uttar Pradesh	8886873	3607700	12494573	20741907	60	21
Uttarakhand	239156	13534	252691	845882.5	30	<1
West Bengal	2047464	1133985	3181449	6812439	47	5
Total	**32091292**	**26756694**	**58847982**	**1.83E+08**		

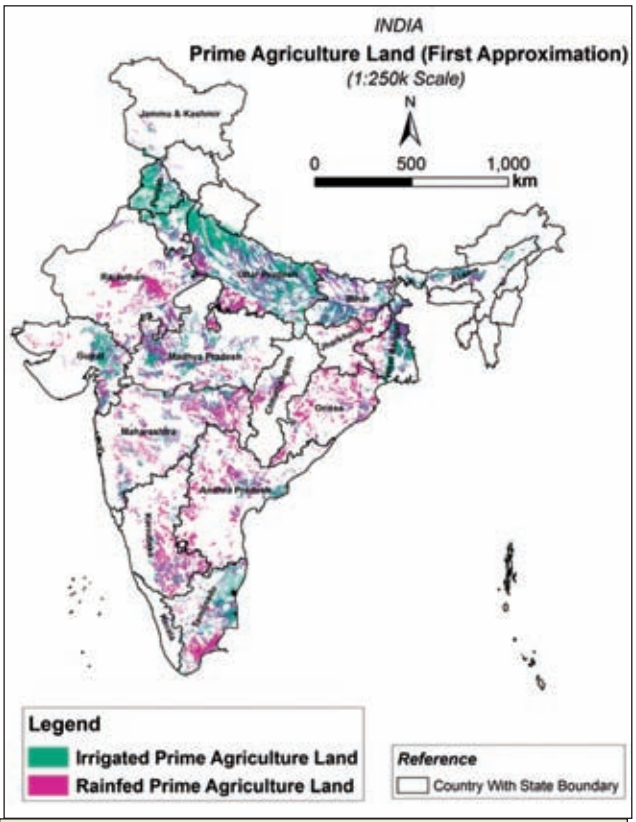


Fig.2.2.1. Prime agriculture lands of India

Revised agro-ecological region map of the country

Agro-ecological zoning refers to the division of an area of land into land resource units, having unique combination of landform, soil and climatic characteristics and or land cover having a specific range of potentials and constraints for land use.

Earlier agro-ecological region map of the country was prepared in 1992 based on the available data on climate, soil and physiography. With availability of new dataset on soils and climate. The agro-ecological region map of the country has been revised (Fig. 2.2.2a and b).

Table 2.2.2. Distribution of irrigated prime agricultural lands in India

State Name	Irrigated (ha)	Rainfed (ha)	Total (ha)	Irrigated prime lands per cent to total prime agricultural land area (%)
Uttar Pradesh	8886873	3607700	12494573	71
Madhya Pradesh	2983452	2198317	5181769	58
Punjab	2459016	197749	2656764	93
Maharashtra	2277782	3469119	5746901	40
Tamilnadu	2144635	1782560	3927196	55
Bihar	2115177	1446612	3561789	59
West Bengal	2047464	1133985	3181449	64
Gujrat	1870433	955202	2825635	66
Rajasthan	1342538	2589883	3932421	34
Haryana	1319743	249613	1569356	84
Karnataka	981437	2378811	3360248	29
Assam	858081	362733	1220814	70
Odisha	619057	2250289	2869345	22
Andhra Pradesh	614707	1097913	1712619	36
Telangana	600876	1476542	2077418	29
Chhattisgarh	256285	605985	862269	30
Uttarakhand	239156	13534	252691	95
Jammu & Kashmir	216807	100894	317700	68
Jharkhand	118018	724116	842134	14
Arunachal Pradesh	42787	9240	52027	82
Kerala	37079	35900	72979	51
Delhi	27656	20621	48276	57
Himachal Pradesh	21147	27590	48737	43
Meghalaya	7621	20467	28088	27
Nagaland	2561	237	2798	92
Mizoram	904	1082	1986	46

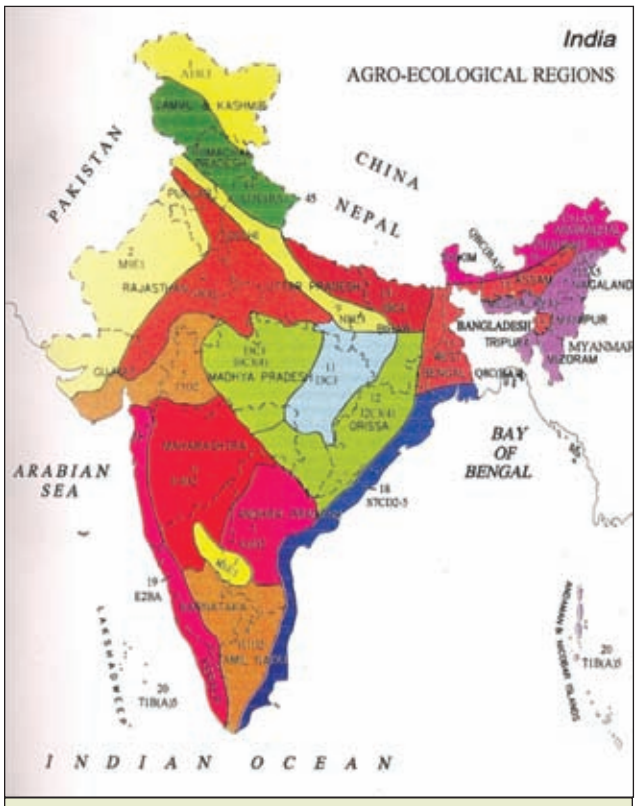


Fig. 2.2.2.a. Agro-Ecological Region Map (1992)

Fig. 2.2.2.b. Agro-Ecologocal Region Map (2015)

Land resource inventory on 1:10000 scales using geo-spatial technique

Programme on land resource inventory on 1:10000 scale launched in the year 2014-15 and is prospering, the progress made during the year 2014-15 and 2015-16 is presented in the Table 2.2.3.

Table 2.2.3. Blocks selected under LRI programme during 2014-15 and 2015-16

Sr. No.	Region	Block	District	State	AESR	Monitorable indicators		
						Base map	Soil survey completed	Soil maps prepared
1.	Southern	Bukkaraya-samudram	Anantpur	Andhra Pradesh	3.0	√	√	√
2.		Indervalle	Adilabad	Telangana	6.2	√	√	√
3.		Thimajipet	Mehbubnagar		7.2	√	√	√
4.		Gajwel	Medak		7.2	√	√	√
5.		Kangayam	Tiruppur	Tamil Nadu	8.1	√	√	
6.		Perhem	North Goa	Goa	19.2 & 19.3	√	√	
7.		Ponda				√	√	
8.		Tiswadi				√	√	
9.		Darbandre				√	√	
10.		Bicholim				√	√	
11.		Sattari				√	√	
12.		Bardej				√	√	
13.		Quepern	South Goa			√	√	
14.		Murmagao				√	√	
15.		Saleate				√	√	
16.		Cancona				√	√	
17.		Sanguam				√	√	

Sr. No.	Region	Block	District	State	AESR	Monitorable indicators		
						Base map	Soil survey completed	Soil maps prepared
18.	Western	Ankaleshwar	Bharuch	Gujarat	5.2	√	√	√
19.		Dholka	Ahmedabad		4.2	√	√	√
20.		Khedbrahma	Sabarkantha		4.2	√	√	√
21.		Deesa	Banaskantha		2.3	√	√	√
22.		Porbandar	Porbandar		5.3	√	√	√
23.	Central	Darwha	Yavatmal	Maharashtra	6.3	√	√	
24.		Dhanora	Seoni	Madhya Pradesh	10.4	√	√	
25.		Bemetara	Bemetara	Chattisgarh	11.0	√	√	
26.	Eastern	Titlagarh	Koraput	Odisha	12.1	√	√	√
27.		Basudevpur	Bhadrak		18.4	√	√	√
28.		Ganjam	Ganjam		18.4	√	√	√
29.		Tangi*	Khurda			√		
30.		Kadwa	Katihar	Bihar	15.0	√	√	√
31.		Mushahari	Samastipur		13.1	√	√	√
32.		Baisi*	Purnia			√		
33.		Dumka	Dumka	Jharkhand	12.3	√	√	
34.		Borio	Sahibganj		12.3	√	√	
35.		Deshapran	Purba Medinipur	West Bengal	18.5	√	√	√
36.		Ramnagar-I			18.5	√	√	√
37.		Kultali	South 24 Parganas		18.5	√	√	√
38.		Canning II			18.5	√	√	√
39.		Namkhana			18.5	√	√	√
40.		Gosaba			18.5	√	√	√
41.		Hasnabad	North 24 Parganas		15.1	√	√	√
42.		Rajnagar	Birbhum		12.3	√	√	
43.	Northern	Jagner	Agra	Uttar Pradesh	4.1	√	√	√
44.		Baragaon	Varanasi		4.3	√		
45.		NagrotaBagwan	Kangra	Himachal Pradesh	14.2	√	√	√
46.		Odhan	Sirsa	Haryana	2.3	√	√	
47.		Rajpura	Patiala	Punjab	9.1	√	√	
48.		Chamba	Chamba	Uttarakhand	14.4	√		
49.	N-E Region	North-West Jorhat	Jorhat	Assam	15.4	√	√	
50.		Mokokchung	Mokokchung	Nagaland	17.1	√	√	
51.		Medziphema	Dimapur		17.1	√	√	√
52.		Diyun	Changlang	Arunachal Pradesh	16.2	√	√	√
53.		Umling	Ri-Bhoi	Meghalaya	17.1	√	√	√
54.		Umsning			17.1	√	√	√
55.					17.1	√	√	√

* Soil survey to be taken up.

Soil resource maps on 1:10000 scale is one the most important products of LRI. The information generated on soil is very unique, representing phases of soil series through letters and numerals; first two/ three letters realated to the name of soil series, first numeral for soil depth followed by letters for soil texture and slope, respectively; numeral after slope predicts severity of soil erosion. Depending upon the situation, letters and numerals are further added for the properties influencing the management such as salinity, sodicity, gravelliness and acidity. Some of the soil maps are illustrated here as an examples.

A) Western region

Ankaleshwar taluk, Bharuch district, Gujarat

Twelve phases of three series (Fig. 2.2.3 & Table 2.2.4) in Ankaleshwar taluk indicated that alluvial plains of west coast in Gujarat have the risk of flooding and suffer from the problem of salinity and sodicity. Severity of salinity is more serious in the coastal region than the basaltic interflues and alluvial plains.

Khedbrahma taluk, Sabarkantha district, Gujarat

Twelve phases of eleven series in Khedbrahma taluk (Fig. 2.2.4 & Table 2.2.5) represents spread of Aravalli landscape in the state of Gujarat. The hills, pediments and piedmont are the constituents of Aravalli landscape, suffering from moderate to severe erosion.

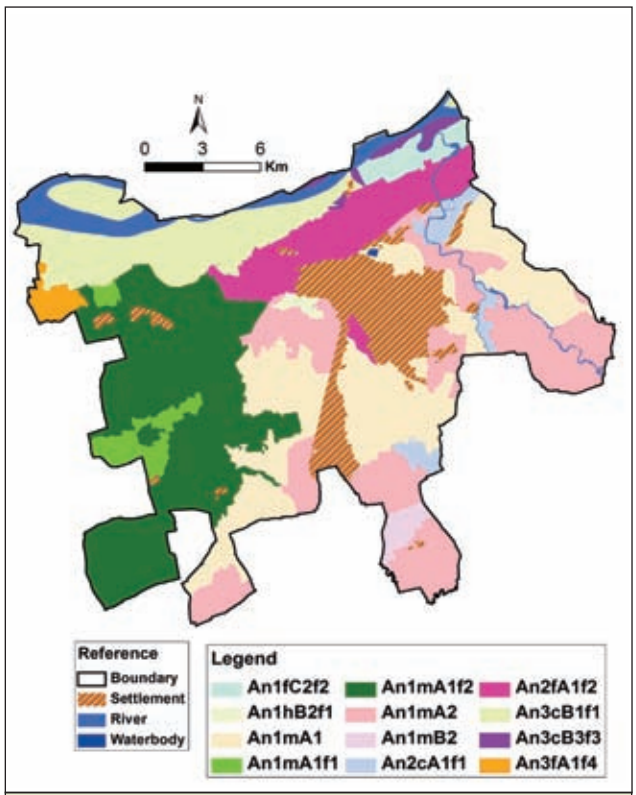


Fig. 2.2.3. Soil map of Ankaleshwar taluk, Bharuch district, Gujarat

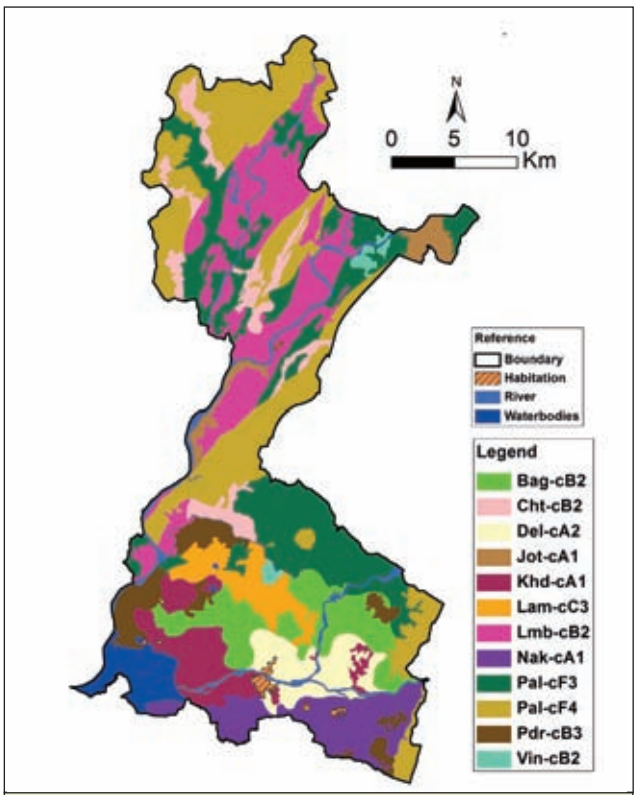


Fig. 2.2.4. Soil map of Khedbrahma taluk, Sabarkantha district, Gujarat

Table 2.2.4. Description of soils in Ankaleshwar taluk, Bharuch district, Gujarat

LEU	Soil series phases	Description of soil characteristics
GpAP1d	An2fA1f2	Very deep, moderately well drained, dark yellowish brown to very dark grayish brown, calcareous sandy loam to sandy clay loam soils on nearly level alluvial plains with clay loam surface having risk of slight erosion, moderate flooding and moderate alkalinity (pH-8.3).
GpAP1s	An1mA2	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on nearly level alluvial plains with clay surface having moderate erosion and moderate alkalinity (pH-8.3).
GpAP1s	An1mA1f2	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on nearly level alluvial plains with clay surface having risk of slight erosion, moderate flooding and moderate alkalinity (pH-8.3).
GpAP1s	An1mA1	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on nearly level alluvial plains with clay surface having risk of slight erosion and moderate alkalinity (pH-8.2).
GpAP1s	An1mA1f1	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on nearly level alluvial plains with clay surface having risk of slight erosion, occasional flooding and moderate alkalinity (pH-8.3).

GpAP1w	An2cA1f1	Very deep, well to moderately well drained, dark yellowish brown to very dark grayish brown, calcareous sandy loam to sandy clay loam soils on nearly level alluvial plains with sandy loam surface having risk of severe erosion, occasional flooding and moderate alkalinity (pH-8.4).
GpAP2d	An3cB1f1	Very deep, well drained, dark grayish brown to dark brown, calcareous, sandy loam to loam soils on very gently sloping alluvial plains with sandy loam surface having risk of slight erosion, occasional flooding and moderate alkalinity (pH-8.4).
GpAP2s	An1mB2	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on very gently sloping alluvial plains with clay surface having risk of moderate erosion and moderate alkalinity (pH-8.3).
GpAP2w	An3cB3f3	Very deep, well drained, dark yellowish brown to dark brown, calcareous sandy to sandy clay loam soils on very gently sloping alluvial plains with sandy loam surface having risk of severe erosion, severe flooding and moderate alkalinity (pH-8.3).
GpAP2d	An1fC2f2	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on gently sloping alluvial plains with clay loam surface having risk of moderate erosion, moderate flooding and moderate alkalinity (pH-8.3).
GpAPBI2d	An1hB2f1	Very deep, imperfectly drained, brown to very dark grayish brown, calcareous clay loam to clay soils on very gently sloping basaltic interfluves with sandy clay loam surface having risk of moderate erosion, occasional flooding and moderate alkalinity (pH-8.3).
GpCP1w	An3fA1f4	Very deep, well drained, dark yellowish brown to dark brown, calcareous sandy loam to clay loam soils on nearly level coastal plains with clay loam surface having risk of slight erosion, very severe flooding and moderate alkalinity (pH-7.9).

Table 2.2.5. Description of soils in Khedbrahma taluk, Sabarkantha district, Gujarat

LEU	Soil series phases	Description of soil characteristics
CaHR5f	PalcF4	Moderately shallow, dark reddish brown, sandy loam soils on steeply sloping hills and ridges with sandy loam surface and neutral soil reaction (pH-6.6) with risk of very severe erosion.
CaHR5k	PalcF4	Moderately shallow, dark reddish brown, sandy loam soils on steeply sloping hills and ridges with sandy loam surface and neutral soil reaction (pH-6.6) with risk of very severe erosion.
CaHR5w	PalcF3	Moderately shallow, brown to dark reddish brown, sandy loam soils on steeply sloping hills and ridges with sandy loam surface and neutral soil reaction (pH-6.6) with risk of severe erosion
CaPE4d	ChtcB2	Moderately shallow, dark brown, sandy loam to sandy clay loam soils on very gently sloping pediments with sandy loam surface and slight alkalinity (pH-7.5) with risk of moderate erosion.
CaPE4d	LamcC3	Deep, dark yellowish brown, sandy loam to sandy clay loam soils on gently sloping pediments with sandy loam surface and neutral soil reaction (pH-6.7) with risk of severe erosion.
CaPE4d	LmbcB2	Deep, brown to dark reddish brown, sandy loam to sandy clay loam soils on very gently sloping pediments with sandy loam surface and neutral soil reaction (pH-6.7) with risk of moderate erosion.
CaPE4d	PdrcB3	Moderately shallow, brown to dark reddish brown, sandy loam to sandy clay loam soils on very gently sloping pediments with sandy loam surface and slight alkalinity (pH-8.0) with risk of severe erosion.
CaPE4k	VincB2	Deep, dark yellowish brown to dark brown, sandy loam soils on very gently sloping pediments with sandy loam surface and slight alkalinity (pH-7.8) with risk of moderate erosion.
CaPE4s	DelcA2	Very deep, dark yellowish brown to dark brown, sandy loam soils on level to nearly level pediments with sandy loam surface and slight alkalinity (pH-7.6) with risk of moderate erosion.
CaPE4w	ChtcB2	Moderately shallow, dark brown, sandy loam to sandy clay loam soils on very gently sloping pediments with sandy loam surface and slight alkalinity (pH-7.5) with risk of moderate erosion.
CaPE5w	ChtcB2	Moderately shallow, dark brown, sandy loam to sandy clay loam soils on very gently sloping pediments with sandy loam surface and slight alkalinity (pH-7.5) with risk of moderate erosion.
CaPI2	BagcB2	Moderately shallow, brown to dark brown, sandy loam to sandy clay loam soils on very gently sloping piedmont plain/alluvial plain with sandy loam surface and neutral soil reaction (pH-6.6) with risk of moderate erosion.
CaPI2d	BagcB2	Moderately shallow, brown to dark brown, sandy loam to sandy clay loam soils on very gently sloping piedmont plain/alluvial plain with sandy loam surface and neutral soil reaction (pH-6.6) with risk of moderate erosion.

LEU	Soil series phases	Description of soil characteristics
CaPI2d	JotcA1	Deep, brown to dark grayish brown, sandy loam to sandy clay loam soils on level to nearly piedmont plain/alluvial plain with sandy loam surface and moderate alkalinity (pH-7.9) with risk of slight erosion.
CaPI2d	KhdcA1	Deep, brown, sandy loam to clay loam soils on level to nearly piedmont plain/alluvial plain with sandy loam surface and slight alkalinity (pH-7.7) with risk of slight erosion.
CaPI2d	NakcA1	Very deep, brown, sandy loam to sandy clay loam soils on level to nearly piedmont plain/ alluvial plain with sandy loam surface and slight alkalinity (pH-7.7) with risk of slight erosion.
CaPI2f	PdrcB3	Moderately shallow, brown to dark reddish brown, sandy loam to sandy clay loam soils on very gently sloping piedmont plain/alluvial plain with sandy loam surface and moderate alkalinity (pH-8.0) with risk of severe erosion.
CaPI2k	KhdcA1	Deep, brown, sandy loam to clay loam soils on level to nearly piedmont plain/alluvial plain with sandy loam surface and slight alkalinity (pH-7.7) with risk of slight erosion.
CaPI2s	Pdr-3cB3	Moderately shallow, brown to dark reddish brown, sandy loam to sandy clay loam soils on very gently sloping piedmont plain/alluvial plain with sandy loam surface and moderate alkalinity (pH-8.0) with severe risk of erosion.
CaPI2w	ChtcB2	Moderately shallow, dark brown, sandy loam to sandy clay loam soils on very gently sloping piedmont plain/alluvial plain with sandy loam surface and slight alkalinity (pH-7.5) with moderate risk of erosion.

Dholka taluk, Ahmadabad district, Gujarat

Study of soils of Dholka taluk (Fig. 2.2.5 & Table 2.2.6) indicated that the flood plains and the coastal plains of west coast and Kathiwar peninsula, respectively in Gujarat coastal plain have the problems of erosion and the risk of flooding.The problem of sheet erosion has the greater bearing on the management in the alluvial plains in west coast part of the taluk.

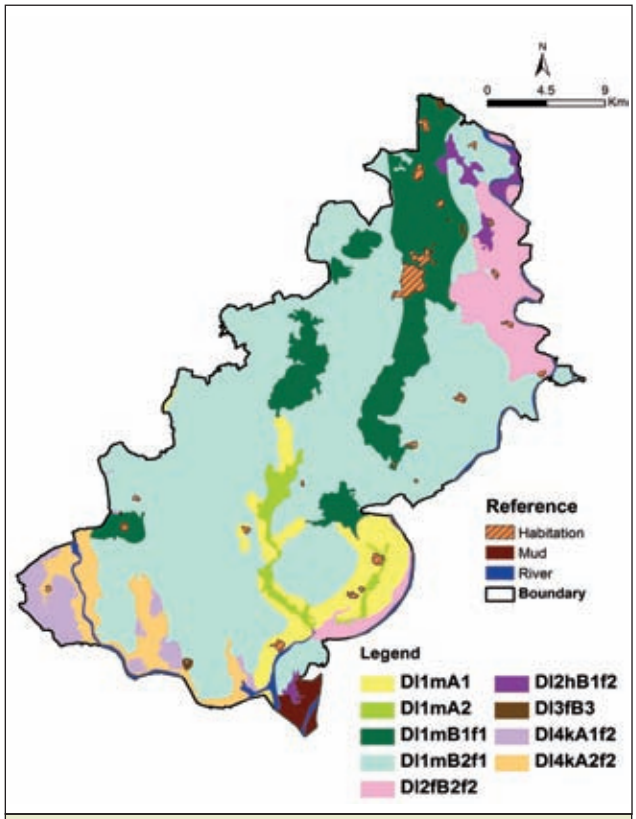


Fig. 2.2.5. Soil map of Dholka taluk, Ahmadabad district, Gujarat

Deesa taluk, Sabarkantha district, Gujarat

Deesa taluk represent the area of the state having the influence of Thar Desert and the soils of taluk are mapped into twenty phases of three series (Fig. 2.2.6 & Table 2.2.7). Desertic landscape like stabilized and unstablized dunes of aeolian and aeofluvial plains have moderate to severe risk of wind erosion together with the problem of salinity and sodicity at places.

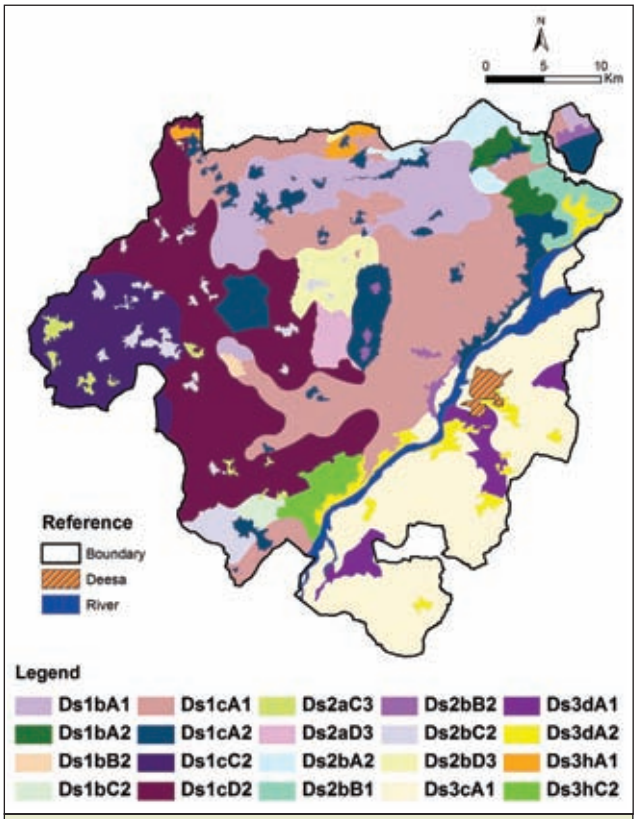


Fig. 2.2.6. Soil map of Deesa taluk, Sabarkantha district, Gujarat

Table 2.2.6. Description of soils in Dholka taluk, Ahmadabad district, Gujarat

LEU	Soil series phases	Description of soil characteristics
GpAP2d	Dl1mB1f1	Deep, moderately well drained, dark brown to very dark grayish brown, clay loam to clayey soils on very gently sloping alluvial plains with clay surface, slight erosion, slight flooding and moderate alkalinity (pH-8.4).
GpAP2s	Dl1mB2f1	Deep, imperfectly drained, very dark grayish brown to very dark grey, clay loam to clayey soils on very gently sloping alluvial plains with clay surface, moderate erosion, slight flooding and strong alkalinity (pH-8.6).
GpAP2w	Dl3fB3	Deep, imperfectly drained dark brown, sandy clay to clay loam soils on very gently sloping alluvial plains with clay loam surface, severe erosion and strong alkalinity (pH-8.5).
GpFP1s	Dl1mA1	Deep, imperfectly drained, very dark grayish brown, clay loam to clay soils on nearly level flood plains with clay surface, very slight erosion and strong alkalinity (pH-8.6).
GpFP1w	Dl1mA2	Deep, imperfectly drained, very dark gray, clay loam to clay soils on nearly level flood plains with clay surface, moderate erosion and strong alkalinity (pH-8.7).
GpFP2d	Dl1mB2f1	Deep, moderately well drained, brown to dark grayish brown, clay loam to clayey soils on very gently sloping flood plains with clay surface, moderate erosion, slight flooding and moderate alkalinity (pH-8.3).
GpFP2s	Dl2fB2f2	Deep, imperfectly drained dark brown, sandy clay loam to clay loam soils on very gently sloping flood plains with clay loam surface, moderate erosion, moderate flooding and strong alkalinity (pH-8.5).
GpFP2w	Dl2hB1f2	Deep, imperfectly drained, dark grayish brown to very dark grayish brown, sandy clay loam to clay loam soils on very gently sloping flood plains with sandy clay loam surface, very slight erosion, moderate flooding and very strong alkalinity (pH-9.1).
GwCPOs	Dl4kA1f2	Deep, very poorly drained, very dark grayish brown, silty clay loam to silty clay soils on low lying nearly level coastal plains with silty clay surface, slight erosion, moderate flooding and moderate alkalinity (pH-8.4).
GwCPOw	Dl4kA2f2	Deep, imperfectly drained, very dark grayish brown, silty loam to silty clay soils on nearly level coastal plains with silty clay surface, moderate erosion, moderate flooding and moderate alkalinity (pH-8.4).
GwCP1s	Dl4kA1f2	Deep, imperfectly drained, very dark grayish brown, silty clay to clay soils on nearly level coastal plains with silty clay surface, slight erosion, moderate flooding and moderate alkalinity (pH-8.1).
GwCP1w	Dl4kA2f2	Deep, imperfectly drained, very dark grayish brown, silty loam to clay soils on nearly level coastal plains with silty clay surface, moderate erosion, moderate flooding and moderate alkalinity (pH-8.4).

Table 2.2.7. Description of soils in Deesa taluk, Sabarkantha district, Gujarat

LEU	Soil series phases	Description of soil characteristics
GpAD1d	Ds1bA1	Very deep, well drained, dark yellowish brown to brown, loamy sand to sandy loam soils on nearly level aeolian plain on stabilized sand dunes with loamy sand surface having risk of slight erosion and moderate alkalinity (pH-8.4).
GpAD1f	Ds1bA2	Very deep, well to excessively drained, dark yellowish brown to dark brown, loamy sand to sandy loam soils on nearly level aeolian plain on stabilized sand dunes with loamy sand surface having moderate erosion and strong alkalinity (pH-8.7).
GpAD1s	Ds2bA2	Very deep, excessively drained, dark yellowish brown to dark brown, sandy soils on nearly level aeolian plain on stabilized sand dunes with loamy sand surface having risk of moderate erosion and strong alkalinity (pH-8.8).
GpAD1t	Ds1cA1	Very deep, well drained, brown to dark yellowish brown, sandy loam to sandy clay loam soils on nearly level aeolian plain on stabilized sand dunes with sandy loam surface having risk of slight erosion and strong alkalinity (pH-8.8).

LEU	Soil series phases	Description of soil characteristics
GpAD1w	Ds1cA2	Very deep, well drained, brown to dark yellowish brown, sandy loam to sandy clay loam soils on nearly level aeolian plain on stabilized sand dunes with sandy loam surface having risk of moderate erosion and strong alkalinity (pH-8.7).
GpAD2d	Ds1bB2	Very deep, well drained brown to dark yellowish brown, loamy sand to sandy clay loam soils on very gently sloping aeolian plain on stabilized sand dunes having loamy sand surface, moderate erosion and moderate alkalinity (pH-8.3).
GpAD2t	Ds2bB1	Very deep, well drained, dark yellowish brown to dark brown, loamy sand to sandy loam soils on very gently sloping aeolian plain on stabilized sand dunes having loamy sand surface, slight erosion and moderate alkalinity (pH-8.4).
GpAD2w	Ds2bB2	Very deep, excessively drained, yellowish brown to dark yellowish brown, loamy sand to sandy loam soils on very gently sloping aeolian plain with stabilized sand dunes having loamy sand surface, moderate erosion and strong alkalinity (pH-8.7).
GpAD3d	Ds1bC2	Very deep, well drained, brown to dark yellowish brown, loamy sand to sandy clay loam soils on gently sloping aeolian plain on stabilized sand dunes with loamy sand surface having risk of moderate erosion and moderate alkalinity (pH-8.4).
GpAD3t	Ds1cC2	Very deep, well drained, yellowish brown to dark yellowish brown, loamy sand to sandy loam soils on gently sloping aeolian plain with stabilized sand dunes having sandy loam surface, moderate erosion and strong alkalinity (pH-8.8).
GpAD3w	Ds2bC2	Very deep, excessively drained, yellowish brown to dark brown, loamy sand to sandy loam soils on gently sloping aeolian plain with stabilized sand dunes having loamy sand surface, moderate erosion and strong alkalinity (pH-8.7).
GpAD4d	Ds2aD3	Very deep, excessively drained, yellowish brown, loamy sand to sandy soils on moderately sloping aeolian plain with stabilized sand dunes having sandy surface, severe erosion and strong alkalinity (pH-8.8).
GpAD4t	Ds1cD2	Very deep, well drained, dark yellowish brown to dark brown, sandy loam soils on moderately sloping aeolian plain with stabilized sand dunes having sandy loam surface, moderate erosion and strong alkalinity (pH-8.7).
GpAD4w	Ds2bD3	Very deep, excessively drained, dark yellowish brown to dark brown, loamy sand to sandy loam soils on moderately sloping aeolian plain with stabilized sand dunes, having loamy sand surface having risk of moderate erosion and strong alkalinity (pH-8.8).
GpAE1t	Ds3hA1	Very deep, well drained, dark yellowish brown to dark brown, sandy loam to sandy clay loam soils on nearly level aeolian plain with sandy clay loam surface, slight erosion and very strong alkalinity (pH-9.4).
GpAE3d	Ds3hC2	Very deep, well drained, dark yellowish brown to dark brown, loam to sandy clay loam soils on gently sloping aeolian plain with sandy clay loam surface having risk of moderate erosion and very strong alkalinity (pH-9.3).
GpAE3w	Ds2aC3	Very deep, excessively drained, yellowish brown, sand to loamy sand soils on nearly level aeolian plain with sandy surface having severe erosion and strong alkalinity (pH-8.8).
GpAF1d	Ds3cA1	Very deep, well drained, dark yellowish brown, sandy loam to sandy clay loam soils on nearly level aeo-fluvial plain with sandy loam surface having slight erosion and moderate alkalinity (pH-8.0).
GpAF1s	Ds3dA1	Very deep, well drained, yellowish brown to dark yellowish brown, sandy loam to sandy clay loam soils on nearly level aeo-fluvial plain with loam surface having risk of slight erosion and strong alkalinity (pH-8.8).
GpAF1t	Ds3cA1	Very deep, well drained, dark yellowish brown to dark brown, sandy loam to sandy clay loam soils on nearly level aeo-fluvial plain with sandy loam surface having risk of slight erosion and moderate alkalinity (pH-8.3).
GpAF1w	Ds3dA2	Very deep, well drained, yellowish brown to dark yellowish brown, loamy sand to sandy clay loam soils on nearly level aeo-fluvial plain with loamy surface having risk of moderate erosion and strong alkalinity (pH-8.8).

Porbandar taluk, Porbandar district, Gujarat

Porbandar taluk represents the parts of Kathiwar peninisula in the state of Gujarat. The soils of the taluk are mapped into twenty seven phases of sixteen series (Fig.2.2.7 & Table 2.2.8). Soil resource map of the taluk could quantify the precise area of the soils having the problems of sodicity with and/or without problems of salinity, flooding and erosion.

Rapar taluk, Kutch district, Gujarat

Rapar taluk covers a part of Kutch peninsula in the state of Gujarat. The soils of taluk, mapped into thirty two phases of twenty series (Fig. 2.2.8 & Table 2.2.9) have the problems of sodicity, salinity and flooding.

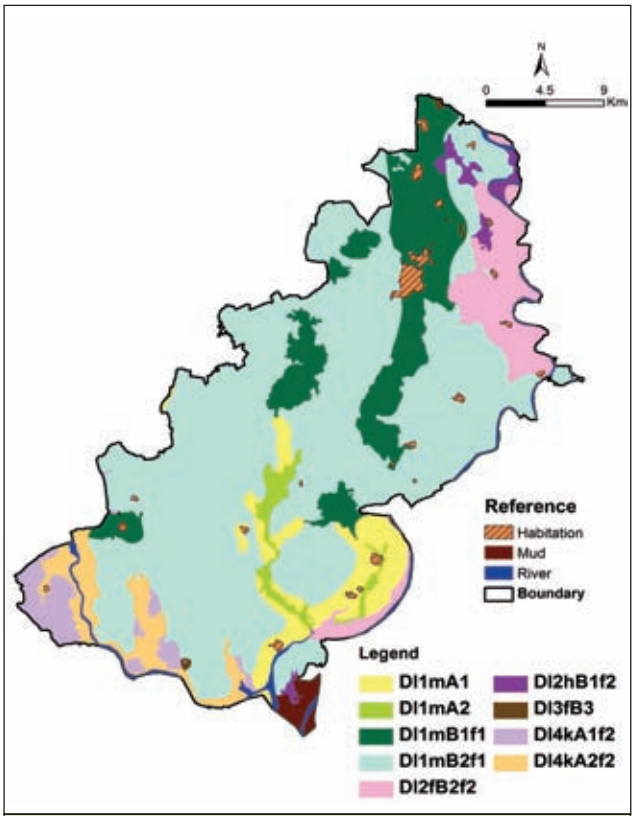


Fig. 2.2.7. Soil map of Porbandar taluk, Porbandar district, Gujarat

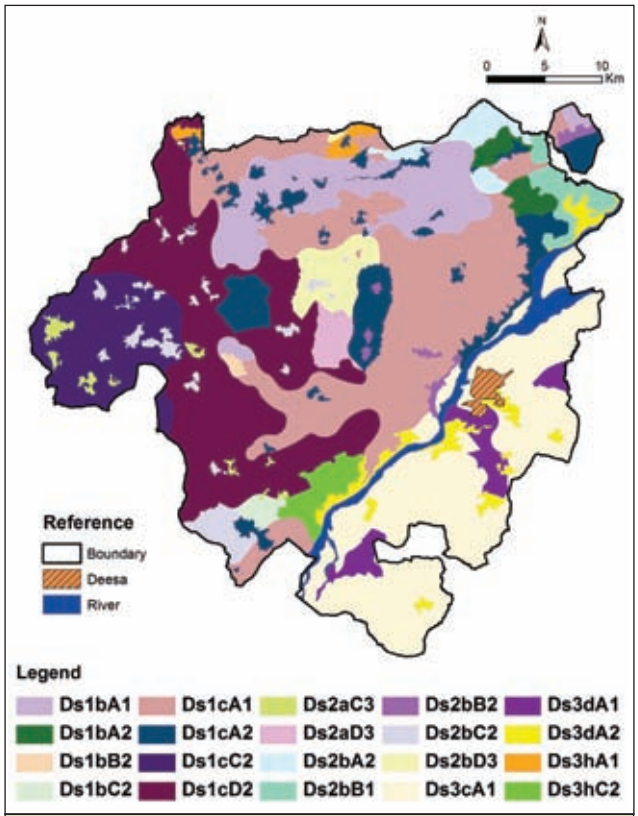


Fig. 2.2.8. Soil map of Rapar taluk, Kutch district, Gujarat

Table 2.2.8. Description of soils in Porbandar taluk, Porbandar district, Gujarat

LEU	Soil series phases	Description of soil characteristics
GwMR3f	Bhp-aC2	Very deep, excessively drained, very pale brown to pale brown, sandy soils on gently sloping coastal plain marine ridges with sandy surface having risk of moderate erosion and strong alkalinity (pH-8.9).
GwMR3k	Bhv-eB1s1n1	Deep, imperfectly drained, dark very dark grayish brown, silt loam soils on very gently sloping coastal plain marine ridgeswith clay loam surface having risk of slight erosion, slight salinity and strong alkalinity (pH-8.8).
GwMR3k	Odr-bB2	Shallow, excessively drained, dark yellowish brown to dark brown, loamy sand soils on very gently sloping coastal plain marine ridges with loamy sand surface having risk of moderate erosion and strong alkalinity (pH-8.5).
GwMR3r	Rtd-dB2	Shallow, well drained, very dark grayish brown, loam soils on very gently sloping coastal plain marine ridges with clay loam surface having risk of moderate erosion and strong alkalinity (pH-8.6).
GwMR3w	Plk-GeC4	Shallow, excessively drained, reddish brown, gravelly silt loam soils on gently sloping coastal plain marine ridges with silt loam surface having risk of very severe erosion and moderate alkalinity (pH-7.9).

LEU	Soil series phases	Description of soil characteristics
GwBE3c	Ksh-cA1s2n3f2	Very deep, poorly drained yellowish brown to brown, sandy loam soils on level to nearly level beaches with sandy loam surface having risk of slight erosion, moderate salinity, moderate flooding and strong alkalinity (pH-8.5).
GwBE3d	Rtd-eB2	Shallow, imperfectly drained, brown to very dark grayish brown, silt loam soils on very gently sloping beach with silt loam surface having risk of moderate erosion and strong alkalinity (pH-8.6).
GwBE3k	Brd-eA1	Moderately deep, moderately well drained, brown to very dark grayish brown, silt loam soils on level to nearly level beaches beach with silt loam surface having risk of slight erosion and strong alkalinity (pH-8.8).
GwBE3r	Vis-fb1s3n1f2	Very deep, moderately well drained, dark brown to very dark grayish brown, clay loam soils on very gently sloping beach with clay loam surface having risk of slight erosion, moderately strong salinity, moderate flooding and strong alkalinity (pH-8.9).
GwBE3w	Bhp-aC2	Very deep, excessively drained, very pale brown to pale brown, sandy soils on gently sloping beach with sandy surface having risk of moderate erosion and strong alkalinity (pH-8.9).
GwCP1c	Brd-eb1s2f2	Moderately shallow, moderately well drained, dark brown to very dark grayish brown, silt loam soils on very gently sloping coastal plain with silt loam surface having risk of slight erosion, moderate salinity, moderate flooding and strong alkalinity (pH-8.8).
GwCP1k	Brd-eA1s1f1	Moderately shallow, well drained, yellowish brown, silt loam soils on level to nearly level coastal plain with silt loam surface having risk of slight erosion, slight salinity, slight flooding and strong alkalinity (pH-8.8).
GwCP1r	Rtd-dB2	Shallow, well drained, very dark grayish brown, loam soils on very gently sloping coastal plain with silt loam surface having risk of moderate erosion and strong alkalinity (pH-8.6).
GwCP1r	ksd-eA1s3f2	Deep, moderately well drained, very dark grayish brown to dark brown, silt loam soils on level to nearly level coastal plain with silt loam surface having risk of slight erosion, moderately strong salinity moderate flooding and strong alkalinity (pH-8.8).
GwCP1s	ksd-fB1s2f2	Deep, imperfectly drained, dark grayish brown to very dark gray, clay loam soils on very gently sloping coastal plain with clay loam surface having risk of slight erosion, moderate salinity, moderate flooding and strong alkalinity (pH-8.8).
GwCP1w	Vis-eB1s3n2f2	Very deep, imperfectly drained, dark brown to very dark grayish brown, silt loam soils on very gently sloping coastal plain with silt loam surface having risk of slight erosion, moderately strong salinity, moderate flooding and moderate alkalinity (pH-8.9).
GwCP2d	Brd-eA1s1f1	Moderately shallow, well drained, yellowish brown, silt loam soils on level to nearly level coastal plain with silt loam surface having risk of slight erosion, slight salinity, moderate flooding and strong alkalinity (pH-8.8).
GwCP2k	Rtd-eB2	Shallow, imperfectly drained, dark grayish brown to dark brown, silt loam soils on very gently sloping coastal plain with silt loam surface having risk of moderate erosion and strong alkalinity (pH-8.6).
GwCP2r	Bhv-lB1s1n1	Deep, well drained, dark yellowish brown to dark brown, sandy clay soils on very gently sloping coastal plain with sandy clay surface having risk of slight erosion, slight salinity and strong alkalinity (pH-8.9).
GwCP2s	Plk-GeC4	Shallow, excessively drained, reddish brown, gravelly silt loam soils on gently sloping coastal plain with silt loam surface having risk of very severe erosion and moderate alkalinity (pH-7.9).
GwCP2w	Odr-bC4	Moderately shallow, excessively drained, dark yellowish brown, loamy sand soils on gently sloping coastal plain with loamy sand surface having risk of very severe erosion and strong alkalinity (pH-8.5).
GwHB3d	Sil-eB1	Deep, well drained, dark yellowish brown to very dark grayish brown, silt loam soils on very gently sloping inter hilly basin with silt loam surface having risk of slight erosion and moderate alkalinity (pH-8.2).
GwHB3k	Ish-eB2	Deep, well drained, brown, silt loam soils on very gently sloping inter hilly basin with silt loam surface having risk of moderate erosion and strong alkalinity (pH-8.7).
GwHB3r	Vac-eB1	Deep, moderately well drained, dark brown to very dark grayish brown, silt loam soils on very gently sloping inter hilly basin with silt loam surface having risk of slight erosion and strong alkalinity (pH-8.7).

LEU	Soil series phases	Description of soil characteristics
GwHB3s	Plk-GeC4	Shallow, excessively drained, reddish brown, gravelly silt loam soils on gently sloping inter hilly basin with silt loam surface having risk of very severe erosion and moderate alkalinity (pH-7.9).
GwHD5w	Sin-GdD3	Shallow well drained, dark yellowish brown gravelly loam soils on moderately sloping domes with loam surface having risk of severe erosion and strong alkalinity (pH-8.7).
GwHR4d	Sil-eB2	Well drained, dark yellowish brown to very dark grayish brown, silt loam soils on very gently sloping hills & ridges with silt loam surface having risk of moderate erosion and moderate alkalinity (pH-8.2).
GwHR4o	Sin-GdD3	Shallow well drained, dark yellowish brown gravelly loam soils on moderately sloping hills and ridges with loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GwHR4r	Sin-GdD3	Shallow well drained, dark yellowish brown gravelly loam soils on moderately sloping hills and ridges with loam surface having risk of severe erosion and strong alkalinity (pH-8.7).
GwHR4w	Sin-GdD3	Shallow well drained, dark yellowish brown gravelly loam soils on moderately sloping hills and ridges with loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GwMP2d	Ish-eB1	Deep well drained, dark grayish brown to very dark grayish brown, silt loam soils on very gently sloping piedmont plain with mound having silt loam surface, slight erosion and strong alkalinity (pH-8.6).
GwMP2k	Rar-eB1	Shallow moderately well drained, dark brown, silt loam soils on very gently sloping piedmont plain with mound with silt loam surface, risk of slight erosion and strong alkalinity (pH-8.6).
GwMP2r	Sin-GeB3	Shallow dark brown gravelly silt loam soils on very gently sloping piedmont plain on mounds with silt loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GwMP2w	Sin-GeB3	Shallow dark brown gravelly silt loam soils on very gently sloping piedmont plain on mounds having silt loam surface, risk of severe erosion and strong alkalinity (pH-8.7).
GwPA2d	Adv-fB2	Moderately shallow well drained, very dark grayish brown clay loam soils on very gently sloping piedmont plain with narrow valley, having clay loam surface, risk of moderate erosion and strong alkalinity (pH-8.7).
GwPA2d	Rar-fB1	Shallow moderately well drained, dark brown to very dark grayish brown clay loam soils on very gently sloping piedmont plain with narrow valley, having clay loam surface, risk of slight erosion and strong alkalinity (pH-8.7).
GwPA2r	Sod-fB1	Deep well drained, grayish brown to very dark brown, clay loam on very gently sloping piedmont plain with narrow valley having clay loam surface, risk of slight erosion and strong alkalinity (pH-8.8).
GwPA2w	Ish-eB2	Deep well drained, dark grayish brown to very dark grayish brown, silt loam soils on very gently sloping piedmont plain with narrow valley, having silt loam surface, risk of moderate erosion and strong alkalinity (pH-8.7).

Table 2.2.9. Description of soils in Rapar taluk, Kutch district, Gujarat

LEU	Soil series phases	Description of soil characteristics
GuAR2g	Dsl-fA1s3f3	Deep, dark brown to dark yellowish brown, loam to clay soils on level to nearly level arid plains with clay loam surface having risk of slight erosion, severe flooding, moderately strong salinity and strong alkalinity (pH-9.0).
GuAR2k	Bdg-aB2	Deep, excessively drained, yellowish brown, sandy soils on very gently sloping arid plains with sandy surface having risk of moderate erosion and strong alkalinity (pH-8.7).
GuAR2k	Dsl-eB1s1n1	Deep, brown, well drained, silt loam to clay soils on very gently sloping arid plains with silt loam surface having risk of slight erosion, slight salinity and strong alkalinity (pH-9.0).
GuAR2k	Jdp-cB1s1	Deep, well drained yellowish brown, calcareous, sandy to loamy soils on very gently sloping arid plains with sandy loam surface having risk of slight erosion, slight salinity and strong alkalinity (pH-9.0).
GuAR2k	Jdp-cB2	Deep, moderately well drained, brown, loamy soils on very gently sloping arid plains with sandy loam surface having risk of moderate erosion and strong alkalinity (pH-9.0).
GuAR2k	Kmr-eB1s2	Deep, moderately well drained, dark yellowish brown to brown, silt loam to clay soils on very gently sloping arid plains with silt loam surface having risk of slight erosion, moderate salinity and strong alkalinity (pH-8.8).

LEU	Soil series phases	Description of soil characteristics
GuAR2k	Nds-eB2s2n2	Deep, well drained, yellowish brown to dark yellowish brown, loam to silt loam soils on very gently sloping arid plains with silt loam surface having risk of moderate erosion, moderate salinity and moderate alkalinity (pH-8.3).
GuAR2k	Ngp-cB2	Moderately deep, moderately well drained, brown to strong brown, sandy loam to loamy soils on very gently sloping arid plains with sandy loam surface having risk of moderate erosion and strong alkalinity (pH-8.8).
GuAR2w	Bhm-gdC3	Shallow, moderately well drained, brown, loamy soils on gently sloping arid plains with gravelly loam surface having risk of severe erosion and strong alkalinity (pH-8.5).
GuAR2w	Gtb-eC3	Shallow, somewhat excessively drained, yellowish red, loam to clay loam soils on gently sloping arid plains with silt loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GuAR2w	Skp-eB2	Deep, imperfectly drained, brown to dark brown, silt loam to clayey soils on very gently sloping arid plains with silt loam surface having risk of moderate erosion and moderate alkalinity (pH-8.2).
GuAV2k	Prt-dB2	Moderately deep, moderately well drained, yellowish brown, loamy soils on very gently sloping arid plain with narrow valley having loam surface, risk of moderate erosion and moderate alkalinity (pH-8.4).
GuAV2k	Rmp-cB2	Moderately deep, well drained, dark yellowish brown to brown, sandy loam to loamy soils on very gently sloping arid plain with narrow valley having sandy loam surface, moderate erosion and moderate alkalinity (pH-8.2).
GuAV2w	Bhm-gdC3	Shallow, moderately well drained, brown, loamy soils on gently sloping arid plain with narrow valley with gravelly loam surface having risk of severe erosion and moderate alkalinity (pH-8.5).
GuAV3k	Prt-dB2	Moderately deep, moderately well drained yellowish brown, loamy soils on very gently sloping arid plain with narrow valley having loam surface, risk of moderate erosion and moderate alkalinity (pH-8.4).
GuAV3k	Kmr-eAs2	Deep, well drained, dark yellowish brown to brown, silt loam soils on level to nearly level arid plain with narrow valley having silt loam surface, moderate salinity and strong alkalinity (pH-8.8).
GuAV3k	Shr-eB2	Shallow, moderately well drained, dark yellowish brown, silt loam to clayey soils on very gently sloping arid plain with narrow valley having silt loam surface, risk of moderate erosion and strong alkalinity (pH-8.7).
GuAV3w	Plp-cC3	Deep, somewhat excessively drained, yellowish brown to strong brown, sandy to sandy loam soils on gently sloping arid plain with narrow valley having sandy loam surface having risk of severe erosion and moderate alkalinity (pH-8.4).
GuCD2s	Mnb-cB1s2n2	Moderately deep, imperfectly drained dark yellowish brown to brown, loamy soils on very gently sloping coastal plain with stabilized sand dunes with sandy loam surface having risk of slight erosion and moderate salinity and moderate alkalinity (pH-8.6).
GuCD2w	Vrn-eA1s3n1	Deep, imperfectly drained, yellowish brown to dark yellowish brown, silt loam to clayey soils on level to nearly level coastal plain with stabilized sand dunes having silt loam surface having risk of slight erosion, severe salinity and slight alkalinity (pH-8.7).
GuEH2k	Jdp-bB2	Deep, moderately well drained, brown, loamy sand to loam soils on very gently sloping elongated hills and ridges having loamy sand surface, risk of moderate erosion and strong alkalinity (pH-9.0).
GuEH2k	Vjp-dC2	Moderately shallow, imperfectly drained, brown to dark brown, loam to clayey soils on gently sloping elongated hills and ridges having loam surface, risk of moderate erosion and moderate alkalinity (pH-8.3).
GuEH2w	Gtb-cC3	Very shallow, somewhat excessively drained, dark yellowish brown, gravelly loam soils on gently sloping elongated hills and ridges with sandy loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GuEH2w	Nlp-gcB2	Moderately deep, moderately well drained, light yellowish brown to dark yellowish brown, gravelly sandy loam to loam soils on very gently sloping elongated hills and ridges with gravelly sandy loam surface having risk of moderate erosion and moderate alkalinity (pH-8.1).
GuMF1g	Dsl-fA1s3f3	Deep, poorly drained, dark yellowish brown to dark brown, loamy to clay soils on level to nearly level mudflats with clay loam surface having risk of slight erosion, severe risk of flooding and severe salinity with very strong alkalinity (pH-9.2).

LEU	Soil series phases	Description of soil characteristics
GuMF1k	Bdg-aB2	Deep, excessively drained, yellowish brown, sandy soils on very gently sloping mudflats with sandy surface having risk of moderate erosion and strong alkalinity (pH-8.8).
GuMF1k	Ngp-eB2	Deep, moderately well drained, yellowish brown to brown, silt loam soils on very gently sloping mudflats with silt loam surface having risk of moderate erosion and strong alkalinity (pH-8.8).
GuMF1k	Rmt-bB2s2	Shallow, moderately well drained, brown, loamy sand to sandy soils on very gently sloping mudflats with loamy sand surface having risk of moderate erosion, moderate salinity and strong alkalinity (pH-8.7).
GuMF1k	Vrn-eB1s2n2	Deep, moderately well drained, olive brown to brown, loam to clayey soils on very gently sloping mudflats with silt loam surface having risk of slight erosion, moderate salinity and moderate sodicity (pH-8.7).
GuMF1k	Sdn-cB2s1n1	Deep, somewhat excessively drained, brown to strong brown, sandy to loamy soils on very gently sloping mudflats with sandy loam surface having risk of moderate erosion, slight salinity and slight sodicity (pH-8.4).
GuMF1s	Mnb-eB2s2n2	Deep, somewhat excessively drained, dark grayish brown to brown, loamy to clayey soils on very gently sloping mudflats with silt loam surface having risk of moderate erosion, moderate salinity and moderate sodicity (pH-8.7).
GuMF1s	Sdn-dB1s4f2	Deep, somewhat excessively drained, olive light brown, loamy to clayey soils on very gently sloping mudflats with loam surface having risk of slight erosion, moderate flooding, strong salinity and moderate alkalinity (pH-8.4).
GuMF1w	Dsl-fA1s2n2	Deep, poorly drained, dark yellowish brown to brown, clay loam to clayey soils on level to nearly level mudflats with clay loam surface having risk of slight erosion, moderate salinity and moderate alkalinity (pH-9.2).
GuMF1w	Rmt-bB1s2	Very deep, somewhat excessively drained, yellowish brown to dark yellowish brown, loamy sand to sandy soils on very gently sloping mudflats with loamy sand surface having risk of slight erosion, moderate salinity and strong alkalinity (pH-8.7).
GuMF1w	Sdn-fA1s4f2	Deep, poorly drained, olive brown to dark yellowish brown, clay loam to clayey soils on level to nearly level mudflats with clay loam surface having risk of slight erosion and moderate flooding, strong salinity and moderate alkalinity (pH-8.4).
GuPH3k	Bhm-aB2	Shallow, somewhat excessively drained, brown, sandy to loamy sand soils on very gently sloping pediments with isolated hillocks having sandy surface, risk of moderate erosion and strong alkalinity (pH-8.6).
GuPH3w	Gtb-cC3	Very shallow, somewhat excessively drained, dark yellowish brown, gravelly loam soils on gently sloping pediments with isolated hillocks with sandy loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
GuRH2k	Jdp-bB2	Deep, moderately well drained, brown, loamy sand to loam soils on very gently sloping residual hills having loamy sand surface, risk of moderate erosion and strong alkalinity (pH-9.0).
GuRH2w	Bhm-gdC3	Shallow, moderately well drained, brown, loamy soils on gently sloping residual hills with narrow valley with silty clay loam surface having risk of severe erosion, strong alkalinity (pH-8.6).
GuRH3g	Dsl-fA1s3f3	Deep, poorly drained, dark yellowish brown to dark brown, loamy to clay soils on level to nearly level residual hills with clay loam surface having risk of slight erosion, severe flooding, severe salinity and moderate alkalinity (pH-9.0).
GuRH3k	Bhm-aB2	Shallow, somewhat excessively drained, brown, sandy to loamy sand soils on very gently sloping residual hills having isolated hillocks having sandy surface having risk of moderate erosion and strong alkalinity (pH-8.6).
GuRH3w	Gtb-cC3	Very shallow, somewhat excessively drained, dark yellowish brown, gravelly sandy loam to loam soils on gently sloping residual hills with isolated hillocks having sandy loam surface having risk of severe erosion and strong alkalinity (pH-8.6).
Rann	Dsl-fA1s3f3	Deep, poorly drained, dark yellowish brown to dark brown, loamy to clay soils on level to nearly level rann with clay loam surface having risk of slight erosion, severe flooding, severe salinity and strong alkalinity (pH-9.0).

b) Eastern region

Basudevpur block, Bhadrak district, Odisha

Basudevpur block in the state of Odisha represent east coast plain of the state and the soils of the block, mapped into twenty two phases of eight series (Fig. 2.2.9 & Table 2.2.10), suffer from moderate to severe problems of salinity.

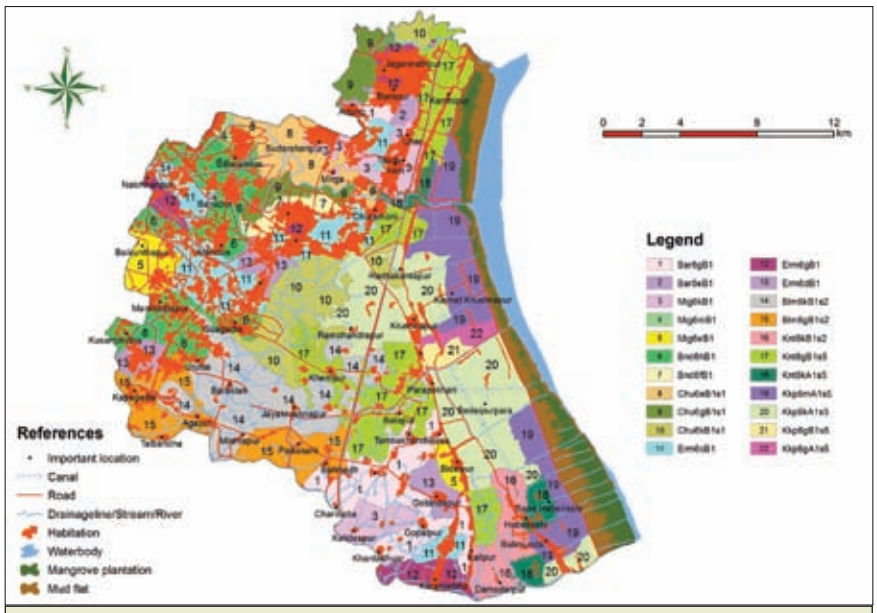


Fig. 2.2.9. Soil map of Basudevpur block, Bhadrak district, Odisha

Table 2.2.10. Description of soils in Basudevpur block, Bhadrak district, Odisha

LEU	Soil series phases	Description of soil characteristics
PeO2s	Bar6gB1	Very deep, poorly drained, yellowish brown, clayey soils on very gently sloping old alluvial plain with silty clay loam surface and slight erosion.
PeO2s	Bar6eB1	Very deep, poorly drained, yellowish brown, clayey soils on very gently sloping old alluvial plain with silt loam surface and slight erosion.
PeO2d	Mig6kB1	Very deep, poorly drained, dark yellowish brown, clayey soils on very gently sloping old alluvial plain with silly clay surface and slight erosion.
PeO2s	Mig6mB1	Very deep, poorly drained, dark yellowish brown, clayey soils on very gently sloping old alluvial plain with clay surface and slight erosion.
PeO2s	Mig6eB1	Very deep, poorly drained, dark yellowish brown, clayey soils on very gently sloping old alluvial plain with silt loam surface and slight erosion.
PeO2s	Bnd6hB1	Very deep, moderately well drained, dark brown, clay loamy soils on very gently sloping old alluvial plain with sandy clay loam surface and slight erosion.
PeO2s	Bnd6fB1	Very deep, moderately well drained, dark brown, loamy soils on very gently sloping old alluvial plain with clay loam surface and slight erosion.
PeY2d	Chu6eB1	Very deep, poorly drained, yellowish brown, silty clay soils on very gently sloping young alluvial plain with silt loam surface, slight erosion and salinity.
PeY2d	Chu6gB1	Very deep, poorly drained, yellowish brown, silty clay soils on very gently sloping young alluvial plain with silty clay loam surface, slight erosion and salinity.
PeY2s	Chu6kB1	Very deep, poorly drained, yellowish brown, siltyclay soils on very gently sloping young alluvial plain with silty clay surface, slight erosion and salinity.
PeO2d	Erm6cB1	Very deep, moderately well drained, brown, loamy soils on very gently sloping old alluvial plain with sandy loam surface and slight erosion.
PeO2s	Erm6gB1	Very deep, moderately well drained, brown, loamy soils on very gently sloping old alluvial plain with sandy clay loam surface and slight erosion.

PeO2s	Erm6dB1	Very deep, moderately well drained, brown, loamy soils on very gently sloping old alluvial plain with loam surface and slight erosion.
PeC2s	Knt6kB1s2	Very deep, poorly drained, dark brown, silty clay loam to silty clay soils on very gently sloping coastal plain with silty clay surface, slight erosion and moderate salinity.
PeC2s	Knt6gB1s2	Very deep, poorly drained, dark brown, silty clay loam to silty clay soils on very gently sloping coastal plain with silty clay loam surface, slight erosion and moderate salinity.
PeY2s	Blm6kB1s2	Very deep, poorly drained, dark brown silty clay to clay soils on very gently sloping young alluvial plain with silty clay surface, slight erosion and moderate salinity.
PeY2s	Blm6gB1s2	Very deep, poorly drained, dark brown silty clay to clay soils on very gently sloping young alluvial plain with silty clay loam surface, slight erosion and moderate salinity.
PeY2s	Blm6kA1s2	Very deep, poorly drained, dark brown silty clay to clay soils on level to nearly level young alluvial plain with silty clay surface, slight erosion and moderate salinity.
PeC1s	Kkp6mA1s5	Very deep, poorly drained, brown, clayey soils on level to nearly level coastal plain with clay surface, slight erosion and severe salinity.
PeC1s	Kkp6kA1s5	Very deep, poorly drained, brown, clayey soils on level to nearly level coastal plain with silty clay surface, slight erosion and severe salinity.
PeC2s	Kkp6gB1s5	Very deep, poorly drained, brown, clayey soils on very gently sloping coastal plain with silty clay loam surface, slight erosion and severe salinity.
PeC1s	Kkp6gA1s5	Very deep, poorly drained, brown, clayey soils on nearly level coastal plain with silty clay loam surface, slight erosion and severe salinity.

Mushahari block, Muzzafarpur district, Bihar

The soils of Mushahari block mapped into in eleven phases of six series (Fig. 2.2.10 & Table 2.2.11), that occurred on the old, young and active flood plains of Indo-Gangetic plain. The soils contain higher content of soft powdery lime and support bountiful Lichi production in the block.

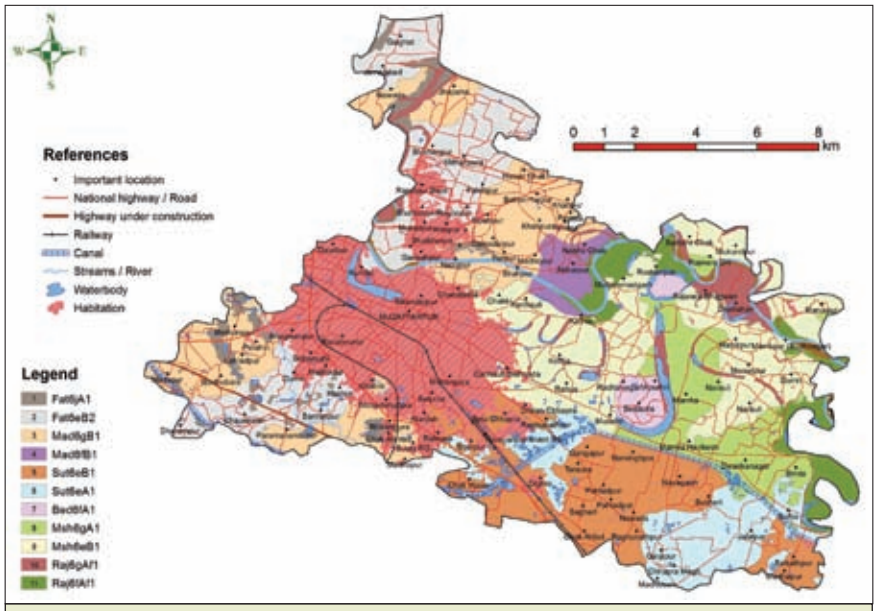


Fig. 2.2.10. Soil map of Mushahari block, Muzzafarpur district, Bihar

Table 2.2.11. Description of soils in Mushahari block, Muzzafarpur district, Bihar

LEU	Soil series phases	Description of soil characteristics
AaO1d	Fat6jA1	Very deep, well drained, grayish brown, highly calcareous silt soils on level to nearly level sloping old alluvial plain with silt surface and slight erosion.
AaO2dp	Fat6eB2	Very deep, well drained, grayish brown, highly calcareous silt loam soils on very gently sloping old alluvial plain with silt loam surface and moderate erosion.
AaO2d	Mad6gB1	Very deep, moderately well drained, dark grayish brown, highly calcareous silty clay loam soils on very gently sloping old alluvial plain with silty clay loam surface and slight erosion.
AaO2d	Mad6fB1	Very deep, moderately well drained, dark grayish brown, highly calcareous clay loam soils on very gently sloping old alluvial plain with clay loam surface and slight erosion.
AaY1s	Sut6eA1	Very deep, moderately well drained, grayish brown, highly calcareous silt loam soils on level to nearly level sloping young alluvial plain with silt loam surface and slight erosion.
AaY2dp	Sut6eB1	Very deep, moderately well drained, grayish brown, highly calcareous silt loam soils on very gently sloping young alluvial plain with silt loam surface and moderate erosion.
$AaA^{m}1d$	Msh6gA1	Very deep, well drained, dark grayish brown, highly calcareous silty clay loam soils on level to nearly level sloping meander plain with silty clay loam surface and slight erosion.
$AaA^{m}2d$	Msh6eB1	Very deep, well drained, dark grayish brown, highly calcareous silt loam soils on very gently sloping meander plain with silt loam surface and slight erosion.
$AaA^{f}1d$	Raj6gAf1	Very deep, imperfectly drained, grayish brown, highly calcareous silty clay loam soils on level to nearly level sloping flood plain with silty clay loam surface and slight flooding.
$AaA^{f}1d$	Raj6fAf1	Very deep, imperfectly drained, olive brown, highly calcareous clay loam soils, on level to nearly level sloping flood plain with clay loam surface and slight flooding.
$AaA^{p}1d$	Bed6fA1	Very deep, well drained, dark grayish brown, highly calcareous clay loam soils on level to nearly level sloping point bar with clay loam surface and slight flooding.

Kadwa block, Katihar district, Bihar

Soils of Kadwa block are mapped into fourteen phases of eight series (Fig. 2.2.11 & Table 2.2.12). Kadwa block represents the active and young alluvial plains of Indo-Gangetic alluvial plains with flooding and periodic water logging problems.

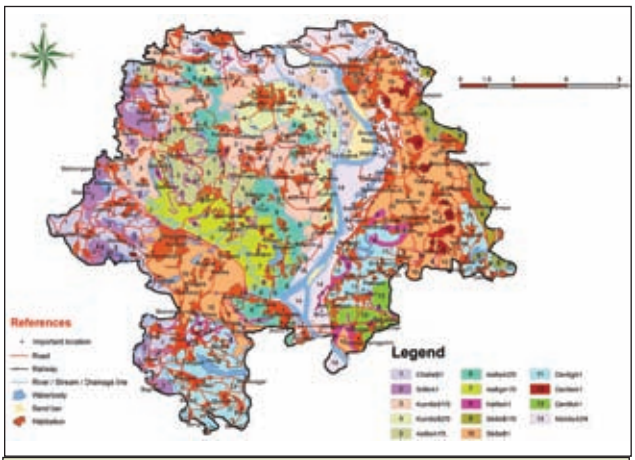


Fig. 2.2.11. Soil map of Kadwa block, Katihar district, Bihar

Ganjam block, Ganjam district, Odisha

It is another block representing east coast of Odisha and the soils of the block are mapped into thirty phases of sixteen series (Fig. 2.2.12 & Table 2.2.13). The soils representing old and young alluvial plains and the coastal plains have the serious problems of flooding and salinity. The soils associated with hills and pediments are affected with the problems of moderate to severe erosion.

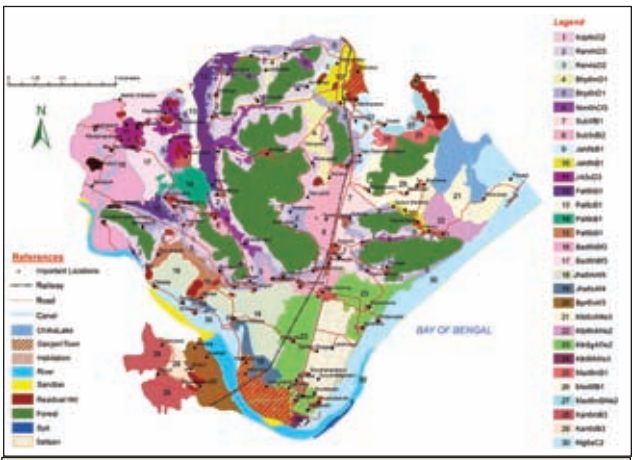


Fig. 2.2.12. Soil map of Ganjam block, Ganjam district, Odisha

Table 2.2.12. Description of soils in Kadwa block, Katihar district, Bihar

LEU	Soil series phases	Description of soil characteristics
AaO2d	Cha6eB1	Very deep, moderately well drained, yellowish brown to dark gray on very gently sloping old alluvial plain with silt loam surface and slight erosion.
AaO1d	Sit6kA1	Very deep, poorly drained, dark gray to dark grayish brown soils on nearly level old alluvial plain with silty clay surface and slight erosion.
AaA^{m}2d	Kum6eB1f3	Very deep, well drained, brown to dark yellowish brown soils on very gently sloping meander plain with silt loam surface , slight erosion and frequent flooding.
AaA^{m}2s	Kum6eB2f3	Very deep, well drained, brown to dark yellowish brown soils on very gently sloping meander plain with silt loam surface, moderate erosion and frequent flooding.
AaA^{m}1d	Asi6eA1f3	Very deep, moderately well drained, brown to gray on nearly level meander plain with silt loam surface, slight erosion and frequent flooding.
AaA^{m}1d	Asi6eA2f3	Very deep, moderately well drained, brown to gray on nearly level meander plain with silt loam surface, moderate erosion and frequent flooding.
AaA1^{m}d	Asi6gA1f3	Very deep, moderately well drained, brown to gray on nearly level meander plain with silty clay loam surface, slight erosion and frequent flooding.
AaA1^{m}s	Kal6eA1	Very deep, poorly drained, brown to gray on nearly level meander scar with silt loam surface and slight erosion.
AaY2d	Sik6eB1f3	Very deep, well drained, brown to dark yellowish brown on very gently sloping young alluvial plain with silt loam surface, slight erosion and frequent flooding.
AaY2d	Sik6eB1	Very deep, well drained, brown to dark yellowish brown on very gently sloping young alluvial plain with silt loam surface and slight erosion.
AaY1d	Dan6gA1	Very deep, moderately well drained, brown to dark yellowish brown on nearly level young alluvial plain with silty clay loam surface and slight erosion.
AaY1s	Dan6eA1	Very deep, moderately well drained, brown to dark yellowish brown on nearly level young alluvial plain with silt loam surface and slight erosion.
AaY1d	Dan6kA1	Very deep, moderately well drained, brown to dark yellowish brown on nearly level young alluvial plain with silty clay surface and slight erosion.
AaA^{f}1d	Mah6eA3f4	Very deep, well drained, light yellowish brown to brown on nearly level flood plain with silt loam surface, severe erosion and very frequent flooding.

Table 2.2.13. Description of soils in Ganjam block, Ganjam district, Odisha

LEU	Soil series phases	Description of soil characteristics
PeH4p	Kdp6cD2	Very deep, well drained, yellowish red to dark red, sandy clay loam soils on moderately sloping foothill with sandy loam surface and moderate erosion.
PeH4d	Ran4hD3	Moderately deep, well drained, dark reddish brown, sandy clay loam soils on moderately sloping foothill with sandy clay loam surface and severe erosion.
	Ran4aD2	Same as above with sandy surface and moderate erosion.
PeP4d	Bhp6mD1	Very deep, somewhat poorly drained, brown to yellowish brown, clay soils with clay surface and slight erosion.
	Bhp6hD1	Same as above with sandy clay loam surface and slight erosion.
PeV3d	Nim6hCf3	Very deep, somewhat poorly drained, brown to dark yellowish brown, sandy clay soils with sandy clay loam surface and have the risk of frequent flooding.

LEU	Soil series phases	Description of soil characteristics
PeU2d	Sub5fB1	Deep, moderately well drained, dark grayish brown to brown, clay soils with clay loam surface and slight erosion.
	Sub5dB2	Same as above with loam surface and moderate erosion.
	Jah6bB1	Very deep, well drained, brown to dark reddish brown, clay soils with loamy sand surface and slight erosion.
	Jah6hB1	Same as above with sandy clay loam surface and slight erosion.
PeH4p	Jrk5cD3	Deep, well drained, strong brown to dark reddish brown, gravelly sandy clay soils with sandy loam surface and severe erosion.
PeO2d	Pal6hB1	Very deep, moderately well drained, dark grayish brown to light olive brown, sandy clay soils with sandy clay loam surface and slight erosion.
	Pal6cB1	Same as above with sandy loam surface and slight erosion.
	Pal6kB1	Same as above with silty clay loam surface and slight erosion.
	Pal6bB1	Same as above with loamy sand surface and slight erosion.
PeO2d	Bad6kBf3	Very deep, well drained, grayish brown to dark grayish brown, silty clay soils with silty clay surface and frequent flooding.
	Bad6hBf3	Same as above with sandy clay loam surface and frequent flooding.
PeY1d	Jha6mAf4	Very deep, somewhat poorly drained, brown to gray, clay soils with clay surface and have the risk of very frequent flooding.
	Jha6cAf4	Same as above with sandy loam surface and have the risk of very frequent flooding.
	Bpr6hAf3	Very deep, moderately well drained, very dark grayish brown to yellowish brown, sandy loam soils with sandy clay loam surface and have the risk of frequent flooding.
PeC1s	Klb6cAf4s3	Very deep, somewhat poorly drained, grey, sandy clay loam soils texture with sandy loam surface, strong salinity and affected with very frequent flooding.
PeC1d	Klb6hAf4s2	Same as above with sandy clay loam surface and moderate salinity and affected with very frequent flooding.
	Ktk6gAf3s2	Very deep, somewhat poorly drained, brown to dark gray, sandy clay soils with silty clay loam surface, moderate salinity and affected with frequent flooding.
	Ktk6fAf4s3	Same as above with clay loam surface, strong salinity and affected with very frequent flooding.
PeC2d	Mad6mB1	Very deep, moderately well drained, very dark grayish brown to dark grayish brown, clay soils with clay surface and slight erosion.
	Mad6fB1	Same as above with clay loam surface and slight erosion.
	Mad6mBf4s2	Same as above with clay surface, moderately salinlty and affected with very frequent flooding.
	Kan6mB3	Very deep, moderately well drained, dark grey to very dark grayish brown, silty clay soils with silty clay surface and affected with frequent flooding.
	Kan6dB3	Same as above with with loamy surface and frequent flooding.
PeC3p	Ktg6aC2	Very deep, somewhat excessive drained, dark grayish brown, sandy soils with sandy surface and moderate wind erosion.

Titlagarh block, Bolangir district, Odisha

The soils of Titlagarh block, representing the part of granite and granitic gneiss landscape of Mahanadi basin in the state of Odisha are mapped into eighteen phases of ten series (Fig. 2.2.13 & Table 2.2.14). The soils associated with the hills, pediments, upland and valleys are affected with erosion; however, extent and severity of erosion are of lesser magnitude in the soils of younger and older alluvial plains.

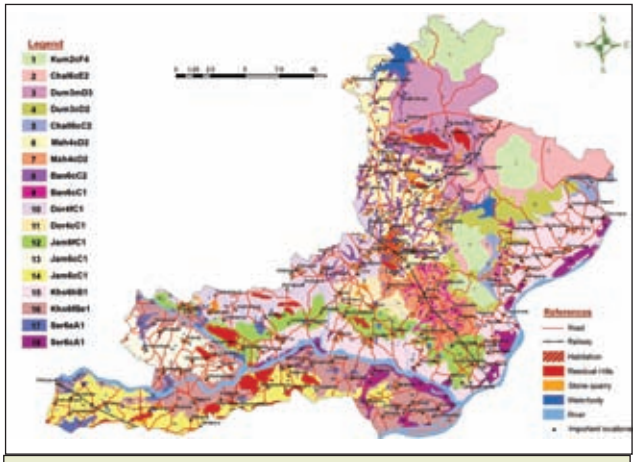


Fig. 2.2.13. Soil map of Titlagarh block, Bolangir district, Odisha

(c) Southern region

Indervalle mandal, Adilabad district, Telangana

The soils of Indravalle mandal represent basaltic terrain of south Deccan plateau and are mapped into twenty phases of seven series (Fig. 2.2.14 & Table 2.2.15). The soils associated with dissected and undissected plateaus, elongated ridges, esacrpments, isolated hillocks, uplands, undulating plateau are severely affected with the problems of erosion, however valleys have the potentiality of good agriculture

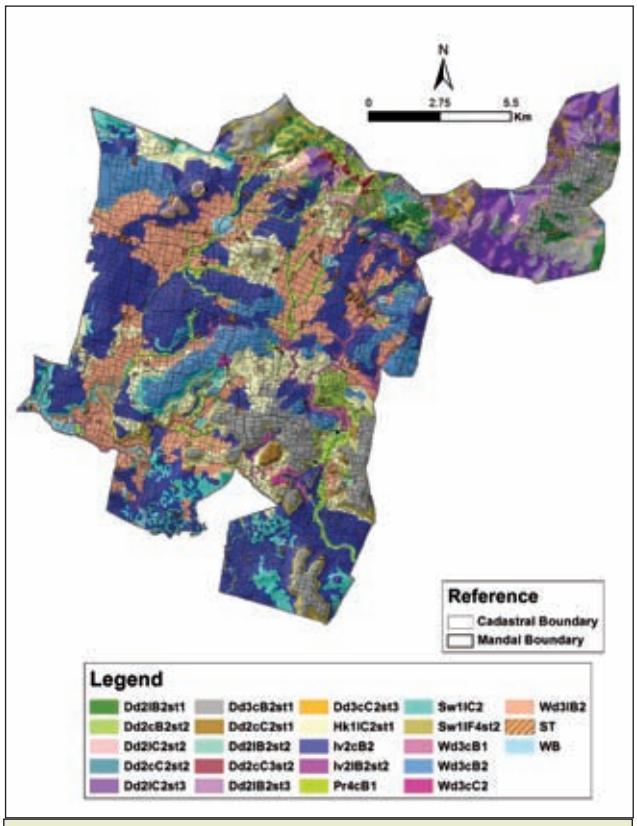


Fig. 2.2.14. Soil map of Indervalle mandal, Adilabad district, Telangana

Table 2.2.14. Description of soils in Titlagarh block, Bolangir district, Odisha

LEU	Soil series phases	Description of soil characteristics
EmH6f	Kum2cF4	Shallow, excessively well drained, brown to strong brown gravelly (40-60%) sandy clay loam soils on steeply sloping hills with sandy loam surface and very severe erosion.
EmH5os	ChaI6cE2	Very deep, well drained, dark reddish brown to red, loam to sandy clay loam soils on moderately steeply sloping hills with gravelly sandy loam surface and moderate erosion.
EmP4s	Dum3mD3	Moderately shallow, well drained, dark yellowish brown to yellowish brown gravelly (40-60%) clayey soils on moderately sloping pediment with loam surface and severe erosion.
EmP4f	Dum3cD2	Moderately shallow, well drained, dark yellowish brown to yellowish brown gravelly (60-70%) sandy loam soils in the surface and sub surface on moderately sloping pediment and affected with severe erosion.
EmP3s	ChaII6cC2	Very deep, well drained, dark reddish brown to red loam to sandy clay loam soils on gently sloping pediment with sandy loam surface and moderate erosion.
EmU4fs	Mah4cD2	Moderately deep, well drained, yellowish red to red gravelly (50-60%) sandy loam soils on moderately sloping upland with gravelly sandy loam surface and moderate erosion.
EmU4fs	Mah4cD2	Moderately deep, well drained, yellowish red to red gravelly (50-60%) sandy loam soils on moderately sloping upland with sandy loam surface and moderate erosion.

LEU	Soil series phases	Description of soil characteristics
EmVf3d	Ban6cC2	Very deep, moderately well drained, dark yellowish brown sandy clay loam soils on gently sloping valley fill with sandy loam surface and moderate erosion.
EmVf3d	Ban6cC1	Very deep, moderately well drained, dark yellowish brown sandy clay loam soils on gently sloping valley fill with sandy loam surface and slight erosion.
EmO3s	Dor4fC1	Moderately deep, moderately well drained, dark brown to dark yellowish brown sandy clay loam soils on gently sloping old alluvial plain with clay loam surface and slight erosion.
EmO3s	Dor4cC1	Moderately deep, moderately well drained, dark brown to dark yellowish brown sandy clay loam soils on gently sloping old alluvial plain with sandy loam surface and slight erosion.
EmY3s	Jam6fC1	Very deep, moderately well drained, very dark grayish brown to dark brown clay loam to clayey cracking soil on gently sloping young alluvial plain with clay loam surface and slight erosion.
EmY3s	Jam6cC1	Very deep, moderately well drained, very dark grayish brown to dark brown clay loam to clayey cracking soil on gently sloping young alluvial plain with sandy loam surface and slight erosion.
EmY3s	Jam6cC1	Very deep, moderately well drained, very dark grayish brown to dark brown gravelly (30-40 %) clay loam to clayey soils on gently sloping young alluvial plain with gravelly sandy loam surface and slight erosion.
EmY2s	Kho6hB1	Very deep, imperfectly drained, yellowish brown to dark yellowish sandy clay loam to sandy clay soils on very gently sloping young alluvial plain with sandy clay loam surface and slight erosion.
EmY2d	Kho6fBe1	Very deep, imperfectly drained, yellowish brown to dark yellowish sandy clay loam to sandy clay soils on very gently sloping young alluvial plain with clay loam surface and slight erosion.
EmY1d	Ser6eA1	Very deep, imperfectly drained, dark grayish brown to very dark grayish brown clay loam to clayey soils on nearly level young alluvial plain with silt loam surface and slight erosion.
EmY1s	Ser6cA1	Very deep, imperfectly drained, dark grayish brown to very dark grayish brown soils clay loam to clayey soils on nearly level young alluvial plain with sandy loam surface and slight erosion.

Table 2.2.15. Description of soils in Indervalle mandal, Adilabad district, Telangana

LEU	Soil series phases	Description of soil characteristics
PD2s	Dd2lB2st1	Shallow to moderately deep, well drained, dark reddish brown, clay soils on very gently sloping dissected plateau with clay loam to clay surface and moderate erosion.
PD2w1	Dd2cB2st2	Shallow, occasionally moderately deep, well drained, dark reddish brown, clay soils on very gently sloping dissected plateau with sandy clay loam to clay surface and moderate to severe erosion.
PD3s	Dd2lC2st2	Very shallow to shallow, somewhat excessively drained, dark reddish brown, clay soils on gently sloping dissected plateau with loamy surface and moderate to severe erosion.
PD3w1	Dd2cC2st2	Shallow, somewhat excessively drained, dark reddish brown, clay soils on gently sloping dissected plateau with clay surface and severe erosion
PD3f	Dd2lC2st3	Shallow to moderately deep, well drained, dark reddish brown, sandy clay loam to clay soils on gently sloping dissected plateau with sandy clay loam to clay surface and moderate to severe erosion.
PU2s	Dd3cB2st1	Shallow to moderately deep, well drained, dark reddish brown to very dark grayish brown, sandy clay loam to clay soils on very gently to gently sloping undissected plateau with clay loam to clay surface and moderate to severe erosion.
PU3s	Dd2cC2st1	Very shallow to shallow, well drained, dark reddish brown to very dark grayish brown, clay soils on moderately sloping undissected plateau with sandy clay loam to clay surface and moderate to severe erosion.

PU3f	Dd3cC2st3	Moderately deep, well drained, dark reddish brown, clay soils on moderately sloping undissected plateau with clay surface and moderate to severe erosion.
RE3f	Dd2cC3st2	Shallow to moderately deep, well drained, dark reddish brown, clay soils on moderately sloping elongated ridge with clay surface and moderate to severe erosion.
E6f	Sw1lF4st2	Very shallow to shallow, somewhat excessively drained, brown to dark yellowish brown, clay loam to clay soils on steeply sloping escarpments with sandy clay loam to clay surface and severe to very severe erosion.
I2s	Dd2lB2st3	Very shallow to shallow, well drained, dark reddish brown, clay loam to clay soils on very gently sloping isolated hillocks with sandy clay loam to clay surface and moderate to severe erosion.
U2s	Wd3cB2	Shallow to moderately deep, well drained, very dark grayish brown, clay soils on very gently sloping upland with clay surface and slight to moderate erosion.
U2w1	Iv2lB2st2	Very shallow to shallow, occasionally moderately deep, well drained, dark yellowish brown to very dark grayish brown, clay soils on very gently sloping upland with clay surface and moderate erosion.
U3s	Wd3cC2	Shallow to moderately deep, well drained, dark yellowish brown to very dark grayish brown, clay soils on gently sloping upland with clay loam to clay surface and moderate to severe erosion.
UU2s	Pr4cB2	Deep, well drained, very dark grayish brown, clay soils on very gently sloping undulating upland with clay surface and slight to moderate erosion.
D2d	Wd3lB2	Shallow to moderately deep, well drained, very dark grayish brown, clay soils on very gently sloping pediments with clay surface and very slight to slight erosion.
D2s	Iv2cB2	Very shallow to shallow, occasionally moderately deep, well drained, very dark grayish brown, clay soils on very gently sloping pediments with sandy clay loam to clay surface and moderate erosion.
D3s	Hk1lC2st1	Very shallow to shallow, well drained, dark brown to dark yellowish brown, clay soils on gently sloping pediments with clay loam to clay surface and moderate erosion.
D3w1	Sw1lC2	Very shallow to shallow, well drained, brown to dark yellowish brown, clay loam to clay soils on gently sloping pediments with sandy clay loam to clay surface and moderate to severe erosion.
D2f	Sw1cB2	Very shallow, well drained, brown to dark yellowish brown, clay soils on very gently sloping pediments with clay surface and moderate erosion
V2d	Pr4cB1	Moderately deep to deep, moderately well to well drained, very dark grayish brown, clay soils on very gently sloping valley with clay surface and slight erosion.
V2s	Wd3cB2	Shallow to moderately deep, occasionally deep, moderately well to well drained, dark yellowish brown to very dark grayish brown, clay soils on very gently sloping valley with clay loam to clay surface and slight to moderate erosion.
V2w1	Dd2lB2st2	Shallow to moderately deep, well drained, dark reddish brown to very dark grayish brown, clay soils on very gently sloping valley with clay loam surface and moderate erosion.

Thimmajipet mandal, Mahabubnagar district, Telangana

Thimmajipet mandal represents south Deccan plateau and the soils are mapped into twelve phases of five series (Fig. 2.2.15 & Table 2.2.16). Erosion is the problem of Granite and granitic gneiss landscape and the salinity of varying degree in the basaltic surface.

Gajwel madal, Medak district, Telangana

Gajwel mandal in the state of Telangna also represents south Deccan plateau and the soils of the mandal are mapped into sixteen phases of six series (Fig. 2.2.16 and Table 2.2.17). Like Thimajipeth, the soils of ganite and granitic gneiss area suffer from erosion and the soils associated with basaltic landscape are noted with occasional problems of salinity and sodicity.

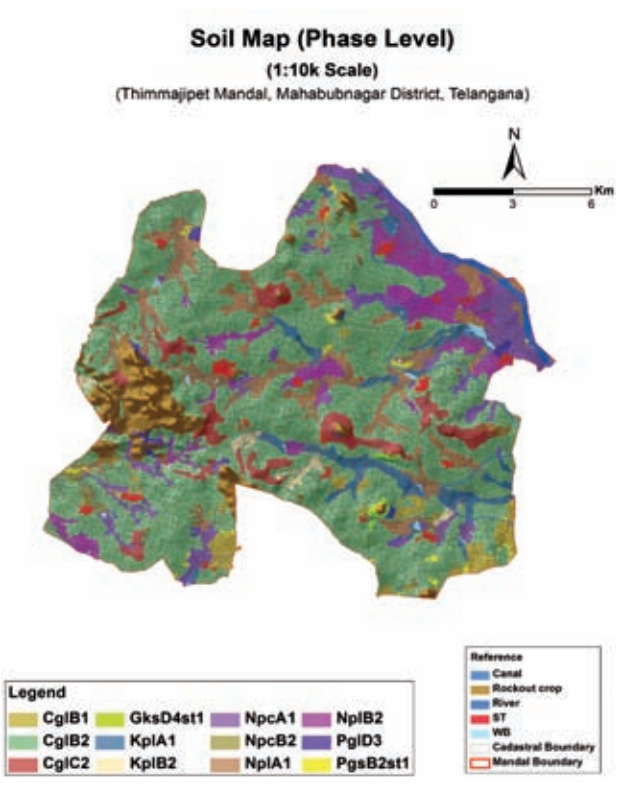


Fig. 2.2.15. Soil map of Thimmajipet mandal, Mahabubnagar district, Telangana

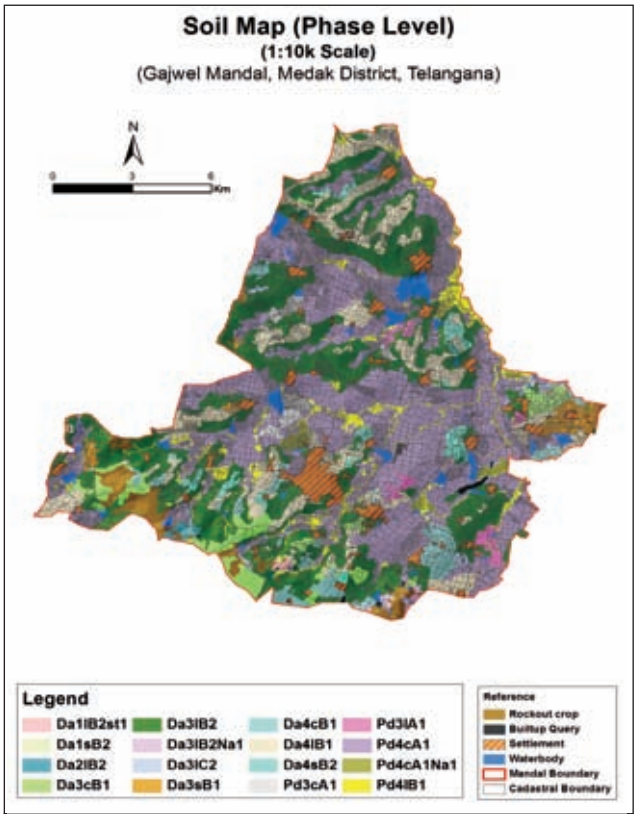


Fig. 2.2.16. Soil map of Gajwel madal, Medak district, Telangana

Table 2.2.16. Description of soils in Thimmajipet mandal, Mahabubnagar district, Telangana

LEU	Soil series phases	Description of soil characteristics
DsGnI6w4	R	Rock Outcrops
DsGnI5w4	R	Rock Outcrops
DsGnD4w4	R	Rock Outcrops
DsGnD4w1	GksD4St1	Very shallow, excessively drained, brown, gravelly sandy loam soils occur on moderately sloping pediment with very severe erosion and moderate stoniness.
DsGnD4s	PglD3	Shallow, excessively drained, reddish brown, sandy loam soils occurring on moderately sloping pediments with sandy surface and moderate to high erosion.
DsGnD3s	CglC2	Moderately deep, well drained, dark brown, sandy clay soils on slightly sloping pediments with loam surface and moderate erosion.
DsGnD2w4	R	Rock Outcrops
DsGnD2w1	PglB2St1	Shallow, excessively drained, dark reddish brown, sandy clay loam soils on very gently sloping pediments with sandy surface, stoniness and moderate erosion.
DsGnD2s	CglB2	Deep, well drained, yellowish brown to reddish brown, sandy clay to clay soils on very gently sloping pediments with loam surface and moderate erosion.

LEU	Soil series phases	Description of soil characteristics
DsGnD2d	CglB1	Deep, well drained, yellowish brown to reddish brown, sandy clay to clay soils on gently sloping pediments with loam surface and slight erosion.
DsBaAp1d	NpcA1	Deep, moderate to poorly drained, dark greyish brown to dark grey, clay soils occuring on nearly level valley with clayey at surface and slight erosion.
DsBaAp1s	NplA1	Deep, poorly drained, dark greyish brown to dark grey, clay soils occuring on nearly level valley with clayey at surface and slight erosion.
DsBaAp2d	NpcB2	Deep, poorly drained, dark greyish brown to dark grey, clay soils occuring on very gently sloping Alluvial plains with clayey at surface and with slight erosion.
DsBaAp2s	NplB2	Deep, poorly drained, dark greyish brown to dark grey, clay soils occuring on very gently sloping valley with clayey at surface and slight erosion.
DsBaV2s	Kp4lA1	Deep, well drained, brown to dark yellowish brown, sandy over clayey soils occuring on nearly level valley with loamy surface and slight erosion.
DsBaV2w1	Kp4lB2	Deep, well drained, brown to dark yellowish brown, sandy over clayey soils occuring on very gently sloping valley with loamy surface and moderate erosion.

Table 2.2.17. Description of soils in Gajwel madal, Medak district, Telangana

LEU	Soil series phases	Description of soil characteristics
DsGnH4r	MudhC3st1	Shallow, well drained, dark yellowish brown, sandy clay soils on gently sloping island with sandy loam surface, severe erosion and slight stoniness.
DsGnD3s	MudbC3	Very shallow, well drained, brown, loamy sand soils on gently sloping pediments with loamy sand surface and severe erosion.
DsGnD3d	MudcC2	Very shallow, well drained, brown, sandy loam soils on gently sloping pediments with sandy loam surface and moderate erosion.
DsGnD2s	AnphB2	Shallow, well drained, dark yellowish brown, sandy clay soils on very gently sloping pediments with sandy clay loam surface and moderate erosion.
DsGnD2w1	AnpcB2	Shallow, well drained, dark yellowish brown, sandy clay soils on very gently sloping pediments with sandy loam surface and moderate erosion.
DsGnD1s	JlghB2	Moderately deep to deep, well drained, strong brown, sandy clay soils on very gently sloping pediments with sandy clay loam surface and moderate erosion.
DsGnD2d	JlgcB2	Moderately deep to deep, well drained, strong brown, sandy clay soils on very gently sloping pediments with sandy loam surface and moderate erosion.
DsGnU2s	JlgdB2	Moderately deep to deep, well drained, strong brown, sandy clay soils on very gently sloping uplands with loam surface and moderate erosion.
DsGnU2s	JlgbB2	Moderately deep to deep, well drained, brown, sandy clay on very gently sloping uplands with loamy sand surface and moderate erosion.
DsGnU2w1	JlgcB2	Moderately deep to deep, well drained, strong brown, sandy clay soils on very gently sloping uplands with sandy loam surface and moderate erosion.
DsGnU2d	MdpiB2	Deep to very deep, well drained, brown, sandy clay soils on very gently sloping uplands with sandy clay surface and moderate erosion.
DsGnU1s	MdpbA1	Deep to very deep, well drained, brown, sandy clay soils on nearly level to level uplands with loamy sand surface and slight erosion.
DsGnU1d	MdpcA1	Deep to very deep, well drained, brown, sandy clay soils on nearly level to level uplands with sandy loam surface and slight erosion.
DsGnU1w1	MdpbB1	Deep to very deep, well drained, brown, sandy clay on very gently sloping uplands with loamy sand surface and slight erosion.
$D_sB_aA_u1s$	SgthA1	Moderately deep to deep, moderately well drained, very dark gray, clayey soils on nearly level to level upper alluvial plain with sandy clay loam surface and slight erosion.
$D_sB_aA_u2w1$	SgthA2	Moderately deep to deep, moderately well drained, very dark gray, clayey soils on nearly level to level upper alluvial plain with sandy clay loam surface and moderate erosion.

LEU	Soil series phases	Description of soil characteristics
DsB_aA_u1d	SgpiA1	Deep to very deep, moderately well drained, dark gray, clayey soils on nearly level to level upper alluvial plain with sandy clay surface and slight erosion.
DsB_aA_u1w1	SgpfA1	Deep to very deep, moderately well to imperfect drained, dark gray, clayey soils on nearly level to level upper alluvial plain with clay loam surface and slight erosion.
DsB_aA_u1d	SgpmA1	Deep to very deep, moderately well drained, dark gray, clayey soils on nearly level to level upper alluvial plains with clay surface and slight erosion.
DsB_aA_u 2d	SgpfA2	Deep to very deep, moderately well drained, dark gray, clayey soils on nearly level to level upper alluvial plains with clay loam surface and moderate erosion.
DsB_aA_l 1d	SgpmA1	Deep to very deep, moderately well drained, dark gray, clayey soils on nearly level to level lower alluvial plains with clay surface and slight erosion.
DsB_aA_l 1s	SgpiA1	Deep to very deep, moderately well drained, dark gray, clayey soils on nearly level to level lower alluvial plains with sandy clay surface and slight erosion.

d) Northern region

Jagner block, Agra district, Uttar Pradesh

Jagner block in the state of Uttar Pradesh represent fringes of Arvalli landscape and the upper part of Indo-gangetic alluvial plains. The soils of the block are mapped into sixteen phases of six series (Fig. 2.2.17 & Table 2.2.18). The soils of pediments and hills have problems of erosion, whereas the other soils associated with the plains of Ganga are classified with the problems of varying degree of salinity and sodicity.

Nagrota Bhagwan block, Kangra district, Himachal Pradesh

Nagrota Bhagwan block of Himachal Pradesh is the representative of side and reposed slope together with piedmont plains of lesser Himalayas. Erosion and depositions are the major problems of the area. The soils are mapped into twenty five phases of thirteen soil series (Fig. 2.2.18 & Table 2.2.19).

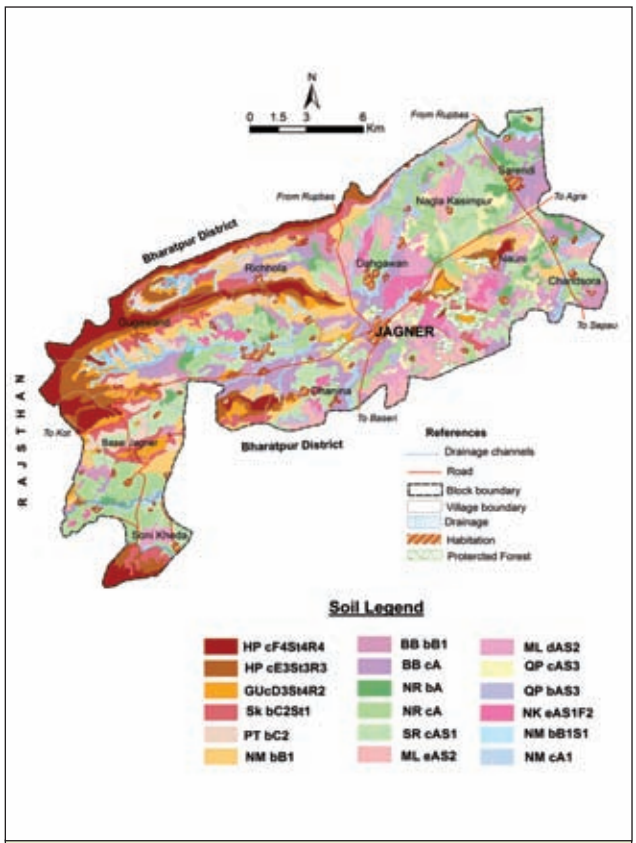


Fig. 2.2.17. Soil map of Jagner block, Agra district, Uttar Pradesh

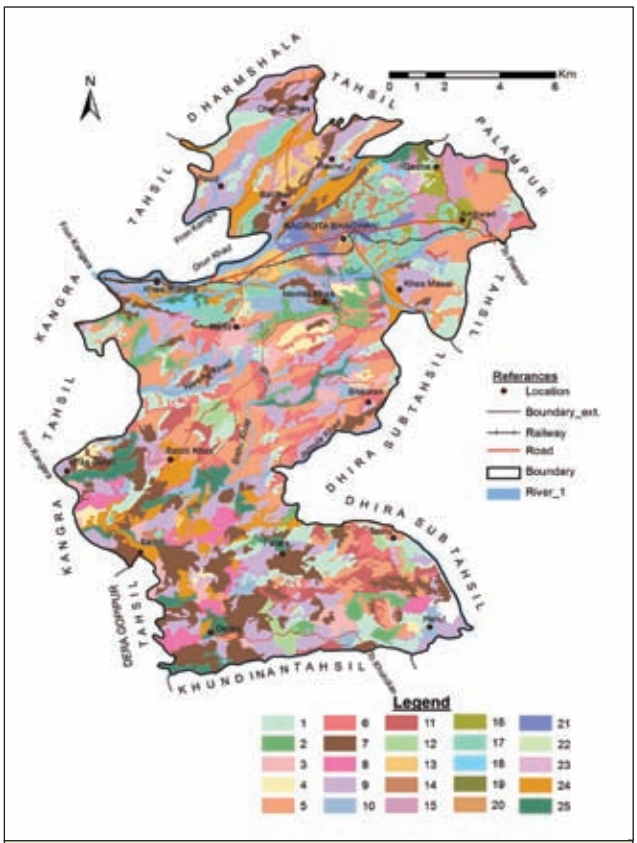


Fig. 2.2.18. Soil map of Nagrota Bhagwan block, Kangra district, Himachal Pradesh

Table 2.2.18. Description of soils in Jagner block, Agra district, Uttar Pradesh

LEU	Soil series phases	Description of soil characteristics
CaH4sw-g	HPcF$_4$St$_4$	Very shallow, excessively drained, brown, gravelly sandy loam soil on strongly sloping hill slopes, extremely stony and very severe erosion.
	HP cE$_3$St$_3$	Very shallow, excessively drained, brown, gravelly sandy loam soil on moderately sloping side hill slopes, strong stony and very severe erosion.
CaH4g-ft H4g-ft	GUcD$_3$St$_4$	Shallow, excessively drained, brown, gravelly sandy loam soils on moderately sloping hill slopes, extremely stony and very severe erosion.
CaPi3s	SkbC$_2$St$_1$	Moderately deep, somewhat excessively drained, yellowish brown, loamy sand to sandy loam soils occurring on gently sloping piedmont plain with loamy sand surface and moderate erosion.
CaPi3d	PTbC$_2$	Deep, somewhat excessively drained, brown to yellowish brown, loamy sand soils occurring on gently sloping piedmont plain with loamy sand surface and moderate erosion.
CaPi2d	NMbB$_1$	Very deep, well drained, brown, sandy loam soils occurring on very gently sloping piedmont plain with loamy sand surface and slight erosion.
AaOp2d	BB bB$_1$	Very deep, well drained, brown to yellowish brown, sandy loam soils on very gently sloping old alluvial plain with loamy sand to sandy loam surface and slight erosion.
	BBcA	Very deep, well drained, brown to yellowish brown, sandy loam soils on nearly level to level old alluvial plain with sandy loam surface.
AaOp1d	NRbA	Very deep, well drained, brown to yellowish brown, sandy loam to loam soils on nearly level to level old alluvial plain with loamy sand to sandy loam surface.
	NRcA	
AaOp1d	SRcAS$_1$	Very deep, moderately well drained, brown to yellowish brown, loam to clay loam soils on level old alluvial plain with sandy loam surface and slight salinity.
AaOpc1d	MLeAS$_2$	Very deep, imperfectly drained, brown to dark grayish brown, clay loam soils on level old alluvial plain with concave relief with clay loam to loam surface and moderate salinity.
	MLdAS$_2$	
AaOpc1s/w1	QPcAS$_3$	Very deep, imperfectly drained, olive to light olive brown, loam to clay loam soils on level old alluvial plain with concave relief with sandy loam to loamy sand surface and severe salinity under cultivation in patches and wasteland intermittently.
	QPbAS$_3$	
AaOpc1s	NKeAS$_1$F$_2$	Very deep, poorly drained, dark grayish brown to light olive brown, stratified soils on level old alluvial plain with concave relief with clay loam surface, slight salinity and moderate flooding.
AaOp/AC2S-d	NMbB$_1$S$_1$	Very deep, moderately well drained, brown to yellowish brown, stratified soils on gently sloping old alluvial plain with fluvial/ abandoned channels, loamy sand to sandy loam surface, slightly saline and slight to moderate erosion.
	NMcA	

Table 2.2.19. Description of soils in Nagrota Bhagwan block, Kangra district, Himachal Pradesh

LEU	Soil series phases	Description of soil characteristics
MIR6fd	MK2cF$_3$St$_3$R$_3$	Shallow, gravely sandy loam soils on 15-25% slopes, with gravelly sandy loam surface, severely eroded, severe stoniness and severely rocky.
	MK2cG$_4$St$_4$R$_3$	Shallow, gravely sandy loam soils on 25-33% slopes, with gravelly sandy loam surface, very severely eroded, strong stoniness and severely rocky.
MIR6af	BT3cF$_2$St$_3$R$_2$	Moderately deep, gravely sandy loam soils on 15-25% slopes, with gravelly sandy loam surface, moderately eroded, severe stoniness and moderately rocky.
	BT3bE$_2$St$_3$R$_2$	Moderately deep, gravely sandy loamy soils on 8-15% slopes, with gravelly loamy sand surface, moderately eroded, severe stoniness and moderately rocky.
MIR6af	MS4cF$_3$St$_3$R$_2$	Deep, gravely sandy loam soils on 15-25% slopes, with gravelly sandy loam surface, severely eroded, severe stoniness and moderately rocky.
	MS4cE$_2$St$_2$R$_1$	Deep, gravely sandy loam soils on 8-15% slopes, with gravelly sandy loam surface, moderately eroded, moderate stoniness and rocky.

LEU	Soil series phases	Description of soil characteristics
MIR5af	$BR4\underline{c}E_2St_2R_2$	Deep, gravely loam soils on 8-15% slopes, with gravelly sandy loam surface, moderately eroded, moderate stoniness and moderately rocky.
	$R4\underline{d}D_2St_2R_2$	Deep, gravely loam soils on 5-8% slopes, with gravelly loam surface, moderately eroded, moderate stoniness and moderately rocky.
MIR4fm	$BG2\underline{c}ED_3St_2R_2$	Shallow, gravely loam soils on 5-8% slopes, with gravelly sandy loam surface, severely eroded, moderate stoniness and moderately rocky.
	$BG2\underline{d}D_2St_2R_2$	Shallow, gravely loam soils on 5-8% slopes with gravelly loam surface, moderately eroded, moderate stoniness and moderately rocky.
MIR4af	$CJ3\underline{c}D_2St_2R_2$	Moderately deep, gravely loam soils on 5-8% slopes, with gravelly sandy loam surface, moderately eroded, moderate stoniness and moderately rocky.
	$CJ3\underline{d}D_2St_2R_2$	Moderately deep, gravely loam soils on 5-8% slopes with gravelly loam surface, moderately eroded, moderate stoniness and moderately rocky.
MIP3ah	$SH3\underline{d}C_2St_3R_1$	Moderately deep, gravely clay loam soils on 3-5% slopes with gravelly loam surface, moderately eroded, severe stoniness and rocky.
	$SH3\underline{c}C_2St_3R_1$	Moderately deep, gravely clayloam soils on 3-5% slopes with gravelly sandy loam surface, moderately eroded, severe stoniness and rocky.
MIP3d	$ST4cC_2St_1$	Deep, loam soils on 3-5% slopes with sandy loam surface, moderately eroded and slight stoniness.
	$ST4dC_2St_1$	Deep, loam soils on 3-5% slopes with loam surface, moderately eroded and slight stoniness.
MIP2d	$UT5cB_1St_1$	Very deep, silty clay loam soils on 1-3% slopes, with sandy loam surface, slightly eroded and slight stoniness.
	$UT5dB_1St_1$	Very deep, silty clay loam soils on 1-3% slopes, with loam surface, slightly eroded and slight stoniness.
	$UT5gB_1St_1$	Very deep, silty clay loam soils on 1-3% slopes with silty clay loam surface, slightly eroded and slight stoniness.
MIP2d	$DG5cB_1St_1$	Very deep, clay loam soils on 1-3% slopes with sandy loam surface, slightly eroded and slight stoniness.
	$DG5dB_1St_1$	Very deep, clay loam soils on 1-3% slopes with loam surface, slightly eroded and slight stoniness.
MIP2d	$KR5cB_1St_1$	Very deep, sandy clay loam soils on 1-3% slopes with sandy loam surface, slightly eroded and slight stoniness.
	$KR5dB_1St_1$	Very deep, sandy clay loam soils on 1-3% slopes with loam surface, slightly eroded and slight stoniness.
MIV_12d	$ML5cB_1St_1$	Very deep, sandy loam soils on 1-3% slopes with sandy loam surface, slightly eroded and slight stoniness.
	$ML5bB_1St_1$	Very deep, sandy loam sand soils on 1-3% slopes with loamy sand surface, slightly eroded and slight stoniness.

e) Northern region

North West Jorhat development block, Jorhat district, Assam

North West Jorhat development block covers a part of Brahmputra valley of north eastern region of India and the soils are mapped into twenty three phases of twelve series (Fig. 2.2.19 & Table 2.2.20). Erosion and slight to moderate acidity are the problems associated with the soils of block.

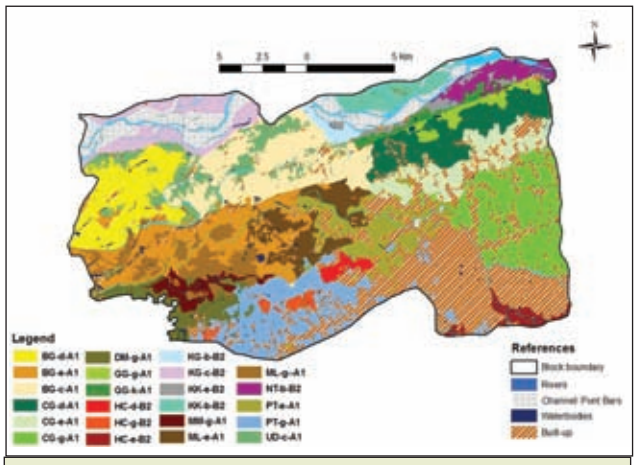


Fig. 2.2.19. Soil map of North West Jorhat development block, Jorhat district, Assam

Land resource inventory (LRI) at village and watershed levels

Land resource inventory for the village and watershed was also carried out at uniform scale of 1:10000. However, the information is collected on the cadestal scale and is being transformed in the established format of LRI.

a) Erravally village, Jagadevpur mandal, Medak district, Telangana (Govt. of Telangana funded)

The soils of Erravally village are mapped into twenty phases of six series (Fig. 2.2.20 & Table 2.2.21).

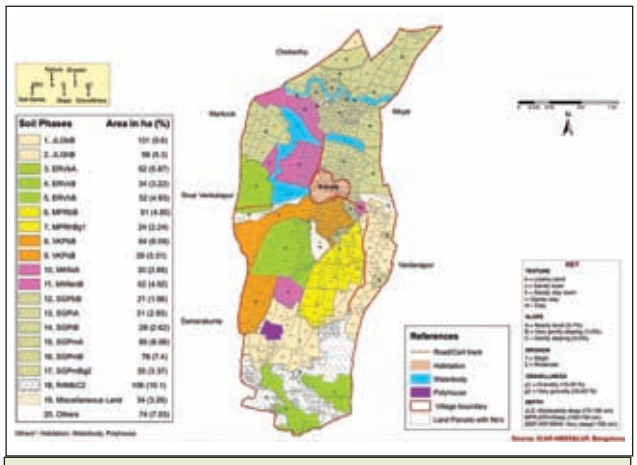


Fig. 2.2.20. Soils map of Erravally village, Jagadevpur mandal in Medak district, Telangana

Table 2.2.20. Description of soils in North West Jorhat development block, Jorhat district, Assam

LEU	Soil series phases	Description of soil characteristics
$NaBrFP_a2d$	KG-c-B2	Very deep, moderately well drained, coarse loamy soils with sandy loam surface occurring on very gently sloping active flood plains with moderate soil erosion.
	KK-b-B2	Very deep, imperfectly drained, coarse loamy soils with loamy sand surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrF_aP2s$	KG-b-B2	Very deep, moderately well drained, coarse loamy soils with loamy sand surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrFP_a2f6$	KK-e-B2	Very deep, imperfectly drained, coarse loamy soils with silt loam surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrFP_a2w1$	KG-c-B2	Very deep, moderately well drained, coarse loamy soils with sandy loam surface occurring on very gently sloping active flood plains with moderate soil erosion.
	KK-b-B2	Very deep, imperfectly drained, coarse loamy soils with loamy sand surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrFP_a2w5$	NT-b-B2	Very deep, imperfectly drained, coarse loamy soils with loamy sand surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrFP_a2wb$	KK-e-B2	Very deep, imperfectly drained, coarse loamy soils with silt loam surface occurring on very gently sloping active flood plains with moderate soil erosion.
	GG-k-B2	Very deep, imperfectly drained, fine-loamy soils with silty clay surface occurring on very gently sloping active flood plains with moderate soil erosion.
$NaBrFP_y1d$	BG-d-A1	Very deep, somewhat poorly drained, fine-loamy soils with loamy surface occurring on nearly level younger flood plains with slight soil erosion.
	BG-e-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt loam surface occurring on nearly level younger flood plains with slight soil erosion.
	BG-c-A1	Very deep, somewhat poorly drained, fine-loamy soils with sandy loam surface occurring on nearly level younger flood plains with slight soil erosion.

LEU	Soil series phases	Description of soil characteristics
$NaBrFP_y1s$	UD-c-A1	Very deep, somewhat poorly drained, coarse loamy soils with sandy loam surface occurring on nearly level younger flood plains with slight soil erosion.
$NaBrFP_y1f6$	UD-c-A1	Very deep, somewhat poorly drained, coarse loamy soils with sandy loam surface occurring on nearly level younger flood plains with slight soil erosion.
$NaBrFP_y1w1$	UD-c-A1	Very deep, somewhat poorly drained, coarse loamy soils with sandy loam surface occurring on nearly level younger flood plains with slight soil erosion.
	MM-g-A1	Very deep, poorly drained, fine-loamy soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
$NaBrFP_y1w5$	ML-g-A1	Very deep, poorly drained, fine-loamy soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
	ML-e-A1	Very deep, poorly drained, fine-loamy soils with silt loam surface occurring on nearly level younger flood plains with slight soil erosion.
	GG-g-A1	Very deep, very poorly drained, fine soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
$NaBrFP_y1wb$	DM-g-A1	Very deep, poorly drained, fine-loamy soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
	GG-g-A1	Very deep, very poorly drained, fine soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
$NaBrFP_o1d$	CG-d-A1	Very deep, somewhat poorly drained, fine-loamy soils with loamy surface occurring on nearly level older flood plains with slight soil erosion.
	CG-e-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	CG-g-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-e-A1	Very deep, poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-g-A1	Very deep, poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
$NaBrFP_o1s$	CG-d-A1	Very deep, somewhat poorly drained, fine-loamy soils with loamy surface occurring on nearly level older flood plains with slight soil erosion.
	CG-e-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	CG-g-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-e-A1	Very deep, poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-g-A1	Very deep, poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
$NaBrFP_o1f6$	CG-d-A1	Very deep, somewhat poorly drained, fine-loamy soils with loamy surface occurring on nearly level older flood plains with slight soil erosion.
	CG-e-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	CG-g-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-e-A1	Very deep, poorly drained, fine-loamy soils with silt loam surface occurring on nearly level older flood plains with slight soil erosion.
	PT-g-A1	Very deep, poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.
$NaBrFP_o1w1$	CG-d-A1	Very deep, somewhat poorly drained, fine-loamy soils with loamy surface occurring on nearly level older flood plains with slight soil erosion.
	CG-g-A1	Very deep, somewhat poorly drained, fine-loamy soils with silt clay loam surface occurring on nearly level older flood plains with slight soil erosion.

LEU	Soil series phases	Description of soil characteristics
	DM-g-A1	Very deep, poorly drained, fine-loamy soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
NaBrFP$_o$1w5	DM-g-A1	Very deep, poorly drained, fine-loamy soils with silty clay loam surface occurring on nearly level younger flood plains with slight soil erosion.
NaBrFP$_o$2p	HC-d-B2	Very deep, moderately well drained, fine-loamy soils with loamy surface occurring on very gently sloping older flood plains with moderate erosion.
	HC-e-B2	Very deep, moderately well drained, fine-loamy soils with silt loam surface occurring on very gently sloping older flood plains with moderate erosion.
	HC-g-B2	Very deep, moderately well drained, fine-loamy soils with silty clay loam surface occurring on very gently sloping older flood plains with moderate erosion.

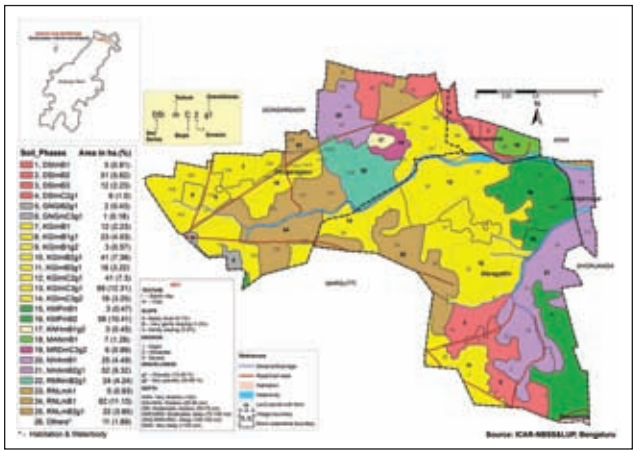
Table 2.2.21. Description of soils in Erravally village, Jagadevpur mandal in Medak district, Telangana

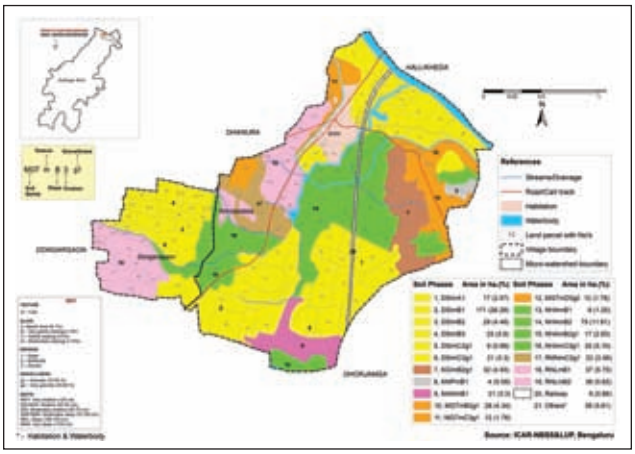
Mapping unit	Description	Area in ha	% Area
JLGbB	Moderately deep, well drained, gravelly loam soils developed from weathered granite gneiss, occurring on very gently sloping uplands under cultivation; loamy sand surface, slope 1-3 %, slight erosion.	101.14	9.60
JLGhB	Moderately deep, well drained, gravelly loam soils developed from weathered granite gneiss, occurring on very gently sloping uplands under cultivation; sandy clay loam surface, slope 1-3 %, slight erosion.	55.86	5.30
ERVbA	Deep, well drained, loamy soils developed from alluvium, occurring on very gently sloping uplands under cultivation; loamy sand surface, slope 0-1 %, slight erosion	61.84	5.87
ERVcB	Deep, well drained, loamy soils developed from alluvium, occurring on very gently sloping uplands under cultivation; sandy loam surface, slope 1-3 %, slight erosion	33.91	3.22
ERVhB	Deep, well drained, loamy soils developed from alluvium, occurring on very gently sloping uplands under cultivation; sandy clay loam surface, slope 1-3 %, slight erosion	51.91	4.93
MPRbB	Deep, well drained, gravelly clay soils developed from weathered granite gneiss, occurring on very gently sloping uplands under cultivation; loamy sand surface, slope 1-3 %, slight erosion.	51.12	4.85
MPRhBg1	Deep, well drained, gravelly clay soils developed from weathered granite gneiss, occurring on very gently sloping uplands under cultivation; sandy clay loam surface, slope 1-3 %, slight erosion and slightly gravelly (15-35 %).	23.59	2.24
VKPbB	Very deep, well drained, loamy soils developed from granite gneiss, occurring on very gently sloping uplands under cultivation; loamy sand surface, slope 1-3 %, slight erosion.	64.10	6.09
VKPcB	Very deep, well drained, loamy soils developed from granite gneiss, occurring on very gently sloping uplands under cultivation; sandy loam surface, slope 1-3 %, slight erosion.	34.84	3.31
MKNiA	Very deep, moderately well drained, calcareous clayey soils developed from alluvium, occurring on nearly level low lands under cultivation; sandy clay surface, slope 0-1%, slight erosion	30.38	2.88
MKNmB	Very deep, moderately well drained, calcareous clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; clay surface, slope 1-3 %, slight erosion	51.86	4.92
SGPbB	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; loamy sand surface, slope 1-3 %, slight erosion	20.88	1.98
SGPiB	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation. Sandy clay surface, slope 1-3 %, slight erosion	30.82	2.93

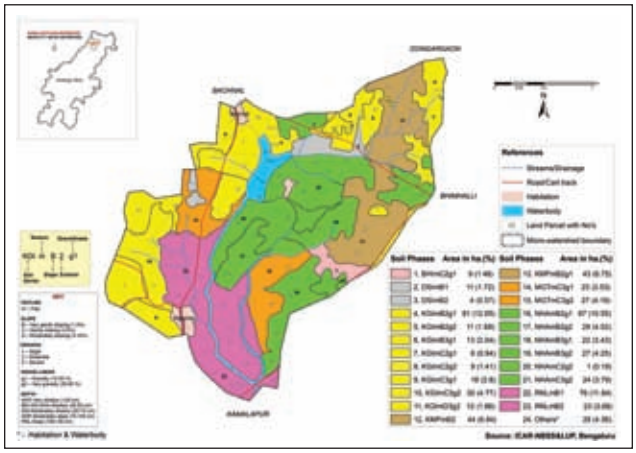
Mapping unit	Description	Area in ha	% Area
SGPmBg2	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; clay surface, slope 1-3 %, slight erosion and moderately gravelly (35-60 %).	27.63	2.62
SGPiA	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; sandy clay surface, slope 0-1 %, slight erosion	85.05	8.08
SGPmA	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; clay surface, slope 0-1 %, slight erosion	77.92	7.40
SGPmB	Very deep, moderately well drained, clayey soils developed from alluvium, occurring on very gently sloping low lands under cultivation; clay surface, slope 1-3 %, slight erosion	35.48	3.37
R4MbC2	Rock lands with 50-90 per cent rock out crops associated with shallow (25-50 cm), somewhat excessively drained, sandy soils developed from weathered granite gneiss, occurring on gently sloping lands; loamy sand surface, slope 3-5 %, moderate erosion	106.34	10.10

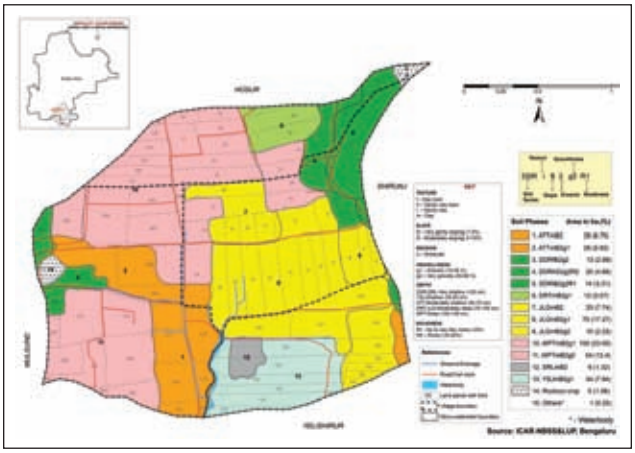
b) Watershed, the state of Karnatka under Sujala-III project (World Bank funded)

Ten micro-watersheds have been studied and the soil resource maps were prepared and farm wise/ farmers wise information have been generated (Fig. 2.2.21).









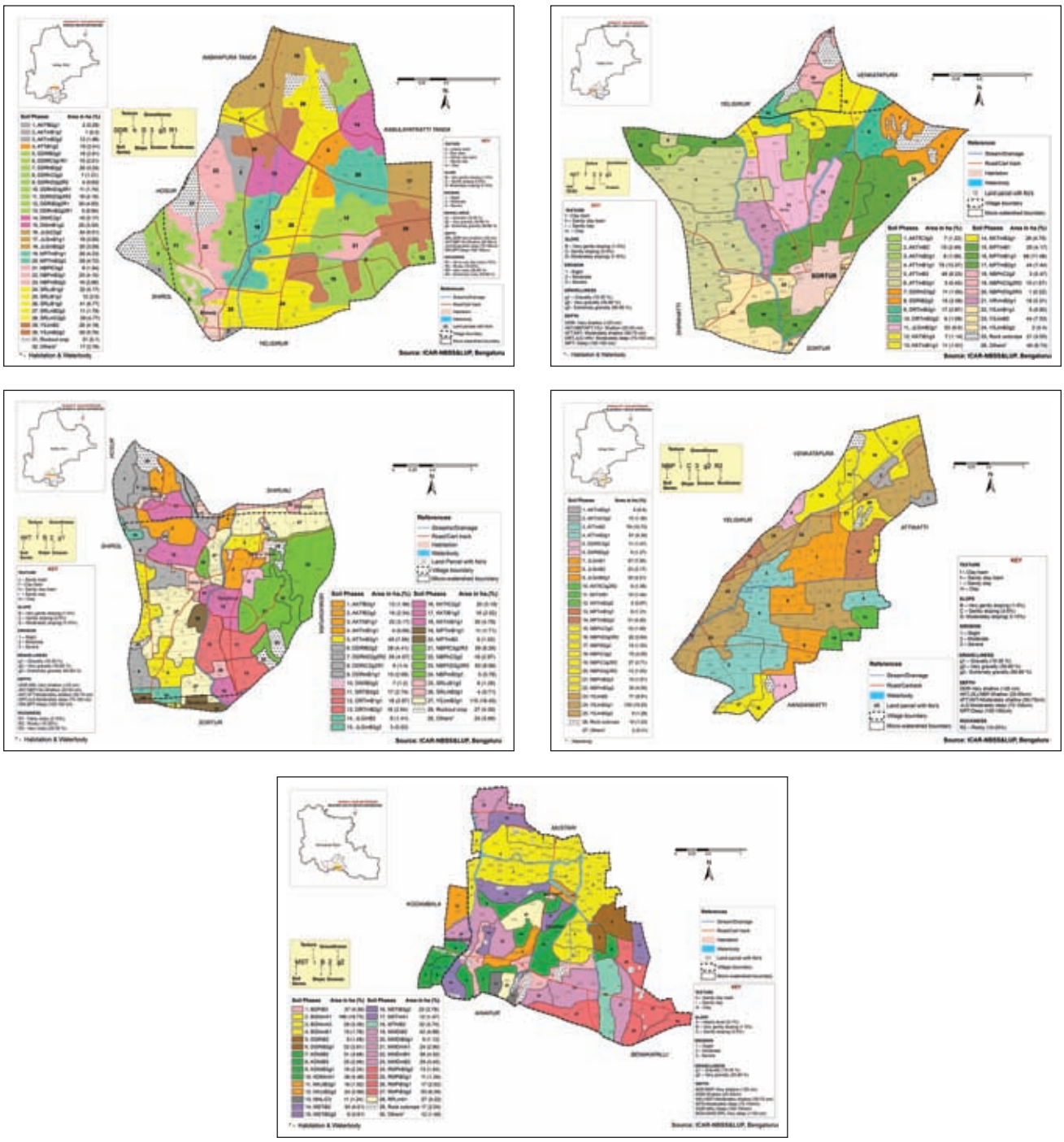


Fig. 2.2.21. Soil map of Microwaterhsed under Sujala project, Karnataka

c) Suratgarh and Sardargarh CSF farm, Suratgarh, Sriganganagar district, Rajasthan (Externally funded)

The soil resource mapping of Suratgarh farm Rajasthan has been taken during the year and the information on soils have been generated on cadastral scale (Fig. 2.2.23).

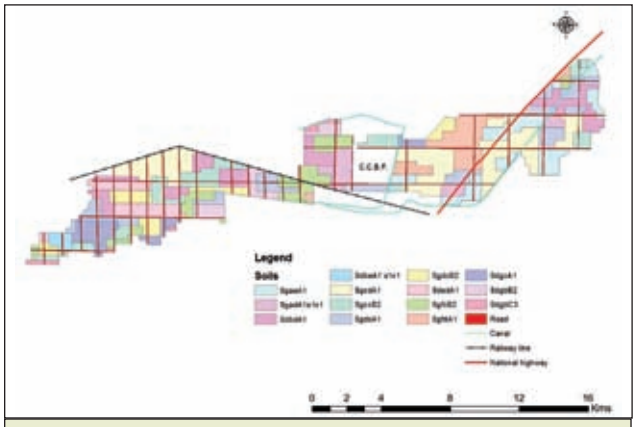


Fig. 2.2.22. Soil map of Suratgarh & Sardargarh CSF farm, Sriganganagar district, Rajasthan

During the course of land resource mapping, thematic maps for those soil and site characteristics governing agriculture in the given block is also generated; for example flooding is the determinant characteristics in Kadawa block, Katihar, Bihar whereas soil erosion is the dominant characteristics need immediate attention in Titalagarh block Bolangir district Odisha. Incontrat, salinity is the property that has to be taken care in the coast of Odisha and West Bengal. Thematic maps of the important properties influencing management vis-à-vis agriculture are shown (Fig. 2.2.23 to 2.2.31) as an examples.

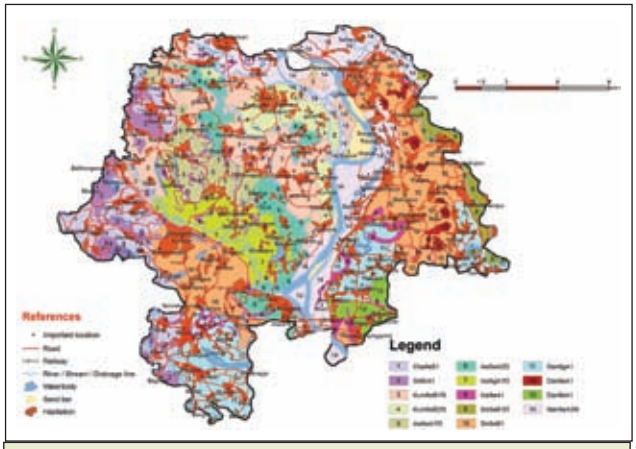


Fig. 2.2.23. Soil erosion map, Titlagarh block, Bolangir district, Odisha

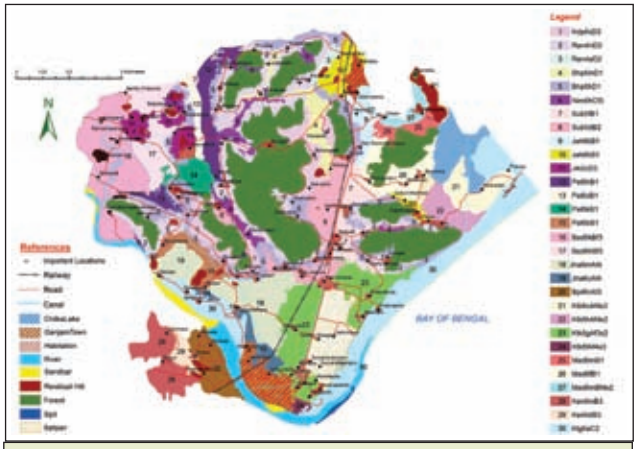


Fig. 2.2.24. Flooding map, Kadwa block, Katihar district, Bihar

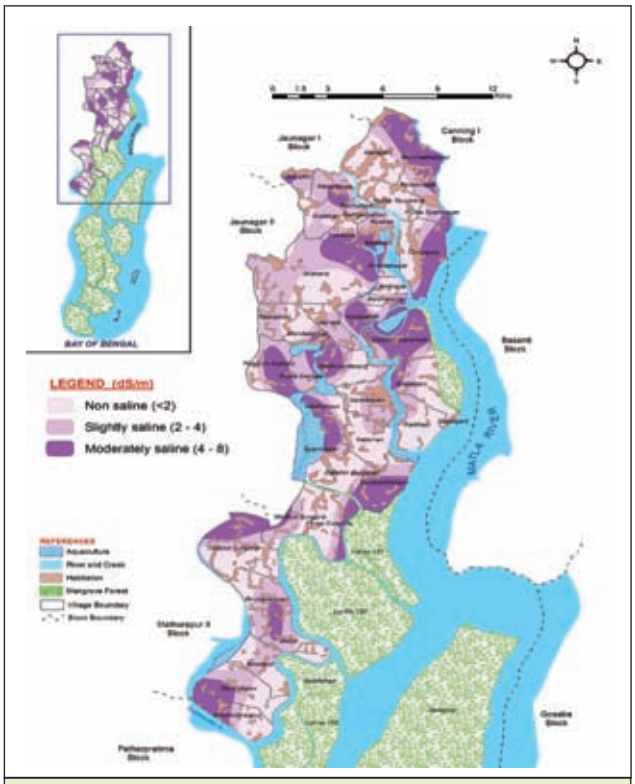


Fig. 2.2.25. Soil salinity map, Kulthali block, South 24 Paraganas district, West Bengal

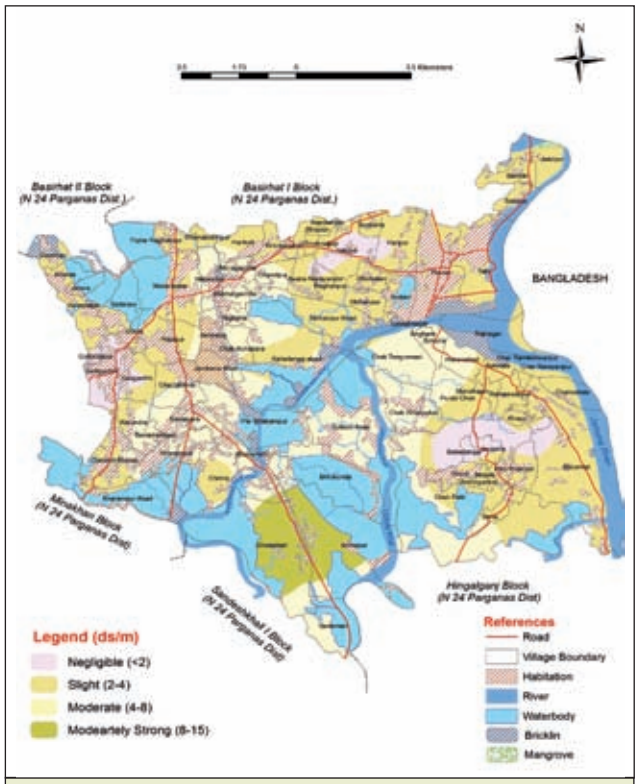


Fig. 2.2.26. Soil salinity map, Hasnabad block, North 24 Paraganas district, West Bengal

Fig. 2.2.27. Soil salinity map, Gosaba block, South 24 Paraganas district, West Bengal

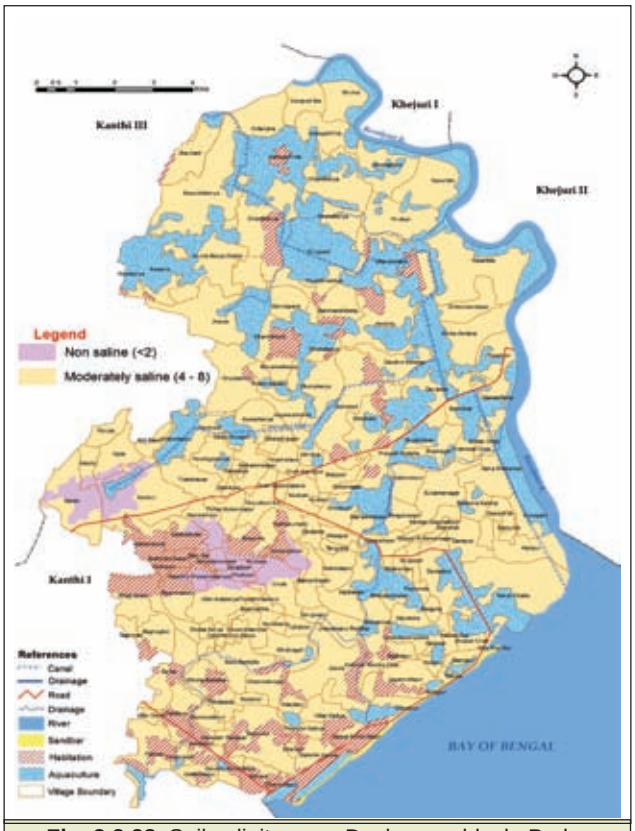


Fig. 2.2.28. Soil salinity map, Desharpan block, Purba Medinipur district, West Bengal

Fig. 2.2.28. Soil salinity map, Namkhana block, South 24 Paraganas district, West Bengal

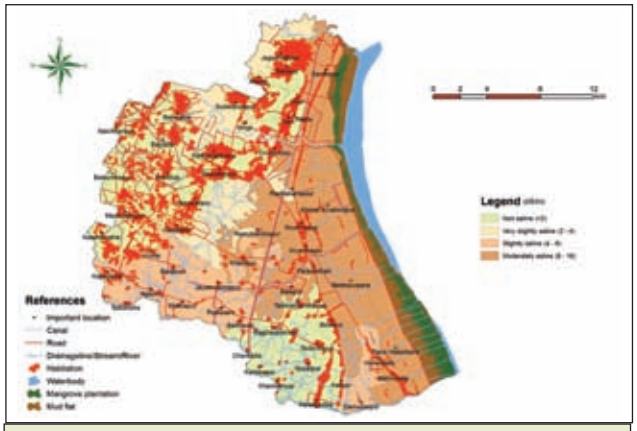


Fig. 2.2.30. Soil salinity map, Basudevpur block, Bhadrak district, Odisha

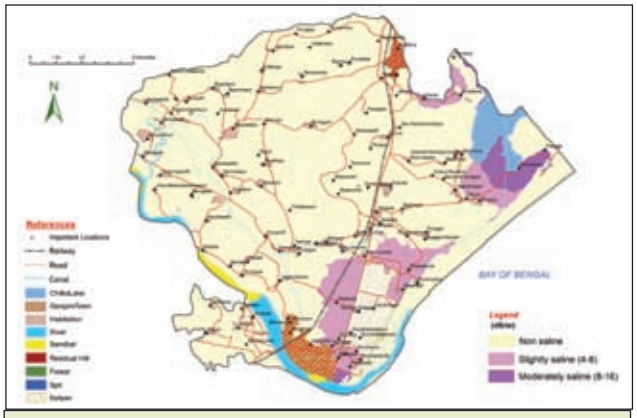


Fig. 2.2.31. Soil salinity map, Ganjam block, Ganjam district, Odisha

2.3 Basic Pedological Research

Studies on soil minerals and their genesis

Mineral composition of Vertisols of AER 10 (Central Highlands Hot dry-sub-humid eco-region) and AER 6 (Deccan Plateau, hot dry semiarid eco-region) studied during the year. Dominant minerals in silt fraction were quartz and kaolin, whereas clay fractions were rich in smectite (Table 2.3.1). In the clay fraction, kaolin was registered as sub-dominant mineral. Hydroxy-inter layering was common, however, its content increased from sub humid (AER 10) to semiarid regions (AER 6); Vertisols of AER 10 showed strong plasma separations with parallel cross or reticulate striated b fabric. However moderate to weak parallel striated b fabric was the characteristic of smectites in the Vertisols of AER 6. Pedogenic and non-pedogenic carbonates were present in the Vertisols of both the regions, however, pedogenic carbonate was noted at deeper depth in AER 10 than their counterparts of AER 6. Minerals like lubinites in AER 6 in some soils were noted suggesting super saturation of carbonates due to aridity. However, the presences of base supplying minerals like calcium zeolites and gypsum present in some of the soils of AER 6 modify the soil properties that retard the effects of degradation.

Table 2.3.1. Semi-quantitative estimates of silt and clay fraction of a typifying pedon of AER 10

Horizon	Depth (cm)	Clay Minerals (%)						
		Smectite	Vermiculite	Chlorite	Kaolin	Mica	Quartz	Feldspar
AER-10 Silt fraction (Location 21°15'18"N and 17°36'40" E)								
Ap	0-16	Tr	Tr	16	24	12	31	9
Bw1	16-44	Tr	6	15	28	12	27	8
Bw2	44-69	Tr	Tr	16	35	10	22	9
Bss1	69-102	Tr	Tr	16	34	9	25	8
Bss2	102-128	Tr	Tr	13	38	11	26	6
Bss3	128-150	Tr	Tr	12	39	9	28	Tr
AER-10 Clay fraction								
Ap	0-16	82	14	4(Tr)	tr	tr	tr	-
Bw1	16-44	87	10	4(Tr)	tr	tr	tr	-
Bw2	44-69	87	9	5(Tr)	tr	tr	tr	-
Bss1	69-102	87	9	4(Tr)	tr	tr	tr	-
Bss2	102-128	87	9	4(Tr)	tr	tr	tr	-
Bss3	128-150	88	9	3(Tr)	tr	tr	tr	-

Genesis of Vertisols in Bemetara block, Bemetara district of Chhattisgarh state

The study area lies within Chhattisgarh basin, developed on purple shale blended with gypsum and dolomite inter-bands, dolomitic limestone and argillaceous dolomite. Weathering of shale leads to formation of clay-rich soils which normally have a very low shear strength when wet and breaks into thin pieces with sharp edges (Fig. 2.3.1). However, the presence of fine textured deep shrink-swell soils in this area is difficult to reconcile. The formation of Vertisols/Vertic intergrades require huge amount of smectites (Fig. 2.3.2) which is not definitely the first weathering product of shale. In view of the above enigmatic situation, the present study is attempted to establish the parental legacy of these soils in relation to the geomorphological and neotectonic history of Chhattisgarh basin.

The Chhattisgarh basin is drained by three major tributaries of Shivnath river. These are Sakri, Half and Chirrpani, originating from Chilpi and Mikal range, and draining to Bemetara via Kawardha into the

Shivnath river (Fig. 2.3.3). These rivers originate from the Maikal ranges which are of basaltic and volcanic origin. A three intersecting geology from which the river originates includes Deccan traps, Chilpi and Nandgaon group.

The Deccan traps are made up of lava flows and spread over in whole of Maharashtra and in parts of Madhya Pradesh. Mineralogical composition of the flow is mainly of plagioclase feldspars, pyroxene and olivine. The mineralogical properties of the Vertisols of Bemetara studied with X-ray diffractometer to understand the parental legacy. The XRD indicate that sand fraction contains the quartz, goethite, ferri-hydrite, biotite and hematite minerals. Silt fraction shows characteristic peaks at 1.0, 0.7, 0.42 and 0.32 nm peaks indicating the presence of mica, kaolin, quartz and feldspar (Fig. 2.3.4). The persistence of 1.0 nm peak on heating upto 550°C confirmed the presence of mica. Quartz is the dominant silt fraction followed by mica and kaolin with traces of feldspars. The conspicuous absence of 1.4 nm peak in the silt sample is observed even at 550°C indicating the absence of chlorite. However, the 1.0 nm peak of mica reinforced when K saturated samples are heated from 25°C to 300°C indicating the presence of 1.4 nm mineral though in very small quantity.

Mineralogy of Ca-saturated total clay fraction of the representative Vertisols indicate peaks at 1.4, 1.0, 0.7 and 0.42 nm regions (Fig. 2.3.5). On glycolation, the 1.4 nm peak shifts to 1.8 nm region indicating the presence of smectite. The 0.7 nm peak of kaolinite is broad at the base with tailing towards the low angle side indicating that this mineral is interstratified probably with expanding type mineral. The presence of such type of mineral behavior is common in Vertisols developed from the weathered Deccan basalt of Maharashtra.

It is assumed that the present geography is carved out by the river which had been eroding the land since fairly long time. The Pong and Sakri river originating from Maikal range and cutting across Nandgaon group carry lot of basaltic alluvium from Deccan trap intrusion from eastern part of Madhya Pradesh. These rivers flow across the Bemetara for a long period, might have paved the way for the presence of deep black soil in this region. The preliminary results thus indicate the similarity between the mineralogy of Vertisols of Chhattisgarh and Maharashtra. The geological formations of shale identified in the area confronts with the dominant soils occurring in the area. Vertisols present in Bemetara can only be formed from plagioclase rich parent material. The work is continued to confirm the preliminary assumptions.

Fig. 2.3.1. Shallow profile with shale geology and its weathering process

Fig. 2.3.2. Typical soil profile of Bemetara block

Fig. 2.3.3. Drainage map of the tributaries of Half river with geology of its origin

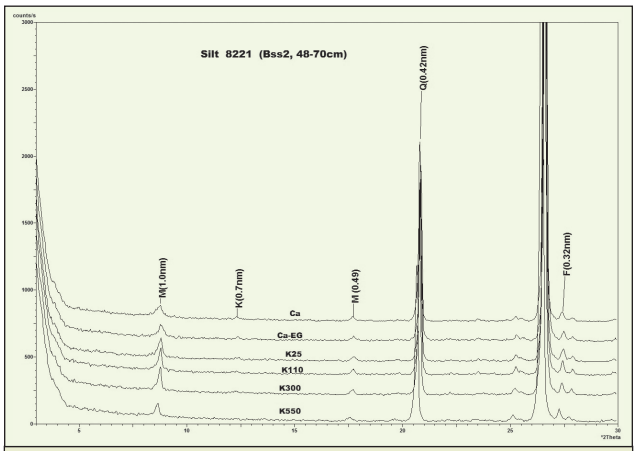


Fig 2.3.4. Representative XRD patterns of the, silt fractions of Bemetara block. Ca=Ca-saturated,

Ca-EG=Ca-saturated plus glycol vapour, K25/110/300/300Eg/550ºC = K–saturated and heated to 25º, 110º, 300º and 550ºC, M=mica, K=kaolin, Q=quartz, F=feldspars,

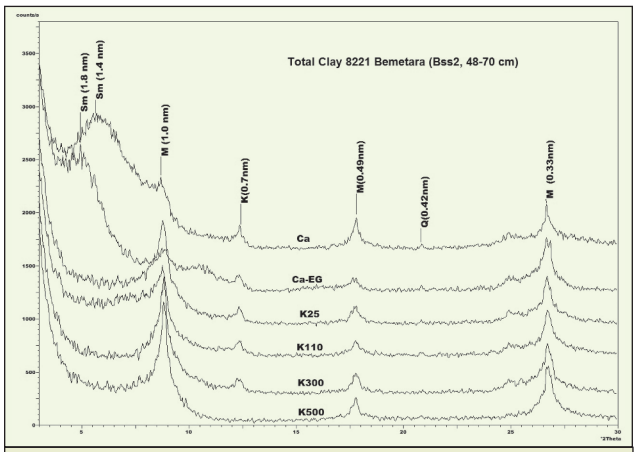


Fig. 2.3.5. Representative XRD patterns of total clay fractions of Bemetara block.

Ca=Ca-saturated, Ca-EG=Ca-saturated plus glycol vapour, K25/110/300/300Eg/550ºC = K – saturated and heated to 25º, 110º, 300º and 550ºC. Sm=smectite, M=mica, K=kaolin, Q= quartz

Generation and modelling of carbon datasets in different agro-ecosystems for climate resilient agricultural planning

The Sixty-two sites of 28 long term fertilizer experiment (LTFE: 28) and 34 of benchmark sites (BM: 34) across the country, are identified for estimating the soil organic carbon (SOC) stock (Fig. 2.3.6). During the year, SOC stock (0-30 cm soil depth) is estimated for 34 benchmark spots representing various bio-climates of the Black Soil Region (BSR) (Fig. 2.3.7) and Indo-Gangetic Plains (IGP) (Fig. 2.3.8). Bio-climate wise distribution suggests that SOC stock varies from 2.88 kg/m^2 (arid bio-climate) to 4.94 kg/m^2 (sub-humid moist bio-climate) in the BSR and 0.86 kg/m^2 (arid bio-climate) to 3.24 kg/m^2 (per-humid bioclimate) in IGP. The study concludes that the potentiality of soil organic carbon sequestration in arid bio-climate is much higher than the other regions.

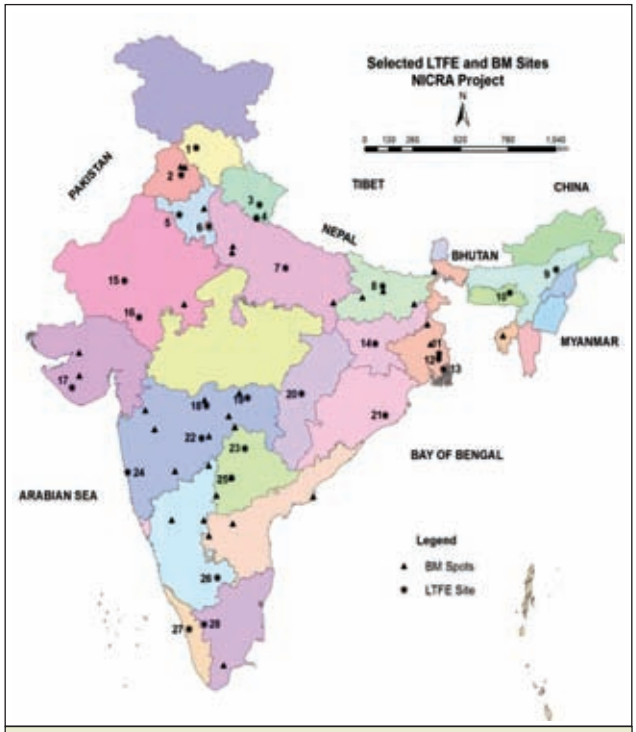


Fig. 2.3.6. Location map of selected LTFE and BM sites

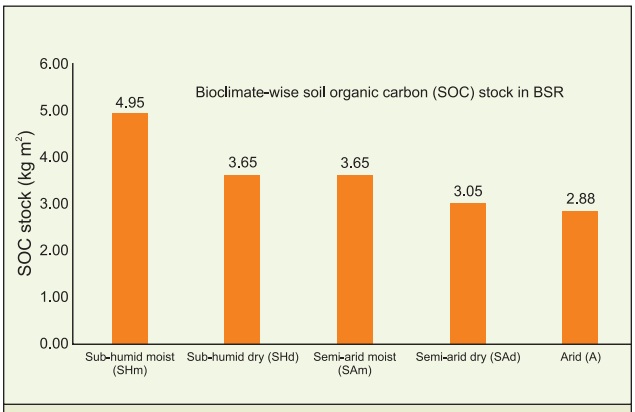


Fig. 2.3.7. Bioclimate-wise soil organic carbon (SOC) stock in the BSR

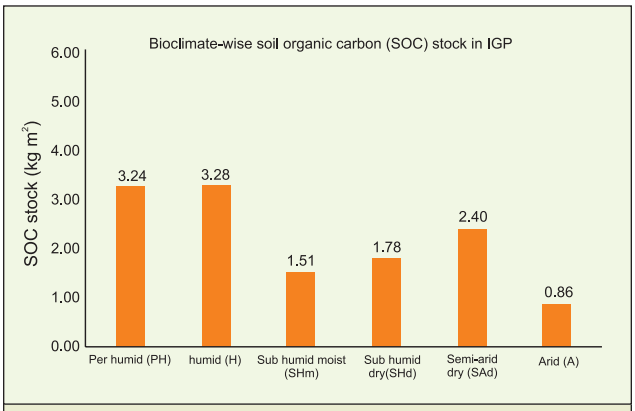


Fig. 2.3.8. Bioclimate-wise soil organic carbon (SOC) stock in the IGP

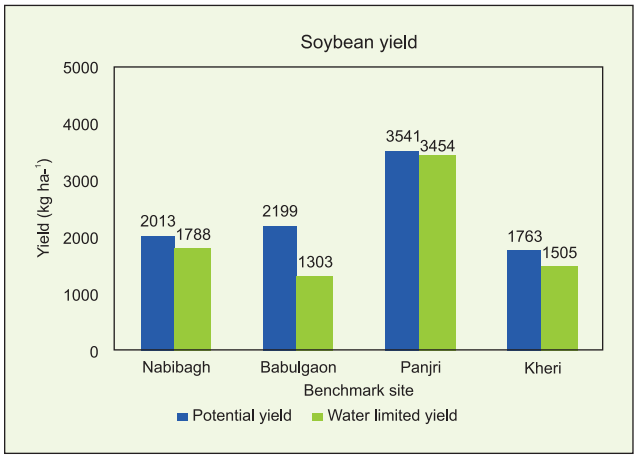
Influence of organic and inorganic carbon sequestration on soil and land quality in selected benchmark spots of India (DST IS-STAC)

Simulating crop growth and yield in the selected benchmark spots

Info-Crop model was used to simulate the crop growth and yield of major crops in 7 benchmark spots selected under different bio-climates (Table 2.3.2). Simulation results for soybean and cotton for different sites are depicted in figure 2.3.9.

Table 2.3.2. Simulated crop yields and total dry matter in the selected soil series of different bio-climates

Soil Series	Bioclimatic Regions (MAR, mm)	Soil Taxonomy	Crops	Simulated Crop Yield ($kgha^{-1}$)	
				Potential	Water limited
Kheri	Sub-humid moist (1448)	Typic Haplusters	Soybean	1763	1505
			Wheat#	7053	5222
Chandranagar	Sub-humid moist (1359)	Vertic Haplustepts	Wheat#	6680	3377
			Rice	4821	2867
Nabibagh	Sub-humid moist (1209)	Typic Haplusterts	Soybean	2013	1788
			Wheat#	6424	5357
Panjri	Sub-humid moist (1127)	Typic Haplusterts	Cotton	3505	3321
Sarol	Sub-humid dry (1053)	Typic Haplusterts	Cotton	3473	3119
Vijaypura	Semi-arid moist (924)	Typic Kandiustalfs	Finger millet	4023	1511
			Maize	6776	4857
Babulgaon	Semi-arid dry (793)	Udic Chromusterts	Soybean	2199	1303
			Cotton	3744	2416



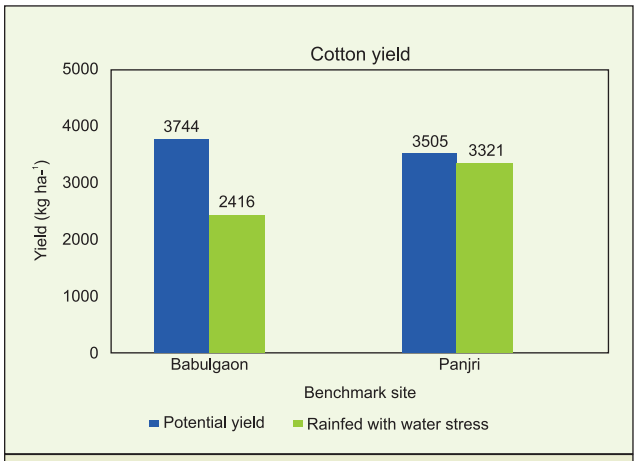
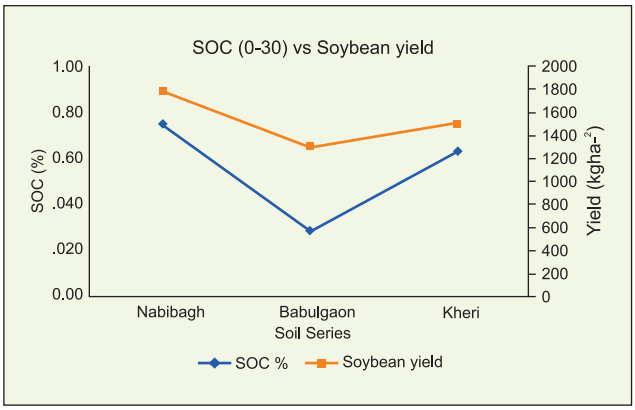


Fig. 2.3.9. Simulated potential and water limited yields of soybean and cotton

The simulation results (Table 2.3.2 and Fig. 2.3.10) indicated that there is more gap between potential and water limited yields in the soils under the semi-arid bio-climate represented by Babulagaon soil series than the soils of other bio-climates. When the soybean yield is compared with the percentage SOC content for 0-30 cm and 0-100 cm (Fig. 2.3.10), it is observed that the soils of Nabibagh soil series with SOC content of 0.8% has higher simulated soybean yield than any other soil series with SOC less than 0.8%..



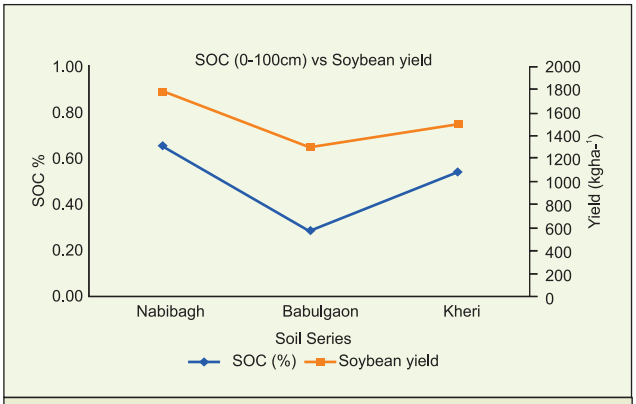


Fig. 2.3.10. Comparison of SOC content and soybean yield

Evaluation of soil organic carbon models for selected LTFE sites

We made an attempt to calibrate some of the parameters of Denitrification-Decomposition (DNDC)

model for selected five LTFE sites, *viz.*, Mohanpur (West Bengal), Gaupur (Pusa, Bihar) Nabibagh (Bhopal, Madhya Pradesh), Babhulgaon (Akola, Maharashtra) and Kheri (Jabalpur, Madhya Pradesh) and used to simulated soil organic carbon. The crop yields were also simulated and compared with the measured yield of sorghum, soybean and wheat crops. The datasets, required as input parameters, were collected from published literature.

Simulation of soil organic carbon

DNDC model was used to simulate soil organic carbon (SOC) for all the selected LTFE sites, however, for brevity the simulation results only two LTFE sites are being presented here. The LTFE site of Akola represents a typical shrink-swell soil (Vertisols) of the Black Soil Region (BSR). The soils are clayey, slightly alkaline with organic carbon of 4.6 g kg^{-1}, CEC 41.6 cmol(p^+)kg^{-1}, calcium carbonate equivalent 5.7%, and bulk density ranging from 1.26 to 1.31 Mg m^{-3}. This site represents semi-arid tropical climate with mean annual maximum air temperature of 34.5^{0}C and mean annual minimum temperature of 19.7 ^{0}C with mean annual rainfall of 793 mm. The LTFE site of Nabibagh also represents the shrink-swell soil of the BSR. The soils are clayey, moderately alkaline with organic carbon 8.0 g kg^{-1}, CEC 45.9 cmol(p+)kg^{-1}, $CaCO_3$ of 5.1% and bulk density of 1.3 Mg m^{-3}. The climate is sub-humid moist with mean annual temperature of 25.25^{o}C and mean annual rainfall of 1208.90 mm. Thus, the sites represent two different bio-climates.

The SOC was simulated for a soil depth of 0-15 cm at Akola LTFE site and 0-20 cm for Nabibagh LTFE site. The simulation results indicated decrease in SOC in control treatment with no application of fertilizers and manures. However, there was significant increase in SOC when inorganic fertilizers were applied in combination to organic manure (Figs. 2.3.11 and 2.3.12).

Performance of DNDC model is evaluated on both sites by comparing the simulated SOC estimates with that of measured SOC. The total simulation error in terms of RMSE ranges from 7 to 20% for both the LTFE sites (Table 2.3.3). Except for T14 (only FYM), the simulation bias is expressed by 't of M' is non-significant for all the treatments at Akola LTFE sites. However, on the basis of 'Student's t' the simulation bias is non-significant for all the treatments. The performance of DNDC for Nabibagh LTFE site is poor, the simulation bias is significant for all the treatments, except for treatment of NPK (20:60:15). In all the cases, the RMSE value is less than 20%. These lead to infer that the model is able to simulate the changes in total organic carbon satisfactorily.

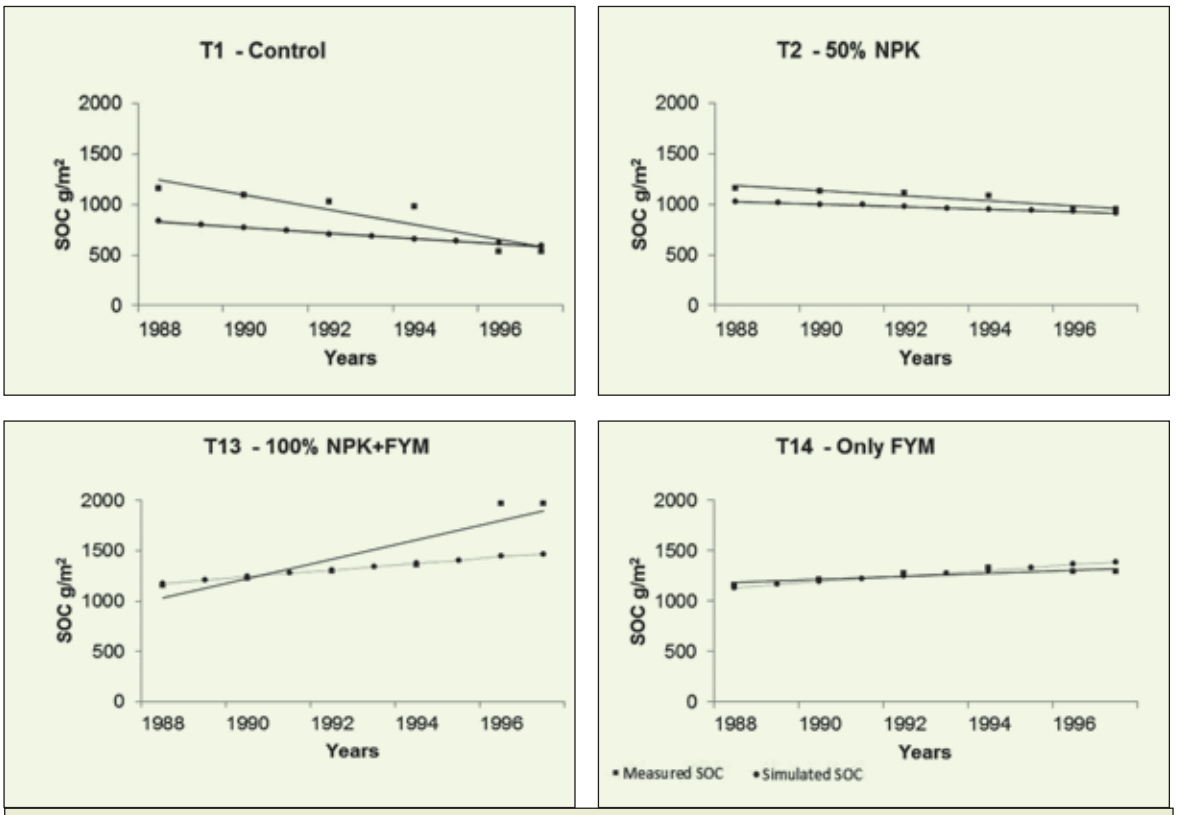


Fig. 2.3.11. Treatment effects on SOC turnover and its comparison (estimated vs. measured) for the Akola LTFE site

Table 2.3.3. DNDC model errors and simulation bias for Akola and Nabibagh LTFE sites

Treatments	Simulation error				Simulation bias	
	RMSE[a] t C ha^{-1}(%)	M	t value of M[b]	Student's t[c]	significance of bias (yes/no)[d]	significance of bias (yes/no)[e]
Akola (0-15cm)						
Control	1.59 (20)	0.65	1.01	0.60	no	no
T2 (50% NPK)	0.76 (7)	0.17	0.53	0.36	no	no
T13 (100%NPK+FYM)	2.96 (19)	1.72	1.59	1.09	no	no
T14 (Only FYM)	1.89 (16)	-1.42	-2.54	-1.98	yes	no
Nabibagh (0-20cm)						
Control	1.90 (15)	-1.90	-90.81	82.55	yes	yes
T2 (NPK)	1.58 (12)	-1.34	-4.39	3.63	yes	yes
T5 (NPK+FYM)	1.69 (12)	-0.94	-1.50	1.50	no	no
T6 (NPK+PM)	1.60 (12)	-1.13	-2.25	2.26	yes	yes
T7(NPK+UC)	1.87 (14)	-1.70	-4.87	4.74	yes	yes

[a]Parentheses indicate % error value from mean measured value.

[b]Critical t value (at two tailed) is 2.23

[c]Student's 't' = $\frac{\textit{Mean of measured value-Mean of modelled values}}{\sqrt{\textit{Variance of observed value+Variance of modelled value/n}}}$

[d]On the basis of t of M

[e]On the basis of Student's 't'

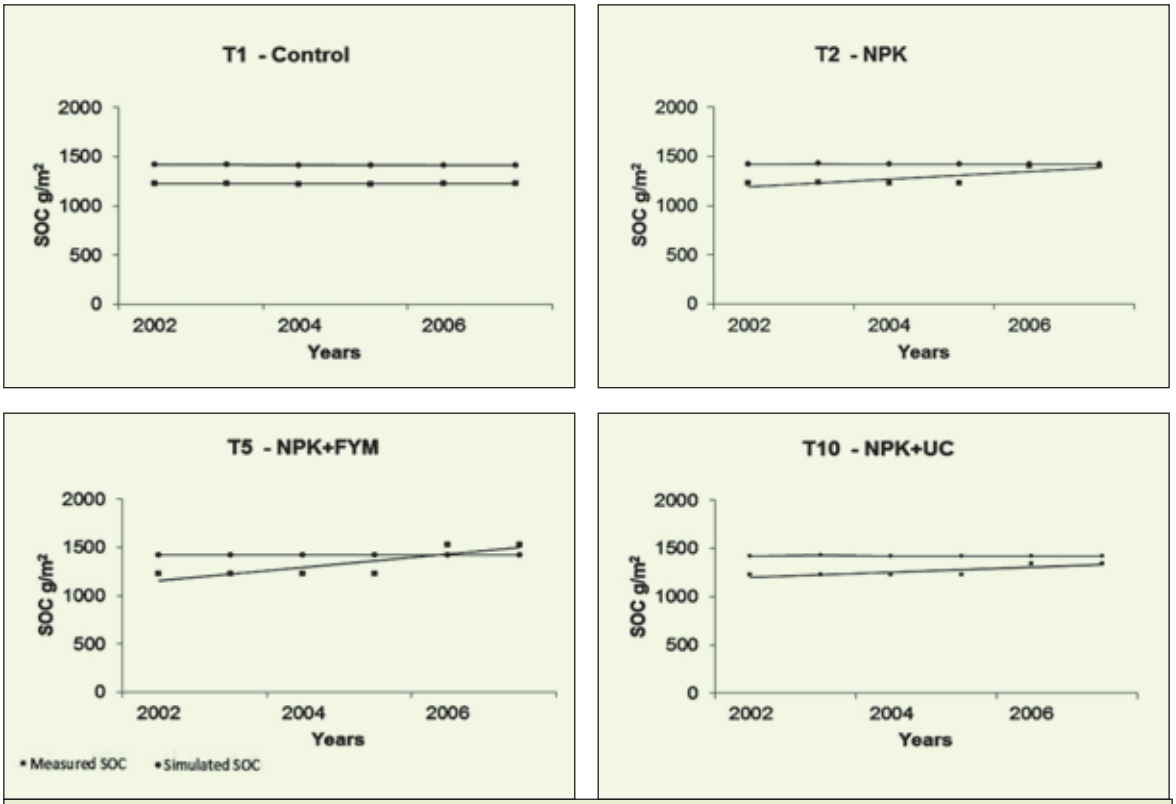
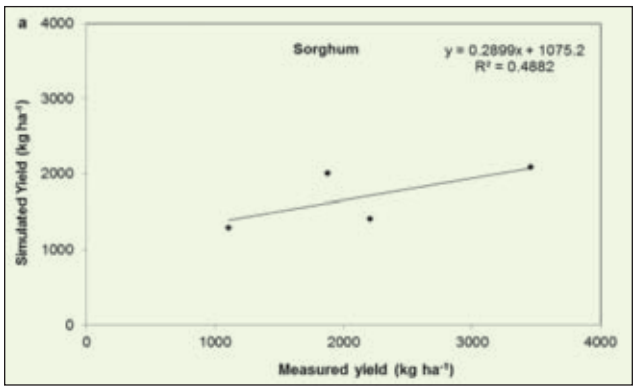


Fig. 2.3.12. Treatment effects on SOC turnover and its comparison (estimated vs measured) for the Nabibagh LTFE site

Simulation of crop yield

DNDC model is also used to simulate yields of sorghum and wheat in Akola LTFE site, and soybean and wheat in Nabibagh LTFE site. The simulated crop yields are compared with the measured crop yields (Figs. 2.3.13). In Akola LTFE site, R^2 value of 0.89 for wheat indicates very good agreement between the measured and simulated yields. There was a reasonably good association with a value of 0.488 and thus, the calibrated DNDC model for sorghum are performed satisfactorily for both sorghum and wheat crops.



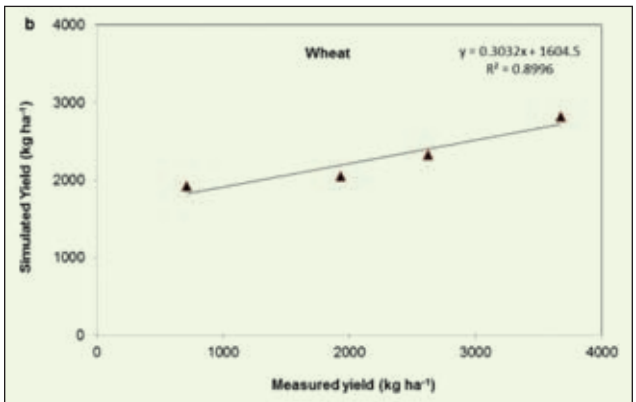
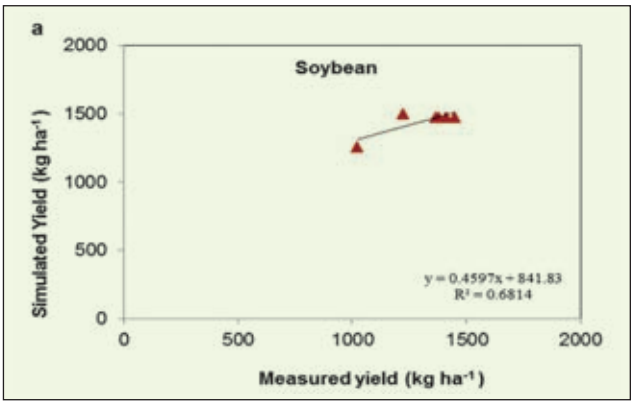


Fig. 2.3.13. Comparison of Crop yields (Measured vs. Simulated from DNDC model) in Akola LTFE site: (a) sorghum, (b) wheat

However, the control treatment in wheat, in spite of best efforts through parameterization process, did not produce satisfactory results.

The model simulated soybean crop yield for the treatments T2 (GRD), T5 (50%NPK of T3+5t FYM), T6 (50% NPK of T3+1 t PM) & T7 (50% NPK of T3 + 5 t UC) and for wheat crop T1 (Control), T5 (50%NPK of T3+5t FYM), T6 (50% NPK of T3+1 t PM) & T7 (50% NPK of T3 + 5 t UC) satisfactorily (Fig. 2.3.14). For wheat crop modelled values were 923 (T1), 1506 (T5), 1500 (T6), 1562 (T7) Kg ha^{-1} against observed values *i.e.* 893, 1600, 1460 & 1550 Kg ha^{-1} respectively (Fig.2.3.15).



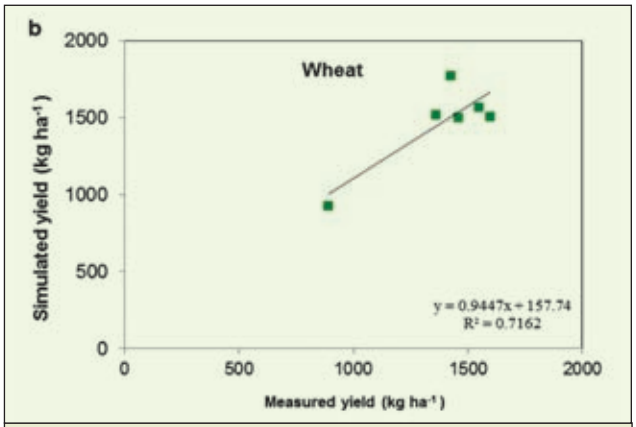


Fig. 2.3.14. Comparison of Crop yields (Measured vs. Simulated from DNDC model) for Nabibagh LTFE site: (a) Soybean, (b) wheat

Comparison of different models

here are many examples of comparison exercises between models. The comparison of TOC data shows fairly very good agreement between SOC measured and estimated values in two different times scale (Tables 2.3.4 and 2.3.5).

The Century, however, underestimates SOC in T2 (50% NPK), T13 (100% NPK+FYM) and T14 (only FYM). As compared to Roth*C* and Century, DNDC is able to capture the events of LTFE in T14 (only FYM). In the beginning, the model underestimated SOC in control (T1) and 50% NPK (T2) treatments (see Table 2.3.4), while for 100% NPK+FYM (T13) model underestimated at the end of the experiment (see Table 2.3.5). It seems that in absence of fertilizers and manure the DNDC model fails to get the correct lead for initiating for Akola site. However, this degree of under estimation is slightly narrowed down when 50% NPK is added. In case of combined dose of inorganic and organic, the model initiates well, but fail to simulate at the end of experiment largely due to excess of inorganics. This finds support from the observation in T14 where only FYM (T14) is applied.

Table 2.3.4. Comparison of measured and estimated SOC from Roth*C*, Century and DNDC model for Akola.

(Values in g/m^2)

RothC[1]				Century[2]				DNDC[4]			
SOC m[a]		SOC e[b]		SOC m		SOC e		SOC m		SOC e	
BE[c] (1988)	AE[d] (1997)	BE (1988)	AE (1997)	BE[c] (1988)	AE (1997)	BE (1988)	AE (1997)	BE (1988)	AE (1997)	BE (1988)	AE (1997)
T1 (Control)											
1105	1075	1100	1070	1159	537	1168	538	1159	537	838	595
T2 (50% NPK)											
1105	1080	1100	1075	1159	945	1184	808	1159	945	1029	910
T13 (100% NPK +FYM)											
1105	1193	1202	1290	1159	1966	1184	1507	1159	1966	1175	1463
T14 (Only FYM)											
1105	1497	1196	1588	1159	1293	1185	947	1159	1293	1134	1381

[a]SOC m : SOC measured; [b]SOC e : SOC estimated; [c]BE: Before experiment; [d]AE: After experiment; [1]RothC considers 23 cm soil depth:wetook15 cm soil depth; [2]Century considers 20cm soil depth; [3]InfoCrop considers 23 cm soil depth [4]DNDC considers 23 cm soil depth.

Table 2.3.5. Comparison of Roth*C*, Century and DNDC model performance in Akola LTFE site

Details of Treatments	Simulation Error					
	RMSE t C ha^{-1} (%)*			t value of M		
	Roth*C*	Century	DNDC	Roth*C*	Century	DNDC
Control (T1)	0.19 (1.79)	0.13 (1.74)	1.59 (20.85)	0.98	-0.11	1.01
50% NPK (T2)	0.36 (3.26)	3.85 (39.05)	0.76 (7.71)	0.47	0.25	0.53
100% NPK+FYM @10t ha^{-1} (T13)	0.95 (8.01)	2.71 (18.01)	2.96 (19.80)	0.31	1.40	1.59
FYM@10t ha^{-1}	0.91 (6.08)	1.98 (17.58)	1.89 (16.83)	0.05	0.97	-2.54

*Parenthesis indicate the % of error value from mean measured value

Performance of DNDC model for T2 (50% NPK) treatment was satisfactory with RMSE absolute value 0.76 t C ha^{-1} (Table 2.3.7) which is less than 10% of mean observed soil carbon. However, in the treatments of T1 (Control), T13 (100% NPK + FYM) and T14 (Only FYM) was not satisfactory. In the case of T14 (Only FYM) the difference in estimated and measured soil carbon was 8.8 g/m^2 which could be due to experimental error.

Among the three models, *viz.*, RothC, Century and DNDC, the performance of RothC model appears more promising than other two models in all the treatments with RMSE values less than 10% of the mean measured value. Another statistical evaluation criterion i.e. t values of M were found to be non-significant at 5% significant level except T14 (only FYM) treatment for DNDC model (Fig. 2.3.15).

When the measured and simulated crop yields of Akola LTFE site are compared, DNDC performed better than Century carbon model (Table 2.3.6) except T1 (control) for wheat crop.

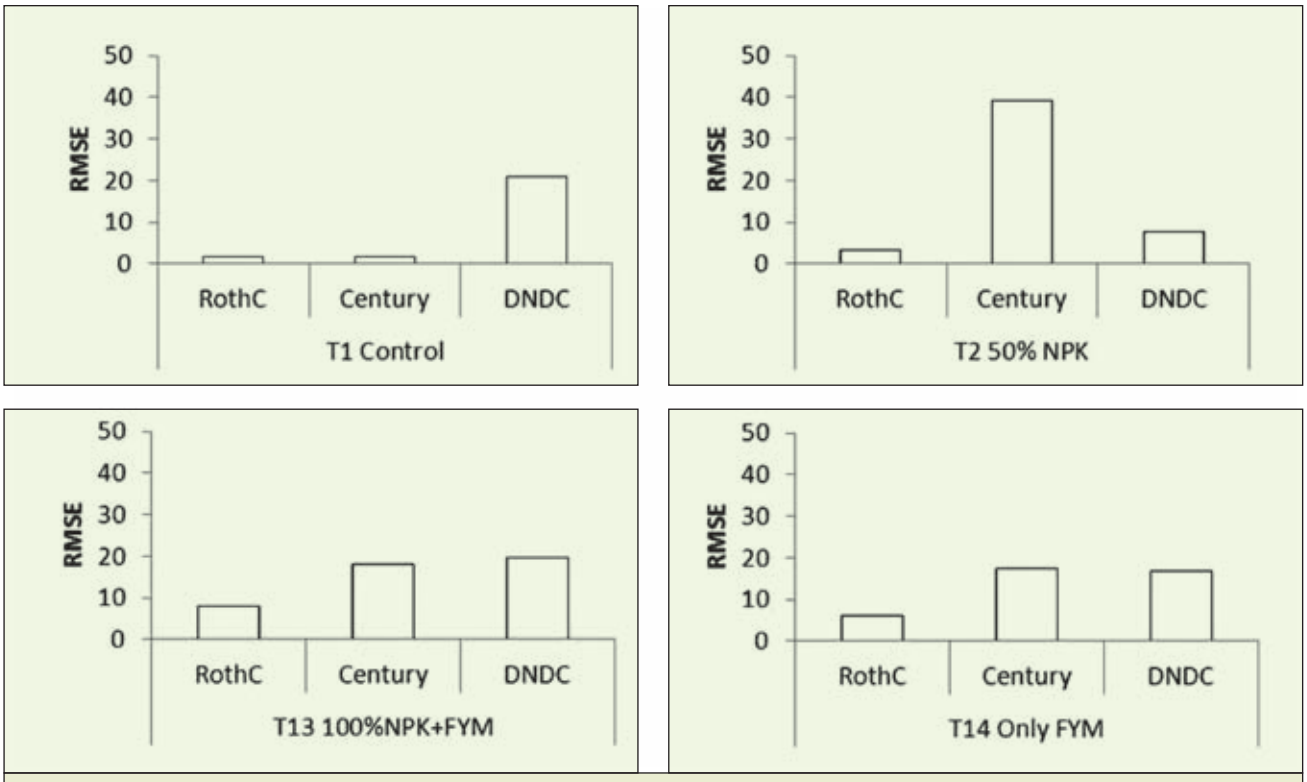


Fig. 2.3.15. Relative performance of RothC, Century and DNDC models showing root mean square error (RMSE)

Table 2.3.6. Comparison of measured yields and crop yields simulated from Century and DNDC model for Akola LTFE site

Century				DNDC			
Sorghum		Wheat		Sorghum		Wheat	
Measured	Estimated	Measured	Estimated	Measured	Estimated	Measured	Estimated
T1 (Control)							
1.105	1.30	0.71	1.23	1.105	1.296	0.71	1.928
T2 (50% NPK)							
2.208	3.10	2.623	2.11	2.208	1.412	2.623	2.327
T13 (100% NPK +FYM)							
3.453	5.60	3.675	2.94	3.453	2.092	3.675	2.824
T14 (Only FYM)							
1.876	1.18	1.934	0.37	1.876	2.007	1.934	2.051

Depth wise distribution of soil properties in Thimmajipeth mandal, Meboobnagar district, Telangana.

Soil survey work was undertaken in Thimmajipeth mandal, Mahabubnagar district, Telangana on 1:10000 scales. A total of 182 soil profiles in 39 transects were studied and the location of soil profiles were recorded using GPS. Six soil series were identified viz., Gummagonda (Loamy, mixed, hyperthermic Lithic Ustorthents); Pullagiri (Fine-loamy, mixed, hyperthermic Typic Haplustepts); Chegunta (Fine, mixed, hyperthermic Typic Rhodustalfs); Nerelapally (Fine, mixed, hyperthermic Typic Haplustepts); Avancha (Fine, smectitic, hyperthermic Sodic Haplusterts) and Koduparthy (Sandy, hyperthermic Typic Ustifluvents).

Soil depth varied from 16 cm (Gummagonda series) to 190 cm (Koduparthy series). Soil texture varied from loamy sand to clay at surface and in soil series control section (Fig. 2.3.16). The soils of Koduparthy series were formed by fluvial processes. As a result, depth wise distributions of properties were irregular and sandy layers in subsurface enhanced leaching losses of nutrients in these soils. Percentage clay

varied from 4.6 (Koduparthy) to 52.4 (Avancha) in the soil series control section. The sHC varied from 0 to 15.85 cm hr^{-1} and soils of Nerelapally and Avancha were poorly drained as noted from lowest sHC. Calcium carbonate content ranged from 2.43% at surface to as high as 23.9% in the control section, and generally showed increasing trend with depth. The OC content varied from 0.4 to 1.6% in surface layer and from 0.15 to 0.70% in the soil series control section, CEC varied from 3.9 to 32.7 cmol(p^+) kg^{-1} in surface, and from 2.6 to 40.2 cmol (p^+) kg^{-1} in the soil series control section. The soils of Nerelapally and Avancha were strongly alkaline in reaction (pH >8.5). ESP of these soils ranged from 16.9 to 46.7. In Semi-arid regions of the Deccan plateau both pedogenic and non-pedogenic $CaCO_3$ are not uncommon and its pedogenic nature limits the crop productivity due to concomitant development of sodicity.

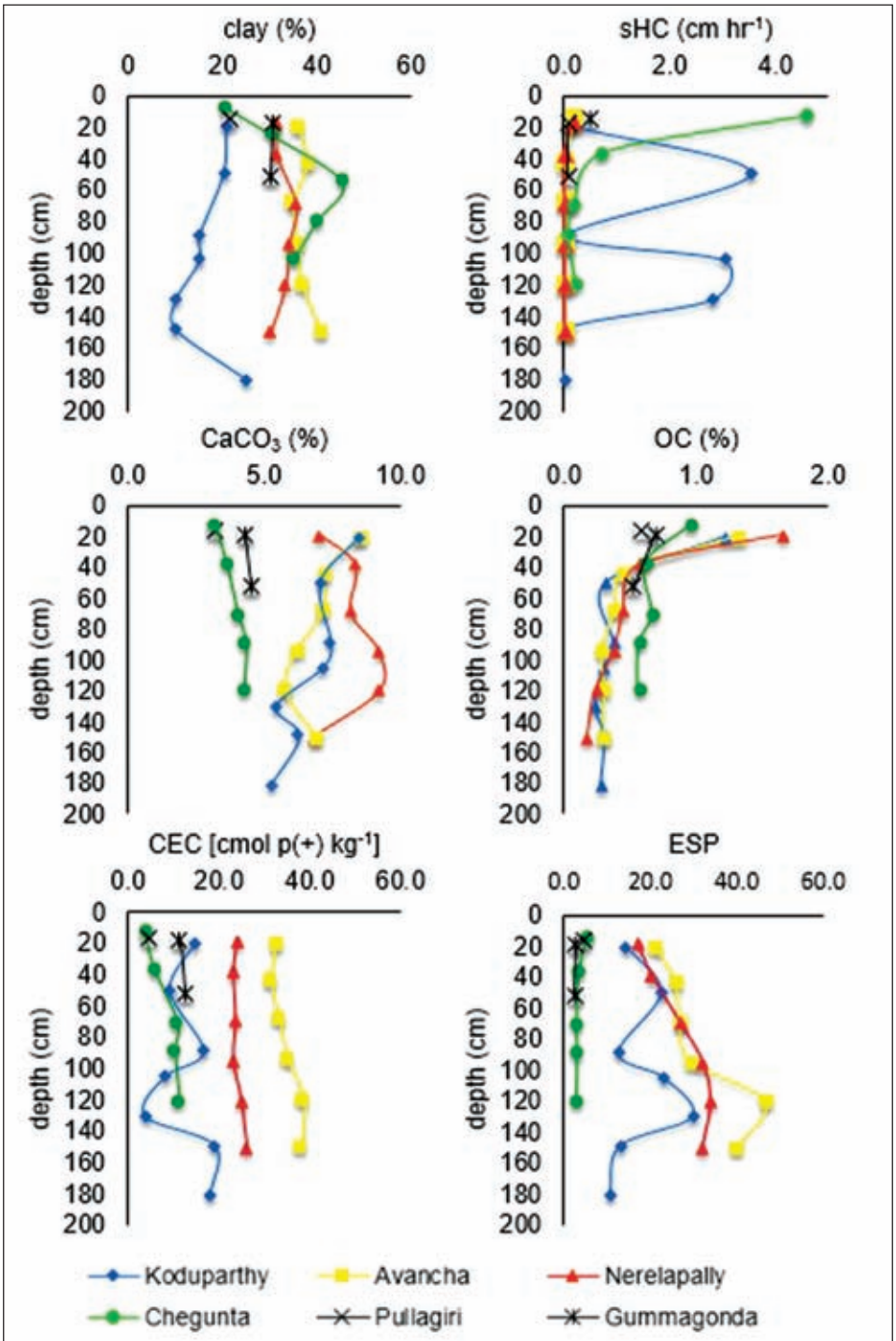


Fig. 2.3.16. Depth-wise distribution of some soil properties in Thimmajipeth

Soil-physiographic relationship

Soil physiographic relationship on smaller scale, soil–landform relationship on larger scale is the key for soil resource mapping on different scales. For understanding and perfecting the model, we have started to work on the relationship in different part of the country. During the year soil-physiographic relationship was studied for the parts of southern region (Figs. 2.3.17 to 2.3.23). On the sedimentary formation at Bagalkot Bijapur soils became finer, greyer and deeper as one moves from Dsd 211 to Dsd 242 (Fig. 2.3.17). In the western ghat at Charmundi Dakshina Kannada district relationship hold true and perform well on the basaltic, metamorphic, lateritic and granitic gnessic landforms. Land use also changes from forest, open scrub on the hills to most valuable crops like cotton and rice in the valley. Groundnut and sorghum are grown in the middle part of the landscape. Thus the soil-physiographic relationship on the different formations hold true on the smaller scale and is a key to set land use and agriculture.

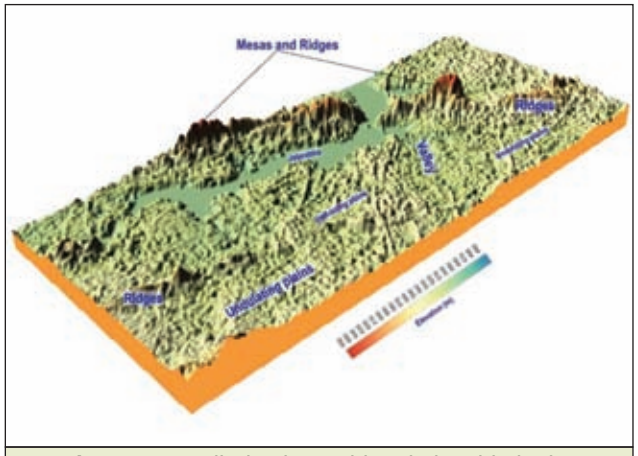


Fig.2.3.17. Soil-physiographic relationship in the sedimentary formation (Bagalkot, Bijapur district)

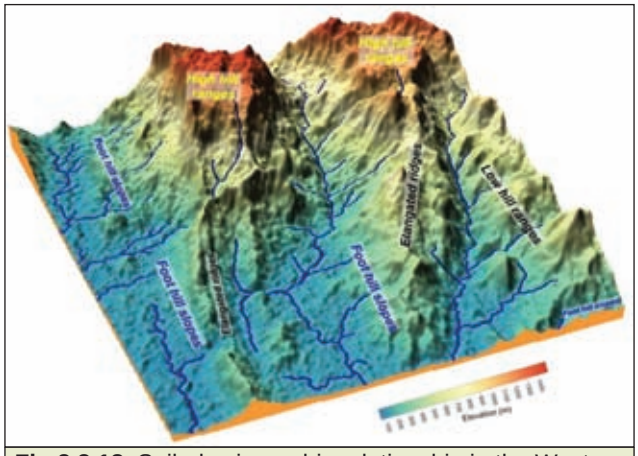


Fig.2.3.18. Soil-physiographic relationship in the Western Ghat (Chamudi, Dakshina Kannada district)

Bagalkot, Bijapur district

Physiography unit	Description	Soils	Land use
Dsd 211	Mesas and ridges	Loamy-skeletal, mixed, Lithic Ustorthents Clayey, mixed, Lithic Ustorthents	Scrub forest, barren land
Dsd 221	Undulating plains (Gray tone)	Very fine, montmorillonitic, Typic Chromusterts Fine, montmorillonitic, Vertic Ustropepts	Sorghum, groundnut
Dsd 222	Undulating plains (Light yellow tone)	Clayey, mixed, Lithic Ustorthents Clayey, mixed, Lithic Ustropepts	Sorghum, pulses
Dsd 223	Undulating plains (dark yellow tone)	Fine, mixed, Typic Rhodustalfs Clayey-skeletal, mixed, Lithic Ustorthents	Groundnut, sunflower pulses
Dsd 242	Valleys	Loamy, mixed, Lithic Ustorthents Fine, mixed, Vertic Ustifluvents	Bajra, sunflower, barren land

Chamudi, Dakshina Kannada district

Physiography unit	Description	Soils	Land use
Hwb 1112	High hill ranges	Clayey, kaolinitic, Ustic Haplohumults Clayey, kaolinitic, Ustic Kandihumults	Forest
Hwb 12	Low hill ranges	Clayey-skeletal, kaolinitic,Ustic Haplohumults Clayey-skeletal, kaolinitic,Ustic Kanhaplohumults	Cashew in patches
Hwb 13	Elongated ridges	Fine, mixed, Rhodic Paleustalfs Clayey, kaolinitic, Ustic Palehumults	Forest
Hwb 16	Foothill slopes	Fine, kaolinitic, Kandic Paleustalfs Forest Fineloamy, mixed, Kanhaplic Rhodustalfs	Cashew Arecanut

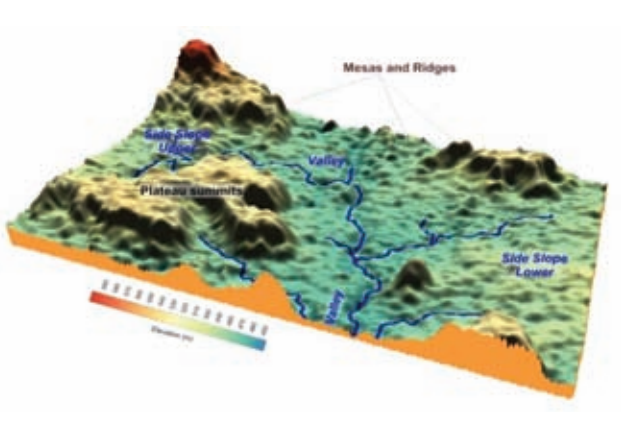


Fig.2.3.19. Soil-physiographic relationship in the basaltic terrain (Chimmanchod, Gulbarga district)

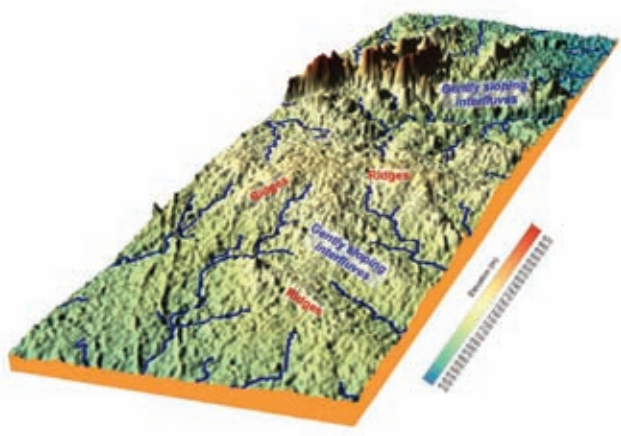


Fig.2.3.20. Soil-physiographic relationship in the metamorphic formations (Gadag, Dharwad district)

Chimmanchod, Gulbarga district

Physiography unit	Description	Soils	Land use
Dsb11	Mesas and ridges	Loamy, mixed, Lithic Ustorthents Fine, montmorillonitic, Vertic Ustropepts	Sorghum, sunflower Pulses, barren land
Dsb12	Plateau summits	Loamy,mixed, Lithic Ustorthents Fine, montmorillonitic, Vertic Ustropepts	Sorghum, safflower Pulses
Dsb131	Side slopes- upper	Loamy, mixed, Lithic Ustorthents Fine, montmorillonitic, Vertic Ustropepts	Safflower, sorghum Barren land
Dsb1321	Side slopes-lower	Very fine, montmorillonitic,Typic Chromusterts, Fine, montmorillonitic Vertic Ustropepts	Sorghum, cotton Pulses
Dsb14	Valleys	Very fine, montmorillonitic, Typic Chromusterts, Fine, montmorillonitic Vertic Ustropepts	Sorghum, cotton Sugarcane, chillies

Gadag, Dharwad district

Physiography unit	Description	Soils	Land use
Dsd111	Ridges	Loamy-skeletal, mixed, Lithic Ustorthents Clayey-skeletal, mixed, Lithic Ustropepts	Forest
Dsd152	Gently sloping Interfluves (yellow tone)	Clayey-skeletal, mixed,Typic Rhodustalfs Clayey-skeletal, mixed, Typic Ustropepts	Groundnut Sorghum
Dsd154	Gently sloping Interfluves (gray tone	Very fine, montmorillonitic,Typic Chromusterts Fine, montmorillonitic, Vertic Ustropepts	Sorghum Cotton, groundnut

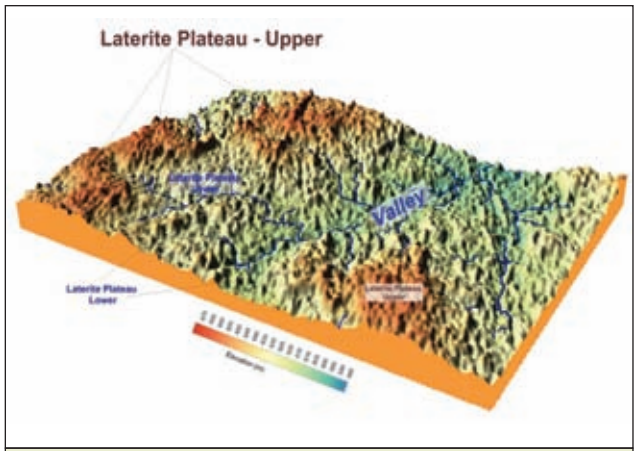


Fig.2.3.21. Soil-physiographic relationship on the lateritic formation (Homnabad, Bidar district)

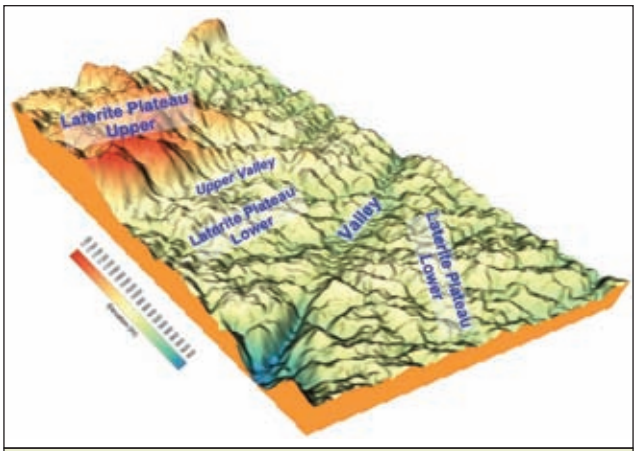


Fig.2.3.22. Soil-physiographic relationship on the lateritic landforms (Mudigere, Chikmagalur district)

Homnabad, Bidar district

Physiography unit	Description	Soils	Land use
Dsc211	Laterite plateau-upper	Fine, kaolinitic, Rhodic Paleustalfs Fine, kaolinitic, Oxic Ustropepts	Pastures, barren land,
Dsc212	Laterite plateau-lower	Clayey-skeletal, kaolinitic, Rhodic Paleustalfs Fine, kaolinitic, Rhodic Paleustalfs	Pastures, barren land, Sugarcane
Dsc22	Valleys	Very fine, montmorillonitic, Typic Chromusterts Fine, montmorillonitic,Vertic Ustropepts	Sorghum, sugarcane

Mudigere, Chikmagalur district

Physiography unit	Description	Soils	Land use
Dsc312	Laterite plateau-upper	Fine, kaolinitic, Kandic Paleustalfs Clayey, kaolinitic, Kanhaplic Haplustults	Coffee
Dsc322	Laterite plateau-lower	Clayey, kaolinitic, Ustic Palehumults Clayey, kaolinitic, Ustic Haplohumults	Coffee
Dsc331	Valleys	Loamy over sandy, mixed, Aquic Ustifluvents Fine loamy, mixed, Typic Ustifluvents	Rice

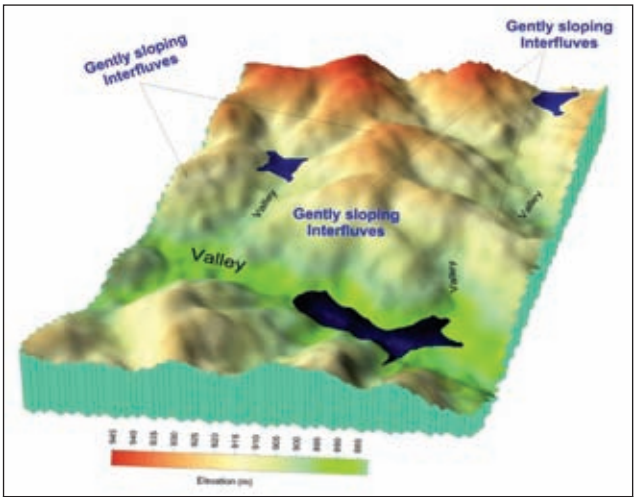


Fig.2.3.23. Soil-physiographic relationship on the granite/ gneisses (Tyamagondalu, Bangalore district)

During the year the relationship was studied at 1:10000 scale in Borio block, Sahibganj district of Jharkhand and in the Ganjam block of Ganjam district Odisha. In the Borio block, relationship was noted beyond the established fact. For example rampant erosion outlaws the relationship on gently sloping undulating plains, where soils are supposed to be deeper and finer than the soils of moderately sloping upland (Fig. 2.3.24). Similarly sea encroachment outlaws the relationship in Ganjam block, Ganjam district, Odisha (Fig. 2.3.25). The relationship among slope, elevation and soils are shown in Figs. 2.3.26 to 2.3.29 for soils of north eastern region.

Tyamagondalu, Bangalore district

Physiography unit	Description	Soils	Land use
Dsa 326	Gently sloping interfluves	Fine, kaolinitic, Kandic Paleustalfs Fine, kaolinitic, Rhodic Kandiustalfs	Finger millet and mixed crops
Dsa 42	Valleys	Fine, mixed, Typic Ustropepts Clayey over loamy, mixed, Typic Ustifluvents	Rice Vegetables

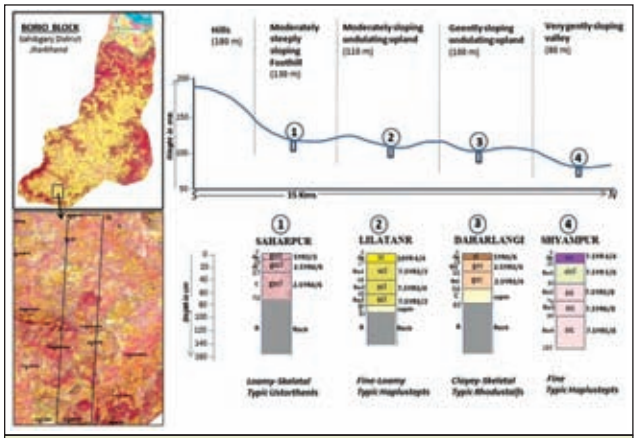


Fig. 2.3.24. Soil landform relationship in Borio block, Sahibganj district, Jharkhand

Medziphema block, Dimapur district, Nagaland

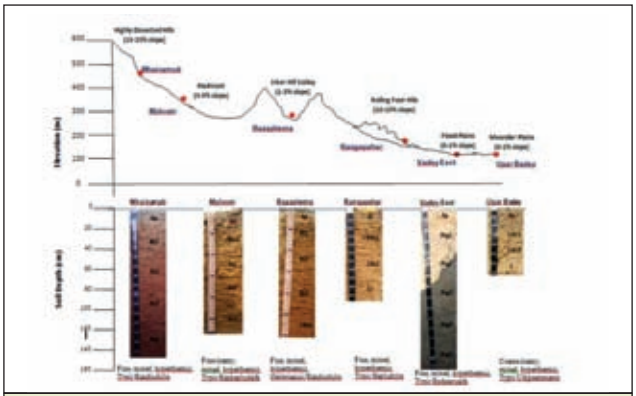


Fig. 2.3.27. Soil-landform relationship of Medziphema block, Dimapur district, Nagaland

Ganjam block, Ganjam district, Odisha

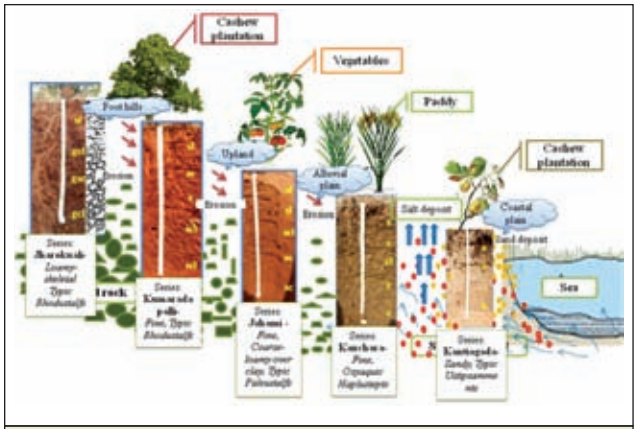


Fig. 2.3.25. Land form, land use and soils relationship in Ganjam block

Diyun block, Changlang district, Arunachal Pradesh

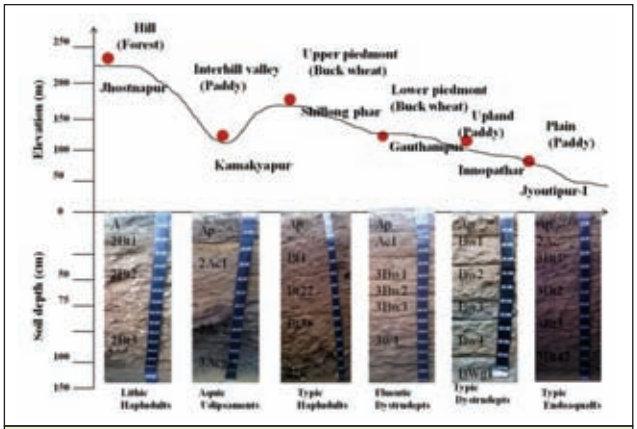


Fig. 2.3.28. Soil-landform relationship of Diyun block, Changlang district, Arunachal Pradesh

North West Jorhat block, Jorhat district, Assam

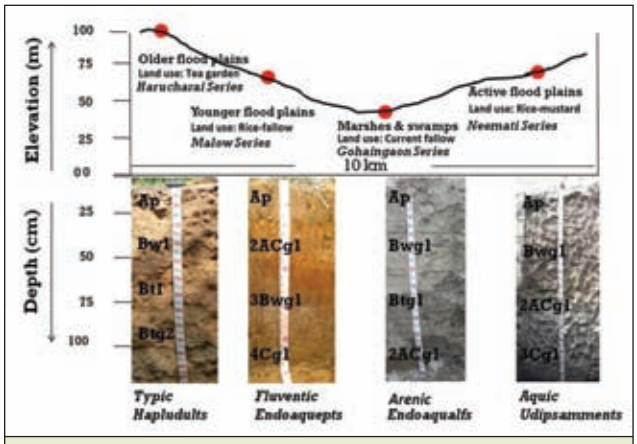


Fig. 2.3.26. Soil-landform relationship of North West Jorhat development block

Jirang block, Ri-bhoi district, Meghalaya

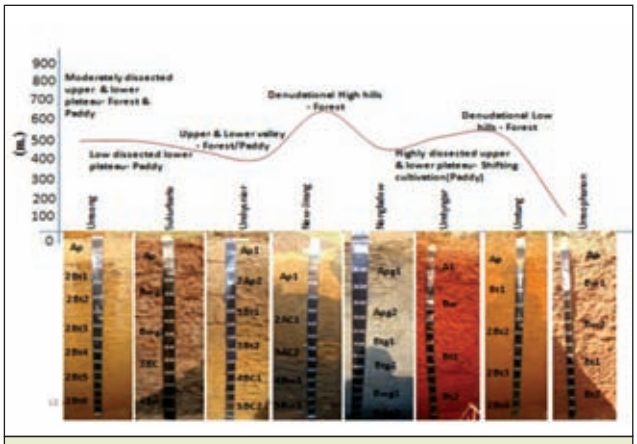


Fig. 2.3.29. Soil-landform relationship of Jirang block, Ri-bhoi district, Meghalaya

Soil correlation

In land resource inventory program of the country on 1:10000 scale a total of 294 number of soil series are identified (Table 2.3.7). Of which 73 belong to Western region, 38 to Northern region, 38 to Southern region, 73 to Eastern region, 42 to North-Eastern region. Of the total 42 were classified in Vertisols, 123 in Inceptisols, 53 in Entisols, 42 in Alfisols, 30 in Aridisols and 15 in Ultisols.

Table 2.3.7. Soil Series Identified

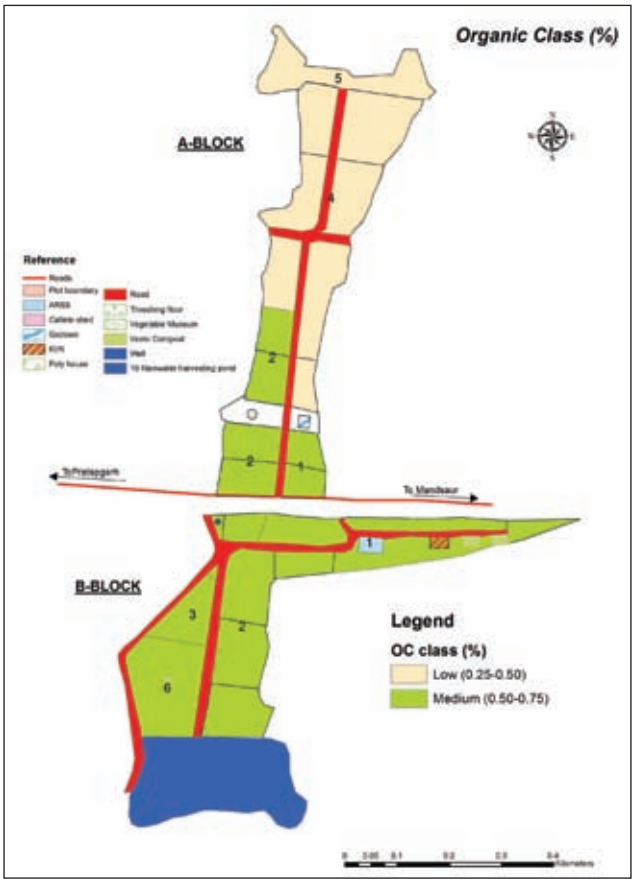
S. No.	Block	Soil Series	Soil Orders					
			Entisols	Inceptisols	Vertisols	Alfisols	Aridisols	Ultisols
HQrs. Nagpur								
1.	Dhanora	9	3	4	2			
2.	Darwha	17	4	9	4			
3.	Bemetara	4			4			
Regional Centre, Bangalore								
4.	Thimajipeth	6	2	2	1	1		
5.	Indravelly	7	2	3	2			
6.	Bukkaray-samundrum	7					7	
7.	Kangayam	12		6		6		
8.	Gajwel	6	1	1	1	3		
Regional Centre, Delhi								
9.	Jagner	12	6	5		1		
10.	NagrotaBagwan	10	7	3				
11.	Odhan	8	4				4	
12.	Rajpura	8	2	6				
Regional Centre, Jorhat								
13.	NW Jorhat Development	12	3	3		5		1
14.	Medziphema	6	1			1		4
15.	Diyun	6	1	2		1		2
16.	Jirang	8		2		2		4
17.	Bishalgarh	10	1	3		2		4
Regional Centre, Kolkata								
18.	Borio	4		3		1		
19.	Dumka	5		1		4		
20.	Basudevpur	8		4		4		
21.	Titlagarh	10	1	7		2		
22.	Mushahari	6		4		2		
23.	Kadwa	8	2	6				
24.	Rajnagar	7		4		3		
25.	Ganjam	16	2	9	1	4		
26.	Ramnagar-1	3	1	2				
27.	Hasnabad	6		6				
Regional Centre, Udaipur								
28.	Ankaleshwar	9		4	5			
29.	Khedbrahma	10		6	4			
30.	Dholka	11	2	4	5			
31.	Deesa	8	3	5				
32.	Porbandar	16	4	9	2		1	
33.	Rapar	19	1				18	

2.4 INTERPRETATION OF SOIL SURVEY DATA

Soil Fertility Mapping

1. KVK Farms, Rajasthan

Status of major, macro and micro nutrients of six KVK farms located in six districts of Rajasthan namely, Pratapgarh, Banswara, Dungarpur, Rajsamand, Bhilwara and Chittaurgarh were assessed. Soil pH and texture were also determined. Soil nutrient status maps, pH and texture map are developed for each of KVK farm surveyed during the year. Some of the thematic maps like organic carbon, particle size class, soil pH and available zinc for KVK farm of Pratapgarh district are shown below as an example (Fig. 2.4.1).



2. Central State Farm Jetsar, Sri Ganganagar district, Rajasthan.

During the year nutrient status mapping for the soils of central state farm Jetsar, Sri Ganganagar district of Rajasthan was accomplished. Soil samples were collected from each plot at 0-15 cm depth and analysed for major, macro, and micro nutrients together with soil pH and texture. Status maps for soil pH, organic carbon, available phosphorus and available zinc are given as an example in the present report (Fig.2.4.2).

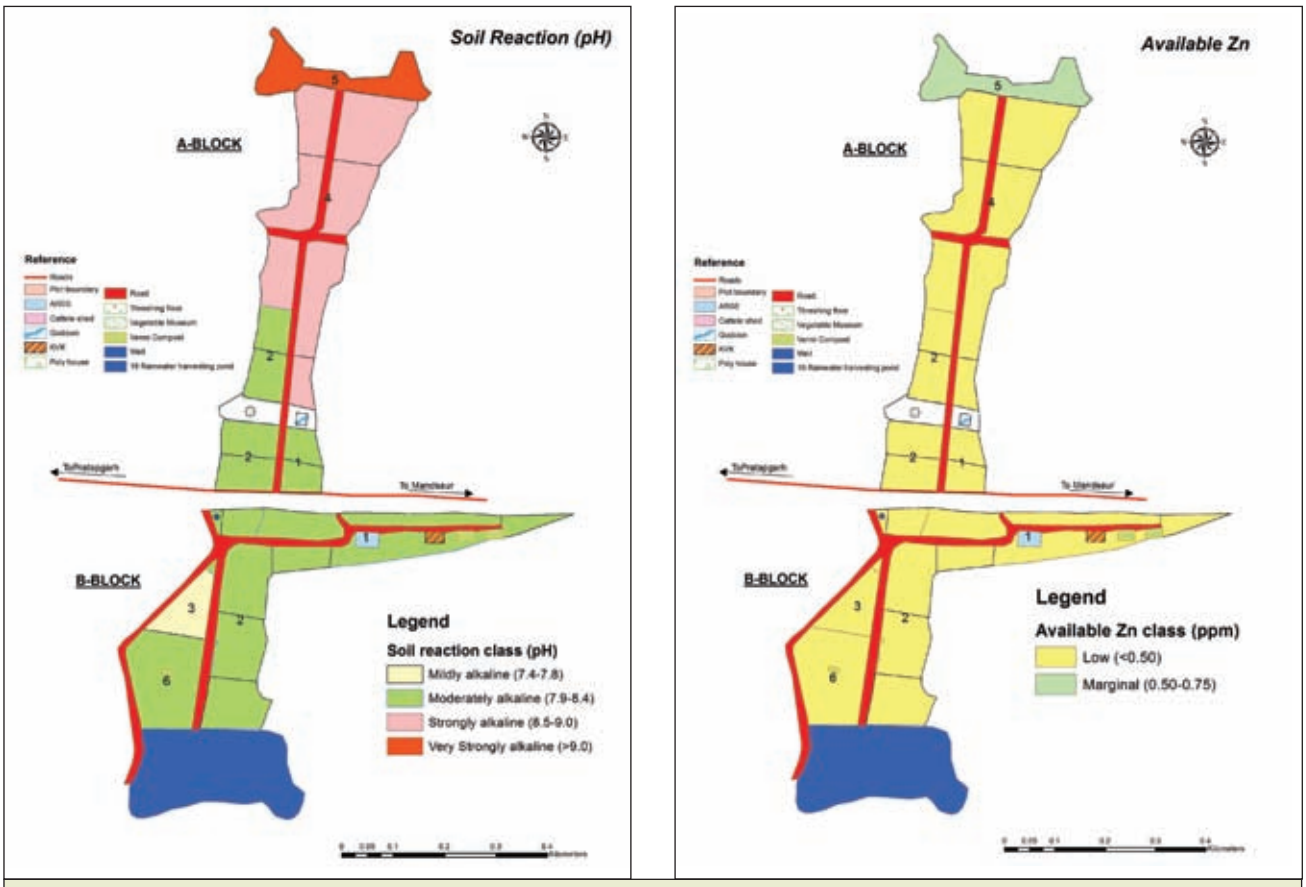


Fig. 2.4.1. Thematic maps of KVK Pratapgarh, MPUAT, Udaipur

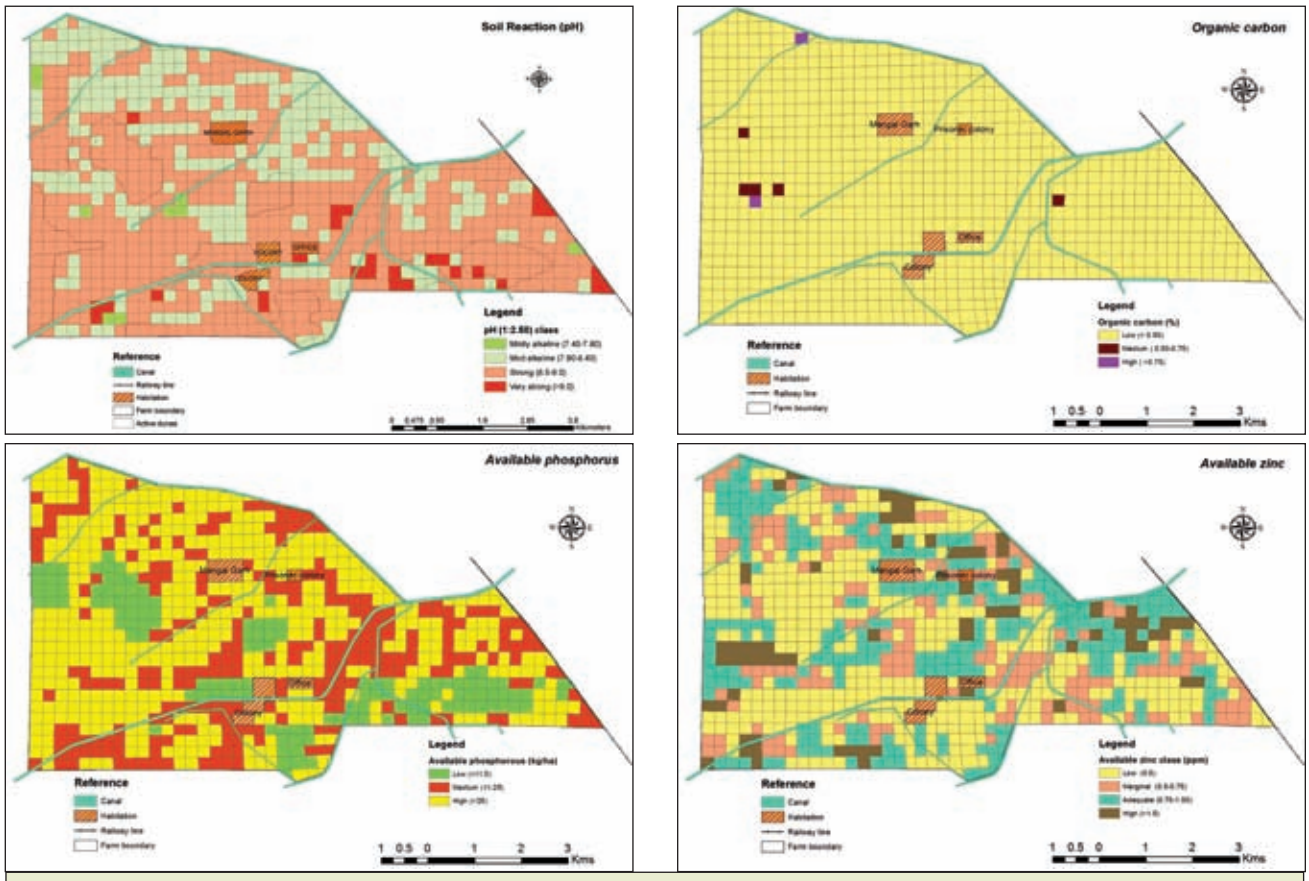


Fig. 2.4.2. Thematic maps of Central State Farm, Jetsar, Sri Ganganagar, Rajasthan

Soil fertility monitoring in the traditional rubber-growing areas of Kerala, Tamil Nadu and Karnataka

Georeferenced soil samples were collected for 0-15 and 15-30 cm depth from the rubber growing and adjoining areas of forest for the state of Kerala, Karnataka and Tamilnadu. Location of the samples collected are geo-tagged for future monitoring. Total 121 soil health monitoring sites are tagged. 102 in Kerala for 5.17 lac hectare area (Fig. 2.4.3), 5 in Tamilnadu for 0.10 hectare area and 14 in Karnataka for 0.32 hectare area. Samples were analysed for major, macro and micro nutrients as the base line information in the year 2015 for comparison in the future. The graphical presentation of some parameters (landform wise) for these soils are shown (Fig.2.4.4 to 2.4.9).

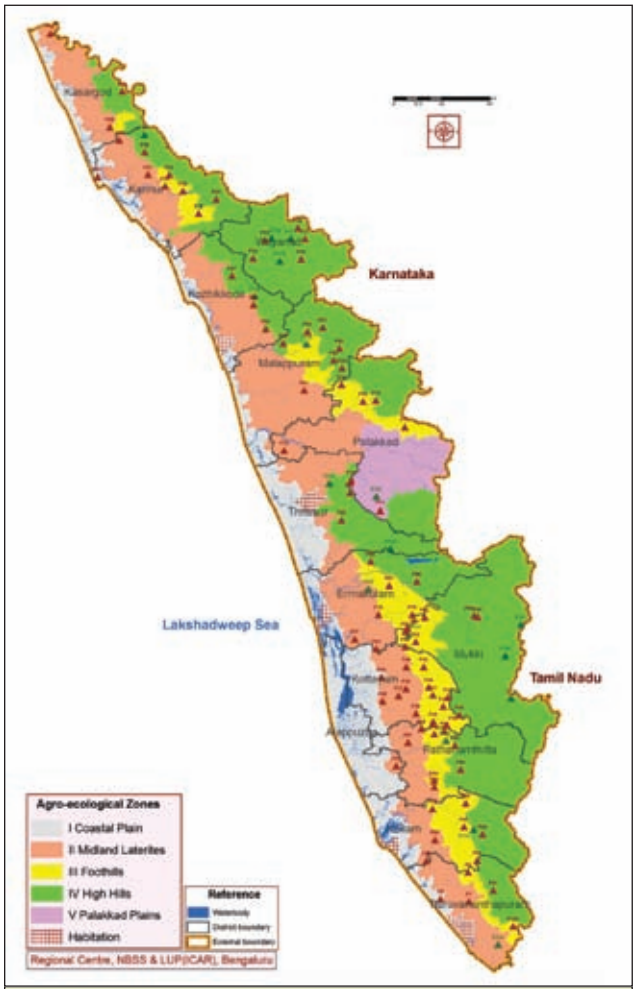


Fig. 2.4.3. Soil health monitoring sites for rubber growing sites in Keral

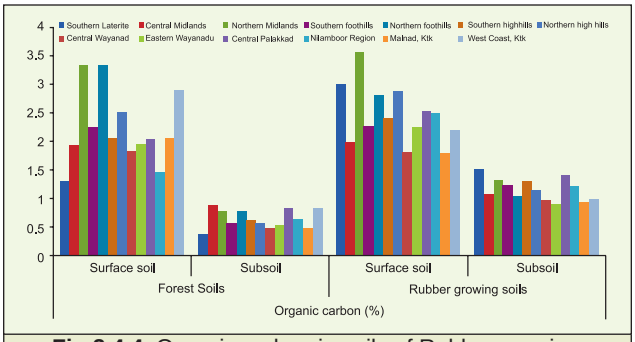


Fig.2.4.4. Organic carbon in soils of Rubber growing soils and forest

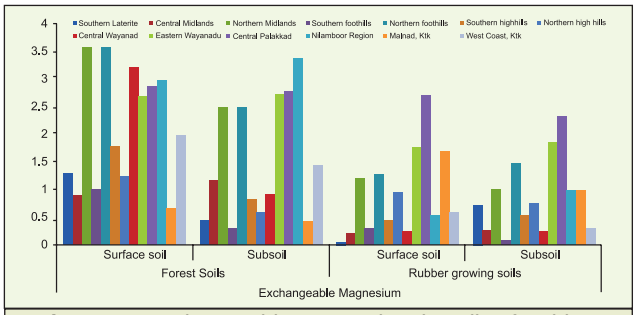


Fig. 2.4.5. Exchangeable magnesium in soils of Rubber growing soils and forest

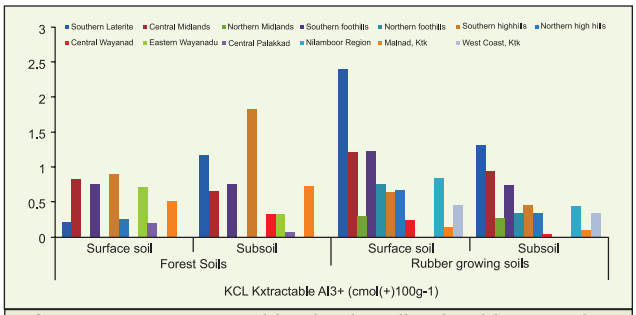


Fig. 2.4.6. KCL extractable Al3+ in soils of Rubber growing soils and forest

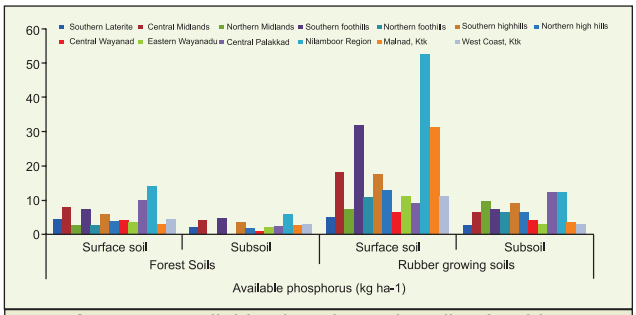


Fig. 2.4.7. Available phosphorus in soils of Rubber growing soils and forest

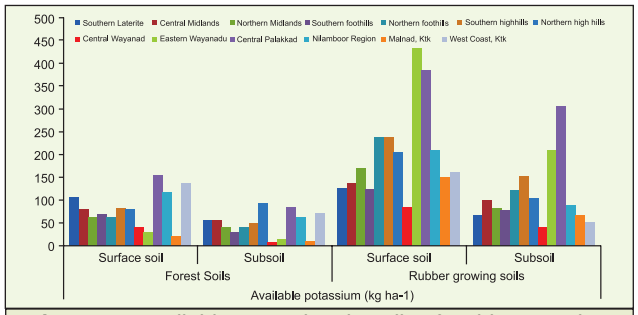


Fig. 2.4.8. Available potassium in soils of Rubber growing soils and forest

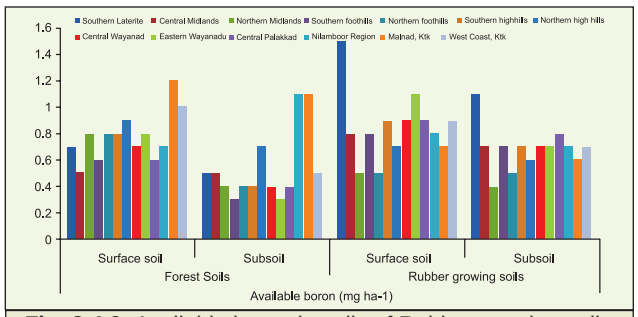
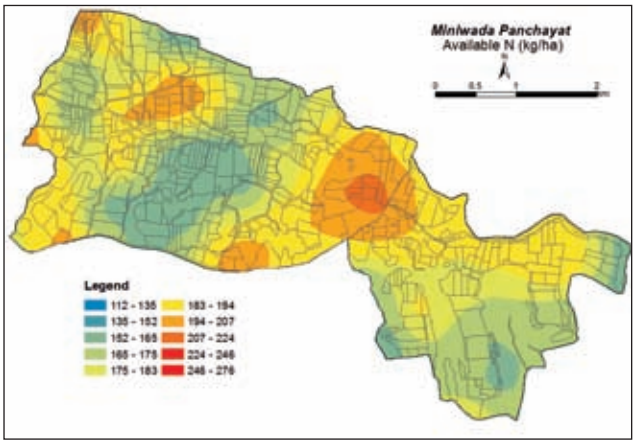
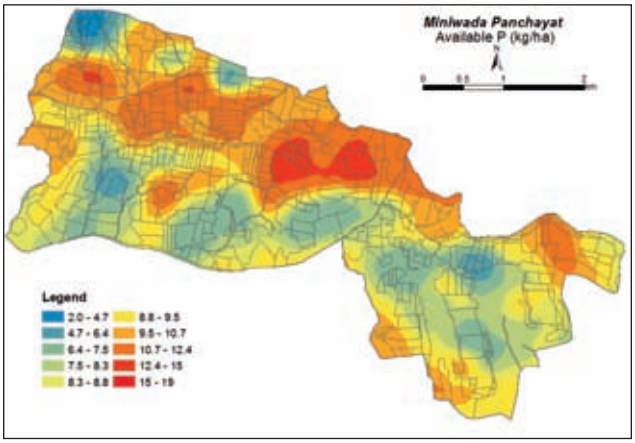


Fig. 2.4.9. Available boron in soils of Rubber growing soils and forest

Soil fertility mapping of Miniwada Panchayat, Katol tehsil, Nagpur

Grid soil sampling at an interval of 250 m using Global Positioning System (GPS) was done in Katol tehsil of Nagpur district. A total of 235 soil samples were collected from the plough layer (0-25 cm) and analyzed for available macronutrients (N, P, K) and micronutrients (Fe, Zn, Mn, Cu). Spatial variability was quantified through semi variogram analysis and the respective surface maps were prepared through ordinary krigging. After filtering the information, krigged maps were linked with cadastral maps. Krigged maps of available N, P, K, Fe, Mn, Zn, Cu are presented in Figures 2.4.10 and 2.4.11.





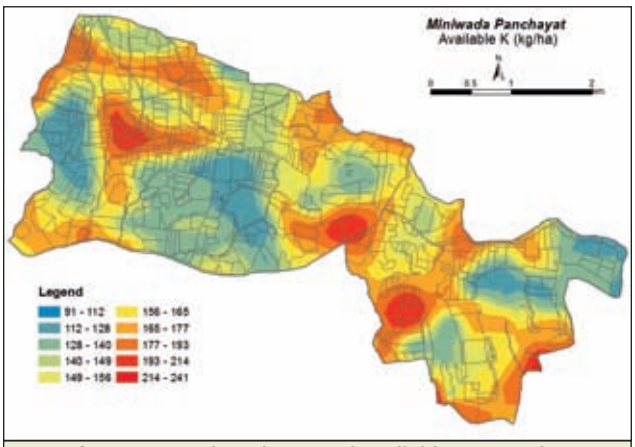


Fig. 2.4.10. Krigged maps of available N, P and K

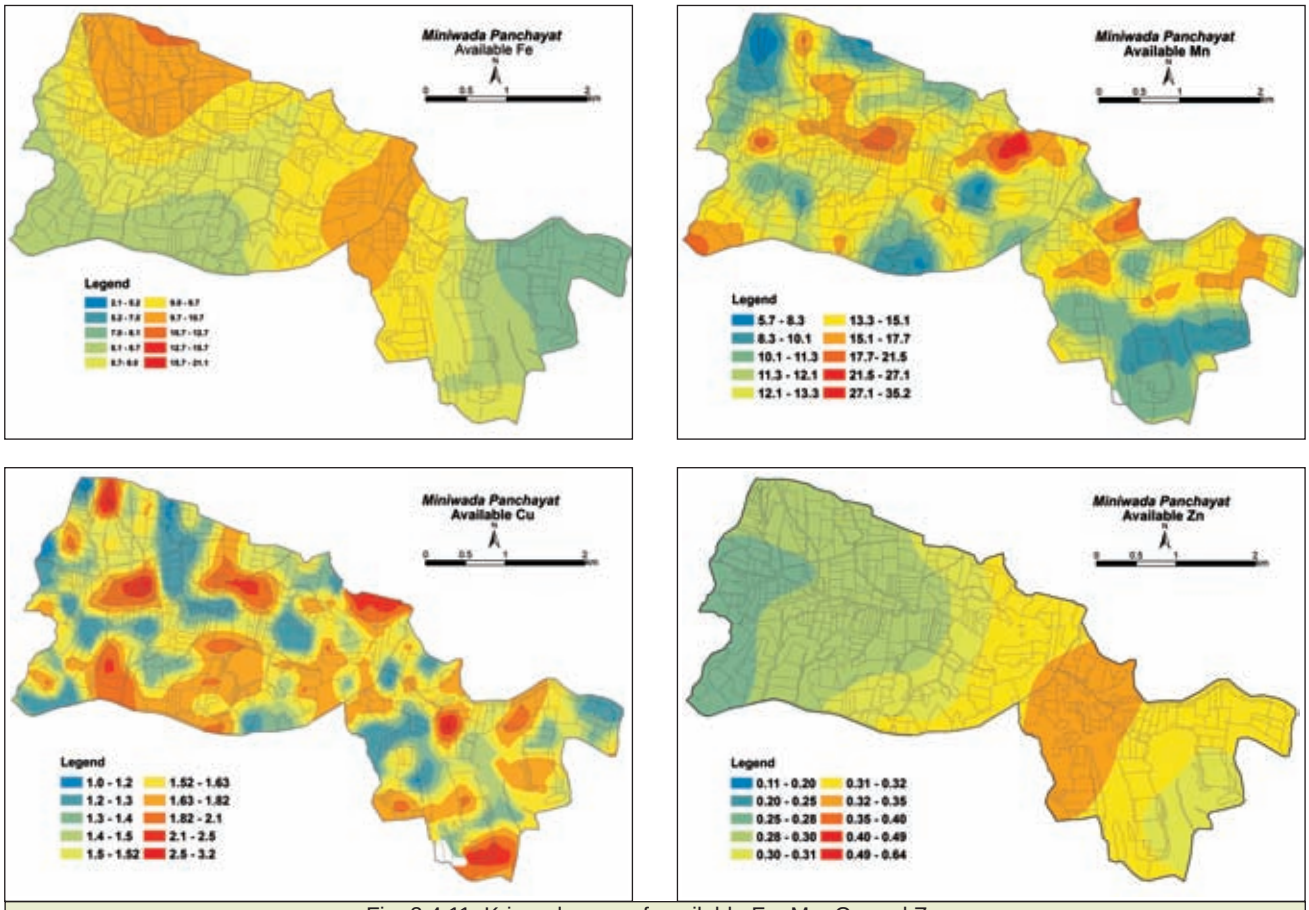


Fig. 2.4.11. Krigged maps of available Fe, Mn, Cu and Zn

Development of Soil Health Card (SHC) using GIS techniques

Soil Health Card (SHC) Scheme was launched by the Government of India in February 2015. Under the scheme, the government plans to issue SHC to farmers which will indicate nutrient status of soils for the individual farms to help farmers for improving productivity through judicious use of inputs. The government plans to distribute 14 crore SHC by 2017.

Under this programme two agencies namely Agricultural Produce Market Committee (APMC), Nagpur and Association with Action for Food Production (AFPRO) selected two blocks namely Nagpur block in the district of Nagpur and Kelapur block in Yavatmal district, respectively. NBSS&LUP is providing technical backup to these agencies. During the report period all the 161 villages in Nagpur and 125 in Kelapur block are covered.

Sampling scheme

Soil sampling is the first step in generating field-specific information on fertilizer recommendation and monitoring the soil nutrient status over time. Technological advances in GPS (global positioning systems) and GIS (geographic information systems) were utilized for precise design for more intensive soil sampling. A network of grid lines was superimposed on a digitized base map at a distance of 325m x 325m to assist in test sample positioning. According to this scheme, one grid point sample represents 10 ha area (Fig. 2.4.12 and 2.4.13). A total of 1700 surface samples were collected in Nagpur block and 5000 in Kelapur block for developing SHC. Samples were analysed for the available major nutrients (N, P, K), micronutrients (Fe, Mn, Zn, Cu) and sulphur. Soil samples were also analyzed for soil reaction (pH), organic carbon and salinity (EC).

Fig.2.4.12. Soil Health Card Sampling Scheme (Part of Kelapur Block, Yavatmal District)

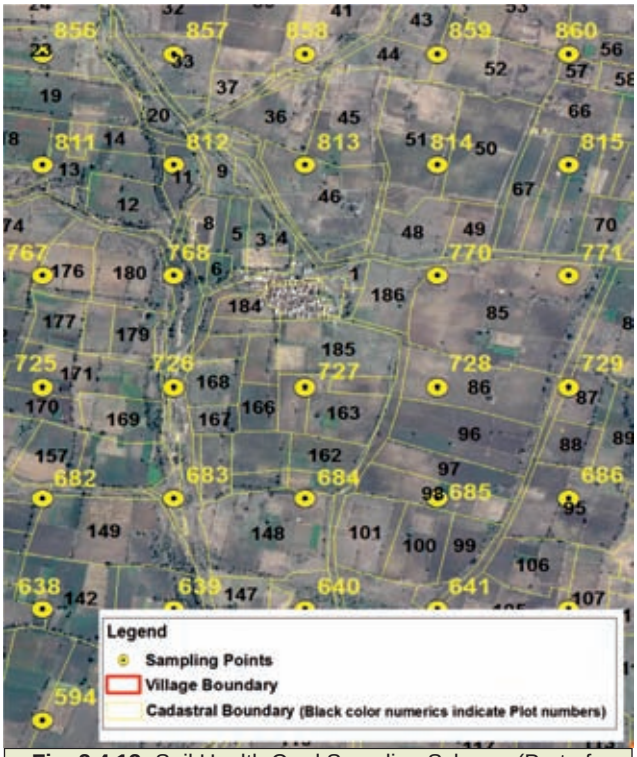


Fig. 2.4.13: Soil Health Card Sampling Scheme (Part of Nagpur Block, Nagpur District)

Soil analysis of Nagpur block indicated that pH ranged from 6.4 to 9.0 with a mean of 8.0. About 76 % samples of the area were moderately alkaline (pH 7.9-8.4), 12% slightly alkaline (pH 7.4-7.8), 7% neutral (pH 6.6-7.3) and 5% as strongly alkaline (pH 8.5-9.0) (Fig.2.4.14). Organic carbon status of 7% samples was low (<0.5%), 69% samples were in medium range (0.5-0.75%) and 24% samples were in the high range (>0.75%). Electrical conductivity (EC) is within the permissible limits of <2.0 dSm^{-1}

All samples were low (<250 kg/ha) in available nitrogen except 1% samples which were medium (250-500 kg/ha).

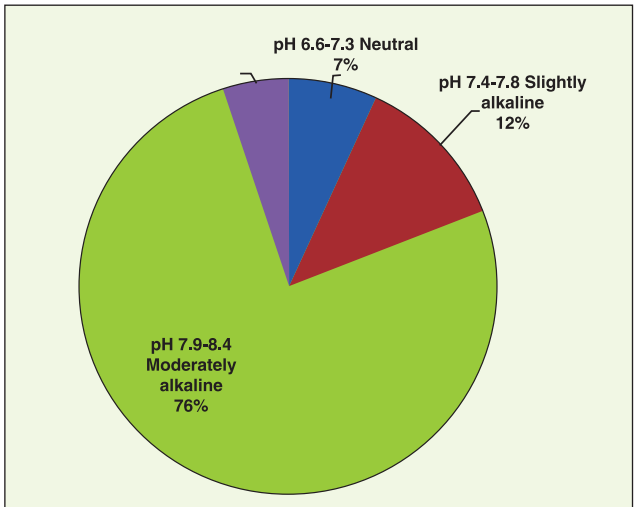


Fig. 2.4.14 Soil reaction (pH) classes of Nagpur block

Availability of potassium in soils of Nagpur block was ranged from 67 to 3764 kg/ha with a mean of 655 kg/ha. The variation was very high (standard deviation 368 kg/ha).Availability of potassium was low (<110 kg/ha) in 1% samples, medium (110-280 kg/ha) in 8% samples and high (>280 kg/ha) in 91% soil samples analyzed. Available sulphur content ranged from 0.0 to 184 ppm with a mean of 15.1 ppm. According to the ratings the available sulphur was recorded low (<6.0ppm) in 24% samples, medium (6-12ppm) in 31% samples and high (>12ppm) in 44% samples. The fertility rating of major nutrients is given in Figure 2.4.15.

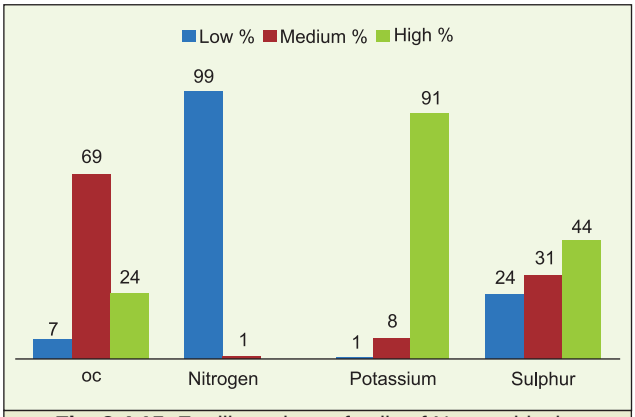


Fig. 2.4.15. Fertility ratings of soils of Nagpur block

Nutrient index

Based on the soil test values for different nutrients, soil samples were classified into three categories, low, medium and high. Using these fertility classes nutrient index was calculated as per the following equation.

Nutrient index = $(N_L * 1 + N_M * 2 + N_H * 3) / N_T$

Where, N_L, N_M and N_H are number of samples belonging to low, medium and high classes of nutrient status, respectively and N_T is total number of samples analyzed for Nagpur block. Considering the concept of "Nutrient Index" the soils of study area were categorized as 'low fertility status' for nitrogen and 'high' with respect to potassium. The values worked out from nutrient index for nitrogen and potassium were 1.01 and 2.91 respectively, against the nutrient index values <1.67 for low, 1.67 to 2.33 for medium and >2.33 for high fertility status of area.

Status of available micronutrients (Fe, Mn, Zn, Cu)

All the soil samples indicated adequate manganese (>1.0 ppm) and copper (>0.2 ppm) status. The availability of iron was ranged from 0.4 to 49.2 ppm with a mean of 8.1 ppm. Out of 1700 soil samples tested in laboratory; 28% were recorded as deficient (<4.5ppm) and 72% samples were sufficient

(>4.5ppm) in available iron. Available zinc content was ranged from 0.1 to 10.6 ppm with a mean of 0.7 ppm. According to the rating criteria 55% soils were deficient (<0.6ppm), 37% marginal (0.6-1.2ppm) and 8% were sufficient (>1.2ppm) (Fig.2.4.16).

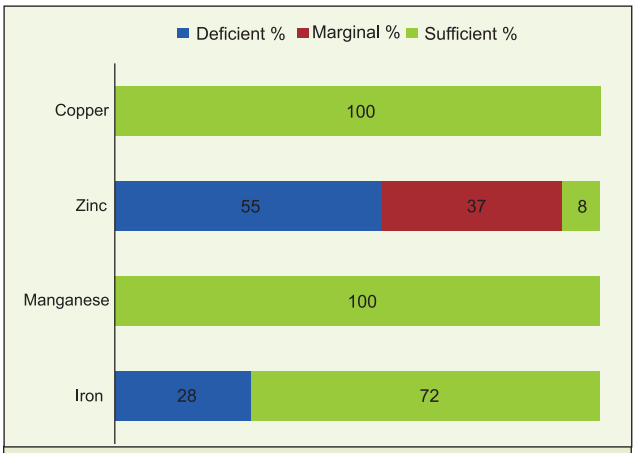


Fig. 2.4.16. Micronutrient availability status in soils of Nagpur block

Thimmajipet mandal, Mahabubnagar district, Telangana

On the similar pattern, soil samples were collected at grid interval of 325 x 325 m for Thimmajipet mandal, Mehboobnagar district of Telangana state. A total of 1542 geo-referenced soil samples were collected from 0-15 cm depth and analyzed for soil macro and micro nutrients. The results indicate that 85% of the samples were low in available nitrogen, 10% were low in available phosphorus and 21.5% low in available potassium and 35% in available sulphur. Among micronutrients, zinc and boron are deficient in 81 and 60% of the soils, respectively. The fertility status map for all the nutrients are prepared by using krigging as interpolation techniques and surface of each nutrients were linked with the cadastral map for developing farmer wise and plot wise information for issuing soil health card. In the present report surface developed for nitrogen and available zinc are given (Fig. 2.4.17 and 2.4.18).

Soil Quality Assessment (SQI)

Soil quality evaluation for soils of Thimmajipet block, Mahabubnagar district, Telangana were carried out using Principal Component Analysis (PCA) and expert opinion (EO) methods. SQI was calculated for the soils of selected soil series using samples from 0 - 15 cm (surface soils) and for 0 - 100 cm (soil control section) except Gummagonda (Total depth 16 cm) and Pullagiri (Total depth 50 cm). Among six

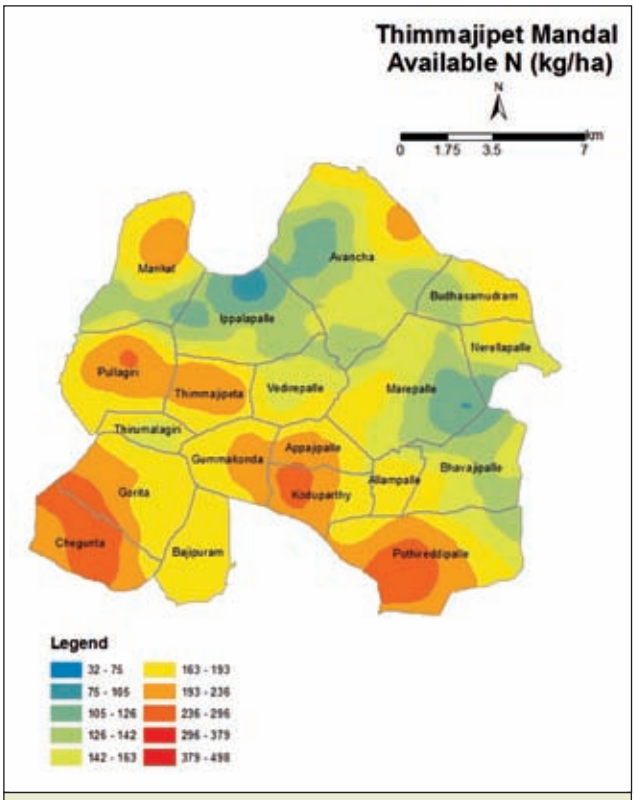


Fig. 2.4.17. Soil available nitrogen status in Thimmajipet, Mahabubnagar district, Telangana

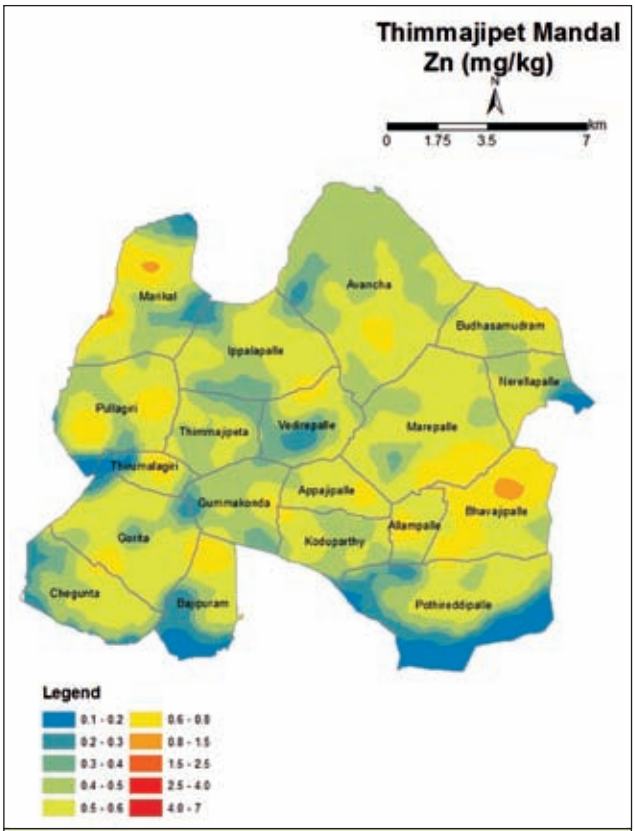


Fig. 2.4.18. Soil available zinc status in Thimmajipet, Mahabubnagar district, Telangana

soil series, the highest SQI was for Chegunta (0.54) and the lowest for Koduparthy (0.27) for 0-15 cm soils by EO weighted index method and similar SQIs were obtained for soil control section (Table 2.4.1).

Table 2.4.1 Soil quality in Thimmajipet mandal, Mehabubnagar district, Telangana

Soil quality			
Soil Series	**Area (ha)**	**Soil Quality Index**	**Soil quality**
Gummagonda	2000	0.32	Low
Pullagiri	2200	0.40	Low to moderate
Chegunta	5800	0.55	Moderate to high
Nerelapally	2100	0.38	Low to moderate
Avancha	3400	0.35	Low to moderate
Koduparthy	3100	0.28	Low

Water quality assessment

Forty nine geo-referenced groundwater samples were collected during February (2015) from bore wells of three geological formations *viz*., peninsular gneissic complex, alluvial plain and granites in Thimajipeth mandal of Mehboobnagar district of Telangana and analyzed for its ionic composition.

The water type classification for the study area was done based on Piper diagram for dominant hydrochemicalfacies plotted on the cation, anion triangles and diamond matrix (Fig. 2.4.19). The samples were classified as Na-Mg-Ca type (50%); Mg-Na-Ca type (14%); Na-Mg-Ca-SO_4 and Mg-Na-Ca-SO_4 type (10% each). The electrical conductivity of the groundwater varied from 500 to 5130 µScm^{-1}. The Na dominated water is the result of interaction of recharging waters with the ferromagnesian silicates. It can be inferred from Piper plots that the groundwater is of mixed type with multiple processes involved in its evolution which further strengthens the fact that the mineralogy of aquifer material played an important role in determining the water chemistry. The plots also suggest that Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-} and Cl^-dominate the ionic composition of the groundwater (Table 2.4.2).

Since most of the water samples were classified as highly saline, use of groundwater blended with freshwater for irrigation should be an option to minimize the potential of soil salinity and salt injury to the plants. Inspite of the fact that the pH of the groundwater are not exceedingly high, the dominance of Na in the groundwater may have indelible effect on the soils and crops if used for irrigation for a longer time by impeding the hydraulic properties of soils.

Table 2.4.2. Groundwater quality in Thimmajipet mandal, Mehabubnagar district, Telangana

Groundwater Quality			
Geology	**Area (ha)**	**Water classification**	**Water Quality**
Peninsular gneissic complex	9800	C3S2	Low to moderate
Basaltic alluvium	5800	C3S3	Low
Younger granite	4600	C3S2	Low to moderate

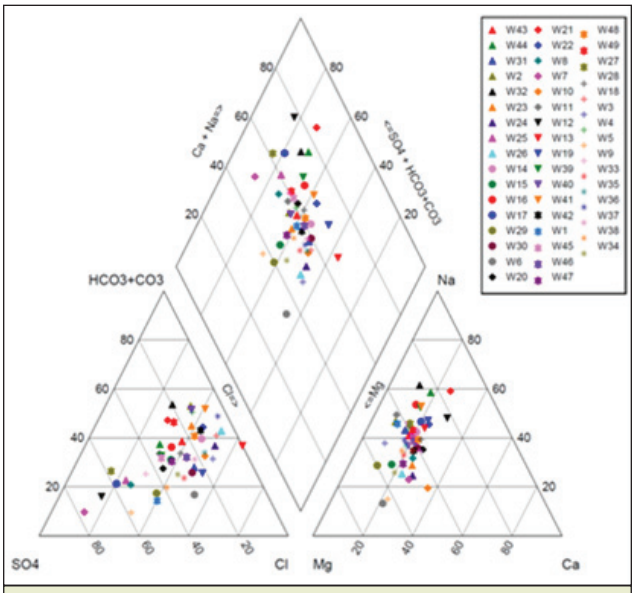


Fig. 2.4.19. Piper diagram indicating ionic chemistry of groundwater samples in Thimmajipet

2.5 LAND EVALUATION AND LAND USE PLANNING

Revisiting Soil Resource Mapping Dataset of 1:250000 scale

Delineating potential areas of crops

During the reporting year, potential areas in the country for growing oilseed crops namely, sunflower and sesame are delineated. Similarly potential areas for ashwagandha in Karnataka and pomegranate in Gujarat are demarcated. Relative Yield Index (RYI) and Relative Spread Index (RSI) derived from area under the crop, production for 5 year (2001-02 to 2005-06) are used (Table 2.5.1) for delineating the potential area of oil seeds. For identifying potential area for medicinal plant in Karnatka and pomegranate in Gujarat, soil site suitability criteria are used.

Table 2.5.1. Criteria for delineating potential areas

RSI	RYI	Potential areas
>100 (High)	>125 (High)	Most potential areas
>100 (High)	75-125 (Medium)	
> 100 (High)	<75 (Low)	Potential areas
75-100 (Medium)	>125 (High)	
75-100 (Medium)	75-125 (Medium)	
75-100 (Medium)	<75 (Low)	Less potential areas
<75 (Low)	>125 (High)	
<75 (Low)	75-125 (Medium)	
<75 (Low)	<75 (Low)	Inefficient areas

RSI-RYI index indicates that potentiality for raising sesame is highest in the state of Gujarat, Rajsthan, M.P, Maharastra, A.P, Telangana, Jharkhand, West Bengal, Odisha and North eastern region (Fig. 2.5.1), whereas sunflower may grow well in the state of Chhatisgarh, A.P and Maharastra (Fig. 2.5.2). Gujarat has moderate potential for growing pomegranate. Karnataka has good potential to grow medicinal plants namely, amla, cassia and ashwagandha (Fig.2.5.3 and 2.5.4).

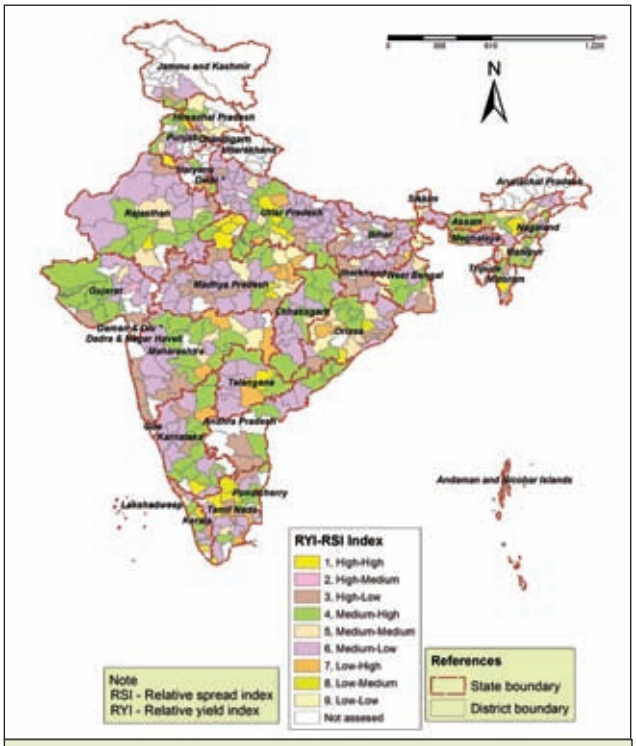


Fig. 2.5.1. Potential areas for sesame cultivation in India

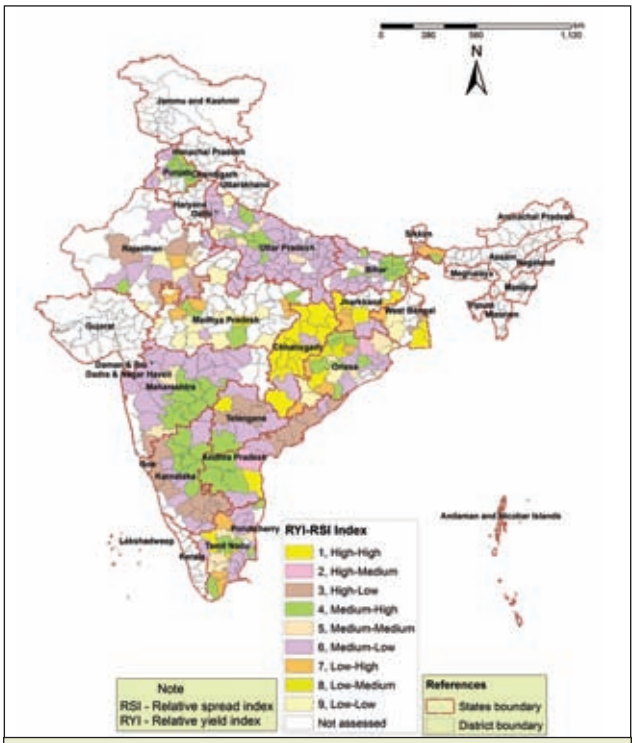


Fig. 2.5.2. Potential areas for sunflower cultivation in India

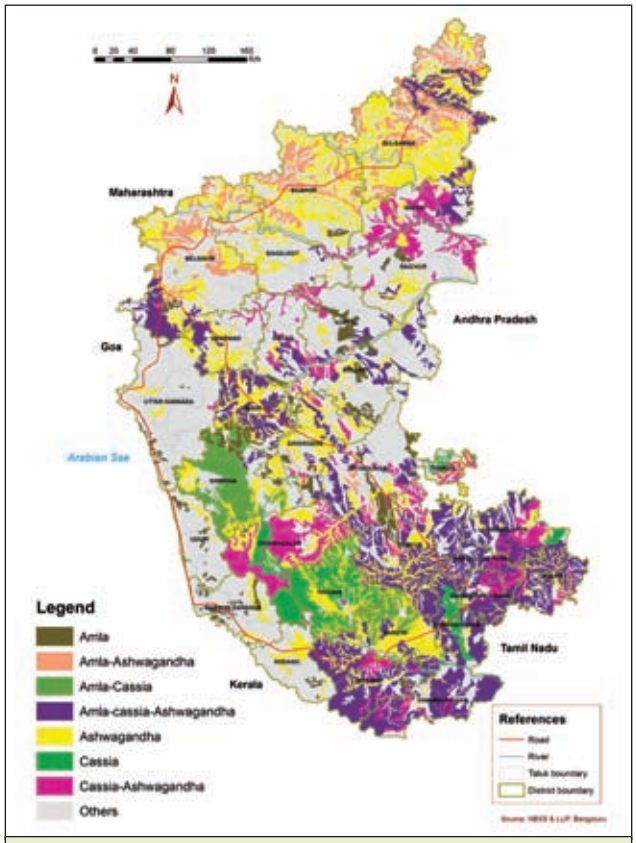


Fig. 2.5.3. Potential areas for cultivation of medicinal plants in Karnataka

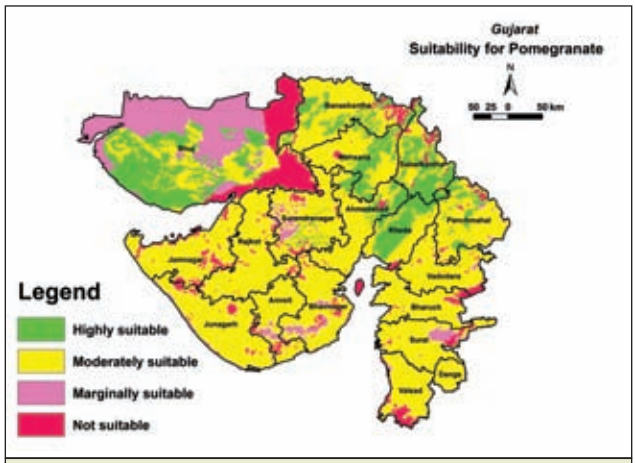


Fig. 2.5.4. Potential areas for cultivating pomogranate in Gujarat

Potential area for tea and coffee in Kerala, Karnataka and Tamilnadu

Soil and site suitability evaluation has been carried out in the states of Kerala, Karnataka and Tamilnadu for two very important plantation crops tea and coffee (Fig. 2.5.5). The potential area for tea and coffee is 25861 and 603768 hectares, respectively.

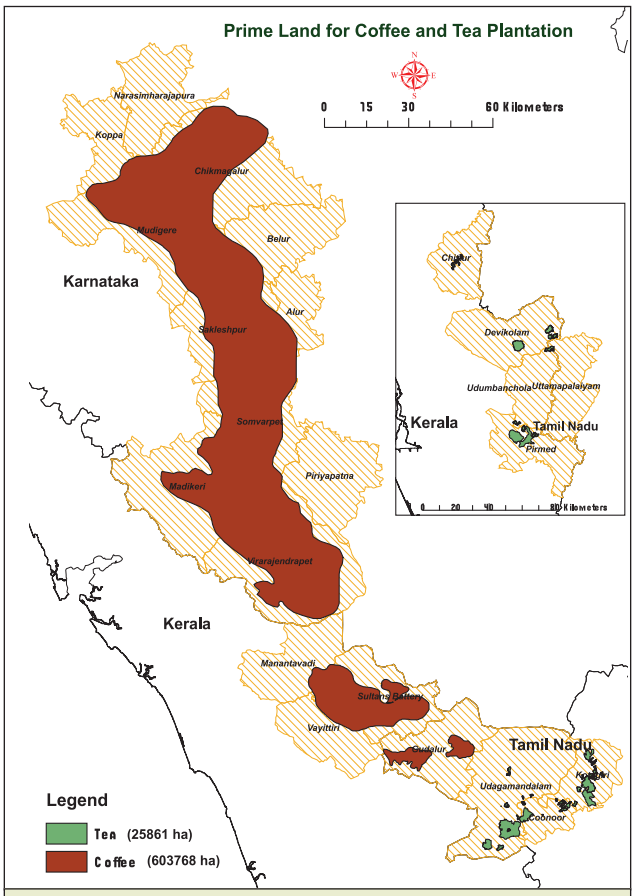


Fig.2.5.5. Potential tea and coffee growing area in Kerala, Karnataka and Tamil Nadu

Potential area for paddy, rubber and spices in Kerala

Soil and site suitability evaluation is done for paddy, rubber and spices cultivation in Kerala state. The results indicate that 47.9, 34.5 and 15.3 per cent area of the state is suitable for spices, rubber and paddy, respectively. Rubber could be grown successfully in the parts of Kasargod, Kannur, Malapuram, Kazhikode, Pallakkad, Kottayam, Kollam, Ernakulam, Thiruanantpuram and Pathanamthitta, whereas the most suitable area for cultivation of Paddy is located in the parts of Thrissor, Ernakulam, Kottayam, Alappuzha and Kollam districts. The Eastern part of the state consisting of parts of Palakkad, Wayanad, Malappuram, Kasargod and Kannur districts are the potential areas for growing spices in the state (Fig.2.5.6).

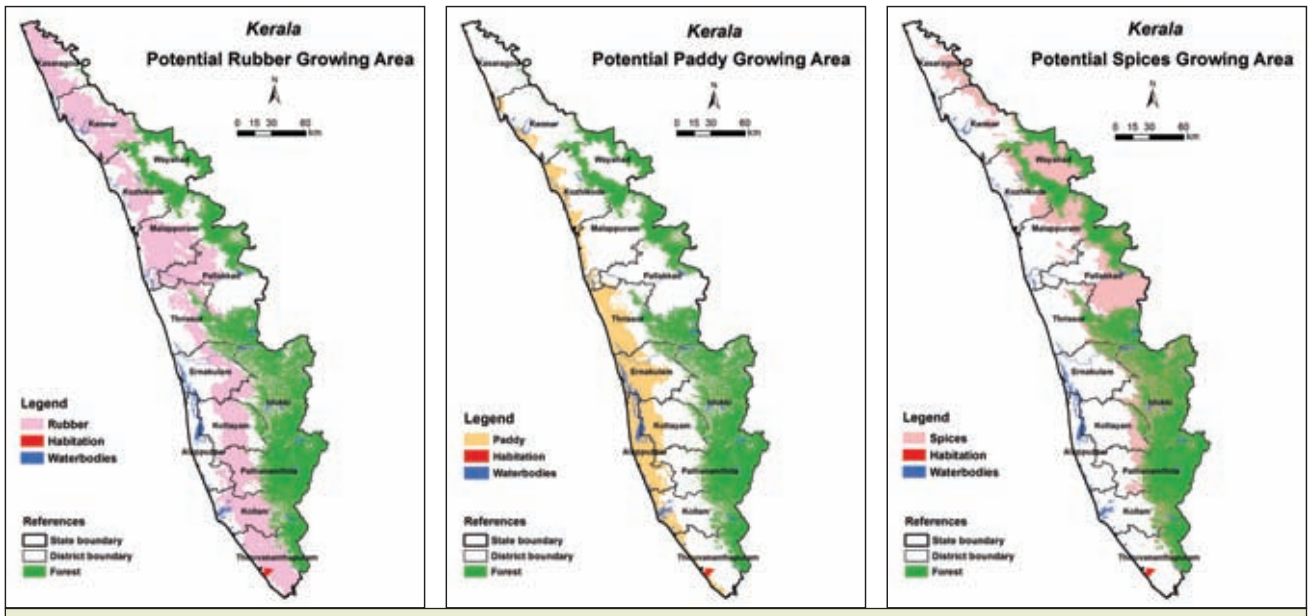
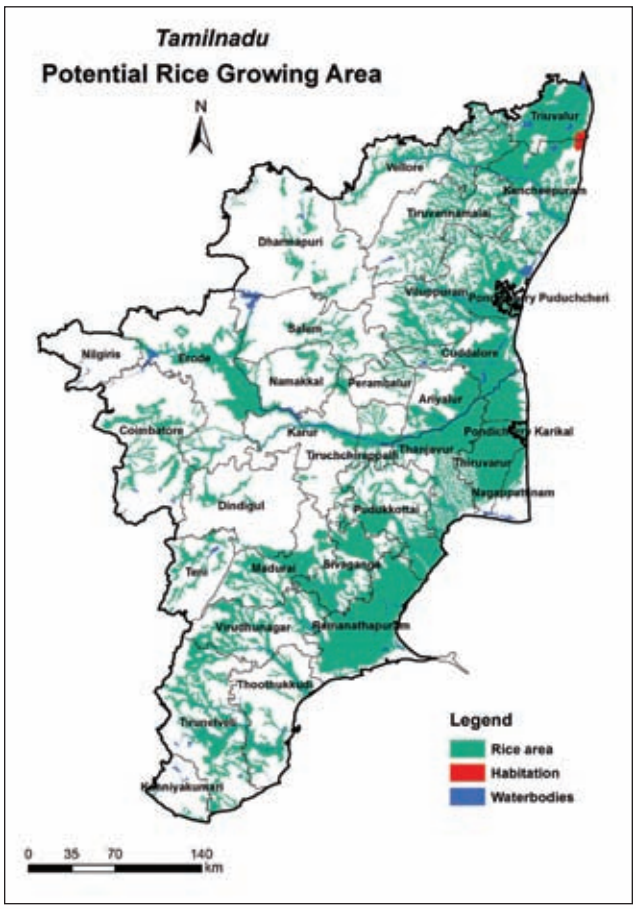
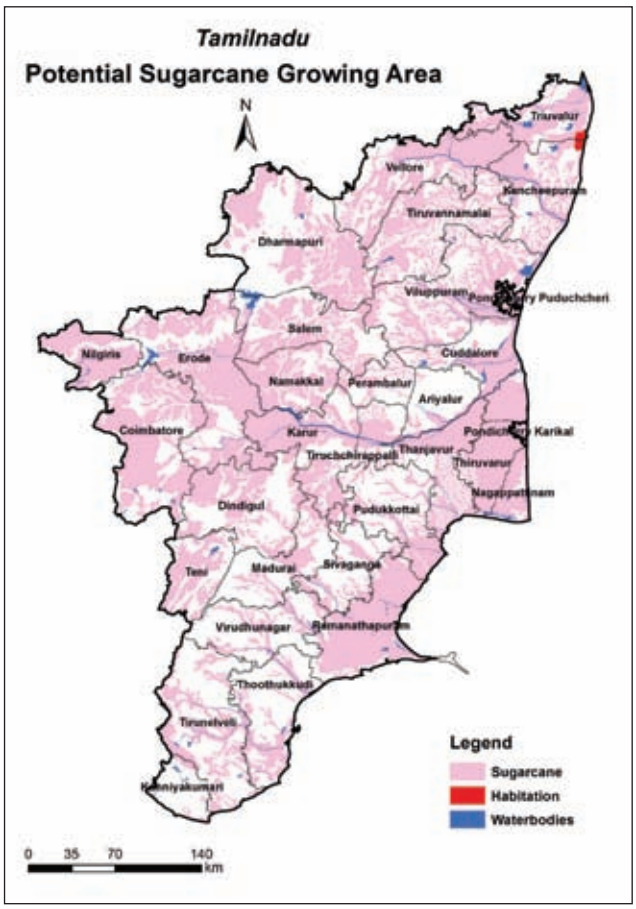


Fig.2.5.6. Potential rubber, paddy and spices growing areas in Kerala

Potential area for rice, sugarcane, groundnut and cotton in Tamilnadu

Soil and site suitability evaluation are further applied for rice, sugarcane, groundnut and cotton in Tamil Nadu state (Fig.2.5.7). The results indicate that 34.4, 54.7, 74.1 and 78.5 per cent area are suitable for rice, sugarcane, groundnut and cotton, respectively.The most suitable area for cultivation of rice belongs into a parts of Erode Tiruvallur, Cuddalore, Sivagangai, Madurai, Ramanathapuram and Tiruchirappalli districts, wheras Sugarcane, Groundnut and Cotton can be grown in the entire state depending upon the availability of water.





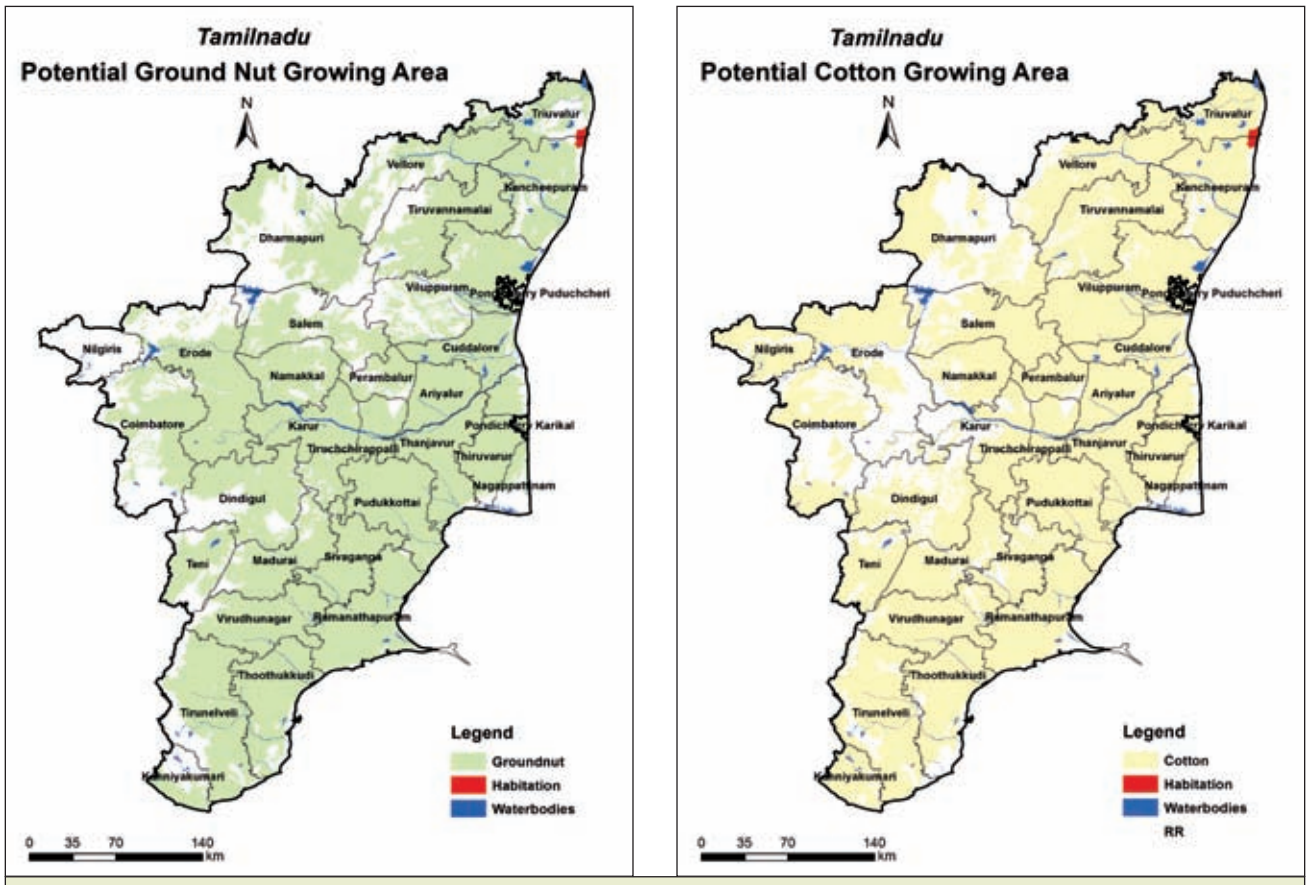


Fig. 2.5.7. Potential rice, sugarcane, groundnut and cotton growing area in Tamilnadu

Potential tea growing area in Assam and West Bengal

Soil and site suitability evaluation has been further carried out for delineating potential areas of tea in Assam and West Bengal states. The study indicated that the potential area for tea is 382561 and 164607 hectares in Assam and West Bengal, respectively. Parts of Sibsagar, Tinsukia, Dibrugarh, Jorhat, Golaghat, Kachar, Darrang, Nagaon districts constitute the potential area in Assam whereas, parts of Darjiling, Jalpaiguri and Koch Bihar districts constitute the core area for tea cultivation in West Bengal (Fig.2.5.8).

Determinant factors of land use planning

A case study of Darwha block, Yavatmal district of Mahrastra

Land uses from 2001 to 2016

Land use and land cover analysis of Darwha block of Yavatmal district of Maharastra is done using

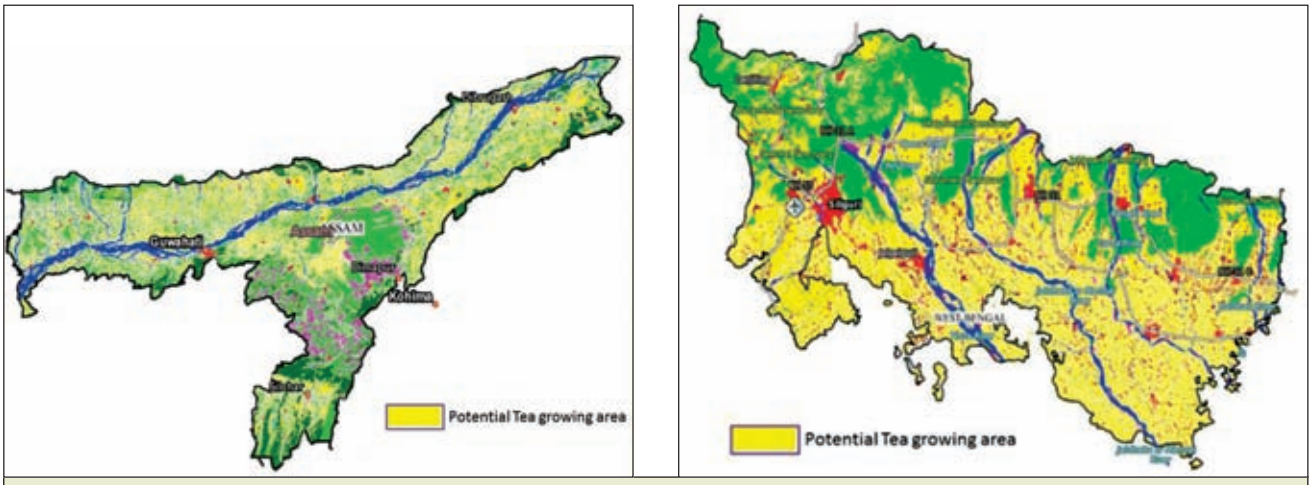
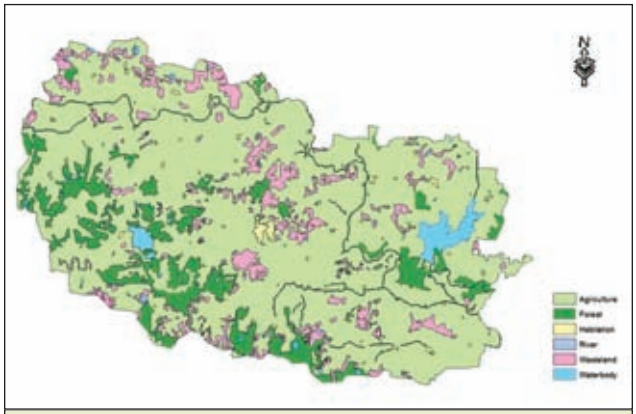
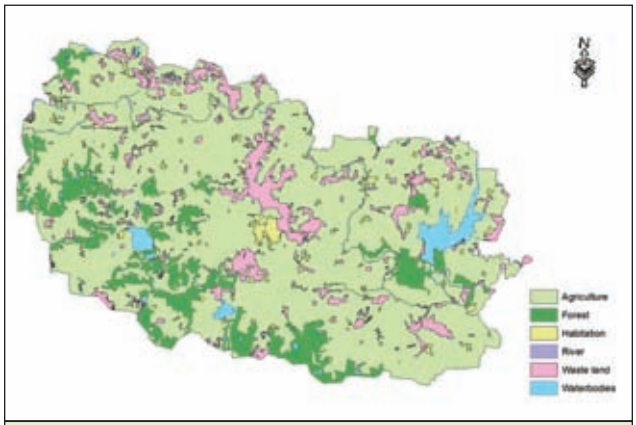


Fig. 2.5.8. Potential tea growing area in Assam and West Bengal

temporal Google Earth images (2007 and 2016). As per Government records, the area under agriculture in 2001 was 54826 ha, 54217 ha in 2003, and 64085 ha in 2006, whereas Maharashtra Remote Sensing Application Centre (MRSAC) estimated 66682 ha area under agriculture in 2005 (Table 2.5.2). Analysis of the image in 2007 and 2016 showed that 64859 ha and 64796 ha area was under cultivation during the respective years (Fig. 2.5.9 and 2.5.10). Change in land use from 2001 to 2005 is verified by taking field observations at thirty points. At 10 points, wastelands were brought under cultivation. All these land parcels were barren wastelands with thorny shrubs/plants in the year 2001. Our study confirmed that more than 10000 ha wasteland area in Darwha block was brought under cultivation during the period 2001 to 2005. Land use change from wastelands to agriculture between 2007 and 2016 is verified at 10 points and the change was not significant.The block lost 1932 ha of forest land and 1401 ha of scrub land during the period of investigation.



Source: MRSAC (2005).
Fig. 2.5.9. Cultivated area in Darwha block during 2005



Source: MRSAC (2005).
Fig. 2.5.10. Cultivated area in Darwha block during 2016

Table 2.5.2 Land use changes in Darwha block, Yavatmal district, Maharashtra

Year/Land use	2001	2005	2007	2016
Agriculture	54826	66682	64859	64796
Forest	12850	9429	9869	9869
Wasteland	NA	7916	8314	8207
Habitation	NA	864	1700	1718
Waterbody	NA	2205	2406	2561
		87096	87148	87150

Crop dynamics from 2001 to 2013

Analysis of crop history for last 15 years in Darwha block shows some big changes.There has been a steep decline in cereal crops (mostly sorghum). Soybean crop area increased from mere 1107 ha to 20565 ha during the period. The loss of area under cereals (mainly sorghum) has led to decreased fodder availability in the block (Table 2.5.3).

Table 2.5.3. Crop dynamics in Darwha block during 2001-2013

	2001	2013	Change in area under the crop	Per cent change
	----------ha----------			
Sorghum	10883	3799	-7084	65
Bengal gram	410	3987	+3577	872
Red gram	6839	5089	-1750	26
Green gram	5339	832	-4507	84
Black gram	4332	727	-3605	83
Cotton	35183	30660	-4523	13
Soybean	1107	21672	+20565	1858
Pearl millet	344	0	-344	100
Pigeon pea	10868	5089	-5779	53

Decreased fodder production together with increased wages of labours are the reasons for declining livestock population from 110559 in 2001 to 103048 in 2007 in the block. Though the latest data are not available, it is confirmed from the villagers that the livestock is declining continuously in the block. The study further reveals that double cropped area has declined. In 2001, 13750 ha area was under double cropping that has decreased to 245 ha in 2006. This change and decrease in short duration *Kharif* season crops like sorghum and maize is attributed to increased area under cotton. By 2013, cotton area was increased to 6278 ha not because of the change in crops but due to increased water availability as two irrigation projects are completed. During the same period, area under oilseeds (soybean) registered 1858% an increase at the expense of area under pulses and cereals.

Similar changes also occured in other blocks of the district (Fig. 2.5.11). Number of functional wells in the district showed a sharp decline from 2976 in 2001 to 276 in 2005 without corresponding decrease in irrigated area. Low yield wells /shallow aquifers perhaps dried up leading to steep decline in number of functional wells.

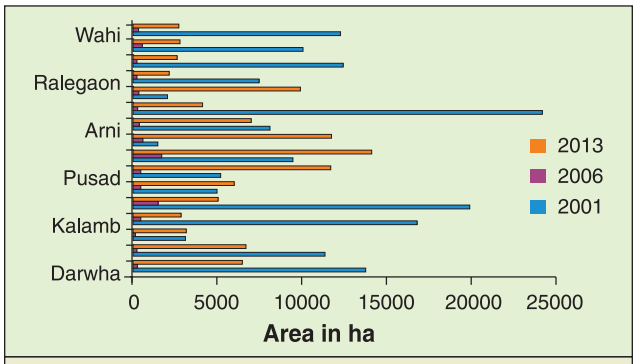


Fig. 2.5.11. Temporal changes in double cropped area in Darwha block and Yavatmal district.

Socio-economic considerations for land use change

Cotton and soybean are the major crops (pigeon pea is grown as intercrop) of Darwha block. Crop choice during the current season (2015) made by 1869 farmers (Table 2.5.4) also showed that cotton and soybean were the major crops with insignificant share of other crops. The data indicated that 26 % farmers allotted equal area to cotton and soybean crops, 13 % alloted two third area to either of the two crops leaving one third for the other crop. Farmers growing sole crop of soybean were 421 whereas 363 chose cotton. Thus 82 % farmers, in effect, cultivated either cotton or soybean or both crops. The average land holding of these farmers was 1.4 ha. Pigeonpea was grown as an intercrop (ratio 6:1) in both cotton and soybean fields. There was a marked preference for cotton crop in deep soils and medium or shallow soils were used for soybean.

Table 2.5.4. Crop choice of Darwha block farmers in 2015-16

Number of farmers *	Allocation to Cotton (%)	Allocation to soybean (%)	Other crops (%)
500 (26)	50	50	
111 (6)	66	33	
143 (7)	33	66	
363 (19)	100	0	
421 (22)	0	100	
242 (12)	>50	0	20-50
89 (4)	0	>50	20-50

*Numbers in parenthesis indicate percent to the total no of farmers

Survey was conducted in 40 villages and the farmers were requested to list and rank the reasons for their crop choice. Six factors were stated to influence crop choice. Despite falling cotton prices farmers considered assured returns as the most important factor in choosing cotton cultivation. The next important factor was ease of night vigil and crop production. The two factors are in fact intermingled. The Nilgai (Boselaphustragocamelus) and wild boar (Susscrofa) were the overwhelming predators of agricultural crops. There is no natural predator of Nilgai in the region. Moreover, Nilgai is the largest Asian antelope that easily endeavours farm compounds, easily scamper through thorny bushes and is not afraid of human. The protection accorded through wild life laws has led to overabundance of wild life. The factors responsible for the choice of soybean were wild life predation and low cost of cultivation. Interestingly, Table 2.5.5 indicates that more than 25 % farmers allocate area to these two crops in almost equal proportion. They spread the risk of monsoon failure and crop predation equally. While cotton is perceived to be a hedge against poor monsoon/rainfall, soybean is less likely to be grazed by wild animals. Soybean in their opinion is the least care crop (requiring only one weedicide spray and no other field operations). Equal splitting of area under cotton and soybean is explained as the strategy of managing financial resources as cotton is a heavy investment, crop, whereas soybean requires low management.

Table 2.5.5. Factors affecting crop choice in Darwha block and their ranking

Reason/Influencing factor	Cotton	Soybean
Assured returns	78	16
Low cost of cultivation	NA	81
Low care/ease of night vigil	75	75
Labour cost	NA	23
Variability of rainfall	60	20
Crop predators/Wild life conflict	72	87

Crop diversification or cultivation of pulse crops was ruled out due to threat from antelopes whereas decline of sorghum area was attributed to wild boars. Thus, wild life (ecological factor) was concluded to be the foremost factor dictating crop choice. The common opinion was that the farmers were well aware of crop diversification and wished to adopt while threat of wild animals forfeit the will to diversify agriculture. General productivity of the major crops in Darwha block is shown in Table 2.5.6. It is apparent that pigeon pea is the most rewarding crop. But it is grown as an intercrop. Farmers observed that the rates for pulses

in India are rising and yet farmers were not willing to risk it as a main crop due to monsoon uncertainties. Second most profitable crop soybean, is grown in more than 22000 ha area. The other rewarding crops like blackgram, greengram and sorghum are ignored against the will.

Average productivity and income data based on the survey is shown in Table 2.5.6. It is apparent that it makes sense to raise pigeonpea followed by soybean and then blackgram for making greater profit. Returns from cotton crop are the lowest of all. As discussed earlier, farmers have adopted to the depredation by choosing crops that are not favoured by wild animals and the risk of crop loss is minimized.

chosen for the delineation of LMUs. For example, four soil and site characteristics namely slope, depth, texture, gravelliness and erosion have been considered for defining LMU in the watersheds of Karnataka (Fig. 2.5.12 – 2.5.19) and the blocks of the state of Telangana suffering from waterstress for raising second crop in a year (Fig. 2.5.20- 2.5.22).In the rainfed conditions of Karnataka and Telangana, the need is to adopt the practices that could conserve moisture at the place. These are the reasons for choosing soil depth, texture, gravelliness and slope as criteria which have direct bearing on soil moisture.

Slope and erosion are the additional factors in Titlagarh

Table 2.5.6. Productivity and income from different crops

Crop	Productivity (q/ha)	Income (Rs)	Crop	Productivity (q/ha)	Income (Rs)
Cotton	2.6	3952	Wheat	11.37	38000
Soybean	8.45	8450	Gram	8.25	33400
Pigeonpea	8.3	13280	-	-	-
Sorghum	8.56	5821	-	-	-
Greengram	3.71	6826	-	-	-
Blackgram	3.92	7056	-	-	-

Thus major land use planning issues identified in Darwha block are 1) low productivity of wastelands being brought under cultivation, 2) wildlife predation restricting crop choice, and 3) declining water availability.

Steps for developing land use options

It involves delineating land management units, defining soil conservation plans and estimating water harvesting potential and finally developing options for crops and cropping pattern based on benefit: cost ratio. During the year the study has been taken in seven watersheds of Karnatka, three blocks of Telangna namely Gajwel Medak district, Thimajipeth Meboobnagar district and Indervelle Adilabad district and one each from Gujarat (Porbandar block, Porbandar district) and Bihar (Kadwa block, Katihar district). Salient considerations for the purpose are described herein.

Step 1. Land Management Unit (LMU) delineation

Database developed in LRI programme is well utilized for delineating LMUs based on the management needs.One or more than one land characteristics, having the influence on agriculture are generally

block of Bolangir district that need to be managed and hence the same were included in crieteria for delineating LMUs. Similarly, extent and severity of salinity have been considered for delineating LMUs in Ganjam and Basudebpur blocks of Ganjam and Bhadrak districts of Odisha, respectively.Soils of these coastal blocks are severely affected by salinity due to the sea water intrusion. In the Bali Island of coastal region of West Bengal, apart from salinity, the depth of sulfidic material is the main factor governing agriculture apart from coastal environment of West Bengal.

In contrast, risk of flooding is the main and sole criteria for defining LMUs in Kadwa block of Katihar district of Bihar (Fig. 2.5.23). The blocks are regularly affected by the floods during rains and the agriculture is by and large delayed during *Kharif* season.In Porbandar block of Gujarat, the criteria chosen of delineating LMUs is salinity and risk of erosion. Thus for defining the criteria for delineating LMU, location/site specific factors are accounted. This is the essence of using site specific information for situation specific recommendations for which the most ambicious LRI programme has been initated in the country.

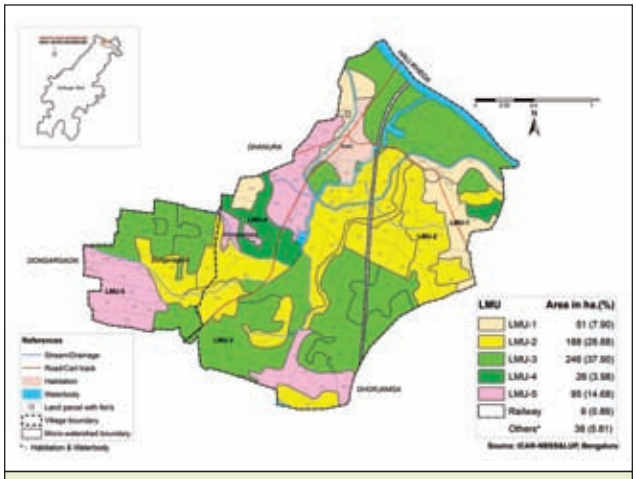


Fig. 2.5.12. Land management unit map (1:10000 scale) of Kinhi Micro watershed, Gulbarga district, Karnataka

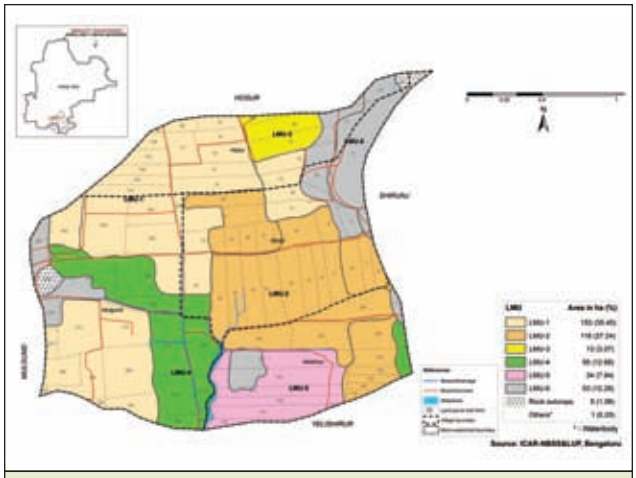


Fig. 2.5.13. Land management unit map (1:10000 scale) of Shirol West 2 micro watershed, Gadag district, Karnataka

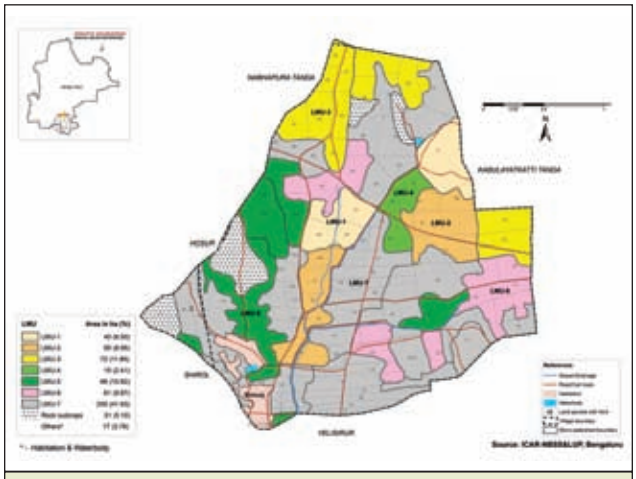


Fig. 2.5.14. Land management unit map (1:10000 scale) of Shirunj micro-watershed, Gadag district, Karnataka

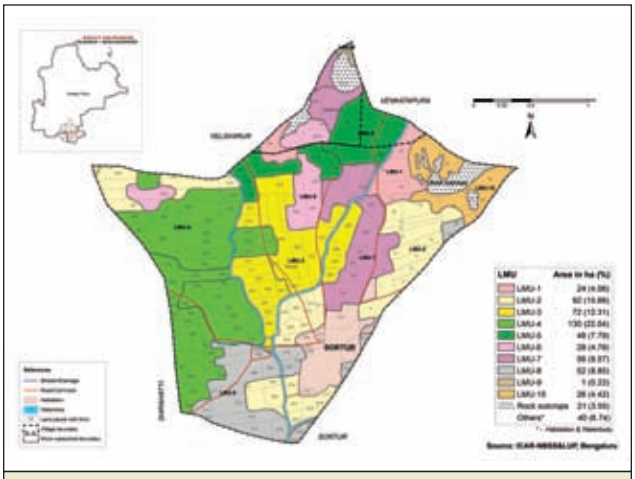


Fig. 2.5.15. Land management unit map (1:10000 scale) of Yelishirur 1 micro watershed, Gadag district, Karnataka

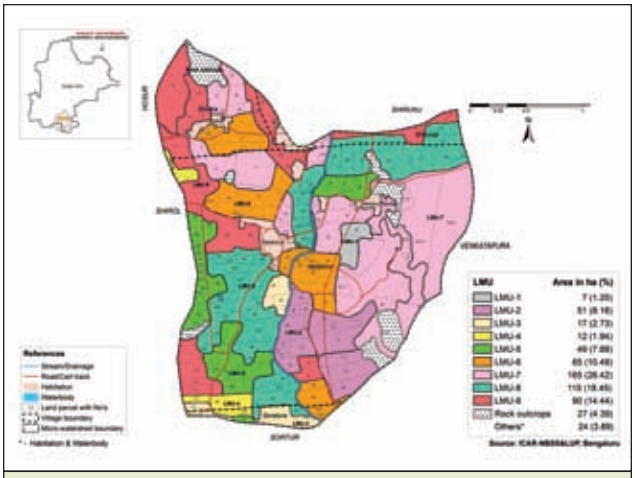


Fig. 2.5.16. Land management unit map (1:10000 scale) of Yelishirur 2 micro Watershed, Gadag district, Karnataka

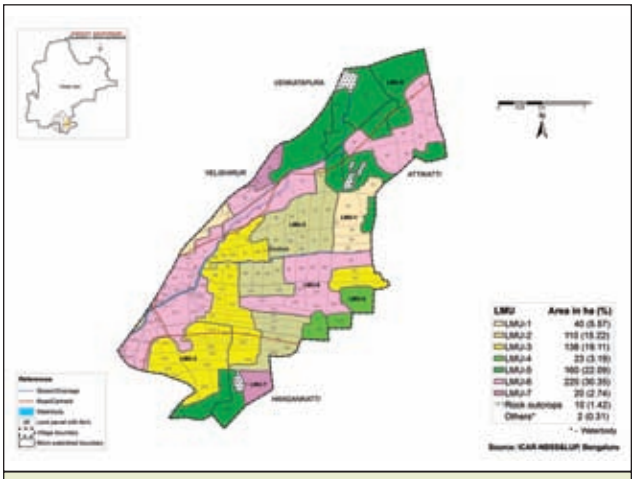


Fig. 2.5.17. Land management unit map (1:10000 scale) of Yelishirur 3 micro Watershed, Gadag district, Karnataka

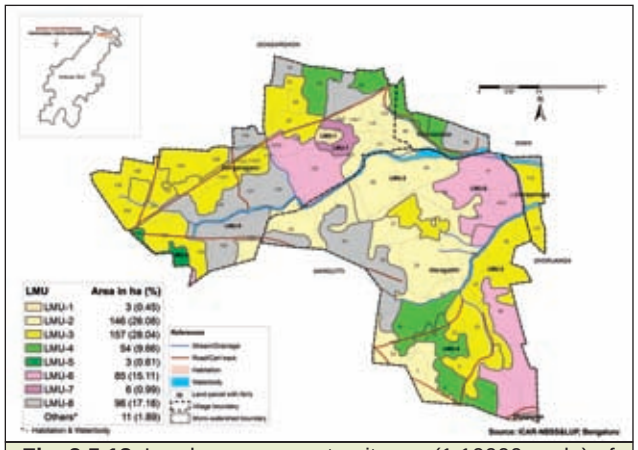


Fig. 2.5.18. Land management unit map (1:10000 scale) of Dharjamga 3 micro Watershed, Gulbarga district, Karnataka

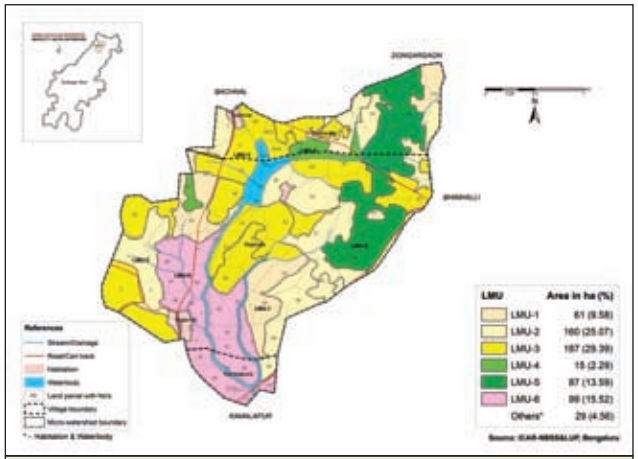


Fig. 2.5.19. Land management unit map (1:10000 scale) of Margutti micro Watershed, Gulbarga district, Karnataka

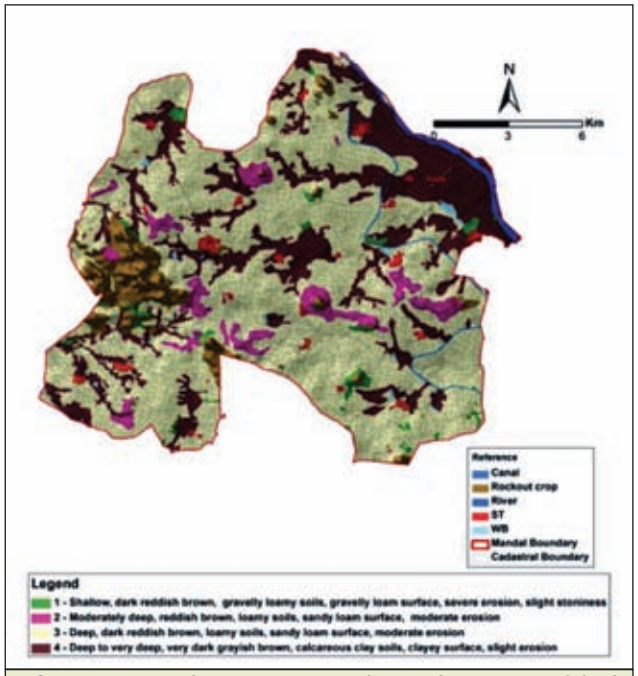


Fig. 2.5.20. Land management unit map (1:10000 scale) of Thimmajipet mandal, Mahabubnagar district, Telangana

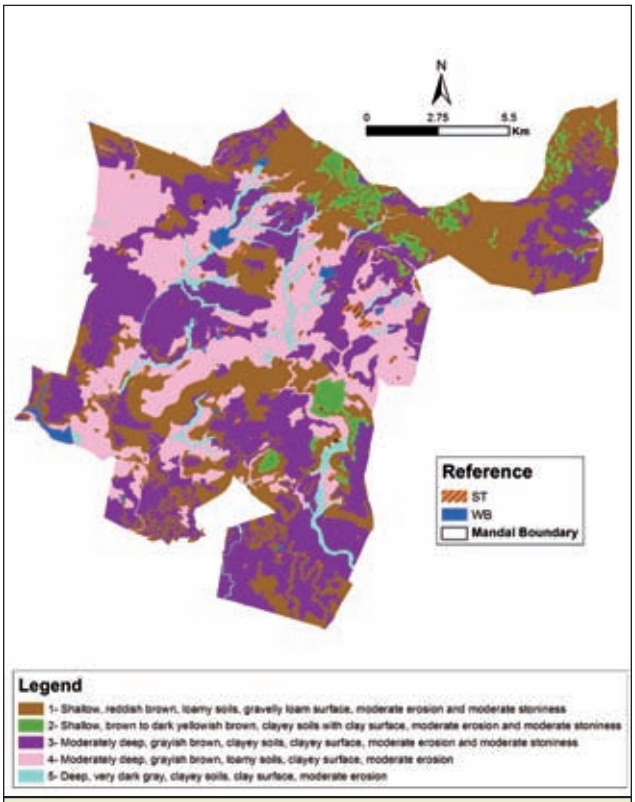


Fig. 2.5.21. Land management unit map (1:10000 scale) of Indervelli mandal, Adilabad district, Telangana

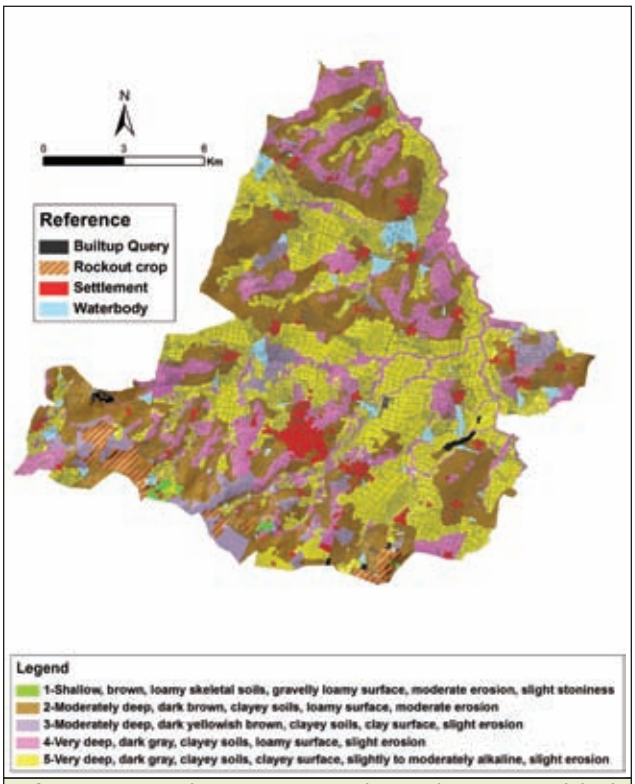


Fig. 2.5.22. Land management unit map (1:10000 scale) of Gajwel mandal, Medak district, Telangana

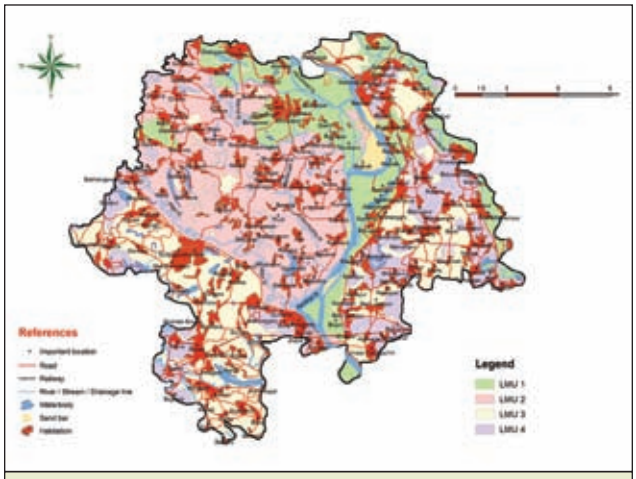


Fig. 2.5.23. Land management unit map (1:10000 scale) of Kadwa block, Katihar district, Bihar

Step 2: Developing soil and water conservation plans

Database such as slope, drainage, contour, extent and severity of erosion observed in the course of LRI programme is very useful in develoing soil conservation plan (type and location of soil and water conservation measures). The results indicated that in the micro-watershed of Kinhi, Shirol, Shiruni and in three micro-watersheds of Yelishirur, trench cum bunding, graded bund and terraces are needed. In Dharjamga, graded bunding and trench cum bunding are recommended. In the other microshed of Margutti, bench terrace and graded bunds are suggested. The location of soil and water conservation measures is indicated (Fig. 2.5.24-2.5.31). LMU wise soil and water conservation needs for micro-watershed in three blocks of Telangana and for the blocks for Gujarat and Bihar are given in Tables 2.5.9-2.5.20. The soil conservation needs of Darwha block in Yavatmal district is also specified in Fig.2.5.32.

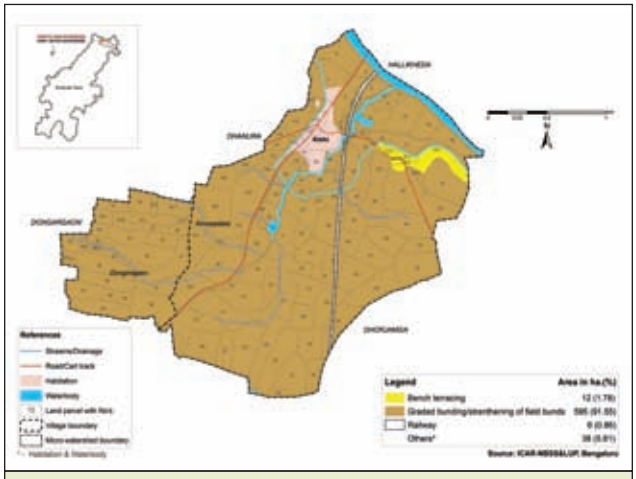


Fig. 2.5.24. Soil and water conservation plan of Kinhi micro watershed

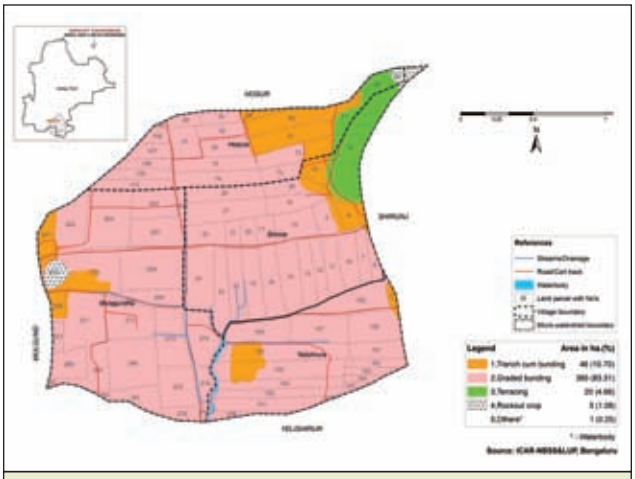


Fig. 2.5.25. Soil and water conservation plan of Shirol West 2 micro watershed

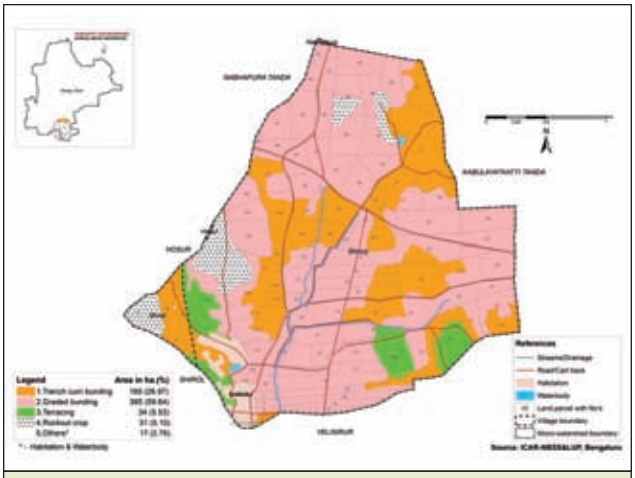


Fig. 2.5.26. Soil and water conservation plan of Shirunj micro-watershed

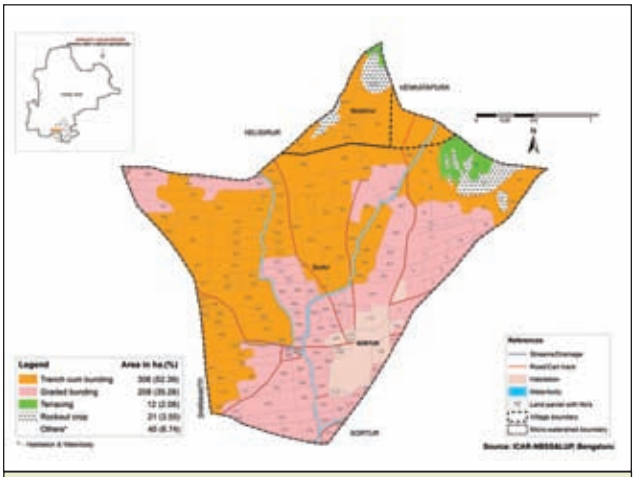


Fig. 2.5.27. Soil and water conservation plan of Yelishirur 1 micro watershed

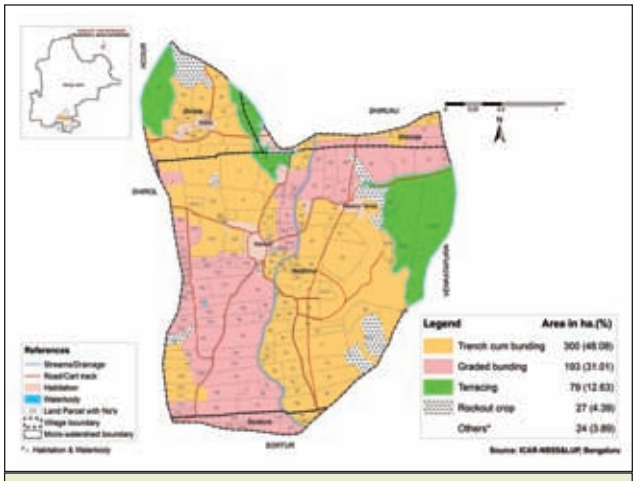


Fig. 2.5.28. Soil and water conservation plan of Yelishirur 2 micro Watershed

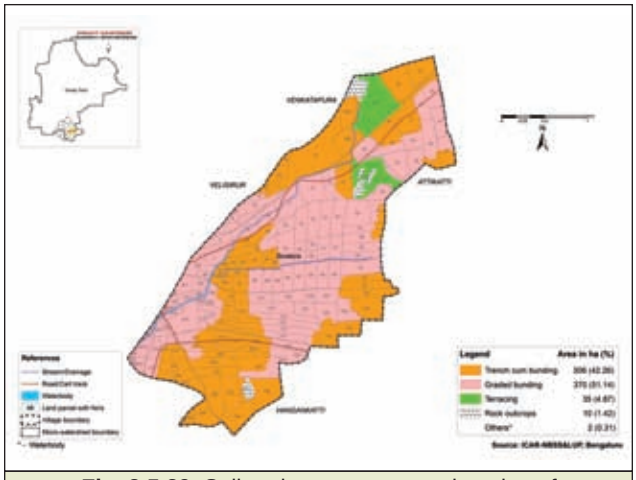


Fig. 2.5.29. Soil and water conservation plan of Yelishirur 3 micro Watershed

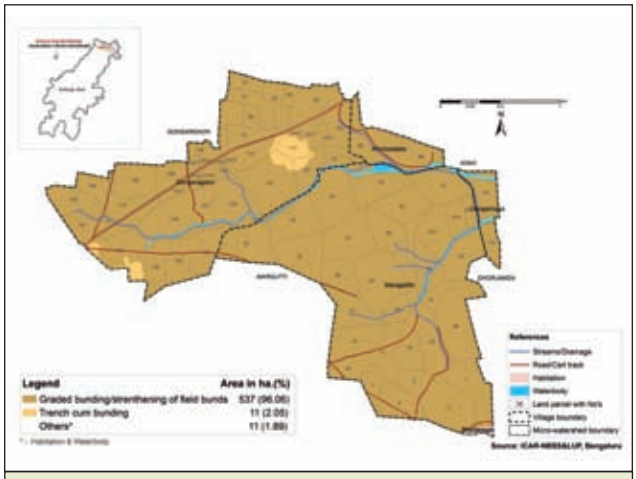


Fig. 2.5.30. Soil and water conservation plan of Dharjamga 3 micro Watershed

Step 3. Estimating Run-off and water harvesting potential

Estimation of runoff potential and suggesting sites for soil and water conservation structures is an integral part of our land use planning. A study has been undertaken with this objective in seven micro-watersheds of Karnataka. Runoff potential and the water harvesting potential with exiting and proposed structure are estimated under the prevailing mean annual rainfall pattern. Balance runoff water in each micro-watershed is also indicated. Additional storage structures and their dimensions are calculated (Table 2.5.7). On utilising the expected stored water in the tank, the expected increase in the area of different crops is given (Table 2.5.8). In the event of irrigation regulated to meet out only 50% of water demand for irrigation, the expected area under the different crops is also indicated (Table 2.5.8). Similar excecise has also been done in the micro-watershed of Darwha block of Yavatmal district of Maharastra. Land Management unit wise runoff potential has been estimated.Type and location of water harvesting structures are indicated to store the estimated runoff water (Fig.2.5.32 and 2.5.33).

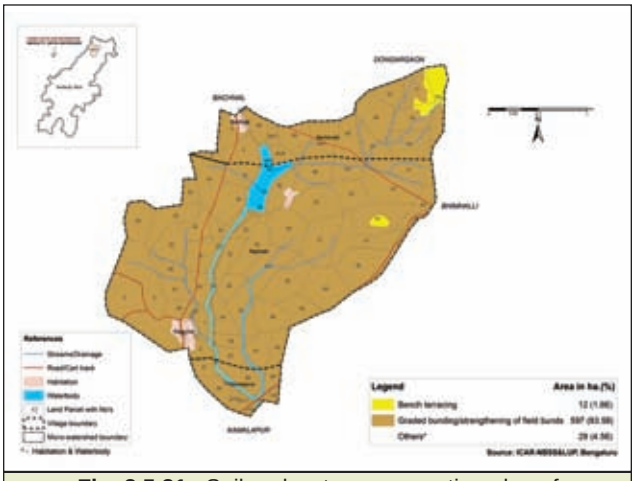


Fig. 2.5.31. Soil and water conservation plan of Margutti micro Watershed

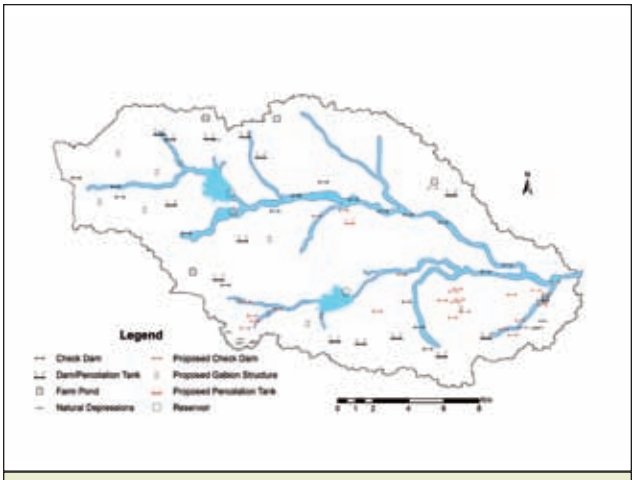


Fig. 2.5.32. Soil and water conservation plan of Darwha block, Yavatmal district, Maharashtra

Table 2.5.7. Runoff potentiality and the water harvesting potentiality of micro-watersheds

Watershed	Area (ha)	Rainfall characteristic (a, b. c)#	Runoff Potential (m^3)	Water harvesting potential*	Balance Runoff (m^3)	Additional Storage structures	
						Excavation by segmental method	Excavation by mechanical means
						12X12X3 M	12X12X3 M
Hosahalli, Chamarajanagara Taluk, Chamrajnagara District	513	(587, 8, 280)	359419	171549	187869	588	728
Mustari South	843.9	(873,13, 284)	812675	609479	203195	588	728
Shirol West 2, Gadag Taluk, Gadak district	432.3	(645,9,167)	343310	177656	165654	497	615
Shirunj, Gadag Taluk, Gadak district	611.4	(645,9,167)	476518	229332	247186	702	869
Yelishirur 1, Gadag Taluk, Gadak district	588.5	(645,9,167)	483747	274480	209267	676	836
Yelishirur 2, Aurad Taluk, Bidar District	624	(888,13,264)	366912	273233	93678	588	728

#(Rainfall (mm), No. of runoff producing rains, Total depth of rain on runoff producing rainy days),*with the proposed structures

Table 2.5.8. Suggested crops on additional irrigation potential

Crop	Hosahalli		Mustari		Shirol West-2		Shirunj		Yelishirur-1		Yelishuru-2	
	A	B	A	B	A	B	A	B	A	B	A	B
Banana	16	32	17	34	10	20	15	30	12	24	8	16
Bean	63	126	68	136	41	82	62	124	52	104	31	62
Cabbage	49	98	53	106	38	76	56	112	48	96	25	49
Castor	38	76	-	-	33	66	49	98	42	84	25	49
Chilli	38	76	41	82	33	66	49	98	42	84	25	49
Citrus	21	42	23	46	16	32	24	48	20	40	25	49
Cotton	27	54	58	116	17	34	25	50	21	42	25	49
Sesamum	54	108	-	-	-	-	-	-	-	-	-	-
Groundnut	38	76	-	-	28	56	41	82	35	70	19	37
Maize	38	76	41	82	25	50	38	76	32	64	19	37
Onion	54	108	58	116	37	74	55	110	47	94	27	54
Peas	54	108	58	116	39	78	58	116	49	98	27	54
Ragi	47	94	-	-	7	14	10	20	8	16		
Sorghum	42	84	45	90	30	60	45	90	38	76	21	42
Sunflower	54	108	45	90	39	78	-	-	-	-	-	-
Tomato	31	62	34	68	24	48	35	70	30	60	16	31
Grape	-	-	41	82	19	38	29	58	25	50	-	-
Wheat	-	-	45	90	30	60	45	90	38	76	21	42
Sunflower	-	-	58	116	-	-	58	116	49	98	27	54
Sugarcane	-	-	14	28	8	16	12	24	10	20	-	-
Rice	-	-	-	-	10	20	15	30	12	24	-	-
Soybean	-	-	-	-	29	58	43	86	36	72	21	42
Tobacco	-	-	-	-	33	66	49	98	42	84	-	-
Potato	-	-	-	-	28	56	41	82	35	70	-	-
Pineapple	-	-	-	-	19	38	29	58	25	50	-	-
Gingelly	-	-	-	-	44	88	66	132	56	112	-	-

A- Area (ha) that can brought under irrigation, B- Area (ha) that can brought under irrigation assuming that 50% of water requirement is met from soil moisture

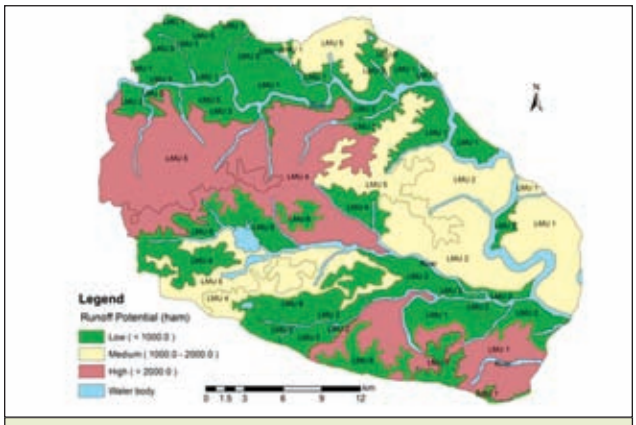


Fig. 2.5.33. Run-off potential map of Darwha block.

Step 4: Suggested land use options

Land use options for seven watersheds in Karnataka (Tables 2.5.9 to 2.5.14), three blocks in Telangana (Tables 2.5.15 to 2.5.17) and one block each in Bihar and Gujarat (Tables 2.5.18 to 2.5.19) are presented. The land use plan of Erravally village of Medak district of Telangana (Table 2.5.20) is also prepared. Field crops, horticultural crops and possible interventions are suggested. The results are summarised in the tables. The crops are arranged in decreasing order of benefit:cost ratio. For understanding of the reader, one example is discussed here in the text. It is apparent from the data given in the tables 2.5.15 to 2.5.17 that in the rainfed situation, for three mandals of Telangana, cotton as a sole crop or with the intercrop of pigeonpea or red gram is the most profitable option on deep to moderately deep black soils, whereas maize sole or with intercrop of pulses are the proven choices on moderately deep to deep sandy loam/sandy clay loam soils. Millets and sorghums are the good options on shallow gravelly soils of three mandals.

Table 2.5.9. Proposed crop plan for Dharjamga-3 micro-watershed (4D5B7G1b), Gulbarga taluk and district based on soil-site–crop suitability analysis

LMU	Crops proposed			Suitable intervention
	Field crops	Horticulture crops (Rainfed Condition)	Horticulture crops with suitable intervention	
LMU-1	Horse gram, green gram,			
LMU-2	Bajra, linseed, green gram, black gram, chick pea	Custard apple, charoli, ber, amla	Custard apple, charoli, ber, amla	Crescent bunds,
LMU-3	Bajra, linseed, green gram, black gram, chick pea	Custard apple, charoli, ber, amla Vegetable: bhendi, brinjal, cowpea, Flower: marigold, chrysanthemum	Custard apple, charoli, ber, amla Vegetable: onion, tomato, brinjal, chilli, bhendi Flower: marigold, chrysanthemum	Drip irrigation, suitable soil and water conservations like cultivation on raised beds with mulches and drip irrigation
LMU-4	Sorghum, cotton, red gram, black gram, green gram, soybean, sesame, sunflower, safflower; *Rabi*: sorghum,	Custard apple, charoli, ber, amla Vegetable: bhendi, brinjal, cowpea, Flower: marigold, chrysanthemum	Custard apple, charoli, ber, amla, papaya, banana, lime, citrus; Vegetable: onion, tomato, brinjal, chilli, bhendi; Flower: marigold, chrysanthemum	-do- Graded bunds, Strengthening of field bunds
LMU-5	Sorghum, cotton, red gram, black gram, green gram, sesame,	Custard apple, charoli, ber, amla, mango,	Mango, sapota, guava, lime, banana, papaya, jamun. mixed orcharding: Mango+ guava+drumstick+ curryleaf Sapota+ guava+drumstick +curryleaf. Vegetables: tomota, capscicum, green chilli, bhendi, crucifers cucurbits. Flower crops: tuberose, aster, chrysanthemum, rose, jasmine, spider lilly. turmeric.	Drip irrigation, suitable soil and water conservations like cultivation on raised beds with mulches and drip irrigation Trench cum bunds
LMU-6	Sorghum, cotton, red gram, green gram, soybean, sesame, sunflower, safflower; R*abi*: sorghum, chickpea	Custard apple, charoli, ber, amla Vegetable: bhendi, brinjal, cowpea, Flower: Marigold, Chrysanthemum	Custard apple, charoli, ber, amla, papaya, banana, lime, citrus; vegetable: onion, tomato, brinjal, chilli, bhendi flower: marigold, chrysanthemum,	-do- Graded bunds, Strengthening of field bunds

LMU	Crops proposed			Suitable intervention
	Field crops	Horticulture crops (Rainfed Condition)	Horticulture crops with suitable intervention	
LMU-7	Ragi, sorghum,bajra horsegram, castor	Custard apple, charoli, ber	Custard apple, charoli, ber	Suitable soil and water conservations like Trench cum bunds
LMU-8	Sorghum, cotton, red gram black gram, green gram, soybean, sesame, sunflower, safflower, *Rabi*: sorghum, chickpea	Vegetable: bhendi, brinjal, cowpea, coriander; Field crops: sorghum, cotton, red gram, sunflower, safflower; perennial component: guava, tamarind, sapota, lime, moosambi; flower: marigold, chrysanthemum	Banana, papaya, lime. mosambi, guava, tamrind Vegetable: onion, tomato, brinjal, chilli, bhendi, Flower: marigold, chrysanthemum	-do- Graded bunds, Strengthening of field bunds

Table 2.5.10. Proposed crop plan for Shirol West - 2 micro-watershed (4D4A3L2d), Shirahatti sub-watershed, Gadag taluk and district based on soil-site–crop suitability assessment

LMU	Crops proposed			Suitable intervention
	Field crops	Horticulture crops (Rainfed Condition)	Horticulture crops with suitable intervention	
LMU1	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* Redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:* marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:* chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 2	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* Redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:* marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:* chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 3	*Sole crop:* maize, sorghum, redgram, cotton, sunflower. *Multiple crop rotation:* Redgram+maize, redgram+groundnut reg gram+fodder sorghum pulses+ sorghum	Mango, sapota, tamarind, jamun. *Intercrops:* groundnut, corainder Vegetables: tomato, chilli, bhendi, drumstick, flower crop, marigold, aster	Mango, sapota, papaya. *Mixed orcharding:* mango+guava+drumstick, guava+drumstick+curry leaf *Vegetables:* tomato, green chilli, bhendi, crucifers. *Flower crops:* tuberose, aster, chrysanthemum, jasmine	Drip irrigation, mulching, crop suitable conservation (like bunding with catch pit)
LMU 4	Sorghum, redgram, cotton, sunflower, bajra. *Multiple crop rotation:* Redgram+fodder sorghum pulses+sorghum	*Perenial component:* custard apple, amla *Annual vegetables:* tomato, chilli, bhendi, crucifers	*Perenial components:* custard apple, amla *Vegetables:* tomato, chilli, bhendi, crucifers *Flower crops:* marigold, gaillarda, tuberose, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practises
LMU 5	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Ber, custard apple vegetable: ridge guard, ash guard	Ber, fig, amla	
LMU 6	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Pasture, grasses	-	-

Table 2.5.11. Proposed crop plan for Shirunj micro-watershed (4D4A3L2a), Gadag taluk and district based on soil-site–crop suitability assessment

LMU	Crops proposed			Suitable intervention
	Field crops/Forestry crops	**Suitable Horticulture crops under irrigation**	**Horticulture crops with suitable interventions**	
LMU1	*Sole crop:* maize, sorghum, redgram, cotton, sunflower. *Multiple crop rotation:* redgram+maize, redgram+groundnut reg gram+fodder sorghum pulses+ sorghum	Mango, sapota, tamarind, jamun. *Intercrops:* groundnut, corainder Vegetables: tomato, chilli, bhendi, drumstick, flower crop, marigold, aster	Mango, sapota, papaya. *Mixed orchards:*mango +guava+drumstick, guava+drumstick+curry leaf *Vegetables:* tomato, green chilli, bhendi, crucifers. *Flower crops:* tuberose, aster, chrysanthemum, jasmine	Drip Irrigation, mulching, crop suitable conservation (like bunding with catch pit)
LMU 2	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:* marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:*chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 3	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:*sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:*marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:* chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 4	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	*Perenial component:* custard apple, amla *Annual vegetables:* tomato, chilli, bhendi, crucifers	*Perenial components:* Custard apple, amla *Vegetables:* tomato, chilli, bhendi, crucifers *Flower crops:* marigold, gaillarda, tuberose, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practises
LMU 5	Groundnut, horsegram silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, wood apple	Fig, amla	Pit size, Drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc..)
LMU 6	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Ber, custard apple vegetable: ridge guard, ash guard	Ber, fig, amla	-
LMU 7	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Pasture, grasses	-	-

Table 2.5.12. Proposed crop plan for Yelishirur-1 micro-watershed (4D4A3L2d), Shirahatti sub-watershed, Gadag taluk and district based on soil-site–crop suitability assessment

LMU	Crops proposed			Suitable intervention
	Field crops/Forestry crops	Suitable Horticulture crops under irrigation	Horticulture crops with suitable interventions	
LMU1	*Sole crop:* Maize, sorghum, redgram, cotton, sunflower. *Multiple crop rotation:* redgram+maize, redgram+groundnut reg gram+fodder sorghum pulses+ sorghum	Mango, sapota, tamarind, jamun. *Intercrops:*groundnut, corainder Vegetables:tomato, chilli, bhendi, drumstick, flower crop, marigold, aster	Mango, sapota, papaya. *Mixed orchards:* Mango +guava +drumstick, Guava+drumstick+curry leaf *Vegetables:* tomato, green chilli, bhendi, crucifers. *Flower crops:* Tuberose, aster, chrysanthemum, jasmine	Drip irrigation, mulching, crop suitable conservation (like bunding with catch pit)
LMU 2	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables:chilli, tomato, bendy, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:*Marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* Sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:*Chilli, bendy, crucifers	Drip irrigation, mulching, crop suitable conservation practices
LMU 3	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables:chilli, tomato, bhendi, cabbage, drumstick *Perenial components:*sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:*marigold, gaillardia, tuberose, chrysanthemum *Perenial components:*sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:*chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 4	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	*Perenial component:*custard apple, amla *Annual vegetables:*tomato, chilli, bhendi, crucifers	*Perenial components:*custard apple, amla *Vegetables:*tomato, chilli, bhendi, crucifers *Flower crops:*marigold,gaillarda, tuberose, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practices
LMU 5	Redgram, groundnut, sunflower, maize, sorghum, bajra, castor	Custard apple, amla Annual vegetables: tomato, chilli, bhendi, crucifers	*Perenial components:*custard apple, amla *Vegetables:*tomato, bhendi, chilli, crucifers *Flower crops:*marigold, gaillarda, tuberosa, chrysanthemum	Pit size, drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 6	Groundnut, horsegram silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, wood apple	Fig, amla	Pit size, drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 7	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, wood apple	Fig, amla	Crop suitable conservation practises (Crescent bunding with catch pit etc.)
LMU 8	Bengalgram, sorgum, bajra, sunflower	Ber, custard apple Vegetable: ridge guard,ash guard	Ber, fig, amla	do
LMU 9	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Ber, custard apple	Ber, fig, amla	do
LMU 10	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassiagrasses: styloxanthes hamata, styloxanthes scabra, khus grass	Pasture, grasses	-	-

Table 2.5.13. Proposed crop plan for Yelishirur-2 micro-watershed, Shirahatti sub-watershed, Gadag taluk and district based on soil-site–crop suitability assessment

LMU	Crops proposed			Suitable intervention
	Field crops/Forestry crops	**Suitable Horticulture crops under irrigation**	**Horticulture crops with suitable interventions**	
LMU1	*Sole crop:* maize, sorghum, redgram, cotton, sunflower. *Multiple crop rotation:* redgram+maize, redgram+groundnut reg gram+fodder sorghum pulses+ sorghum	Mango, sapota, tamarind, jamun. *Intercrops:* groundnut, corainder Vegetables: tomato, chilli, bhendi, drumstick, flower crop, marigold, aster	Mango, sapota, papaya. *mixed orchards:* mango+guava +drumstick, guava+drumstick+curry leaf *Vegetables:* tomato, green chilli, bhendi, crucifers. *Flower crops:* tuberose, aster, chrysanthemum, jasmine	Drip irrigation, mulching, crop suitable conservation (like bunding with catch pit)
LMU 2	do	do	do	do
LMU 3	Sorghum, redgram, cotton, sunflower, safflower, linsed, coriander, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:* marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:* chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 4	do	do	do	do
LMU 5	do	*Perenial component:* custard apple, amla *Annual vegetables:* tomato, chilli, bhendi, crucifers	*Perenial components:* custard apple, amla *Vegetables:* tomato, chilli, bhendi, crucifers *Flower crops:* marigold, gaillarda, tuberose, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practices
LMU 6	Redgram, groundnut, sunflower, maize, sorghum, bajra	Custard apple, amla Annual vegetables: tomato, chilli, bhendi, crucifers	*Perenial components:* custard apple, amla *Vegetables:* tomato, bhendi, chilli, crucifers *Flower crops:* marigold, gaillarda, tuberosa, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 7	Groundnut, horsegram silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, woodapple	Fig, Amla	Drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 8	Bengalgram, sorghum, bajra, sunflower	Ber, Custard apple Vegetable:ridge guard,ash guard	Ber, fig, amla	-do-
LMU 9	Silviculture, accacia, glyriidia, simaraba, agave Grasses: Styloxanthes hamata, Styloxanthes scabra, khus grass	Pasture, grasses	-	-

Table 2.5.14. Proposed crop plan for Yelishirur-3 micro-watershed (4D4A3L2e), Gadag taluk and district based on soil-site–crop suitability assessment

LMU	Crops proposed			Suitable intervention
	Field crops/Forestry crops	**Suitable Horticulture crops under irrigation**	**Horticulture crops with suitable interventions**	
LMU1	sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bendy, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:*marigold, gaillardia, tuberose, chrysanthemum *Perenial components:*sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:*chilli, bendy, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 2	Sorghum, redgram, cotton, sunflower, bengalgram, safflower, linseed, bajra. *Multiple crop rotation:* redgram+fodder sorghum pulses+sorghum	Vegetables: chilli, tomato, bhendi, cabbage, drumstick *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi	*Flower crops:* marigold, gaillardia, tuberose, chrysanthemum *Perenial components:* sapota, tamarind, custard apple, amla, lime, moosambi. *Annual vegetables:* chilli, bhendi, crucifers	Drip irrigation, mulching, crop suitable conservation practises
LMU 3	-do-	*Perenial component:* custard apple, amla *Annual vegetables:* tomato, chilli, bhendi, crucifers	*Perenial components:*custard apple, amla *Vegetables:*tomato, chilli, bhendi, crucifers *Flower crops:* marigold,gaillarda, tuberose, chrysanthemum	Drip irrigation, mulching, crop suitable conservation practices
LMU 4	Redgram, groundnut, sunflower, maize, sorghum, bajra, castor	Custard apple, amla Annual vegetables: tomato, chilli, bhendi, crucifers	*Perenial components:* custard apple, amla *Vegetables:* tomato, bhendi, chilli, crucifers *Flower crops:* marigold, gaillarda, tuberosa, chrysanthemum	Pit size, Drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 5	Groundnut, horsegram silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, woodapple	Fig, amla	Pit size, Drip irrigation, mulching, crop suitable conservation practises (crescent bunding with catch pit etc.)
LMU 6	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia	Custard apple, amla, woodapple	Fig, amla	Crop suitable conservation practises (Crescent bunding with catch pit etc.)
LMU 7	Silviculture, accasia, glycirdia, simaruba, subabul, agave, cassia Grasses: styloxanthes hamata, styloxanthes scabra, khus grass	Pasture, grasses	-	-

Table 2.5.15. Suggested Land use plan for Thimmajipet mandal, Meboobnagar district, Telangna

LMU	Short term plan*	Long term plan
Shallow to very shallow, excessively drained, red gravelly sandy soils occur on gently sloping uplands and escarpments with moderate erosion and stoniness (LMU-1)	Rainfed: small millets, sorghum, maize, horse gram, green gram, black gram, coriander, cluster bean, cotton. Irrigated: Aerobic rice, maize, vegetables like water melon, chillis, tomato, sunflower, groundnut Nutrient Plan: Apply 25% more than recommended dose (RD) of N, 25% lower than RD of P with PSB and RD of K, Sulphur, Zinc and 5kg borax/ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	Banana with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and silvi-horti-pasture system (*C.ciliaris*, Stylo grass mixture, custard apple, amla, jamun, ber and suitable multi purpose trees (MPTs) like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) and boundary planting of Gliricidia helps in improving organic source. To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. Soil and Water Conservation (SWC) measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created.

LMU	Short term plan*	Long term plan
		Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and yellow mosaic virus (YMV) resistant varieties of Pulses. Prefer fodder type cereals and pulses. High density mixed cropping of fodder maize/sorghum, cowpea and horse gram. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Moderately deep, moderately well drained, black clayey soils occurring on very gently sloping valleys with moderate to severe erosion and slight calcareousness (LMU 2)	Rainfed:Cotton+ red gram, sorghum+ red gram, maize, maize/sunflower (short duration)-gram, cowpea, green gram, black gram, coriander, cluster bean. Irrigated: Paddy, aerobic rice, sunflower and vegetables like beans, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, 25% lower than RD of P with PSB and RD of K, Sulphur, Zinc and 5kg borax/ ha. Follow Integrated Nutrients Management (INM) approach. Boundary planting of Gliricidia helps in improving organic source	Banana with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*,Neem). To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Moderately deep, well drained, red sandy loam soils occurring on very gently sloping pediments with moderate erosion (LMU-3).	Maize, cotton + red gram, groundnut, groundnut + red gram/millets, castor, sunflower, red gram, sorghum, sorghum+ red gram, maize/sunflower (short duration)-gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, water melon. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, 25% lower than RD of P with PSB and RD of K, Sulphur, Zinc and 5kg borax/ ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source	Silvi-horti-pasture system (*C.ciliaris*, Stylo grass mixture, custerd apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis,*Neem) SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ Sorghum varieties and YMV resistant varieties of Pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Deep, well drained, red sandy loam soils occurring on very gently sloping pediments with slight to moderate erosion (LMU 4).	Maize, groundnut, cotton + red gram, cotton, sorghum + red gram, sunflower, red gram, sorghum, maize/ sunflower (short duration)- gram, paddy, cowpea, green gram, black gram, castor and vegetables like beans, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin	Banana, mango, guava with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.

LMU	Short term plan*	Long term plan
	Nutrient Plan: Apply 25% more than recommended dose of NK and recommended dose of P, Sulphur, Zinc and 5kg borax/ha. Boundary planting of Gliricidia helps in improving organic source and follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	Sow primed seeds of cotton and maize. Use higher seed rate for Sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of Pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Deep to very deep, poorly drained, black clayey soils occur on very gently sloping valleys with slight to moderate erosion and calcareousness (LMU-5).	Cotton + red gram, maize, cotton, sunflower, red gram, sorghum, maize/sunflower (short duration)-gram, millets, paddy as aerobic rice cultivation (irrigated),cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato, chilli. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, 25% lower than RD of P with PSB and RD of K, Sulphur, Zinc and 5kg borax/ha. Boundary planting of Gliricidia helps in improving organic source.	Banana, mango, guava with drip irrigation. In rainfed areas grow millets and pulses like Cowpea, Green and Black gram and Agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*,Neem) SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of Pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.

* Based on bio-physical suitability and economic viability

Table 2.5.16. Suggested Land use plan for Indervelli mandal, Adilabad district, Telangana

LMU	Short term plan*	Long term plan
Shallow to very shallow, well drained, reddish brown loamy soils with moderate to severe erosion and stoniness (LMU-1)	Rainfed: Small millets, bajra, sorghum, maize, horse gram, green gram and black gram,groundnut, sesame, soybean, coriander, cluster bean, cotton. Irrigated: Paddy, aerobic rice, maize, vegetables like bhendi, brinjal, chillis, tomato, sunflower, groundnut Nutrient Plan: Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur, Zinc and 5kg borax/ ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	In elevated uplands grow millets and pulses like cowpea, green and black gram and silvi-horti-pasture system (*C.ciliaris*, Stylo grass mixture, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) and boundary planting of Gliricidia. To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. SWC measures like modified contour bunds and stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. Sow primed seeds of maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/sorghum varieties and YMV resistant varieties of Pulses. Prefer fodder type cereals and pulses. High density mixed cropping of fodder maize/ sorghum, cowpea and horse gram. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Shallow, well drained, brown to dark yellowish brown clayey soils with moderate to severe erosion and moderate stoniness (LMU 2).	Rainfed: Sorghum+ red gram, soybean, cotton + red gram, maize, sesame, maize/ sunflower (short duration)-gram/safflower, cowpea, green gram, black gram, coriander, cluster bean.	Banana with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*,Neem).

LMU	Short term plan*	Long term plan
	Irrigated: Paddy, aerobic rice, sunflower and vegetables like beans, bhendi, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur, Zinc and 5kg borax/ ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of Pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Moderately shallow to moderately deep, well drained, grayish brown clayey soils with moderate erosion and moderate to severe stoniness (irrigated) (LMU-3)	Maize, cotton, groundnut, sunflower, red gram, maize/sunflower (short duration)-wheat/gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like tomato, turmeric, chilli, bhendi, brinjal, coriander, cluster bean, pumpkin, water melon and mango. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur, Zinc and 5kg borax/ ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*,Neem). SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m. SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of Pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Moderately shallow to moderately deep, well drained, grayish brown loamy soils with severe erosion and moderate stoniness.	Maize, soybean, cotton, groundnut, bajra, cotton + red gram, sorghum + red gram, sunflower, red gram, sorghum, maize/sunflower (short duration)-gram/wheat, paddy, cowpea, green gram, black gram, castor and vegetables like beans, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin and mango. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur and 5kg borax/ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	Banana, Mango, Guava with drip irrigation. In elevated uplands grow millets and pulses like cowpea, Green and Black gram and Agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, Neem) SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.

LMU	Short term plan*	Long term plan
Deep, well drained, very dark gray clayey soils with moderate erosion (irrigated) (LMU-5)	Cotton, cotton + red gram, maize, rice, sunflower, sorghum, cotton, red gram, maize/sunflower (short duration)-wheat/gram, millets, cowpea, green gram, black gram and vegetables like bhendi, tomato, chilli, brinjal, coriander, cluster bean, pumpkin and mango. Nutrient Plan:Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur and 5kg borax/ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	Banana, mango, guava with drip irrigation. In rainfed areas grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*,Neem) SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Use higher seed rate for sorghum. Prefer medium duration dual purpose millet/ sorghum varieties and YMV resistant varieties of pulses. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.
Deep, well drained, very dark gray loamy soils with moderate erosion (LMU 6).	Maize, soybean, sunflower, cotton, bhendi, tomato, brinjal, groundnut, sesame, bajra, sorghum, maize-gram, soybean-wheat, mango. Nutrient Plan: Apply 25% more than recommended dose (RD) of N, RD of P, K, Sulphur and 5kg borax/ha. Follow INM approach. Boundary planting of Gliricidia helps in improving organic source.	Banana, mango, guava with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, Neem) SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created. Sow primed seeds of cotton and maize. Irrigate alternate row to protect the crop if water is available and top dress urea after supplemental irrigation to boost the growth.

* Based on bio-physical suitability and economic viability

Table 2.5.17. Suggested land use plan for Gajwel mandal of Medak district, Telangana

LMU	Short term plan	Long term plan	Nutrient plan
Shallow to very shallow, somewhat excessively drained, loamy skeletal soils with moderate stoniness (LMU1)	Small millets, sorghum, horse gram, green gram and black gram, cotton and maize.	Silvi-horti-pastur system (*C.ciliaris*, Stylo grass mixture, custered apple, amla, ber and suitable MPTs like *DalBergia sissoo*, *Faidherbia albida*, *A.auriculiformis*, neem). To conserve soil and water open intermittent contour trenches at 3-7 m interval with 0.3 m base width and 0.3 m height with 1:1 side slope, afforestation with MPTs on the Berm side of trench and stone terracing at an interval of 30 m.	Apply recommended dose of NPK with 5 kg borax/ha. Boundary planting of Gliricidia helps in improving organic source.
Moderately deep to deep, well drained to mod. Well drained, loamy sand soils with moderate erosion (LMU 2).	Maize, cotton, sunflower, redgram, sorghum, maize/ sunflower (short duration) - gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin	Agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, Mango, Guava, Custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) with SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created.	Apply recommended dose of NPK and Zinc with 5 kg borax/ha follow INM approach. Phosphorus should be applied as SSP. Boundary planting of Gliricidia helps in improving organic source.

LMU	Short term plan	Long term plan	Nutrient plan
Moderately deep to deep, moderately well drained to well drained, clayey soils with slight erosion (LMU 3)	Cotton, maize, sunflower, red gram, sorghum, maize/ sunflower (short duration) - gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato and chilli.	Silvi-horti-pasture system (*C.ciliaris*, Stylo grass mixture, Custerd apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis,* Neem) with SWC measures like stone bunds on the boundaries across major slope and farm ponds needs to be created for water harvesting.	Apply recommended dose of NPK with 5 kg borax/ha follow INM approach. Boundary planting of Gliricidia helps in improving organic source.
Very deep, well to moderately well drained, loamy soils with slight to moderate erosion (LMU 4)	Maize, cotton, sunflower, red gram, sorghum, maize/ sunflower (short duration) - gram, paddy, cowpea, green gram, black gram and vegetables like beans, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin, tomato andchilli.	Banana, mango, guava with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, Neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and farm ponds needs to be created.	Apply recommended dose of NK and boron, use PSP with 25 per cent reduced recommended dose of P and follow INM approach. Phosphorus should be applied as SSP. Boundary planting of Gliricidia helps in improving organic source.
Very deep, well to moderately well drained, clayey soils with slight erosion (LMU 5)	Cotton, maize, paddy, sunflower, red gram, sorghum, maize/sunflower (short duration) - gram, cotton+red gram, millets, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato, chilli,	Banana, mango, guava with drip irrigation. In rainfed areas grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.	Apply recommended dose of NPK and Zinc with 5 kg borax/ha follow INM approach. Apply P through SSP. Boundary planting of Gliricidia helps in improving organic source.

Table 2.5.18. Land use options for the various land management units of Porbandar taluk, Porbandar district, Gujarat

LMUs	Present land use	Characteristics	Suggested land use options
LMU 1	Groundnut-coriander	Shallow, loamy skeleton on very gentle slope, hill pediment soil, double cropping	Marginally suitable for crops like groundnut, pearl millet coriander, cumin, pulses with few management practices, good for fodder sorghum and grasses cultivation like napier cultivation for animal
LMU 2	Castor-cumin	Shallow, clayey skeleton on very gentle slope, hill pediment soil, double cropping	moderately suitable for groundnut, pearl millet, *kharif* pulses, wheat, coriander, cumin & chickpea with few management practices related to soil and water
LMU 3	Groundnut-coriander/ sorghum	Shallow, fine on very gentle slope, piedmont alluvial plain, double cropping	Moderately suitable for the groundnut, wheat, cumin and vegetables. Horticultural crops lemon, guava, coconut, vegetables also suitable for the earning income
LMU 4	Groundnut-coriander/ cumin/-greengram/ sesame	Deep, fine, very gentle slope, piedmont alluvial plain, triple cropping	Most suitable land for the cultivation of cotton, castor, wheat, sorghum & vegetables. summer crops like cucurbits and pulses are also beneficial with conserve moisture, animal husbandry for milk and FYM purpose for the fields
LMU 5	Groundnut	Very shallow, clayey skelton, gentle slope, coastal plain, single cropping	Suitable for tree/bushes and grasses like cynodon dactylon, cenchrus ciliaris using SWC measures, social forestry an also advocate

LMUs	Present land use	Characteristics	Suggested land use options
LMU 6	Sorghum-chickpea	Moderately deep, fine, very gentle slope, coastal plain double cropping	suitable for most of the *kharif* and *rabi*crops like groundnut, wheat, cotton, coriander, cumin, castor & *kharif* & *rabi* pulses, intercropping also advisable
LMU 7	Pearl millet/groundnut-*rabi* sorghum	Very deep, sandy with gently sloping, coastal plain with single/ barren cropping, waterlogged during *Kharif*season	Suitable for water chestnut-wheat/cowpea cultivation, fish cultivation. Fodder crops like sorghum and maize also advisable with few drainage facilities, mixed or intercropping is beneficial
LMU 8	Fallow/pasture-gram fallow-wheat	Very deep, fine, nearly level slope, coastal plain with single crop, waterlogged during *kharif*	Suitable for rice-wheat/chickpea cultivation, coconut plantation in waterlogged area with Fish cultivation.
LMU 9	Groundnut/pasture-chickpea	Shallow, sandy, very gentle slope, coastal plain, single cropping	Groundnut/pearl millet-*rabi* fodder sorghum/maize, buffalo+ cow rearing with grasses like Cenchrus ciliaris and Panicum maximus.

Table 2.5.19. Present and suggested land use of the Kadwa block, Katihar district, Bihar

LMU	Present land use	Suggested land use options
1	Only potato/vegetable/ maize cultivation in *Rabi* season	After short duration maize, summer vegetables like bottle guard, snake guard, cucumber and watermelon can be grown. Management: It is recommended that some ameliorative measures are necessary in this unit to maintain the pH of the surface soils in near neutral range which will help to increase the efficiency of phosphatic fertilizers.
2	*Kharif* paddy / fallow - mustard / maize - boro paddy / fallow	If no flooding then *Kharif* paddy – lathyrus / bengal gram as paira crop – maize – boro paddy. If heavy flooding is there, then early vegetable / mustard / potato - wheat / maize - boro paddy. Management: early rice variety: Prabhat, Dhanlaxmi, Richharia, Turanta; Wheat: HD-2733, PBW-343, PBW-502
3	*Kharif* paddy - maize / wheat / potato	*Kharif* paddy - lathyrus / bengal gram as paira crop - maize / wheat - boro paddy. Management: early rice variety: Prabhat, Dhanlaxmi, Richharia, Turanta; Wheat: HD-2733, PBW-343, PBW-502
4	*Kharif* paddy - maize / wheat / potato	*Kharif* paddy - lathyrus / bengal gram as paira crop - maize / wheat - boro paddy. Management: It is recommended that some ameliorative measure are necessary in this unit to maintain the pH of the surface soils in near neutral range which will help to increase the efficiency of phosphatic fertilizers; reduced the use of nitrogenous fertilizer; the drainage may be improved by installing surface and sub-surface drainage channels.

Table 2.5.20. Suggested land use plan for Erravally village of Medak district.

	Crops and cropping systems	Agri-horti-silvi-pasture systems	Nutrient plan
Moderately Deep, well drained, gravelly loam soils (LMU-1)	Maize, cotton, sunflower, red gram, sorghum, maize (short duration)-gram, millets, paddy as aerobic rice cultivation, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin	Agri-horti-pasture system (*C.ciliaris*, Stylo, *Bracharia* on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo*, *Faidherbia albida*, *A.auriculiformis*, neem) with SWC measures like stone bunds on the boundaries across major slope and water harvesting farm ponds needs to be created.	Apply recommended dose of NPK, Zinc and 5 kg/ha Borax. Use PSP to utilize fixed P and follow INM approach. phosphorus should be applies as SSP. Boundary planting of Gliricidia helps in improving organic source.
Deep, well drained gravelly clay soils (LMU 2)	Maize, cotton, sunflower, red gram, sorghum, maize/ sunflower (short duration)-gram, cotton+red gram, millets, paddy as aerobic rice cultivation (irrigated),cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato, chilli	Agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custerd apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo, Faidherbia albida, A.auriculiformis*, neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.	Apply recommended dose of NPK and follow INM approach. Apply 15kg $ZnSo_4$ and apply P through SSP. Boundary planting of Gliricidia helps in improving organic source.

Deep to very deep, well drained,loamy soils (LMU 3)	Maize, cotton, sunflower, red gram, sorghum, maize/ sunflower (short duration)-gram, paddy, cowpea, green gram, black gram and vegetables like beans, chilli, water melon, musk melon, tomato, coriander, cluster bean, pumpkin	Banana, mango, guava with drip irrigation. In elevated uplands grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, mango, guava, custard apple, amla, jamun, ber and suitable MPTs like *Dalbergia sissoo, Faidherbia albida, A.auriculiformis*, neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.	Apply recommended dose of NK and boron, use PSP to utilize fixed P and follow INM approach. Phosphorus should be applied as SSP. Boundary planting of Gliricidia helps in improving organic source.
Very deep, moderately well drained, calcareous clayey soils (LMU-4)	Paddy, maize, cotton, sunflower, red gram, sorghum, maize/ sunflower (short duration) - gram, cotton+red gram, millets, paddy as aerobic rice cultivation (irrigated), cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato, chilli.	Agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, guava, custerd apple, amla, jamun, ber and suitable MPTs like *DalBergia sissoo*, *Faidherbia albida*, *A.auriculiformis*, Neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.	Apply recommended dose of NK and 25% more than recommended P and Zinc with 5kg borax/ha. Use Neem coated urea or place fertilizers near plant and cover with soil. Follow INM approach. Apply P through SSP. Boundary planting of Gliricidia helps in improving organic source.
Very deep, moderately well drained, clayey soils(LMU 5)	Cotton, maize, paddy, sunflower, red gram, sorghum, maize/ sunflower (short duration)-gram, cotton+red gram, millets, cowpea, green gram, black gram and vegetables like coriander, cluster bean, pumpkin, tomato, chilli,	Banana, mango, guava with drip irrigation. in rainfed areas grow millets and pulses like cowpea, green and black gram and agri-horti-pasture system (*C.ciliaris*, Stylo, Bracharia on bunds, guava, custard apple, amla, jamun, ber and suitable MPTs like *Dalbergia sissoo, Faidherbia albida, A.auriculiformis*, neem) with SWC measures like graded bunds, stone bunds on the boundaries across major slope, vegetative bunds within the field boundaries and water harvesting farm ponds needs to be created.	Apply 25% higher than recommended dose of NP and Zinc with 5kg borax/ha, and follow INM approach. Apply P through SSP. Boundary planting of Gliricidia helps in improving organic source.
Rock out with shallow, sandy soils on mounds (LMU-6)	Sorghum, millets and pulses like cowpea, green and black gram, cluster bean	Silvi-horti-pasture system (*C.ciliaris*, Stylo grass mixture, custard apple, amla, jamun, ber, development of CPR by introducing HYV of grasses and legumes and suitable Multipurpose trees (MPTs) like *Dalbergia sissoo*, *A.auriculiformis*, Neem) with SWC measures like trench cum bunding.	Apply recommended dose of NPK and Zn with 5kg borax/ha.

Soil based land use options

Soil based alternate land use options were suggested in Bahphalagaon, Upar Deurigaon, Nam Deurigaonin North-West Jorhat Development block and Natun Chapori Tribal Village, Kakodonga Block, Golaghat district (Table 2.5.21 to 2.5.24). Similar exercise has been carried out for Pata Meghpar village in Kalavad block of Jamnagar district, Gujarat (Table 2.5.25).

Table 2.5.21. Alternate land use options for Bahphalagaon, North West Jorhat development block, Jorhat district, Assam

Soil Series	Soil Characteristics	Present Land Use	Alternate Land Use Options
Bahphala-1 (BP-1-b-B-2) *Typic Udipsamments*	Coarse loamy, moderately well drained, weakly acidic to neutral soils with loamy sand surface, occurring on very gently sloping active flood plains with moderate erosion hazards.	Current fallow	Mustard/ potato/ pea by adopting low lifting pump-sets (5 HP) and shallow tube wells. Mustard- var. TS-38 Potato-var. Kufri Jyoti/ Kufri Meghraj Pea- var. F1 Hybrid
Bahphala-2 (BP-2-c-A-1) *Typic Fluvaquents*	Coarse loamy, moderately well drained, moderately to weakly acidic soils with sandy loam surface, occurring on nearly level younger flood plains with slight erosion.	Rice-fallow	Rice (var.Ranjit)-Mustard (var. TS-38)-Pea (F1 hybrid) Rice (var. Ranjit)-Potato (Kufri Jyoti)- Pea (F1 hybrid)by adopting low lifting pump-sets (5 HP) and shallow tube wells.
Bahphala-3 (BP-3-d-A-1) *Fluventic Dystrudepts*	Fine loamy, somewhat poorly drained, moderately to weakly acidic soils with loamy surface, occurring on nearly level younger flood plains with slight erosion.	Rice-fallow	Rice (var.Ranjit)-mustard (var. TS-38) Rice (var. Ranjit)-potato (Kufri Jyoti) Rice (var. Ranjit)- pea (F1 hybrid)
Bahphala-4 (BP-4-e-A-1) *Fluventic Endoaquepts*	Fine loamy, poorly drained, moderately to strongly acidic soils with silt loam surface, occurring on nearly level younger flood plains with slight erosion.	Current fallow (Wet lands)	Rice (var.Ranjit)-mustard (var. TS-38)

N.B. N2-Permanently not suitable; S3-Marginally suitable; S2-Moderately suitable; S1-Highly suitable; (f)-Fertility factor; (s)-Root zone/ Soil physical factors; (w)-Wetness factor; 1-slight limitation; 2-Moderate limitations; 3-Severe limitations

Table 2.5.22. Alternate land use options for Upar Deurigaon, North West Jorhat development block, Jorhat district, Assam

Soil Series	Soil Characteristics	Present Land Use	Alternate Land Use Options
Deuri A-b-B-2 *Typic Fluvaquents*	Coarse loamy, well drained, neutral soils with loamy sand surface texture, occurring in nearly level active flood plains with moderate erosion hazard	Current fallow	Mustard/ potato by adopting low lifting pump-sets (5 HP) and shallow tube wells. Mustard-var. TS-38 Potato-var. Kufri Jyoti/ Kufri Meghraj
Deuri B-c-A-1 *Fluvaquentic Endoaquepts*	Coarse loamy, imperfectly drained, weakly to moderately acidic soils with sandy loam surface texture, occurring in nearly level flood plains with slight erosion hazard	Rice-fallow	Rice (Ranjit)-mustard (TS-38)/ potato (Kufri Jyoti)-pea (F1 Hybrid)
Deuri B-e-A1 *Fluvaquentic Endoaquepts*	Coarse loamy, imperfectly drained, weakly moderately acidic soils with silt loam surface texture, occurring in nearly level flood plains with slight erosion hazard	Rice-fallow	Rice (Ranjit)-Mustard (TS-38)/ potato (Kufri Jyoti)-pea (F1 Hybrid)

N.B. N2-Permanently not suitable; S3-Marginally suitable; S2-Moderately suitable; S1-Highly suitable; (f)-Fertility factor; (s)-Root zone/ Soil physical factors; (w)-Wetness factor; 1-slight limitation; 2-Moderate limitations; 3-Severe limitations

Table 2.5.23. Alternate land use options for Nam Deurigaon, North West Jorhat Development block, Jorhat district, Assam

Soil Series	Soil Characteristics	Present Land Use	Alternate Land Use Options
Nam Deuri-1 (ND-1-c-A-1) *TypicFluvaquents*	Coarse loamy, moderately well drained, moderately acidic soils with sandy loam surface, occurring on nearly level younger flood plains with slight erosion.	Rice-fallow	Rice (var.Ranjit)-mustard (var. TS-38)-pea (F1 hybrid) Rice (var. Ranjit)-potato (Kufri Jyoti)- pea (F1 hybrid) by adopting low lifting pump-sets (5 HP) and shallow tube wells.
Nam Deuri-2 (ND-2-e-A-1) *Fluventic Endoaquepts*	Fine loamy, somewhat poorly drained, strongly acidic soils with silt loam surface, occurring on nearly level younger flood plains with slight erosion.	Rice-fallow	Rice (var.Ranjit)-mustard (var. TS-38) Rice (var. Ranjit)-potato (Kufri Jyoti)

N.B. N2-Permanently not suitable; S3-Marginally suitable; S2-Moderately suitable; S1-Highly suitable; (f)-Fertility factor; (s)-Root zone/ Soil physical factors; (w)-Wetness factor; 1-slight limitation; 2-Moderate limitations; 3-Severe limitations

Table 2.5.24. Alternate land use options for Natun Chapori tribal village, Kakodonga block, Golaghat district, Assam

Soil Series	Soil Characteristics	Present Land Use	Alternate Land Use Options
Natun Chapori-1 (NC-1-c-A-1) *Typic Fluvaquents*	Coarse loamy, well drained, near neutral soils with sandy loam surface, occurring on nearly level active flood plains with slight erosion.	Current fallow	Potato /mustard / pea by adopting low lifting pump-sets (5 HP) and shallow tube wells. Mustard- var. TS-38 Potato-var. Kufri Jyoti/ Kufri Meghraj Pea- var. F1 Hybrid
Natun Chapori-1 (NC-1-e-A-1) *Typic Fluvaquents*	Coarse loamy, well drained, near neutral soils with silt loam surface, occurring on nearly level active flood plains with slight erosion.	Rice-fallow	Mustard (var. TS-38)-pea (F1 hybrid) Potato (Kufri Jyoti)- pea (F1 hybrid) By adopting low lifting pump-sets (5 HP) and shallow tube wells.
Natun Chapori-2 (NC-2-c-A-1) *Typic Udipsamments*	Psamments, well drained, near neutral soils with sandy loam surface, occurring on nearly level active flood plains with slight erosion.	Current fallow	Mustard (var. TS-38) - pea (F1 hybrid) Potato (Kufri Jyoti) - pea (F1 hybrid) By adopting low lifting pump-sets (5 HP) and shallow tube wells.
Natun Chapori-3 (NC-3-c-B-2) *Flunentic Endoaquepts*	Coarse loamy, moderately well drained, near neutral soils with sandy loam surface, occurring on very gently sloping younger flood plains with moderate erosion.	Rice-fallow	Mustard (var. TS-38) - pea (F1 hybrid) Potato (Kufri Jyoti) - pea (F1 hybrid)

Table 2.5.25. Suggested land use plan for Pata Meghpar village in Kalavad block of Jamnagar district, Gujarat

Series	Landform	Slope (%)	Present land use	Constraints	Management need/ soil conservation measures	Suggested land use	Area (ha)
Pata Meghpar-1	Isolated upland	8-15	Degraded lands / scrub land	Very shallow, strong stoniness, severe to very severe erosion, moderately sloping, excessively drained, rapid permeability and very low in available water capacity.	Contour vegetative bunds, contour trenching and field bunding	Afforestation	65.4
Pata Meghpar-2	Isolated upland	3-8	Degraded lands/ scrub land	Very shallow, moderate to strong stoniness, moderate to severe erosion, gently to very gently sloping, very low in available water capacity, somewhat excessively drained and rapid permeability.	Contour vegetative bunds, contour trenching and field bunding	Silvipasture	53.8
Pata Meghpar-3	Ravenous land	8-15	Ravenous / scrub land	Moderately shallow, severe erosion, undulating and ravenous land, strong stoniness, moderate slope and rapid permeability	Contour vegetative bunds, contour trenching and field bunding	Community or village forestry	409.6
Pata Meghpar-4	Very gently sloping plain	1-3	Cultivated (double crop)	Very gently sloping, moderately shallow with moderate erosion and low to medium in nutrient status	Field bunding	Double cropping	248.1
Pata Meghpar-5	Very gently sloping plain	1-3	Cultivated (double crop)	Moderately shallow with medium available water content, strongly alkaline and low to medium in nutrient status	Field bunding, apply fine powdered gypsum	Double cropping	361.8
Pata Meghpar-6	Nearly level plain	0-1	Cultivated (double crop)	Medium available water content, moderately alkaline and low to medium in nutrient status	Field bunding, apply fine powdered gypsum	Intensive cropping	238.4
Pata Meghpar-7	Nearly level plain	0-1	Cultivated (double crop)	Moderately alkaline, strongly calcareous and low to medium in nutrient status	Field bunding, apply fine powdered gypsum	Intensive cropping	305.5

Impact study of suggested Land Use Plan

Suggested land use plan has been executed at three places, Bali Island Sundarban West Bengal, vllages in Jorhat and Golaghat district, Assam and in H.D. Kote block of Mysore district Karnatka. The change in socio-economic conditions of the farmers is described here in.

Coastal Region : Bali Island of Sundarbans, West Bengal

It is noted that there is considerable change in pH, ECe and organic carbon (Table 2.5.26) due to the implementation of suggested land use plan consisiting of crops and cropping pattern together with soil conservation measures like land shaping and soil amendments. Productivity and income of the farmers have gone up appreciably (Table 2.5.27).

Table 2.5.26. Change in soil properties

Land shaping technology	pH		ECe (dSm^{-1})		OC (%)	
	2014	2015	2014	2015	2014	2015
Farm pond technology Plot/Dag no1324 Village - Bali	5.4	5.8	6.2	5.6	0.61	0.65
Farm pond technology Plot/Dag no1524 Village - Bali Adibasi Para	5.5	5.9	6.8	5.7	0.62	0.67
Shallow furrow and medium ridge Plot/Dag no 383 Villagge - Bijoynagar	4.4	4.7	7.8	6.7	0.43	0.47
Paddy-cum fish cultivation Plot/Dag no 792 Village - Birajnagar	4.2	4.5	12.5	10.3	0.40	0.43

Table 2.5.27. Impact of interventions on crop productivity and income

S.No.	Crops	Productivity (q/ha)		Increase in productivity (%)	Increase in income(Rs.`)
		Before intervention	After intervention		
1	*Kharif* paddy	25.0-30.0	27.5-33.0	10-11	3,000/--3840/-
2	Moong	2.4-2.6	2.7-3.2	12.5-23.0	1500/--3000/-
3	Potato	55.0-67.0	77.3-84.1	25.6-40.5	17100/--22,300/-
4	Chilli	19.1-22.6	24.0-28.3	25.2-25.7	29,400/-34,200/-
5	Cabbage	110-123	153-186	39.0-51	43,000/-63,000/-
6	Cauliflower	198-212	237-254	19.6-19.8	39,000/-42,000/-
7	Tomato	92.1-94.6	103.2-114.7	12.1-21.2	22,200/-40,400/-
8	Bhendi	8.1-9.7	13.6-16.2	67.0-67.9	16,500/--19,500/-
9	Brinjal	122-135	147-169	20.5-25.2	75,000/-1,02,000/-
10	Pumpkin	nil	42.7-56.3	nil	42,700/-56,300/-
11	Calocasia	nil	95-143	nil	95,000/-1,43,000/-
12	Boro paddy	nil	48-56	nil	48,000/--56,000/-
	Pond fish	No record	9,600/--12,200/-	No record	9,600/-12,200/-

North-Eastern Region

Suggested land use options were validated in the farms of Upar Deurigaon, Bahphalagaon, Nam Deurigaon villages in Jorhat district and Natun Chaporigaon village in Golaghat district and the results are given in Table 2.5.28. It is apparent from the table that percentage gain in yield varied from 7 to 220% on the adoption of suggested land use. It is the highest in 220% Bahphalagaon and the lowest 7% in Nam Deurigaon with mustard. The study concludes that soils play very important role in selecting the crop and cropping pattern for a given situation.

Table 2.5.28. Output analysis of TSP activities during 2015-16

Name of the village	Crops	State level yield (t/ ha)	Yield at Research Station (t/ ha)	Obtained yield (t/ ha)	#Yield gap (%)	*Yield gain (%)	Net Returns (Rs./ ha/ year)	**Benefit to cost ratios
Upar Deurigaon, Jorhat (Assam)	Mustard	0.50-0.75	0.85-1.0	1.6	60	113	64,250/-	4.08
	Potato	5.0-7.5	7.5-10.0	14	40	87	78,150/-	1.26
	Pea	0.3-0.5	0.5-1.0	1.4	40	180	33,500/-	1.49
Bahphalagaon, Jorhat (Assam)	Mustard	0.50-0.75	0.85-1.0	2.4	140	220	96,375/-	6.12
	Potato	5.0-7.5	7.5-10.0	10.5	5	33	58,610/-	0.95
	Pea	0.3-0.5	0.5-1.0	1.3	30	160	31,100/-	1.39
Nam Deurigaon, Jorhat (Assam)	Mustard	0.50-0.75	0.85-1.0	0.8	-20	7	32,125/-	2.04
	Potato	5.0-7.5	7.5-10.0	9.8	-2	31	54,700/-	0.88
Natun Chaporigaon, Golaghat (Assam)	Mustard	0.50-0.75	0.85-1.0	1.1	10	47	44,170/-	2.81
	Potato	5.0-7.5	7.5-10.0	11.2	12	49	62,520/-	1.01
	Pea	0.3-0.5	0.5-1.0	0.6	-40	20	14,350/-	0.64

#With respect to maximum yield at research station; *With respect to maximum state level yield; ** With respect to net returns.

H.D. Kote taluk, Mysore district, Karnataka

Soil based integrated land use plans were validated in farmers' field through participatory approach. Promising integrated land use plans for different soils are given in Table 2.5.29.

Table 2.5.29. Soil based land use options

Description of Land Management Units	Promising integrated land use plans	Net returns (Rs/ha)
Shallow, well drained, gravelly red loam soils	Cotton (0.5 ac), finger millet + field bean (1ac), sesame-finger millet (1ac), vermicomposting	25200
Medium deep to deep, well drained, sandy clay loam soils (irrigated)	Maize-banana (1.2 ac); cotton-ragi (1.2 ac); fodder crops (0.1 ac) + dairy (1 milch cow), vermicompost	138800
Medium deep to deep, well drained, sandy clay loam soils (rainfed)	Maize, chilli, cotton, finger millet, vegetables + fodder on bunds (each 0.5 ac), dairy, vermicomposting	107800
Deep to very deep, well drained to moderately well drained, clayey soils	Vegetables (1.5 ac); coffee + pepper + yam + drumstick (0.7 ac); turmeric & jinjar (0.3); back yard poultry & vermicomposting	94000

Economic benefits obtained at farmers' fields by implementing promising integrated land use plans (ILUPs) need to be up-scaled to taluk level to show the possible impact of ILUPs. Possible economic benefits at taluk level were worked out by taking net returns obtained per ha at farmers' field in specified soil conditions, multiplied by area under same soil conditions available in the taluk. Information on soil-specific area under irrigation is not available and therefore, while up-scaling to taluk, especially LMU-2 and 3 monetory values were averaged and calculated (Table 2.5.30).

Table 2.5.30. Impact of promising ILUPs on monitory gain at taluk level.

Soils	Area (ha) in H.D.Kote	Monitory gain at farmer's field level (Rs/ha)		Expected monitory gain at taluk level (Rs. millions)	
		Farmer's practice	ILUPs	Farmer's practice	ILUPs
Shallow, well drained, gravelly red loam soils	4153	5750	25200	23.88	104.65
Medium deep to deep, well drained, sandy clay loam soils	32816	10300	122900	338.00	4033.10
Deep to very deep, well drained to moderately well drained, clayey soils	2872	18000	94000	51.70	270.00
Total				413.58	4407.75

Medium deep to deep sandy clay loam soils constitute maximum area in the taluk and also highest monitory gain is reported in the same soil units with ILUPs. If suggested and validated ILUPs are implemented in all the identified soil units of H.D.Kote, the monitory profit of the taluk or farmers' present income could be increased upto 10 times.

Automation of Land Evaluation and Land Use Planning

Automated Land Potential Evaluation System

In order to create systematic database on farm households and speedy analysis, developed Automated Land Potential Evaluation System (ALPES) using MS Access program (Fig 2.5.34). ALPES helps in coupling the socioeconomic and biophysical data for integrated land use planning and policy analysis.Farmework of ALPES is given in Figure 2.5.35. Using the ALPES, land use options were suggested for Yelishirur2 Micro Watershed, Karnataka (Table 2.5.31).

Fig. 2.5.34. Automated Land Potential Evaluation System (ALPES)

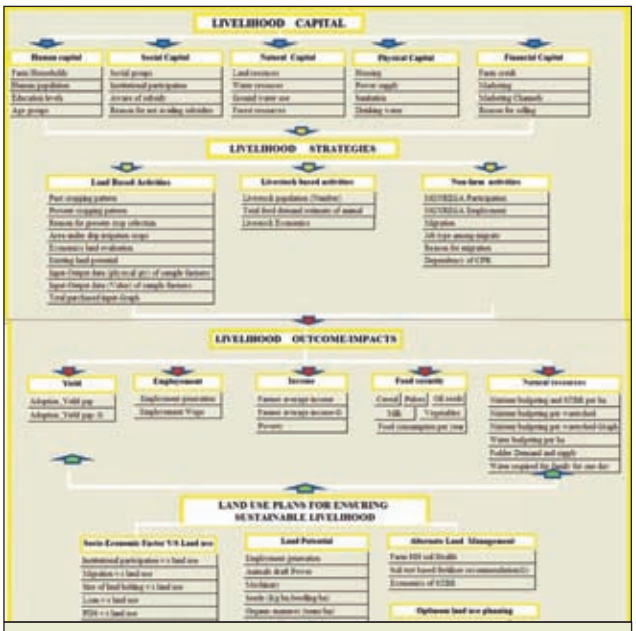


Fig 2.5.35. ALPES Framework

Table 2.5.31. Alternate land use options for different size group of farmers (Benefit Cost ratio) in Yelishirur2 micro-watershed

LMU (Area)	Soil phases	Size group		
		Small farmers	Medium farmers	Large farmers
1 (7 ha)	10- DNIfB2g2		Cotton (2.16) Sorghum (1.56) Green gram (1.31)	
2 (51 ha)	11- DRTiB2g2 12- DRTmB1g1 13- DRTmB2g1	Green gram (2.05) Wheat (1.73) Chilli (1.64) Cotton (1.63) Onion (1.24) Maize (1.06)		
3 (17 ha)	19- MPTmB1g1 20- MPTmB2	Cotton (1.59) Groundnut (1.40) Maize (1.34) Sorghum (1.25)		
4 (12 ha)	14- JLGmB2 15- JLGmB2g2	Chilli (1.47) Sorghum (1.01) Chrysanthemum (1.00)		
5 (49 ha)	5- ATTmB2g1	Groundnut (1.11) Sorghum (1.05) Wheat (1.09) Chrysanthemum (1.04) Maize (1.04)	Sorghum (1.39) Groundnut (1.31) Green gram (1.17) Onion (1.14) Maize (1.03) Chilli (1.03)	
6 (66 ha)	16- KKTfC2g2 17- KKTiB1g2 18- KKTmB1g1	Maize (1.68) Sorghum (1.17) Banana (1.14) Chrysanthemum (1.12) Wheat (1.11) Cotton (1.07)	Cotton (1.56) Sorghum (1.39) Groundnut (1.26) Maize (1.26) Wheat (1.09)	
7 (76 ha)	1- AKTfB2g1 2- AKTfB2g2 3- AKThB1g1 4- AKTmB1g1 22- NBPhC2g2 24- NBPmB2g1	Betel leaf (1.49) MulBerry (1.32) Sorghum (1.06) Maize (1.06)	Chilli (1.79) Chrysanthemum (1.39) Green gram (1.20) Soybean (1.29) Groundnut (1.21) MulBerry (1.08) Cotton (1.12) Maize (1.1)	Green gram (1.44) Soy bean (1.25) Groundnut (1.29) Sorghum (1.25) Bengal gram (1.10) Cotton (1.02) Maize (1.03)
8 (115 ha)	27- YSJmB2g1	Groundnut (2.64) Green gram (1.04) Sorghum (1.33) Cotton (1.21) Maize (1.17) Small millet (1.10) Onion (1.05)	Green gram (2.37) Groundnut (1.18) Cotton (1.73) Chilli (1.16)	Chilli (1.27)
9 (62 ha)	6- DDRfB2g2 8- DDRiC2g2R1 9- DDRmB1g1 25- SRLcB1g2 26- SRLmB2g1	Wheat (1.46) Green gram (1.37) Sorghum (1.24) Groundnut (1.18) Soybean (1.12) Cotton (1.11) Maize (1.05) Chrysanthemum (1.02)	Cotton (1.14) Groundnut (1.02)	
10 (118 ha)	7- DDRhD2g2R2 21- NBPfC3g2R3 23- NBPhD3g3R3	Maize (1.18) Cotton (1.06)	Green gram (2.49) Cotton (1.33) Maize (1.10) Groundnut (1.10)	

Decision support system for agricultural land use planning

Biophysical land evaluation

A submodule for land evaluation has been developed (Fig. 2.5.36). The submodule was based on the modified Requier's method of land evaluation. The required input soil parameters are: (i) soil moisture content at wilting point (H), (ii) drainage or waterlogging condition (D), (iii) effective depth of soil control section (p), (iv) texture or structure of soil (T), (v) soluble salts content (S), (vi) organic matter in A horizon (O), (vii) mineral exchange capacity and nature of the clay in B horizon (A) and (viii) reserves of weatherable minerals in B horizon (M). However, all the soil parameters may not be required as inputs and based on the minimum data set (MDS) the soil parameters may be selected for land evaluation.

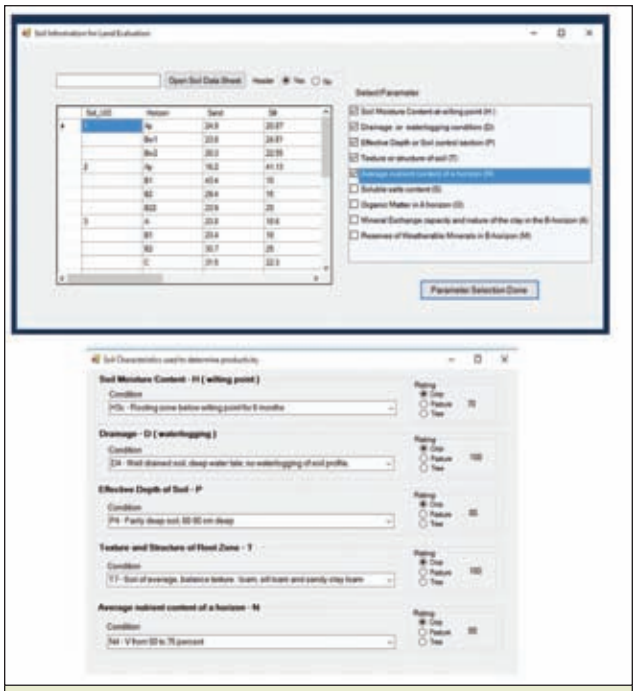


Fig. 2.5.36. A screen view of submodule for land evaluation

Android based mobile application for data mining and visualization of land use options for the state of Gujarat

An Android-based mobile Application viz. Comprehensive Soil Health Cards and Web GIS based decision support system (DSS) for the state of Gujarat have been developed in collaboration of the Bhaskaracharya Institute for Space Application and Geo-informatics, Department of Science and Technology, Government of Gujarat, Gandhinagar . The first version of Mobile app developed is static one and specific to Deesa taluka of the Banaskantha district of Gujarat. It has five options in the main menu viz., Soil parameter, suitable crops, fertility map of the survey number of interest and technologies of the ICAR/SAU (Fig. 2.5.37). It will display district, taluka, village and survey number. Depending on the requirement of information, one can select district, taluka and within the taluka desired village then survey number of interest, App. will display the details of soil map unit information and suggested land use plan for that survey number. Similarly, the web base DSS contains database on land resources and land use planning which can be mined at the village and farm level (Fig. 2.5.38).

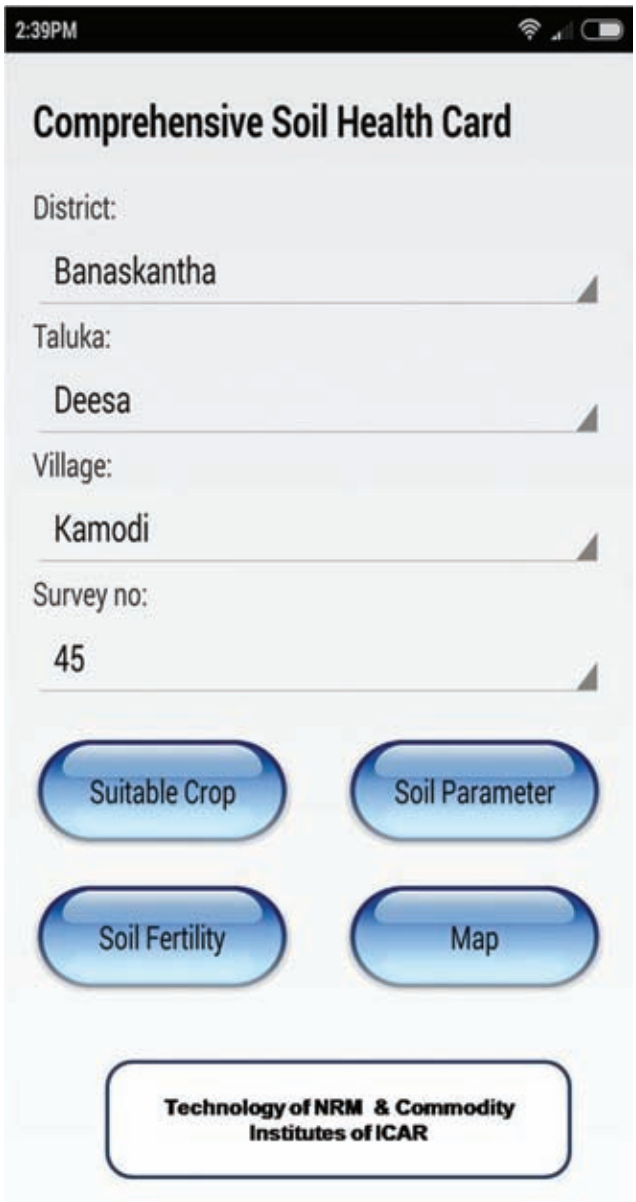


Fig.2.5.37. Android based mobile application for Gujarat state

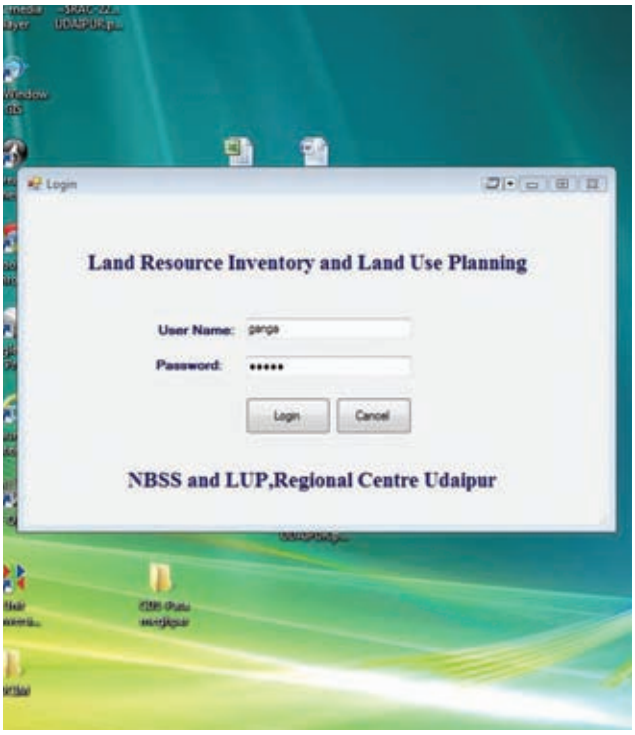


Fig.2.5.38. Decision support system for land use planning in Gujarat state

3 Research Programme

Institute Projects (Ongoing)

Inventorying Natural Resources

Land Resource Inventory at 1:10000 scale using geo-spatial techniques for agricultural land use planning

- Lahul Block, Lahul Spiti District, Himachal Pradesh
- Pangi Block, Chamba District, Himachal Pradesh
- Odhan Block, Sirsa district, Haryana
- Land resource inventory of *Jhum* intensified areas, Mokokchung district, Nagaland
- Mangan block, North Sikkim district Sikkim.
- Suratgarh block, Sriganganagar district, Rajasthan
- Bukkarayasamudrum mandal, Anantapur district, Andhra Pradesh
- Kangeyam block, Thiruppur district, Tamil Nadu
- Elamdesom block, Idukki district, Kerala
- Tiswadi block, North Goa district, Goa State
- Nagrota Bagwan block, Kangra district, Himachal Pradesh
- Jagner block, Agra district, Uttar Pradesh
- Baragaon block, Varanasi district of Uttar Pradesh
- Rajpura block, Patiala district, Punjab
- Chamba block, Tehri Garhwal district, Uttarakhand
- Noa-Dihing river basin (Bordumsa block), Changlang district, Arunachal Pradesh
- North West Jorhat Development block, Jorhat district, Assam
- Kadwa block, Katihar district, Bihar
- Rajnagar block, Birbhum district, West Bengal
- Dumka block, Dumka district, Jharkhand
- Borio block, Sahibganj district, Jharkhand
- Basudevpur block, Bhadrak district, Odisha
- Mushahari block, Muzaffarpur district, Bihar
- Ganjam block, Ganjam district, Odisha
- Titlagarh block, Bolangir district, Odisha
- Dholka taluka, Ahmadabad district, Gujarat
- Deesa taluka, Banaskantha district, Porbandar taluka, Porbandar district and Rapar taluka, Kucchha district, Gujarat
- Neem Ka Thana tehsil, Sikar district, Rajasthan
- Fatehgarh block, Jaisalmer district (Rajasthan)
- Gujarat state on 1:10000 scale - A step towards enhancing agricultural productivity and transfer of technology
- Dhanora block, Seoni district, Madhya Pradesh
- Bemetara block, Bemetara district, Chattisgarh State (AESR 11)
- Darwah tehsil, Yavatmal district, Maharashtra
- Madahalli and Singanallur micro watersheds, Chamrajnagar district, Karnataka for integrated watershed planning

Soil Correlation

- Correlation of Soil Series of India.

Remote Sensing and GIS Applications

- Design and development of land resource information system and NBSS geoportal for geospatial database management and dissemination
- Landform and land use/land cover mapping of some selected blocks of Basudevpur, Ganjam, Mushahari, Kadwa and Titlagarh for land resource inventory at 1:10000 scale
- Landform and land use/land cover mapping of Rajnagar, Dumka and Borio blocks for land resource inventory at 1:10000 scale
- Development of digital terrain database and landform mapping (1:10000 scale) at Tehsil/Block level in different agro-ecological sub-regions of central India using geospatial techniques
- Revision of agro-ecological regions (AER) Map of India

Basic Pedological Research

- Genesis of Vertisols in Peninsular India : Evidence from mineralogy and geochemistry
- Impact assessment of canal irrigation on the desert agro-eco system – A case study in a part of IGNP Command Area

- Genesis and classification of soils of Bemetara block, Chattisgarh
- Study the influence of land use system on soil properties under different geomorphic situations in Mahanadi Basin, Bolangir district, Odisha
- Effect of land use changes in total soil organic carbon and its active pool in humid to perhumid eco-region of West Bengal

Land Evaluation and Land Use Planning

- Impact assessment of agri-environmental factors on agricultural productivity in irrigated ecosystem of Gurgaon district, Haryana
- Agricultural land use planning, Nagrota Bagwan block, Kangra district, Himachal Pradesh using land resource inventory database on 1:10000 scale
- Prime agricultural land identification and their spatial distribution in West Bengal
- Assessment of prime agricultural lands in Central India – An approximation at 1:250000 scale
- Agricultural land use planning, Porbandar taluka, Porbandar district using land resource inventory database on 1:10000 scale
- Agricultural land use planning, Bemetara block, Chattisgarh using land resource inventory database on 1:10000 scale
- Development of decision support system for agricultural land use planning
- Agricultural land use planning using land resource inventory database on 1:10000 scale for Dhanora block, Seoni district, Madhya Pradesh
- Agricultural land use planning using land resource inventory database on 1:10000 scale for Darwah block, Yavatmal district, Maharashtra.
- Agricultural land use planning, Rajnagar Block, Birbhum District, West Bengal using land resource inventory database on 1:10000 scale
- Agricultural land use planning, Basudevpur block, Bhadrak district Odisha using land resource inventory database on 1:10000 scale.
- Agricultural land use planning, Umsning block, Ri-Bhoi district, Meghalaya, Using Land Resources inventory database on 1:10000 scale
- Analysis of temporal and spatial land use changes and its impacts in basaltic terrain of Vidarbha region in Maharashtra
- Land use dynamics in rural-urban interface of NCR for regional planning – a case study of NCT-Delhi and Haryana sub regions
- Developing alternate farming system model using soil resource information in the Sonagachhi village of Baruipur block (South 24 Paraganas), West Bengal

Tribal Sub Plan (TSP) Programme

- Livelihood improvement of tribal communities in selected hamlets of H.D. Kote, Mysore through integrated land use planning
- Land use option for enhancing productivity and improving livelihood in Bali Island of Sundarbans.
- Land resource management for farm planning of Upar Deuri Gaon, North West Jorhat development block, Jorhat, Assam
- Soil fertility and water management of enhancing agricultural productivity in a cluster of tribal villages in Warud tehsil, Amravati district, Maharashtra

Externally Funded Project (Ongoing)

Land Resource Inventory

- Land resource inventory of selected micro-watersheds in 11 districts of Karnataka under Sujala-III watershed development project (Component-I: Support for improved programme integration in rainfed areas, Watershed Development Department (WDD), Govt. of Karnataka)
- Development of digital terrain and land use dynamics geodatabase on 1:10K scale for land resource inventory of cultivated and fallow land use systems of Goa state
- Land resource inventory in sub-watersheds of Chikmagalur district, Karnataka for optimal agricultural land use planning using geo spatial techniques
- Land resource inventory of Thimmajipet mandal, Mahabubnagar district, Telangana using geospatial techniques for agricultural land use planning
- Land resource inventory of Gajwel mandal of Medak district, Telangana on 1:10000 scale for agricultural land use planning using geospatial techniques
- Land resource inventory of Sepahijala district, Tripura on 1:10000 scale
- Land resource inventory of Ri-Bhoi District, Meghalaya at 1:10000 scale for agricultural land use planning using geo-spatial technique

Remote Sensing & GIS Applications

- GIS based Digital Library (DL) for the Land resources of Sujala-III watershed development project (Sub Project of Sujala III - World bank funded project)
- Mapping and Assessment of land degradation in major ecosystems of India using geospatial technologies (**ICAR Extramural Research Projects)**
- ICAR KRISHI Geoportal-Experts Knowledge based Resources Information Systems Hub for Innovations in Agriculture (**ICAR Research Data Repository for Knowledge Management)**

Basic Pedological Research

- Generation and modeling of carbon datasets in different agro-ecosystems for climate resilient agricultural planning (NICRA)
- Influence of organic and inorganic carbon sequestration on soil and land quality in selected benchmark spots of India (DST-IS-STAC)
- Soil quality assessment and developing indices for soil and production regions of India - in collaboration with Lead Institute IISS, Bhopal **(ICAR Extramural Research Projects)**

Issue Based Survey

- Assessment of salt-affected soils of Tamil Nadu and its impact on crop (Tamil Nadu State Land Use Research Board)
- Management of coconut based land use systems in Kerala
- Soil fertility assessment and soil health monitoring in traditional Rubber growing areas of Kerala, Tamil Nadu and Karnataka (Rubber Research Institute of India, Kottayam)
- Soil fertility appraisal and soil health monitoring in traditional coffee growing regions of Karnataka, Kerala and Tamil Nadu (Central Coffee Research Institute Board, Govt. of India)
- Fallow lands of Tamil Nadu – cause, effects and measures to arrest the march of fallows
- Desertification status mapping of India (2nd Cycle) (SAC, Ahmedabad)
- Characterization of mulberry growing soils in selected seri-villages of Golaghat district, Assam

Land Evaluation and Land Use Planning

- Adaptation of irrigated agriculture to climate change (AICHA) (partnering with ongoing International Project of IISC, Bangalore and INRA France)
- Assessment of environmental and economic input of the new agricultural policy of Karnataka in land use, land productivity and rural livelihood (DST)
- Socio-economic Evaluation of Agricultural land use in India – Phase I (Sub-project of Sujala III)

Institute Projects (Completed) during the year 2015-16

Land Resource Inventory

- Land resource inventory of KVK farms in south-eastern Rajasthan, MPUAT, Udaipur, Rajasthan
- Land resource inventory for farm planning of Jhalarapatan Block, Jhalawar district of Rajasthan
- Land resource inventory of the NICRA Village (Pata Meghpar) in Jamnagar District, Gujarat
- Soil Resource Inventory for developing geodatabase towards land use planning in Bolangir subdivision in Bolangir district, Odisha
- Soil resource inventory and geo-database for developing land use planning in Patnagarh subdivision of Bolangir district, Odisha
- Land resource inventory for integrated agriculture planning of Miniwada panchayat, Katol tehsil, Nagpur using high resolution satellite data and GIS
- Generation of soil resource database of IARI Farm, New Delhi
- Land resource inventory of Central State Farm Jaitsar, Sriganganagar district, Rajasthan
- Land resource inventory of arable lands of Medziphema block, Dimapur district, Nagaland for agricultural planning
- Soil resource inventory and land evaluation of Chittaurgarh district for land use planning

Remote Sensing & GIS Applications

- Integrated use of remote sensing and field data for assessing soil quality under rainfed conditions in Parsori watershed, Katol tehsil, Nagpur district, Maharashtra
- Digital soil mapping using digital terrain analysis and multispectral remote sensing data - A pilot study in Tendulwani watershed of Nagpur district, Maharashtra
- Assessment and mapping of spatial variability of soil properties in basaltic terrain for precision

agriculture using VNIR spectroscopy and geo-statistical techniques

- Digital terrain modeling for object – based automatic delineation and classification of landforms in Katol tehsil, Nagpur district using high resolution Cartosat DEM and IRS P-6 LISS IV data
- Detailed soil mapping in basaltic terrain for land resource management using Cartosat 1 data
- Area prioritization for land use planning in some selected blocks of Bankura, Puruliya and West Medinipur districts - A remote sensing and GIS approach

Basic Pedological Research

- Studies on soil minerals and their genesis in selected benchmark spots representing different agro-eco sub region of India
- Revising methods for the determination of available potassium content in shrink-swell soils of India
- Water retention characteristics and saturated hydraulic conductivity of dominant soil series of Yavatmal district, Maharashtra

Land Evaluation and Land Use Planning

- Alternate land use options for Chhata tehsil of Mathura district towards sustainable crop production for livelihood security.
- Development of district level Land Use Plan for Gondia district, Maharashtra- A sub project of network project on district level land use planning.
- Land use planning of Buraka micro watershed in Mewat district of Haryana under irrigated eco system for integrated development.
- Development of district level land use plan for Almora district, Uttarakhand under hill and mountain ecosystem.
- Evaluation of management practices for different sustainable cropping system in major soils of Shikohpur village in Haryana
- Soil resource - their assessment for horticulture in Shimla district (part) of Himachal Pradesh for horticultural plantation
- Dynamics of land use plan and its impact on soil properties in Jalandhar district, Punjab state.

Human Resource Development

- Human resource development in post-graduate education and research in land resource management (LRM), PDKV, Akola and NBSS&LUP, Nagpur

Externally Funded Project (Completed)

Land Resource Inventory

- Land resource inventory and GIS database for farm planning in coastal region of West Bengal
- Detailed soil survey of Ladhowal Farm, District Ludhiana, Punjab for crop suitability assessment
- Soil resource inventory of National Institute of Biotic Stress Management (NIBSM) farm, Baronda, Raipur, Chattishgarh

Land Use Planning

- Modeling impact of climate change on soil quality and land use in arid, semi-arid and sub-humid regions of Karnataka for agricultural sustainability (C-MMACS-CSIR)

Issue Based Survey

- Fallow lands of Tamil Nadu- causes, effects and measures to arrest the march of fallows. sponsored by Tamil Nadu State Planning Commission
- Assessment and mapping of some important soil parameters including macro and micro nutrients for the state of Nagaland (1: 50000 scale) towards optimizing land use planning
- Assessment and mapping of some important soil parameters including macro and micronutrients for the state of Sikkim towards optimum utilization of land resources for integrated and sustainable development
- Assessment and mapping of some important soil parameters including macro & micro nutrients at block level of Dumka, Jamtara and Hazaribagh and Ramgarh districts for optimum land use plan

4 Publications

Research Papers

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National Seminar on 'Integrating Agri-Horticultural and Allied Research for Food and Nutritional Security in the

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Lalitha, M., Dharumarajan, S., Hegde, R. and Singh, S. K. Salt affected soils of Mailam block and its relationship with water management.

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Singh, S.K. Land Resource Inventory and Land Use Planning for arresting land degradation and adapting

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Obi Reddy, G.P. Development of Soil Geoportal for Smart Agriculture- Some Initiatives.

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Jagdish Prasad and Singh, A.K. Land Degradation in India – A Menace. p.118-127.

25th National Conference on Natural Resource Management in Arid and Semi-arid Ecosystem for Climate Resilient Agriculture and Rural Development from Feb 17-19,2016 at MKAUT,Bikaner organized by Soil Conservation Soc. of India.

Singh, R.S. Land Resource Inventory and Agricultural Land Use Planning in Western Region, on the theme "Land Use Survry and Planning".

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Lectures Delivered

- Dr. S.K. Singh, Director delivered the lecture "Land Resource Inventory for the Assessment and the Management of Soil Health" in Technical Session IV: Soil Degradation and Management". At National Seminar on "Soil health management and food security: Role of Soil Science, Research and Education" held during 8-10 Oct. 2015 at Paribesh Bhawan, Building No. 10A, Block LA, Sector-III, Salt Lake City, Kolkata jointly organized by Indian Society by Soil Science and International Plant Nutrition Institute.
- Dr. A.K. Sahoo, Principal Scientist delivered the lecture

on "Management of Soil Health of Burdwan and Birbhum District, West Bengal for Agricultural Land Use Planning" in the farmers training programme at KVK, Bud Bud organised by KVK, Bud Bud, Burdwan, West Bengal on 08.03.2016.

- Dr. G.P.Obi Reddy delivered a lecture 'Application of Remote Sensing, GIS and GPS in Resource Surveys' on 22nd March, 2016 at Raisoni Engineering College, Nagpur.
- Dr. G.P.Obi Reddy delivered a lecture on 'Geoinformatics Applications in Soil Resource Management, at NIRDPR, Hydarabad.
- Dr. G.P.Obi Reddy delivered a lecture on 'Geomorphic process and landform evolution' in Training Programme on Soil Survey, Mapping, Land Evaluation and Soil Analyses for Land Use Planning during 1st Feb to 31st March, 2016 held at ICAR-NBSS&LUP, Nagpur.
- Dr. G.P.Obi Reddy delivered a lecture on 'Geospatial Databases and Data Sources for KRISHI Geoportal' in ICAR-KRISHI Geoportal Workshop during 11-12th March, 2016 held at ICAR-NBSS&LUP, Nagpur.
- Dr. G.P.Obi Reddy delivered a lecture on 'Geospatial Databases for KRISHI Geoportal' in User's Training Workshop on ICAR-KRISHI Geoportal during 28-30th March, 2016 held at ICAR-NBSS&LUP, Nagpur.
- Dr. G.P.Obi Reddy delivered a lecture on 'Introduction to GIS and GPS' in Training Programme on Soil Survey, Mapping, Land Evaluation and Soil Analyses for Land Use Planning held during 1st Feb to 31st March, 2016 held at ICAR-NBSS&LUP, Nagpur.
- Dr. G.P.Obi Reddy delivered a lectures on Introduction to Geospatial Technologies, Principles and applications of GIS and GPS in land resource inventory, Remote sensing in Geomophological mapping, Remote sensing and GIS in digital terrain analysis and landform mapping, Development and analysis of geospatial database in GIS and Design and Development of Soil Information System and Geoportal in NRDMS (DST) Sponsored Training Programme on *"Geospatial Technologies in Mapping, Monitoring and Management of Natural Resources"* held during 5th to 25th August, 2015 at NBSS&LUP, Nagpur.
- Dr. Jagdish Prasad delivered a lecture on "Soil Survey concept and Methodology" for trainees of VANAMATI, Nagpur at ICAR-NBSS&LUP, Nagpur.
- Dr. Jagdish Prasad delivered a lecture on Concept and Methodology of Soil Survey for trainees of State Government, organized by ICAR-NBSS&LUP, Nagpur.
- Dr. Jagdish Prasad delivered following lectures during winter school on "Utilization of Degraded Land and Soil through Horticultural Crops for Improving Agricultural Productivity and Environmental Quality- Organized by National Research Centre on Seed Spices (03 to 23 Dec., 2015); "Organic Farming"; "Land Degradation In India- Corrective measure"; "Land Resource Inventory at different Levels: Needs and Methods".
- Dr. Jagdish Prasad delivered lecture on "Land Resource Inventory for block level planning –Issues and Strategies" delivered at NRDMS (DST) Sponsored 21 days training programme: Geospatial Technologies in Land Resource Mapping , Monitoring and Management (5-25 August 2015).
- Dr. Jagdish Prasad delivered lecture on "Land Resource Inventory at different Level's – Need and Methods and Case Studies" in training of Land Use Planning for Arresting Land Degradation , Climate Change and Ensuring food Security (19-26 Nov 2015) organized by NBSS and LUP, Nagpur.
- Dr. Jagdish Prasad delivered lecture on "Soils of Western Region; Potential and Problems" during Awareness Raising Workshop (Western Region) on the eve of International Year of Soils at BAIF Development Research foundation (FAO Sponsored).
- Dr. Jagdish Prasad delivered the lectures on "Soil Variability, Importance and Purpose of Soil Survey", "Soil Forming Factors", "Soil Classification", "Soil of Maharashtra", "Soil Mapping Units, Field review and Soil Correlation" during the Training Programme onSoil survey, mapping, land evaluation and lab analysis for land use planning held from 1st February to 31 March 2016.
- Dr. M.S.S. Nagaraju delivered lecture on "Application of Remote sensing and GIS in NRM" , "Remote sensing applications in watershed management" and conducted practicals on "Hands on GIS" in the training programme on "Advances on Soil Resource Inventory for Agricultural land use planning using Remote Sensing and GIS" held at ICAR-NBSS&LUP, Regional Centre, Jorhat from 15th September to 5th October, 2015
- Dr. M.S.S. Nagaraju delivered lecture on "High-resolution Remote Sensing Data: Characteristics and Applications" and "Remote sensing Applications in Large-scale Mapping" in the NRDMS sponsored training programme on "Geospatial Technologies in Mapping, Monitoring and Management of Natural Resources" conducted by ICAR-NBSS&LUP, Nagpur from 5th to 25th August, 2015.
- Dr. M.S.S. Nagaraju delivered lectures on "Remote sensing: Concept and Applications", "Visual interpretation", "Digital interpretations", "Remote sensing applications in watershed management" and conducted practicals on "Introduction to remote sensing data products", "Preparation of physiographic, land use and land cover map from RS data products" in the training programme on "Soil survey, mapping, land evaluation and soil analyses for land use planning" held at ICAR-NBSS&LUP, Nagpur from 1st February to 31st March, 2016.
- Dr. Nisha Sahu delivered lecture on Land Resource Mapping for Village Level Planning and conducted GIS practicals in NRDMS (DST) Sponsored Training Programme on *"Geospatial Technologies in Mapping, Monitoring and Management of Natural Resources"*

held during 5th to 25th August, 2015 at NBSS&LUP, Nagpur.

- Dr. P. Chandran delivered a lecture on "Application of SOTER in Land use planning on 24thAug 2015 during the NRDMS (DST) Sponsored Training Programme on *"Geospatial Technologies in Land Resource Mapping, Monitoring and Management"* to be held from 5th to 25th August, 2015 at NBSS&LUP, Nagpur**.**
- Dr. P. Chandran delivered a lecture on "Database Development in SOTER for Land use Planning" on 23rd Nov 2015 during the Model Training Course on "*Land Use Planning for arresting land degradation, climate change and ensuring food security"*sponsored by Dept of Agri., Govt of India held from 19th to 26th Nov 2015 at NBSS&LUP, Nagpur.
- Dr. P. Chandran delivered two lectures on "Weathering of Rocks and Minerls and Problem soils on 4th and 17th Feb 2016, respectively during the training on "Soil survey, mapping, land evaluation and lab analysis for land use planning" conducted at National Bureau of Soil Survey and Land Use Planning Nagpur during 1st Feb-31st March 2016.
- Dr. P. Tiwary delivered lecture on "Pedo-transfer functions in soil moisture estimation" to the participants of 21-day NRDMS (DST) sponsored training programme on "Geospatial Technologies in Land Resource Mapping, Monitoring and Management" conducted from 5 to 25 August, 2015 at ICAR-NBSS&LUP, Nagpur.
- Dr. P. Tiwary delivered lectures on "Hydrological aspects aspect of Watershed Management" and "Decision support system for land use planning" to the participants of 2-month training programme on "Soil Survey, Mapping, Land Evaluation and Soil Analyses for Land Use Planning*"* conducted from 1st February to 31st March 2016 at ICAR-NBSS&LUP, Nagpur.
- Dr. P. Tiwary delivered lectures on "Use of DEM in estimation of water harvest potential" and "Decision support system for land use planning" to the participants of Department of Extension, Ministry of Agriculture sponsored 8 days Model Training Course on "Land Use Planning for Arresting Land Degradation, Climate Change and Ensuring Food Security*"* conducted from 19th to 26th November 2015 at ICAR-NBSS&LUP, Nagpur.
- Dr. R.P. Sharma delivered a lecture to 33 cotton growers of Junagarh district, Gujarat on "Management of black cotton soils after introduction of Bt-cotton" on 14.07.2015.
- Dr. R.P. Sharma delivered a lecture to B.Sc. students and faculty of Santaji Mahavidyalaya (Rashtrasant Tukdoji Maharaj University), Nagpur on "Soils of India and its relevance to crop production" on 18.03.2016.
- Dr. R.P. Sharma invited as resource person to deliver two lectures by Regional Agriculture Extension Management Training Institute (RAMETI), Nagpur on "Soil sampling and testing for the development of soil health card" and "Role of balanced fertilizer application in increasing the fertilizer use efficiency for sustainable crop production" on 30.10.2015 and 15.02.2016.
- Dr. Rajeev Srivasatava delivered lectures in 2-Months Training Programme on 'Soil survey, mapping, land evaluation and lab analysis for land use planning' held from 1st February to 31 March 2016.
- Dr. Rajeev Srivasatava delivered lectures in Model Training Course on 'Land Use Planning for Arresting Land Degradation, Climate Change and Ensuring Food Security' held at NBSS&LUP, Nagpur from 19-26 November 2015.
- Dr. Rajeev Srivasatava delivered lectures in NRDMS (DST) sponsored 21 days training programme on "Geospatial Technologies in Land Resource Mapping, Monitoring and Management" held during 5-25th August, 2015 at ICAR-NBSS&LUP, Nagpur.
- Dr. S.K.Mahapatra, Principal Scientist Delivered Invited Lecture on Land Resource Inventory of Nagrota Bagwan Block, Kangra district of Himachal Pradesh for Agricultural Land Use Planning in Indian Science Congress-2016, held at Mysore University, Mysore, Karnataka, January 3-7, 2016.
- Dr. N.G. Patil, delivered a lecture on Water Management in Agriculture at Central Integrated Pest Management Centre at Nagpur.
- Dr. N.G. Patil, delivered a lecture on Land Use Planning and Water Management: at VANAMATI, Nagpur.
- Dr. N.G. Patil, delivered a lecture on Soil and Water Resources Management: at VANAMATI, Nagpur.

Videography

The following videos were documented by the centre

- International Year of Soils (Participated in video contest organized by FAO, Rome, Italy).
- Soil Health Card programme.
- Jai Kisan Jai Vigyan programme.

In Newsletters

- Jagdish Prasad. 2015. Sustainable soil management through interdisciplinary approach. *Indian Society of Soil Science Newsletter* **37 & 38**:1-3.
- Jagdish Prasad. 2015. Soil Matters. *Soil and Water Conservation Today* **10(4):**4.
- Jagdish Prasad. 2015. Healthy soils for a healthy life. *Indian Society of Soil Survey and Land Use Planning (ISSLUP) Newsletter* **4(2):**1.

5 Participation in Conference, Workshop, Symposium, Seminar and Meeting

Workshops

Date	Details of programmes	Participants
	2015	
April 4	Workshop on "Global experience and best practices of using recycled waste water from urban areas in theperi-urban watershed management at Karnataka Watershed Development Department by Paula Uyttendalele, Belgium, International consultant held at Bangalore.	Dr Rajendra Hegde
April 13-14	Workshop on "Making Engineering Scientists Contribution more Meaningful to Stake Holders and the Nation" held at New Delhi. The workshop was chaired by Dr. S. Ayyappan, Director General (ICAR) and Secretary (DARE).	Dr. P. Tiwary
June 24	Workshop on Sustainable Land Use Plan of Haryana at Haryana Kisan Ayog, Panchkula, Chandigarh.	Dr. Jaya N. Surya Sh. Ashok Kumar
August 4-5	Workshop of Nodal Officers of ICAR Research Data Repository for Knowledge Management initiative being organized at NASC Complex, New Delhi.	Dr. S.K. Singh
September 10-11	SAARC Workshop on "Use of Geospatial Technology for Assessment and Mapping of Land Degradation in SAARC Countries held at ICIMOD, Kathmandu, Nepal.	Dr. G.P. Obi Reddy
September 18	National workshop on Soil Health Management and Soil Health Card at GKVK Bangalore.	Dr Rajendra Hegde
October 05	Workshop in Agro-Climatic Zone No. 06 (Trans-Gangetic) (Plains Region) at ICAR-CSSRI, Karnal	Dr. S.K. Mahapatra
October 27	Workshop on "International Year of Soils-2015" organized at the centre by Bangalore chapter of ISSLUP, Nagpur	Dr. Rajendra Hegde
November 4	Regional workshop on "Revision of forest policy of India 2015" at Institute of Wood Science and Technology" organized by IIFM, Bhopal	Dr. Rajendra Hegde
November 7	Workshop on "Vaighyanic Sansthano me Rajbhasa Karyanvayan: Prayog avam Protsahan". Project Directorate, Director Agriculture Knowledge Management, New Delhi.	Dr. R.P. Yadav
November 18	NMSHE Vulnerability Analysis Workshop at ICAR-(IISWC), Dehra Dun on discussion on land use and other relevant data on district level, viz. bio-physical, socio-economic etc. in GIS format. Presented an elaborate lecture on "degradation and management issues and strategies in the country".	Dr. S.K. Singh
November 23	Brainstorming Session on *Managing Soil Health,* organized by NRM Division of ICAR as a part of celebrating of International Year of Soils -2015 at NASC Complex, New Delhi	Dr. R.P. Yadav
December 4	World Soil Day and International Year of Soils 2015 – Awareness Raising Workshop organized by FAO of the United Nations (UN) at New Delhi.	Dr. R.P. Yadav
	2016	
February 8	Interactive workshop on applications of drones in Agriculture, Real time automated irrigation system and water quality monitoring system organised by UAS, Bangalore	Dr. V. Ramamurthy Dr. S. Dharmarajan
March 7-10	Global Ravine Conference-2016 on Managing Ravines for Food and Livelihood Security at RVSKVV, Gwalior.	Dr. R.P. Yadav

Seminar / Symposia / Conference

Date	Details of programmes	Participants
	2015	
April 27	Seminar on "Recent advances in Soil Bio-diversity, Genomic Indicators and Integrated Measurement of Soil Biological Health" organized by Indian Society of Soil Science, Jorhat Chapter, AAU, Jorhat.	Dr. S. Bandyopadhyay
June 6	National Seminar on Value addition of cotton status and other Agro-Wastes for rural livelihood organized by Ginning training Centre, ICAR - Central Institute for Research on Cotton Technology (CIRCOT), Nagpur	Dr. Jagdish Prasad
August 5	2nd National Conference and exhibition on land survey and mapping organized by Survey of India in Bengaluru and delivered leadership lecture on "Land Resource Survey and Mapping of the country for Agricultural Land Use Planning using Geospatial Techniques".	Dr. S. K. Singh
August 7-8	19th Annual Convention and National Conference entitled "Application of Clay Science in Agriculture, Environment and Industry", organized by CMSI, ICAR-NBSS & LUP and ICAR-IARI, held at Regional Centre, Kolkata.	Dr. S. K. Singh Dr. S.K. Ray Dr. S.K. Mahapatra Dr. S. Bandyopadhyay Dr. S. Padua
August 13-14	4th Annual workshop of NICRA project at CMFRI, Kochi inaugurated by Dr S. Ayyappan, Director General, ICAR.	Dr. P. Tiwary
August 20	National Seminar on "Organic Ameliorants for Soil Resilience and Environmental Securities" held at RVSKVV (19th to 21st August, 2015), Gwalior and delivered a talk on "Organic farming – Myth or Reality", co-chaired the session "Organic amelioration for management of soil health."	Dr. Jagdish Prasad
September 17	3rd Awareness Raising Workshop during the International Year of Soils in Gangtok organized by the Food & Agricultural Organization (FAO).	Dr. S.K. Ray
September 21-22	Brainstorming workshop on *Landscape Approach for Addressing Climate Change* organized by Assam Project on Forest Biodiversity and Conservation Society, Ministry of Forest & Environment, Govt. of Assam , Guwahati	Dr. S.K. Ray
September 28-29	National Dialogue on "Efficient *Nutrient Management for Improving Soil Health"* at New Delhi organized by TAAS, New Delhi.	Dr. S.K. Singh Dr. Jagdish Prasad
September 29	Workshop on "Developing roadmap for North Eastern Agro-climatic Zone" organized by ICAR Res. Complex for NEH Region, Meghalaya.	Dr. S.K. Ray
October 8-10	National Seminar on "Soil health management and food security: Role of Soil Science, Research and Education" held at Kolkata organized by IISS and IPNI and delivered a lecture on *Land Resource Inventory for the Assessment and the Management of Soil Health* in Technical Session IV: Soil Degradation and Management.	Dr. S.K. Singh
November 2-3	State Level Seminar on "Soil and Water Quality: A Concern" organized by Akola Chapter of Indian Society of Soil Science and delivered keynote address	Dr. Jagdish Prasad Dr. Rajeev Srivastava, Dr. M.S.S Nagaraju
December 05-08	80th Annual Convention of the Indian Society of Soil Science, University of Agricultural Sciences, GKVK, Bengaluru.	Dr.(Ms)Nisha Sahu Dr. Jagdish Prasad Dr. Chandrakala, M. Dr. S.K. Mahapatra Dr. Rajendra Hegde Dr. S. Srinivas Dr. M. Lalitha, Dr. K.S Anil Kumar Mrs. Vasundhara Dr. Chandrakala, M.
December 11-14	Agro-vision (Workshop, National Expo & Conference) at Nagpur	Dr. Jagdish Prasad Dr. Pramod Tiwary

Date	Details of programmes	Participants
	2016	
January 3 -7	103rd Indian Science Congress Association (ISCA) Young Scientist's Award 2015-16 held at University of Mysore, Karnataka.	Dr. S.K. Singh Dr. S.K. Mahapatra Dr. Nisha Sahu
February 10	Participated in the Bangalore Bio–India conference organized by Govt. of Karnataka	Dr Rajendra Hegde
March 4-6	National Seminar on "Integrating Agri-Horticultural and Allied Research for Food and Nutritional Security in the Era of Global Climate Disruption" in Imphal, Manipur and delivered oral presentation on "Need of Soil Health Study towards Integrating Agri-Horticultural Research *vis-à-vis* Global Climate Change Disruption in North Eastern Regions of India".	Dr. S.K. Ray
March 7-11	Global Ravine Conference on "Managing Ravines for Food and Livelihood Security", Co-chaired the Session "Bio-diversity Conservation and Management" and attended the field tour to ravines to study the geomorphology, soils and their potentials	Dr. Jagdish Prasad
	Global Ravine Conference on "Managing Ravine for Food and Livelihood Security" at Gwalior. Organised by Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior and delivered poster presentation on "Characterization and classification of soils of Noa-Dihing River basin of Arunachal Pradesh for appropriate management".	Dr. S. Ramachandran
March 11 -12	Two days Geoportal Workshop of Experts at ICAR-NBSS&LUP, Nagpur under "ICAR Research Data Repository for Knowledge Management" held at Nagpur.	Dr. Jagdish Prasad Dr. P. Chandran Dr. P. Tiwary Dr. S.K. Ray Dr. R.P. Yadav

Important Meetings

Date	Details of Programmes	Participants
	2015	
April 06	Attended the ITMC meeting at ICAR Central Citrus Research Institute to consider the proposal for the technologies developed in the tissue culture laboratory *viz.* shoot tip grafting and other tissue culture techniques for the plant multiplication	Dr. Jagdish Prasad
May 15	Divisional Directors meetings of NRM and Interactive meeting of Vice-Chancellors of SAUs and ICAR Directors at New Delhi.	Dr. S.K. Singh
May 15	An interaction meet was organized at Bahaphalagaon tribal village under North West Jorhat development block of Jorhat district, Assam, underTSP.	Dr. S.K. Ray Dr. K.D. Sah Dr. U. Baruah Dr. S. Bandyopadhyay Dr. P. Ray
May 20	Meeting with Principal Secretary (Agriculture), GoK, on "Methodology and utility aspects of Sujala project"	Dr Rajendra Hegde
May 23	XXII Meeting of ICAR Regional Committee No. III comprising the States of Assam, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Tripura, Meghalaya and Manipur scheduled to be held at Agartala.	Dr. S.K. Singh
June 3	Meeting with, Hon'ble Vice Chancellor, Assam Agricultural University, Jorhat in connection with future collaboration between ICAR-NBSS&LUP Jorhat and A.A.U.	Dr. S.K. Ray Dr. U. Baruah Dr. K.M. Bujarbaruah
June 4	Meetings with Dr. Girin Hazarika, Director of Research, A.A.U and Dr. Hemen Bhattacharyya, Director of Education Extension Institute, A.A.U Jorhat regarding collaborative research between the two organizations.	Dr. S.K Ray Dr. U Baruah

Date	Details of Programmes	Participants
June 5	Meeting of the Parliament Committee on Rajbhasa at Ashoka Hotel, New Delhi.	Dr. R.P.Yadav Dr. Tarsem lal
June 8-9	Attended a meeting of Integrated Modelling Group under NICRA project, at IARI, New Delhi.	Dr. P. Tiwary
June 17	Council Meeting of The Clay Minerals Society of India at Division of Soil Science, ICAR-IARI, New Delhi.	Dr. S.K.Mahapatra Dr. Jaya N. Surya
June 20	Participated in the meeting on LRI Telangana, with APC and Principal Secretary(Agriculture), Telangana State	Dr Rajendra Hegde
June 23	Meeting on "Official language orientation program" for the Heads of Central Govt. offices in Bangalore at CPRI, Bangalore	Dr Rajendra Hegde
June 30	Meeting with Joint Committee on the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Second Amendment) Bill, 2015.	Dr. S.K. Singh Dr. R.P. Yadav
July 6	Meeting to sign MoU with Govt of Goa on characterization and mapping of land resources of Goa state	Dr. S.K. Singh Dr. R. Hegde Dr. R. Ramamurthy
July 9	Meeting on Digital library for Sujala organized at the centre, in which Executive Director: Sujala and WDD Consultants	Dr Rajendra Hegde
July 12	Release function of Soil Nutrient Mapping of Nagaland Report in presence of the Hon'ble Parliamentary Secretary, Agriculture, Govt. of Nagaland at Nagaland University, Medziphema Campus, Dimapur, Nagaland.	Dr. S.K. Ray Dr. S. Bandyopadhyay Dr. S.K. Singh
July 13	Meeting with NRM Division regarding celebration of IYS 2015	Dr. Jagdish Prasad
July 14	Field visit to comprehend various farming systems of Nagaland in Kikruma village, Phek district, Nagaland.	Dr. S.K. Singh Dr. S.K. Ray Dr. S. Bandyopadhyay
July 24	A meeting held at Bangalore Regional Centre with scientists from Indian Institute of Science on the data sharing for the Hydrological study watersheds of Sujala	Dr Rajendra Hegde
July 25	87th ICAR Foundation Day & Award Ceremony and National Conference of KVKs to be held at ICAR Research Complex for Eastern Region, ICAR Parisar, Patna. Hon'ble Prime Minister of India Shri Narendra Modiji inaugurated the function. He called upon scientists to dedicate their career to upliftment of farmers and downtrodden people.	Dr. S. K. Singh
August 13	Meeting on Sujala LRI inputs for Animal husbandry component. Various thematic maps generated under Sujala were shared for this purpose.	Dr Rajendra Hegde
August 28	Meeting with the Director, CAZRI, Jodhpur and the scientists to discuss the issues related to the execution of Land Resource Inventory (LRI) programme in the western part of Rajasthan in collaborative mode with CAZRI at Jodhpur.	Dr. S.K. Singh
August 28	Presentation on Soil health management land use planning and related issues to the Extension Officials called by DAC, New Delhi	Dr. S.K. Singh
September 7	National meet for promoting Space Technology based tools and applications in Governance and Development held at Vigyan Bhavan, New Delhi. Dr. S. Ayyappan, Secretary, DARE and Director-General, ICAR has given his presentation on "use of geospatial technologies in agriculture". Initiative taken by ICAR-NBSS&LUP including Land Resource Inventory on 1:10000 scale, soil nutrient mapping programme, soil health card, prime land delineation have been discussed elaborately. Hon'ble Prime Minister addressed to the scientists stressed on development and distribution of soil health cards to the farmers and use of contour drainage map for more efficient use of water under Pradhan Mantri Sinchai Yojana.	Dr. S.K. Singh

Date	Details of Programmes	Participants
September 9	Meeting with Department of Soil & Water Conservation, RWD, Govt. of Arunachal Pradesh, Itanagar. Dr. S.K. Ray, Principal Scientist and Head of the Regional Centre, attended and gave a presentation on LRI, land use planning and land use policy framework for Arunachal Pradesh.	Dr. S.K. Ray
September 10-11	Pre meeting for World Bank review of Sujala project	Dr. Rajendra Hegde Dr. Sekar Muddu Dr. Parama
	Interaction meeting on "Sujala: LRI & Hydrological studies for arriving at Net plan for watershed development"	Dr. Rajendra Hegde
September 22-30	Sujala watershed project review meeting by World Bank Review team	Dr. Rajendra Hegde Dr. S. Srinivas
November 5	Meeting at Hyderabad with Director of Agriculture, Govt of Andhra Pradesh and Agriculture Production Commissioner, Telangana state for initiating the LRI programs in the state	Dr S.K. Singh Dr Rajendra Hegde
November 5	ST Cell meeting on National Programme on Land Resource Inventory with Director of Agriculture, Andhra Pradesh at Hyderabad.	Dr. S.K. Singh
November 06	Farmers Day-cum-exhibition at Titabor Rice Research Station, organized by AAU, Jorhat, Assam	Dr. S.K. Ray and other staff
November 17	Meeting with DDG (NRM), ADG (SWM), Under Secretary (NRM) and had discussion on the project, "degradation status and dynamics in the country"	Dr. S.K. Singh
December 18	Meeting regarding finalization of Land Resource Inventory (LRI), soil health card and land use plan of Eravelli village, Telangana with the Scientists of Regional Centre, Bangalore and discussed the future roadmap of the project.	Dr. S.K. Singh
November 23-24	Meeting on 'International Year of Soils-2015: Managing Soil Health' at New Delhi as a core member of organizing team. This programme was inaugurated by Dr. R.S. Paroda, Ex-Director General, ICAR in presence of DG, ICAR and DDG (NRM). Acted as a panelist in the Technical Session III devoted to Applications of Space Technology in Agriculture.	Dr. S.K. Singh
November 26	1st Meeting of Nagar Rajbhasa Karyavayan Samitit (NARAKAS) chaired by By Gurbachan Singh, Chairman ASRB & NARAKAS, North Delhi region, NASC Complex, New Delhi.	Dr. R.P.Yadav
December 23	Meeting on Salt Affected Soils Database in India with CSSRI Karnal at ICAR-NBSS&LUP, Nagpur	Dr. Jagdish Prasad
	2016	
January 14	National stakeholder Meeting on the Biodiversity Finance Initiative organised by Ministry of Environment, Forest and Climate Change at Paryavaran Bhavan, New Delhi.	Dr. Jaya N. Surya Sh. R.K. Fagodiya
January 14	Meeting with Mr. M.P. Singh, S.D.O. (Civil), Titabor, Jorhat for planning irrigation project of Jorhat.	Dr. S.K. Ray
January 19	Kisan Mela-cum-Technology Demonstration programme held at Majuli organized by ICAR-Indian Veterinary Research Institute, Eastern Regional Station, Kolkata at Uttar Kamalabari Satra, Kamalabari, Majuli Sub Division, Jorhat (Assam).	Dr. S.K. Ray Dr. S. Bandyopadhyay Dr. S. Ramachandran Mr. P. Ray
January 21	Regional Research Advisory Committee (RRAC) meeting of Central Sericultural Research and Training Institute (CSR&TI), Berhampore at Regional Sericultural Research Station (RSRS), Jorhat.	Mr. Prasenjit Ray
January 22	Meeting with Director of Agriculture, Govt. of Tripura, Agartala on for LRI work of Sepahijala district, Tripura.	Dr. S.K. Ray
January 22	Review Meeting called by Deputy Director General (NRM) at New Delhi.	Dr. S. K. Singh

Date	Details of Programmes	Participants
January 23-29	Scientist of Regional Centre, Kolkata participated in the Subhas Mela (Exhibition) for displaying the activities of ICAR-NBSS&LUP at Taldi, PS. Canning, South 24-Parganas, West Bengal.	Dr. D.C. Nayak and Scientists
January 29-30	Review meeting of the progress made in LRI and LUP project held at ICAR-NBSS&LUP, Nagpur.	Dr. S.K. Ray Dr. Pramod Tiwary
February 2	Participated in the Scientific Advisory Committee meeting of ICAR-IIHR-KVK Hirehalli	Dr Rajendra Hegde
February 4	Sujala Project Empowered Committee (PEC) meeting called by Additional Chief Secretary and Development Commissioner, GoK and presented the progress of the project	Dr Rajendra Hegde
February 6	Farmers' Meet at Gondia, Maharashtra	Dr. S. K. Singh
February 9	Meeting with APC and Vice-Chancellor, Sri Konda Laxman Telangana State Horticultural University, Hyderabad regarding ongoing LRI project in the state of Telangana	Dr. S. K. Singh
February 9	Valedictory Function as Chief Guest for DOE sponsored Model training course on "Efficient soil management techniques for minimizing climate change impacts in rainfed areas" for Subject Matter Specialists and Extension functionaries of Line Departments of Agriculture and Horticulture of states of Andhra Pradesh, Telangana, West Bengal, Tamil Nadu Karnataka and Kerala organized by Transfer of Technology unit of ICAR-CRIDA, Hyderabad.	Dr. S. K. Singh
February 12	Meeting with Dr. R.M. Karmakar, Head, Department of Soil Science, AAU, Jorhat regarding collaboration in LRM courses and other activities.	Dr. S.K. Ray
February 22	Institute IJSC meeting at NBSS&LUP, Regional Centre, Delhi	Dr. S. K. Singh
February 28	Scientists of Regional Centre, Udaipur participation in one day Kisan Fair at KVK, Badgaon	Dr. R.S. Singh and Scientists
February 29	Meeting with officials of Department of Agriculture, Govt. of Goa and to discuss progress made in fallow land identification and LRI of Goa.	Dr. S. K. Singh
March 1	Steering Committee meeting on Geo-portal "Krishi" chaired by Dr. A.K. Sikka, Deputy Director General (NRM) at New Delhi.	Dr. S. K. Singh
March 3	Meeting on "Geo-portal, Digital Library and DSS with Additional Chief Secretary and Development Commissioner WDD	Dr Rajendra Hegde
March 4	Meeting with Director of Agriculture, Govt. of Manipur, held at Imphal regarding future LRI programmes to be undertaken in the state.	Dr. S.K. Ray
March 14	Geo-portal meeting held at Ghaziabad	Dr. S. K. Singh
March 15	Review meeting of Agri-CRP on Water at ICAR-Indian Institute of Water Management, Bhubaneswar chaired by Dr. A.K. Sikka, Deputy Director General (NRM), ICAR.	Dr. P. Tiwary
March 16-17	Interaction Meeting cum Sensitization Workshop of ITMU/ZTMU Units under NRM division held at New Delhi.	Dr. Jagdish Prasad
March 16 -18	Meeting for finalization of criteria for prime lands at CRIDA, Hyderabad.	Dr. S. K. Singh
March 17	Review meeting with staff of Meghalaya Basin Development Authority, Shillong, Meghalaya wherein Mr. R.K Jena presented the progress of work in Ri-Bhoi district.	Dr. S.K. Ray Mr. R.K Jena Mr. P. Deb Roy
March 17-19	Scientists of Regional Centre, Udaipur participated in Tillhan Kisan Mela, Udaipur, Rajasthan	Dr. R.S. Singh and Scientists

6 Meetings Organized

Review Meeting on work progress in LRI / LUP Projects.

A Review Meeting on work progress in LRI / LUP Projects was held during 29-30 January 2016 at Hqrs., Nagpur under the chairmanship Dr. A.K. Sikka, DDG (NRM), ICAR, New Delhi. The other committee members of the meeting were Dr. S.M. Virmani, Ex-Pr. Scientist, ICRISAT, Dr. J.C. Katyal, Ex-Vice Chancellor, CCSHAU, Hissar, Dr. J.S. Parihar, Former DDG, SAC, Ahmedabad, Dr. T. Ravisankar, Group Head, NRSC, Hyderabad, Dr. S.K. Chaudhari, ADG (S&WM), ICAR, New Delhi, and Dr. S.K. Singh, Director, ICAR-NBSS&LUP, Nagpur.

A view of the Review Meeting on work progress in LRI / LUP Projects

Research Advisory Committee (RAC)

The second meeting of the RAC (2013-2016) of ICAR-NBSS&LUP was held at its HQrs. during June 26-27, 2015 under the Chairmanship of Prof. S.K. Sanyal, Ex-Vice Chancellor, BCKV, Nadia, Mohanpur, West Bengal. Dr. D.K. Das, Member, Dr. N.S. Pasricha, Member, Dr. J. S. Parihar, Member, Dr. T. Ravisankar, Member, Dr. S.S. Magar, Member, Mr. Ramesh Jichkar, Farmers' Representative Member and Dr. S.K. Singh, Director, Heads of Regional Centres / Divisions. Dr. P. Chandran, Pr. Scientist and Member Secretary, RAC and Dr. S. Chatterji, Pr. Scientist and In-Charge, PME Cell participated in the meeting.

A view of the Research Advisory Committee (RAC) Meeting

Institute Research Committee (IRC)

Institute Research Committee (IRC) Meeting was held during September 4-6, 2015, at NBSS&LUP, Nagpur. Dr. S.K. Singh, Director and Chairman, IRC, Dr. S. Chatterji, Principal Scientist and Member Secretary, IRC and scientists of the Bureau participated in the meeting.

Group photo of IRC meeting

Institute Management Committee (IMC)

46th Institute Management Committee meeting of the Bureau was held on 17th February 2015 under the Chairmanship of the Director, NBSS&LUP, Nagpur. The other members were Dr. S.S. Magar, Ex-Vice Chancellor, MPKV, Rahuri, Prof. S.N. Hiwase, Director of Research, Dr. PDKV, Akola, Sh. Ramesh P. Jichkar, Member and Sh. Sanjay Bokaliya, Member Secretary to discuss scientific, technical and administrative matters of the Bureau.

A view of the Institute Management Committee (IMC) Meeting

Institute Joint Staff Council (IJSC)

Institute Joint Staff Council Meeting of the Bureau was held on February 2, 2016 at Regional Centre, NBSS&LUP, Delhi to discuss various matters related to the staff of the Bureau under the chairmanship of the Dr. S.K. Singh Director, NBSS&LUP, Nagpur. Sh. Sanjay Bokoliya, Chief Administrative Officer was also present in the meeting.

Other Important Meetings

Date	Description of meeting	Venue
	2015	
April 25	8th Dr. P.K. De Memorial Lecture in collaboration with Indian Society of Soil Science (ISSS), Kolkata Chapter	ICAR-NBSS & LUP, Regional Centre, Kolkata
May 15	An interaction meet was held at Bahaphalagaon tribal village under North West Jorhat development block of Jorhat district, Assam, to take-up Tribal Sub Plan programme for the year 2015-16. Dr. S.K. Ray, Principal Scientist and Head, Dr. K.D. Sah, Principal Scientist and former Head, Dr. U. Baruah, Principal Scientist and former Head, Dr. S. Bandyopadhyay and Dr. P. Ray, Scientists of ICAR-NBSS & LUP, Regional Centre, Jorhat participated in the meeting.	Bahaphalagaon tribal village, North West Jorhat development block, Jorhat district, Assam
June 24	A meeting was held with Shri R. Rajagopalan, IAS, Additional Secretary, DARE and Secretary, ICAR, New Delhi in the Regional Centre, Kolkata for discussion regarding the staff welfare in presence of Dr. D.C. Nayak, Principal Scientist and Head, ICAR-NBSS & LUP, Regional Centre, Kolkata and all staff of the Centre.	Regional Centre, Kolkata
August 18	The first meeting of the National Level Arsenic Monitoring Committee was held under the Chairmanship of Dr. D.C. Nayak, Head, ICAR-NBSS & LUP, Kolkata and other members *viz.*. Prof. S. Sarkar, Professor, Deptt. of Agrl. Meteorology & Physics, BCKV, Mohanpur (Member-Secretary); Prof. S.K. Sanyal, Ex-Vice Chancellor, BCKV, Mohanpur, Nadia, West Bengal; Dr. P. P. Biswas, Principal Scientist (Soils), NRM Division, ICAR, New Delhi; Dr. P.K. Patra, Associate Professor, Deptt. of Agril. Chemistry & Soil Science, BCKV, Mohanpur and Dr. A.K. Sahoo, Principal Scientist, ICAR-NBSS & LUP, Kolkata were present in the meeting.	ICAR-NBSS & LUP, Regional Centre, Kolkata
September 24	A Meeting was organized at ICAR-NBSS & LUP, Regional Centre, Jorhat (Assam). Mr. P Deb Roy gave a presentation on the topic "Arsenic contamination in soil, crop and ground water and its possible mitigation in the Brahmaputra and Barak Valley of Assam and other North Eastern states of India.	Regional Centre, Jorhat

Date	Description of meeting	Venue
November 10	A meeting was organized at ICAR-NBSS & LUP, Regional Centre, Jorhat, Assam. Dr. S. Ramachandran informed the house that he had participated as a trainee official in a 21 days DST-sponsored training programme on Geo-spatial Techniques from 30th September to 20th October, 2015 and gave a brief presentation on this aspect.	Regional Centre, Jorhat
November 17	A meeting was held at ICAR-NBSS & LUP, Regional Centre, Jorhat, Assam. Mr. R.K. Jena gave a brief presentation giving special importance to applications of remote sensing and GIS.	Regional Centre, Jorhat
	2016	
February 29	A meeting with officials of Department of Agriculture, Govt. of Goa and Scientists of the Bureau was held to discuss progress made in fallow land identification and LRI of Goa state project	Panaji, Goa

7 Major Events

Inauguration of Soil Museum

The newly renovated **Soil Museum** was inaugurated by Dr. A.K. Sikka, DDG (NRM), ICAR, New Delhi on 29th January 2016 in presence of Dr. S.M. Virmani, Ex-Pr. Scientist, ICRISAT, Dr. J.C. Katyal, Ex-Vice Chancellor, CCSHAU, Hissar, Dr. J.S. Parihar, Former DDG, SAC, Ahmedabad, Dr. T. Ravisankar, Group Head, NRSC, Hyderabad, Dr. S.K. Chaudhari, ADG (S&WM), ICAR, New Delhi, and Dr. S.K. Singh, Director, ICAR-NBSS&LUP, Nagpur.

The museum is expected to benefit students, farmers, scientists, etc. a great deal in helping them acquire / enhance knowledge on soils and related aspects.

A view of inauguration of Soil Museum

Foundation Day Celebration

The Bureau celebrated 39th Foundation Day on 25th August 2015 at Hqrs., Nagpur. Dr. J.S. Samra, Ex-DDG (NRM) and Former CEO, National Rainfed Authority was Chief Guest of the function and also delivered Foundation Day lecture. The other dignitaries who attended the function as Guest Honour were Dr. R.G. Dani, Vice-Chancellor, Dr. PDKV, Akola and Dr. R.K. Gupta, Team Leader, CIMMYT.

Release Function of Soil Nutrient Mapping of

A view of Foundation Day celebration

Nagaland Report

The Official Release Function Programme of Soil Nutrient Mapping of Nagaland Report was organized by Directorate of Agriculture, Govt. of Nagaland, held on 13th July, 2015, held at IECT, Nagaland

Nagaland Post

Staff Reporter DIMAPUR, JUL 13 (NPN): Published on 14 Jul. 2015 1:16 AM IST

Releasing 'Soil Nutrient Mapping of Nagaland' at Integrated Extension Training Centre (IETC), Medziphema on Monday, the parliamentary secretary for agriculture Dr. Benjongliba Aier said it was a big step forward in removing a critical gap in nutrient deficiencies in the state.

Releasing Soil Nutrient Map of Nagaland Report at Dimapur (Nagaland)

University Campus, Medziphema, Dimapur district (Nagaland). Dr. S.K. Singh, Director, ICAR-NBS & LUP, Dr. S.K. Ray, Principal Scientist and Head and Dr. S. Bandyopadhyay, Scientist of the Regional Centre participated in the aforesaid programme. One thousand copies of report along with one hundred leaflets comprising valuable information on soil nutrient status of Nagaland were disseminated to the officials of various state line departments of Nagaland. Dr. Bengjongliba Aier, the Parliamentary Secretary of Agriculture, released the report as the Chief Guest of the programme.

Mera Gaon and Mera Gourav Programme

Interacted with ADA and farmers of Baruipur block of 24-Parganas (S), Habra-II blocks of 24-Parganas (N) and Chakdah block of Nadia district, West Bengal, under Mera Gaon Mera Gourav Programme (September 2015).

Gathering of farmer's at the Pukurkona primary school for Farmer's Meet under "Mera Gaon Mera Gourav" Programme

Scientists addressing the farmers of Pukurkona and Patdanga village of Habra-2 block in the Farmer's Meet.

Special Swachhta Abhiyan (National Cleanliness Campaign)

The Bureau actively participated in **Special Swachhta Abhiyan (National Cleanliness Campaign) during** 25th September to 11th October, 2015 by taking Swachhta Abhiyan oath by all the staff members. During the week, cleanliness of laboratories, office premises including roads and garden. The special swachhta Abhiyan observed with all sincerity and whole heartedly.

Staff members at HQrs., Nagpur taking Swachhta Abhiyan oath

Staff members cleaning the office campus during Swachhta Abhiyan

Vigilance Awareness Week

Vigilance Awareness Week was observed at HQrs., Nagpur and other Regional Centres during 26 – 31st October 2015, by taking pledge on 26th October, 2015.

Dr. S.K. Gangopadhyay, Dr. K.D. Sah and Dr. K. Das, Principal Scientists sitting in dias and Dr. A.K. Sahoo, Principal Scientist delivering lecture on the occasion of Vigilance Awarness Week on 26th October, 2015

Various campaigns organized through conducting lectures, displaying banners, awareness posters, etc.

Celebration of World Soil Day and Distribution of Soil Health Cards

World Soil Day was celebrated on 5th December, 2015 by ICAR-NBSS&LUP, HQrs., Nagpur and its Regional Centres located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur by distributing 1075 Soil Health Cards to the farmers in different parts of the country.

Dr. S. K. Singh, Director, ICAR-NBSS&LUP, Nagpur distributing Soil Health Card at Manikpur village, Warud Teshil, Amravati district, Maharashtra

Dr. Tapan Dutta, Former Advisor to the Hon'ble Chief Minister, Govt. of Assam addressing the farmers on World Soil Day at Bahphalagaon village, Jorhat, Assam

Dr. Rajendra Hegde, Head, Regional Centre, NBSS&LUP, Bangalore distributing Soil Health Cards to farmers at Thondagerekaval village, Tumkur District, Karnataka

Soil health card distribution at Bali Islands, Gosaba Block, South 24-Parganas, West Bengal

Soil Health Card distribution at Titauli and Buraka villages of Haryana

Soil Health Card distribution programme at Bali Islands, Gosaba Block, , West Bengal

মাটিৰ স্বাস্থ্য কাৰ্ড

ভাৰতীয় কৃষি অনুসন্ধান পৰিষদ
ৰাষ্ট্ৰীয় মাটি জৰীপ আৰু ভূমি ব্যৱহাৰিক পৰিকল্পনা সংস্থা, আঞ্চলিক কেন্দ্ৰ (যোৰহাট)(অসম)

মাটিৰ স্বাস্থ্য কাৰ্ড সংখ্যা A5/3/NW3/BPH/1420/128

কৃষকৰ নাম নিমাই সেন

বৈশাখৰ মধ্য 2015 সন 2020 লৈ 2018

কৃষকৰ বিবৰণ	
নাম	নিমাই সেন
ঠিকনা	নামনী বাহিফলা
গাঁও	বাহিফলা
উন্নয়ন-খণ্ড	উত্তৰ-পশ্চিম যোৰহাট
জিলা(সিল)	যোৰহাট - 785108
পৰিচয়-পত্ৰ	N.A.
মোবাইল নং	N.A.
মাটিৰ নমুনাৰ বিবৰণ	
মাটিৰ নমুনা নং	1420
খচৰা/ ভাগ নং	14(4)
সংগ্ৰহ-স্থল	বানগানি অঞ্চল, বৰি খেতি
ভৌগো. স্থিতি	26°47'59"N, 94°03'28"E
মাটিৰ টেক্চাৰ	বালিচহীয়া

ভা. কৃ. অনু. প.-ৰাষ্ট্ৰীয় মাটি জৰীপ আৰু ভূমি ব্যৱহাৰিক পৰিকল্পনা সংস্থা, আঞ্চলিক কেন্দ্ৰ, যোৰহাট (অসম)

ক্ৰমিক নং	মাটিৰ গুণাগুণ	ফল	সীমা
1	pH (অম্লতা/ খাৰ)	5.91	মধ্যম অম্লতা
2	E.C. (তৰিত-পৰিবাহিতা) (dS/ m)	0.45	নিম্ন (0-4)
3	O.C. জৈৱ-প্ৰংগাৰ) (%)	0.29	অভাব (0.40-0.75)
4	লভ্য নাইট্ৰজেন (N) (কেজি/ বিঘা)	39	মধ্যম (37-75)
5	লভ্য ফস্ফৰাস (P_2O_5) কেজি/ বিঘা)	4.2	অভাব (4.5-9.0)
6	লভ্য পটাছিয়াম (K_2O) (কেজি/ বিঘা)	13	অভাব (18-45)
7	লভ্য গন্ধক (S) (কেজি/ বিঘা)	17	পৰ্য্যাপ্ত (3.0-4.7)
8	লভ্য জস্তা (Zn) (কেজি/ বিঘা)	0.06	অভাব (0.18-0.36)
9	লভ্য বৰন (B) (কেজি/ বিঘা)	0.14	পৰ্য্যাপ্ত (0.07-0.13)
10	লভ্য লৌহ (কেজি/ বিঘা	13	পৰ্য্যাপ্ত (1.3-2.7)
11	লভ্য মেংগানিজ (Mn) (কেজি/ বিঘা)	3.4	পৰ্য্যাপ্ত (1.0-2.0)
12	উপলব্ধ তাম (Cu) (কেজি/ বিঘা)	0.39	পৰ্য্যাপ্ত (0.06-0.12)

মধ্যম মাটু অনুযায়ী প্ৰয়োগবিধি

ক্ৰমিক নং	মাটিৰ গুণাগুণ	মাটিৰ প্ৰয়োগ
1	গন্ধক (S)	অপ্ৰয়োজনীয় (পৰ্য্যাপ্ত পৰিমাণ থকাৰ বাবে)
2	জস্তা (Zn)	জিংক সালফেট @ 3.3 কেজি/ বিঘা (মাকৈ, মাটু, ধান, পৰিষ্ঠ)
3	বৰন (B)	অপ্ৰয়োজনীয় (পৰ্য্যাপ্ত পৰিমাণ থকাৰ বাবে)
4	লৌহ (Fe)	
5	মেংগানিজ (Mn)	
6	তাম (Cu)	

সাধাৰণ প্ৰয়োগবিধি

1	গোবৰ সাৰ	FYM @ 5 টন/ হে. (মাটি প্ৰস্তুতিকৰণৰ সময়ত)
2	জৈৱ-সাৰ	এজোস্পাইৰিলাম + PSB @ 5 কেজি/ হে. (পুতি ৰোপণৰ সময়ত)
3	চুণ	250 কেজি/ হে.

2015 International Year of Soils
healthy soils for a healthy life

পান-ব্যৱসায়িক প্ৰয়োগবিধি (লভ্যবৰ্ণনিয় প্ৰাথমিক খাদ্য)

ক্ৰমিক নং	শস্য (গাছ)	ফলনৰ ধাৰ (টন/ হে.)	প্ৰয়োগবিধি (NPK) (বৰ্ষা নিৰ্ভৰ খেতি)	প্ৰয়োগবিধি (NPK) (সেচ নিৰ্ভৰ খেতি)
1	শালি ধান (বশিষ্ঠ, মাধুৰি)	5.0-6.0	N: P_2O_5: K_2O= 75: 20: 40 কেজি/ হে. ইউৰিয়া-21, ছুপাৰ-17, পটাছ-9 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা	–
2	বৰী ধান (বৰো-1, বৰো-2)	5.5-6.0	–	N: P_2O_5: K_2O= 125: 60: 60 কেজি/ হে. ইউৰিয়া-36, ছুপাৰ-50, পটাছ-13 কেজি/ বিঘা, গোবৰ সাৰ = 10 কেজি/ বীজতলী (10m×1.25m)
3	আহু ধান (আইৰি, লাহিৰি)	3.5-4.0	N: P_2O_5: K_2O= 50: 20: 20 কেজি/ হে. ইউৰিয়া-15, ছুপাৰ-17, পটাছ-4 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা	N: P_2O_5: K_2O= 50: 20: 20 কেজি/ হে. ইউৰিয়া-15, ছুপাৰ-17, পটাছ-4 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা
4	মইৰ-মাহ (F1 হাইব্ৰিড)	1.2-1.5	–	N: P_2O_5: K_2O= 20: 46: 10 কেজি/ হে. ইউৰিয়া-6, ছুপাৰ-40, পটাছ-2 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 850 কেজি/ বিঘা
5	মাটি-মাহ (T-9, PU-31)	0.8-1.0	N: P_2O_5: K_2O= 20: 35: 10 কেজি/ হে. ইউৰিয়া-5, ছুপাৰ-30, পটাছ-2 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 165 কেজি/ বিঘা	–
6	পনিয়ৰ (M27, T518)	1.2-1.5	N: P_2O_5: K_2O= 50: 35: 15 কেজি/ হে. ইউৰিয়া-15, ছুপাৰ-30, পটাছ-3 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 400 কেজি/ বিঘা	N: P_2O_5: K_2O= 75: 40: 40 কেজি/ হে. ইউৰিয়া-21, ছুপাৰ-33, পটাছ-9 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 400 কেজি/ বিঘা
7	আলু (কুফৰি-সেন্দুৰি)	15.0-20.0	N: P_2O_5: K_2O= 75: 50: 50 কেজি/ হে. ইউৰিয়া-21, ছুপাৰ-45, পটাছ-12 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা	N: P_2O_5: K_2O= 75: 100: 100 ইউৰিয়া-21, ছুপাৰ-90, পটাছ-24 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা
8	বন্ধা-কবি (F1 হাইব্ৰিড)	25.0-30.0	–	N: P_2O_5: K_2O= 120: 60: 60 (kg/ ha) ইউৰিয়া-35, ছুপাৰ-50, পটাছ-13 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 1625 কেজি/ বিঘা
9	মাকৈ (বিয়াৰা, গুৰিয়ন)	4.5-5.0	N: P_2O_5: K_2O= 60: 30: 30 কেজি/ হে. ইউৰিয়া-18, ছুপাৰ-27, পটাছ-7 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 850 কেজি/ বিঘা	N: P_2O_5: K_2O= 60: 40: 40 কেজি/ হে. ইউৰিয়া-18, ছুপাৰ-33, পটাছ-9 কেজি/ বিঘা, গোবৰ সাৰ (FYM) = 850 কেজি/ বিঘা

CELEBRATION OF JAI KISAN JAI VIGYAN PROGRAMME

The Bureau has its HQrs. located in Nagpur and its Regional Centres located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur celebrated the "**Jai Kisan Jai Vigyan Week 2015**" during 23-29 December 2015.

Farmers attending the interaction meet at HQrs., Nagpur

Scientists of Regional centre, Delhi interacting with farmers of tehsil Titauli, Rohtak district and Buraka, Panchgaon of Tauru Tehsil, Mewat district, Haryana on the occasion of World Soil Day.

Field visit on Jai Kissan Jai Vigyan programme in Bahphalagaon, Jorhat

Field visit to demonstration plot of mustard cultivation in Bahphalagaon, Jorhat

An interaction meeting of Scientists of Regional Centre, Kolkata and farmers of Sonagachhi and Maheshpur villages

Farmer's Day was organized by Regional Centre, Bangalore to celebrate Jai Kisan Jai Vignan

Farmers' Day

Scientists of Regional Centre, Jorhat participated in Farmers' Day programme held at RARS, Titabar, Assam Agricultural University, Jorhat on 6th November, 2015.

Kisan Mela' held in Majuli Sub Div. of Jorhat (Assam) organized by ICAR-IVRI, Regional Centre, Kolkata on 17-19th January, 2016.

Participating in Farmers' Day at RARS, Titabar, Jorhat

Participating in Kisan Mela at Majuli Sub Division, Jorhat (Assam)

National Science Day

National Science Day was organized on 27th February, 2016, at ICAR –NBSS&LUP, Regional Centre, Jorhat, Assam. Dr. R. S. C. Jayaraj, Director, Rain Forest Research Institute (RFRI), Jorhat and Dr.Utpal Baruah, Former Head and Principal Scientist, ICAR-NBSS & LUP, Jorhat Assam and students of Air Force School, Jorhat were invited to discuss the scientific programmes at the Regional Centre.

Celebrating National Science Day at Regional Centre, Jorhat

Demonstration of soil profile on the occasion of National Science Day, Jorhat

Participation in Krishi Unnati Mela

Regional Centre Delhi participated in "KRISHI UNNATI MELA" inaugurated by Hon'ble Prime Minister of India, Sri Narendra Modi and organized by Ministry of Agriculture & Farmers Welfare, Government of India held at ICAR – IARI, New Delhi during March 19-21, 2016.

Regional Centre Delhi participated in Pusa Krishi Unnati Mela, during March 19-21, 2016 inaugurated by Hon'ble Prime Minister of India.

Irrigation Facility Installation Programme

Pump sets (4 no. of LLP, 4 HP & Shallow Tube Wells) for irrigation were provided to the farmers of Natun Chaporigaon, Golaghat district of Assam on 4.2.2016. This will benefit 27 farm families in the village.

Launching irrigation facility at Natun Chaporigaon, Golaghat (Assam) under TSP

Rashtriya Ekta Diwas

The Bureau observed Birth Anniversary of **Sardar Vallabhbhai Patel** as "**Rashtriya Ekta Diwas (National Unity Day)"** on **31st October, 2015**, by taking National Unity pledge.

8 Linkages and Collaborations

Name of the Institution	Purpose
Department of Agriculture, Govt. of West Bengal.	Soil survey, fertility mapping and soil correlation activities.
Department of Agriculture and Cane Development, Govt. of Jharkhand.	Block level fertility mapping in Jharkhand.
Directorate of Agriculture, Krishi Bhawan, Govt. of Goa	Land resource inventory programme
Department of Agriculture, Govt. of Sikkim	Soil survey, fertility mapping and soil correlation activities.
West Bengal State Watershed Development Agency (WBSWDA)	Integrated Watershed Management Programme (IWMP) in West Bengal
Department of Agriculture, Govt. of Telangana	Execution of Land Resource Inventory of 3 blocks of Telengana state
Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola	Post Graduate teaching and research
Department of Soil Science and Agricultural Chemistry, IGKV, Raipur	Post Graduate teaching and research
Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu	Post Graduate teaching and research
Watershed Development Department (WDD), Govt. of Karnataka	Land resource inventory programme of selected microwatersheds of backward districts (Sujala-III Project)
Dept. of Agriculture, Govt. of Meghalaya	For extending land resource inventory programme in the different parts of the state
Department of Agriculture, Govt. of Tripura	For initiating land resource inventory programme on1:10000 scale
Department of Agriculture (DAC), New Delhi	Extending education and training on soil survey and land use planning
Maharashtra Govt, Irrigation Department, Pune	Education and training of officials of irrigation department
Asia-Pacific Association of Agricultural Research Institutions (APAARI), Bangkok, Thailand	Extending dialogue on the investment on agricultural Research and Development
Trust for Advancement of Agricultural Sciences (TAAS),	Exchanging ideas for advancing in studies on soils & agricultural land use planning
National Informatics Centre (NIC), Govt. of India.	Development of Web based farmers advisory.
ICAR-Indian Institute of Soil Science, Bhopal	Reconciliation of nutrient maps
CIMMYT, (International Maize and Wheat Improvement Centre)	Developing demonstration for Borlaugh Institute of South Asia, Samastipur, Bihar.
International Plant Nutritional Institute (IPNI), Asia & Africa Programme, Gurgaon, Haryana.	For exchanging ideas for Integrated Nutrient Management Programme in Eastern Region of India.
Odisha Watershed Development Mission (OWDM), Bhubaneswar.	Developing linkage for Watershed Management in Odisha State.

9 Training and Capacity Building

9.1 Training

A. Participation in Training

Bureau Officials

Date	Training details and venue	Participants
	2015	
	Scientists	
April 13– May 12	One month orientation training programme at the HQrs., ICAR-NBSS&LUP, Nagpur	Mr. Abhishek Jangir Mr. Gopal Tiwari Mr. Partha Deb Roy
May 13 – August 12	Three months professional attachment training programme at the Regional Remote Sensing Centre (RRSC), ISRO, Nagpur during	Mr. Abhishek Jangir Mr. Gopal Tiwari
May 13 - September 4	4 months Attachment and In-house training ICAR-NBSS & LUP, HQ.	Mr. Partha Deb Roy
August 5-25	21 days NRDMS (DST) Sponsored Training Programme on " Geospatial Technologies in Mapping, Monitoring and Management of Natural Resources" at ICAR-NBSS&LUP, Nagpur	Sh. Vikas Miss Ritu Nagdev Mr. R.K. Jena Mr. Prasenjit Ray Mr. R. L. Meena Dr. P. C. Moharana Mr. Gopal Tiwari Mr. Abhishek Jangir
September 24	One day training programme on Intellectual property Management at Rajiv Gandhi National Institute of Intellectual property management (RGNIIPM) , Nagpur organized by Government of India , Ministry of Commerce and Industry , Department of Industrial / Policy and Promotion office of the Controller General of Patents Designs and Trade marks	Dr. Jagdish Prasad Dr. T.K. Sen Dr. M.S.S. Nagaraju Dr. N.G. Patil Dr. K. Karthikeyan Mr. D. Vasu Dr. Nisha Sahu Dr. S. Chattaraj
September 25-October 26	30 days DST NRDMS Sponsored Training Programme on "Geospatial Technologies" at Tamil Nadu Agricultural University, Coimbatore	Dr. S. Ramachandran
November 19-26	Eight day's modal training course (MTC) on "Land Use Planning for Arresting Land Degradation, Climate Change and Ensuring Food Security" sponsored by Department of Agriculture, Govt. of India and organized by ICAR-NBSS&LUP, Nagpur	Dr. R.P. Sharma Mr. D. Vasu Mr. Gopal Tiwari Mr. Abhishek Jangir Dr. Nisha Sahu
	2016	
March 11-12	Two days workshop on ICAR Krishi Geoportal-Experts Knowledge based resources information systems hub for innovations in agriculture (ICAR research data repository for knowledge management).	Dr. Nisha Sahu
	Technical Staff	
September 24	One day training programme on Intellectual property Management at Rajiv Gandhi National Institute of Intellectual property management (RGNIIPM) , Nagpur organized by Government of India , Ministry of Commerce and Industry , Department of Industrial / Policy and Promotion office of the Controller General of Patents Designs and Trade marks	Dr. N.C. Khandare Dr. A. P. Nagar Dr. R. A. Nasre Dr. A.M. Nimkar Sh. Dipak S. Mohekar Sh. Pravin S. Butte

B. Training Organized for Others

Date	Topic	Sponsored by	Beneficiary/ Number of trainees/
	2015		
April 1-28	Organized training on soil-site crop suitability	Sujala-III Project ICAR-NBSS&LUP Bangalore	4- SAU partners
July 6 – 15	10 days Training on "Laboratory methods of soil analysis for land resource inventory" at ICAR-NBSS & LUP, RC, Jorhat, Assam	Tribal Sub Plan (TSP)	9 Officials from MBDA, Govt. of Meghalaya and State Soil Conservation Dept., Govt. of Nagaland
July 20-25	LRI field work Training program	Sujala-III Project ICAR-NBSS&LUP Bangalore	UAHS Shivamogga
July 23-28	LRI field work Training program	Sujala-III Project ICAR-NBSS&LUP Bangalore	UAS Raichur
August 3-24	Students of UAS, Raichur undergone GIS training during their internship	NBSS & LUP Bangalore, GIS	4-SAU Partners
August 5 - 25	21 days training programme on "Geospatial Technologies in Land Resource Mapping, Monitoring and Management" at ICAR-NBSS&LUP, Nagpur	NRDMS (DST)	25 offcials from SAUs, ICAR institutes and state department of Agril.
 Group photo of NRDMS (DST) Sponsored Training Programme on *"Geospatial Technologies in Mapping, Monitoring and Management of Natural Resources"* from 5th to 25th August, 2015 at NBSS&LUP, Nagpur			
September 10-16	Training program on GIS applications	Sujala-III Project ICAR-NBSS&LUP Bangalore	UAHS-Shivamogga
September 11-16	Training given to Shimoga university Sujala-III GIS project staff about GIS	Sujala-III project ICAR-NBSS&LUP Bangalore	2-SAU Partners
September 15-October 5	21 days training on "Advances in soil resource inventory for agricultural land use planning through agro-technology transfer" at ICAR-NBSS & LUP, RC: Jorhat (Assam)	TSP	28 (Officials from various state line departments of NE Regions
October 7	Launching workshop of the project "Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer"	ICAR-NBSS&LUP Bangalore	All scientists and the project collaborators i.e., IIOR, NBSS&LUP Regional Centre and Zuari Agro-chemicals

Date	Topic	Sponsored by	Beneficiary/ Number of trainees/
November 13 - 26	Organized two training programs on "Soil analysis for soil health card generation" in collaboration with Staff Training Unit, UAS-Bangalore.	Karnataka state Department of Agriculture	42 officials from Karnataka State Deptt. of Agriculture
November 19 - 26	Eight days Model Training Course on "Land Use Planning for Arresting Land Degradation, Climate Change and Ensuring Food Security" at ICAR-National Bureau of Soil Survey & Land Use Planning, Nagpur.	Department of Agriculture & Cooperation (Govt. of India)	17 officials from SAUs, ICAR institutes and from KVKs
			
December 5 - 18	Training Programme conducted on "Land Resource Inventory (LRI) Database Management of Sujala-III project partners GIS-staff	Sujala-III Project ICAR-NBSS&LUP Bangalore	9 from SAU
December 14 - 18	Training program on application of GIS standards	Sujala-III Project ICAR-NBSS&LUP Bangalore	All the project partners of Sujala
	2016		
January 1	International Training program: Organized a one day training program under CIRDAP- Sri Lanka and NIRD&PR, Hyderabad " International training session on "LRI and LUP-GIS applications"	ICAR-NBSS&LUP Bangalore	16 international trainees from 10 countries
January 11-16	Training program on "LRI field survey and profile study"	Sujala-III Project ICAR-NBSS&LUP Bangalore	20 trainees of UAHS, Shivamogga
February 1-March 31	2-Months Training Programme on 'Soil survey, mapping, land evaluation and lab analysis for land use planning' at NBSS&LUP, Nagpur		12 Officers from Govt. of Maharashtra and 2 officers of ICAR
			

Date	Topic	Sponsored by	Beneficiary/ Number of trainees/
February 4-7	Organized a training programme of "Image interpretation and field review at Vijayapura district, Karnataka.	Sujala-III Project ICAR-NBSS&LUP Bangalore	45 project staff and scientists of Vijayapura, UAS-Dharwad
February 4-7	Organized LRI field survey	Sujala-III Project ICAR-NBSS&LUP Bangalore	UAHS Shivamogga
February 29	Review workshop on "Characterization and Mapping of Land Resources of Goa in Reference to Cultivated and Fallow Land Use Systems - A Step Towards Enhancing Agricultural Productivity"	Dept. of Agriculture, Tonca, Panaji	ADAs and ZDAs from all taluk head quarters of GoK.
February 29	"Technology Backstopping for Subject Matter Specialist (SMS), AAU, Assam" ICAR-NBSS & LUP, RC: Jorhat (Assam)	Institute funded	20 (Subject Matter Specialist (SMS), AAU, Assam)
March 14-26	Soil Survey and Land Use Planning" of Maharashtra State Irrigation Department and scientists from ICAR-NBSS&LUP, UAS, Bangalore (Sujala III)	Maharashtra State Irrigation Department	15

For farmers (Bali Island, West Bengal)

Date	Topic	Sponsored by	Beneficiary/ Number of trainees/
09.03.2016	Farmers Training programme on Vermicomposting in the Bali Island	TSP	35 Tribal Farmers

Scientists of ICAR-NBSS & LUP, Kolkata and Sasya Shyamala KVK, Ramkrishna Mission University, Narendrapur addressing to the Tribal Farmers of Bali Island

Tribal Farmers of Bali Island observing the technique of vermicompost processing

13th & 15th March, 2016	Two days Farmers Training Programme on Integrated Farming Practices of Bali Island	TSP	40 Tribal Farmers

Scientists of ICAR-NBSS & LUP, Kolkata and Sasya Shyamala KVK, Ramkrishna Mission University, Narendrapur addressing to the Tribal Farmers of Bali Island on Integrated Farming Practices.

C. HRD fund allocation and utilization.

S. No.	Total HRD allocation as per RE 2014-15	Actual Expenditure 2014-15 for HRD	% Utilization	RE 2015-16 for HRD			Actual Expenditure 2015-16 for HRD	% Utilization	Total HRD allocation as per RE 2013-14	Actual Expenditure 2013-14 for HRD
				Plan	Non plan	Total				
	(Lakh Rs.)	(Lakh Rs.)	2014-15	(Lakh Rs.)			(Lakh Rs.)	2015-16	(Lakh Rs.)	(Lakh Rs.)
1	14.65	14.63	99.86	1.85	0	1.85	1.85	100	20	19.99

9.2 Post Graduate Education in Land Resource Management (LRM)

Project Title: Human Resource Development in Post-Graduate Education and Research in Land Resource Management (LRM), PDKV, Akola and NBSS&LUP, Nagpur.

A post graduate teaching and research programme is being conducted by the National Bureau of Soil Survey and Land Use Planning, Nagpur in collaboration with Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV), Akola since 1987. Subsequently, this activity was introduced at Regional Centre, Kolkata in collaboration with BCKV, Mohanpur in 1999, at Regional Centre, Bangalore with UAS, Bangalore in 2002 and at Regional Centre, Udaipur with RAU, Udaipur in 2004. Besides, the Scientists of Regional Centre, Jorhat are participating as visiting faculty at Department of Soil Science, AAU, Jorhat.

A Memorandum of Understanding (MOU) has also been signed between NBSS&LUP, Nagpur and Department of Soil Science and Agricultural Chemistry, Indira Gandhi Agricultural University, Raipur (C.G.) for undertaking collaborating teaching and research programmes. Under this MOU two students are pursuing their Ph.D. programmes at NBSS&LUP, Nagpur.

At the HQrs., Nagpur, this programme is coordinated by the Division of Land Use Planning. The programme has to major components i.e. Teaching and Research.

Achievements	Nagpur		Bangalore		Kolkata		Udaipur		Total	
	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.
Degree awarded up to 2015-2016	132	20	--	--	--	--	--	--	132	20
On Roll	04	06	2	--	--	--	--	--	06	06

9.2a HQrs., Nagpur

9.2a (i) Post Graduate Teaching

Courses offered for M.Sc. Programme		
Course No.	Title	Credit
Soils-516	Introduction to Land Resource Management	(2+1)
Soils-517	Land Evaluation	(2+1)
Soils-518	Land Resource Constraints and their Management	(1+1)
Soils-591	Seminar	(0+1)
Courses offered for Ph.D. Programme		
Course No.	Title	Credit
Soils-608	Advanced Soil Genesis	(2+0)
Soils-609	Advanced Soil Mineralogy	(2+1)
Soils-610	Land Evaluation for Land Use Planning	(2+1)
Soils-611	Remote Sensing and Geographical Information System for Land Resource Management	(2+1)
Soils-612	Visual and Digital Interpretation Techniques in Soil Mapping	(2+1)
Soils-691	Seminar-I and Seminar-II	(0+1)
SSAC 611	Land Use Planning for Watershed Management	
SSAC 604	Advances in Soil Mineralogy	(1+1)

9.2a (ii) Research

M.Sc. Programme

The following M.Sc. (LRM) students have admitted in 2013 at Dr. PDKV, Akola and later joined NBSS&LUP, Nagpur in September 2014 for their specialized course in LRM and have completed their courses and have submitted their thesis.

Sr. No.	Name of student	Thesis Title
1.	Mr. Rathi Sawan G.	Detailed soil mapping and land evaluation of Khandala village in Nagpur district using high resolution satellite data and GIS
2.	Mr. Deshmukh Prafulkumar D.	Efficacy of Alexiades and Jackson method to determine vermiculitic potassium in some Vertisols of Maharashtra
3.	Ms. Kherade Prajakta P.	Assessment of soil organic carbon stocks and sequestration potential in different land use systems in Nagpur district of Maharashtra
4.	Ms. Deshmukh Vrushali S.	Assessment of soil quality of sugarcane growing soils of Umred tehsil, district Nagpur

Ph.D. Programme

The following have submitted their theses.

Sr. No.	Name of student	Thesis Title
1.	Mr. Gajre, A.S.	Evaluation of land quality indicators for major cotton growing soils of Jalgaon district
2.	Mr. Pawar, Yogesh S.	Land quality assessment in rainfed cotton-growing environs of a micro-watershed in Yavatmal district, Maharashtra
3.	Mr. Ingale Sagar N.	Evaluation of land resources and soil quality in Bareli watershed of Seoni district of Madhya Pradesh using Remote Sensing and GIS

A memorandum of understanding (MOU) has been signed between NBSS&LUP, Nagpur and Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vidyapeeth (IGKV), Raipur (C.G.), and TNAU, Coimbatore for undertaking collaborating research programme.

Sr. No.	Name of student	Name of the University	Thesis Title
	Mr. Nirmal Kumar	IGKV, Raipur	Study on Identification, characterization and Mapping of degraded lands using time series MODIS NDVI and Landsat data
	Mr. Rakesh Banwasi	IGKV Raipur	Land evaluation of paddy and soybean based cropping system using geospatial database of Bemetara block, Chhattisgarh
	Mr. Anurag J. Patangray	IGKV Raipur	Resource based land use planning for Kupta watershed of Darwah tehsil, Yavatmal district, Maharashtra
	Mr. D. Vasu	TNAU, Coimbatore	Soil resource inventory (1:10000 scale) for agricultural land use planning in Deccan plateau using geospatial techniques – a study in Thimmajipet mandal, Telangana

The following scientist, Regional Centre, Bangalore is pursuing her Ph.D. programme at UAS, Bangalore.

1.	Smt. Vasundhara	UAS, Bangalore	Assessment of soil carbon stock under arecanut and coconut plantations in southern Karnataka

The following M.Sc.(LRM) students were admitted in 2014 at Dr. PDKV, Akola and who later joined NBSS&LUP, Nagpur in September 2015 for their specialized course in LRM. They have completed their course work and at present engaged in research work for their theses. Name of the student and their guides along with the respective thesis title is mentioned below.

Sr. No.	Name of student	Thesis Title
1.	Mr. Gopal M. Bedre	Characterization and evaluation of rice-growing soils of Jhal watershed of Bemetara block of Chhattisgarh
2.	M. Ganesh A. Kumbhar	Oxidizable soil organic carbon (SOC) fractions under major cropping systems in shrink-swell soils of Central India
3.	Ms. Ankita R. Padhune	Land suitability evaluation for cotton-based cropping system in Kupri watershed, Yavatmal district, Maharashtra using geospatial techniques
4.	Ms. Yagani G. Sinha	Effect of salinity levels on spectral reflectance properties of some shrink-swell soils in Nagpur district of Maharashtra

10 Workshops/ Seminars Organized

Workshops / seminar organized

Date	Topic	Venue
2015		
May 14	First Hindi Karyashala on "*Hindi Rajbhasa ka Sarjan*" was organized for the Administrative and Technical Assistants staff.	Regional Centre Delhi
July 29	Second Hindi Karyashala on "*Rajbhasa Sambandhit Niti Nirdesh Aur Takniki Sampark Me Hindi Ki Bhumoka*" was organized for the Scientists and Technical Officers.	Regional Centre. Delhi
August 7-8	Nineteenth Annual Convention and National Conference on "Application of Clay Science in Agriculture, Environment and Industry" with The Clay Minerals Society of India, New Delhi	Paribesh Bhawan, Salt Lake, Kolkata
October 8-10	National Seminar on "Soil Health Management and Food Security: Role of Soil Science, Research and Education" with the Indian Society of Soil Science (ISSS), Kolkata Chapter and IPNI, South Asia Programme, Gurgaon	Regional Centre, Kolkata
2016		
February 11	Third Hindi Karyashala on "*Hindi Me Vaigyanik Aur Takniki Lekhan Ke Labh*" was organized for the Scientists and Technical Officers	Regional Centre Delhi

Shri Tathagata Roy, Hon'ble Governor, Tripura delivering inaugural address on 7th August, 2015.

Dr. S.K. Singh, Director, ICAR-NBSS & LUP, Nagpur addressing during inaugural programme of CMSI on 7th August, 2015

March 11-13	3 day Workshop on *ICAR KRISHI Geoportal"*	Hqrs., Nagpur

March 28-30	3 days *"User's Training Workshop on 'ICAR KRISHI Geoportal"*	HQrs., Nagpur

11 Awards, Recognitions and Foreign Visits

Awards

- ICAR-NBSS&LUP, Nagpur has been conferred with "**Rajarshi Tandon Rajbhasha Puraskar 2015**" for the best Official language implementation among the ICAR Institutes in 'B' Region at a function held on 15th May 2015 at New Delhi. Shri Mohanbhai Kundariya, Hon'ble Minister of State for Agriculture handed over the prize to Dr. S.K. Singh, Director of the organization. Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR, Shri R. Rajagopal, Additional Secretary, DARE and Secretary, ICAR, Shri Pradeep Kumar Pujari, Special Secretary & Financial Advisor, DARE and Dr. Gurbachan Singh, Chairman, ASRB were present on the occasion.

Dr. S.K. Singh, Director receiving "Rajarshi Tandon Rajbhasha Puraskar 2015" from Sh Mohanbhai Kundariya, Hon'ble Minister of State for Agriculture while Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and others look on.

Dr. Rajeev Srivastava, Principal Scientist and Head and **Dr. M.S.S. Nagaraju,** Principal Scientist received **'The ISSS-Dr. J.S.P. Yadav Memorial Award for Excellence in Soil Science"** at 80th Annual Convention of the Society held on 5th December, 2015 at Bengaluru.

- FAI Golden Award for outstanding Doctorate Research in Fertilizer usages on December, 2015 by Fertilizer Association of India with gold medal, citation and cash prize of Rs. 50,000/- received by **Dr. P.C. Moharana**, Scientist on December 2, 2015.

Dr. M.S.S. Nagaraju, on behalf of Dr. Rajeev Srivastava, receiving "The ISSS-Dr. J.S.P. Yadav Memorial Award for Excellence in Soil Science" at the hands of Hon'ble Union Minister for Chemicals and Fertilizers Sh. Anant Kumar and Hon'ble Karnataka State Agriculture Minister Sh. Krishna Byre Gowda

- **Dr. Chandrakala**, scientist has been bestowed upon South Zone award and Commendation certificate for Ph.D. research work on December 7, 2015 at 80th ISSS annual convention at GKVK, Bangalore
- **R.P. Yadav, Ram Prasad and Swarn Lata Arya** were awarded Best Research Paper 2015 by Indian Association of Soil and Water Conservationist, Dehradun for the publication entitled, "Effect of different horti-pastoral systems in amelioration soil compaction in Shivalik region".
- **The Regional Centre, Jorhat** has been awarded First Prize for best stall and theme display and presentation on the occasion of 'Kisan Mela' held in Majuli Sub Div. of Jorhat (Assam) organized by ICAR-IVRI, Regional Centre, Kolkata on 17-19th January, 2016.

Best Poster Award

- Best research poster award to **M. Lalitha, S. Dharumarajan, Rajendra Hegde and S.K. Singh** during Annual Convention of Indian Society of Soil Science held at GKVK Bangalore during

5-8th December 2015 for the research paper Salt affected soils of Mailam block and its relationship with water management

- Best Poster Presentation Award to **A.K. Sahoo, D.C. Nayak, T. Banerjee, S.K. Gangopadhyay, K. Das and S.K. Singh** during National Seminar on Soil Health Management and Food Security: Role of Soil Science Research and Education organized by Indian Society of Soil Science, Kolkata Chapter during 8-10 October, 2015 at Kolkata. For Soils of Nadia District, West Bengal – Their Characteristics, Problems and Potentials for Agricultural Land Use Planning".

Recognitions

- **Dr. S.K. Singh**, Director nominated as a Member of National Monitoring committee(NMC) constituted by Ministry of Rural Development, Department of Land Resources, Govt. India (N0.26011/04/2007-LRD (Part II).
- **Dr. S.K. Singh**, Director nominated as a Nodal officer for more effective use of Space Technology tools in Central Ministries/Departments, Constituted by Dr. K. Radhakrishnan Secretary Department of Space, Chairman, Space Commission.
- **Dr. S.K. Singh**, Director nominated as a Member of Technical Committee for Data Harmonization of Desertification, Land Degradation and Drought, constituted Ministry of Environment, New Delhi.
- **Dr. S.K. Singh**, Director representing NBSS&LUP, nominated as expert organizations for undertaking peer group review of the chapter on Environmental Sustainability;No.13033/1/2015-E&F, Govt. India, National Institution for Transforming India, E&F Division, 352, NITI Aayog, Parliament Street, New Delhi.
- **Dr. S.K. Singh**, Director, ICAR-NBSS&LUP, Nagpur was elected as President, Clay Minerals Society of India.
- **Dr. R.P. Yadav**, Pr. Scientist nominated as a Member of Expert committee to study and firm up the definition of Kandi areas (commonly identified as foothill region in north and north western states), India constituted by Ministry of Drinking Water and Sanitation.
- **Dr. Rajeev Srivastava**, Principal Scientist and Head, Division of Remote Sensing Applications was invited by Seminar organizing committee to deliver lead paper on 'Remote Sensing and GIS applications in land resource characterization and management' in State level Seminar on "Soil and Water Quality: A Concern" held during November 2-3, 2015 at Dr. PDKV, Akola, Maharashtra.
- **Dr. Jagdish Prasad**, Principal Scientist and In-charge Head, Division of Soil Resource Studies has been nominated as Member in IMC of Indian Institute of Soil Science, Bhopal 2015-2018.
- **Dr. Jagdish Prasad,** Principal Scientist and In-charge Head, Division of Soil Resource Studies has been awarded for "Reviewer Excellence Award – as reviewer of Indian Journal of Agricultural Research and Legume Research – An International Journal".
- **Dr. Jagdish Prasad**, Principal Scientist and In-charge Head, Division of Soil Resource Studies has been nominated as Member of Asian Soil Partnership (GSP Pillar 4).
- **Dr. P. Chandran**, Principal Scientist and Head, Division of Soil Resource Studies has been awarded as the fellow of the Clay Minerals Society of India, New Delhi.
- **Dr. S. Dharumarajan**, Scientist, Regional Centre, Bangalore awarded Endeavour Research fellowship by Department of Education and training, Govt. of Australia to undergo post doctoral programme at The University of Sydney from April to October 2016.
- **Regional Centre, Delhi** was felicitated with Special Honour by NRM Division, ICAR, New Delhi for special contribution in organizing Brainstorming Session on Managing Soil Health for celebration of International Year of Soil at NASC Complex, New Delhi, 23-24 Nov. 2015.
- **Dr. S.K. Mahapatra**, Principal Scientist, Regional Centre, Delhi was invited by Indian Science Congress Association (ISCA) as Invited Speaker for presenting a Lead Paper at Indian Science Congress 2016 held at Mysore University, Mysore, Jan. 3-7, 2016.
- **Dr. S.K. Ray**, Principal Scientist and Head, Regional Centre, Jorhat has been nominated as the member of IMC of ICAR Research Complex for NEH region, Barapani, Meghalaya.
- **Dr. S.K. Ray,** Principal Scientist and Head, Regional Centre, Jorhat has been nominated as the member of Research Advisory Group of the Rain Forest Research Institute, Jorhat, Assam.
- **Dr. S. K. Ray**, Principal Scientist and Head, Regional Centre, Jorhat has been nominated as the member of Scientific Research Committee of the KVKs of Assam Agricultural University.

- **Dr. N.G. Patil**, Principal Scientist, Division of LUP was nominated as IMC Member of CSSRI, Karnal for the period 2015-18.
- **Dr. N.G. Patil**, Principal Scientist, Division of LUP was nominated as a Member of Hailstorm Task Force.

Visit Abroad

- **Dr. S.K. Singh**, Director visited Bangkok, Thailand to attend "High Level Policy Dialogue on Investment in Agricultural Research for Sustainable Development in the Asia-Pacific" during December 8-9, 2015 and presented paper on "Land Resource Inventory of India for Development of Sustainable Agricultural Land Use Plans using Geospatial Techniques – Avenues for Investment".
- **Dr. Jagdish Prasad**, Principal Scientist and In-charge Head, Division of Soil Resource Studies visited Bangkok, Thailand to attend Regional Asian Soil Partnership Consultation Workshop on "Sustainable Management and Protection of Soil Resources" during May 13-15, 2015 and presented the status paper on "Soil Resources of India"
- **Dr. Jagdish Prasad**, Principal Scientist and In-charge Head, Division of Soil Resource Studies visited Nanjing, China to attend 12th International Conference of the East and Southeast Asia Federation of Soil Science Societies (ESAFS2015) on Rational Utilization of Soil Resources for Sustainable Development (FAO Sponsored) during 18-21 Sept., 2015.

Radio talks

- **Dr. Rajendra Hegde**, Principal Scientist and Head, Regional Centre, Bangalore gave a radio talk on "Green manuring for enhancing soil fertility and productivity (Kannada) from AIR, Bangalore on April 24, 2015.
- **Dr. Rajendra Hegde**, Principal Scientist and Head, Regional Centre, Bangalore gave a Radio interview on "International year of Soils – 2015, AIR, Bangalore on September 24, 2015)
- **Dr. Rajendra Hegde**, Principal Scientist and Head, Regional Centre, Bangalore gave a radio talk on: LRI for soil and water conservation plan. AIR Bangalore on January 3, 2016.
- **Dr. N.G. Patil**, Principal Scientist delivered a radio talk on 11.6.2015 (All India Radio, Nagpur).

12 Distinguished Visitors

Headquarters, Nagpur

1. Sh. Nitin Gadkari, Hon'ble Minister of Road Transport and Highways, Govt. of India
2. Dr. A.K. Sikka, Deputy Director General (NRM), ICAR, New Delhi
3. Dr. S.K. Chaudhari, Asstt. Director General (S&WM), ICAR, New Delhi
4. Dr. J.S. Samra, Ex-CEO, NRAA, Planning Commission, Govt. of India
5. Dr. S.M. Virmani, Ex-Pr. Scientist, ICRISAT,
6. Dr. J.C. Katyal, Ex-Vice Chancellor, CCSHAU, Hissar
7. Dr. S.S. Magar, Ex-Vice Chancellor, MPKV, Rahuri, and Member RAC & IMC
8. Prof. S.N. Hiwase, Director of Research, Dr. PDKV, Akola and Member, IMC
9. Sh. Ramesh P. Jichkar, Member RAC and IMC
10. Prof. S.K. Sanyal, Ex-Vice Chancellor, BCKV, Nadia, Mohanpur, West Bengal.
11. Dr. D.K. Das, Ex-Head, Division of Soil Physics, IARI and Member, RAC
12. Dr. N.S. Pasricha, Ex-Director, PRII, Gurgaon and Member, RAC
13. Dr. J. S. Parihar, Ex-DDG, SAC, Ahmedabad and Member, RAC
14. Dr. T. Ravisankar, Group Head, NRSC, Hyderabad and Member, RAC
15. 50 Students of from Dr. Ambedkar College Nagpur
16. 21 Students from College of Agriculture Gadchiroli

Regional Centre, Bangalore

1. Dr. Srinath Dixit Project director, Zone -8 ICAR Bangalore
2. Dr. Prakash Kammaradi Chairman, Agricultural Prices Commission, Govt of Karnataka
3. Dr. Sekar Muddu, Professor of Hydrology, Indian Institute of Science, Bangalore
4. Dr. Tatan Tiwary, Principal Scientist Indian institution of Wheat and Barley, Karnal Haryana
5. Sh. Jichkar, RAC member, ICAR- NBSS&LUP
6. Sh. Rajagopal IAS, Secretary-ICAR, New Delhi
7. Madam Almitra Patel, Member Supreme Court appointed committee for Solid Waste Management in India
8. Dr. A.K. Sikka, Deputy Director General (NRM), ICAR, New Delhi.
9. Dr. M.L. Shastry, Scientist, SAC Ahmadabad.
10. Dr. M. Parag, Hydrologist, MIT-USA and visiting Scientist, IISc, Bangalore.

Regional Centre, Jorhat

- Dr. K.M. Bujarbaruah, the Hon'ble Vice Chancellor, Assam Agricultural University, Jorhat, Assam.
- Dr. G. Hazarika, Director of Research, Assam Agricultural University, Jorhat, Assam.
- Dr. H. Bhattacharyya, Director of Extension Education Institute, Assam Agricultural University, Jorhat, Assam.
- Dr. Dilip Gogoi, Former Director of Extension Education Institute, Assam Agricultural University, Jorhat, Assam.
- Dr. Tapan Dutta, Former Agricultural Advisor to the Hon'ble Chief Minister of Assam.
- Dr. R.S.C. Jayaraj, Director, Rain Forest Research Institute, Jorhat.
- Dr. C. Varadachari, Director, Raman Centre for Applied & Interdisciplinary Sciences (RCAIS), Kolkata.
- Dr. Kunal Ghosh, FNA, Former Professor & Head, Department of Agricultural Chemistry & Soil Science, University of Calcutta.
- Dr. Mrinmay Dutta, Former Joint Director, ICAR Complex for NEH Region, Regional Centre, Lembuchera, Tripura.
- Dr. A.K. Garg, Joint Director, Extension Education, ICAR-Indian Veterinary Research Institute, (D.A.R.E., Ministry of Agriculture, Govt. of India), Izatnagar- 243 122, Bareilly (U.P.) India
- Dr. S.N. Gogoi, Head, Regional Sericultural Research Station, Central Silk Board, Jorhat.

- Dr. R.C. Kalita, Head, Division of Extension, Rain Forest Research Institute, Jorhat
- Dr. R.M. Karmakar, Professor & Head, Division of Soil Science, Assam Agricultural University, Jorhat, Assam
- Dr. R.K. Bhattacharyya, Head, ICAR-CIFRI, North Eastern Regional Centre, Guwahati.
- Dr. T.N. Nath, Head of the Department of Chemistry, Moran College, Sivasagar.
- Dr. T.J. Ghose, Principal Scientist, RARS, Titabar, Assam Agricultural University, Jorhat.
- Dr. D. Bhattacharyya, Professor, Division of Horticulture, Assam Agricultural University, Jorhat, Assam.
- Mr. T. Imkongmar Aier, Additional Director, Soil & Water Conservation, Nagaland, Kohima
- Mr. Swen P.M. Bos, Ph.D Student, ETH Zurich, Dept. of Environmental Systems Science, ITES-Forest Management & Development Group CHN F75.3, Universitaestrasse 16, 8092 Zurich, Switzerland.
- Dr. H.J. Godbole, Dy.SE(Envt), ONGC, Asset HSE, Assam Asset, Sivasagar
- Dr. Subhasish Bandyopadhyay, In-charge Head, ICAR- Indian Veterinary Research Institute, Eastern Regional Centre, Kolkata
- Dr. Utam Bandyopadhyay, Principal Scientist, ICAR- Indian Veterinary Research Institute, Eastern Regional Centre, Kolkata
- Dr. K.M. Manjaiah, Principal Scientist & Registrar, Indian Agricultural Research Institute, New Delhi
- Dr. Nayan Ahmed, Principal Scientist, Indian Agricultural Research Institute, New Delhi
- Dr. A.K. Mishra, Principal Scientist, Indian Agricultural Research Institute, New Delhi
- Mr. Ajoy Kumar, Secretary, Town Official Language Implementation Committee, NEIST, Jorhat
- Mr. Vinay Kumar, Secondary Commandant, CRPF, 119 Battalion, Jorhat
- Teachers and Students from St. Mary's High School, Hemlata Handique Memorial Institute and Air Force High School, Jorhat.

Regional Centre, Kolkata

- Dr. J.S. Samra, Ex-DDG, ICAR, New Delhi
- Shri R. Rajagopal, IAS, Additional Secretary, DARE and Secretary, ICAR, New Delhi
- Dr. S.K. Singh, IAS, Additional Secretary and Finance Advisor, DARE, New Delhi.
- Prof. S.K. Sanyal, Former Vice Chancellor, BCKV, Mohanpur, Nadia

13 Personnel

Scientific

Dr. S.K. Singh, Director

PRIORITY SETTING, MONITORING AND EVALUATION CELL

Dr. S. Chatterji, Principal Scientist (Soil Science) & In-charge

DIVISION OF SOIL RESOURCE STUDIES

1. Dr. Jagdish Prasad, Principal Scientist (Soil Science) & In-Charge, Head (From 01.12.2014 to 16 March 2016)
2. Dr. P. Chandran, Principal Scientist (Soil Science) & Head (From 17 March 2016)
3. Dr. B.P. Bhaskar, Principal Scientist (Soil Science)
4. Dr. (Mrs.) P.L.A. Satyawathi, Senior Scientist (Soil Science)
5. Dr. Pramod Tiwari, Scientist (SWCE)
6. Dr. R.P. Sharma, Scientist (Soil Science)
7. Dr. K. Karthikeyan, Scientist (Soil Science)
8. Sh. Vasu, D., Scientist (Soil Science)
9. Sh. Abhishek Jangir, Scientist (Soil Science)
10. Sh. Gopal Tiwary, Scientist (Soil Science)

DIVISION OF REMOTE SENSING APPLICATIONS

1. Dr. Rajeev Srivastava, Principal Scientist (Soil Science) & I/C Head
2. Dr.(Mrs) C. Mandal, Principal Scientist (Geography)
3. Dr. M.S.S. Nagaraju, Principal Scientist (Soil Science)
4. Dr. G.P. Obi Reddy, Principal Scientist (Geography)
5. Sh. Nirmal Kumar, Scientist (Soil Physics)
6. Dr.(Ms) Nisha Sahu, Scientist (Soil Science)
7. Dr. Sudipta Chattaraj, Scientist (Soil Physics)
8. Sh. Benukantha Dash, Scientist (SWCE)

DIVISION OF LAND USE PLANNING

1. Dr. A. Chaturvedi, Principal Scientist (Geography) & Head
2. Dr. T.K. Sen, Principal Scientist (Soil Science)
3. Dr. D.K. Mandal, Principal Scientist (Soil Science)
4. Dr. S. Chatterji, Principal Scientist (Soil Science)
5. Dr. T.N. Hajare, Principal Scientist (Agronomy)
6. Dr. N.G. Patil, Principal Scientist (SWCE)
7. Dr. (Mrs.) Amrita Daripa, Scientist (Environmental Science)
8. Sh. Mahaveer Nogiya, Scientist
9. Sh. H.L. Kharbikar, Scientist (Agril.Economics)

REGIONAL CENTRE, KOLKATA

1. Dr. D.C. Nayak, Principal Scientist (Soil Science) & In-charge Head (from 1.2.2015)
2. Dr. S.K. Gangopadhyay, Principal Scientist (Soil Science)
3. Dr. A.K. Sahoo, Principal Scientist (Soil Science)
4. Dr. Krishnendu Das, Principal Scientist (Soil Science)
5. Dr. Dipak Dutta, Principal Scientist (Soil Science)
6. Dr. S.G. Chaudhary, Principal Scientist (Soil Science)
7. Dr. (Mrs.) Tapti Banerjee, Principal Scientist (Geography)
8. Dr. T. Chatopadhyay, Senior Scientist (Soil Science)
9. Dr. S. Mukhopadhyay, Senior Scientist (Soil Science)
10. Dr. Sah Kausar Reza, Scientist (Soil Science)
11. Sh. R. Srinivasan, Scientist (Soil Science)
12. Dr. (Ms) S. Gupta Chaudhary, Scientist (Soil Science)

REGIONAL CENTRE, BANGALORE

1. Dr. Rajendra Hegde, Principal Scientist (Agronomy) & Head (From
2. Dr. K.M. Nair, Principal Scientist (Soil Science)
3. Dr. K.S. Anil Kumar, Principal Scientist (Soil Science)
4. Dr. V. Ramamurthy, Principal Scientist (Agronomy)
5. Dr. S.C. Ramesh Kumar, Principal Scientist (Agril.

Economics)

6. Sh. S. Srinivas, Senior Scientist (Computer Appln.)
7. Sh. S.P. Maske, Scientist (SWCE)
8. Dr. S. Dharumarajan, Scientist (Soil Science)
9. Mrs Vasundhara R., Scientist (Soil Science)
10. Dr. (Mrs) M. Lalitha, Scientist (Soil Science)
11. Ms M. Chandrakala, Scientist (Soil Science)
12. Dr. (Mrs) B. Kalaiselvi, Scientist (Soil Science)

REGIONAL CENTRE, NEW DELHI

1. Dr. R.P. Yadav, Principal Scientist (Soil Science) & Head
2. Dr. Tarsem Lal, Principal Scientist (Geography)
3. Dr. S.K. Mahapatra, Principal Scientist (Soil Science)
4. Dr. (Mrs) J. D. Surya, Principal Scientist (Soil Science)
5. Dr. Dharam Singh, Senior Scientist (Agronomy)
6. Sh. Ashok Kumar, Scientist (Agronomy)
7. Sh. Rajesh Kumar Meena, Scientist (Soil Science)
8. Sh. Vikas, Scientist (Agricultural Statistics)
9. Ms. Ritu Nagdev, Scientist (Environmental Science)
10. Sh. Ram Kishore Fagodiya, Scientist (Environmental Science)

REGIONAL CENTRE, JORHAT

1. Dr. S.K. Ray, Principal Scientist (Soil Science) & Head (w.e.f.12.5.2015)
2. Dr. S. Bandopadhyay, Scientist (Soil Science)
3. Dr. S. Ramchandran, Scientist (Soil Science)
4. Sh. Roomesh Kumar Jena, Scientist (Soil Science)
5. Sh. Prasanjit Ray, Scientist (Soil Science)
6. Mr. Partha Deb Roy, Scientist (Soil Science)

REGIONAL CENTRE, UDAIPUR

1. Dr. Ram Sakal Singh, Principal Scientist (Soil Science) & I/C Head
2. Dr. S.S. Rao, Principal Scientist (Agronomy)
3. Dr. T.P. Verma, Senior Scientist (Soil Science)
4. Sh. R.S. Meena, Scientist (Soil Science)
5. Sh. Ravinder Naitam, Scientist (Soil Science)
6. Sh. Roshan Lal Meena, Scientist (Agronomy)
7. Sh. Pravash C. Moharana, Scientist (Soil Science)
8. Sh. Sunil Kumar, Scientist

Technical

HEADQUARTERS, NAGPUR

1. Dr. N.C. Khandare, Chief Technical Officer (FFT)
2. Dr. S.S. Nimkhedkar, Chief Technical Officer (FFT)
3. Sh. S.V. Bobade, Chief Technical Officer (FFT)
4. Dr. R.A. Nasre, Asstt. Chief Technical Officer (FFT)
5. Dr. (Mrs.) Ratna P. Roy, Asstt. Chief Technical Officer (FFT)
6. Sh. S.G. Anantwar, Asstt. Chief Technical Officer (FFT)
7. Mrs. Smita Patil, Asstt. Chief Technical Officer (FFT)
8. Sh. V.P. Patil, Asstt. Chief Technical Officer (FFT)
9. Dr. A.M. Nimkar, Asstt. Chief Technical Officer (FFT)
10. Dr. A.P. Nagar, Asstt. Chief Technical Officer (FFT)
11. Sh. Vijay Bhongade, Asstt. Chief Technical Officer (Photo.)
12. Sh. V.N. Parhad, Asstt. Chief Technical Officer (FFT)
13. Dr. M.T. Sahu, Senior Technical Officer (P&E)
14. Sh. P.V. Ambekar, Senior Technical Officer (Photo.)
15. Sh. S.S. Gaikawad, Senior Technical Officer (FFT)
16. Dr. (Mrs.) Jiji Cyriac, Senior Technical Officer (LID)
17. Sh. T.L. Khobragade, Senior Technical Officer (WS)
18. Sh. P.S. Butte, Senior Technical Officer (FFT)
19. Sh. D.S. Mohekar, Senior Technical Officer (FFT)
20. Sh. K.S. Banasure, Technical Officer (WS)
21. Sh. M.P. Khobradage, Technical Officer (WS)
22. Sh. H.J. Bhondwe, Technical Officer (FFT)
23. Sh. S.D. Meshram, Technical Officer (LT)
24. Sh. S.C. Gharami, Technical Officer (LT)
25. Sh. R.N. Zambre, Senior Technical Assistant (WS)
26. Sh. M.D. Kadav, Senior Technical Assistant (WS)
27. Sh. S.K. Kalbande, Senior Technical Assistant (WS)
28. Mrs. Ujwala Tijare, Senior Technical Assistant (WS)
29. Sh. B.M. Khorge, Senior Technical Assistant (WS)
30. Sh. S.S. Dohatre, Senior Technical Assistant (FFT)

31. Sh. R.K. Bhalasagar, Senior Technical Assistant (FFT)
32. Sh. V.R. Vinchurkar, Technical Assistant (FFT)
33. Sh. W.B. Mate, Technical Assistant (FFT)
34. Sh. G.V. Manmode, Technical Assistant (FFT)
35. Sh. S.G. Khapekar, Technical Assistant (FFT)
36. Sh. U.B. Gaikawad, Technical Assistant (WS)
37. Sh. V.T. Sahu, Technical Assistant (FFT)
38. Sh. S.K. Mendhekar, Technical Assistant (FFT)
39. Sh. M.M. Bhagat, Senior Technician (FFT)
40. Sh. D.R. Borkar, Technician (WS)
41. Sh. P.N. Jadhav, Technician (FFT)
42. Sh. S.R. Singade, Technician (FFT)
43. Sh. A.M.G. Sheikh, Technician (FFT)
44. Sh. J.B. Padole, Technician (FFT)
45. Sh. Atul Dankhade, Technician (WS)

REGIONAL CENTRE, KOLKATA

1. Mrs. S. Das, Senior Technical Officer (LT)
2. Dr. (Mrs.) J. J. Mukhopadhyay, Senior Technical Officer (FFT)
3. Dr. Abhijit Haldar, Senior Technical Officer (FFT)
4. Sh. V. Mohan, Technical Officer (LT)
5. Sh. M.M. Roy, Technical Officer (WS)
6. Sh. B.C. Naskar, Technical Officer (WS)
7. Sh. A.K. Maitra, Senior Technical Assistant (FFT)
8. Sh. S. Islam, Senior Technical Assistant (FFT)
9. Sh. R.K. Dutta, Senior Technical Assistant (FFT)
10. Sh. B.M.N. Reddy, Technical Assistant (FFT)
11. Mrs. R. Basu, Technical Assistant (LT)
12. Sh. S. Sarkar, Technical Assistant (FFT)
13. Mrs. S. Saha, Technical Assistant (WS)
14. Sh. P. Mondal, Technical Assistant (WS)
15. Sh. Sitaram, Technical Assistant (FFT)
16. Sh. Deepak Mourya, Technical Assistant (FFT)
17. Sh. G.C. Sarkar, Senior Technician (FFT)
18. Sh. Sukonto Pal, Technician (FFT)
19. Sh. Siddharth Karamkar, Technician (LT)
20. Smt. Zharna Kar, Technician (FFT)

REGIONAL CENTRE, BANGALORE

1. Dr. B.A. Dhanorkar, Chief Technical Officer (FFT)
2. Mrs. Arti Koyal, Chief Technical Officer (FFT)
3. Sh. K.V. Niranjane, Chief Technical Officer (FFT)
4. Mrs. P. Chandramathi, Asstt. Chief Technical Officer (LID)
5. Dr. M. Ramesh, Asstt. Chief Technical Officer (LT)
6. Sh. Y. Venkatesha Reddy, Senior Technical Officer (FFT)
7. Sh. Bhoora Prasad, Senior Technical Officer (FFT)
8. Sh. D.H. Venkatesh, Senior Technical Officer (LT)
9. Mrs. K. Sujatha, Technical Officer (WS)
10. Sh. Shivappa Agadi, Technical Officer (FFT)
11. Sh. C. Bache Gawda, Technical Officer (FFT)
12. Sh. R. Venkatgiriappa, Senior Technical Assistant (FFT)
13. Sh. K. Paramesha, Senior Technical Assistant (FFT)
14. Sh. Jairamaiah, Senior Technical Assistant (FFT)
15. Sh. N. Somasekhara, Senior Technical Assistant (FFT)
16. Ku. K.V. Archana, Technical Assistant (FFT)
17. Sh. K. Ramaswamy, Senior Technician (WS)
18. Sh. N. Maddileti, Technician (FFT)
19. Ms. S. Parvathy, Technician (LT)
20. Sh. Manish Chaudhary, Technician (WS)

REGIONAL CENTRE, NEW DELHI

1. Dr. Ram Gopal, Chief Technical Officer (FFT)
2. Sh. K.M. Pal, Asstt. Chief Technical Officer (WS)
3. Dr. D.K. Katiyar, Senior Technical Officer (FFT)
4. Sh. Arvind Kumar, Senior Technical Officer (LT)
5. Sh. Harjit Singh, Senior Technical Officer (FFT)
6. Sh. K.K. Bharadwaj, Technical Officer (P&E)
7. Sh. Anil Kumar, Technical Officer (P&E)
8. Sh. Jai Mangal, Senior Technical Assistant (P&E)
9. Sh. S. Saboo, Senior Technical Assistant (WS)
10. Sh. Vijay Singh, Senior Technical Assistant (WS)
11. Sh. P.R. Kharwar, Senior Technical Assistant (FFT)
12. Sh. Shiv Kumar, Technical Assistant (FFT)
13. Sh. Rajneesh Kumar, Technical Assistant (FFT)
14. Sh. Makhan Singh, Technical Assistant (FFT)
15. Sh. Nawab Khan, Technical Assistant (FFT)
16. Sh. Vas Dev, Technical Assistant (FFT)
17. Sh. Rajesh Rajpal, Technical Assistant (FFT)
18. Sh. Kuldeep Singh, Senior Technician (FFT)
19. Sh. P.S. Chaudhary, Senior Technician (FFT)
20. Sh. Roshan Lal, Senior Technician (FFT)

REGIONAL CENTRE, JORHAT

1. Sh. D.P. Dutta, Senior Technical Officer (FFT)
2. Sh. K.M. Soni, Technical Officer (FFT)

3. Sh. S.S. Yadav, Technical Officer (FFT)
4. Sh. Durnan Gogai, Technical Officer (WS)
5. Sh. P.K. Dutta, Technical Officer (WS)
6. Mrs. Shamoli Chetia, Senior Technical Assistant (WS)
7. Sh. Dilip K. Dutta, Senior Technical Assistant (WS)
8. Sh. Lokeshwar Gogai, Technical Assistant (FFT)
9. Sh. Pradip Kotoky, Technical Assistant (FFT)
10. Sh. N. Saikia, Technical Assistant (FFT)
11. Sh. Chandeshwar Das, Technical Assistant (FFT)
12. Sh. Gopi Saikia, Technical Assistant (WS)
13. Sh. Someshwar Das, Senior Technician (FFT)
14. Sh. Amitabh Baruah, Senior Technician (FFT)

REGIONAL CENTRE, UDAIPUR

1. Sh. S.S. Sharma, Sr. Technical Officer (FFT)
2. Sh. Bhagwati Lal Trailor, Senior Technical Assistant (WS)
3. Sh. Bansilal Jat, Senior Technical Assistant (FFT)
4. Sh. Nola Ram Ola, Senior Technical Assistant (FFT)
5. Sh. Devilal Oad, Senior Technical Assistant (FFT)
6. Sh. N.D. Khan, Senior Technical Assistant (WS)
7. Sh. Rameshwar Singh, Senior Technical Assistant (FFT)
8. Sh. B.S. Kumawat, Technical Assistant (FFT)
9. Sh. B.R. Meena, Technical Assistant (WS)
10. Sh. Ambalal Bhoi, Senior Technician (WS)
11. Sh. C.K. Kumawat, Technician (FFT)
12. Sh. Sohanlal Sharma, Technician (FFT)
13. Sh. J.S. Rao, Technician (FFT)
14. Sh. Shiv Pal Singh, Technician (FFT)

Administrative

HEADQUARTERS, NAGPUR

1. Sh. Sanjay Bokolia, Chief Admn. Officer (w.e.f. 15.6.2015)
2. Sh. Z.H. Khilji, Sr. Finance & Accounts Officer (w.e.f. 21.5.2015)
3. Sh. A.A. Goswami, Admn. Officer (w.e.f. 1.6.2015)
4. Smt. Girija Rangari, Assistant Administrative Officer
5. Sh. A.P.Tembhurnikar, Assistant
6. Sh. S.C. Kolhe, Assistant
7. Sh. Wakeel Ahmed, Assistant
8. Sh. A.M. Kosare, Assistant
9. Mrs. Vimal Kharabe, Assistant
10. Sh. Y.L. Misal, Assistant
11. Sh. Rajesh Choudhary, Assistant
12. Sh. M.M. Khan, Private Secretary
13. Sh. S.M. Pathak, Private Secretary
14. Mrs. Rohini Watekar, Personal Assistant
15. Mrs. W.D. Khandwe, Personal Assistant
16. Mrs. Ranjana Sharma, Personal Assistant
17. Mrs. Vaishali Arbat, Personal Assistant
18. Sh. S.P. Awale, Upper Division Clerk
19. Sh. U.S. Kapse, Upper Division Clerk
20. Mrs. Shalu Nandanwar, Upper Division Clerk
21. Sh. Nitin Mohurle, Upper Division Clerk
22. Sh. Ajay Meshram, Upper Division Clerk
23. Sh. N.B. Mankar, Upper Division Clerk
24. Sh. S.S. Kamble, Lower Division Clerk
25. Sh. S.J. Patil, Lower Division Clerk

REGIONAL CENTRE, KOLKATA

1. Sh. A.P. Chaitupune, Assistant Administrative Officer
2. Sh. R.K. Dutta, Assistant
3. Mrs. Nirmala Kumar, Assistant
4. Ms Bedantika Dutta, Assistant
5. Mrs. Aparna Das, Stenographer Gr. III

REGIONAL CENTRE, BANGALORE

1. Mrs. R. Gayatri Devi, Assistant Administrative Officer
2. Mrs. P. Chandrakala, Upper Division Clerk
3. Mrs. Priti Chamuah, Lower Division Clerk

REGIONAL CENTRE, NEW DELHI

1. Mrs. Manju Malik, Assistant
2. Sh. Sumit Sindhu, Assistant
3. Ms Shruti Sharma, Assistant
4. Mrs. Sunita Mittal, Upper Division Clerk
5. Sh. Kamlesh Sharma, Upper Division Clerk

REGIONAL CENTRE, JORHAT

1. Sh. B.V. Gogai, Assistant Administrative Officer
2. Sh. P.K. Das, Assistant
3. Sh. N.C. Baruah, Personal Assistant
4. Sh. Madan Das, Personal Assistant

REGIONAL CENTRE, UDAIPUR

1. Sh. Harish Rajput, Personal Assistant
2. Sh. Unikrishnan Nair, K.K., Upper Division Clerk
3. Sh. V.S. Sankhla, Upper Division Clerk

Skilled Supporting Staff

HEADQUARTERS, NAGPUR

1. Sh. A.B. Bhasme
2. Sh. S.P. Dimote
3. Sh. B.C. Wahane
4. Sh. D.B. Thombre
5. Sh. A.T. Kantode
6. Sh. A.Z. Sarode
7. Sh. R.M. Parate
8. Sh. A.L. Kathikar
9. Sh. D.B. Asarat
10. Sh. G.B. Topre
11. Sh. N.T. Thawkar
12. Sh. S.A. Bhoyar
13. Sh. Ramesh Khawle
14. Sh. Lokesh Sontakke
15. Mrs. S.N. Gajbhiye

REGIONAL CENTRE, KOLKATA

1. Sh. B.K. Singh
2. Smt Usha Kujur
3. Smt Kalpana Biswas
4. Sh. Mahesh Roy
5. Sh. Nandlal Pramanik
6. Sh. V.N. Mishra
7. Mrs. Radha Turi
8. Mrs. Alpana Roy
9. Shr Krishna Guchait

REGIONAL CENTRE, BANGALORE

Sh. G.P.N. Hanumaiah
Sh. Rudrappa
Sh. R. Jairaja
Sh. M.T.N. Murthy
Sh. N. Sampangi
Sh. R. Balakrishna
Sh. C. Nagraj

REGIONAL CENTRE, NEW DELHI

1. Sh. Jagdish Mehto
2. Sh. Prakash
3. Sh. Radhey Shyam
4. Sh. Ram Sewak
5. Sh. R.B. Mehto
6. Sh. Rakesh Kumar
7. Sh. Harender Singh Rawat

REGIONAL CENTRE, JORHAT

1. Sh. N.C. Saikia
2. Sh. Nirmal Saikia
3. Sh. Raju Balmiki
4. Sh. J.C. Baruah
5. Sh. J.P. Gogai
6. Sh. Dilip Borah
7. Sh. Bipin Gogai
8. Sh. R.C. Rajak
9. Sh. Pabitra Gogai

REGIONAL CENTRE, UDAIPUR

1. Sh. J.S. Vasava
2. Sh. Devilal Prajapat
3. Smt. Vandana Patil
4. Sh. Mohanlal Meghwal
5. Sh. Shambhulal Meena
6. Sh. Bhanwar Singh Devra

NEW ENTRANTS

- Mr. Sanjay Bokolia, Chief Admn. Officer joined on 16.06.2015
- Mr. Zakir Khilji, Sr. Finance & Accounts Officer joined on 21.05.2015
- Mr. Abhishek Jangir, Scientist joined HQrs. on 10.4.2015
- Sh. Gopal Tiwari, Scientist joined HQrs., on 10.4.2015
- Sh. Benukantha Das, Scientist joined HQrs. on 8.4.2015
- Sh. Mahaveer Nogiya, Scientist joined HQrs. on 12.10.2015
- Sh. Hukumraj Kharbikar, Scientist joined HQrs. on 1.2.2016
- Sh. Ram Kishor Fagodiya, Scientist joined at Regional Centre, Delhi on 7.9.2015
- Mr. Partha Deb Roy, Scientist was posted at Regional Centre, Jorhat *w.e.f.* 10.4.2015.
- Mr. Sunil Kumar, Scientist joined at Regional Centre, Udaipur on 08.09.2015
- Mr. A.A. Goswami, Admn. Officer joined on 01.06.2015
- Shri Sita Ram joined Regional Centre, Kolkata as Technical Assistant (FFT) on 13.01.2016
- Shri Deepak Mourya joined Regional Centre, Kolkata as Technical Assistant (FFT) on 28.01.2016.

RETIREMENTS

- Dr. J.D. Giri was superannuated on 30.4.15.
- Shri. D.B. Mankar was superannuated on 30.5.15.
- Shri. T. Nagaraja Rao was superannuated on 31.12.2015.
- Sh. R.M. Hadke, Technical Assistant retired on superannuation in 31.7. 2015.
- Sh. N.H. Charde, Senior Technician (FFT) was retired on superannuation on 31.5.2015
- Sh. S.K. Arora, Chief Technical Officer, retired on superannuation on 31/07/2015 from Regional Centre Delhi (Printing Section).

- Sh. Nanda Ballabh, Skilled Supporting Staff, retired on superannuation on 30/06/2015 from Regional Centre Delhi
- Sh. Deepak Adya, Private Secretary to Head, retired on superannuation on 31/07/2015 from Regional Centre Delhi
- Sh. Mohan Lal, Technical Officer, retired on superannuation on 31/08/2015 from Regional Centre Delhi
- Smt. Manju Malik, Asstt. Admn. Officer retired on superannuation on 31/01/2016 from Regional Centre Delhi
- Smt. Sikha Majumdar, Assistant retired on superannuation on 31.07.2015.
- Shri S. Chakraborty, SSS retired on superannuation on 31.07.2015.
- Shri M. M. Roy, Technical Officer (Workshop Staff) retired on superannuation on 30.10.2015
- Sh. Venkatesha Reddy, Sr. Technical Officer retired on superannuation on 30.6.2015
- Shri M.R. Majumdar, Sr. Tech. Assistant (FFT) has been retired on superannuation on 30.11.2015.
- Shri Brij Kumar Singh, S.S.S. retired on superannuation on 29.02.2016.
- Mr. G.B.Rathwa, S.S.S. retired from service on superannuation on 31.05.2015
- Sh. K. Murugesh, S.S.S. retired on superannuation on 31.1.2016
- Sh. Maniram Dutta, S.S.S. retired on superannuation on 30.4.2015
- Sh. Borchetia L., S.S.S. retired on superannuation on 30.12.2015
- Smt. Bhanu Narayanan, Administrative Officer, retired on superannuation on 31.7.2015
- Mrs. Sunanda Lade, Assistant Administrative Officer, retired on superannuation on 30.9.2015
- Sh. C.K. Kharche, Assistant Administrative Officer, retired on superannuation on 30.9.2015
- Mrs. S.K. Hayat, Private Secretary retired on superannuation on 30.6.2015
- Sh. S.S. Vaidya, Assistant was retired on superannuation in 31 March 2016.

STAFF MOVEMENT

- Dr. Shelton Padua was transferred from ICAR-NBSS & LUP, Regional Centre, Jorhat to ICAR-CMFRI, Kochi *w.e.f.* 29.02.2016.
- Dr.R.P. Sharma, Scientist, Regional Centre NBSS&LUP, Udaipur transferred to NBSS&LUP, Nagpur on 15.06.2015.
- Mr. A.T. Kantode, SSS, Regional Centre NBSS&LUP, Udaipur, transferred to NBSS&LUP, Nagpur, on 08.09.2015.
- Mr. Rajesh Chaudhari, Asstt. Regional Centre NBSS&LUP, Udaipur transferred to NBSS&LUP, Nagpur on11.09.2015
- Mr. S.S. Yadav, (T-5) was transferred from Regional Centre, Jorhat and joined duties at ICAR-NBSS & LUP, HQ. Nagpur *w.e.f.* 19.03.2016.
- Sh. Anil Kumar, Technical Officer, Sh. Jai Mangal, Sr. Technical Assistant & Smt. Sunita Mittal, Assistant joined Regional Centre Delhi on 27/08/2015 on transfer from ICAR-NBSS&LUP, Printing Section New Delhi
- Sh. B.D. Phansal, Chief Administrative Officer was transferred to NAARM, Hyderabad
- Sh. G.C. Prasad, Senior Finance & Accounts Officer was transferred to CICR, Nagpur
- Sh. Kamlesh Sharma was transferred from Regional Centre, Delhi to HQrs. on 9.9.2015
- Sh. R.K. Fagodia, Scientist joined Regional Centre Delhi on 07/09/2015 on transfer from ICAR-NBSS&LUP, Hdqrs, Nagpur
- Sh. S.S. Vaidya, Asstt. Admn. Officer joined Regional Centre Delhi on 12/06/2015 on transfer from ICAR-NBSS&LUP, Hdqrs, Nagpur
- Sh. Toran Prasad, Assistant was transferred from Regional Centre, Bangalore to HQrs.
- Sh. V. Mohan, Technical Officer was relieved from Regional Centre Delhi on 08.01.2016 on transfer to ICAR-NBSS&LUP, Regional Centre Kolkata
- Shri. S. Pathak has joined RSA Division as Private Secretary w.e.f. 21.8.2015.
- Smt. Rohini Watekar was transferred to PME Cell on 26.8.15.
- Smt. Vandana Patil was transferred from Division of RSA to Regional Centre, Udaipur
- Smt. Vandana Patil was transferred to RC, Udaipur on 8.1.16.

PROMOTIONS

- Shri. L.G. Sontakke was promoted from SSS to Technician from 29.12.2015.
- Smt. Manju Malik, Assistant was promoted to Asstt. Admn. Officer with effect from 29.12.2015.
- Smt. Sunita Mittal, UDC was promoted to Assistant with effect from 30.12.2015.
- Mr. S. Pathak , P.A. was promoted to P.S.
- Mr. M.M. Khan, P.A. was promoted to P.S.

- Sh. P.B. Kumbhare, Asstt. was promoted to Asstt. Admn. Officer at Regional Centre, Udaipur
- Dr.(Mrs.) Sunita Das, Sr. Tech. Officer was promoted to Asstt. Chief Tech. Officer
- Sh. V.N. Parhad, Sr. Tech. Officer was promoted to Asstt. Chief Tech. Officer w.e.f. 12.5.2014
- Dr.(Mrs.) Tapati Banerjee, Sr. Scientist was promoted to Pr. Scientist w.e.f. 17.11.2011.
- Sh. S.S. Vaidya, Assistant was promoted to Asstt. Admn. Officer, Regional Centre Delhi on 30.12.2015

STUDY LEAVE

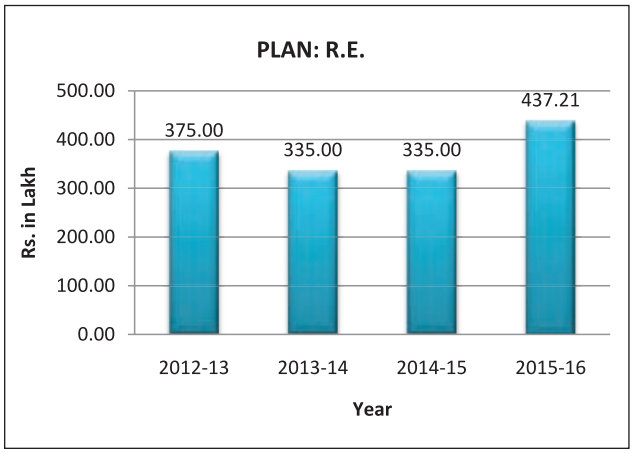
- Sh. Ashok Kumar, Scientist was relieved on 14-01-2016 for proceeding on study leave for Ph. D. programme.

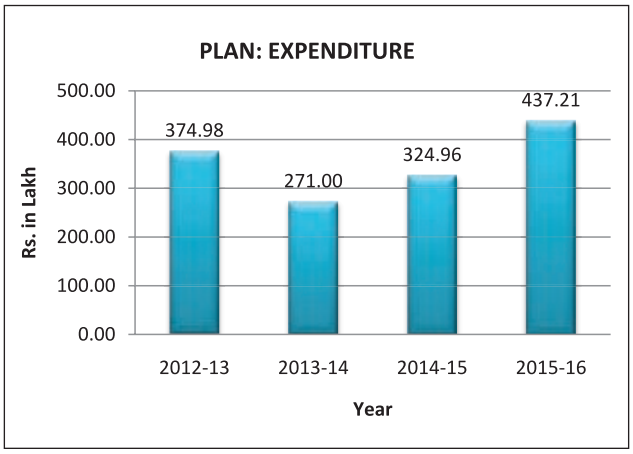
DECEASED

- Sh. S.N. Nandeshwar, Technical Assistant (FFT) expired on 27.10.2015
- Sh. Prakash, Skilled Suporting Staff expired on 06.11.2015.
- Mrs. P. Prabhavathamma expired on 29.12.2015

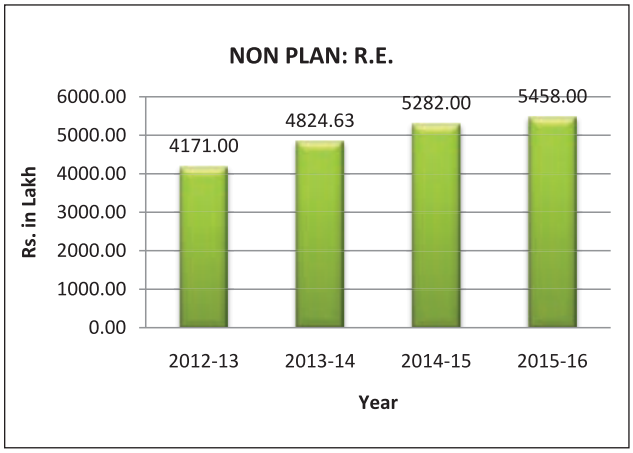
14 Budget

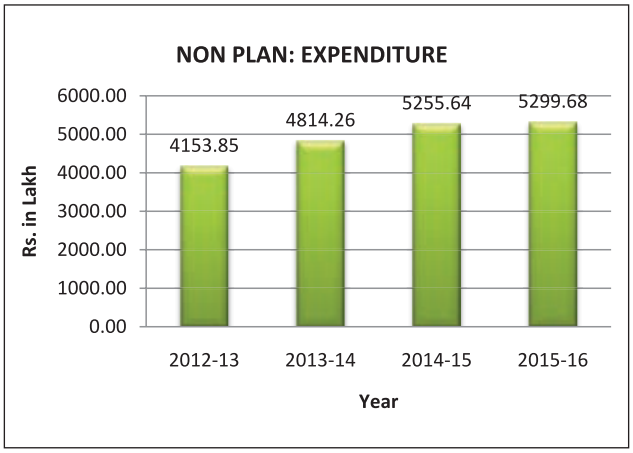
PLAN





NON PLAN





ICAR-NBSS&LUP IN MEDIA

- +Soil Series of Chhatisgarh State, NBSS Publ.85, 2002. ISBN: 81-85460-61-2.
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