ICAR-NBSS&LUP

ANNUAL REPORT 2014-15

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 2014-15 has been one of those few remarkable years in which the ICAR-NBSS&LUP has attained significant milestones. These are, among others, launching of research projects of national importance to agricultural productivity namely, Land Resource Inventory (34 blocks across the country) on Large Scale (1:10000 scale) and Development of National Portal on Soils and Block-level agricultural land use planning, development of innovative cost effective, time effective techniques of landform mapping, (so important to developing land resource inventory of a region), national geoportal, and **Soil Health Card** for as many as 1.5 lakh farmers of Telangana state.

We developed linkages with a number of state and central government organizations for execution of the two mega projects. These organizations are either funding the project or providing manpower or both. One of the most important collaborations has been with Govt of Telangana wherein the state govt is providing the necessary funds for the execution of the project. The first hand outputs of this collaborative project include land form, land use/land cover and soil maps (at phase level) of different blocks of the state. The soil map will provide us to know the soil characteristics at farm level and will be base for undertaking land use planning at cadastral level and hence assumes immense importance.

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. Besides, a number of staff underwent national trainings in varied fields.

The Bureau brought out a total of 194 publications including 79 research papers in national and international referred journals. 13 of them were published in journals with NAAS rating of 6.0 or above. The Bureau also finalised its Vision 2050 document which has been an outcome of sincere collective efforts of scientists at its Hqrs. and Regional Centres. The Bureau performed extremely well with respect to RFD achievement with an excellent composite score of 100.

I am thankful to the Chairman and members of Research Advisory Committee (RAC), the Institute Management Committee (IMC) and Quinquennial Review Team (QRT) for the guidance and support provided in formulating and pursuing our RD&T programmes.

I am highly grateful to Dr. S. Ayyappan, Secretary, DARE (Govt. of India) and Director General, ICAR, New Delhi, Dr. A.K. Sikka, Deputy Director General (NRM), ICAR and Dr. S.K. Choudhary, Assistant Director General (SW&M), ICAR, 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 (2014-15) 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: 12th May 2015

CONTENTS

EXECUTIVE SUMMARY

INVENTORYING NATURAL RESOURCES

Flagship project entitled "Land resource inventory on 1:10000 scale for enhancing productivity and transfer of technology" was initiated in a phased manner during 2014-15. 60 blocks/Mandals/Talukas targeting 3.3 million hectare are to be surveyed in the first phase (2014-2018) representing 60 agro-ecological subregions (AESRs) of the country. First step of methodology involved is generation of digital terrain model (DTM) using cartosat-1 data of 1 meter resolution and development of landform map. Second step involved the generation of land use and land cover (LULC) maps. Derived land use and land cover map were superimposed on landform map to develop Land Ecological Unit (LEUs) map, the base map of LRI. Third and final step was the extensive traversing and groundtruth collection. Establishing phases of soil series and developing soil- landform relationship are the next part of third step. Thirty four blocks were surveyed, 5 from southern, western and north eastern region each, 14 from eastern region, 2 from northern region, 3 from central region.

Soils maps were prepared in Gajwel, Thimmajipet, Indravalle mandals of Telangana state. 11 soil series were identified in Bukkarayasamudrum Mandal of Andhra Pradesh state. Landform map was prepared in Kangayam Mandal, Tamil Nadu. Soil maps were prepared in Ankaleshwar, Khedbrahma, Deesa, Porbandar and Dholka Taluks of Gujarat. Soil maps of Deshapran and Ramnagar-I block, Purba Medinipur district, Kultali, Gosaba, Canning II and Namkhana block, South 24 Parganas district and Hasnabad Block, North 24 Parganas district, all of West Bengal were prepared. Soil survey was carried out in Kadwa block, Katihar district and Mushahari block, Muzaffarpur district, both from Bihar and tentative soil series were identified. Soil series were identified in Basudevpur (6), Titlagarh (12) and Ganjam (5) blocks all from Odisha state. Landform and land use maps were prepared for Dumka and Borio blocks of Jharkhand state. Soil map was prepared for Medziphema block, Dimapur, Nagaland, Diyun block, Changlang district, Arunachal Pradesh. In Meghalaya, soil map was prepared for Jirang block and land use and land form maps were delineated for Umling and Umsing blocks of Ri-bhoi district. Soil series were tentatively identified in Jagner Block, Agra district, Uttar Pradesh and Nagrota Bagwan block, Kangra district, Himachal Pradesh. In central region Darwha tehsil, Yavatmal district, Maharashtra and Bemetara block, Chattisgarh were surveyed. Landforms map was prepared for Dhanora block, Seoni district, Madhya Pradesh.

The organisation with different partner institutes studied 147 microwatersheds in the state of Karnataka under Sujala III Project. Land resource inventory was carried out and land use plan was suggested for six KVK farms located in Pratapgarh, Banswara, Dungarpur, Rajasamand, Bhilwara and Chittaurgarh, Central State Farm, Jaitsar, Sriganganagar district, Rajasthan and Pata Meghpar village, district Jamnagar, Gujarat ware also surveyed. Soil map was prepared of Baronda Farm in Raipur, Chhattisgarh and Ladhowal Farm of Ludhiana district, Punjab. Landform and land use / land cover maps were prepared in Miniwada Panchayat, Katol tehsil, Nagpur. Soil maps (1:50000 scale) were prepared for Bolangir subdivision, Odisha and Shimla district, Himachal Pradesh and Malappuram district, Kerala.

REMOTE SENSING AND GIS APPLICATIONS

The goal of land resource inventory (LRI) is to identify and delineate homogeneous soil patterns formed within a complex, heterogeneous soil forming environment to enable the lab to land transfer of agro-technology on a sustainable basis. The first subsection deals with the methodology standardization for pre-field activities of LRI. It includes generation of digital terrain model (DTM) of 10m spatial resolution through rigorous math model using Cartosat-1 stereopair data. Object-based (OBIA) semi-automated modeling techniques are applied to generate the slope, landform and land use/land cover (LULC) classification zone by taking into consideration the spectral and spatial/contextual properties of pixels and segmentation process with interactive learning algorithm. In OBIA, knowledge-based landform classifications model is employed on the combination of DTM, DTM derivatives and satellite images through multi-resolution (MRS) segmentation and classification rule set to incorporate the implicit knowledge of an expert into machine-understandable classification process. The LULC maps are prepared based on the current *rabi* season data of Cartosat merged IRS-R2-LISS-IV (2.5m) as well as high resolution (0.5m) public domain imagery at the backend so as to get the reliable land use boundary at cadastral level. The integration of three secondary layers i.e. landform, slope and land use are used to develop landscape ecological unit (LEU) map. Transacts were demarcated in GIS environment by assimilating the legacy data of 250k and expert knowledge.

Android based smart phone customized GIS application (consisting of following development tool: Microsoft Visual Studio 2010, HTML, Oracle 10g, OS-Windows) was developed for real-time collection and transfer of ground truth data to NBSS&LUP central web server.

A hierarchical geo-database structure having unified schema is proposed for developing the National Soil GeoPortal to disseminate the information in a user friendly way. Some of the proto type Geo-Portal application such as Indian Soil Information System (1:250000 scale) and District Soil Information system (DSIS) on 1:50,000 scale (50 Districts) developed during the year is also presented in the section. The Soil Information System developed for 50 districts is conserved in Geo PDF format for user friendly interactive map composition purpose.

Some case studies regarding the application of LRI data set are presented. Identification of soil quality indicators and assessing soil quality for different agricultural land utilization types under rainfed condition by integrating remote sensing technology with the LRI based field dataset is a novel attempt. Moreover, fertility mapping using geostatistical tool is also a value addition to the LRI dataset.

PEDOLOGICAL RESEARCH

Pedotransfer functions (PTFs) have been developed for prediction of moisture retention at 33, 300, 500, 800, 1200 and 1500 kPa. A noval method has been developed to determine available K in shrink-swell soils. Dataset of mineral assemblages in different function of soils for AER 10 (hot subhumid) and AER 6 (hot semiarid) of central India have been developed. Micromorphological studies indicated variations in plasma fabrics in soils under different climates because of extent of clay activity and shrink-swell phenomena. Characterisation of minerals in selected benchmark soils of Vidarbha region indicate the dominance of smectite in silt and clay fractions. Fine clays contain subordinate amount of Vermiculite, feldspars and mica. Soil organic carbon and yield of soybean and wheat crops were simulated using DNDC model which indicated that the model can simulate soybean and wheat yields satisfactorily for selected treatments only. An indigenous SOLAQ model has been developed for simulating soil carbon. The management practices such as application of nutrients which affect the soil and land qualities are also taken into account for nitrogen cycle. An algorithm was also developed using bioclimate/mean annual rainfall for correction factor of soil organic carbon determined by the Walkley-Black method.

INTERPRETATION OF SOIL SURVEY DATA

Soil map and nutrient maps were prepared in GIS environment. Plotwise and farmerwise soil health cards were extracted from site and nutrient database which will help to provide fertilizer recommendations and revise management for the crops of the region. Sixty soil health monitoring sites of traditional coffee growing region of Karnataka, Tamil Nadu and Kerala were identified and sampled. The soils are medium in macronutrients, rich in micronutrients except boron and zinc and deficient in Ca, Mg and S in some pockets. Similarly, 100 soil health monitoring sites for traditional rubber growing area were also identified and sampled. Fallow lands of Tamil Nadu have been mapped with latest techniques of geoinformatics. Two sample blocks were surveyed in detail to understand problem and potentials of fallows.

Mapping of salt affected soils of Tamil Nadu with the help of latest remote sensing data indicated that 4.8 per cent area of Tamil Nadu state is salt affected. Mapping of salt affected area in Mewat district of Haryana revealed that about 24% area of the district are severely to moderately affected with salinity. Studies were undertaken on desertification status of four vulnerable districts, two each in Andhra Pradesh and Karnataka with the help of Resource-2 AwiFs data on 1:50,000 scale. Comparison of time scale data indicated alkalinity development in Cauvery command area of Chamarajnagar district of Karnataka. Soil quality assessment in cotton growing areas of Maharashtra was carried out. Comparison of different methods indicated that PCA was best suited for soils of AESR 6.3 whereas conventional methods were superior in AESR 10.2. Studies on influence of irrigation on soil quality of Amravati district indicated that poor quality irrigation water had deteriorated the soil quality and the rate of deterioration has been faster in the last 5-10 years. To address this issue, recommendations were put forth to reclaim the soils and arrest further damage to the soils.

LAND EVALUATION AND LAND USE PLANNING

Some important issues bearing impact on Land Use Planning were investigated. In view of changing climate, it necessitated revisiting the earlier bioclimatic regime and length of growing maps (both published by ICAR-NBSS&LUP in 1992). The observations recorded in 2015 indicated considerable shifts in different bioclimatic regimes, the sub humid (moist) arid regime showed a decrease in area by 62.8 per cent and the humid regime increased by 74.0 per cent. The shift in LGP has increased in the western plains of Rajasthan, Gujrat plains and Haryana to 120-150 day class against the earlier LGP of 60-90 days. LGP has reduced in the states of Chattisgarh, north Odisha and western parts of Jharkhand by 16-20 per cent whereas LGP has increased in southern Andhra Pradesh, West and East Maharashtra, south Tamil Nadu, deltaic areas of Cauvery, south and west Karnataka, Assam valley, adjoining areas of Meghalaya and Tarai plains (West Bengal). Stronger magnitude of increasing extreme climatic events (viz. rainfall) was observed in AERs of semi arid, humid and sub-humid areas as compared to that in arid region.

70 per cent of prime land in a case study undertaken in Maharashtra remains under-utilized and 40 per cent of non prime land is not managed as per its suitability and both lead to extensive degradation in the event of drought/ excessive rainfall. The present scenario suggests that 64.8 million hectare cultivated land are degraded, 39.13 million ha accounting for rainfed and 25.69 million ha accounting for irrigated land. Extensive mining of P and K and also decreased income of each household were the results of nutrient-based subsidy of urea (N) in a case study of Karnataka; the impact of the subsidy on status of soil nutrients remains to be observed. A relook into the core growing areas of the commodity crops namely, soybean cotton and citrus indicated that, selection of right cultivar suiting to well defined soil and site characteristics and available resources with farmers is essentially needed to avoid degradation and ensure productivity of these corps.

Land evaluation undertaken to identify potential areas for pomegranate in the states of Maharashtra and Gujarat indicate about 3.5 per cent of the total area is highly suitable and 25.9 per cent not suitable in Maharashtra whereas 16.8 per cent and 9.2 per cent are highly and not suitable respectively in Gujarat. In Akola district, Modified Sys' parametric method was the best suitability evaluation method for cotton in the rainfed situations of Maharashtra. Chilli production in Maharashtra was observed to be a function of amount of clay, moisture content at -33 kPa and -1500 kPa, available water content, CEC, K Mg and Ca in the soils developed on basalt as well as granite-gneiss geological origin. Evaluation of soils of Buraka micro-watershed, Haryana for major crops indicated that pearl millet and mustard are highly suitable in less than 10 per cent area; wheat, sorghum, pigeonpea, mustard and potato are moderately suitable in 35 per cent area and are permanently not suitable for irrigated rice and pearl millet in about 21 per cent area.

The amount of runoff water that could be harvested in a monsoon season could be estimated by using SCS curve method under the best management options of soil and water conservation measures. Alternate land use options were developed for identified soil series of Chhata tehsil, Mathura district, Uttar Pradesh that were ecologically viable, economically sustainable and technologically appropriate. The higher sustainability yield index of pearl millet-wheat cropping system (as wheat equivalent yield) was observed in soil series A under management practice IV (15 t FYM ha^{-1}) of Shikhopur village, Gurgaon district, Haryana. Alternate land use options were also developed for each soil series that could fetch economic returns. Alternate land use options vis-a-vis size of land holdings were developed for identified phases of soil series of Hosanhalli micro-watershed in Karnataka. Cost:benefit ratios were also calculated for different farm classes in identified soil series.

Soil-based technologies were demonstrated in farmers' fields of H.D. Kote, Mysore, Bali Islands, Sundarbans, West Bengal and Upar Deurigaon in the Brahmaputra valley of Assam. A methodological framework was developed to prepare an integrated mutually agreed land use plan of H.D. Kote. Suggested land use plan in different crop-based interventions fetched economic returns in all the three places. There is also scope for upscaling of the technologies in H.D. Kote and Bali islands. Efforts are on for developing Decision Support System for Agricultural Land Use Planning using visual basic programming language. A sub-module formulating multi objective optimization model has been developed for land resource allocation.

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 centres came into existence that are located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur and address region 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 on page 2

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.

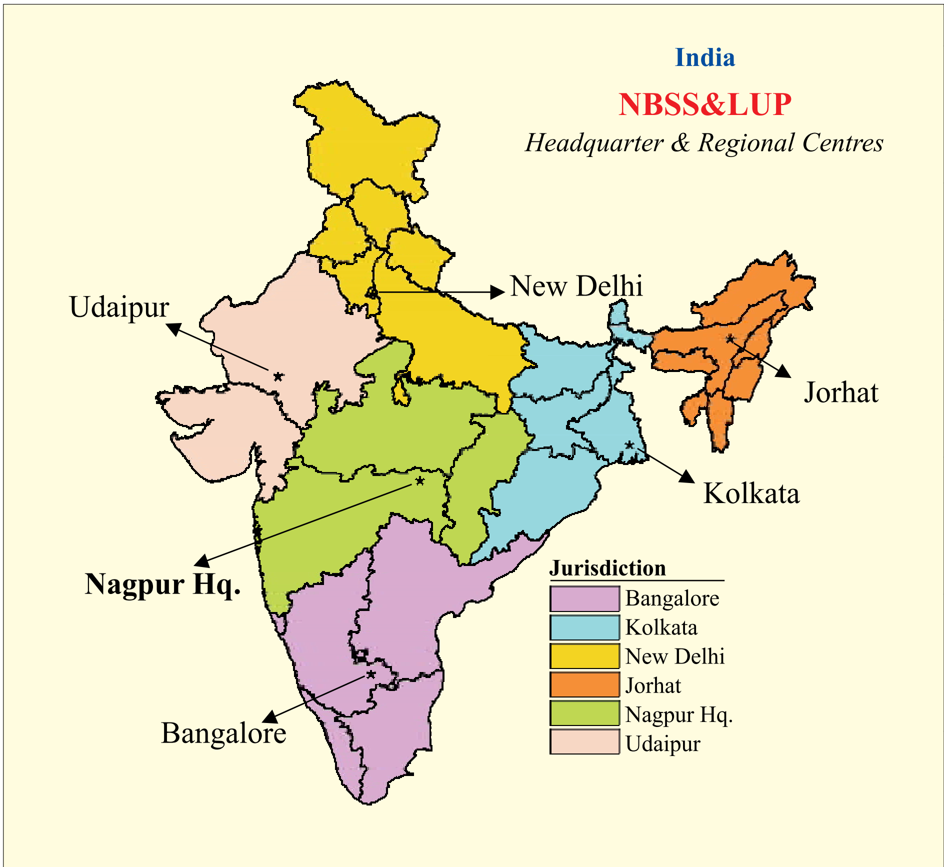
The role of the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) becomes all the more important in view of the serious challenges the country faces in terms of shrinking soil and land resource base, soil/land degradation, depleting nutrient stock, deterioration in soil/land quality, changing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



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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 Committee, 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

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.

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

➢ 1975-2010

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 1:500000 scale.
- A 20-Unit Agro-ecological region and a 60-unit Agro-ecological sub-region map of the country were developed for regional planning.
- 273 soil series have been entered into the National Register*.
- 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.

(* 300 soil series have been entered into the National Register upto March 2015)

➢ 2010-2014

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.

LRI Programme

- Time efficient and cost effective semi-automated method of landform mapping has been developed.
- Land Resource Inventory has been developed for 33 blocks of the country.

NEW INITIATIVE

National Network Project on Agricultural and Rural Land Use Planning

Micro-level agricultural land use planning will be taken up at the level of microwatershed/cluster of villages through interpretative use of Land Resource Inventory data generated under the above mentioned flagship project on LRI. The planning will be based on integration of biophysical, agro-technological and socio economic (including market forces) interactions to generate informed land use decisions.

LINKAGES

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

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

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.

PLAN BUDGET (2014-15)

Funds Received : 335 Lakhs

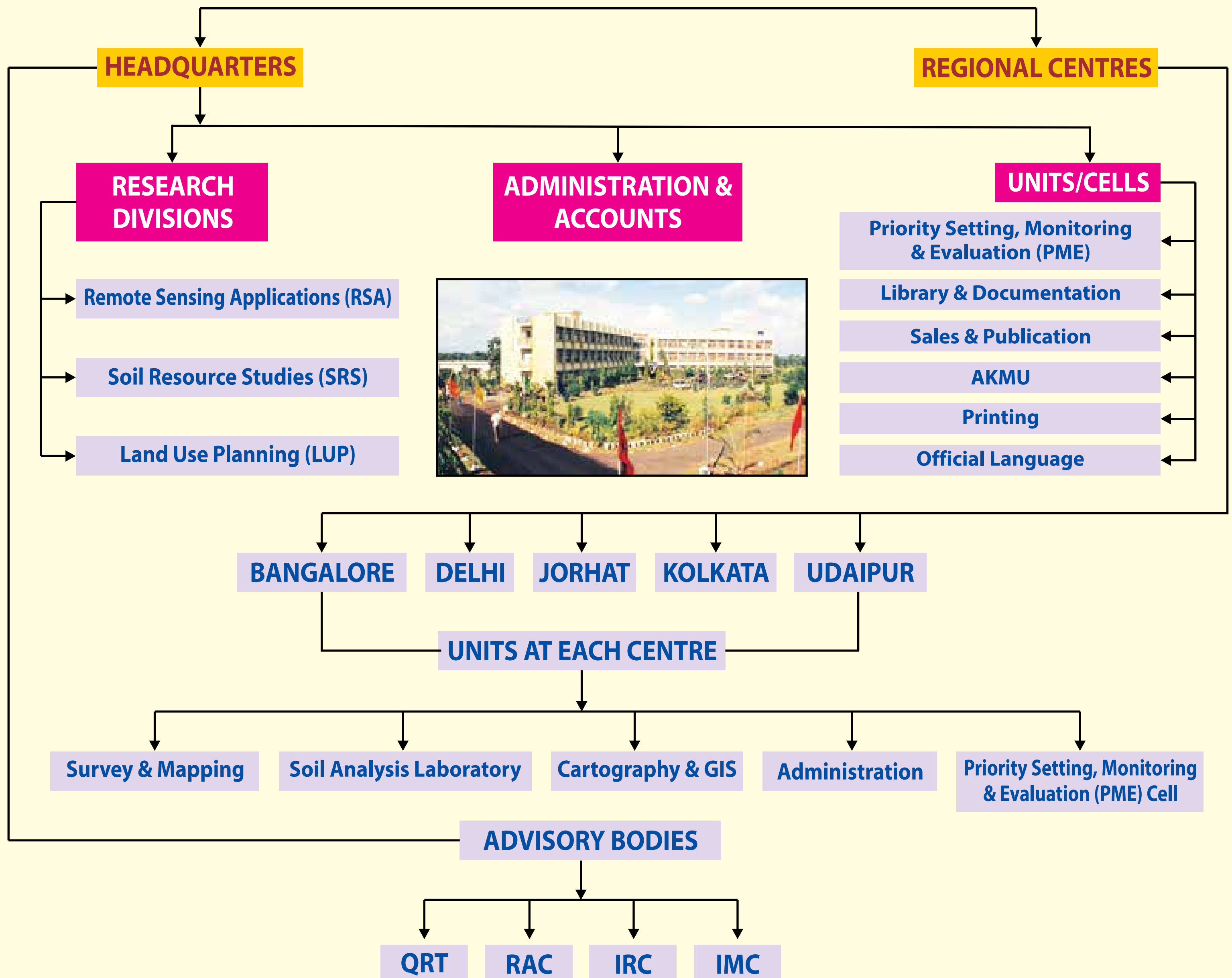
Funds Utilized : 324.96 Lakhs

STAFF STRENGTH (AS ON 31.03.2015)

Sl. No.	Name of Post	Total		
		S	F	V
1.	Scientific	100	72	28
2.	Technical	167	140	27
3.	Administrative	67	54	13
4.	Skilled Sup. Staff	76	61	15
	Grand Total	410	327	83

S: Sanctioned; F-Filled; V-Vacant

ORGANOGRAM


HEADQUARTERS
REGIONAL CENTRES
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UNITS/CELLS
Remote Sensing Applications (RSA)
Soil Resource Studies (SRS)
Land Use Planning (LUP)
Priority Setting, Monitoring & Evaluation (PME)
Library & Documentation
Sales & Publication
AKMU
Printing
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

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

2.1 INVENTORYING NATURAL RESOURCES

LAND RESOURCE INVENTORY (LRI) ON 1:10000 SCALE

Flagship project entitled "Land resource inventory on 1:10000 scale for enhancing productivity and transfer of technology" was initiated in a phased manner during 2014-15. In the first Phase (2014-2018), 60 blocks/ Mandals/Taluka targeting 3.3 million hectare are selected (Fig. 2.1.1). Each block/ Mandals/Taluka represents one agro-ecological subregion (AESR) of the country (Table 2.1.1). However, at the requests of different state goverments and other stakholders, number of blocks is increased in some of AESRs.

Fig. 2.1.1 : Blocks selected in different AESRs

Table 2.1.1 : Region-wise selected Blocks for the current year 2014-15

Region	Block/Mandals/Taluka
Southern	• Bukkarayasamudram (Anatpur, AP)
	• Indravalle (Adilabad, TG)
	• Thimajipet (Mehbubnagar, TG)
	• Gajwel (Medak, TG)
Western	• Ankaleswar (Bharuch, GJ)
	• Dholka (Ahmedabad, GJ)
	• Khedbrahma (Sabarkantha, GJ)
	• Deesa (Banaskantha, GJ)
	• Rapar (Kucchha, GJ)
	• Porbandar (GJ)
Eastern	• Titlagarh (Koraput, OR)
	• Basudevpur (Bhadrak, OR)
	• Ganjam (OR)
	• Kadwa (Katihar, Bihar)
	• Mushahari (Samastipur, Bihar)
North-eastern	• Medziphema (Dimapur, NG)
	• Diyun (Changlang, Arnachal Pradesh)
	• Three blocks of Ri-Bhoi district (MG)
Northern	• Jagner (Agra, UP)
	• Nagrota Bagwan (Kangra, HP)
Central	• Darwha (Yavatmal, MH)
	• Dhanora (Seoni, MP)
	• Bemetra (CH)

STEPS IN LAND RESOURCE INVENTORY

First step: is the generation of digital terrain model (DTM) particularly in the undulating terrain using cartosat-1 data of 1 meter resolution.Contour, drainage, hillshade and slope are the derived products of DTM. These are the input layers for developing precise and quantified data on landforms (Fig. 2.1.2).

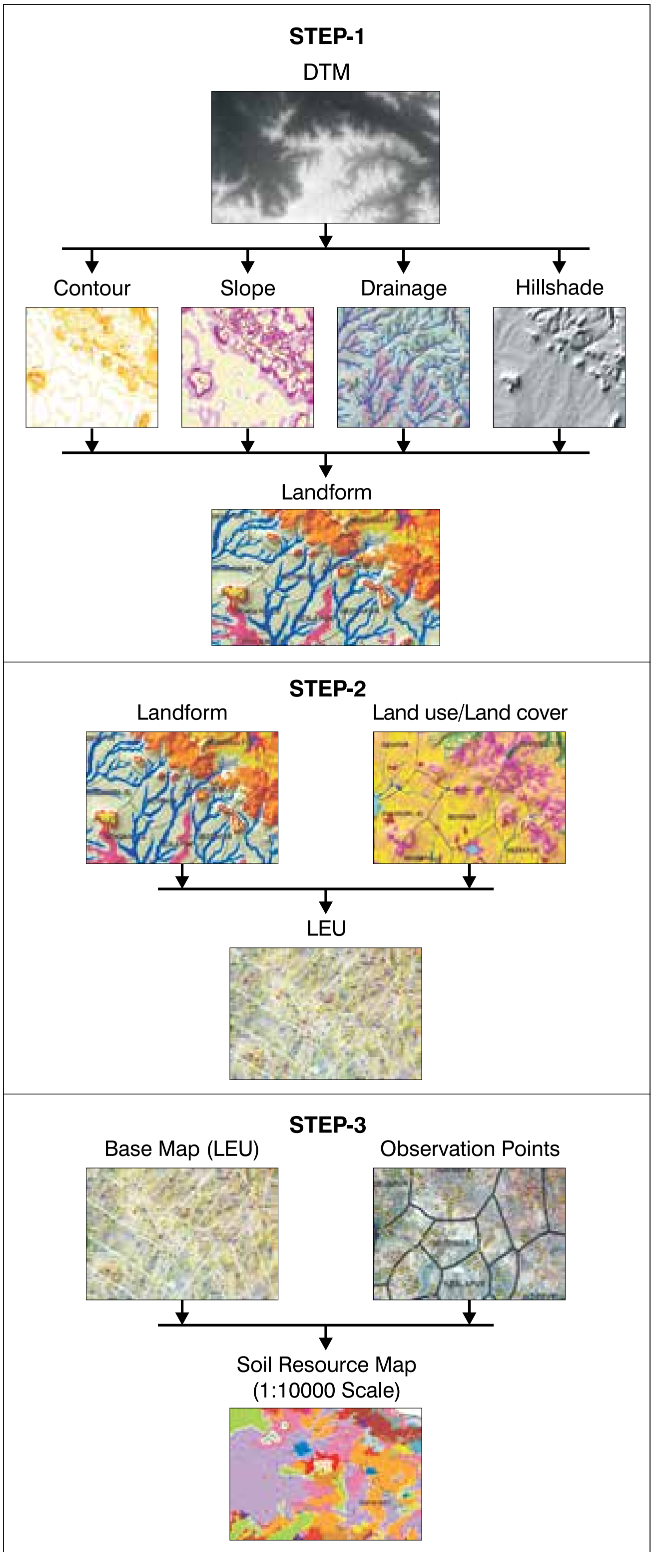


Fig. 2.1.2 : Steps in Land Resource Inventory

Second step: is the generation of land use and land cover (LULC) maps using IRS LISS IV data of 5.8 meter resolution and other data available in public domain. Derived land use and land cover map superimposed on landform map to develop Land Ecological Unit (LEUs) map, the base map of LRI. For delineating LEUs on flat topography IRS-LISS IV data together with other data available in public domain is used. LEUs are defined by a set of symbol D2s, D4w, U4w, D2d etc, consisting of letters and numerals. 1^{st} letter is the landform, 2^{nd} numeral is slope class and 3^{rd} letter is land use and land cover.

Third and final step: is the extensive traversing and groundtruth collection through minipits and profile investigations in well defined strips representing assemblage of LEUs. Precautions are taken to represent all the delineated units with adequate number of observatations.Establishing phases of soil series and developing soil- landform relationship are the next part of third step. Phases of soils series are defined by texture, depth, slope, erosion, gravelliness, salinity, sodicity and acidity. Extent and distribution of phases of soil series are shown on the maps, using soil-landform relationship. Finally linking cadastral and soil map constitutes the last part of the third step. The region-wise progress made in the project during year is reported here under.

SOUTHERN REGION

Gajwel

Gajwel mandal, Medak district in the state of Telangana extends from 78°34'53"to 78°47'23" E longitude and 17°47'21"to17°58'35" N latitude and covers an area of 21168 hectares in AESR 7.2. Six landform units were identified and the soils were mapped in sixteen phases of six soil series (Fig. 2.1.3a and b).

Thimmajipet

Thimmajipet mandal, Mahabubnagar district in the state of Telangana extends from 78°07'38" to 78°18'38" E longitude and 16°35'01"to 16°44'38" N latitude, and covers an area of 21579 hectare in AESR 7.2. Four landform units were identified (Fig. 2.1.4) and the soils were mapped in sixteen phases of eight soil series (Fig. 2.1.5).

Indravalle

Indravalle mandal, Adilabad district, Telangana is located between 78°32'58"to 78°46'10" E longitude and 19°22'36"to 19°34'12" N latitude covers an area of 23081 hectare in AESR 6.2. Eight landform units were delineated (Fig. 2.1.6) and soils were mapped in twenty phases of seven soil series (Fig. 2.1.7).

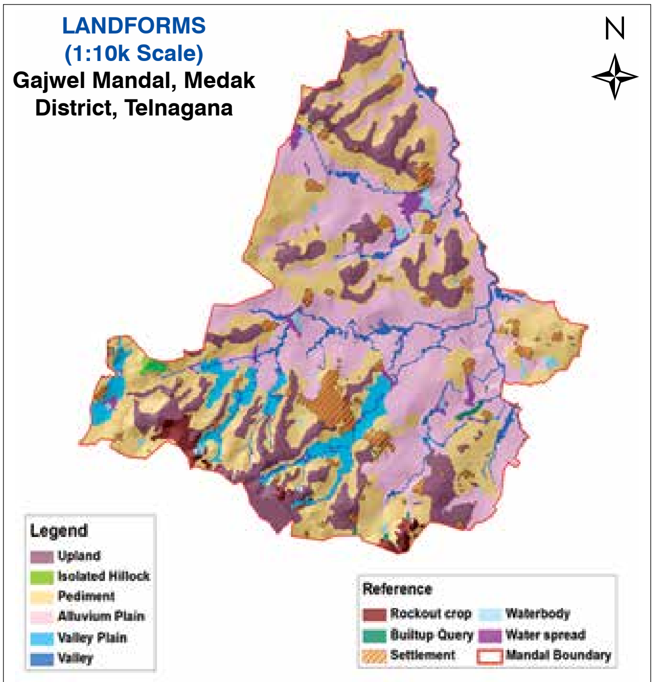


Fig. 2.1.3a : Landforms, Gajwel Mandal, Medak District, Telnagana

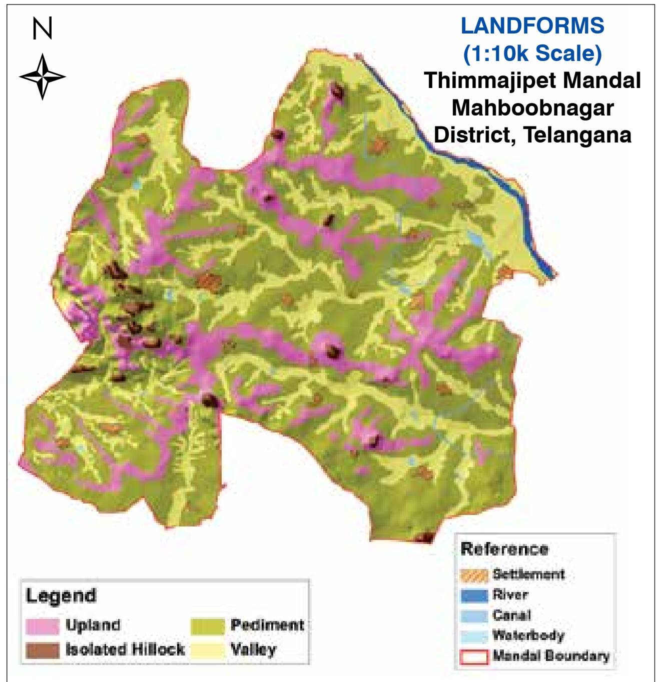


Fig. 2.1.4 : Landforms, Thimmajipet Mandal Mahboobnagar District, Telangana

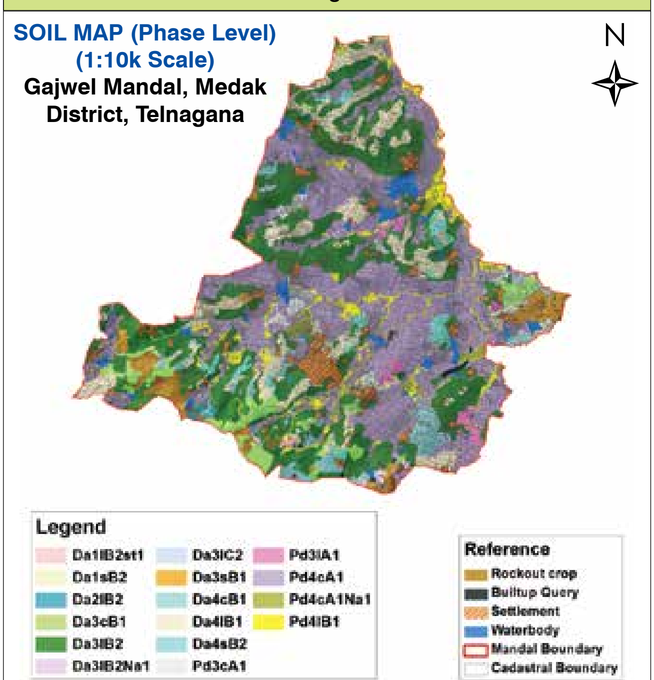


Fig. 2.1.3b : Soil Map, Gajwel Mandal, Medak District, Telnagana

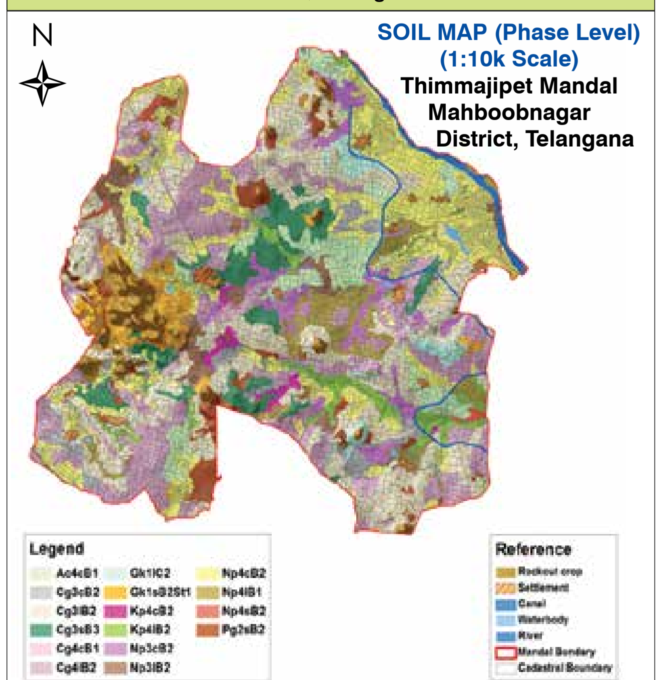


Fig. 2.1.5 : Soils, Thimmajipet Mandal, Mahboobnagar district, Telangana

(1st two letters – Soil series, 3rd numeral- soil depth, 4th letter – textural class (surface), 5th letter- slope class, 6th numeral-erosion class, 7th-stoniness)

(1st two letters – Soil series, 3rd numeral- soil depth, 4th letter – textural class (surface), 5th letter- slope class, 6th numeral-erosion class, 7th-stoniness)

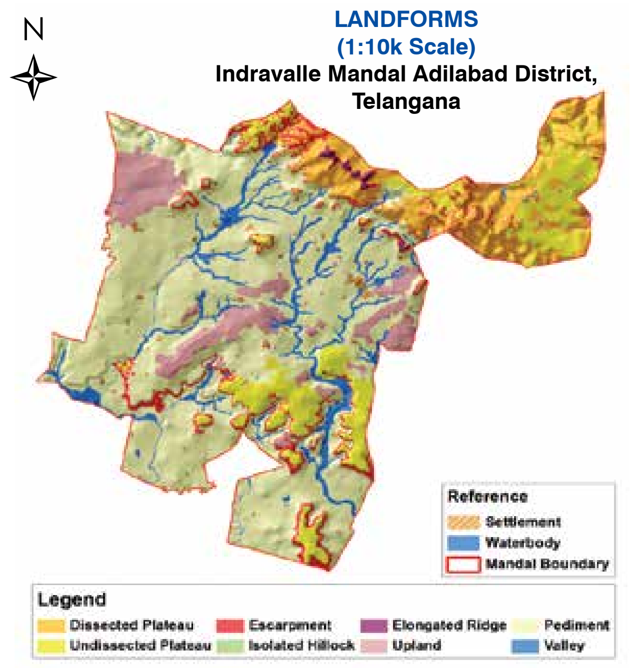


Fig. 2.1.6 : Landforms, Indravalle Mandal Adilabad District, Telangana

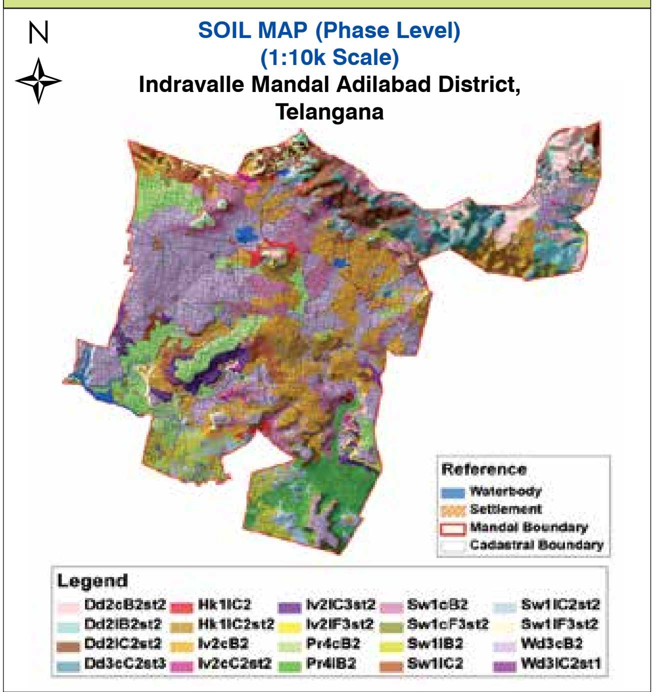


Fig. 2.1.7 : Soils, Indravalle Mandal Adilabad District, Telangana

Soil map (1st two letters – Soil series, 3rd numeral- soil depth, 4th letter – textural class (surface), 5th letter- slope class, 6th numeral- erosion class, 7th-stoniness)

Bukkarayasamudrum

Bukkarayasamudrum mandal, Anantpur district in the state of Andhra Pradesh extends from 77°47'42.6" to 77°33'39.8" E longitudes and 14°48'12.6" to 14°37'51.7" N latitudes and covers an area of 24808 hectare in AESR 3. The net sown area is 17991 hectares of which 2250 hectares are irrigated. Major crops under rainfed conditions are groundnut and red gram. The landform and profile locations are given in figure 2.1.8. Morphological characteristics of identified soil series are given in table 2.1.2.

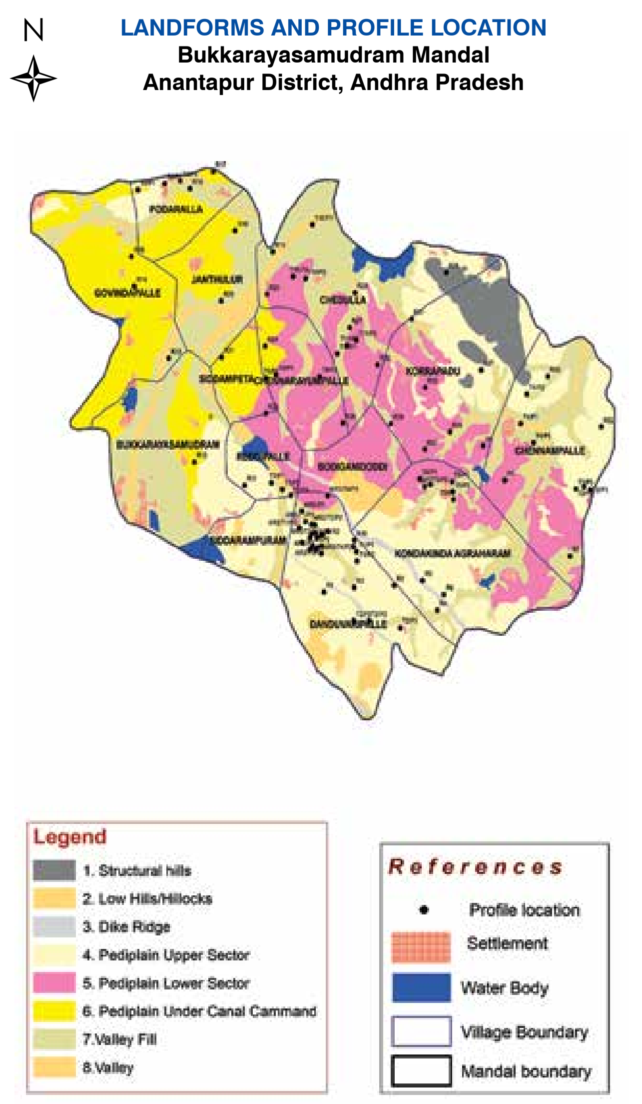


Fig. 2.1.8 : Landforms and profile location, Bukkarayasamudram Mandal, Andhara Pradesh

Table 2.1.2 : Description of soil series, Bukkarayasamudram mandal	
Series	Description
Granite-gneiss	
Siddaramapuram	Shallow, well drained, dark reddish brown to dark red soils, loamy sand to sandy clay loam at the surface; sandy clay loam to sandy clay in the subsurface
Chennampalli	Shallow, well drained, dark brown to dark reddish brown soils, loamy sand to sandy clay at the surface; gravelly (35-70) sandy clay loam to sandy clay in the subsurface
Dayyadakun-tapalli	Moderately shallow, well drained, dark reddish brown soils, loamy sand to sandy loam at the surface; gravelly (35-70) sandy clay loam to sandy clay soils in the subsurface
Lingareddipalli	Moderately shallow, well drained, dark reddish brown soils, loamy sand to sandy loam at the surface; sandy clay loam to sandy clay in the subsurface
Oldchedulla	Moderately shallow, well drained, dark reddish brown soils, calcareous sandy clay loam at the surface; gravelly (35-70) sandy clay loam to sandy clay in the subsurface
Venkatapuram	Moderately shallow, well drained, dark reddish brown soils, calcareous loamy sand to sandy clay loam at the surface; sandy clay to clay in the subsurface
Nilampalli	Moderately deep, well drained, dark reddish brown to red soils, loamy sand to sandy clay at the surface; sandy clay loam to sandy clay in the subsurface
Rekulakuntapalli	Deep, well drained, dark reddish brown to dark red soils, loamy sand to sandy loam at the surface; sandy clay to sandy clay loam in the subsurface
Alluvium	
Lolluru	Moderately deep, moderately well drained, very dark greyish brown to dark grey soils, calcareous clay to sandy clay at the surface and clay to sandy clay in the subsurface
Ragadikottur	Deep, moderately well drained, dark greish brown to very dark greyish brown soils, calcareous clay to sandy clay at the surface and clay to sandy clay in the subsurface
Govindapalli	Very deep, moderately well drained, dark brown to very dark greyish brown soils, calcareous loamy sand to sandy clay loam at the surface; sandy clay in the subsurface

KANGAYAM

Kangayam mandal, Tiruppur district in the state of Tamil Nadu extends from 77°43' 30'' to 77°24' 54'' E longitudes and 10°51' 35'' to 11°07' 47'' N latitudes and covers an area of 34072 hectares. Landforms namely, isolated structural hills and ridges, local rises, upper sectors of pediplains, middle sectors of pediplains, lower sectors of pediplains, valley fringes and the Noyyal-Amaravathi River valley floors are delineated and verified (Fig. 2.1.9).

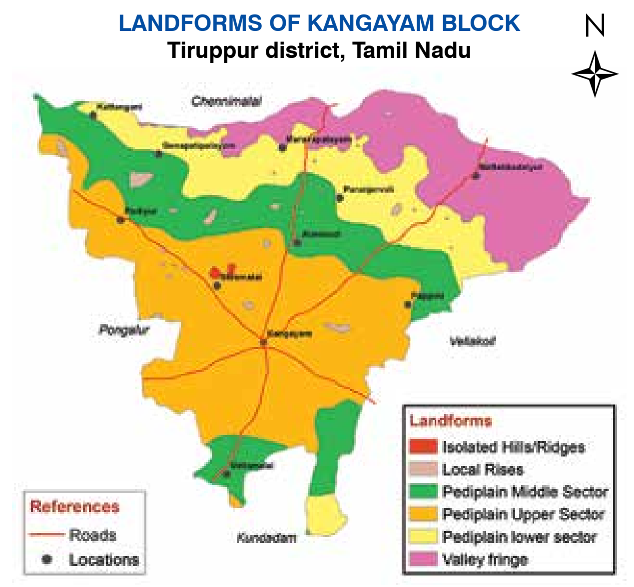


Fig. 2.1.9 : Landforms, Kangayam Mandal, Tiruppur District, Tamil Nadu

WESTERN REGION

Ankaleshwar

Ankaleshwar taluka, Bharuch district, Gujarat extends from 72°50'7" to 73°8'6" E longitude and 21°28'00" to 21°43'34" N latitude and covers an area of 43600 hectare in AESR 5.2. Agriculture is the dominant land use (Fig. 2.1.10). Four landforms, flood plain, alluvial plain, pediplain and mudflat are delineated. Soils are mapped into 14 phases of 10 soil series (Fig. 2.1.11).

Khedbrahma

Khedbrahma taluka, Sabarkantha district, Gujarat extends from 72°53'42" to 73°13'10" E longitude and 23°57'18" to 24°29'37" N latitude and covers an area of 83540 hectare in AESR 4.2. Land use map is prepared and soils are mapped in 12 phases of ten soil series (Fig. 2.1.12a and b).

LAND USE MAP OF ANKALESHWAR TALUKA
Bharuch District, Gujarat

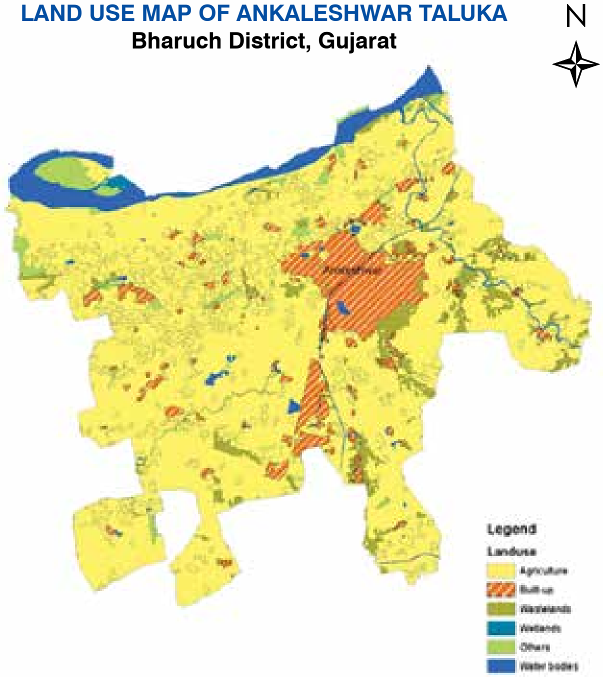


Fig. 2.1.10 : Land uses, Ankaleshwar taluka, Bharuch District, Gujarat

LAND USE MAP OF KHEDBRAHMA TALUKA
Sabarkantha District, Gujarat

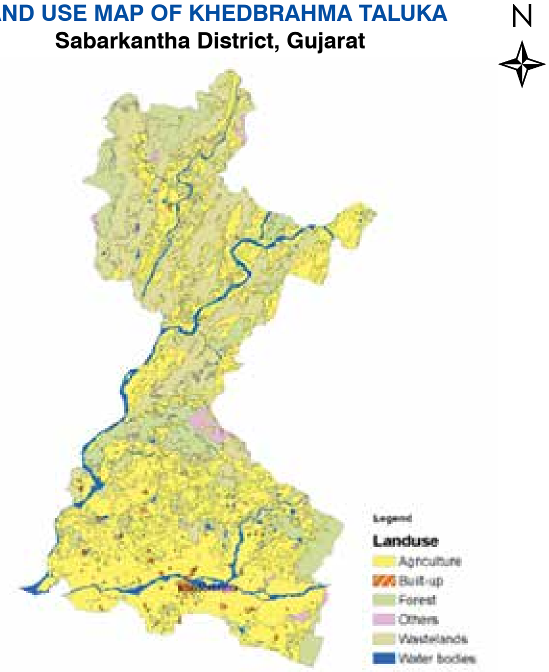


Fig. 2.1.12a : Land uses, Khedbrahma taluka, Sabarkantha District, Gujarat

SOIL MAP OF ANKALESHWAR TALUKA
Bharuch District, Gujarat

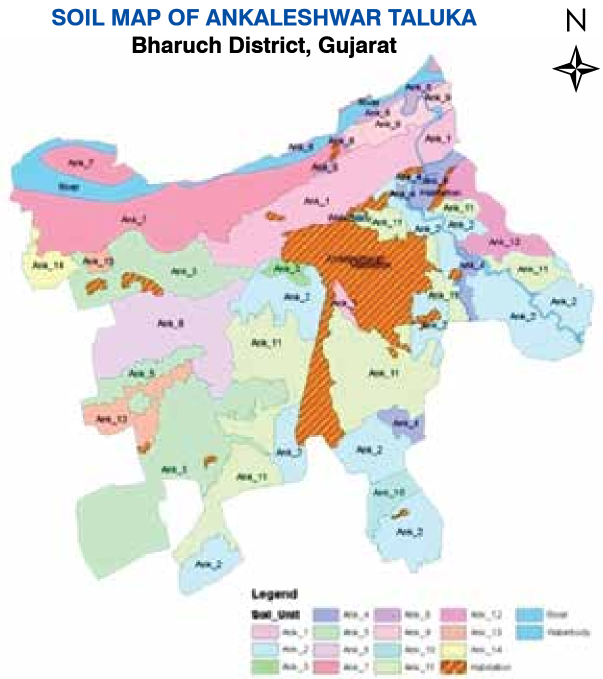


Fig. 2.1.11 : Soils, Ankaleshwar taluka, Bharuch District, Gujarat

SOIL MAP OF KHEDBRAHMA TALUKA
Sabarkantha District, Gujarat

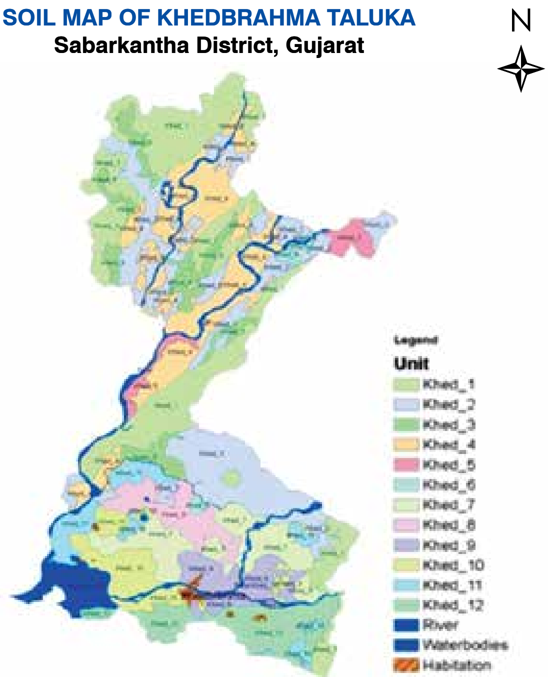


Fig. 2.1.12b : Soils, Khedbrahma taluka, Sabarkantha District, Gujarat

Deesa

Deesa taluka, Banaskantha district, Gujarat extends from 71°47'47" to 72°18'21" E longitude and 24°2'55" to 24°29'8" N latitude and coves an area of 1460 hectare in AESR 2.3. Agriculture is the dominant land use. (Fig. 2.1.13) and the soils are mapped in 16 phases of eight soil series (Fig. 2.1.14).

Porbandar

Porbandar taluka, Porbandar district, Gujarat extends from 69°22'57" to 70°1'43" E longitude and 21°13'38" to 21°58'41" N latitude and covers an area of 114330 hectare in AESR 5.3. Agriculture (Fig. 2.1.15) is the dominant land use with major cropping systems like groundnut-wheat, groundnut-coriander / cumin, groundnut / castor-jowar /lucerne, groundnut-cumin / coriander-til / mung, fallow-jowar, groundnut-chickpea etc. Soils are mapped in twenty eight phases of sixteen soil series (Fig. 2.1.16).

Dholka

Dholka taluka, Ahemdabad district, Gujarat extends from 72°8'54" to 73°13'10" E longitude and 22°23'59" to 22°51'39" N latitude and covers an area of 95000 hectare in AESR 4.2. Soils of Dholka Taluka are mapped into 19 phases of eleven soil series. Land uses (Fig. 2.1.17) and soil maps (Fig. 2.1.18) are prepared. Morphological characteristics of each mapping unit are given in table 2.1.3.

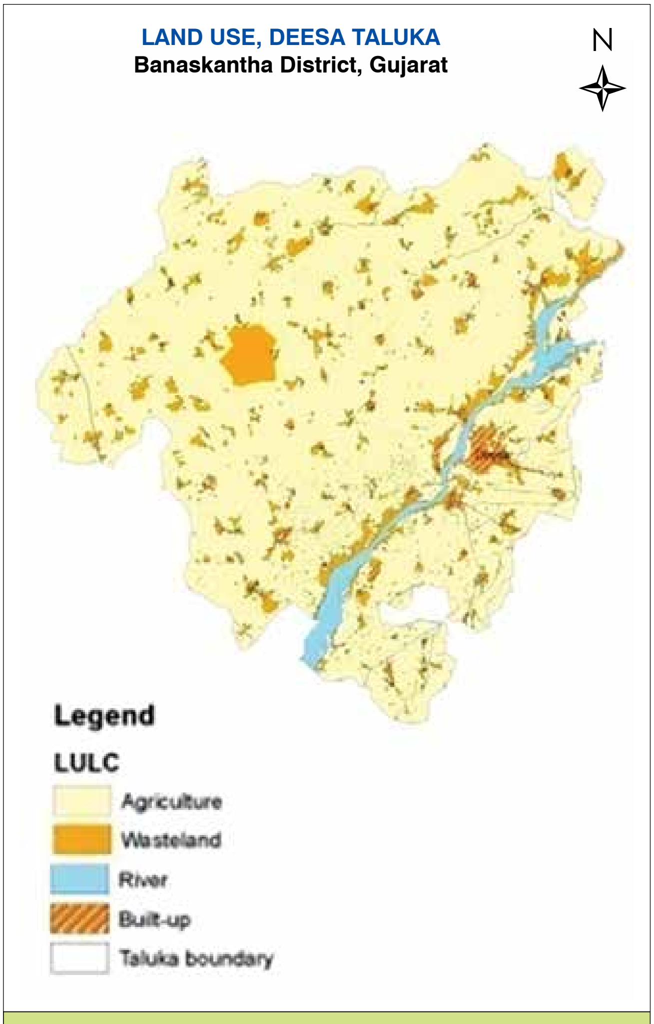


Fig. 2.1.13 : Land uses, Deesa taluka, Banaskantha district, Gujarat

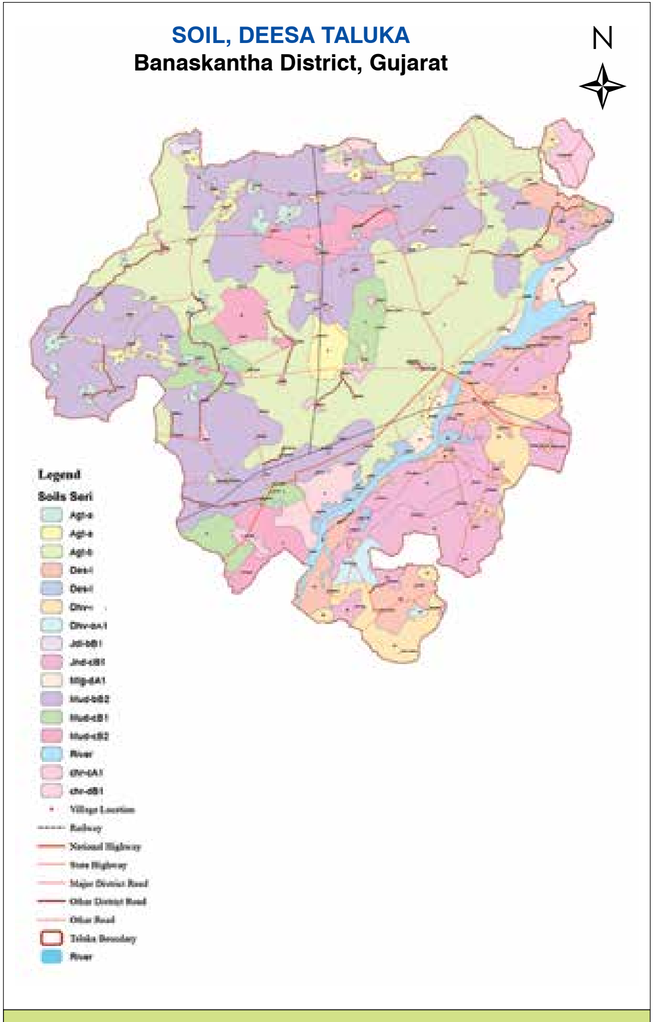


Fig. 2.1.14 : Soils, Deesa taluka, Banaskantha district, Gujarat

LAND USE MAP OF PORBANDAR TALUKA
Porbandar District, Gujarat

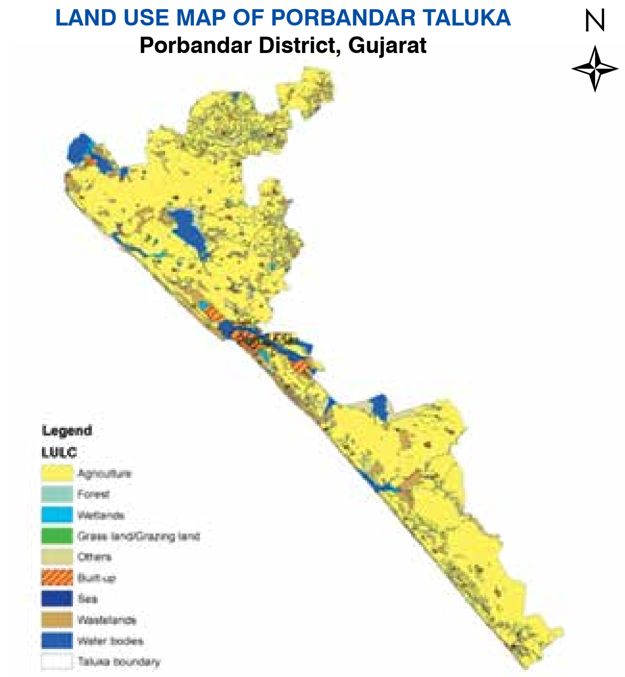


Fig. 2.1.15 : Land uses, Porbandar taluka, Porbandar district, Gujarat

LAND USE MAP OF DHOLKA TALUKA
Ahemdabad District, Gujarat

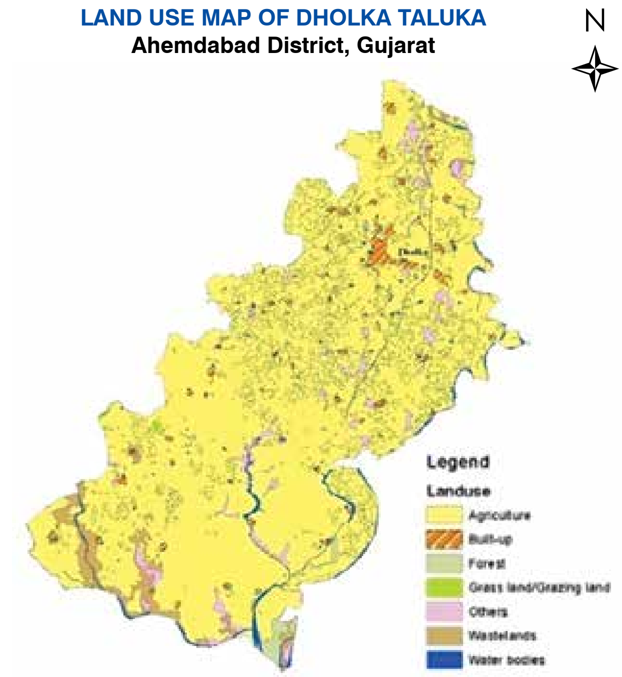


Fig. 2.1.17 : Land uses, Dholka taluka, Ahemdabad district, Gujarat

SOIL MAP OF PORBANDAR TALUKA
Porbandar District, Gujarat

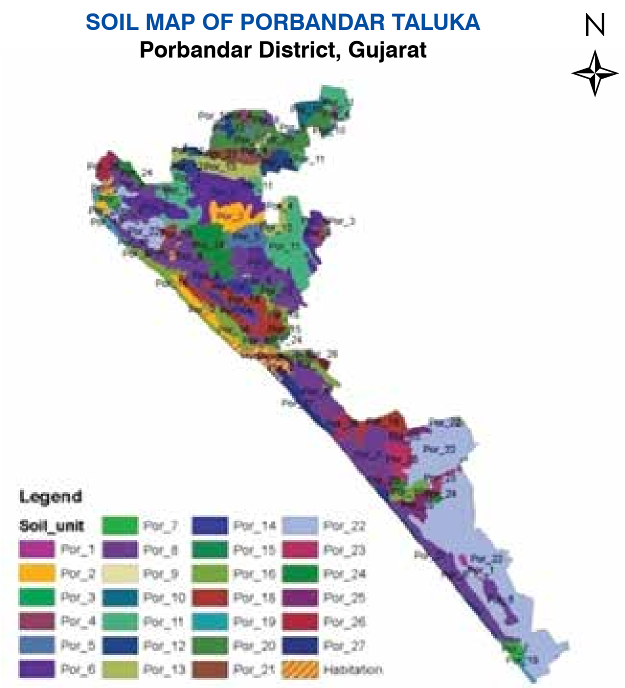


Fig. 2.1.16 : Soils, Porbandar taluka, Porbandar district, Gujarat

SOIL MAP OF DHOLKA TALUKA
Ahemdabad District, Gujarat

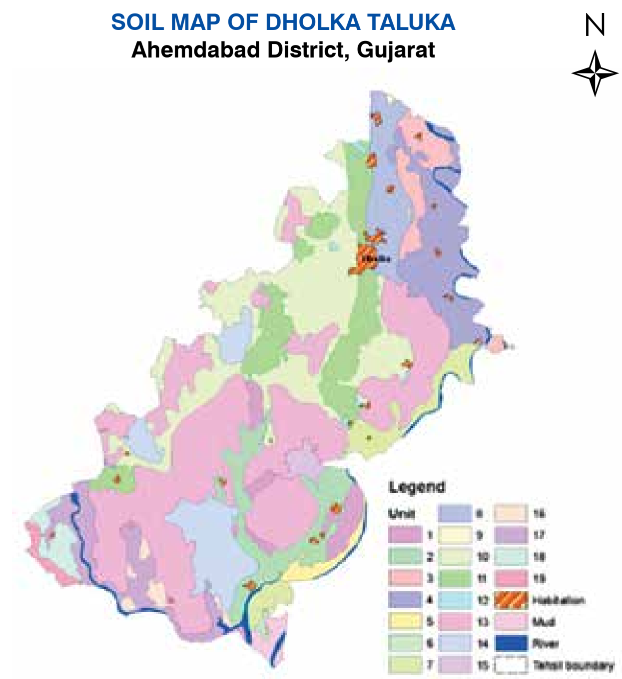


Fig. 2.1.18 : Soils, Dholka taluka, Ahemdabad district, Gujarat

Table 2.1.3 : Morphological characteristics of phases of soil series, Dholka taluka							
Series	Mapping unit	Drainage	Salinity	Flooding	Colour	Texture (Surface)	Texture (SCS)
GpD2:Very gently sloping flood plain							
Vataman	DHK 1	Imperfect	S2	F2	10YR3/2	cl	sl-l
Dholi	DHK 2	Moderately well	S2	F0	10YR3/1	c	sic-c
Saroda	DHK 3	Moderately well	S0	F0	10YR4/3	scl	sl-l
Ambliyara	DHK 4	Imperfect	S1	F2	10YR4/2	scl	cl-sc
Anandpura	DHK 5	Imperfect	S1	F2	10YR3/3	cl	sl-scl
	DHK 6	Imperfect	S2	F2	10YR3/3	scl	sil-scl
Girand	DHK 7	Moderately well	S0	F1	10YR4/2	cl	c-sic
GpD1:Very Gently sloping alluvial plain							
Badarkha	DHK 8	well	S0	F0	10YR3/3	scl	l-cl
	DHK 9	Imperfect	S0	F0	10YR3/3	cl	sc-c
GpD1:Very Gently sloping old alluvial plain							
Khanpur	DHK 10	Imperfect	S0	F0	10YR3/2	c	c-sc
	DHK 11	Very poor	S0	F2	10YR3/3	cl	sc-sc
	DHK 12	Imperfect	S1	F2	10YR3/2	c	sc-c
Ganeshpur	DHK 13	Imperfect	S1	F1	10YR3/2	c	c, cl
	DHK 14	Imperfect	S2	F2	10YR3/1	c	c, sicl
	DHK 15	Moderately well	S2	F1	10YR3/2	c	c
	DHK 16	imperfect	S2	F2	10YR3/2	c	c, sic
GwD6: Nearly level Low lying coastal plain							
Loliya-1	DHK 17	Very poor	S4	F3	10YR3/2	sic	sic, sicl, si, s
GwD4: Level to nearly level coastal plain							
Loliya-2	DHK 18	imperfect	S3	F1	10YR3/2	c	c, sic, sil
	DHK 19	Moderately well	S4	F2	10YR3/2	c	sicl, si

EASTERN REGION

Kadwa

Kadwa block, Katihar district, Bihar extends from 25°30' to 25°47' N latitude and 87°35' to 87°55' E longitude and covers an area of 34047 hectare. Two hundred sixty three villages under thirty Panchayats constitute Kadwa block which represent a part of Kosi and Mahananda interfluves in AESR 15 (Bengal basin and North Bihar Plain). IRS P6 LISS-IV is interpreted to prepare land use (Fig. 2.1.19) and landform maps (Fig. 2.1.20). Five soil series are tentatively identified. Soil-landform relationship is given in table 2.1.4.

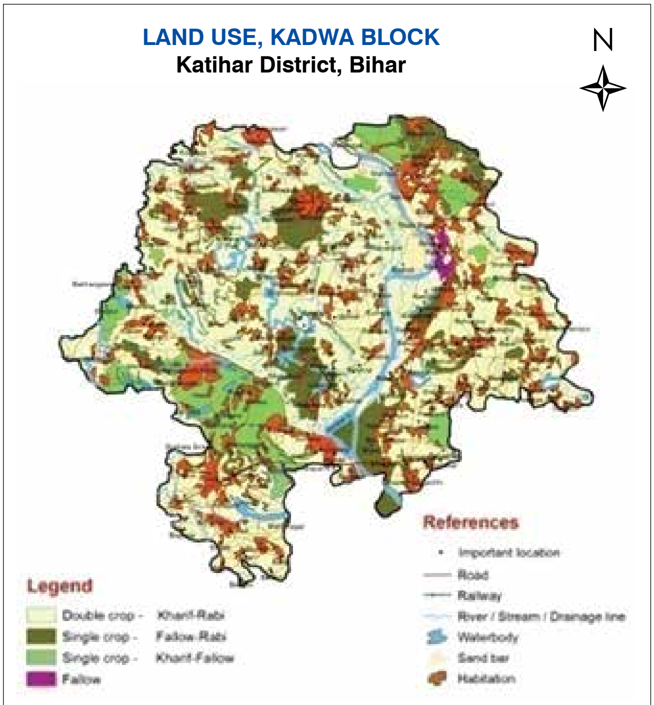


Fig. 2.1.19 : Land uses, Kadwa block, Katihar district, Bihar

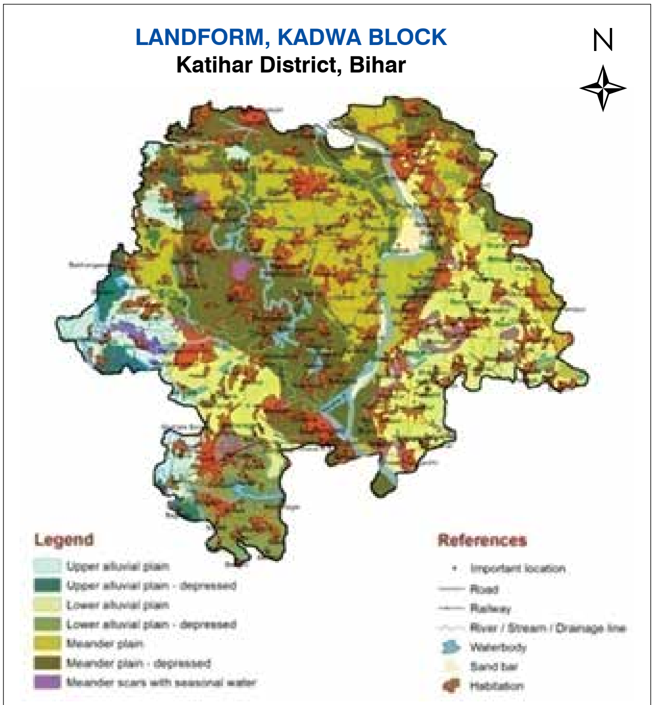


Fig. 2.1.20 : Landforms, Kadwa block, Katihar district, Bihar

Table 2.1.4 : Soil-landform relationship in Kadwa block

Landforms	Soil series	Characteristics	Classification
Meander plain	Sikarpur	Very deep, well drained, dark grayish brown, silty loam at the surface; brown to dark yellowish brown, sandy loam to silty loam in the subsurface with dark reddish brown mottles and moderate erosion	Coarse loamy, Typic Ustifluvents
Meander plain-depressed	Ashaini	Very deep, moderately well drained, grayish brown, silty loam at surface; brown to gray, loam to silt loam in the subsurface with reddish brown mottles and slight erosion	Coarse loamy, Aquic Haplustepts
Lower alluvial plain	Malikpur	Very deep, moderately well drained, light brownish gray, silt loam at surface; yellowish brown to dark gray, silt loam to silty clay in the subsurface with brown mottles and slight erosion	Fine loamy, Fluventic Haplustepts
	Dangi	Very deep, moderately well drained, gray, clay loam at surface, and brown to dark yellowish brown, silt loam to silty clay loam in the subsurface with dark brown mottles and slight erosion	Fine loamy, Typic Haplustepts
Upper alluvial plain	Bijhara	Very deep, somewhat poorly drained, gray, silt loam at surface; grayish brown to dark grayish brown, silt loam in the subsurface with brown mottles and slight erosion	Coarse loamy, Typic Endoaquepts

Mushahari

Mushahari block, Muzaffarpur district, Bihar extends from 26°02'30" to 26°1258"2 N latitude and 85°18' 42" to 85°31'20" E longitude and covers an area of 19610 hectare with net shown areas of 14571 hectare. It constitutes a part of AESR 13.1 (Eastern plain, hot sub humid moist) and represents the alluvium derived from a group rivers like Gandak, Burhigandak, Ghagra, Kosi and others. All of them originate from the lime rich foothills of the Himalayas. Land use map of the block is prepared (Fig. 2.1.21) and three landforms are delineated viz. upland (4511 hectare), medium land (8712 hectare) and low land (1348 hectare) (Fig. 2.1.22). Three tentative soil series are identified and are described in table 2.1.5.

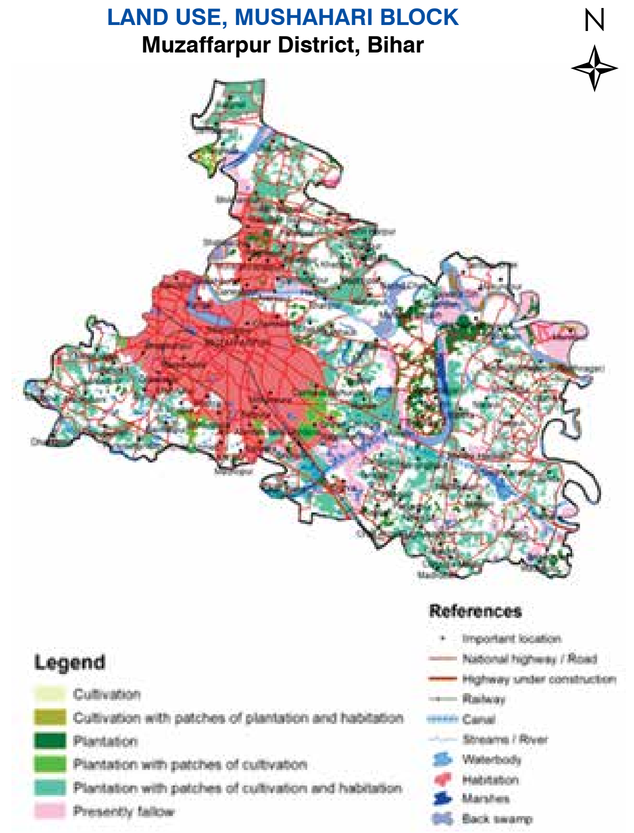


Fig. 2.1.21 : Land uses, Mushahari block, Muzaffarpur district, Bihar

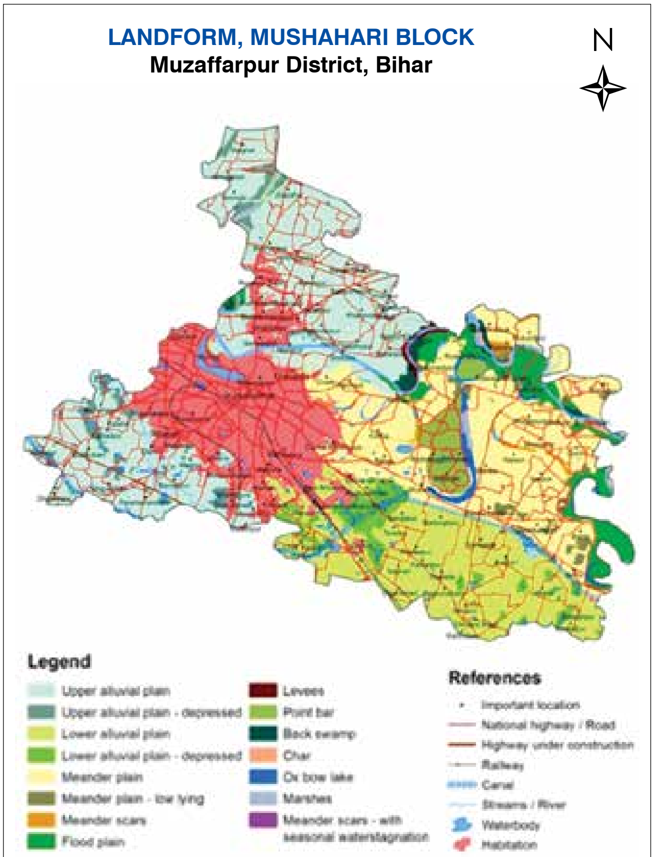


Fig. 2.1.22 : Landforms, Mushahari block, Muzaffarpur district, Bihar

Table 2.1.5 Soil series in Mushahari block

Landforms	Series Name	Description	Classification
Upper alluvial plain	Mushahari	Very deep, well drained, fine loamy calcareous soils, slightly eroded	Fine loamy, Typic Haplustepts
Meander scars	Fatepur	Very deep, moderately well drained, fine loamy calcareous soils, slightly eroded.	Fine loamy, Aeric Endoaquepts
Point bar	Madhubani	Very Deep, well drained, fine loamy calcareous soils, slightly eroded	Fine loamy, Typic Haplustepts

Basudevpur

Basudevpur block, Bhadrak district, Odisha extends from 20°56'36" to 21°13'58" N latitude and 86°38'32" to 86°54'47" E longitude and covers an area of 43150 hectare in AESR 18.4. Land uses (Fig. 2.1.23) and landform maps (Fig. 2.1.24) are prepared and six soil series are identified and described (Table 2.1.6).

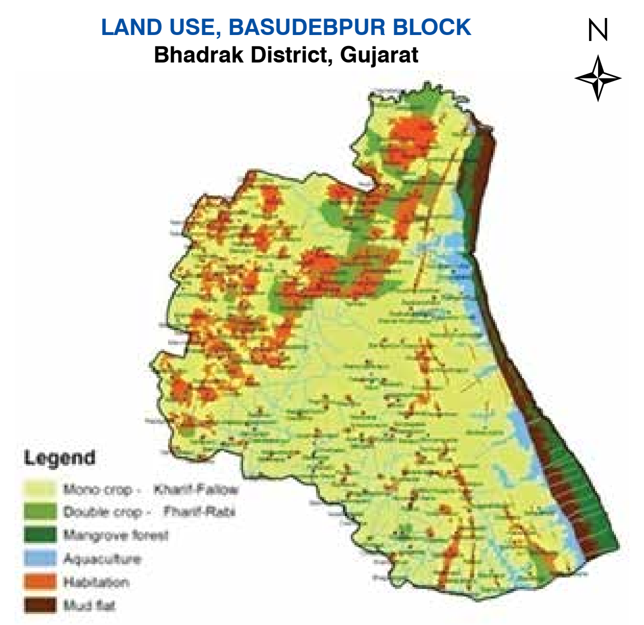


Fig. 2.1.23 : Land uses, Basudebpur block, Bhadrak district, Odisha

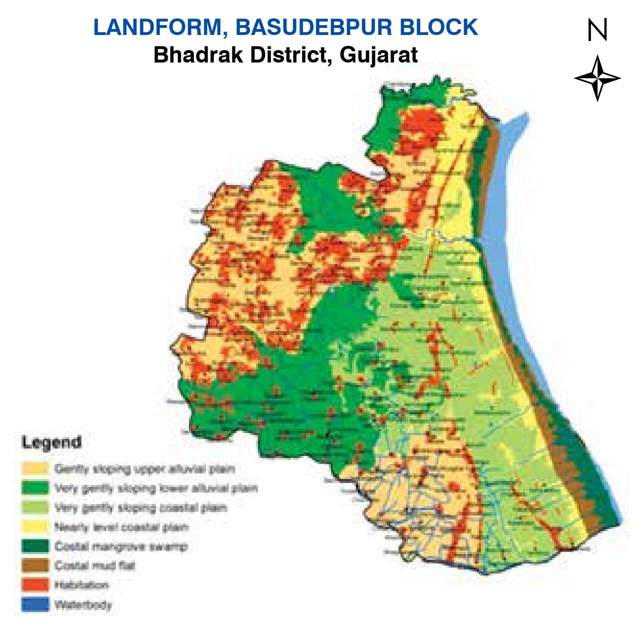


Fig. 2.1.24 : Landforms, Basudebpur block, Bhadrak district, Odisha

Table 2.1.6. Characteristics of identified soil series in Basudevpur block, Bhadrak district, Odisha

Landforms	Soil series	Characteristics	Classification*
Upper alluvial plain	Nuagaon	Very deep, poorly drained, yellowish brown, silt loam at the surface; yellowish brown to light brownish gray with brown mottles, silty clay loam to silty clay in the subsurface, slightly eroded.	Fine-loamy, Aeric Endoaquepts
	Mirga	Very deep, poorly drained, dark yellowish brown, clay at the surface; brown to light brownish gray with dark yellowish brown to red mottles, clay to silty clay in the subsurface, slightly eroded.	Fine, Typic Endoaquepts
Lower alluvial plain	Guagaria	Very deep, poorly drained, very dark grayish brown, silty clay at the surface; dark grayish brown to dark gray with dark reddish brown to dark brown mottles, silty clay in the subsurface, slightly eroded.	Fine, Vertic Endoaquepts
	Churamoni	Very deep, imperfectly drained, brown, sandy loam at the surface; light brownish gray to gray with yellowish brown mottles sandy clay loam to silty clay in the subsurface, slight erosion.	Fine-loamy, Typic Endoaquepts
Coastal alluvial plain	Kantipur	Very deep, poorly drained, very dark grayish brown, silt loam at the surface; dark grayish brown to gray with dark yellowish brown mottles, silt loam to silty clay loam in the subsurface, slightly eroded.	Fine silty, Typic Endoaquepts

Titlagarh

Titlagarh block, Bolangir district, Odisha extends from 20°10'02" to 21°04'38"N latitude; 82°40'52" to 83°40'33"E longitude with an area of 34931 hectare, consisting of 148 villages in AESR 12.1. Land use and landform maps are presented in Fig. 2.1.25 and Fig. 2.1.26 respectively. Soil series are tentatively identified and described (Table 2.1.7).

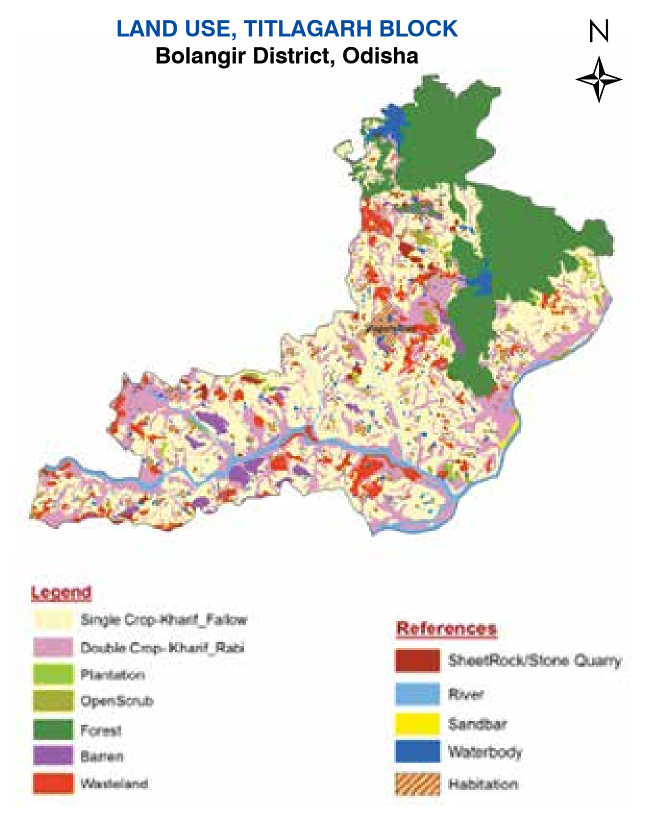


Fig. 2.1.25 : Land uses, Titlagarh block, Bolangir district, Odisha

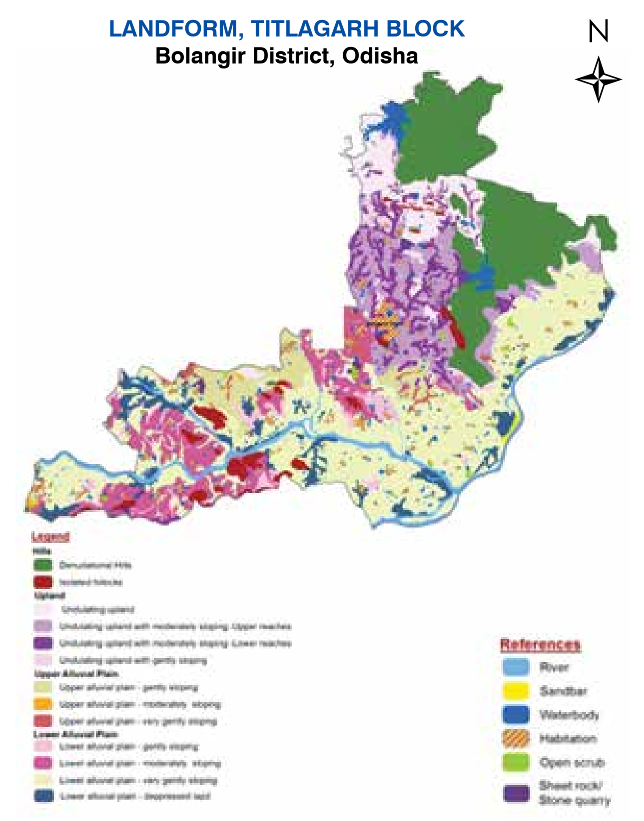


Fig. 2.1.26 : Landforms, Titlagarh block, Bolangir district, Odisha

Table 2.1.7 Soil series of Titlagarh block

	Landforms	Series	Description and Classification
A.	**HILLS** (Above 260 meters)		
	i) Denudational Hill (D)		Rock outcrops
	ii) Isolated Hillock (HI)		
B.	**Upland** (240 - 260 meters)		
	a. Undulating upland	Dumdumi	Moderately shallow, well drained, dark yellowish brown to yellowish brown gravelly (40-60%), sandy clay loam to loam at the surface; clay in the sub-surface, moderately to severely eroded **(Clayey-skeletal, Typic Haplustepts)**

cont....

B1.	**Upland** (220- 240 meters)		
	a. Undulating upland with moderately sloping upper reaches	Mathanpalla	Very deep, well drained, dark reddish brown to red sandy loam to loam at the surface;sandy clay loam in the sub-surface, moderately eroded **(Fine loamy, Typic Rhodustalfs)**
	b. Undulating upland with moderately sloping- lower reaches	Banjihal	Very deep, moderately well drained, dark yellowish brown, sandy clay loam at the surface; sandy clay loam to sandy clay in the sub-surface with slight erosion **(Fine loamy, Typic Haplustepts)**
	c. Undulating upland with gently sloping	Mahulpada	Moderately deep, well drained, yellowish red to red gravelly (60%), loamy sand at the surface; sandy loam in the sub-surface, with moderate erosion **(Loamy skeletal, Typic Haplustepts)**
C.	**Alluvial Plain** - Upper (200 - 220 meters)		
	i) Alluvial plain very gently sloping	Jampara	Very deep, moderately well drained, very dark grayish brown to dark brown, clayey at the surface; clay to sandy clay in the sub-surface with slight erosion **(Fine, Vertic Haplustepts)**
	ii) Alluvial plain gently sloping	Dorla	Moderately deep, moderately well drained, dark brown to dark yellowish brown, clay at the surface; clay loam in the sub-surface, slightly eroded **(Fine,Typic Haplustepts)**
	iii) Alluvial plain moderately sloping	Sihini	Deep, well drained, reddish brown to yellowish red, sandy loam at the surface; clay loam in the sub-surface with moderate erosion **(Fine loamy, Typic Haplustalfs)**
	iii) Alluvial plain very gently sloping	Jampara	Very deep, moderately well drained, very dark grayish brown to dark brown, clay at the surface; clay to sandy clay in the subsurface with slight erosion **(Fine, Vertic Haplustepts)**
D.	**Alluvial Plain** - Lower (170 – 200 meters)		
	i) Gently sloping lower alluvial plain	Nuvapara	Moderately shallow, imperfectly drained, brown to yellowish brown with yellowish red mottles, sandy clay loam at the surface and in the sub-surface with slight erosion **(Fine- loamy, Typic Haplustepts)**
	ii) Moderately sloping lower alluvial plain	Parsara	Very deep, imperfectly drained, dark grayish brown to very dark grayish brown with yellowish brown mottles, clay loam at the surface; clay in the sub-surface with slight erosion **(Fine, Aeric Endoaquepts)**
	iii) Very gently sloping lower alluvial plain	Kholan	Very deep, imperfectly drained, dark yellowish brown to yellowish brown with light olive brown mottles, sandy loam at the surface; clay in the the sub-surface with slight erosion **(Fine, Vertic Haplustepts)**
		Sirekala	Very deep, moderately well drained, dark grayish brown, clay loam at the surface; clay in the sub-surface with slight erosion **(Fine, Typic Haplusterts)**

Ganjam

Ganjam block, Ganjam district, Odisha lies between 19°22' 07" to 19°32'24" N latitude; 84°58'04" to 85°10'30" E longitudes; covers an area of 21104 hectare and administered with 14 gram panchayat and 114 villages in AESR 18.4. Land uses (Fig. 2.1.27) and landform maps (Fig. 2.1.28) are prepared.Five soil series are identified (Table 2.1.8).

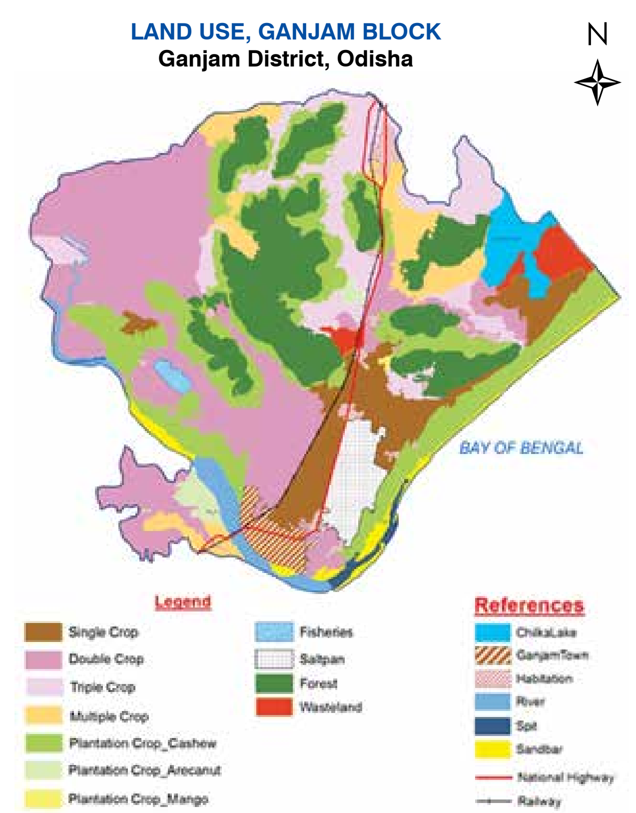


Fig. 2.1.27 : Land uses, Ganjam block, Ganjam district, Odisha

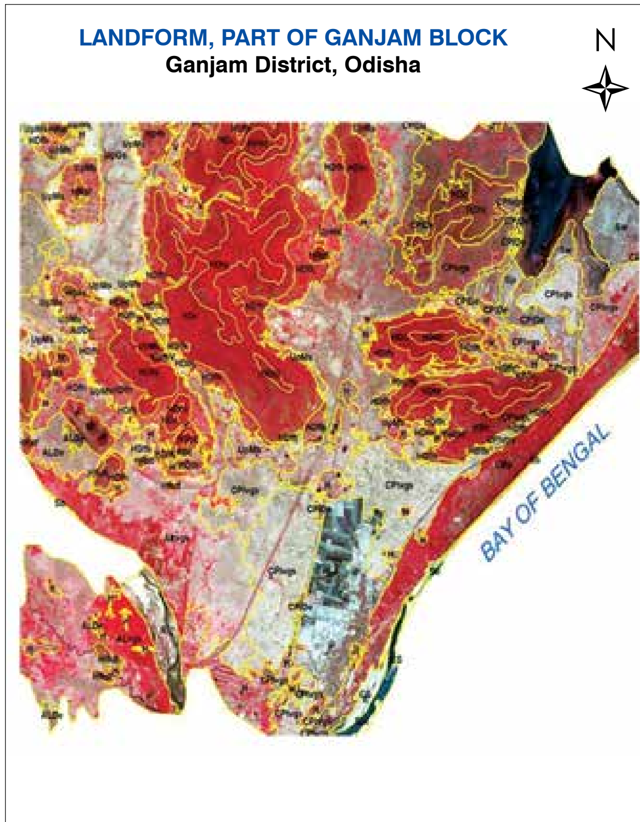


Fig. 2.1.28 : Landforms, part of Ganjam block, Ganjam district, Odisha

Table 2.1.8 Soil series, Ganjam block

Landform	Soil Series	Description
Foot hills	Kumaradapalli	Deep, well drained, dark yellowish red to dark red, sandy loam to clay soils with moderate to severe erosion **(Fine, Typic Rhodustalfs)**
Upland gently sloping	Jahami	Deep, well drained, brown to dark reddish brown, sandy loam to sandy clay soils with moderate erosion **(Fine, Typic Paleustalfs)**
Alluvial plain very gently sloping	Kanchara	Deep, moderately well drained, dark gray to very dark brown, silty clay to clay soils; frequently flooded **(Fine, Vertic Haplustepts).**
Coastal plain very gently sloping	Khatuakuda	Deep, somewhat poorly drained, brown to dark gray, silty clay loam to sandy loam soils, frequently flooded **(Coarse loamy, Typic Endoaquepts).**
Backshore/ Sandune	Kantiagada	Deep, somewhat excessivly drained, dark grayish brown, sandy loam to sandy soils, severely eroded and frequently flooded **(Sandy, Typic Ustipsamments).**

Dumka

Dumka block, Dumka district, Jharkhand is situated between 24°03'55" to 24°25'42" N latitude and 87°12'21" to 87°24'38" E longitude, covering an area of 37950 hectare in AESR 12.3. Four major landforms are delineated viz. plateau summit, pediment, upland, undulating plains, covering 4244, 5346, 11209 and 9824 hectares area respectively. These are further subdivided into thirteen units depending upon slope classes and land uses (Fig. 2.1.29)

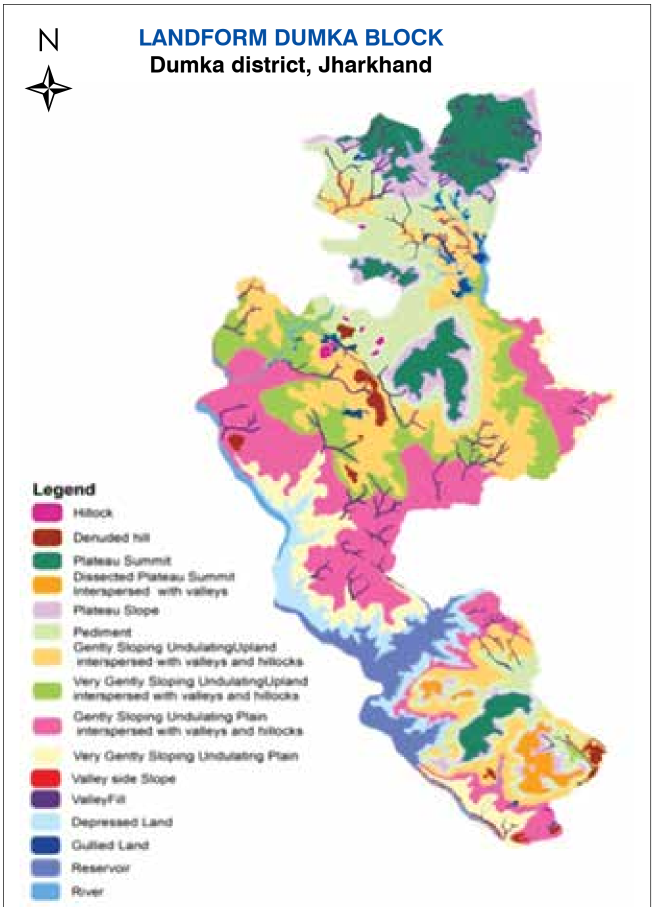


Fig. 2.1.29 : Landforms, Dumka Block, Dumka district, Jharkhand

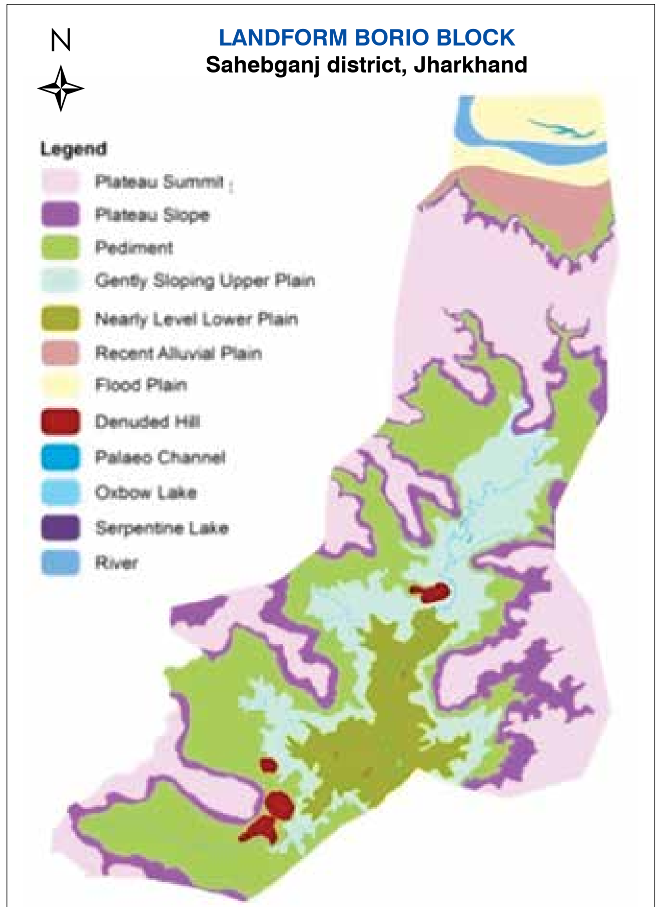


Fig. 2.1.30 : Landforms Borio block, Sahebganj district, Jharkhand

Borio

Borio block, Sahibganj district, Jharkhand lies between 24°57'36" to 25°16'48" N latitude and 87°25'00" to 87°35'45" E longitude and covers an area of 22000 hectare in AESR 12.3. Six major landforms are delineated and are subdivided into twelve sub units depending on slope classes and land uses (Fig. 2.1.30). The hills and plateau summits under forest cover occupied 11042 hectare area. Plateau slope and pediments accounted for 4976 hectare and 9925 hectare area in the block, respectively. The flood plain and recent alluvial plain in the north; gently to very gently sloping upper and lower plain in the southern part of the block occupied 10394 hectare area and are dominantly under intensive agriculture.

Deshapran

Deshapran block, Contai subdivision of Purba Medinipur district, West Bengal extends from 21°43'23" to 21°54'53" N latitude and 87°45'34" to 87°53'10" E longitude and covers an area of 17790 hectare in AESR 18.5. Three soil series are identified and mapped into nine phases (Fig. 2.1.31a and b).

Fig. 2.1.31a : Base map, Deshapran Block, Purba Medinipur district, West Bengal

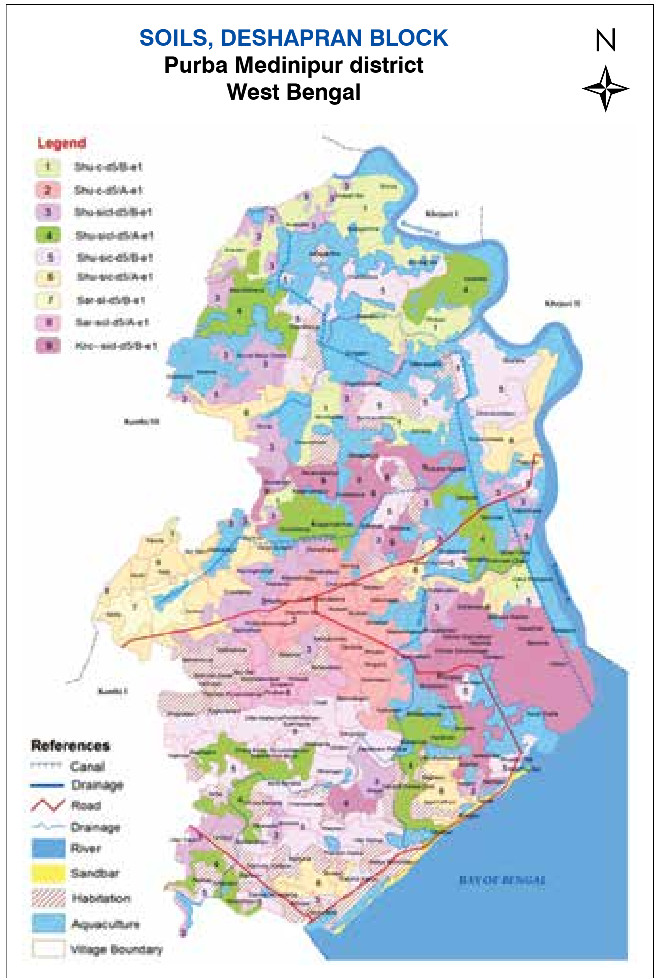


Fig. 2.1.31b : Soils, Deshapran Block, Purba Medinipur district, West Bengal

Kultali

Kultali block, South 24 Parganas district, West Bengal is located between 21°29'34'' to 22°13'21'' N latitude and 88°27'54'' to 88°42'8.6'' E longitude and has an area of 23948 hectare in AESR 18.5. Four soil series are identified and mapped into 11 phases (Fig. 2.1.32).

Canning II

Canning II block, South 24 Pargana district, West Bengal extends from 22°19'20” to 22°29'36” N latitude and 88°31'55” to 88°47'39” E longitude and covers an area of 40279 hectare in AESR 18.5. Five soil series are identified and mapped in 12 phases (Fig. 2.1.33).

Namkhana

Namkhana block, South 24 Parganas district, West Bengal is located between 21°04'33” to 21°50'59” N latitude and 88°10'52” to 88°18'27” E longitude and covers an area of 37061 hectare in AESR 18.5. Three soil series are identified and mapped into thirteen phases (Fig. 2.1.34).

Gosaba

Gosaba block, South 24 Parganas district, West Bengal is located between 21°32'07” to 22°17'17” N latitude and 88°42'14” to 89°04'30” E longitude and covers an area of 28585 hectare in AESR 18.5. Four soil series are identified and mapped in 16 phases (Fig. 2.1.35).

SOILS KULTULI BLOCK
24 Pargana South, West Bengal

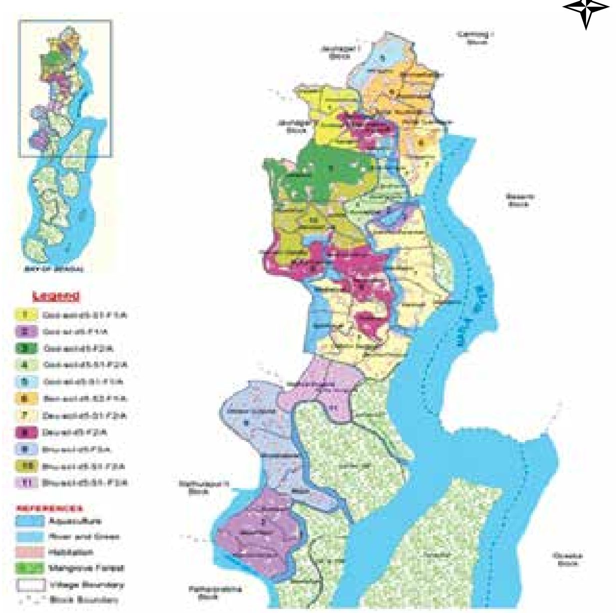


Fig. 2.1.32 : Soils of Kultuli block, 24 Pargana South, West Bengal

SOILS NAMKHANA BLOCK
24 Pargana South, West Bengal

Fig. 2.1.34 : Soils of Namkhana block, 24 Pargana South, West Bengal

SOILS, CANNING II BLOCK
24 Pargana South, West Bengal

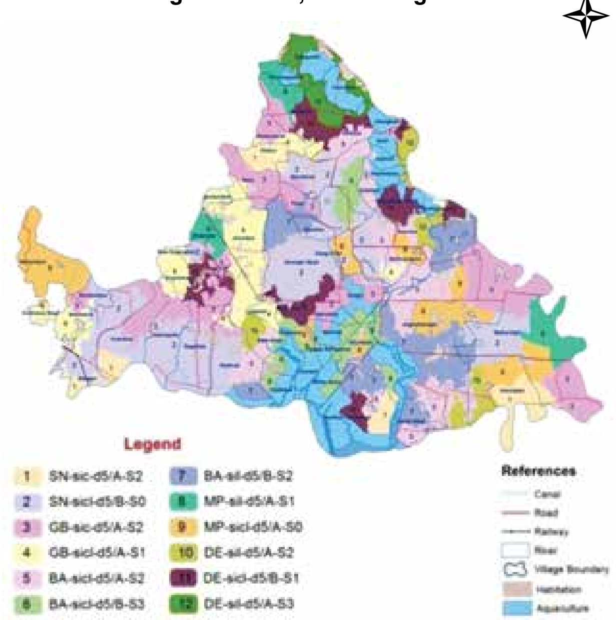


Fig. 2.1.33 : Soils, Canning II block, South 24 Parganas, West Bengal

SOILS GOSABA BLOCK
24 Pargana South, West Bengal

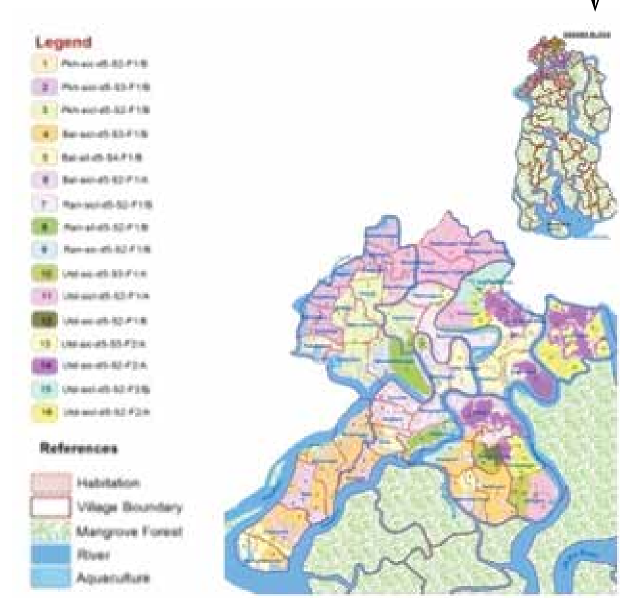


Fig. 2.1.35 : Soils, Gosaba block, South 24 Parganas, West Bengal

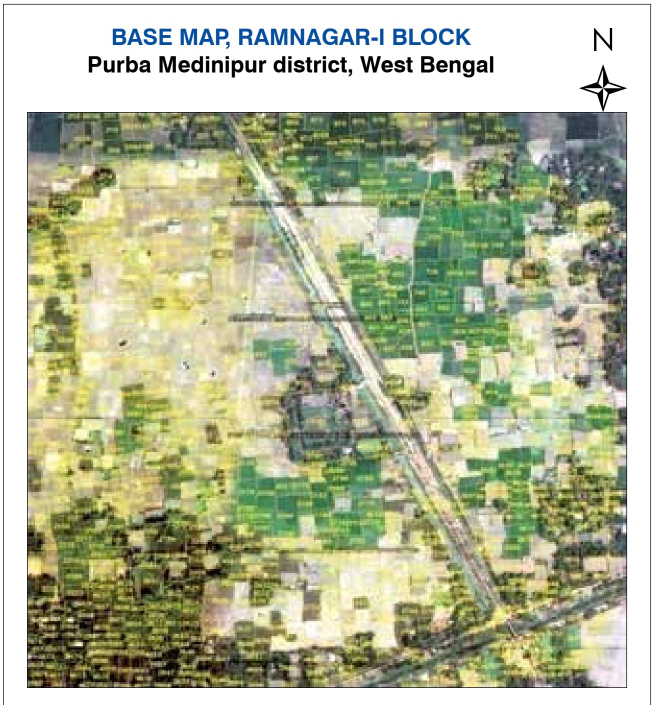


Fig. 2.1.36a : Base map Ramnagar-I block, Purba Medinipur district, West Bengal

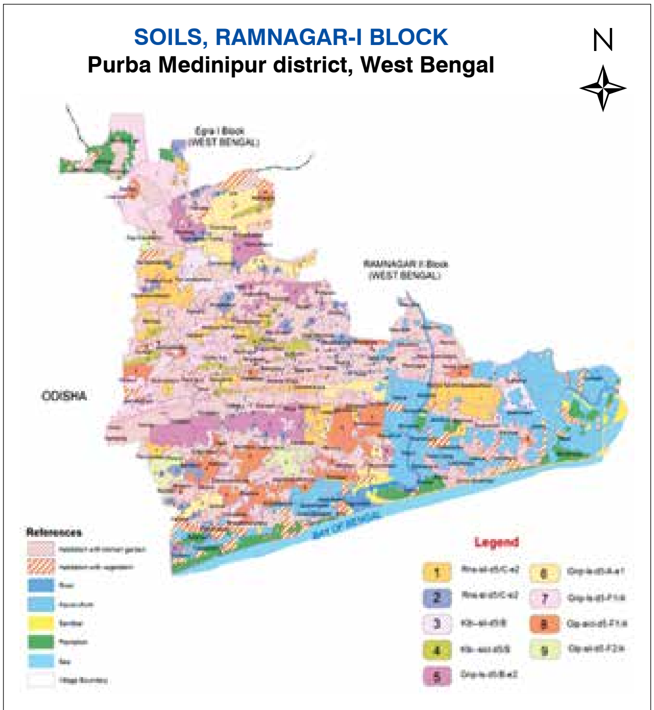


Fig. 2.1.36b : Soil map of Ramnagar-I block, Purba Medinipur district, West Bengal

Ramnagar-I

Ramnagar-I block, Purba Medinipur, West Bengal extends from 21°36'38" to 21°45'03" N latitude and 87°26'38" to 87°38'34" E longitude and covers an area of 13943 hectare area in AESR 18.5. Three soil series are identified and mapped into nine phases (Fig. 2.1.36a and b).

Hasnabad

Hasnabad block, North 24 Parganas district, West Bengal extends from 22°27'52" to 22°37'18" N latitude and 88°47'59" to 88°58'41" E longitude and covers an area of 15544 hectare in 15.1 AESR . Six soil series are identified and mapped into sixteen phases (Fig. 2.1.37).

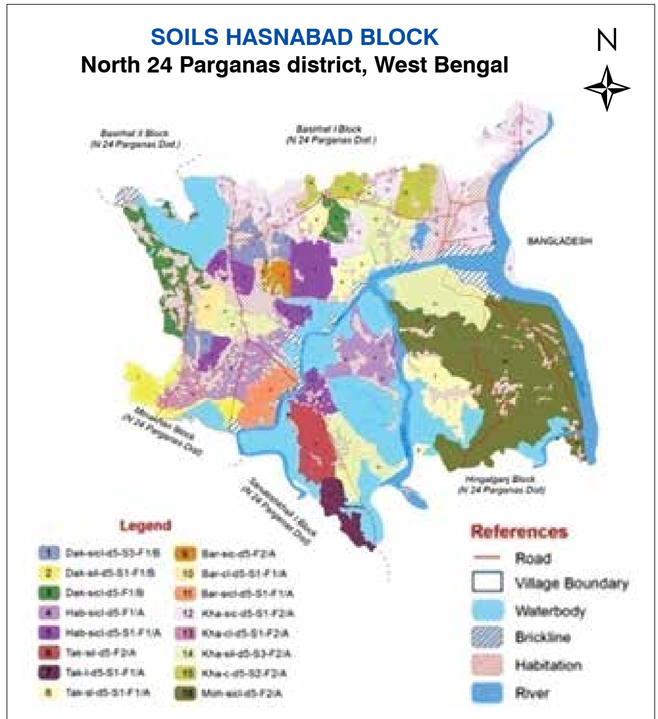


Fig. 2.1.37 : Soil map Hasnabad block, North 24 Parganas district, West Bengal

NORTH-EASTERN REGION

Medziphema

Medziphema block, Dimapur, Nagaland is situated between 25.62° to 25.98° N latitude and 93.63° to 94.0° E longitudes in AESR 17.1 and covers 63,262 hectare area in the state. Twelve landforms units are delineated (Fig. 2.1.38a and b); six soils series are identified and mapped in twenty phases.

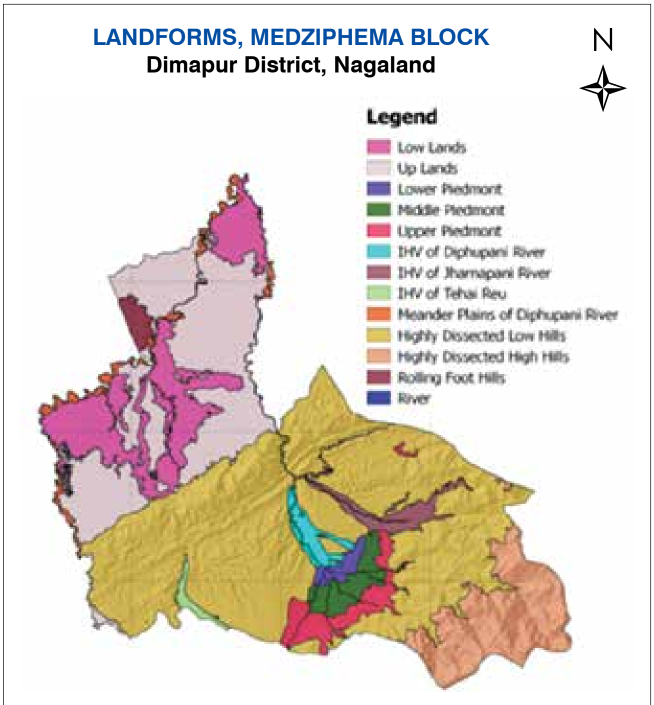


Fig. 2.1.38a : Landforms, Medziphema block, Dimapur District, Nagaland

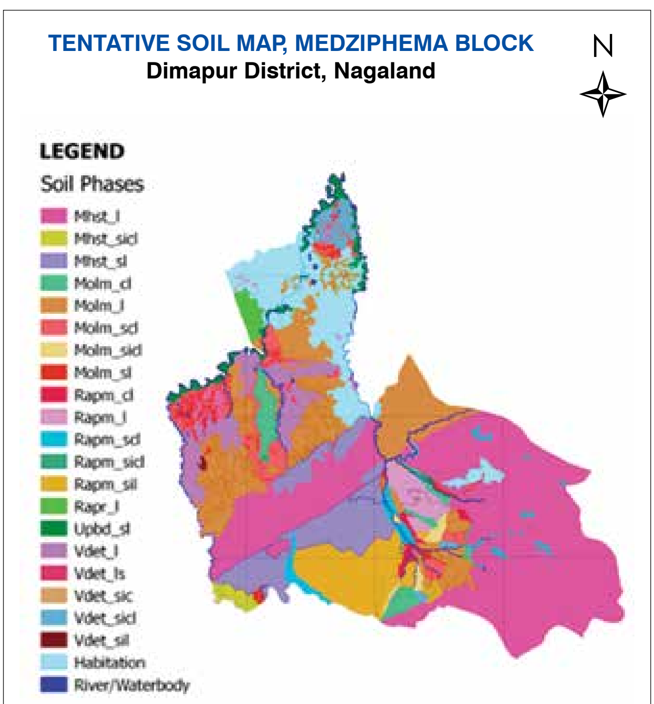


Fig. 2.1.38b : Soils Medziphema block, Dimapur District, Nagaland

Diyun

Diyun block, Changlang district, Arunachal Pradesh extends from 27°24'45" to 27°41'08" N latitude and 95°48'45" to 96°15'43" E longitude in AESR 16.3 and covers an area of 25414 hectare. Six landform units are identified (Fig. 2.1.39) and six soil series are mapped in 15 phases (Table 2.1.9).

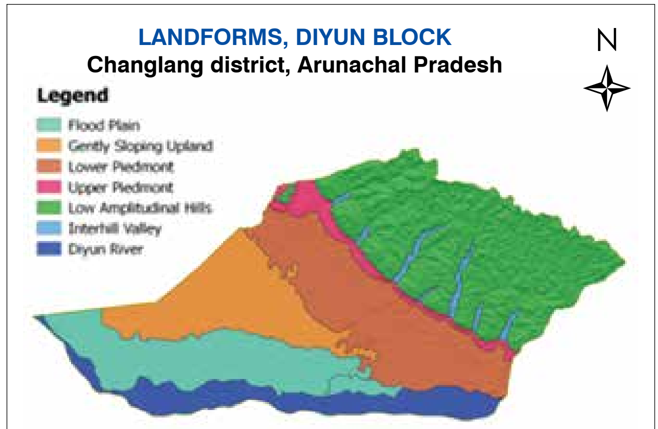


Fig. 2.1.39 : Landforms, Diyun block, Changlang district, Arunachal Pradesh

Table 2.1.9 : Soil series, Diyun Block

Landform	Series Name	Classification	Mapping unit (phases)*
Very gently sloping lower piedmont	Avoipur	Coarse loamy, Typic Eutrudepts	AvcC2, AvdC2, AvhC2.
Moderately sloping upper piedmont	Shyambasti	Coarse loamy, Typic Eutrudepts	SpcB1, SphB1, SpdC2.
Very gently sloping upland	Dumpathar	Coarse loamy, Typic Dystrudepts	DudC2
Moderately sloping upland	Sompoi	Coarse loamy, Typic Psamments	SocC2, SodC2, SofB1, SohB1.
Upper flood plain	Innao Sangmai	Fine loamy, Typic Dystrudepts	ISdC2, ISbB2.
Lower flood plain	Mudoi	Fine loamy, Typic Endoaquept	MohB1, ModB l.

*Phases 1st two letter denotes Soil series, 3rd letter texture, 4th letter slope and 5th number erosion.

Jirang

Jirang block, Ri-Bhoi district, Meghalaya located between 25°47'7.46" to 26°5'28.69" N latitude and 91°20'31.13" to 91°51'52.37" E longitude covers 68774 hectare area in AESR 17.1. Six major landform are delineated (Fig. 2.1.40) and six soil series are mapped in twelve phases (Table 2.1.10). Land use map is also prepared (Fig. 2.1.41).

Table 2.1.10 Soil series, Jirang block

Landforms	Series Name	No. of phases
Highly dissected hills with forest	Umsophanon-I	3
Highly dissected hills with scrubs	Nongrim Jirang	2
Lower plateau with tea plantation	Umsohphria	1
Lower plateau with shifting cultivation	Umtang	1
Gently sloping valleys with terrace paddy cultivation	Umsophanon-II	1
Nearly level plains with paddy cultivation	Sukurbaria	4

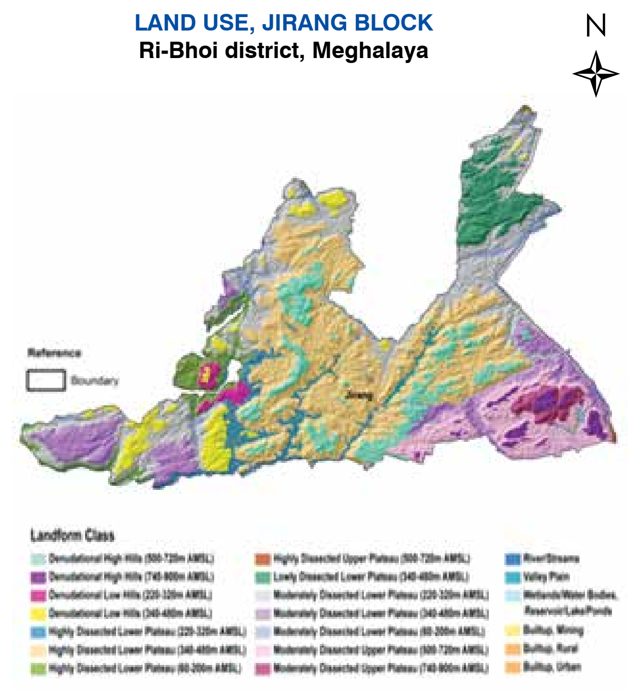


Fig. 2.1.40 : Land uses, Jirang block, Ri-Bhoi district, Meghalaya

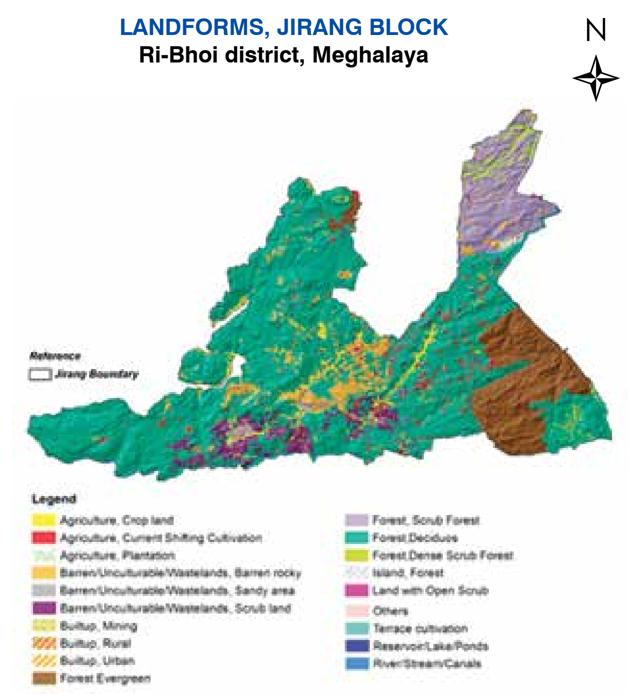


Fig. 2.1.41 : Landforms, Jirang block, Ri-Bhoi district, Meghalaya

Umling

Umling block, Ri-Bhoi district, Meghalaya located between 25°48'43" to 26°7'20" N latitude and 91°45'24" to 92°8'38" E longitude covers 69574 hectare area in AESR 17.1. Land use map is prepared (Fig. 2.1.42) and thirteen land form units are delineated (Fig. 2.1.43).

Umsing

Umsing block, Ri-Bhoi district, Meghalaya located between 25°37'31" to 26°4'43" N latitude and 91°45'50" to 92°16'41" E longitude covers 97566 hectare area in AESR 17.1. Land use and land cover map (Fig. 2.1.44) is prepared and fifteen land form units are delineated (Fig. 2.1.45).

LAND USE, UMLING BLOCK
Ri-Bhoi district, Meghalaya

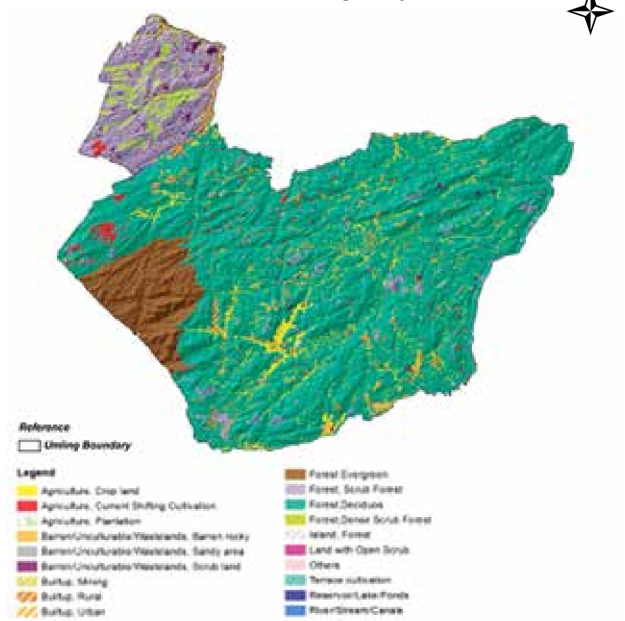


Fig. 2.1.42 : Land uses, Umling block, Ri-Bhoi district, Meghalaya

LAND USE, UMSNING BLOCK
Ri-Bhoi district, Meghalaya

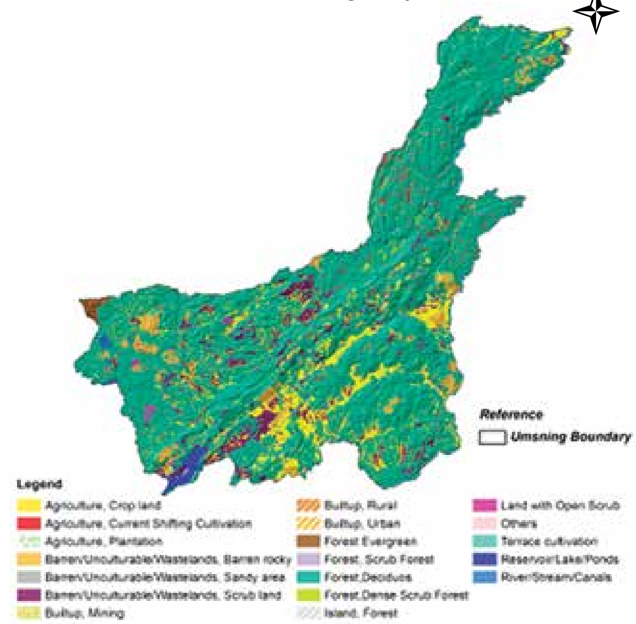


Fig. 2.1.44 : Land uses, Umsning block, Ri-Bhoi district, Meghalaya

LANDFORMS, UMLING BLOCK
Ri-Bhoi district, Meghalaya

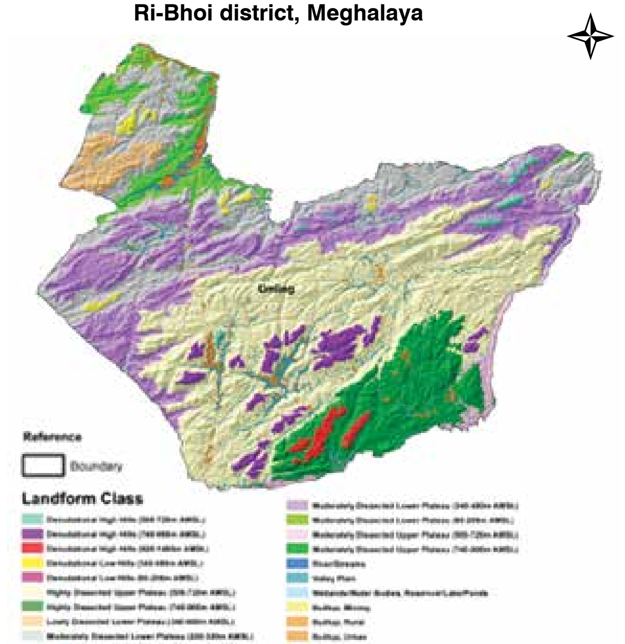


Fig. 2.1.43 : Landforms Umling block, Ri-Bhoi district, Meghalaya

LANDFORMS, UMSNING BLOCK
Ri-Bhoi district, Meghalaya

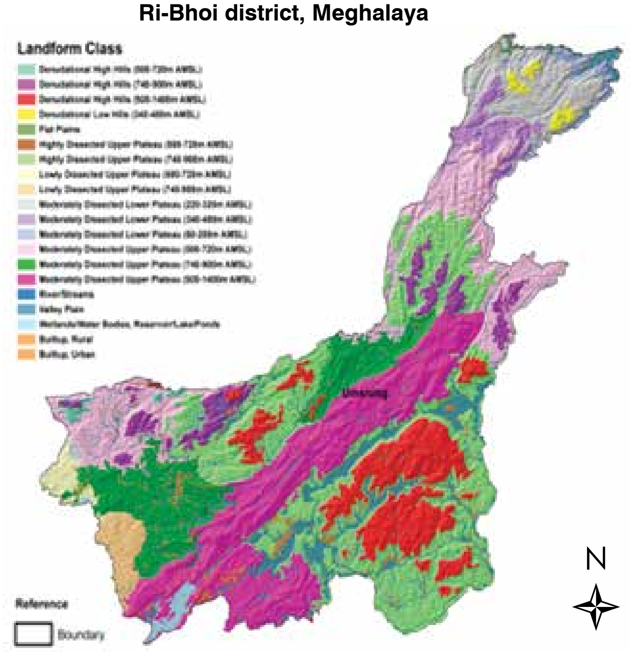


Fig. 2.1.45 : Landforms, Umsning block, Ri-Bhoi district, Meghalaya

NORTHERN REGION

Jagner

Jagner block, Kheragarh tehsil, Agra district, Uttar Pradesh (26°44' to 26°59' N latitudes and 77°25' to 77°45' E longitudes) covers an area of 29371 hectare and comprises 52 villages in AESR 4.1. Net sown area is 20607 hectare (70% of the total area) of which irrigated area is 15230 hectare (Fig. 2.1.46). Dominant rainfed crops are pearl millet, sorghum, pigeon pea and soybean in summers; gram, lentil, mustard and wheat in winters. Five landform are delineated such as Hill and hill slopes, very gently to gently sloping piedmont plains; gently sloping to nearly level alluvial plain; undulating gullies and fluvial channels, these are further subdivided into 14 subunits (Fig. 2.1.47). Around 28000 hectare area is surveyed during the year and thirteen soil series are identified (Table 2.1.11).

LAND USE / LAND COVER JAGNER BLOCK
Agra, U. P.

N

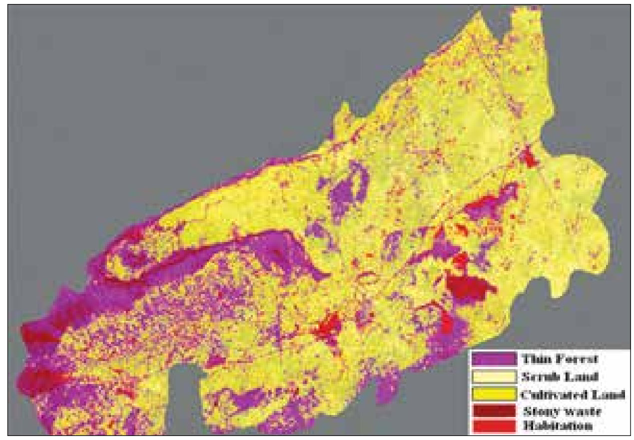
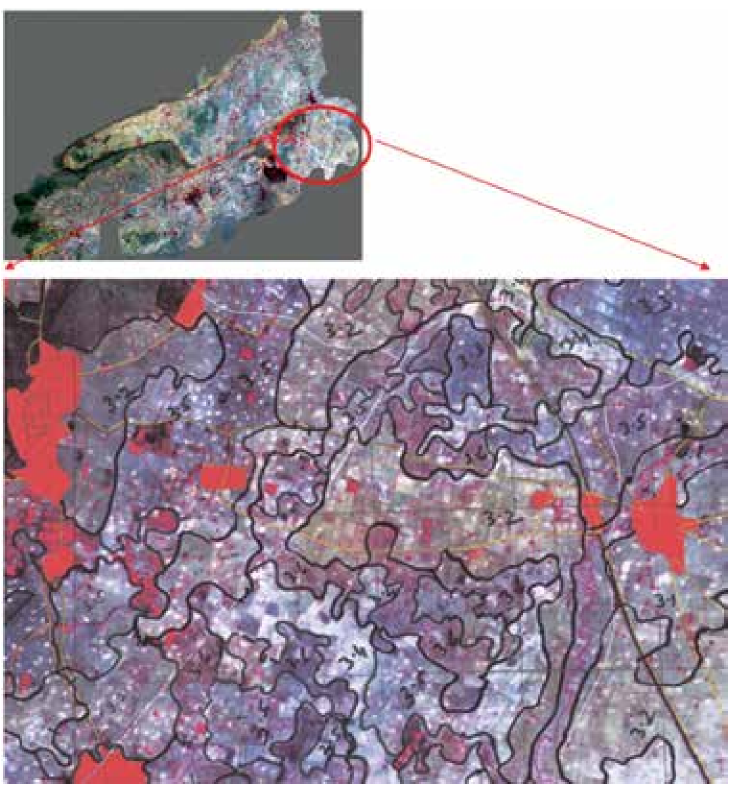


Fig. 2.1.46 : Land use / Land cover, Jagner block, Agra, U. P.

LAND USE / LAND COVER JAGNER BLOCK
Agra, U. P.

N



Landform Units	
1.8	Moderately sloping dissected residual hills with thin shrub forest
3.1	Alluvial plain with intensive cultivation
3.2	Alluvial plain with medium cultivation and patches of wasteland
3.3	Alluvial plain with concave slope under medium cultivation
3.4	Alluvial plain under wasteland and intermittently cultivated (salt affected lands)
3.5	Alluvial plain under cultivation with isolated wasteland
3.6	Undulating alluvial plain under wasteland (shrubs) cultivated at places
4.1	Fluvial channels

Fig. 2.1.47 : Land form map, Jagner Block, Agra district, U. P.

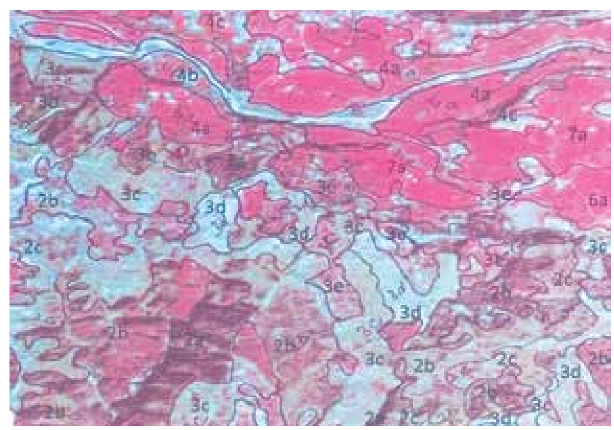
Table. 2.1.11 : Soil series, Jagner block	
Soil Series	Description
Hill / Hill Slopes	
A	Very shallow, excessively drained, brown, gravelly sandy loam, severely eroded soils on 10-15 % slopes **(Lithic Ustorthents)**
Piedmont Plain	
B	Very deep, somewhat excessively drained, brown, loamy sand soils, slightly to moderately eroded on 3-5 % slopes **(Typic Ustipsamments)**
C	Very deep, well drained, brown, loamy sand to sandy loam soils, slightly eroded on 1-3 % slopes **(Typic Ustifluvents)**
Old Alluvial plain	
Upper Alluvial Plain	
D	Very deep, well drained, brown to yellowish brown, sandy loam, calcareous soils, slightly eroded on 1-3 % slopes **(Coarse loamy, cal., Typic Haplustepts).**
E	Very deep, well drained, brown to yellowish brown, sandy loam soils, slightly eroded on 1-3 % slope **(Coarse-loamy, Typic Haplustepts)**.
Nearly level old Alluvial Plain	
F	Very deep, well drained, brown to yellowish brown, sandy loam to loam, calcareous soils with few lime nodules on 0-1 % slope **(Fine loamy, (cal), Typic Haplustepts)**
G	Very deep, well drained, brown to yellowish brown, sandy loam to loam soils on 0-1 % slope **(Fine loamy, Typic Haplustepts)**
H	Very deep, moderately well drained, brown to grayish brown, loam to clay loam, calcareous soils with lime and Fe-Mn nodules, slightly saline/sodic **(Fine loamy, cal, Typic Haplustepts)**
I	Very deep, moderately well drained, brown to yellowish brown, loam to clay loam soils with fe-mn nodules in lower horizon **(Fine loamy, Typic/Udic Haplustepts)**
Old Alluvial Plain with Concave Relief (Low-lying)	
J	Very deep, moderately well drained, brown to dark greyish brown, loam to clay loam soils with lime and Fe-Mn nodules in lower depth with patches of salinity and sodicity **(Fine loamy, cal. Typic Halaquepts)**
K	Very deep, imperfectly drained, olive to light olive brown (mottled at lower depth), loam to clay loam, calcareous soils, Fe-Mn and lime nodules with salinity and sodicity **(Fine loamy, cal. Natric Haplustepts)**
L	Very deep, imperfectly drained, dark grayish brown, clay loam, calcareous, stratified soils having Fe-mn nodules throught the profile and the mottles at lower depth, occationally flooded **(Fine loamy, cal. Fluventic Haplustepts)**
Fluvial Channels	
M	Very deep, moderately well drained, brown to dark brown/ yellowish brown, stratified, calcareous soils having lime concretions at lower depth with salinity and sodicity **(Coarse loamy, cal., Typic Ustifluvents)**

Nagrota Bagwan

Nagrota Bagwan block, Kangra district, Himachal Pradesh extends from 32° 03' 00" to 32° 10' 50" N latitudes and 76° 20' 55" to 76° 28' 00" E longitudes in AESR 14.2 and covers an area of 25997 hectare. Forest covers >45 % area of the block and agriculture contributes 27% area in the block. Major landform units are steep hill slopes, moderately steep hill slopes, moderate hill slopes, valley side slopes, upper piedmont, middle piedmont, lower piedmont and interfluvial valley basins. Landform map for a part of block is shown in Fig. 2.1.48. Twelve thousand hectares area are surveyed and ten soil series are identified (Table- 2.1.12).

LANDFORM UNIT MAP (PART)
NAGROTA BAGWAN BLOCK
Kangra district, H.P.

N



2a	Moderately steep sloping hills under thick forest cover
2b	Moderately steep sloping hills under medium forest cover
2c	Moderately steep sloping hills under shrub forest and scattered wasteland
3a	Moderately sloping hills under thick forest
3b	Moderately sloping hills under medium to thick forest cover
3c	Moderately sloping hills under shrub forest and scattered wasteland
3d	Moderate sloping hills under wasteland and scattered shrub forest
3e	Moderate sloping hills under cultivation and scattered shrub forest
4a	Valley side slopes under intensive crop cultivation with scattered patches of orchards
4b	Valley side slopes under medium crop cultivation with intermittent orchards
4c	Valley side slopes under cultivation with patches of wasteland and forest
6a	Middle piedmont under intensive crop cultivation with patches of orchards
7a	Lower piedmont under intensive crop cultivation with patches of orchards

Fig. 2.1.48 : Landform unit map (part), Nagrota Bagwan block, Kangra district, H.P.

Table 2.1.12 : Soil series, Nagrota Bagwan Block

Soil Series	Description
Moderately steep Hill slopes (Thick Forest cover)	
Momta Khas	Shallow, somewhat excessively to well drained, dark brown to slightly brown, gravelly sandy loam soils **(Loamy skeletal, Lithic Udorthents)**
Manasu	Deep, well drained dark yellowish brown, gravelly sandy loam soils **(Loamy- skeletal, Typic Udorthents)**
Bhatti	Moderately shallow, well drained, dark brown, gravelly sandy loam to loam soils **(Loamy-skeletal, Typic Udorthents)**
Moderately steep Hill slopes (Wasteland and scattered shrubby forest)	
Ronkhar	Moderately deep, moderately excessively drainage, dark yellowish brown, gravelly sandy loam soils **(Loamy- skeletal, Typic Udorthents)**
Bhardehr	Moderately deep, somewhat excessively to well drained, dark yellowish brown, gravelly sandy loam to gravelly loamy soils **(Loamy- skeletal, Typic Udorthents)**
Moderate hill slopes (Shruby forest and scattered waste land)	
Bag	Shallow, well drained, dark yellowish brown, gravelly sandy loam to loam soils **(Loamy-skeletal, Lithic Udorthents)**
Upper Piedmonts (Double cropped with scattered orchards)	
Khas Ronkhar	Very deep, moderately poor drained, grayish brown to dark yellowish brown, sandy clay loam to sandy clay soils, **(Fine loamy, Typic Hapludepts)**
Middle Piedmonts (Double cropped)	
Palli-Jasor	Very deep, poorly drained, light olive brown to dark yellowish brown, silty clay loam to silty clay soils **(Fine silty, Typic Hapludepts)**
Khas Sihund	Moderately shallow, poorly drained, grayish brown to light olive brown, silty clay loam to gravelly clay loam soils **(Loamy- skeletal, Typic Udorthents)**
Khas Rajiana	Very deep, moderately poor drained, grayish brown to brown, sandy loam to silty clay loam soils **(Fine loamy, Typic Hapludepts)**

CENTRAL REGION

Darwha

Darwha tehsil in Yavatmal district, Maharashtra extends from 77°33'58" to 77°59'50" E longitude; 20°11'15" to 20°27'45" N latitude and cover an area of 86959 hectare in AESR 6.3. Sampling scheme of the soil survey programme is given in figure 2.1.49. Field investigations indicated that Met and Lakhi series dominantly occure on plateau, whereas Hatola and Lakhi series dominantly occupy pediments. Hatola, Arunavati and Chikhali series dominately occur on upper pediplains. Landform-soil relationship is developed and shown in figure 2.1.50.

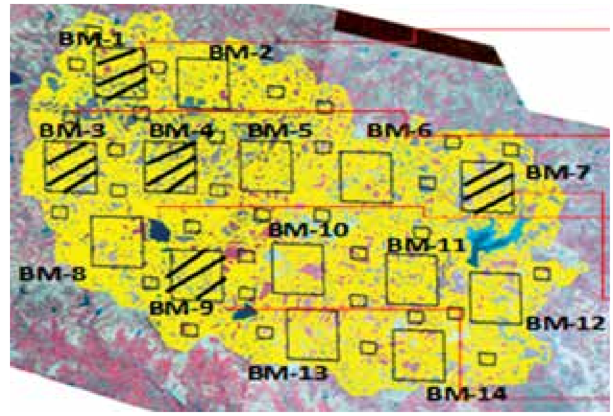


Fig. 2.1.49 : Sampling scheme in Darwha block, Yavatmal district, Maharashtra

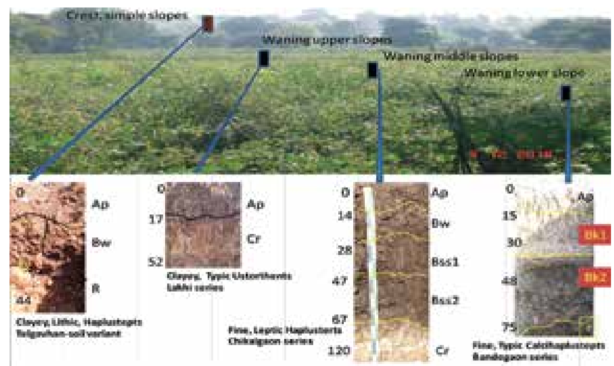


Fig. 2.1.50 : Soil Landscape relationship in Dharwa block, Yavatmal district, Maharashtra

Bemetara

Bemetara block, Bemetara district, Chhattisgarh extends from 81°24'45" to 81°46'10" E longitude and 21°36'50" to 22°01'12" N latitude and covers an area of 72680 hectare in AESR 11. Landform map is prepared (Fig. 2.1.51). About 3000 hectare area is surveyed and soil series are correlated.

Dhanora

Dhanora block, Seoni district, Madhya Pradesh lies between 22°19' N to 22°35' N latitude and 79°38' E to 80°00' E longitude covering an area of 61400 hectare in AESR 10.4. Eleven landforms namely, subdued hills, isolated mounds, plateau top, scarp slopes, pediments, undulating uplands, undulating midlands, undulating lowlands, alluvial plains, valley floors and narrow valleys are identified. The delineated landforms in the the block are verified (Fig. 2.1.52).

IRS-P6 LISS-IV DATA (26th December, 2013)
BEMETARA BLOCK
Bemetara district, Chhattisgarh

N

LANDFORMS
BEMETARA BLOCK
Bemetara district, Chhattisgarh

N

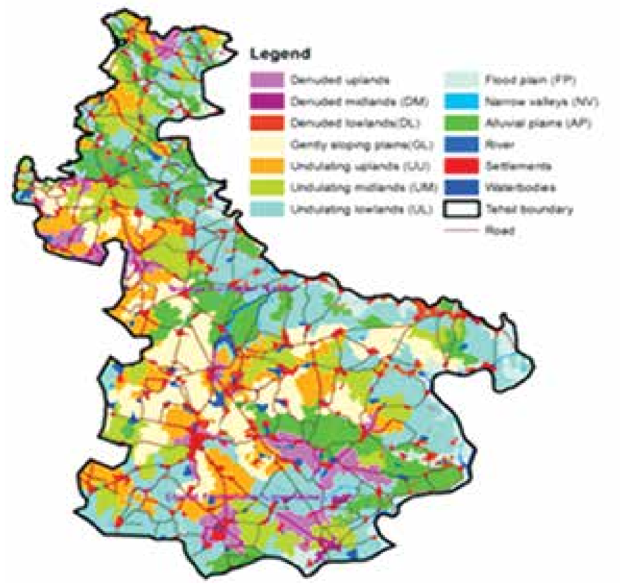


Fig. 2.1.51: Landforms, Bemetara block Bemetra district, Chhattisgarh

IRS-P6 LISS-IV DATA (22nd November, 2013)
DHANORA BLOCK
Seoni district, Madhya Pradesh

N

LANDFORMS
DHANORA BLOCK
Seoni district, Madhya Pradesh

N

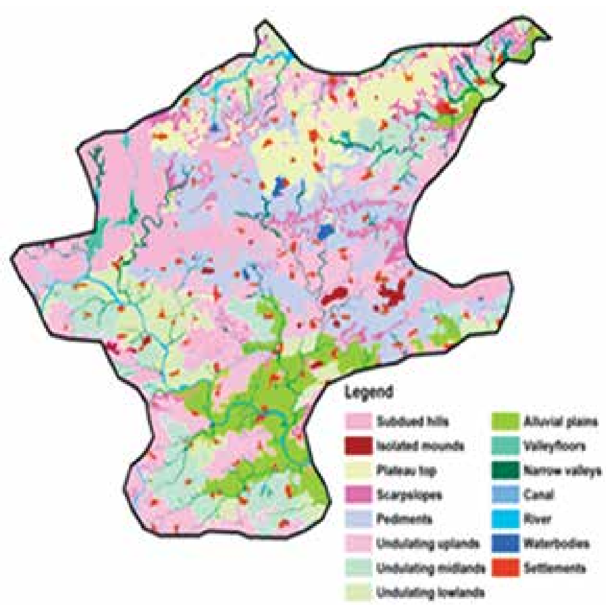


Fig. 2.1.52 : Landforms, Dhanora block, Seoni district, Madhya Pradesh

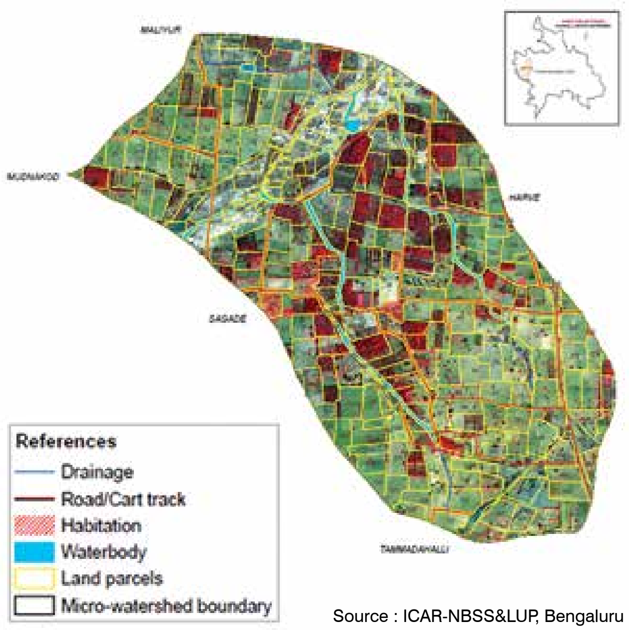
Land Resource Inventory for watershed planning

NBSS&LUP with the partner institutes studied 147 microwatersheds during the year in the state of Karnataka (Table 2.1.13). Dataset of Hosahalli micro-watershed, Harve sub watershed, Chamarajanagara taluka, Chamarajanagara district, Karnataka is presented in figure 2.1.53 as an example.

Table 2.1.13. Batch-V (IWMP) Micro watersheds

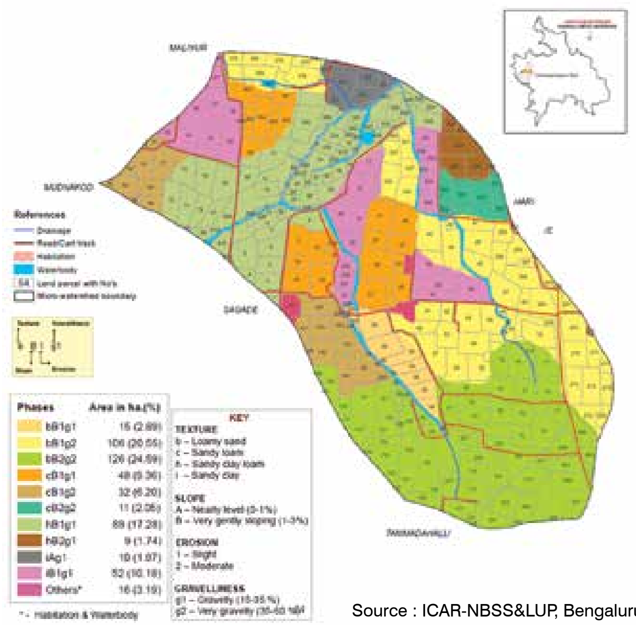
Sl. No	District	Talukas	No. micro watershed
	NBSS & LUP, Bangalore		
1	Bidar	Aurad	5
2	Bidar	Humnabad	6
3	Chamarajanagara	Gundlupet	19
4	Gadag	Gadag	5
5	Gadag	Shirahatti	7
6	Yadgir	Yadgir	6
7	Gulbarga	Gulbarga	3
8	Gulbarga	Kalburgi	6
	U A S, Bangalore		
9	Chamarajanagara	Chamarajanagara	11
10	Chamarajanagara	Kollegala	7
11	Davangere	Harappanahalli	6
12	Davangere	Jagalur	11
	UAS Raichur		
13	Yadgiri	Yadgiri	9
14	Kalburgi	Kalburgi	9
	UAS, DHARWAD		
15	Gadag	Gadag	6
16	Koppal	Yelburga	12
	UHS, Bagalkot		
17	Bidar	Aurad	9
18	Bidar	Humnabad	10
	Total number of watershed		147

SATELITE IMAGE
HOSAHALLI MICRO-WATERSHED
Chamarajanagara taluka, Chamarajanagara district, Karnataka



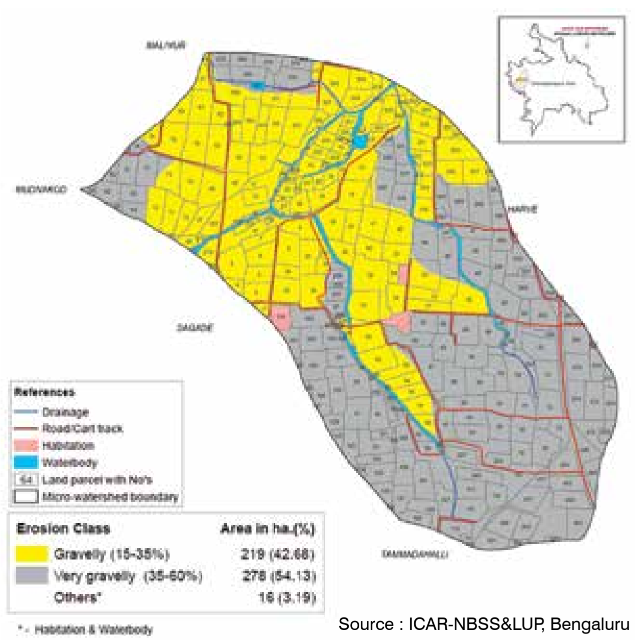
Source : ICAR-NBSS&LUP, Bengaluru

SOIL-SITE CHARACTERISTICS
HOSAHALLI MICRO-WATERSHED
Chamarajanagara taluka, Chamarajanagara district, Karnataka



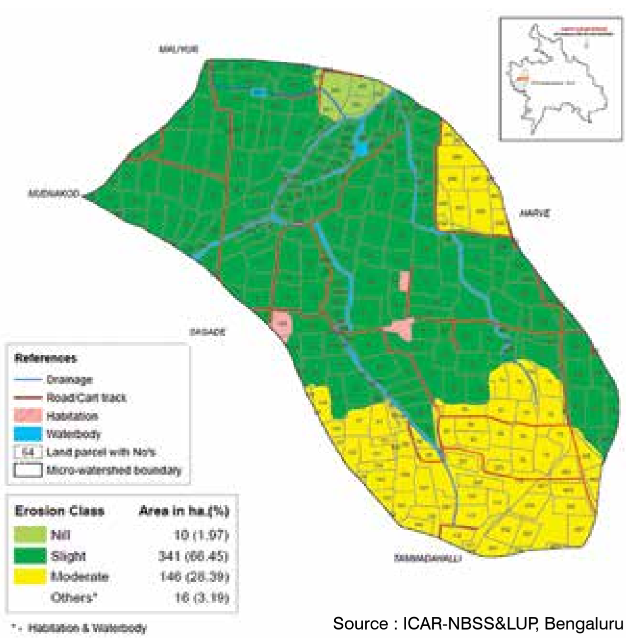
Source : ICAR-NBSS&LUP, Bengaluru

SOIL GRAVELLINESS
HOSAHALLI MICRO-WATERSHED
Chamarajanagara taluka, Chamarajanagara district, Karnataka



Source : ICAR-NBSS&LUP, Bengaluru

SOIL EROSION
HOSAHALLI MICRO-WATERSHED
Chamarajanagara taluka, Chamarajanagara district, Karnataka



Source : ICAR-NBSS&LUP, Bengaluru

Fig. 2.1.53 : Dataset generated for Hosahalli watershed, Chamrajnagar block, Chamrajnagar district, Karnataka

Land Resource Inventory for farm planning

Land resource inventory on 1:10000 scale of six KVK farms located in Pratapgarh, Banswara, Dungarpur, Rajasamand, Bhilwara and Chittaurgarh districts of Rajasthan under the administrative control of Maharana Pratap University of Agriculture and Technology (MPAUT), Rajasthan is prepared. Soils are classified and land use plan is suggested.

(ii) Central State Farm Jaitsar, Sriganganagar district, Rajasthan

Land resource inventory of Central State Farm, Jaitsar, Sriganganagar district in the state of Rajasthan on 539435 hectare area, is carried out. Eight soil series are identified and mapped into eleven phases of eight soil series (Fig. 2.1.54 & Table 2.1.14).

(iii) NICRA Village (Patameghpar)

The village Pata Meghpar represents typical basaltic landscape in the peninsular region of north-west Gujarat, lies between 22°13'12" to 22°16'06" N latitude and 70°29'07" to 70°32'56" E longitude covering an area of 1703 hectare. Four major landform units are identified viz. isolated upland, ravinous land, very gently sloping plain and nearly level plain. Seven soil series are mpped in ten phases (Fig. 2.1.55 and Table 2.1.15).

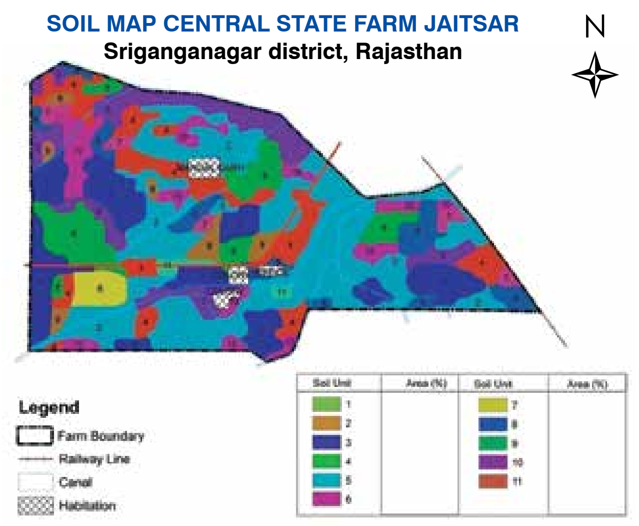


Fig. 2.1.54 : Soil map of Central State Farm Jaitsar, Sriganganagar district, Rajasthan

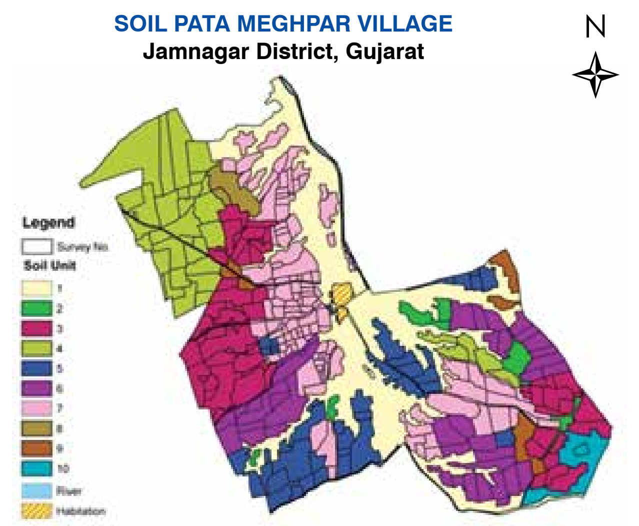


Fig. 2.1.55 : Soils of Pata Meghpar village, Jamnagar District, Gujarat

Table 2.1.14 Soil series in CSFC Farm Jaitsar

Map unit No.	Series	Slope (%)	erosion	drainage	Texture (surface)	Texture (sub-surface)	salinity-sodicity	LCC	LIC
1	Jaitsar-A	3-8	e3	excess	s	s	-	Ves	5st
2	Jaitsar-B	1-3	e2	well	ls	ls	-	IVes	3st
3		3-8	e2	well	ls	ls	-	IVes	3st
4	Jaitsar-C	1-3	e1	well	ls	sl-scl	-	IIs	2s
5		1-3	e1	well	sl	sl-scl	-	IIs	2s
6	Jaitsar-D	0-1	I1	Imp	ls	ls-sl	S1	Ivws	4sd
7	Jaitsar-E	1-3	e1	mod well	ls	sl-sicl	s1n1	IIIs	3s
8		0-1	e1	mod well	sl	sl-sicl	s1n1	IIIs	3s
9	Jaitsar-F	1-3	e1	well	ls	sl-ls	-	IIs	2s
10	Jaitsar-G	1-3	e1-e2	well	ls	ls-sl	-	IIIs	3s
11	Jaitsar-H	1-3	e1	well	sl	sicl-ls	S2N1	Ivs	4s

Table 2 .1.15 : Phases of soil series Pata Meghpar village, Jamnagar district			
Mapping Unit No.	Mapping Symbol	Brief Description	Area (ha)
1	Ptm-3GeD4	Moderately shallow (50-75 cm), dark yellowish brown, silt loam soils on ravinous land	409.6 (24%)
2	Ptm-1GdC3	Very shallow (0-25 cm), brown,-gravelly loam soils on isolated uplands	32.9 (1.9%)
3	Ptm-6mA2	Moderately deep (75-100 cm), very dark gray, clayey soils on nearly level plain.	238.4 (14.0%)
4	Ptm-4fB2	Moderately shallow (50-75 cm), very dark yellowish brown, clayey soils on very gently sloping plains	248.1 (14.6%)
5	Ptm-5mB2	Moderately shallow (50-75 cm), very dark grayish brown, clayey soils on very gently sloping plain.	160.5 (9.4%)
6	Ptm-5mC2		160.5 (9.4%)
7	Ptm-7mA2	Deep (>100 cm), very dark gray, clayey soils on nearly level plain	305.5 (17.9%)
8	Ptm-2GdB2	Very shallow (0-25 cm), dark yellowish brown, gravelly loam soils on isolated uplands.	21.1 (1.2%)
9	Ptm-2GdC3		32.7 (71.9%)
10	Ptm-1GdD4	Very shallow (0-25 cm), brown,-gravelly loam soils on isolated uplands.	32.5 (1.9%)

Ptm-Patameghpar, G-Gravelly, d-loam, e-silt loam, f-clay loam, m-clay, A- slope 0-1%, B- slope 1-3%, C-slope 3-8%, 2-Moderate erosion, 3-Severe erosion, 4-Very severe erosion.

Baronda Farm in Raipur, Chhattisgarh

Baronda Farm in Raipur, Chhattisgarh for ICAR-National Institute of Biotic Stress Management (NIBSM) is situated between 21°22'36" to 21°23'10" N latitude and 81°49'17" to 81°49'43" E longitude and cover an area of 51.1 hectare. Seven soil series were tentatively identified (Table 2.1.16) and mapped in 11 phases (Fig. 2.1.56).

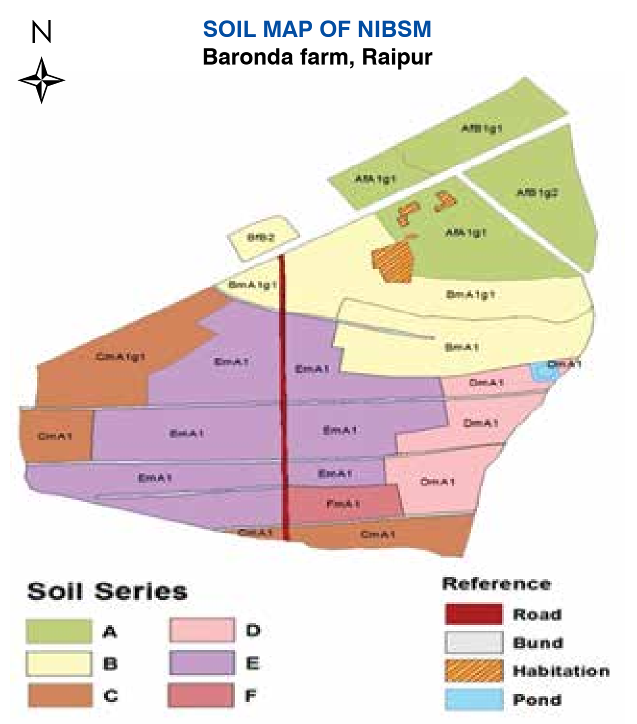


Fig. 2.1.56 : Soil map of NIBSM Baronda farm, Raipur

Table 2.1.16 : Phases of soil series Baronda Farm		
Sl. No.	Map Legend	Description
1	AfB1g1	Series A - clay loam, 1-3% slope, slight erosion and slight gravelliness
2	AfA1g1	Series A - clay loam, 0-1% slope, slight erosion and slight gravelliness
3	AfB1g2	Series A - clay loam, 1-3% slope, slight erosion and moderate gravelliness
4	BmA1g1	Series B - clay, 0-1% slope, slight erosion and slight gravelliness
5	BmA1	Series B - clay, 0-1% slope and slight erosion
6	BfB2	Series B - clay loam, 1-3% slope, moderate erosion
7	CmA1g1	Series C - clay, 0-1% slope, slight erosion and slight gravelliness
8	CmA1	Series C - clay, 0-1% slope and slight erosion
9	DmA1	Series D - clay, 0-1% slope and slight erosion
10	EmA1	Series E - clay, 0-1% slope and slight erosion
11	FmA1	Series F - clay, 0-1% slope and slight erosion

Ladhowal Farm (ICAR-Indian Institute of Maize Research site)

Ladhowal Farm in Ludhiana district, Punjab lies between 30⁰ 59' 39.33" to 30⁰ 59'38.60" N latitude and 75⁰ 43' 32.67" to 75⁰ 44' 31.35" E longitudes and covers an area of 100 ha in AESR 4.1, representing central plain of Punjab. Physiographically, study area is a part of nearly level to gently sloping lands of abandoned river bed of Sutluj river. Three distinct landforms viz., abandoned channels, sand bars and point bars are identified. Three soil series are established and mapped into 4 phases (Fig. 2.1.57).

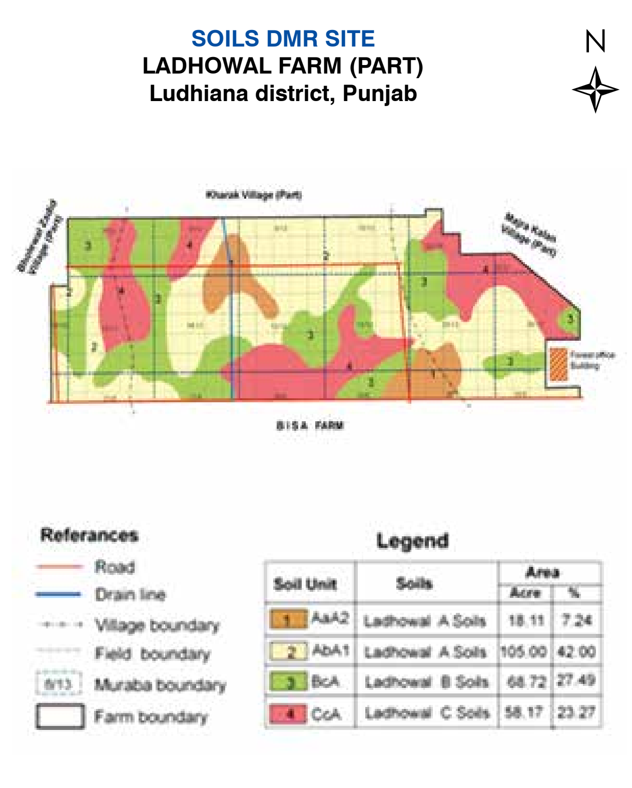


Fig. 2.1.57 : Soils Ladhowal Farm (IIMR Site), Ludhiana district, Punjab

Miniwada Panchayat

Six major landforms are delineated (Fig. 2.1.58); land use and land cover map (Fig. 2.1.59) are prepared during the year in Miniwada Panchayat, Katol tehsil, Nagpur.

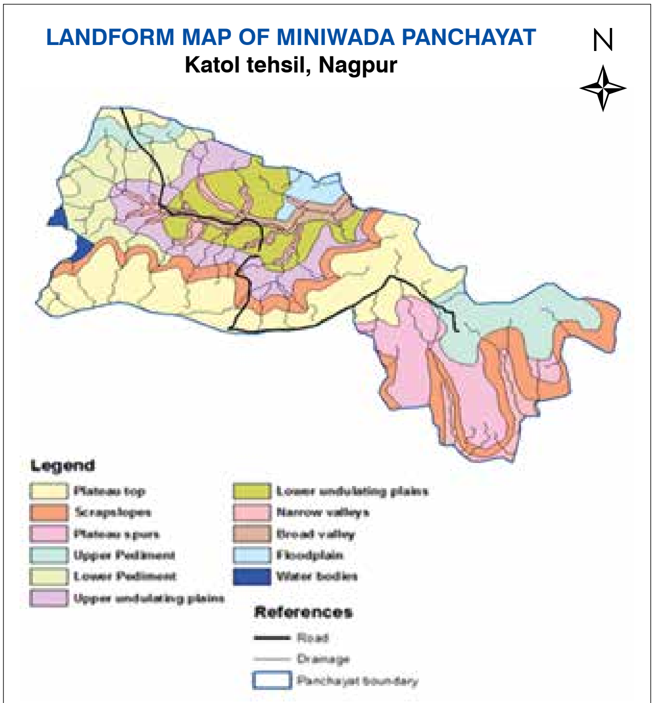


Fig. 2.1.58: Landform map of Miniwada Panchayat, Katol tehsil, Nagpur

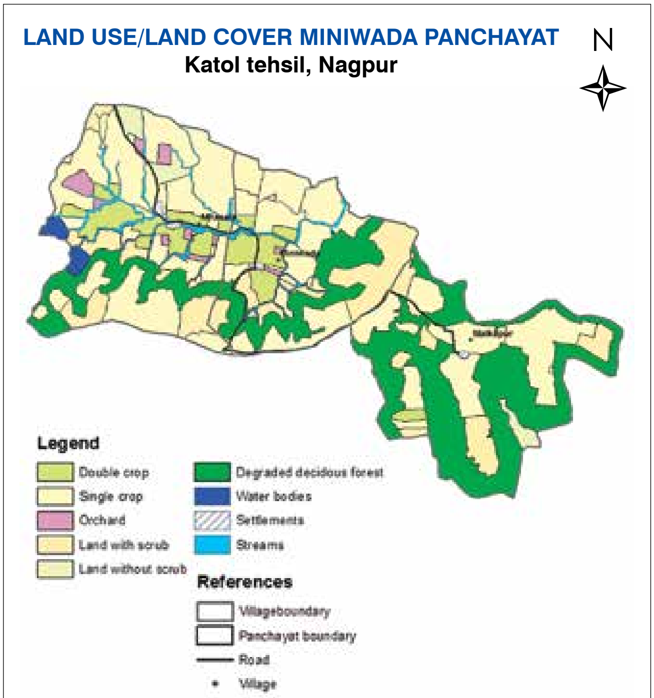


Fig. 2.1.59: Land use/land cover map of Miniwada Panchayat, Katol tehsil, Nagpur

LAND RESOURCE INVENTORY ON 1: 25 TO 1:50000 SCALE

Bolangir sub-division, Bolangir, Odisha

Seventeen series are identified and are mapped in thirteen soil series associations (Fig. 2.1.60a). Soil and site characteristics are interpretated for land capability classification (2.1.60b).

Shimla district, Himachal Pradesh

Land resource mapping of Shimla district (Part), Himachal Pradesh (30° 58' 18" to 31° 21' 443 N latitude; 77 °15' 50" to 77° 44' 573 E longitude) is carried out on 1:25000 scale. 19 soil series are identified and mapped (Fig. 2.1.61). The soils of the district belong to 4 orders, 5 suborders, 5 great groups, 7 subgroups and 10 families (Table 2.1.17).

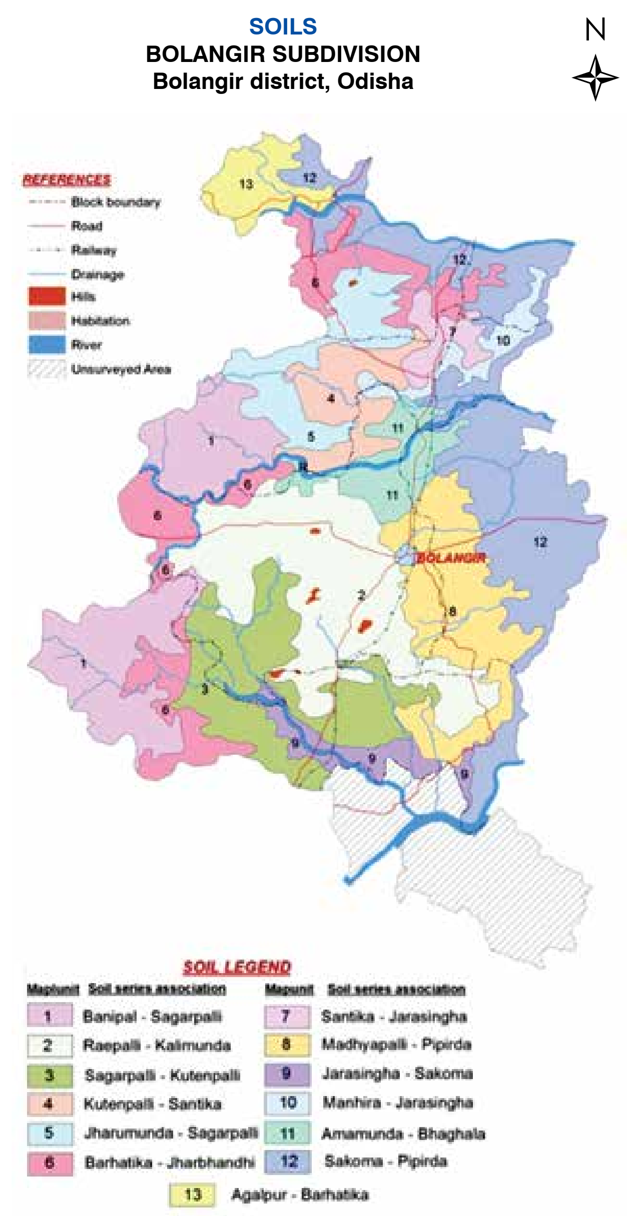


Fig. 2.1.60a : Soils, Bolangir subdivision, Bolangir district, Odisha

Fig. 2.1.60b : Land capability, Bolangir subdivision, Bolangir district, Odisha

Table 2.1.17. Soil series, Shimla district

Order	Sub Order	Greatgroups	Subgroup	Family	Soil Series
Entisols	Psamments	Udipsamments	Typic Udipsamments	Typic Udipsamments	Jubbal
	Orthents	Udorthents	Lithic Udorthents	Loamy-skeletal, Lithic Udorthents	Meha
	Orthents	Udorthents	Typic Udorthents	Loamy-skeletal, Typic Udorthents	Halain
Inceptisols	Udepts	Eutrudepts	Dystric Eutrudepts	Loamy-skeletal, Dystric Eutrudepts	Torponu
			Dystric Eutrudepts	Coarse loamy, Dystric Eutrudepts	Jarot, Tikkar, Kumarsain, Gumthala, Kotgarl
			Dystric Eutrudepts	Fine loamy, Dystric Eutrudepts	Chiyog, Hatu, Ganori, Kiri, Mahori
			Fluventic Eutrudepts	Loamy-skeletal, Fluventic Eutrudepts	Balghar
			Fluventic Eutrudepts	Fine loamy, Fluventic Eutrudepts	Prashan
Alfisols	Udalfs	Hapludalfs	Ultic Hapludalfs	Fine loamy, Ultic Hapludalfs	Kelwi
Mollisols	Udolls	Hapludolls	Typic Hapludolls	Coarse loamy, Typic Hapludolls	Narkanda, Thalga

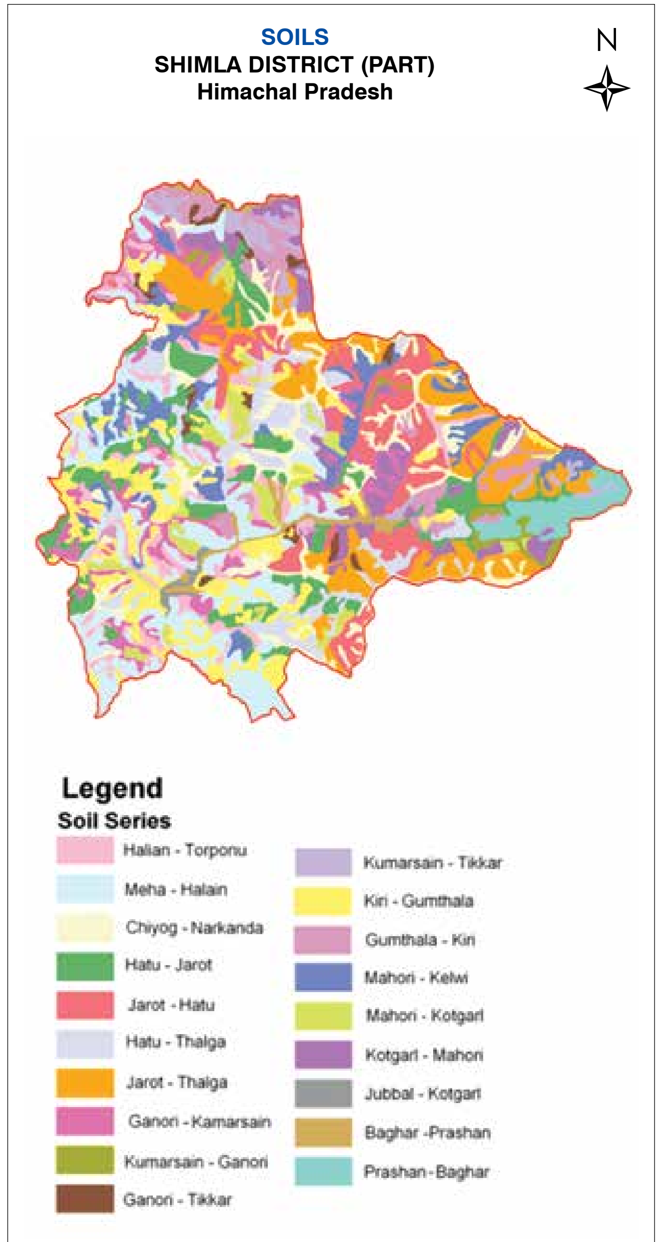


Fig. 2.1.61 : Soils of Shimla district, Himachal Pradesh

Malappuram District

Soil map of Malappuram district, Kerala was finalized. 46 soil series were mapped in 48 soil series associations (Fig. 2.1.62). Major soils belonged to Humults, Ustults, Ustepts or Ustolls sub-order and series identified are Vijayapuram, Kanjirappilly and Ezhallur. Major land use is coconut, rubber, arecanut, forest or forest plantations.

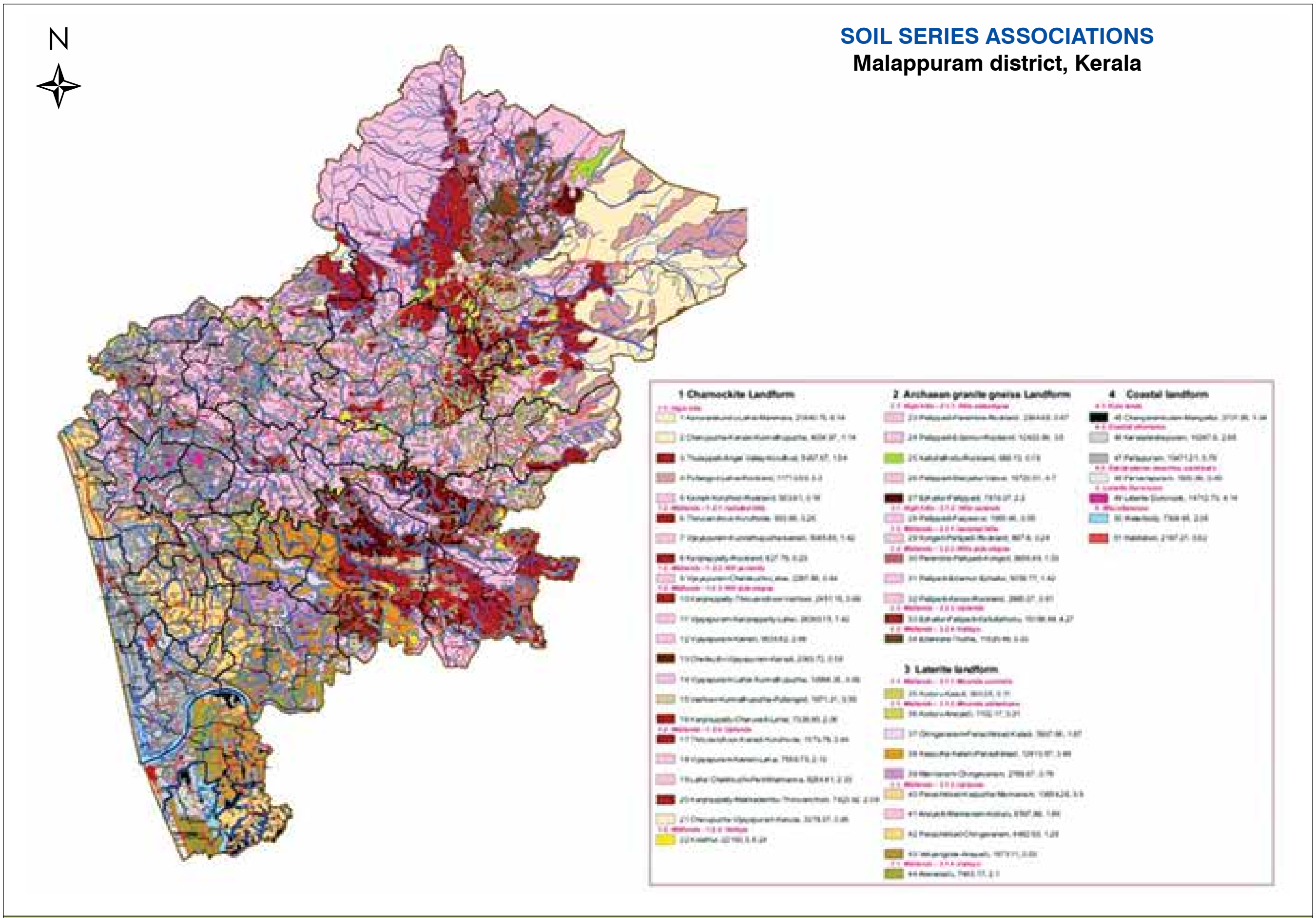


Fig. 2.1.62 : Soil map of Malappuram district, Kerala

2.2 REMOTE SENSING AND GIS APPLICATIONS

STANDARDIZATION OF METHODOLOGY FOR DIGITAL TERRAIN MODEL (DTM)

Successful mapping on 1:10000 scale is highly dependent on precise information of landforms. Input data for landform delineation are elevation, slope, aspect and profile curvature. Digital terrain model (DTM) using high resolution stereo pair remote sensing data can provide very precise and quantified data on landform attributes. With the availability of high resolution stereo pair data, DTM becomes a very handy tool for landform mapping, a pre-requisite for soil resource mapping. Methodology of generating DTM using cartosat data of 1 meter resolution is standardized and explained for a part of Indravalle block/mandal, Adilabad district, Telangna as an example and explained in the subsequent paragraphs. Object-based digital terrain classification models are also explained that have been standardized for slope, landforms and LULC classification. Hierarchical Landscape Ecological Unit (LEU) Model, which is the base of LRI on 1:10000 scales, is also explained.

DIGITAL TERRAIN MODEL (DTM)

Cartosat-1 stereo pair data were processed to generate the digital terrain model (DTM) of 10 m spatial resolution using rigorous math model (Toutin's Model). In the model, OrthoEngine of Geomatica version 14.0 was used to generate DTM following the sequence of steps namely, projection setup, sensor data reading, collection of GCPs and tie points, block adjustment, model computation (Satellite Math Model), epipolar image generation and Digital surface model (DSM) extraction. Balancing algorithm was applied to obtain the seamless mosaic DSM height. Filtering was done to convert bare earth model DSM to DTM. Editing was done to smooth out the irregularities and create a quality output. RMSE statistics report was also generated to evaluate the accuracy of the DTM output (Fig. 2.2.1).

Furthermore, DTM was subjected to a series of hydro-enforcement process including reconditioning, sinks and pit removal, flat and level water bodies, flat and level bank to bank and gradient smoothening by DAT/EM and Arc Hydro tool, etc. This is essentially needed to enrich the quality of the hydrological output such as slope, contour and drainage. This is altogether needed to improve the accuracy of landform mapping (Fig. 2.2.2).

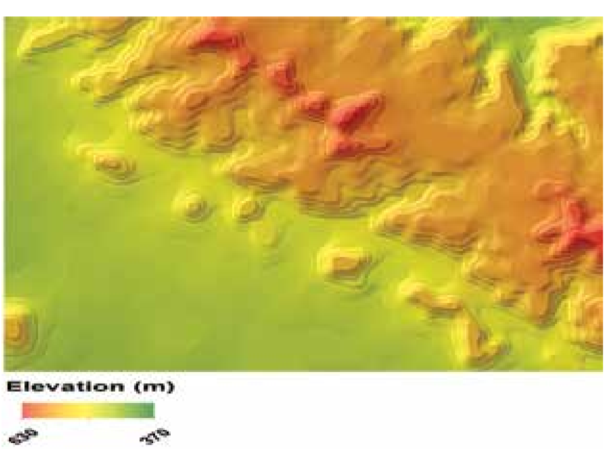


Fig. 2.2.1 : DTM of 10 m resolution for a part of Indravelle block, Adilabad district, Telangana

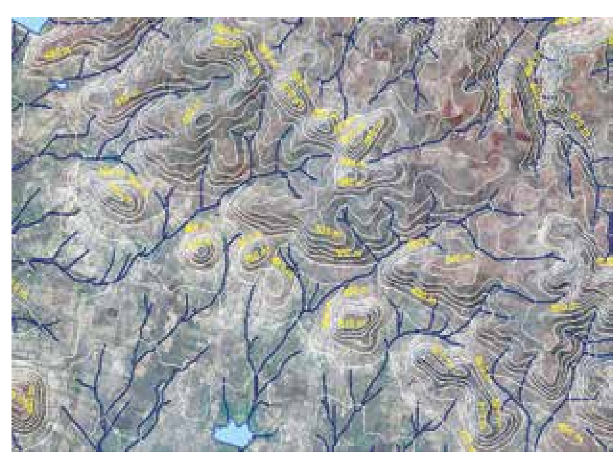


Fig. 2.2.2 : Contour (10m) and auto-drainage derived from DTM for a part of Indravalle block, Adilabad district, Telangana

OBJECT-BASED DIGITAL TERRAIN CLASSIFICATION MODELS

The pixel based classification procedure analyzes only the spectral properties but the spatial or contextual information is lacking. Pixel-based methods applied to high-resolution images, give a "salt and pepper" effect that contributes to the inaccuracy of the classification. For decades, GIS specialists have theorized about the possibility of developing a fully or semi automated classification procedure that would be an improvement over pixel-based procedures. The object-based modeling by taking into consideration the spectral and spatial/contextual properties of pixels and segmentation process with interactive learning algorithm promises to be more accurate than the pixel-based methods. The following object based semi-automated models are developed in the project.

a. Slope classification model

The raster slope layer output of DTM was taken as input in the object-based image analysis in the environment of eCognition® software. The slope layer was subjected to chessboard segmentation. Nine slope classes were created following the USDA-NRCS slope class threshold criteria. The criteria was fitted as fuzzy instead of hard rule using the less than and greater than "s-curve" membership function so as to get closer to the natural slope boundary. Morphology and contextual filters were applied to generate smooth slope class zones (Fig. 2.2.3).

b. Landform classification model

Case study-I

The pilot study was taken up in three blocks of Telangana. The terrain attributes derived through digital terrain analysis of DTM layer i.e. contour, drainage, slope and hill shade were treated as input for landform delineation. The landform classification process was hastened taking into consideration the slope class zone, hill shade, contour and auto-drainage pattern along with legacy mapping unit of 1: 250000. Table 2.2.1 illustrates an example of logical rule set used for different landform units in these blocks (Fig. 2.2.4).

Table 2.2.1 : An example of logical rule set used for landform units in the selected blocks of Telangana

Landform	Logical Ruleset Condition
1. Un-dissected Plateau	• Slope Range: 0 to 5%
	• Relative boarder to escarpment: >80%
	• Existence of drainage = False
	• Relative Topographic Position = Upper
2. Pediment	• Side slope of Plateau/Upland
	• Slope Range: >1 to <15%
	• Profile Curvature = Convex
	• Presence of erosive features
3. Valley	• Existence of drainage = True
	• V-shaped contour with decreasing elevation gradient
	• Profile Curvature = Concave
	• Relative Topographic Position = Lower

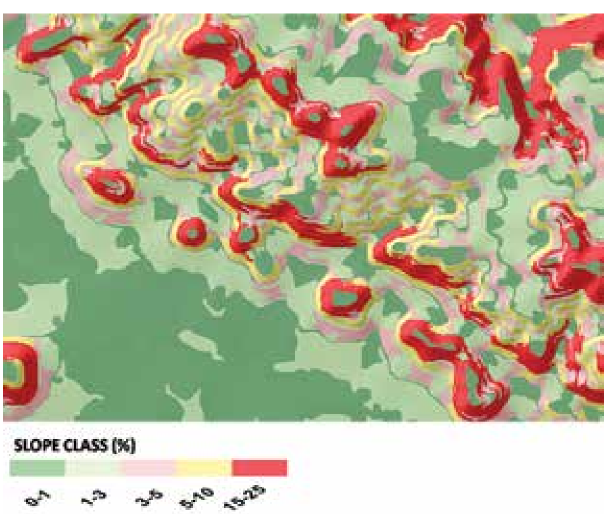
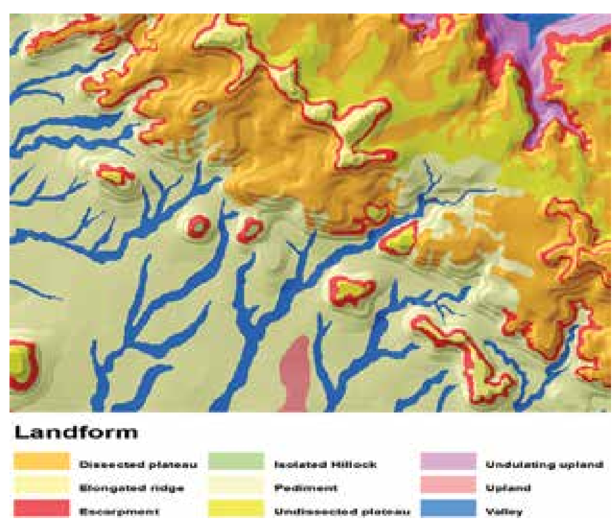


Fig. 2.2.3 : Slope class zone derived from DTM for a part of Indravalle block, Adilabad district, Telangana



2.2.4 : Landform map on 1:10000 scale derived from DTM for a part of Indravalle block, Adilabad district, Telangana

Case study-II

The similar kind of exercised was done in the North Eastern hilly region of Ri-Bhoi district, Meghalaya where the objects resulting from segmentation are partitioned into sub-domains based on thresholds given by the mean values and standard deviation of elevation respectively, following the modeling approach given by Lucian Drăguț and Clemens Eisank, 2012. The layer variable thresholds were modified as per the local condition. The resultant landform (Fig. 2.2.5) along with the rule set window is given in Fig. 2.2.6.

Fig. 2.2.5 : Rule Set algorithm for delineating landform in Ri-bhoi district, Meghalaya

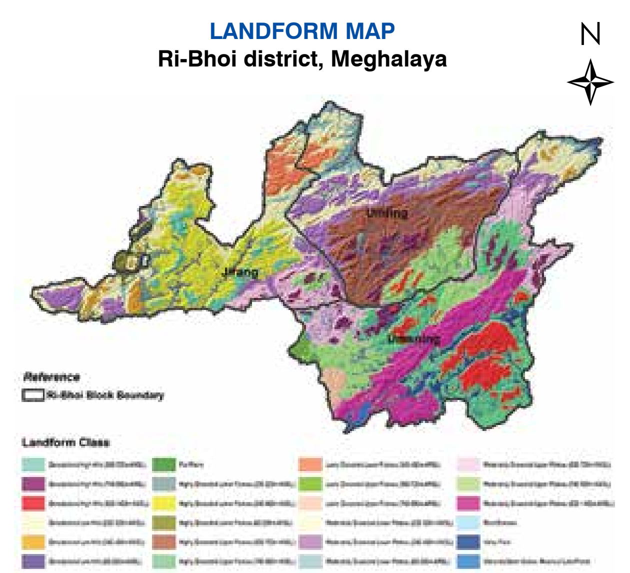


Fig. 2.2.6 : Landform map derived from DTM for Ri-Bhoi District of Meghalaya state

Case study-III

Digital terrain modeling for object based automatic classification of landforms in Katol tehsil, Nagpur district using high resolution Cartosat DEM and IRS P-6 LISS IV data was done. Model and knowledge-based decision rules have been developed in eCognition software; primary and secondary terrain variables have been integrated in the model to delineate the automatic landforms. The landforms have been classified based on the nature, extent, topographic position and standard classification system (Fig. 2.2.7). The developed model is generic in nature and knowledge based decision rules in the model are specific to local terrain conditions.

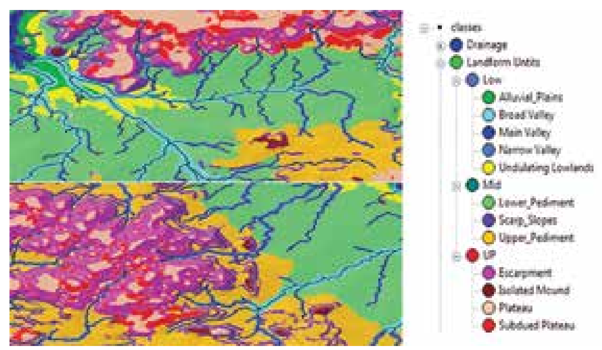


Fig. 2.2.7 : Landform of a part of Katol Tehsil, Nagpur, Maharashtra

c. Object-based land use land cover (LULC) classification model

The LULC map was prepared based on the current *rabi* season data of Cartosat-1 merged LISS-IV (2.5m) as well as high resolution (0.5m) public domain imagery at the backend so as to get the reliable land use boundary at cadastral level. The delineation of subclasses viz. single and double cropped areas within the agriculture zone were done using novel *LULC subclass classification algorithm* (Fig. 2.2.8). The merged data was segmented into spectrally homogeneous region using multi-resolution segmentation algorithm. The optimum scale parameter for segmentation of the layer was achieved through estimation of scale parameter (ESP) analysis tool. The point of interest lies where the local variance and rate of change is minimum in the graphical output. The data mining technique i.e. feature space optimization was applied to extract the double cropped area based on certain no. of layer variables and vegetation indices combination as obtained through the maximum separation distance.

Fig. 2.2.8 : LULC subclass classification model workflow

Following such scheme of LULC map for a part of Indravalle Mandal is given in figure 2.2.9.

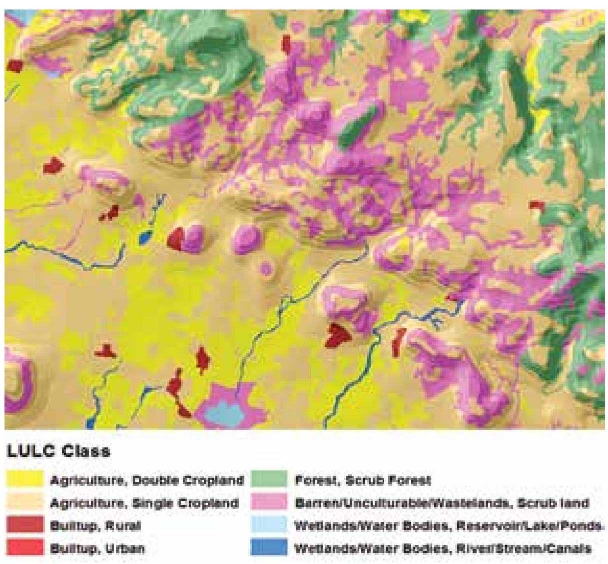


Fig. 2.2.9 : Land use/land cover map on 1:10000 scale for a part of Indravalle Mandal , Adilabad district, Telangana

Hierarchical landscape ecological unit (LEU) model

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

(i) Level-I: First level segmentation was done based on the landform layer.

(ii) Level-II: This segmentation was run within each of the 1st level segment based on fuzzy threshold based slope class. Second level intermediate output gave rise to landform-slope unit.

(iii) 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 logical condition 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. The Fig. 2.2.10 explains the steps involved in the delineation of LEU:

Fig. 2.2.10 : Hierarchical object based segmentation algorithm process for generating LEU maps

Base map in LRI project

This LEU map has been used as base for developing soil-landform relationship for mapping soils on 1:10000 scales (Fig. 2.2.11). Transacts were demarcated in GIS based

Fig. 2.2.11 : Base map on 1:10000 scales for a part of Indravalle block, Adilabad district, Telangana

geo-database framework by assimilating the legacy data of 1:250000 scale and expert knowledge. The logical automation algorithm developed at each stage results in considerable reduction in time for base map preparation. This will assist in optimizing sampling intensity, which leads to a considerable saving of manpower, labor, cost and most importantly the time.

SMART MOBILE PHONE

ICAR-NBSS & LUP collects soil-related data throughout India as well as soil samples to create/update the soil resource map. The main dataset comprises the details of the soil profile section and its site characteristics. Generally, observations have five or more layer data and each layer has more than 50 parameters. The complete dataset also need to be geo-tagged with the photograph of the site and soil profile for future reference. For this purpose, the field parties are given a hand-held device (WP60) with a customized application specially designed and developed for all soil related real time data collection along with current GPS location (latitude, longitude & altitude). This application also allows user to take geo-tagged photographs with the dataset. Proforma (menus) have been developed in drop down mode to enter the

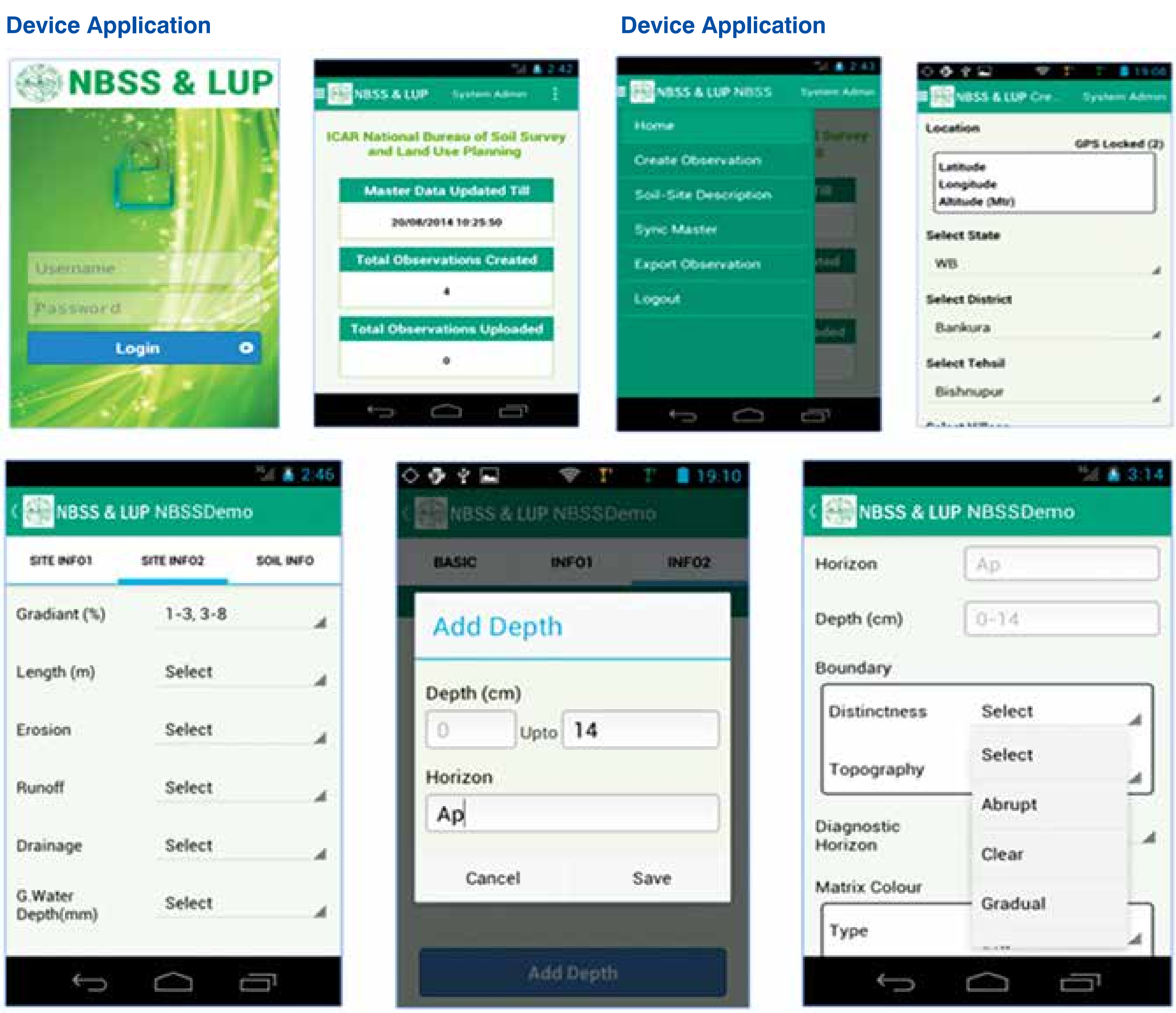


Fig. 2.2.12 : Screen shots of Android based smart phone GIS application for real-time field geo-database management

field data for various parameters to minimize the human error. 32 GB storage capacity of the device can store the entries in absence of internet signal in remote areas. Separate web based systems have also been developed for individual user and for management of database at different levels for monitoring and report generation. Provisions for entry of laboratory data of physical and chemical properties of soils have also been made to have an integrated database in the server. Provision has been made in device to send the data to the server on availability of internet connectivity. The hierarchical quality check workflow system from bottom to top approach is also included to ensure the quality data delivery at user end. The software contains following interfaces:

- *User on Internet : Web Browser, Operating System (any)*
- *Application Server : WAS*
- *Data Base Server : Oracle 10g*
- *Network : Internet*
- *Development Tools : Microsoft Visual Studio 2010, HTML, Oracle 10g, OS (Windows)*

Thus the GPS based system provides systematic field data collection and real-time transfer to central server with less manual error, accurate GPS location; date and time from satellite, three level data security, instant generation of reports, monitoring of work progress from anywhere through centralized data repository. The whole process has replaced the age old pen and paper based data collection techniques by a user friendly geo-database management system (Fig. 2.2.12).

4. DEVELOPMENT OF INDIAN SOIL INFORMATION SYSTEM (1:250000 SCALE) – A GEOPORTAL

The core objective of the project was to develop soil information system of India in Geographic Information System (GIS). The schema for data input has been created, available soil resources and allied data were reformatted and brought under similar projection system. The soils data available on 1:1000000, 1:250,000 and 1:50,000 scales (only selected districts), Agro-ecological regions, Agro-ecological sub-regions, soil loss, degraded and wastelands data, AWiFs data (58m), IRS-P6 LISS-III (23.5m) satellite data, SRTM (90m), ASTER GDEM (30m), were generated under soil information system. The system provides the facility to search, visualize and update geospatial data. Prototype Geoportal for soil information system is shown in Fig. 2.2.13.

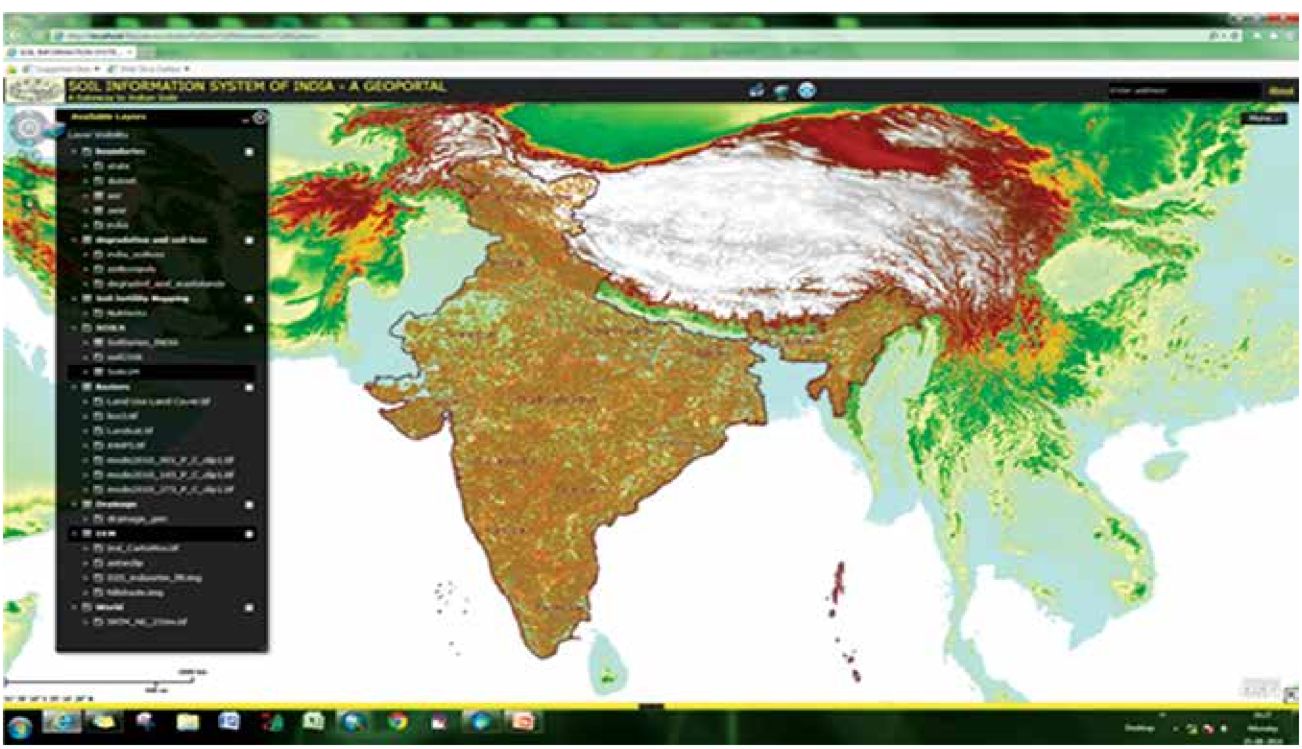


Fig. 2.2.13: User interface of prototype geoportal and soils of India shown as Web Map Service (MWS)

DEVELOPMENT OF DISTRICT SOIL INFORMATION SYSTEM (DSIS) ON 1:50,000 SCALE (50 DISTRICTS)

District Soil Information System (DSIS) have been developed with uniform standards to store, query, update and manage the district level soils database on 1:50000 scale. The soil database for 50 districts, which includes 7 districts (Jorhat, Kamroop, Morigaon, North Tripura, Sibsagar, South Tripura and West Tripura District) of north-east region 8 districts (Bastar, Bhandara, Chandrapur, Gondia, Raisen, Seoni, Wardha and Yavatmal) of central region, 10 districts (Bellary, Chitradurga, Hassan, Kolar, Medak, Mysore, Tumkur, North Goa, South Goa and Mallampuram) of southern region, 4 districts (Ajmer, Banswara, Bhilwara, Bundi) of western region, 15 districts (Arungabad, Bankura, Bardhaman, Birbhum, East Sikkim, Hugli, Kooch Bihar, Madhubani, North Sikkim, Puri, Purulia, Ranchi, Sambalpur, South Sikkim and West Sikkim) of eastern region and 7 districts (Delhi, Fatehgarh Sahib, Hoshiarpur, Moradabad, Mujaffarnagar, Nawashahar and Patiala) of northern region. The soil maps have been digitized and brought under uniform projection system with datum WGS 84. The available databases on soil loss, degraded/ wastelands, climate, AER and AESR have been harmonized with districts soils database. The SRTM DEM (90m), ASTER DEM (30m) and two dates (*kharif* and *rabi*) of Landsat ETM+ (30m) data of the districts were added in the database to understand the soil–terrain-land use/ land cover relationship. A total of 30 terrain and soil based thematic maps have been generated for each district. The developed district soil information system has been brought under proto-type geoportal to systematically search, access, visualize and update soils and allied data. Prototype of geoportal of District Soil Information System is given in Fig. 2.2.14a. District Soil Information System developed for 50 districts in GeoPDF format is shown in figure 2.2.14b.

National Soil Geo-portal

A web-based geo-portal is being developed by the ICAR-National Bureau of Soil survey and Land Use Planning for storing and managing the entire spatial and non-spatial database generated at various scales. The site characteristics, morphological, physical and chemical properties of the soils will be compiled in a common format (Table 2.2.2) and stored in MS access which will act as a background database for the geoportal. The soil data generated through the Soil Resource mapping (SRM) project will also be linked to the geoportal. The conceptual model of the geoportal is presented in Fig. 2.2.15. The unique feature of the geo-portal is its ability to facilitate query based geo processing of the soil database.

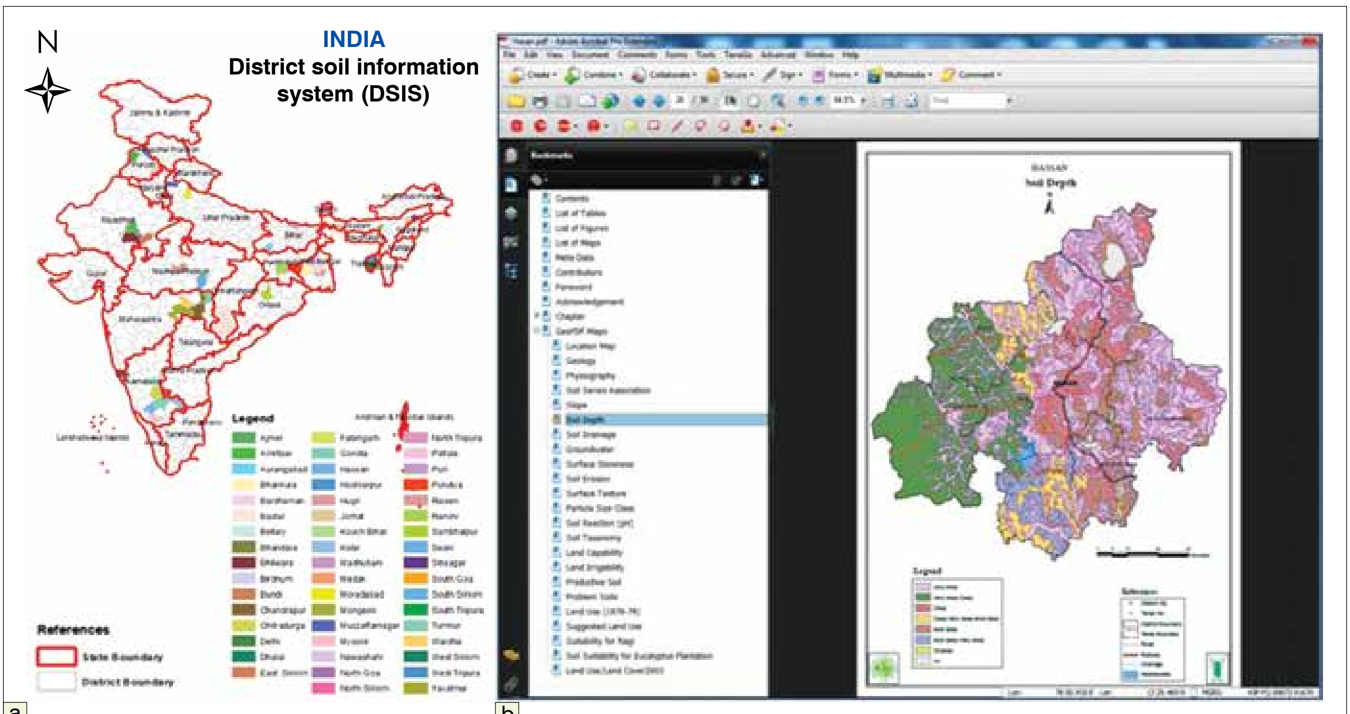


Fig. 2.2.14 : (a) District soil information system developed for 50 districts and (b) for Hassan district in Geo PDF format

Table 2.2.2 : Standard Data Entry Format for Land Resource Inventory

Site Characteristics

Unique_ id	Profile_id	Profile No.	Date of sam-pling	Sample by	Series Name	Topo-sheet No.	Lat	Long	Village	Tehsil	District	State	Geology	Parent Material	Land-form	Slope	Erosion	Drain-age	Runoff	Rainfall	Land use
							DMS	DMS												(in mm)	

Morphological Parameters

Unique_id	Profile_id	Profile No.	Sample No.	Series Name	Horizon	Depth (cm)	Boun-dary		Matrix colour	Texture	Coarse fragments %	Structure			Consistency			Porosity		Cutans			Nod-ules		Roots		Efferven	Other
									(Munsell notation)														(conca)				scence	features
							D	T	M			S	G	Ty	D	M	W	S	Q	Ty	Th	Q	S	Q	S	Q		

Physical Charcateristics

							Size class and Particle diameter (mm)												
							Total												
Unique_id	Profile_id	Profile No.	Sample No.	Series Name	Horizon	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Fine clay (%)	BD (Mg/m3)	COLE cm/cm	HC	sHC (mm/hr)	Moisture Retaintion			AWC	AWC
							(2-0.05 mm)	(0.05-0.002 mm)	(<0.002 mm)	(<0.0002 mm)					33KPa	100kPa	1500Pa	%	(mm)

Chemical Charcateristics

													Exchangable Cations								Available nutrients																								
Uni-que_id	Pro-file_id	Pro-file No.	Sam-ple by	Series Name	Hori-zon	Depth (cm)	pH 1:2	pHKcl	EC 1:2	ECe	Ca Co3	OC	Ca	Mg	Na	K	Sum	CEC	Clay: CEC	BS	-nutrients				ro-nutrients (mg)						Heavy Metals (mg/kg)													
									(dS/m)	(dS/m)	%	(gm/kg)	[cmol (p+) kg^{-1}]					[cmol (p+) kg^{-1}]		%	N	P	K	S	Fe	Mn	Zn	Cu	Mo	B	Pb	Co	Ni	As	Cd	Se	Cr	V	Fe	Ba	Zn	Sr	Mo	Cu

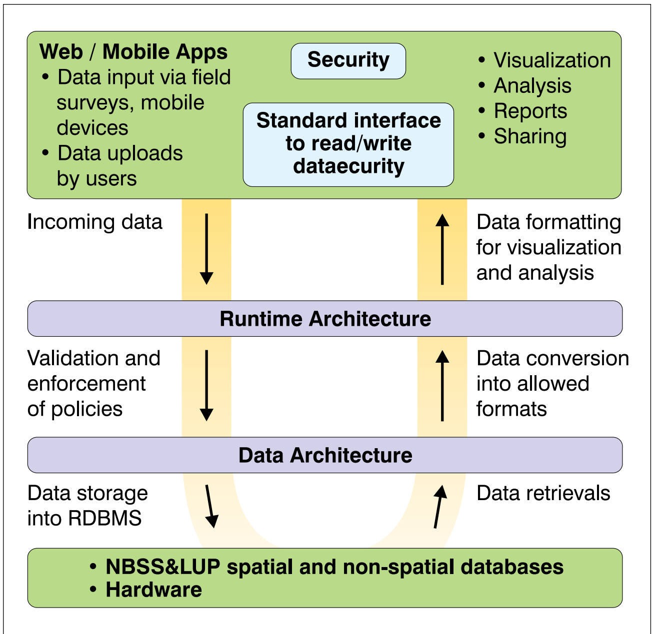


Fig. 2.2.15 : Conceptual figure for geoportal project

Spatial variability in soils

GPS based soil samples (0 to 20 cm depth) were collected from a regular grid of 200 by 200 m and analyzed for soil physical properties (particle-size, bulk density), hydraulic properties (moisture retention at -33kPa and -1500kPa), chemical properties (pH, organic carbon, cation exchange capacity), soil available macronutrients (N, P, K) and micronutrient cations (Fe, Mn, Cu, Zn).

Spatial variability was quantified through semivariogram analysis and the respective surface maps were prepared through ordinary kriging. Sand, bulk density, pH, organic carbon, cation exchange capacity, moisture retention at -33 kPa, available N, Fe, Mn and Zn have displayed medium spatial dependence, whereas, silt, clay, moisture retention at -1500 kPa, available P, K and Cu showed weak spatial dependence. Organic carbon, moisture retention at -33 kPa and available Cu were spatially correlated for a short range. Spherical model fits well with experimental semivariogram of sand, pH, OC CEC, moisture retention at -33 and -1500 kPa, available P, K, Fe and Cu, whereas, Gaussian model was found to be the best fit for silt, clay, available N, Mn and Zn. After filtering the information was krigged and linked with cadastral maps, which will help in site-specific nutrient and crop management. The spatial distribution of Available N, P, K, Fe, Mn, Cu and Zn in the micro-watershed are presented in Fig. 2.2.16a-c and 2.2.17a-d in that order.

Assessment of soil quality

The study was undertaken to identify soil quality indicators and assess soil quality indices for different land utilization types under rainfed conditions by integrating remote sensing information with field data. Parsodi watershed in Katol tehsil of Nagpur district, Maharashtra was selected for the case study.

IRS-P6 LISS-IV and Landsat TM data were used to prepare landform, land use/land cover and sustainable vegetation index maps of the study area. Minimum dataset (MDS) for different land utilization types (LUTs) were derived based on Pearson correlation matrix of Sustainable Vegetation

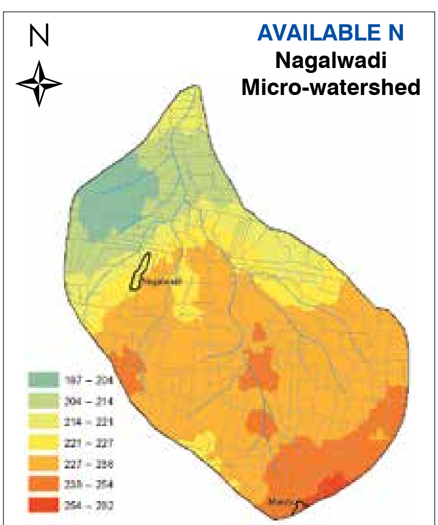


Fig. 2.2.16a : Available N

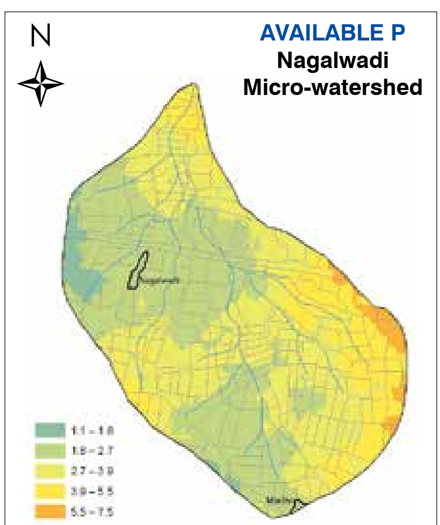


Fig. 2.2.16b : Available P

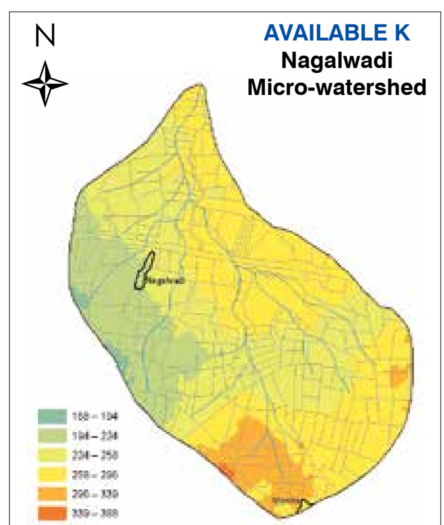


Fig. 2.2.16c : Available K

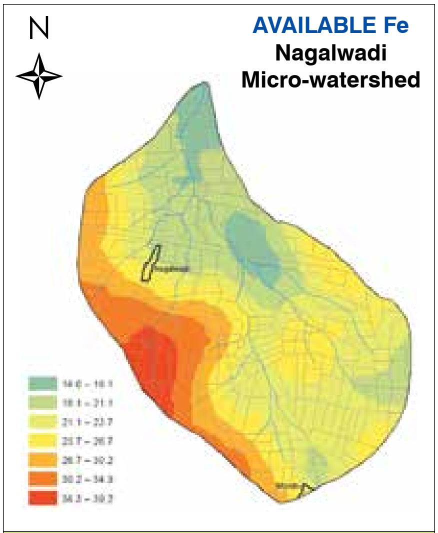


Fig. 2.2.17a : Available Fe

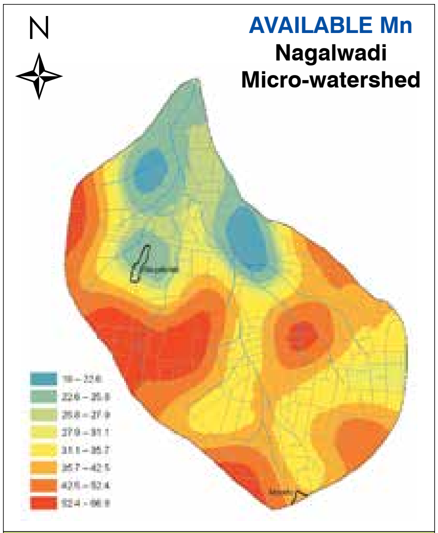


Fig. 2.2.17b : Available Mn

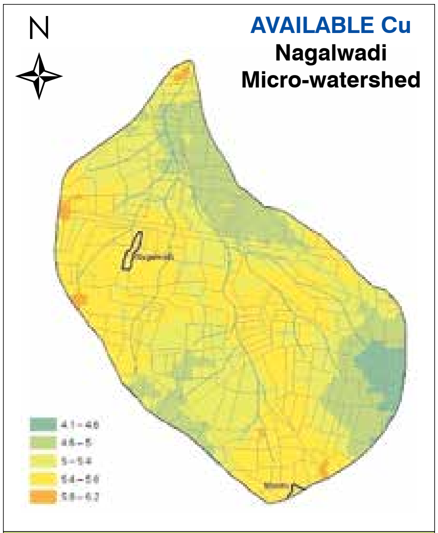


Fig. 2.2.17c : Available Cu

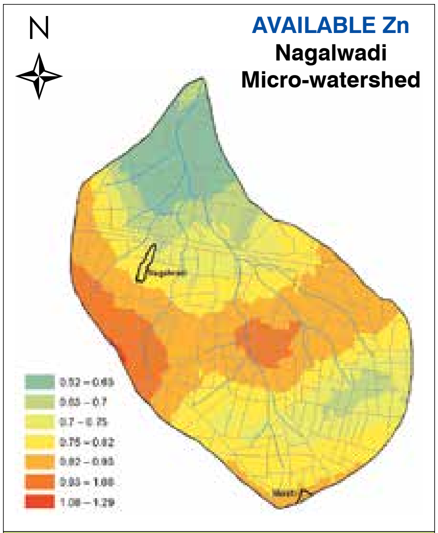


Fig. 2.2.17d : Available Zn

Index (SVI) with key soil and terrain response variables. Among soil variables, soil depth, clay, per cent $CaCO_3$ and -33Kpa soil moisture showed good correlation with SVI. Attempts have been made to develop topo-transfer functions for prediction of organic carbon, clay and soil depth from terrain parameters.

Organic Carbon (%) = 5.917 – (0.029 * Hillshade) – (0.038 *Slope) ………Eq.1

Clay (%) = 137.371 + (2.27 * TWI) – (0.058 * Aspect) – (0.206 * Elevation) ……Eq.2

Soil depth (cm) = 849.96 –(1.695 * Elevation) – (855.233 * Plan curvature) …….Eq.3.

The calibration statistics in terms of R^2, AMRE (Absolute Mean Relative Error), RMSE (Root of the Mean Square Error), NRMSE (Normalized RMSE), SE (Standard Error of Mean) revealed good calibration having values as 0.75, 0.15, 0.12, 0.18, and 0.03 for OC; 0.83, 0.08, 4.69, 0.09 and 1.53 for clay; and 0.81, 0.42, 15.57, 0.32 and 4.86 for depth, respectively. Validation statistics of the models i.e. R^2 (0.80, 0.80 and 0.84), AMRE (0.12, 0.08 and 0.30), RMSE (0.10, 4.95 and 18.35,), NRMSE (0.13, 0.10, and 0.25) and SE (0.05, 2.50, and 9.69) also indicate an efficient prediction of OC, clay and depth, respectively.

GIS-based Digital Library (DL)

Digital data base of 41 watersheds was created for the surface features i.e. slope, texture, gravelliest, erosion, LULC, water bodies, S&W structures and bore wells. Fertility and micro nutrient maps were created for one watershed. The spatial data organization is being carried out in File Geo-database format in ArcGIS environment and a front end is being developed using Visual Studio. NET to query the information. The spatial data created using ArcGIS software is being exported into ArcReader format to facilitate query without GIS software. We can retrieve the data of the given land parcel from different layers using the software and present to the user (Fig. 2.2.18).

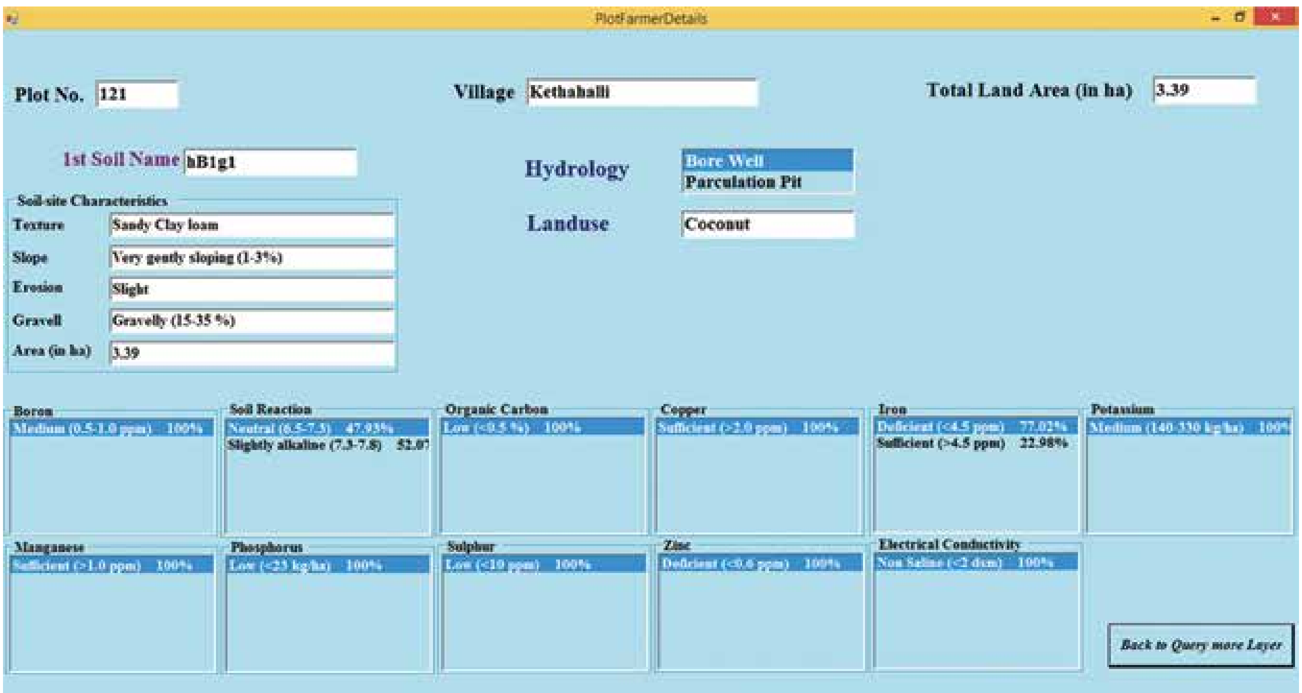


Fig. 2.2.18 : Soil and fertility details of the selected land parcel

2.3 BASIC PEDOLOGICAL RESEARCH

METHODS OF SOIL ANALYSIS

Water retention characteristics and saturated hydraulic conductivity

The moisture retention characteristics of dominant (shrink-swell) soils in Yavatmal district were found to be influenced by clay, CEC and ESP. Ks in these soils was a resultant function of two sets of factors influencing in opposite direction, with one set of factors viz., fine clay and ESP influencing negatively, whereas the other, organic carbon influencing positively. The derived Pedo-Transfer Functions (PTFs) in the present study to estimate moisture retention at 33, 300, 500, 800, 1200 and 1500 kPa are the best PTFs with RMSE < 10 %. The ME value (> 0.0 and < 1.0) also indicates acceptable performance of these PTFs. But the remaining two PTFs (MC 100 and sHC) showed a poor performance. The PTFs of Pidgeon (1972), Dijkerman(1988) and Oliveira et al. (2002) and Tiwary et al. (2013) did not perform well . This is probably due to the differences in soil properties between the datasets used to develop the above PTFs and the Yavatmal dataset. Only 33 per cent of the variability in sHC was explained by the variation in independent variables viz., organic carbon, fine clay and ESP. Hence, it can be stated that predicting sHC is difficult and uncertain in shrink-swell soils. Further studies are required in this regard.

Revising methods for the determination of available potassium content in shrink-swell soils of India

The problems in estimating K availability using ammonium acetate reagent for shrink-swell soils are well known, but the reasons for the same have not been identified. Research efforts in this direction have brought out interesting results with regard to source and sink of K in these soils. Ideally these soils should not fix K as the dominant mineral in shrink-swell soils (Vertisols and their intergrades) i.e., smectites do not have affinity for K. Moreover, these soils being mainly derived from plagioclase feldspar-rich basaltic alluvium, do not contain appreciable amounts of K bearing minerals such as mica and vermiculite (the vermiculite content of shrink-swell soils varies from 3 to 10%). However, available K determined by 1N ammonium acetate (pH 7.0) the method does not match with K actually available to the plants. The Bureau has attempted to resolve the basic issue pertaining to fixation/release of K in shrink-swell soils with the help of determination of the layer charge density of the smectites.

Variation in swelling properties of clays with identical interlayer cations are mainly due to differences in layer charge densities. Hence, a study was undertaken involving alkylammonium method of determining layer charge by XRD for pure bentonite (Wyoming) and representative soils (for the sake of brevity only few are presented here) from Amravati district of Maharashtra namely Kharwari (Typic Haplusterts) and Sait (Sodic Haplusterts) soil series showing variations of d-values with number of C atoms of alkylammonium chloride (Fig. 2.3.1) and the layer charge and frequency distribution of Kharwari and Sait are shown in figure 2.3.2. The layer charge for pure bentonite which is montmorillonitic in nature and whose charge is seated solely in the octahedral layer was 0.26 $mol(-)/(Si,Al)_4O_{10}(OH)_2$ which is ideal for pure smectites. Whereas, for Kharwari (Typic Haplusterts) and Sait (Sodic Haplusterts) the values of layer charge were 0.43 and 0.48 $mol(-)/(Si,Al)_4O_{10}(OH)_2$, respectively and the charge was distributed in both the layers; the tetrahedral layer having more charge than the octahedral layer. As stated earlier, the major benchmark Vertisols of India contain only about 3-10% vermiculite and it is mainly responsible for adsorption / fixation of potassium in these soils. Higher charge obtained for the dominantly smectitic fine clays of Kharwari and Sait may be due to presence of vermiculite. It can be said that about 30% of charge in Kharwari and about 38% of charge in Sait fine clays is above the range of 0.5 unit charge. It is also known that smectites with layer charge above 0.45 units has the affinity to fix K which is likely to increase with increase in layer charge. Therefore, this basic information can be used to solve the paradoxical situation in shrink-swell soils which has arised from the non-availability of K to plants on one hand, and adequate ammonium acetate extractable K on the other.

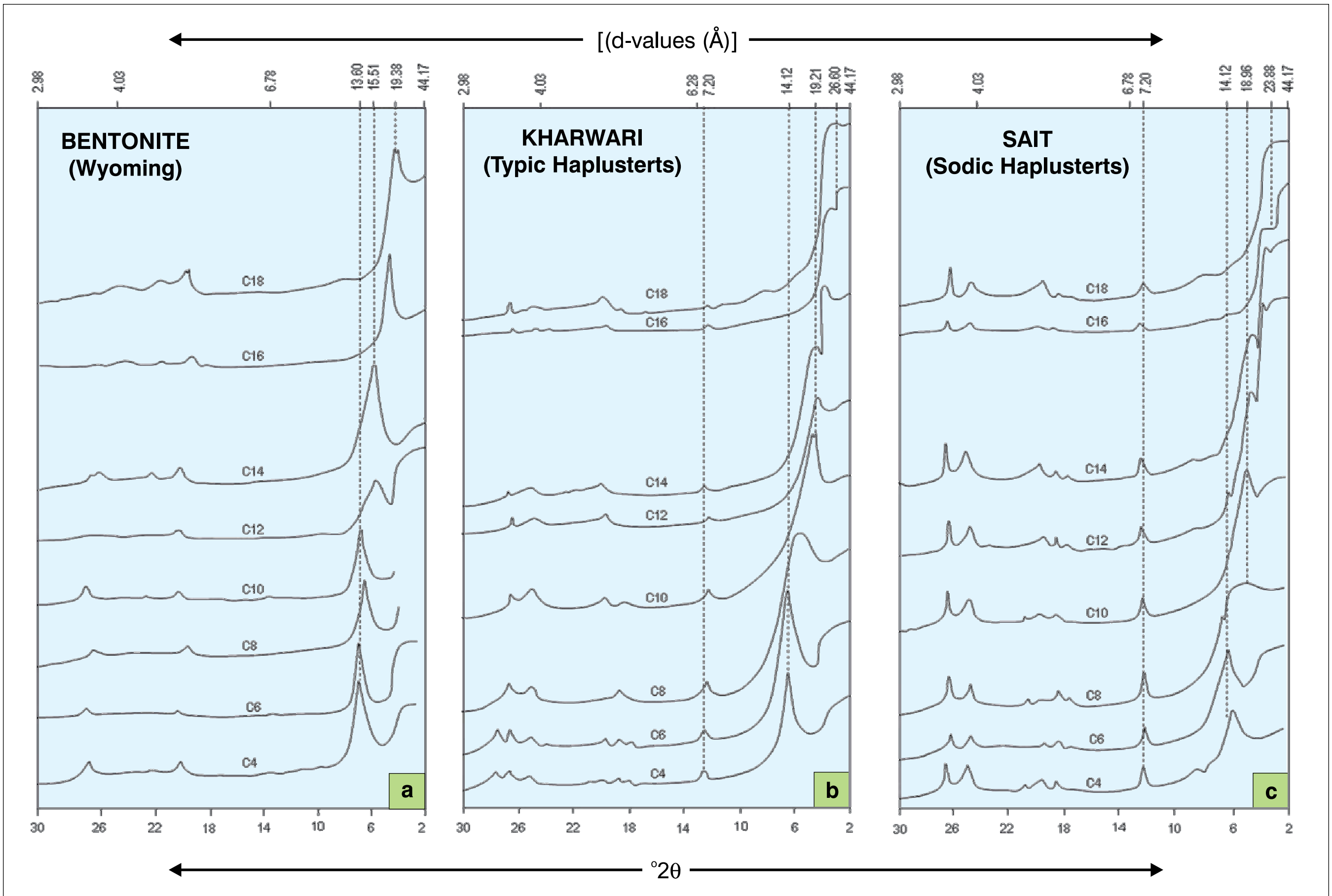


Fig. 2.3.1 : X-ray diffractograms of fine clay fractions treated with alkylammonium chlorides having number of carbon atoms C4, C6, C8, C10, C12, C14, C16 and C18 with respect to (a) Bentonite (Wyoming, USA), (b) Kharwari series (Typic Haplusterts), (c) Sait series (Sodic Haplusterts) (Maharashtra)

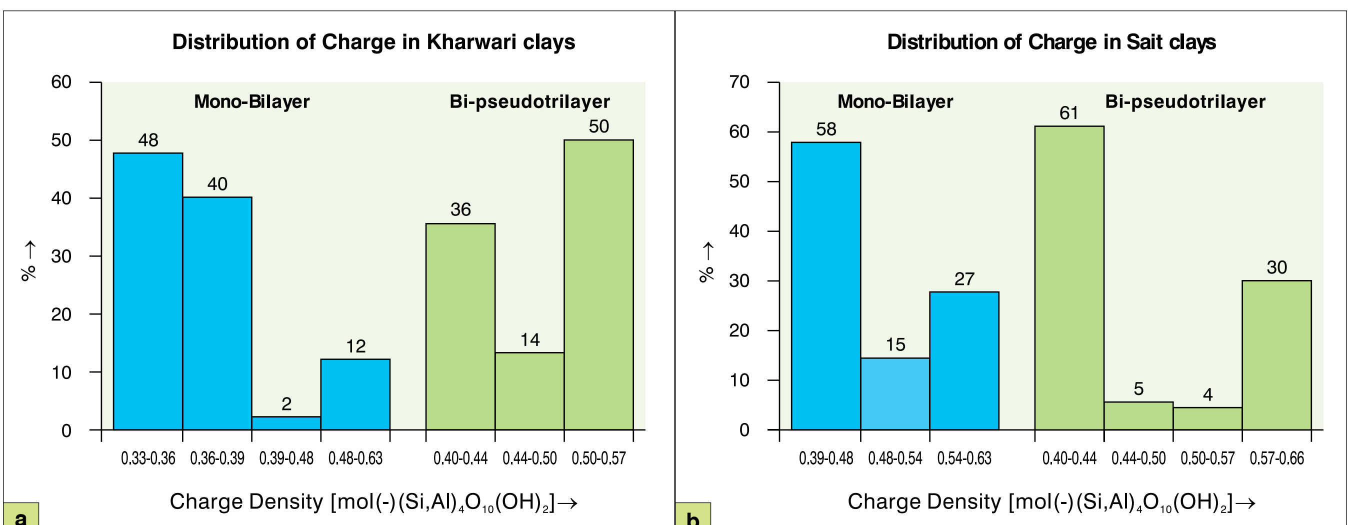


Fig. 2.3.2 : Distribution of layer charge density and frequency for (a) Kharwari series and (b) Sait series, Amravati district, Maharashtra

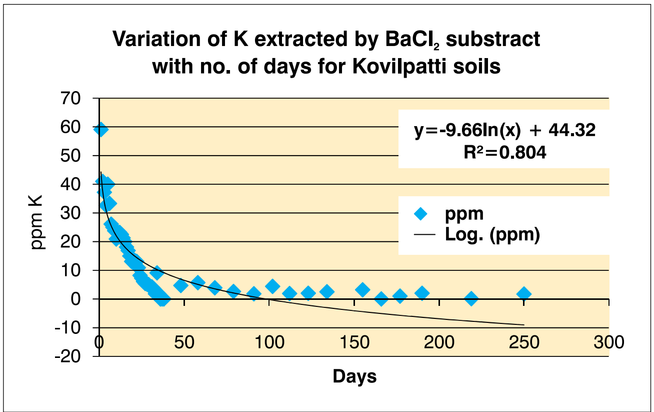


Fig. 2.3.3. Variation of K extracted with number of days by $BaCl_2$ for Kovilpatti soils, Tamil Nadu

Taking these information into consideration, a new method has been developed to determine available K in soils. About 150 shrink-swell soil samples of surface and subsurface have been analyzed for available K by this method and the results are promising. However, the same needs to be validated with soil test crop response studies being conducted in similar soils at various experimental sites in India.

The $BaCl_2$ method used for the extraction of K was to relate its values with the amount of mica and / or vermiculitic K present in these soils. Even after 40 extractions it was not clear whether K was extracted completely. Hence the extraction procedure was continued upto 250 days. $BaCl_2$ extracted K even after 40 days of extraction. It was observed that most of the soils, except Sarol (Indore, Madhya Pradesh) and Sokhda (Rajkot, Gujarat), assumed constancy and attained almost zero values of K extracted after about 150-200 days. An example of Kovilpatti soils (Tutikorin district, Tamil Nadu) is shown (Fig. 2.3.3) which indicates that after 100 days of extraction, the K release attained constancy and it continued even upto 250 days.

GENESIS AND CHARACTERIZATION OF SOIL MINERALS

Genesis of minerals in selected benchmark soils in different agro-ecoregions of India

Studies have been undertaken to collate available and new datasets in appropriate format and quantify mineral assemblages in different fractions of soils.The datasets were developed for AERs 10 (hot subhumid) and 6 (hot semi-arid) of central region which is further divided into 7 AESRs dominated by shrink-swell soils. Micro morphological studies indicated variation in plasma fabrics in soils under different climates because of extent of clay activity and shrink-swell phenomena. The soils contain both pedogenic and nonpedogenic carbonates but in subhumid areas the pedogenic carbonates are present deep in the profile. The soils under study in all AESRs are Vertisols and are dominated smectite but the amount in different fractions vary among themselves. Fine clay fraction contains more than 80 per cent smectite. Attempts have been made to develop mineral map of AESRs of AER 10 and 6 along with submicroscopic analysis. An example of AESR 10.1 is given below with a brief description. This AESR is a part of the Central highlands and Bundelkhand regions with hot dry subhumid climate. The Vertisols of this agro-eco-subregion are typified by Kheri and Nabibaghsoils The soils have 46 to 56 % clay of which more than 60-70 % is fine clay. Bulk density is low (1.3-1.6Mg m^{-1}) and saturated hydraulic conductivity (sHC) is more than 2cm hr^{-1} in the surface though it decreased in the lower horizons of about 80cms. This sHC can be related to the presence of zeolites in the sand though it is not detectable in XRD of silt or clay samples. $CaCO_3$ in these soils varies from 4 to 7.3%.

Sub-microscopic studies indicated strong plasma separation with parallel striated b-fabric (Fig. 2.3.4a & b) indicating better drainage condition owing to zeolite minerals in the sand fractions (Fig. 2.3.4c & 2.3.4d). Other minerals identified in the sand fractions of Kheri soil includes feldspars and mica (Fig. 2.3.4e & 2.3.4f). X ray diffraction studies indicate that the silt and clay fractions contain dominant amount of smectite with presence of kaolin, mica, chlorite, feldspars and quartz (Fig. 2.3.5). A clay mineral map of the region (1st approximation) has been developed.

Characterization of minerals in some selected benchmark soils of Western Vidarbha Region of Maharashtra

The benchmark sites of Western Vidarbha are dominated by smectites in the silt and clay fractions. However, fine clays contain subordinate of vermiculite and feldspars. Coarser fractions of sand are dominated by quartz feldspars. Conspicuous presence of mica has been observed in the finer fractions.

Characterization of minerals in some typical soils representing different AESRs of eastern Vidarbha in Maharashtra

The benchmark spots of Eastern Vidarbha are dominated by smectites in the silt and clay fractions. Sand mineralogy study indicated that the coarser fractions of sand are dominated by quartz and feldspar, whereas observed

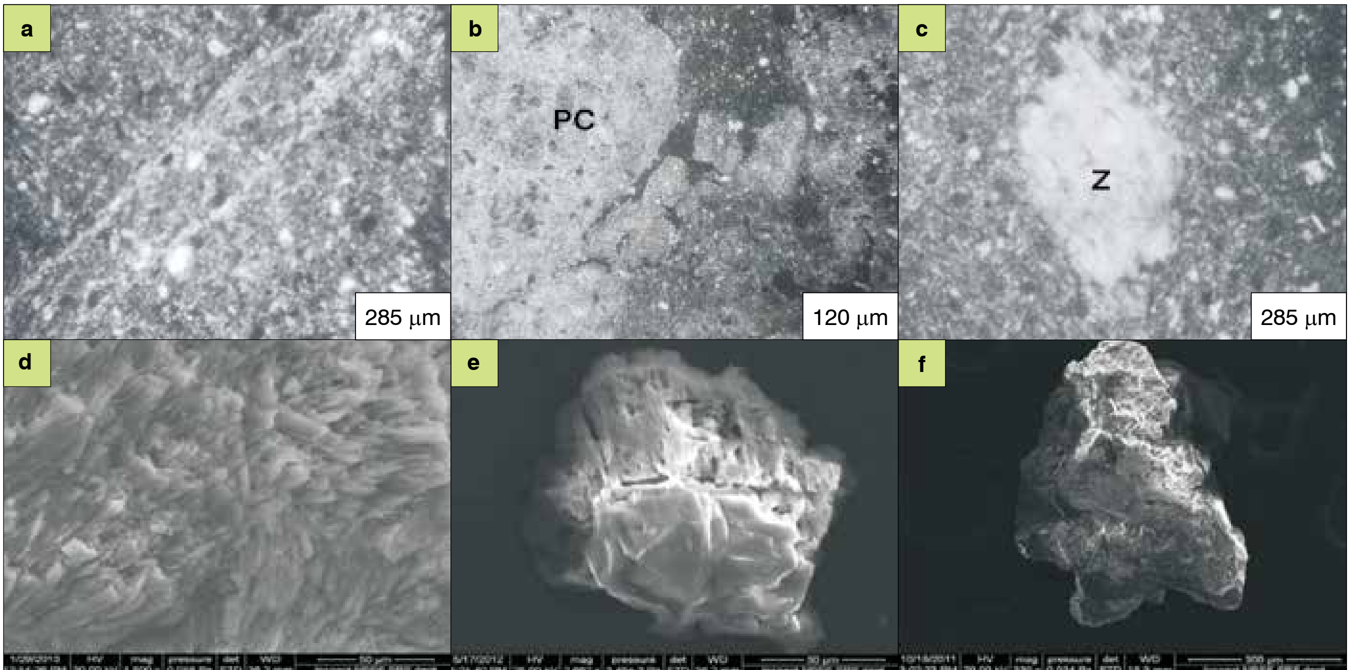


Fig. 2.3.4 : Microscopic and submicroscopic features of soils of AESR 10.1: a) Representative photograph of moderately strong parallel-striated plasmic fabric in cross polarized light Jabalpur(Kheri) soils, (70-78 cm). b) Representative photograph of pedogenic calcium carbonate (PC) in cross polarized light in Jabalpur (Kheri) soils (45-53 cm). c) Weathering features of soil modifiers : zeolite in Jabalpur. d) Elongated zeolite (d) in Bhopal (Nabibagh) soils. e) Different stages of feldspar weathering in Jabalpur soils (e) relatively unweathered and (f) highly weathered.

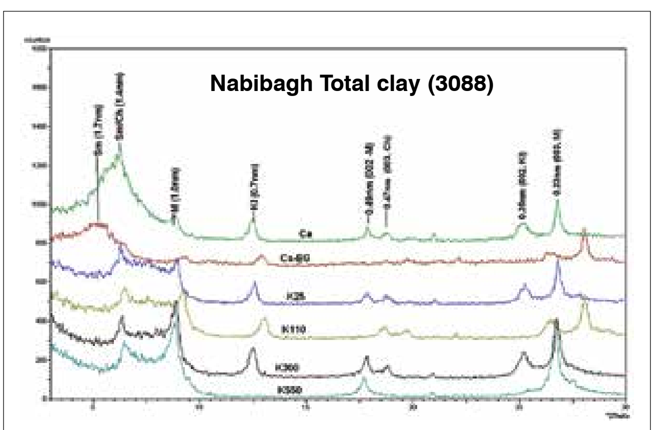


Fig. 2.3.5 : Represented XRD patterns of the silt, total clay and fine clay fractions from AESR 10.1, Ca = Ca-saturated, CaEG = Ca-saturated plus glycol vapour, K25/110/300/550°C = K-saturated and heated to 25°,110°,300° and 550°C. Sm = smectite, M = mica, Kl = kaolin.

conspicuous presence of mica in fine fraction may have implications in the nutrient management of these soils in general and potassium in particular. The nature of clay minerals has implications on various soil properties like sHC, CEC, BD etc., which affect the soil productivity. Thus, this study helps in to identify the important clay minerals which have positive or negative effect on the soils productivity potential.

Forms of soil phosphorus as an index of weathering and soil maturity

The study was conducted in hot dry subhumid ecoregion of Maharashtra. Soil maturity sequence derived from Weathering Index (WI) based upon soil inorganic phosphorus (IP) fractions viz. P1 (most matured) > P2 > P4 > P5 > P3 > P6 (least matured) in toposequence-I and P4 (most matured) > P2 > P1 > P5 > P6 > P3 (least matured) in toposequence-II was in good agreement with the maturity sequence obtained from silica sesquioxide molar ratio, active iron ratio as well as from Soil Taxonomy for both the toposequence, but did not corroborate with maturity sequence obtained based upon total P viz. > P4 > P5 > P1 > P3 > P2 > P6 (Toposequence-I) and > P4 > P3 > P5 > P6 > P1 > P2 (Toposequence-II) suggesting that the total P in a poor indicator of relative degree of soil maturity in the present context. The study emphasized the suitability of soil IP based WI for adjudging soil maturity in terms of pedogenic development of soil.

CARBON SEQUESTRATION

Influence of organic and inorganic carbon sequestration on soil and land quality in selected benchmark spots of India

The soil organic carbon (SOC) and yields of soybean and wheat crops were simulated using Dinitrification Decomposition (DNDC) model from the Long Term Fertilizer Experiment (LTFE) datasets for Nabibagh site of Bhopal. The model simulated soybean 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. For wheat crop we get modelled value for T1, T5, T6 & T7 as 923, 1506, 1500, 1562 kg ha^{-1} yr^{-1} against observed value i.e. 893, 1600, 1460 & 1550 kg ha^{-1} yr^{-1} respectively.

An indigenous model (SOLAQ) has been developed for simulating soil carbon. The input parameters required to run the model are climatic data (rainfall, max. and min. temperatures in daily, weekly and monthly time steps), soil data (no. of layers, soil texture, initial soil temperature, initial soil moisture content, bulk density, moisture content at field capacity and wilting point, etc.), residue/litter properties (carbon content in residue, rate constant for residue or litter decomposition, rate constant for humus decomposition, efficiency factor, humification factor, etc.) and simulation control parameters (starting date of simulation, duration of simulation, time-step of simulation, volumetric range of water content where response increases, volumetric range of water content where response decreases, minimum water content for process activity, threshold water content for denitrification, threshold temperature below which response is linear function, base temperature and coefficient for defining soil water response function at saturation).

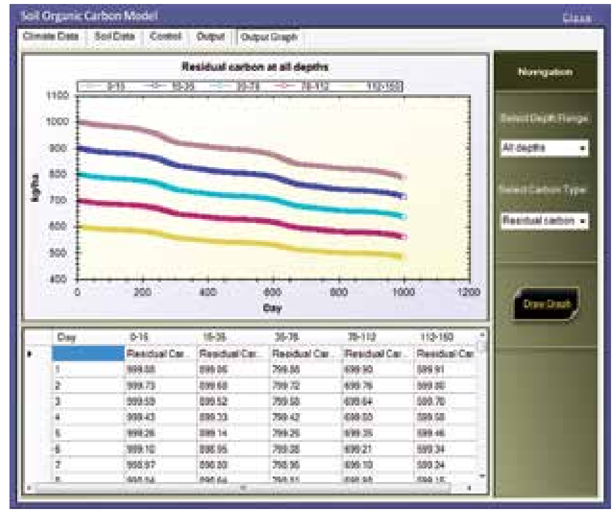


Fig. 2.3.6 : Output of the soil organic module in SOLAQ

The management practices such as application of nutrient (mainly nitrogen based chemical fertilizers, FYM and crop residue, tillage practices, etc.), which affect the soil and land quality, are also taken into account for the nitrogen cycle. Based on the bioclimate /mean annual rainfall, an algorithm was also developed for correction factor of soil organic carbon determined by the Walkley-Black method. The simulation results are displayed in both tabular and graphical forms at different time steps (Fig. 2.3.6).

2.4 INTERPRETATION OF SOIL SURVEY DATA

LAND RESOURCE DATA BASE SOIL HEALTH CARD – TELANGANA STATE

Soil health cards have been prepared for three blocks of Gajwel, Medak district, Thimmajipet, Mahaboobnagar district and Indravalle, Adilabad district at the request of Department of Agriculture, Govt. of Telangana. Soil samples were collected on 325 X 325 meter grid interval (Fig. 2.4.1). Thus each sample point represents 10 hectare area on the ground. Following the procedure, around 1500 samples are collected from each block. Samples are processed and analyzed for organic carbon, pH, electrical conductivity, calcium carbonate, macro (N, P, K) and micro nutrients (Fe, Mn, Zn, Cu, B, S). The features like slope, soil type, depth, texture, potential soil loss, land capability class and land irrigability class are extracted from soil map prepared under LRI programme. Soil nutrient database is reclassified into different class ranges given in table 2.4.1. The classified data were interpolated following simple krigging in GIS environment. Raster file of each nutrient data was linked with cadastral map. Finally, plot wise and farmer wise soil health cards were prepared. A part of dataset given for developing soil health card of Gajwel mandal is given in table 2.4.2. Besides the data given in table 2.4.3, soil health cards would also contain fertilizer and amendment recommendations and other management practices for most promising crops of the mandal (Fig. 2.4.2).

Table 2.4.1 : Ranges of soil nutrient database

Soil Characteristics	Low		Medium		High	
Organic carbon	<0.50		0.50-0.75		>0.75	
Available Nitrogen (kg ha^{-1})	<280		280-450		>450	
Available phosphorus (kg ha^{-1})	<10		10-25		>25	
Available potassium (kg ha^{-1})	<200		200-350		>350	
Available sulphur (mg kg^{-1})	<10		10-15		>15	
Available water capacity (mm/m)	<100		100-150		>150	
	Deficient				Sufficient	
Available iron (mg kg^{-1})	<4.5				>4.5	
Available manganese(mg kg^{-1})	<1.0				>1.0	
Available zinc (mg kg^{-1})	<0.6				>0.6	
Available copper (mg kg^{-1})	<0.2				>0.2	
Available boron (mg kg^{-1})	<0.36				>0.36	
pH class	Acidic (<6.5)	Neutral (6.5-7.5)	Alkaline (>7.5)	Slightly alkaline (7.5-8.0)	Moderately alkaline (8.0-8.5)	Highly alkaline (>8.5)

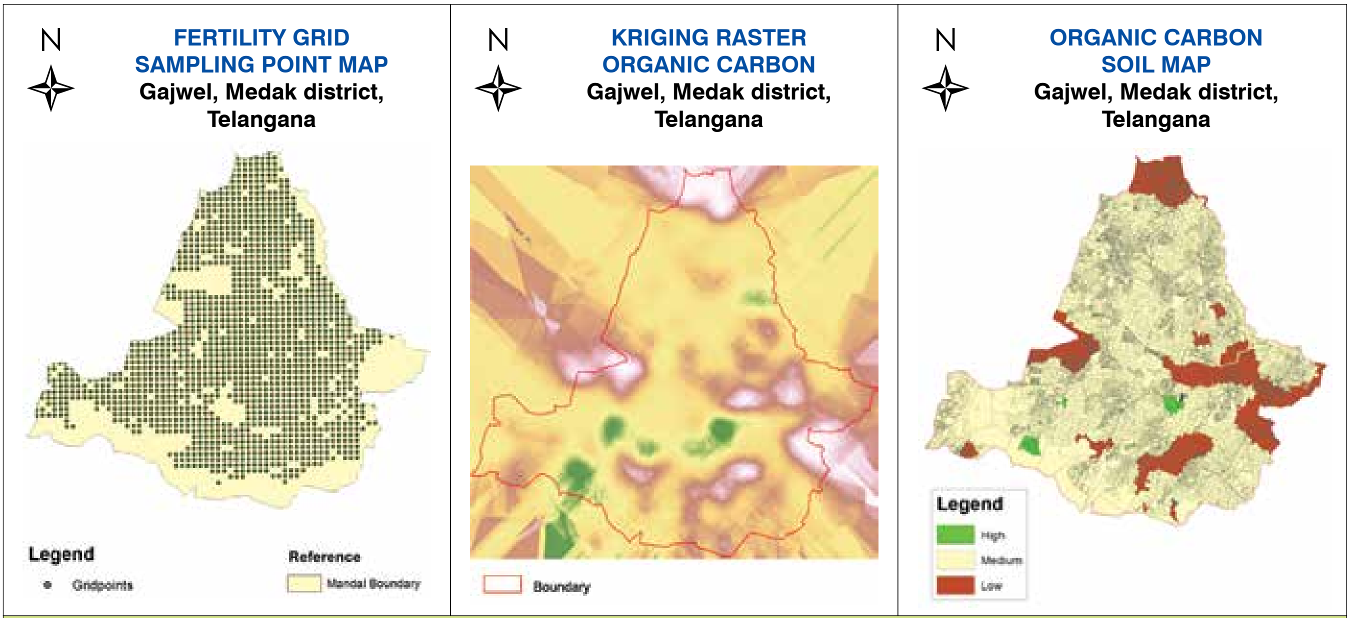


Fig. 2.4.1 : Soil sampling scheme, Krigging technique and fertility map of Gajwel block

Table 2.4.2 : Data used for developing Soil health card

Par-cel_ no	Village	Mandal	District	Slope	Soil Type	Depth	Color	Texture	Avail-able water	Poten-tial_ Soil_ Loss	LCC	LIC	pH	EC	Caco3
/1	Ahmadipur	Gajwel	Medak	0-1	Medium	Medium	Brown	Loamy	Medium	Slight	IVes	4s	Slightly Alkaline	Non Saline	Low
/2	Ahmadipur	Gajwel	Medak	0-1	Medium	Medium	Brown	Loamy	Medium	Slight	IVes	4s	Slightly Alkaline	Non Saline	Low
/3	Ahmadipur	Gajwel	Medak	0-1	Medium	Medium	Brown	Loamy	Medium	Slight	IVes	4s	Slightly Alkaline	Non Saline	Low
/4	Ahmadipur	Gajwel	Medak	0-1	Medium	Deep	Dark Graeyish	Loamy	Medium	Slight	IIIs	4s	Slightly Alkaline	Non Saline	Low
1	Ahmadipur	Gajwel	Medak	0-1	Medium	Medium	Brown	Loamy	Medium	Slight	IVes	4s	Slightly Alkaline	Non Saline	Low
10	Ahmadipur	Gajwel	Medak	0-1	Medium	Medium	Brown	Loamy	Medium	Slight	IVes	4s	Slightly Alkaline	Non Saline	Low
100	Ahmadipur	Gajwel	Medak	0-1	Medium	Deep	Dark Graeyish	Loamy	Medium	Slight	IIIs	4sd	Slightly Alkaline	Non Saline	Low
101	Ahmadipur	Gajwel	Medak	0-1	Medium	Deep	Dark Graeyish	Loamy	Medium	Slight	IIIs	4sd	Slightly Alkaline	Non Saline	Low
102	Ahmadipur	Gajwel	Medak	0-1	Medium	Deep	Dark Graeyish	Loamy	Medium	Slight	IIIs	4sd	Slightly Alkaline	Non Saline	Low
103	Ahmadipur	Gajwel	Medak	0-1	Medium	Deep	Dark Graeyish	Loamy	Medium	Slight	IIIs	4sd	Slightly Alkaline	Non Saline	Low

Parcel_no	Village	Organic carbon	Nitrogen	Phosphorus	Potassium	Sulfur	Iron	Manganese	Zinc	Copper	Boron	Irrigation	Degradation type
/1	Ahmadipur	Medium	Medium	HIgh	Medium	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
/2	Ahmadipur	Medium	Medium	HIgh	Medium	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
/3	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
/4	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
1	Ahmadipur	Medium	Medium	HIgh	Medium	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
10	Ahmadipur	Medium	Medium	HIgh	Medium	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
100	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Irrigated	Non degraded
101	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Irrigated	Non degraded
102	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Rainfed	Non degraded
103	Ahmadipur	Medium	Medium	HIgh	High	High	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Irrigated	Non degraded

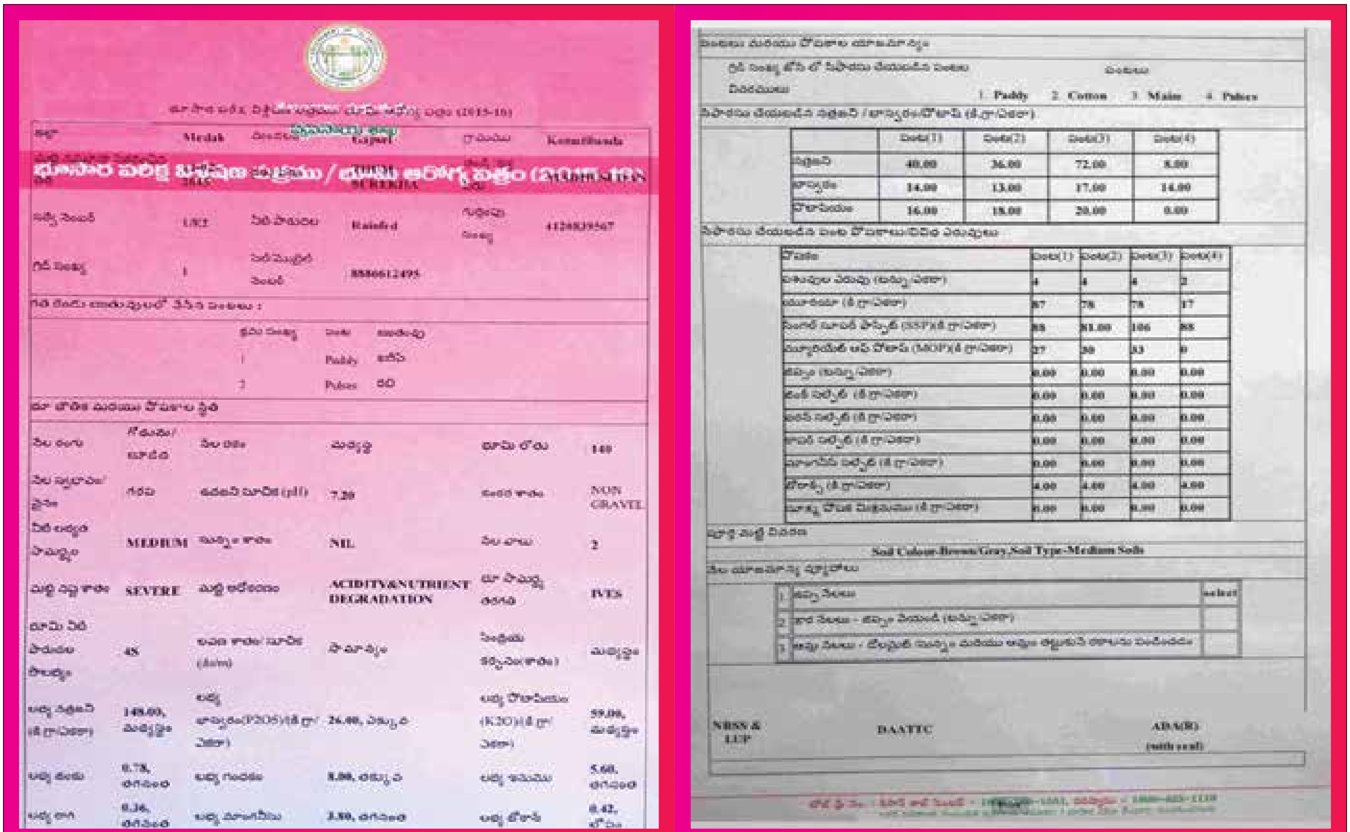


Fig. 2.4.2 : Soil Health Card

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

The field work has been completed with identification and characterization of 100 soil health monitoring sites. Of them, 85 benchmark sites represents 5.17 lakh hectare area in Kerala, four benchmark sites for 0.19 lakh hectare in Tamil Nadu and 11 benchmark sites for 0.32 lakh hectare in Karnataka. Profile and landscape for one of the monitoring sites is shown in the figure 2.4.3 as an example.

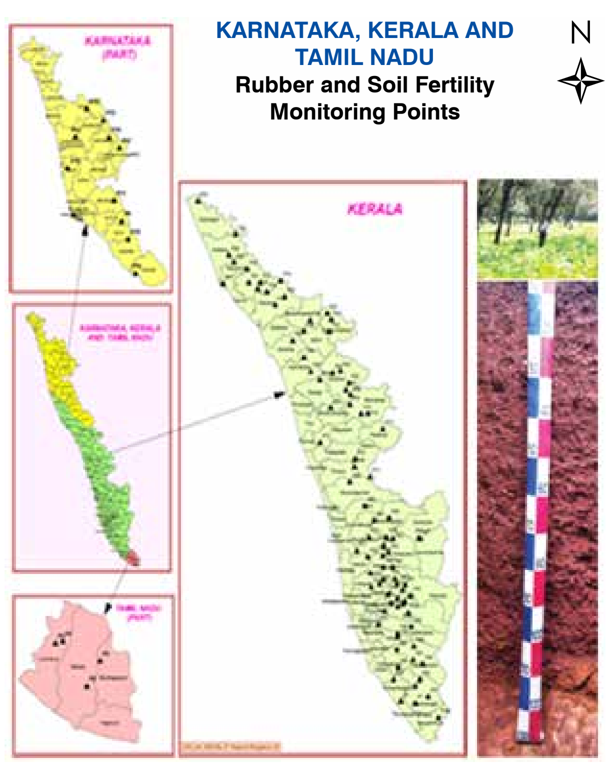


Fig. 2.4.3 : Soil Health Monitoring sites

Fallow lands of Tamil Nadu

Fallow lands (Fig. 2.4.4) of Nanguneri and Kangeyam blocks were characterised using IRS LISS IV imagery and mapped at 1: 10000 scale. Field survey was carried out during April-May 2014 to check the fallow land map of Kangeyam block. The dominant soils were very shallow calcareous loamy, shallow calcareous loamy, moderately shallow calcareous gravelly fine loamy, moderately deep calcareous fine loamy and deep calcareous alluvial loamy soils.

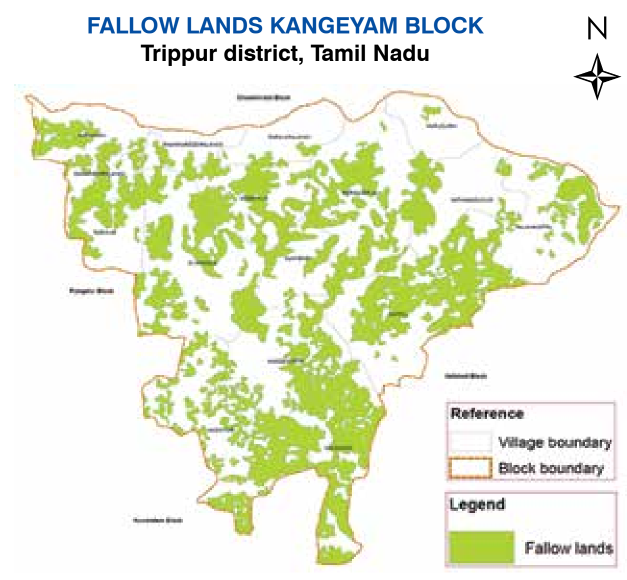


Fig. 2.4.4 : Fallow land map of Kangeyam block

Moderately alkaline soils occupied 68.01 cent of fallow lands of Kangeyam block followed by slightly alkaline (19.36%) and strongly alkaline (8.77%). Low rainfall, strong calcareousness, high pH, strong gravelliness and high level of degradation alone or in combination are the major biophysical factors for increasing fallow lands. Socio-economic study indicates that lack of irrigation, labour scarcity, low profitability in agriculture, increase in fragmentation of land are the other important factors affecting dynamics of fallow lands.

Salt Affected Soils in Tamil Nadu

The LISS-III satellite imagery for the year 2004 and 2005 was visually interpreted and salt affected soils were delineated on 1:50000 scale with ground truth. 4.8 per cent of the total area was mapped as salt affected soils in entire state. per cent of salt affected area is almost similar in Tiruvannamalai (0.4% of TGA), Ramanathapuram (0.4%), Sivagangai (0.37%), Villupuram (0.35%) and Trichy (0.34%) district. The survey also identified that about 39 per cent of area in Mailam block and 18 per cent of area in Kalayarkoil block are salt affected.

Soil fertility appraisal and soil heath monitoring of traditional coffee-growing regions of Karnataka, Kerala and Tamil Nadu

The project aims to establish and classify soil health monitoring sites represents various agro-climatic situations in the coffee-growing areas along with adjacent forest lands as standard checks. During the year 60 soil health monitoring sites were studied. The results indicated that the soils are deep, gravelly clayey, acidic and rich in organic carbon especially in surface horizons underlain with an argillic/kandic horizon with low cation exchange capacity and base saturation. Soils belong to Humults, Ustalfs, Ustolls or Ustults sub-order. These are medium in nitrogen, phosphorus and potassium supplying capacity, rich in micro-nutrients like Fe, Mn and Cu and deficient in boron and zinc. Deficiencies of Ca, Mg or S also are not uncommon in these soils.

DESERTIFICATION STATUS MAPPING OF INDIA (2ND CYCLE)

Four vulnerable districts namely, Anantapur and Mahbubnagar in Andhra Pradesh, Chamarajnagar and Bellary in Karnataka were selected for desertification status mapping at 1: 50000 scale using Resourcesat-2 AWiFS data at 1: 500000 scale. Three season viz. *kharif*, *rabi* and summer IRS LISS-III data of two different time series was used for desertification status mapping. The three-tier classification system viz. land use/land cover, desertification processes and severity was used to identify the different desertification units/land degradation units (Fig. 2.4.5).

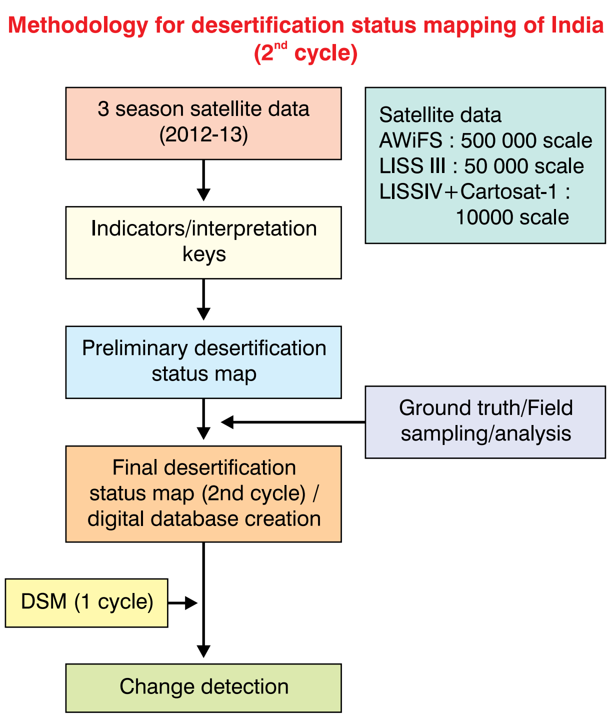


Fig. 2.4.5 : Desertification status mapping

The desertification status of Anantapur district is shown in table 2.4.3 as an example. Change detection assessment was carried out by comparing the results of 2013-14 and 2003-04 data. An example of a comprehensive study highlighting alkalinity development in Cauvery command area in Chamarajnagar district, Karnataka is presented in Fig. 2.4.6.

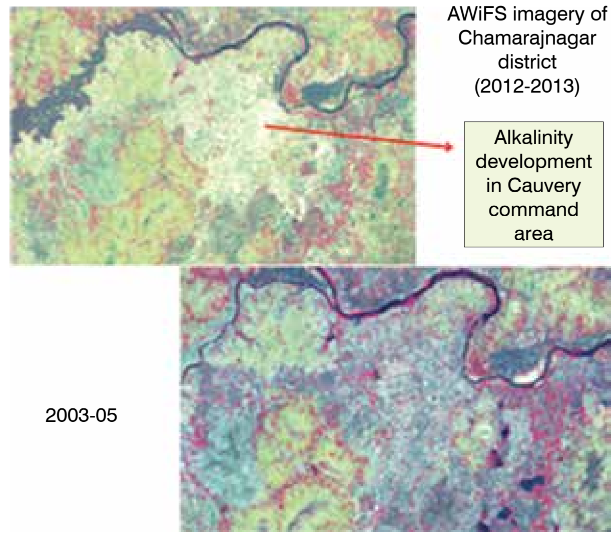


Fig. 2.4.6 Cauvery command area over 10 years

Table 2.4.3 : Processes of desertification, their classes and extent in Anantpur district, Karnataka

Land use	Processes	Severity	Area (ha)
Agriculture-Unirrigated	Water erosion	Low	346735
		Medium	70584
		High	4166
	Salinisation/alkalinisation	Low	48623
		Medium	4730
		High	3474
Agriculture Irrigated	Water erosion	Low	1971
	Salinisation/alkalinisation	Low	22593
		Medium	127
		High	4938
Forest/ Plantation	Vegetal degradation	Low	136291
		Medium	17100
		High	6567
Scrubland	Vegetal degradation	Low	1052
Others	Man made mining	Low	230

Salt affected soils in southern district of Haryana state

The salt affected soils of Mewat District, Haryana were studied, characterized and classified. Majority of the soils were sandy loam or loamy sand in texture and moderately to strongly saline in nature with ECe ranging from 2.5 to as high as 138.9 dSm^{-1}. At many places soil surface is encrusted with salt efflorescence with ECe ranging from 48.1 to 138.9 dSm^{-1}. Sodium was dominant soluble cations with concentration as high as 1964.34 me/L. These soils are moderate to strongly saline with neutral salt of sodium chloride. These soils are very low in available nitrogen content (70 Kg ha^{-1}) and low in available potassium content (175 Kg ha^{-1}) and medium in available phosphorus content (39 Kg ha^{-1}). DTPA extractable Mn ranged from 11-15 mg kg^{-1}, Fe from 13- 25 mg kg^{-1}, Zn from 2-6 mg kg^{-1} and Cu from 1-2 mg kg^{-1}. In the Mewat district, nearly 3.45% of total geographical area (64.11km^2) is severely salt affected, 11.14% (207.21 km^2) as moderately salt affected and 9.48% (176.4 km^2) as waterlogged salt affected soils.

Soil quality assessment in rainfed cotton growing area in Maharashtra

Assessment of soil quality was attempted in cotton growing environs (AESR 6.3 and AESR 10.2) of Vidarbha, Maharashtra. Six soils each in AESR 6.3 (Akola district) and AESR 10.2 (Nagpur district) were selected, studied for their morphological, physical, chemical and biological properties and assessed for their quality.

Minimum datasets (MDSs) required for assessing soil quality were developed using i) expert knowledge and ii) Principal Component Analysis (PCA). The major soil constraints identified in AESR 6.3 were shallow depth, high BD, low hydraulic conductivity and high ESP and those in AESR 10.2 were high clay content, high BD and low hydraulic conductivity. The MDS developed by expert knowledge was used in developing Relative Soil Quality Index (RSQI) and Composite Soil Index (CSI) by conventional and fuzzy modelling-based method respectively. PCA was also used in developing MDS, followed by use of a (contemporary) PCA-based method for soil quality assessment through Soil Quality Index (SQI). The results indicate that all the methods identified pedon 3 and pedon 12 as the best soil (rank 1) in AESR 6.3 and AESR 10.2 respectively. The PCA-based method was identified as the best method of soil quality assessment in AESR 6.3 whereas conventional method was superior to other methods in AESR 10.2.

Influence of Management on Soil Quality

The soil quality of irrigated sites of Amravati district have deteriorated because of several reasons such as: i) high clay content of soil, ii) irrigation with poor quality water, iii) high exchangeable and water soluble sodium and magnesium and iv) poor saturated hydraulic conductivity of the irrigated soils which have been impaired due to increase in ESP after irrigation. Attempts to increase and stabilize crop yields in Amravati tehsil with poor quality irrigation water may render the soil unproductive. Farmers should, therefore, i) confine as far as possible to rainfed agriculture, ii) need to avoid continuous use of poor quality well or river water, iii) water as well as soil samples should be checked at regular intervals. Existing irrigation water is deteriorating the soil quality. The deterioration is gradually increasing at a faster rate for last 5 to 10 years. To address the issues, the following recommendations are put forth.

- As for as possible rainfed agriculture may be practiced.
- Use of Gypsum blocks to improve irrigation water quality.
- Green manuring crops like dhaincha *(Sesbania spp.)* and Sunhemp *(Crotalaria juncea)*.
- Provide economically-feasible drainage system.
- To adopt suitable cropping systems like agri-horticulture, agri-silviculture.
- Surface application of gypsum before the onset of monsoon.

2.5 LAND EVALUATION AND LAND USE PLANNING

LAND USE PLANNING – ISSUES BEARING IMPACT

Changing Bioclimatic Regimes

In view of the changing climate, it becomes important to examine the validity of the bio-climatic map of India published in 1992 by ICAR-NBSS&LUP. Bio-climatic map (Fig. 2.5.1a) was based on average rainfall data for 50-80 years (after 1930s) which were superimposed on newly acquired rainfall data of 2005-2012. Water balance was computed and moisture Indices (Im) (more than 70% probability) were superimposed to develop a new bio climatic map of the country (Fig. 2.5.1b). Observations were acquired from more than 530 meteorological stations. The area shifts in different bioclimatic regions are presented in table 2.5.1. The maps show Hyper Arid zone which covered 22.9 million hectare and that has considerably reduced to 12.5 million hectare amounting to a decrease of 45.4% whereas Typic Arid area has increased by 8.4% from the earlier value of 22.7 million hectare.

Semiarid (dry) areas have shown insignificant change (2.5%) but semiarid (moist) areas have increased by approximately 30% from earlier estimated 72.2 mha. This is at the expense of dry and moist sub humid areas of the country. The dry sub humid areas have increased by approximately 47% from the earlier estimate of 54.1 million hectare at the expense of moist and transitional sub humid areas in Maharashtra, Madhya Pradesh, Chhattisgarh

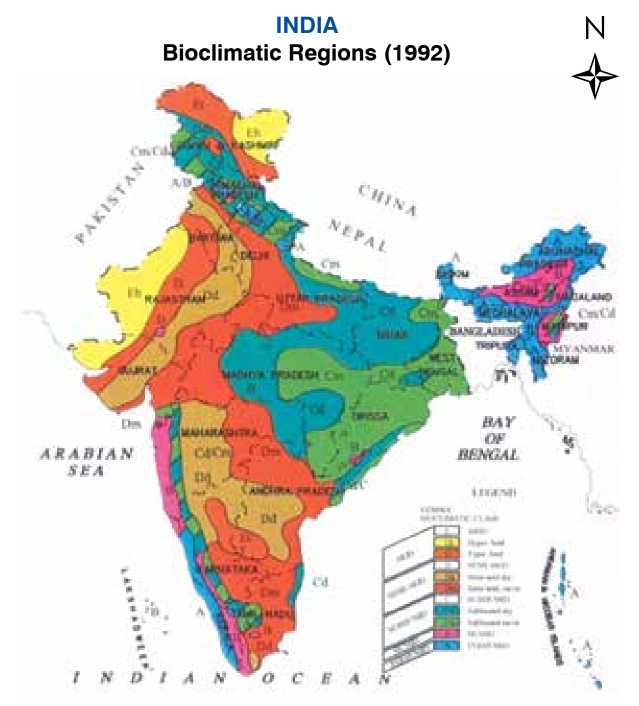


Fig. 2.5.1a : Bioclimatic map (1992)

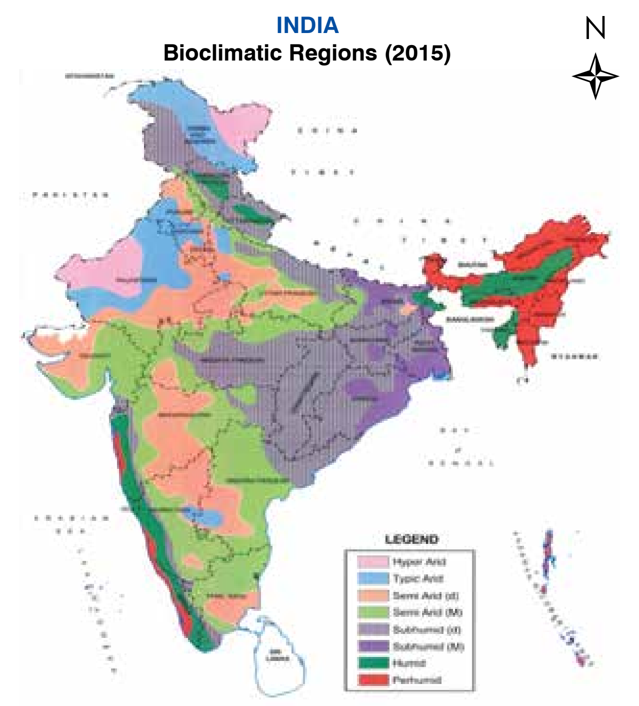


Fig. 2.5.1b : Bioclimatic map (2015)

(North West), Andhra Pradesh (Central) and North fringes of Odisha, Jharkhand and Bihar (South). The humid area has increased by 74% from earlier estimated value of 16.6 million hectare which falls under coastal parts of West Bengal and Odisha, deltaic regions of Andhra Pradesh, Bengal basin, Tarai plains of West Bengal, Brahmaputra Valleys and Western Coastal Plains.

Table 2.5.1: Bioclimatic regions

Bio-Climatic Type	Area (1992)		Area (2015)		% change [increase (+) or decrease (-)]
	(Mha)	% TGA	(Mha)	%TGA	
Hyper Arid	22.9	6.9	12.5	3.8	-45.41
Typic Arid	22.7	8.3	24.6	7.5	+8.4
Semiarid (Dry)	51.2	15.5	52.5	16.0	+2.50
Semiarid (Moist)	72.2	21.9	93.5	28.5	+29.5
Sub humid (Dry)	54.1	16.9	79.4	24.5	+46.7
Sub humid (Moist)	39.8	12.0	14.8	4.5	-62.8
Sub humid (dry and moist transition)	21.0	6.8	-	-	-
Humid	16.6	5.0	28.9	8.8	+74.0
Per Humid	20.5	6.2	21.9	6.7	-
Humid / Per humid transition	1.8	0.5	-	-	-

Shifting LGP

Length of growing period (LGP) is the period when the moisture (1/3rd and 15 bar) and temperature regime (5-45°C) is suitable for growing arable crops. Length of Growing Period (LGP) has been considered as a better index for crop production and performance within a bioclimatic system; as such LGP is widely used for crop modeling, yield prediction, crop suitability assessment and determination of constraint free crop yield in an agro environment in land use planning study. Based on 540 station rainfall data spatially distributed throughout India, year-wise LGP has been computed based on FAO (1983) method. Yearly computed value at 60% probability has been used for revising the earlier LGP map published by ICAR – NBSS&LUP in 1992.

The revised LGP (Fig. 2.5.2) map (2015) reveals that the earlier 60-90 day LGP has reduced in the area covering mostly the western plains of Rajasthan, Gujarat plains and Haryana; and the area is now covered under 90-120 day LGP class. The map also indicates that there is reduction of LGP in the states of Chhattisgarh, north Odisha and western part of Jharkhand. The new LGP class of this area is 120-150 day against the earlier LGP class of 150-180 days indicating a reduction by 16-20 per cent.

Fig. 2.5.2 : Revised Length of Growing Period

In the Deccan peninsular area, LGP is estimated to have increased in southern Andhra Pradesh, west and east Maharashtra, southern Tamil Nadu, deltaic areas of Cauvery and south and west Karnataka, from 120-180 days. The moisture availability which was 240-270 days in Assam valley, adjoining areas of Meghalaya and Tarai Plains (West Bengal) has increased to more than 270 days indicating chances of frequent flooding, water logging, and accelerated soil erosion.

Increasing extreme climatic events

Rainfall data of 640 districts were collected, formatted and analyzed for the period of 2001 to 2012 (Table 2.5.2). The moisture index (IM) for each year was computed through water balance technique. Isoline maps based on average point values were plotted in GIS environment during the reported year. It has been found that the moisture indices (Fig. 2.5.3a, b, c, d, e) vary year to year and region to region. The frequency of extreme events was of high order in AER 4, 5, 6, 7 of semi arid, humid and sub-humid areas as compared to AER 3 belonging to arid region. It has also been found that districts falling within AER have also wide variations in rainfall pattern (CV 20-110%).

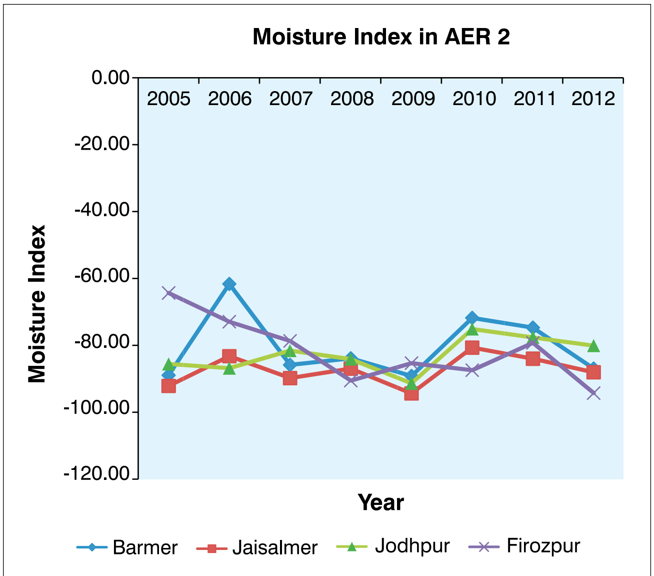


Fig. 2.5.3a : Moisture index variation in AER 2 (Arid ecosystem)

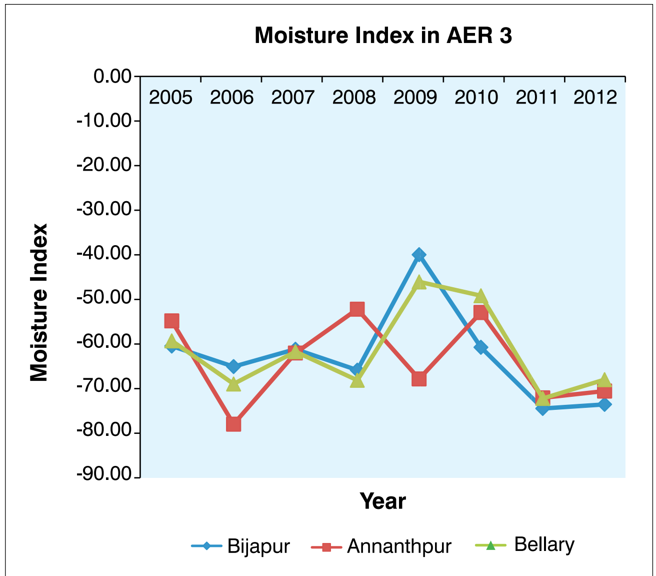


Fig. 2.5.3b : Moisture Index variation in AER 3 (Arid ecosystems)

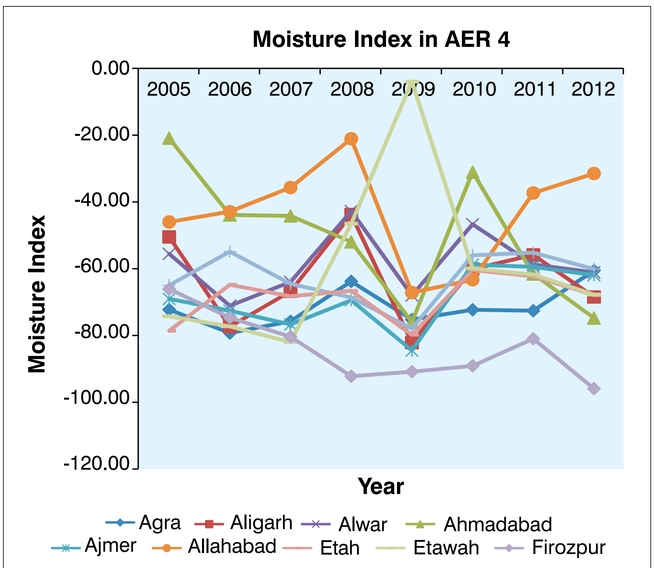


Fig. 2.5.3c : Moisture Index variation in AER 4 (Semi Arid ecosystems)

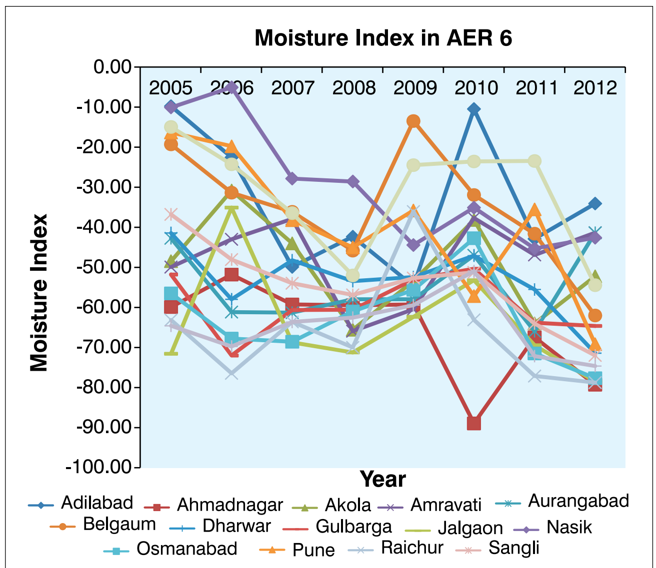


Fig. 2.5.3d : Moisture Index variations in AER 6 (Semiarid agro ecosystem)

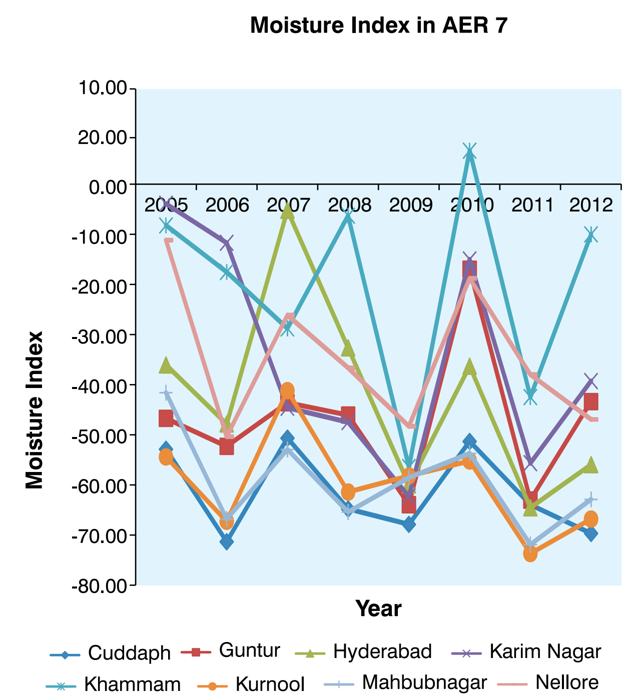


Fig. 2.5.3e : High fluctuation of Moisture Index in AER 7 (Semi-arid ecosystem)

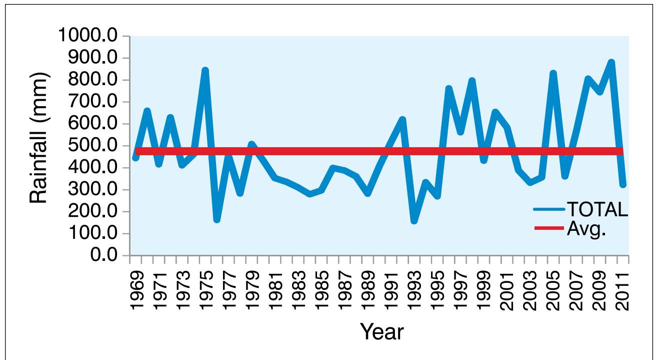


Fig. 2.5.4 : Total and average rainfall distribution at Challakere

Analysis of annual rainfall and extreme rainfall events (>100, 50-100 and 25-50 mm/week) in the arid part of Karnataka between 1969 and 2012 indicated that years of below normal rainfall were more during 1976 to 1993, whereas the years having rainfall above normal was more in the 90s and also in the first decade of 21st century (Fig. 2.5.4). Similarly, >50mm/week events are more in the first decade of 21st century (Table 2.5.3). Analysis of occurrence of >50mm/week events indicated that post and pre-monsoon periods have recorded more number of such events. Therefore, a revisit of AER and AESR map of India prepared by ICAR-NBSS&LUP was necessiated.

Table 2.5.2: Computed Moisture Index of selected districts/stations

District/Stations	Moisture Index							
	2005	2006	2007	2008	2009	2010	2011	2012
Agra	-71.41	-78.51	-74.95	-62.84	-74.71	-71.44	-71.74	-59.56
Aligarh	-49.33	-76.56	-65.84	-42.54	-81.42	-59.08	-54.8	-67.55
Allahabad	-44.79	-41.65	-34.33	-19.51	-66.25	-62.34	-35.99	-30.08
Auraiya	-80.84	-75.46	-64.75	-49.41	-64.41	-57.92	-53.38	-62.91
Azamgarh	-20.79	-17.51	18.09	-31.57	-45.61	-38	-23.45	-51.74
Baghpat	-53.73	-69.73	-60.33	-44.64	-52.80	-41.11	-68.3	-79.09
Bahiraich	-9.21	-33.61	-0.37	-11.53	-15.08	-41.07	-27.37	-33.8
Ballia	-56.23	-59.75	-48.37	-19.57	-80.64	-66.01	-53.52	-55
Banda	-22.21	-52.03	-55.59	-27.22	-46.59	-50.65	-25.63	-42.14
Bareilly	-36.25	-50.41	-25.92	-3.40	-36.31	1.87	-14.81	-56.02
Bijnor	-26.50	-47.63	-25.29	-37.35	-54.83	-16.1	-45.08	-60.38
Bulandshahr	-57.71	-76.88	-68.03	-47.75	-70.56	-46.5	-49.94	-71.58
Deoria	-48.69	-40.15	-19.94	-20.35	-72.72	-41.85	-45.32	-46.67
Etah	-78.22	-64.27	-67.67	-66.01	-79.46	-59.41	-61.29	-66.98

Cont...

Etawah	-73.42	-76.50	-81.22	-45.30	-2.17	-58.88	-60.74	-66.83
Farrukhabad	-62.93	-53.21	-65.96	-50.09	-2.67	-31.97	-51.39	-70.12
Fatehpur	-63.07	-71.43	-60.55	-23.70	-71.01	-57.79	-61.73	-51.53
Ghaziabad	-57.82	-71.82	-76.57	-86.42	-86.61	-55.06	-67.89	-76.05
Ghazipur	-56.34	-46.68	-33.90	-43.78	-57.85	-50.6	-36.27	-55.41
Gonda	-19.23	-56.07	-21.00	-21.21	-30.92	-26.43	-27.45	-38.02
Gorakhpur	-12.81	-25.99	6.10	20.47	-31.94	-8.73	-30.2	-23.07
Hamirpur	-57.75	-68.80	-68.50	-30.65	-53.06	-62.89	-37.79	-59.68
Hardoi	-57.17	-59.95	-71.96	-46.78	-56.81	-47.83	-57.84	-45.2
Jaunpur	-48.15	-40.23	-37.18	-27.08	-66.88	-67.44	-57.73	-61.41
Jhansi	-59.17	-74.35	-76.73	-22.85	-64.00	-60.29	-41.7	-57.16
Kanpur	-61.16	-67.33	-13.14	-13.14	-64.61	-68.51	-61.32	-70.39
Kheri	-40.07	-42.04	-25.34	11.02	-14.05	-6.52	-29.68	-16.73
Lalitpur	-32.89	-52.22	-60.86	-50.75	-50.36	-50.26	-12.86	-42.48

Table 2.5.3. Number of rainfall events per week in different decades of Challakere, Chitradurga district

Year	No. of events in								
	Pre-monsoon			South-west monsoon			North-east monsoon		
	25-50	50-100	>100	25-50	50-100	>100	25-50	50-100	>100
1969-1978	5	6	2	10	12	4	9	8	3
1979-1988	14	2	0	15	10	2	9	4	1
1989-1999	9	2	0	15	13	4	11	7	3
1999-2011	18	7	1	11	21	6	14	10	1

Underutilized Prime Lands - A pilot study in Maharashtra

Prime land is defined as the land highly suitable for agriculture in a set of agro-climatic conditions. These are characterized as the land where moderately deep to deep (soil depth >75 cm), neutral to slightly alkaline (pH 6.5 to 8.5) soils occur on less than 8% slope. An exercise of delineating prime and non-prime land has been taken for the state of Maharashtra as a pilot study, using soil information of 1:250000 scale. Extent of irrigation both under prime and non-prime land (Fig. 2.5.5) is defined by superimposing land use and land cover map of 2013-14. The area under the double/triple crops is considered as the irrigated part of prime and non-prime lands. The factors restricting the productivity of non-prime lands are also analyzed.

Total net sown area in the state of Maharashtra is 21.82 million hectare. Rainfed and irrigated agriculture are practiced on 63.1 and 36.9% of the total area under agriculture respectively, of which 6.2 and 15.6 million hectare area, respectively were classified as prime and non-prime land. Only 30 and 37% area of prime and non-prime land are irrigated. Productivity of 41% area of non-prime land is constrained on account of soil depth. Soil depth, slope and pH are the factors (taken together) restricting agriculture on 17% area, whereas the other moderate limitations on 42% of the total area may be of soil depth between 50 to 75 cm and/or soil pH>8.5 and/or slope more than 8%.

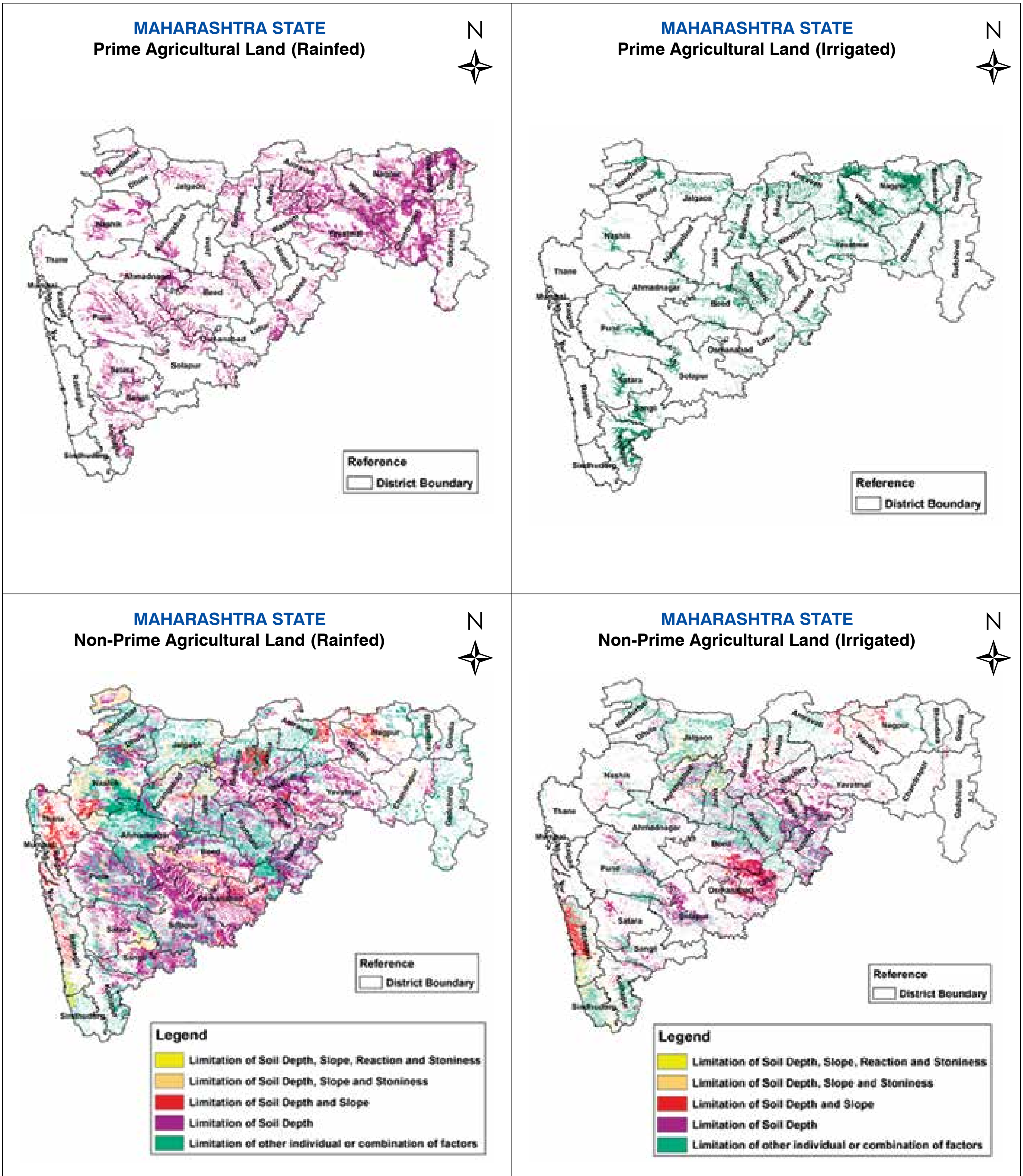


Fig. 2.5.5 : Prime and non-prime lands in Maharashtra

The study suggests that full potentiality of 70% of prime land is yet to be realized due to lack of assured irrigation, whereas around 40% of the total non prime land is managed out of their capability class due to the availability of irrigation. Both these lead to extensive degradation in the event of drought/ excessive rainfall.

Degradation of cultivated land – the changing national scenario

In India, 120 million hectare land is estimated as degraded land. Extent and type of degradation prevailing only in the cultivated land in the country is yet to be estimated. The workflow of the model developed in Arc GIS version 10.1 for this kind of country level degradation mapping in different agricultural land uses is presented in figure 2.5.6. The datasets used are: i) 1:250k LULC data (interpreted from AWiFS data, 56m spatial resolution), 2013-14 of the country (procured from NRSC, ISRO, Hyderabad) ii) Land degradation map prepared by NBSS&LUP in collaboration with other ICAR institutes, NAAS and NRSC. The area distribution statistics for both the irrigated and rainfed land are given in table 2.5.4. Figure 2.5.7 shows the spatial distribution of the degradation processes in both irrigated and rainfed conditions. The study reveals that 64.8 million hectare cultivated area is affected by different kind of degradation (Table 2.5.4). 76% and 9.2% of the degraded area is affected by water and wind erosion respectively whereas salinity and sodicity affect 2.3 and 3.5% area of the cultivated land. Salinity and sodicity together with erosion are observed to affect another 0.04 and 1.54% area respectively. Acidity and acidity plus water erosion affect 3.11 and 3.22% area.

Table: 2.5.4 : Area distribution of rainfed and irrigated agricultural land affected by different kinds of degradation in the country

Degradation Type	Area Distribution (ha)			Area Distribution (%)		
	Rainfed	Irrigated	Total	Rainfed	Irrigated	Total
Saline Soils Under Wind Erosion	73121	3048	76169	0.19	0.01	0.12
Acid Saline Soils	7352	5912	13264	0.02	0.02	0.02
Sodic Soils Under Wind Erosion	10480	12334	22814	0.03	0.05	0.04
Acid Soils Under Water Erosion	1471651	615370	2087021	3.76	2.40	3.22
Water Logged Saline Soils	6301	2859	9160	0.02	0.01	0.01
Eroded Saline Soils	11552	15056	26608	0.03	0.06	0.04
Eroded Sodic Soils	391181	608746	999927	1.00	2.37	1.54
Exclusively Acid Soils	1249163	763875	2013038	3.19	2.97	3.11
Exclusively Saline soils	1067746	423860	1491606	2.73	1.65	2.30
Exclusively Sodic Soils	1025787	1243024	2268811	2.62	4.84	3.50
Exclusively Water Erosion	28781314	21099470	49880784	73.56	82.13	76.96
Exclusively Wind Erosion	5030391	898208	5928599	12.86	3.50	9.15
Total	39126039	25691762	64817801	-	-	-

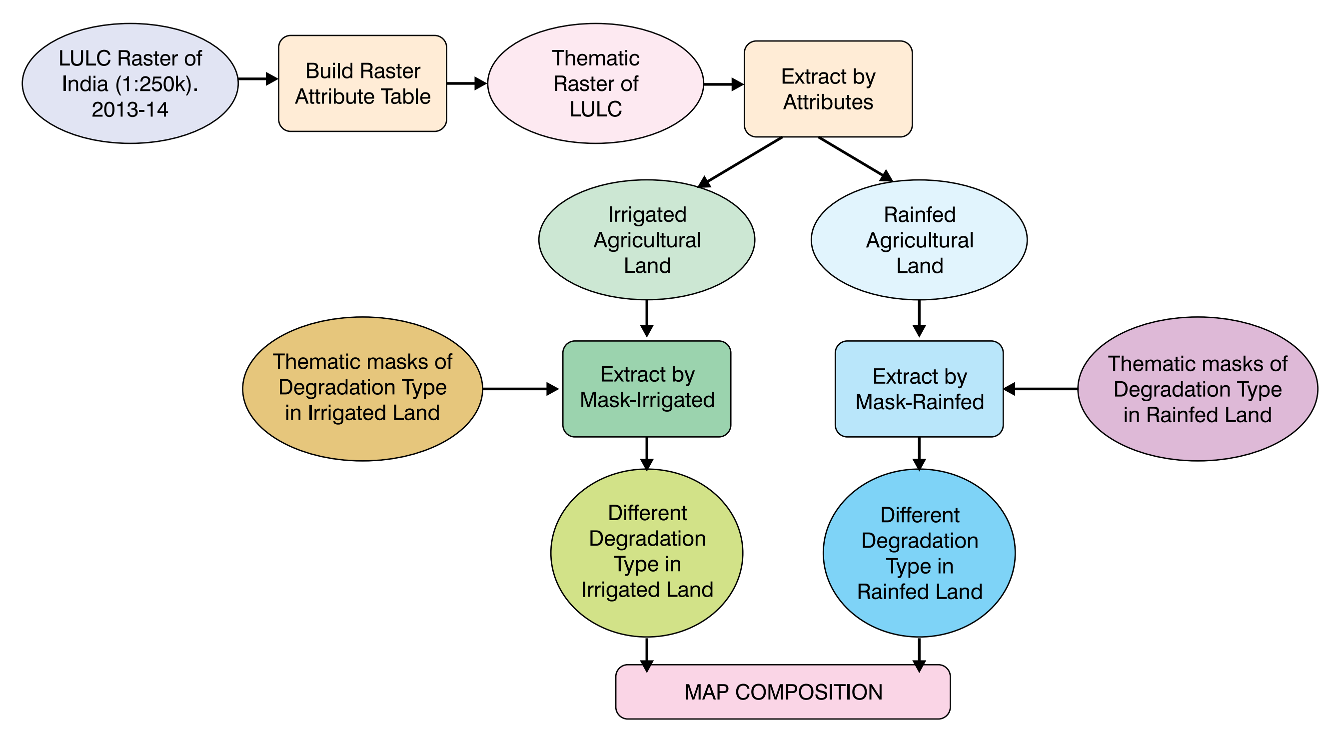


Fig. 2.5.6 : Modelling workflow of country level land use and land degradation interaction mapping

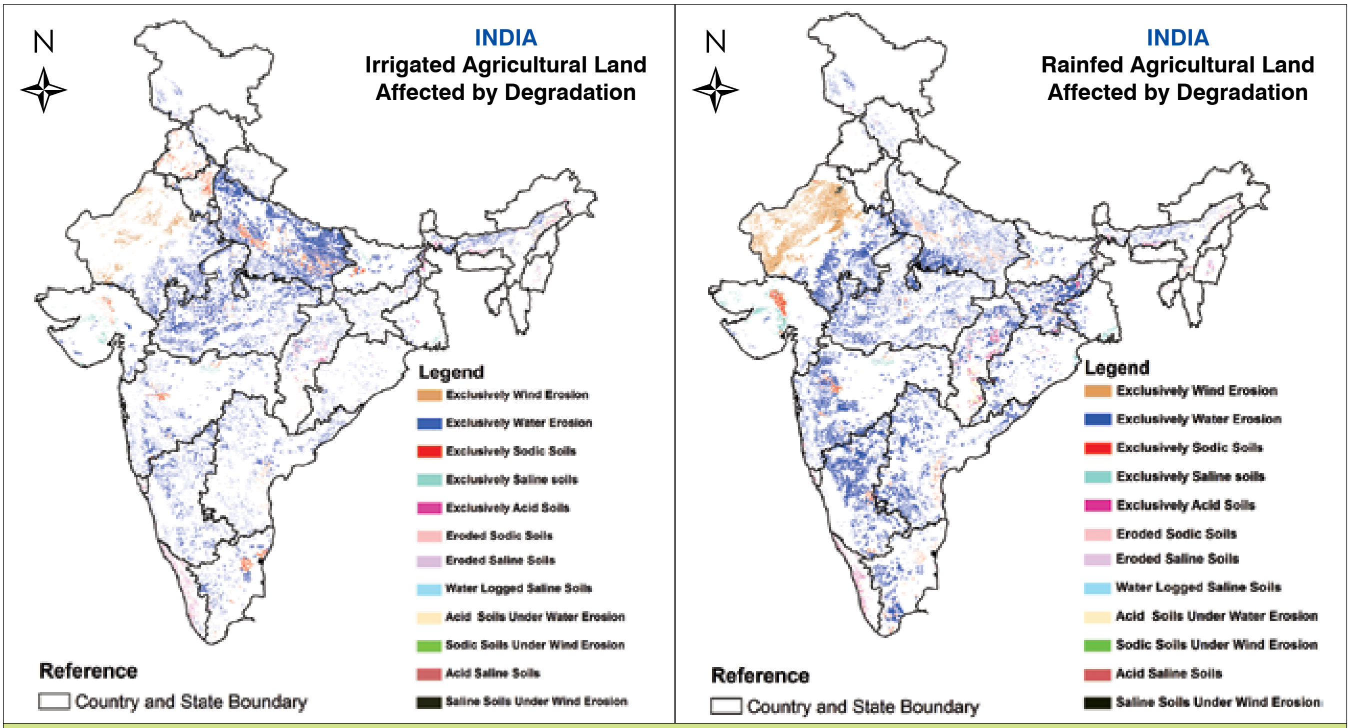


Fig. 2.5.7 : Extent of Land degradation in the cultivated land of the country

Fertilizer pricing policy – A case study in Karnataka

Government of India recently implemented Nutrient Based Subsidy (NBS) policy for phosphatic and potassic fertilizer from 1 April 2010. The objective NBS policy is for ensuring national food security, improving agricultural productivity and ensuring balanced application of fertilizers. An attempt has been made to analyze the impact of fertilizer pricing policy on fertilizer use, soil health, land productivity and rural livelihood in Garakahally micro watershed located in Ramanagara District, Karnataka. Detailed soil survey was carried out and soil fertility assessment was made at 1:10000 scale. The socio economic information of farmers was collected in 2014. Changes in terms of land use, land productivity; household income and soil fertility status in 2014 were quantified with 1999 taken as the base year (Fig. 2.5.8).

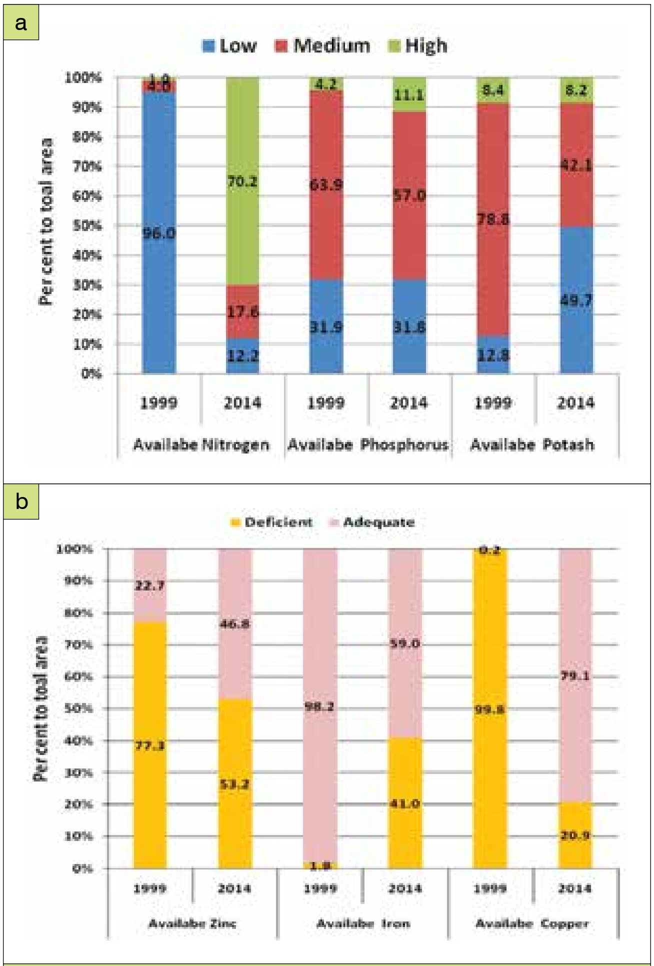


Fig. 2.5.8 : Changes in macro (a) and micro nutrients (b) status in Garakahalli micro watershed

The results indicated that the area under finger millet drastically decreased from 174 to 71.8 hectare. The reduction in area was also seen in mulberry (-24.7 hectare) and paddy (-16.1 hectare). Increases in area under mango and coconut were by 54 hectare and 32.6 hectare respectively. About 70 per cent of the watershed is higher in nitrogen status in 2014 compared to that in 1999 (Fig. 2.5.8a). Decrease in the status of available phosphorus and potassium occurred in the year 2014. Relatively very low retail price of urea (N) compared to P and K fertilisers had resulted in distortion in NPK use ratio. That has resulted in extensive mining of phosphorus and potassium. This could be also reflected in terms of decreased income of each household. The impact of nutrient based subsidy on status of nutrients in soils is yet to be realized.

REVISITING CORE GROWING AREAS OF SOME COMMODITY CROPS

Soybean

Madhya Pradesh is the largest soybean growing area followed by Maharashtra and Rajasthan. Both Madhya Pradesh and Maharashtra grow soybean largely on Vertisols and associated soils. The district-wise largest area under soybean is in Ujjain (Madhya Pradesh), Amravati (Maharashtra) and Kota (Rajasthan). The agro-ecological sub-region (AESR) wise core soybean growing areas for the year 2012-13 are shown in Fig. 2.5.9a and b which indicate that AESRs 5.2, 6.1, 6.2, 6.3, 10.1, 10.2, 10.3 and 10.4 represent the core soybean growing areas. Our findings suggest that poor drainage and high rainfall are constraints to soybean production, whereas moderately shallow soils and well distributed rainfall are good for cultivation. However, in the core area of soybean cultivation, both deep and shallow black soils occur in association. The productivity of soybean is constrained on deep Vertisols in the event of high rainfall like that in Madhya Pradesh, whereas shallow black soils perform better even with high rainfall like in the large part of soybean growing area in Maharashtra. High productivity in the district Amravati further substantiates the findings. Therefore selection of right cultivar for well defined soil and site characteristics is essentially needed.

Cotton

Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Telangana, Tamil Nadu and Karnataka constitute core rainfed growing areas of cotton in the country, whereas Punjab, Haryana and Rajasthan are major parts of core irrigated cotton growing states (Fig. 2.5.9b). It is well established that deep black soils are highly suitable for

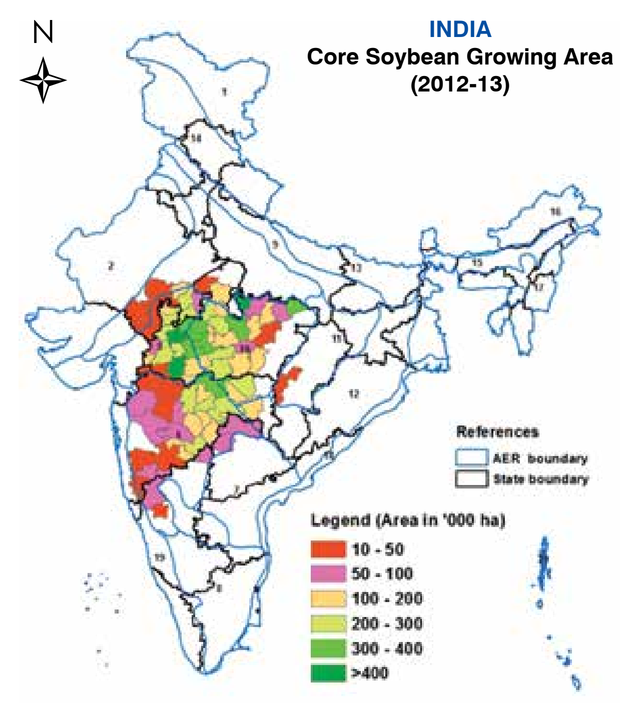


Fig. 2.5.9a : Core Soybean growing areas in India

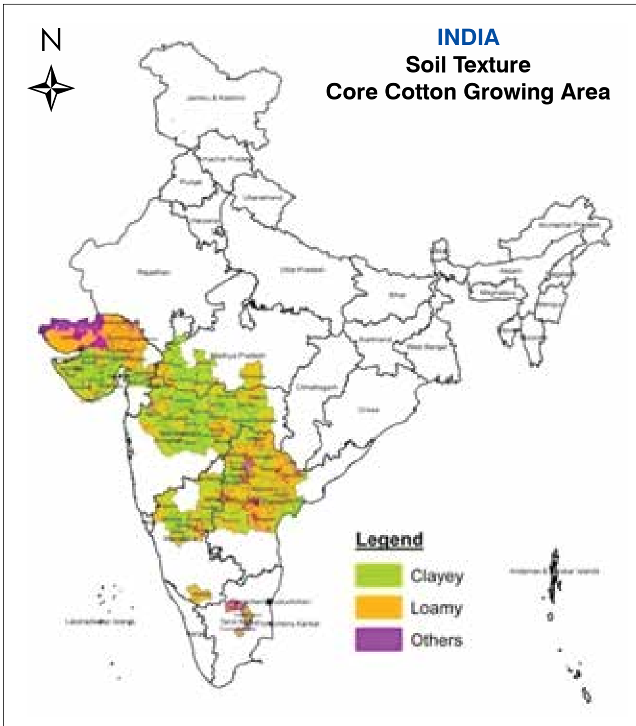


Fig. 2.5.9c : Soil texture in core cotton growing area

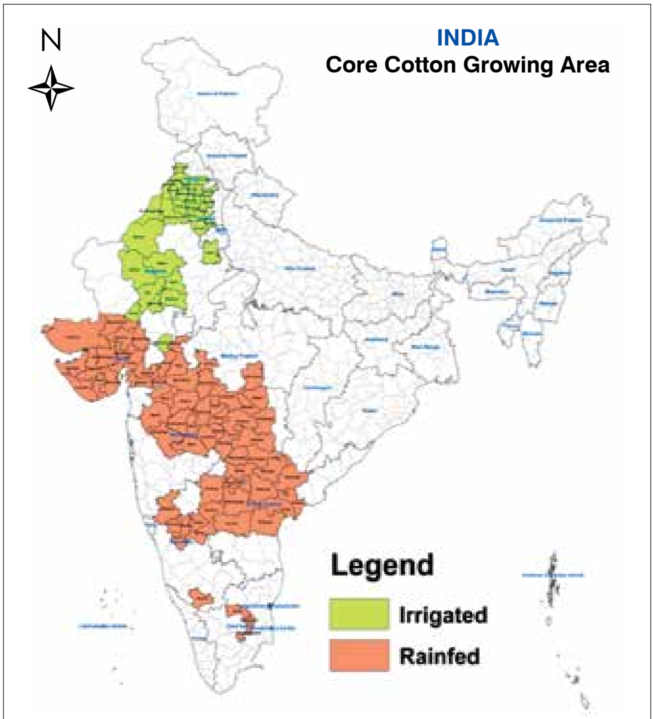


Fig. 2.5.9b : Core cotton growing areas in India

growing BT cotton, whereas the local variety of cotton can be grown well in shallow black soils. This is very well related with amount and the duration of water stored in the soils. Deep black soils can retain high moisture for longer duration, whereas shallow black soils can retain low moisture for shorter duration. Moisture holding capacity of soils belonging to other textural class is also lower as compared black soils of typical clayey texture (Fig. 2.5.9c). Cotton can sustain on deep black soils in the situation of mild drought, while same is not true on the shallow black or other soils. A cursory examination of the soil site characteristics in core growing areas suggests BT cotton irrespective of soils are grown across the area. This may be one of the reasons for failure of the crop even on the advent of small dry spell.

In the irrigated areas, cotton is grown with the support of canal water. However, the availability of water is restricted at the time of crop ripening particularly at the tale end of canal. This is very common in the state of Rajasthan. Farmers are forced to irrigate the crop with brackish ground water. This is one of the reasons for spreading salinity in the canal command areas of northern region of India. Therefore, it is ideally needed to select right cultivars depending upon soil and site characteristics and the available resources with the farmers.

Citrus

Major citrus fruits grown in the country are sweet orange, mandarin, acid lime, grapefruit and lemon. These are grown in a wide range of soils ranging from sandy loam to alluvial soils of north India to shallow clay loam to deep clay loam or lateritic/acidic soils in the Deccan plateau and north-eastern hills. Citrus orchards flourish in light soils with good drainage properties. Deep soils with pH range of 5.5 to 7.5 are considered ideal. However, they can also be grown in a pH range of 4.0-9.0. High calcium carbonate concentration in feeder root zone may also adversely affect the growth. Fig. 2.5.10 shows that the crop is grown in the country in the wide range of situations. However, its quality and profitability is much higher on deep, well drained soils in the pH range of 5.5 to 7.5.

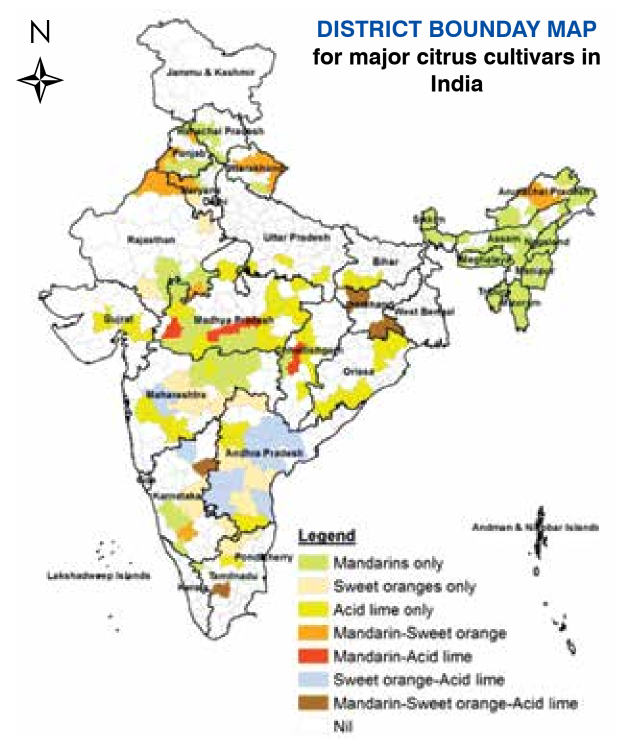


Fig. 2.5.10 : Citrus growing areas in India

IDENTIFYING POTENTIAL AREAS FOR DIFFERENT LAND USES

Pomegranate

An attempt has been made to identify best suitable area for Pomegranate in the states of Maharashtra and Gujarat. The bio-physical crop suitability model was developed using Multi-Criteria Overlay Analysis (MCA) technique in GIS. The major input parameters like average rainfall, soil depth, surface drainage, surface texture and soil pH were considered in the GIS based model. The suitable weights have been assigned to the input layers in the model to delineate the potential areas for pomegranate in Maharashtra and Gujarat states. The analysis for pomegranate suitability in Maharashtra reveals that about 3.5 per cent of the total area is highly suitable, 56.4 per cent moderately suitable, 14.2 per cent, marginally suitable and 25.9 per cent not suitable (N) (Fig. 2.5.11). In the state of Gujarat, the analysis shows that about 16.8 per cent area of the state is highly suitable, 65.3 per cent moderately suitable, 10.0 per cent marginally suitable and 9.2 per cent not suitable. However, the necessary field validation would need to be carried out to confirm the biophysical suitability for pomegranate in the two states.

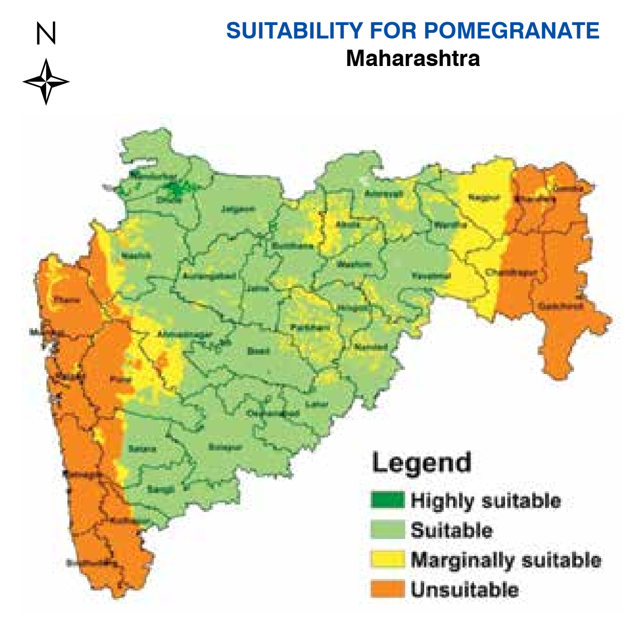


Fig. 2.5.11 : Potential Pomegranate growing areas in Maharashtra

Cotton

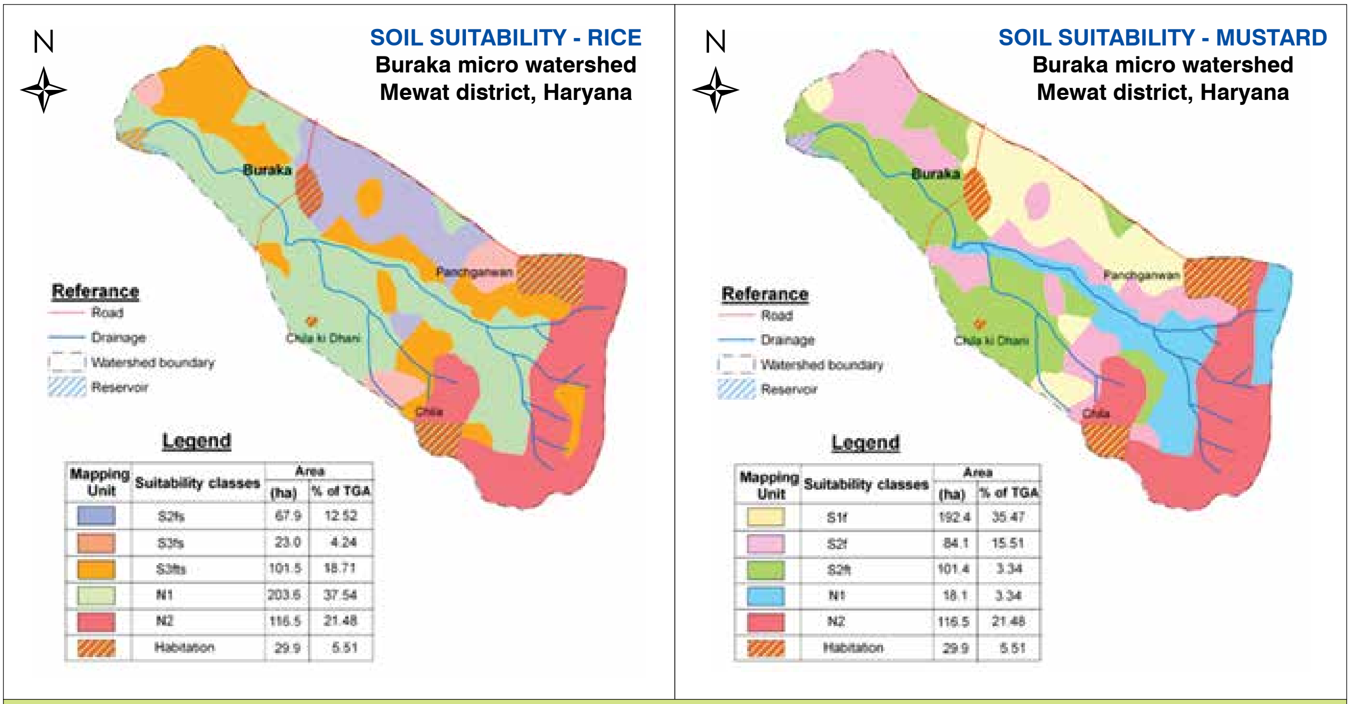
The quantitative methods under report could be used for evaluating suitability of soils for cotton for Akola district due to the merits of each method namely, modified Sys' parametric method for its ease in developing land indices, fuzzy modelling based method providing quantification of the belongingness of a characteristic to a particular class and taking into account the differences in factor weighting and crop modelling method for reliable indentifying the limiting factor and the crop yield which were the basis for land evaluation as well as water limited potential yield. Modified Sys' method proved to be superior to other methods as the R^2 value between land indices and cotton yield was the highest (0.73) in the study area.

Chilli

The study indicated that the chilli production is influenced by soil properties in soils of basalt as well as granite-gneiss geological origin. Those properties are abiotic factors like amount of clay, moisture content at -33 kPa and -1500 kPa, available water content of soils, cation exchange capacity, potassium, magnesium and calcium.

CEREALS AND OTHER CROPS - A CASE STUDY IN BURAKA MICRO-WATERSHED, MEWAT DISTRICT, HARYANA

Based on soil site characteristics and crop requirement, relative suitability of major crops has been worked out using unified suitability criteria with some modifications (Table 2.5.5). The suitability maps for rice and mustard are presented in Fig. 2.5.12.



Figs. 2.5.12 : Soil site suitability of rice and mustard in Buraka micro watershed

Table 2.5.5 : Soil site suitability of some important crops in Buraka Micro-Watershed

Sr. No.	Crop	Highly suitable		Moderately suitable		Marginally suitable		Temporarily not suitable		Permanently not suitable	
		Con-straints	Area in ha (%)	Constraints	Area in ha (%)	Constraints	Area in ha (%)	Constraints	Area in ha (%)	Constraints	Area in ha (%)
1	Wheat	-	-	Low fertility, light soil texture (sandy loam) and/or topography (1-3% slopes)	192.4 (35.47)	Low fertility, light soil texture (loamy sand to sandy loam) and topography (1-3 and 3-5% slopes)	185.5 (34.20)	Low fertility, light soil tex-ture (loamy sand) and topography (5-10% slopes)	18.1 (3.34)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)

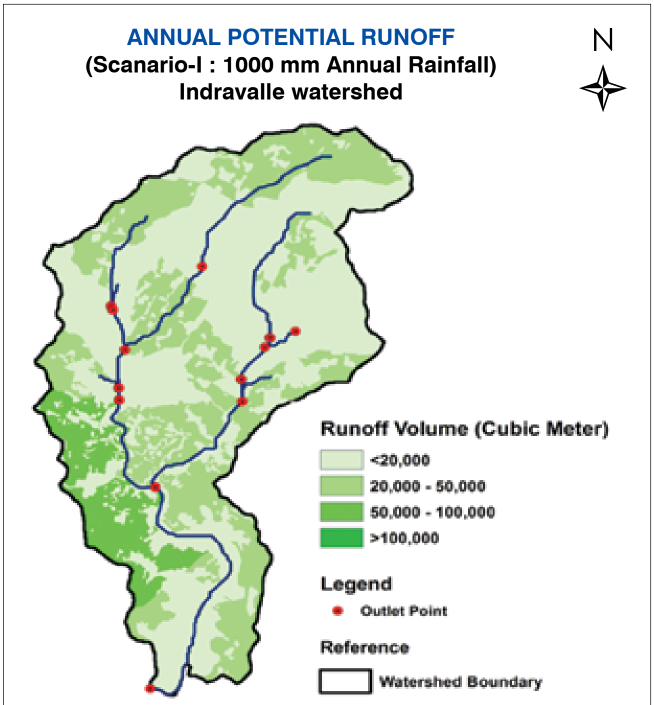
Cont...

2	Irrigated rice	-	-	Low fertility, and light soil texture (sandy loam)	67.9 (12.52)	Low fertility, light soil texture (loamy sand to sandy loam) and/or topography (1-3% slopes)	124.5 (22.95)	Low fertility, light soil texture (loamy sand) and topography (1-3, 3-5 and 5-10% slopes)	203.6 (37.54)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)
3	Pearl millet	Low fertility	192.4 (35.47)	Low fertility, and/or topography (3-5% slopes)	98.4 (18.14)	Low fertility, light soil texture (loamy sand) and topography (3-5% slopes)	87.1 (16.06)	Low fertility, light soil texture (loamy sand) and 5-10% slopes	18.1 (3.34)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)
4	Sorghum	-	-	Low fertility, light soil texture (sandy loam) and/or topography (1-3% slopes)	192.4 (35.47)	Low fertility, light soil texture (loamy sand to sandy loam) and topography (1-3, and 3-5% slopes)	148.2 (27.32)	Low fertility, light soil texture (loamy sand) and topography (3-5 and 5-10% slopes)	55.4 (10.22)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)
5	Pigeon pea	-	-	Low fertility, light soil texture (sandy loam) and/or topography (1-3% slopes)	192.4 (35.47)	Low fertility, light soil texture (loamy sand to sandy loam) and topography (1-3 and 3-5% slopes)	148.2 (27.32)	Low fertility, light soil texture (loamy sand) and topography (3-5 and 5-10% slopes)	55.4 (10.22)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)
6	Mustard	Low fertility	192.4 (35.47)	Low fertility, and/or topography (3-5% slopes)	185.5 (34.20)	-	-	Low fertility, light soil texture (loamy sand) and topography (5-10% slopes)	18.1 (3.34)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)
7	Potato	-	-	Low fertility, light soil texture (loamy sand to sandy loam) and/or topography (1-3 and 3-5% slopes)	206.7 (38.11)	Low fertility, light soil texture (loamy sand) and topography (1-3 and 3-5% slopes)	171.2 (31.56)	Low fertility, light soil texture (loamy sand) and topography (5-10% slopes)	18.1 (3.34)	very shallow soil depth and 3-5, 5-10 and 10-15% slopes with stony / rocky phases	116.5 (21.48)

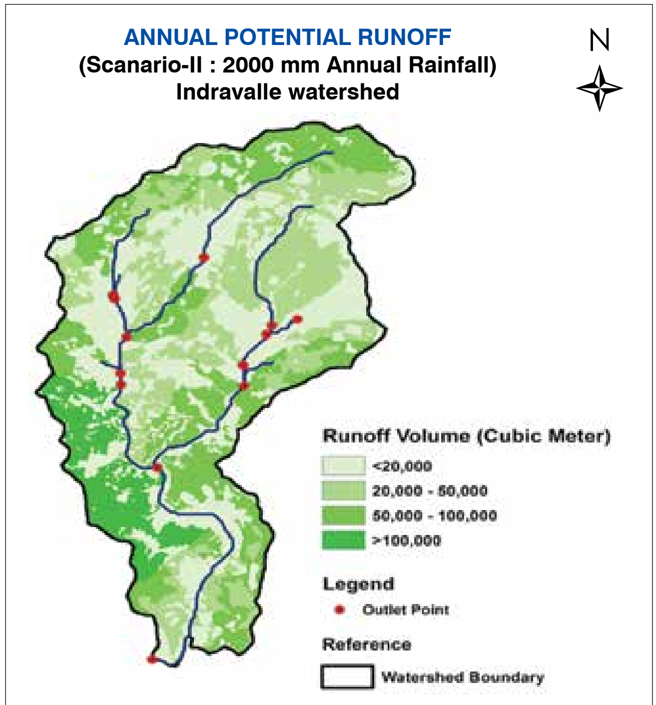
Values in parenthesis indicate percentage of TGA.

ESTIMATING AVAILABLE WATER RESOURCES – A CASE STUDY IN INDRAVALLE MANDAL, ADILABAD DISTRICT, TELANGANA

Based on the slope and drainage pattern, a watershed was delineated in Indravalle mandal, Adilabad district, Telangana (Fig. 2.5.13a, b, c, d) in GIS environment. Two scenarios were developed, one with 1000 mm rainfall and other with 2000 mm rainfall. Runoff potentiality was estimated under different land uses, using SCS Curk method. It was the highest from single and double cropped agricultural land. The amount of runoff water that could be possibly harvested in one monsoon season was estimated by using the best management options of soil and water conservation measures.



2.5.13a : Annual potential runoff in Indravalle watershed (Scanario I)



2.5.13b : Annual Potential runoff in Indravalle watershed (Scenario II)

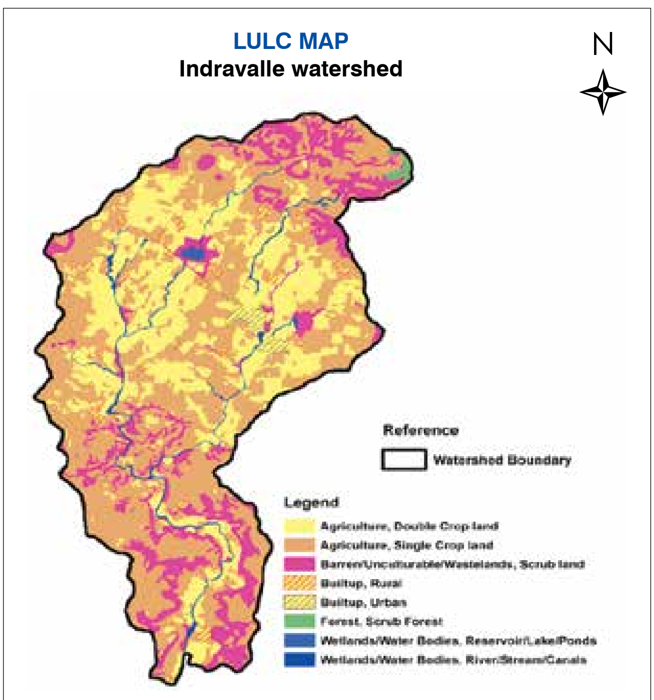


Fig. 2.5.13c : Annual potential runoff and Land Use Land Cover Map of Indravelle mandal, Adilabad district, Telangana

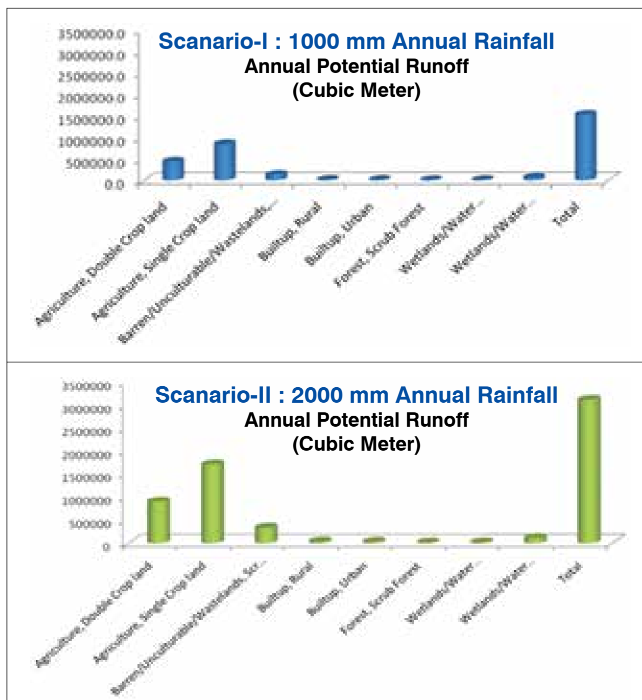


Fig. 2.5.13d : Annual potential runoff in Indravalle watershed under different rainfall scenarios

DEVELOPING ALTERNATE LAND USE OPTIONS

Chhata tehsil, Mathura, Uttar Pradesh

Various crops and cropping systems suitable for different soil series were developed on the basis of crop yield, B:C ratio and SYI (Table 2.5.6). The alternate land use options are economically viable, ecologically sustainable and technologically appropriate and capable to fulfil the demands of feed, fuel and fodder of the peoples and livestock of the region.

Shikhopur village, Gurgaon District, Haryana

Sustainability of pearlmillet-wheat cropping system with four types of management practices (MP) viz: MPI) Inorganic fertilizers @ 70 kg N and 30 kg P and K is zero kg ha^{-1}, own seed; MP II) NP K @ 100 :40: 00 Kg + 5 t FYM ha^{-1} with hybrid seed; MP III) NPK @ 140:70:00 Kg + 10 t FYM ha^{-1} with hybrid seed and MP IV) NPK @ 140: 70: 00 Kg + 15 t FYM ha^{-1} with hybrid seed of pearl millet during *kharif* season was studied. MPI for wheat was as NP K @ 60:40: 30 Kg ha^{-1} with own seed; MP II) NP K @ 100:40: 30 Kg ha^{-1} with pioneer seed; MP III) NP K @ 120: 60:30 Kg ha^{-1} with pioneer seed and MP IV) NP K @ 140:70:30 Kg ha^{-1} with pioneer seed during *rabi* on the four soil series of Shikohpur soil series namely A, B, C, and D.

The sustainability yield index (SYI) of pearl millet-wheat cropping system as wheat equivalent yield under different management practices on different soil series of Shikohpur village was calculated by the formula. $SYI = \bar{Y} - s / Ymax$

Where $\bar{Y}$ was average yield of a treatment, s was treatment standard deviation and Ymax was maximum yield in the experiment over the years.

Among the management practices, the highest SYI was recorded with management IV (0.89) followed by MP III, II and I (0.58), respectively. Among the soil series, highest SYI was observed in Shikohpur soil series A (0.84) followed by B (Table 2.5.7), C, and D. Highest sustainable yield index (0.98) was observed in MP IV with soil series A with 15 t FYM ha^{-1} followed by MP III, II and I (0.55).

Table 2.5.6 : Alternate land use options for identified soil series vis-à-vis existing cropping system for Chhata tehsil

Series	Existing cropping pattern/ system		Alternate land use options for sustainable crop production and livelihood security		
	Kharif crops	*Rabi* crops	*Kharif* crops	*Rabi* crops	Alternatives other than crops
Simri	Rice, sorghum, green gram, black gram	Wheat, mustard	Cotton, Rice, Pearl millet, pulses	Mustard, wheat, sugarcane,	Vegetables, fruit crops, agro- forestry and animal husbandry
Garhsauli	Rice, sorghum	Wheat, berseem	Rice, maize, pigeon pea	wheat, sugarcane, potato, fodder berseem	Vegetables, fruit crops, agro- forestry and animal husbandry
Tarauli	Rice, sorghum, Pearl millet	Wheat, mustard	Rice, maize, pigeon pea	Mustard, wheat, sugarcane, potato	Vegetables, fruit crops and animal husbandry
Neri	sorghum, Pearl millet	Wheat, sugarcane	Rice, pigeon pea, maize,pulses	Wheat, mustard, sugarcane, potato	Vegetables, fruit crops and animal husbandry
Chhatikara	Pearl millet, sorghum	Wheat, mustard	Pearl millet, pigeon pea, fodder sorghum	Mustard, wheat, sugarcane, potato	Vegetables, fruit crops, farm forestry and animal husbandry
Chhata	Rice, Sorghum, Cotton, Sesamum, Cluster bean, Pigeon pea and Sesbania rostrata	Wheat, mustard, berseem	Cotton, Rice, fodder crops, Cluster bean, Pearl millet, Pigeon pea and Sesbania rostrata	Mustard, wheat, sugarcane, potato	Vegetables and animal husbandry
Bechhawan Bihari	Rice, Pearl millet	Wheat, mustard	Pearl millet, fodder crops	Mustard, wheat,	Agro-forestry, jujube, citrus, Vegetables and animal husbandry
Ladpur	Rice, Sorghum, Pearl millet and Pigeon pea	Wheat, mustard	Rice, Sorghum, Pearl millet, maize and Pigeon pea	Mustard, wheat, sugarcane, potato	Vegetables, fruit crops, agro- forestry and animal husbandry

Soil suitability for important crops

Based on soil site characteristics and crop requirement, relative suitability of major crops has been worked out and is presented in Table 2.5.8.

Land use choice and socio-economic profiling : Hosahalli micro watershed in Chamarajanagara district of Karnataka

Chilli, cotton, horse gram, sorghum and tomato were the major crops in the watershed irrespective of the holding size; however, the yield was more for the farmers who do not have land right and managing the farm by sharing labour and resources (Table 2.5.9). The soil survey was conducted in the watershed and phase of soil series was delineated. Alternate land use options for small, medium, semi-medium and large land holdings were given in the table 2.5.10. Expected cost benefit ratio is also calculated and given in the table.

Table 2.5.7 : Sustainable yield index of wheat equivalent yield

Soil series	Sustainability Yield Index				
	Management practice I	Management practice II	Management practice III	Management practice IV	Mean
Shikohpur A	0.60	0.83	0.93	0.98	0.84
Shikohpur B	0.59	0.79	0.87	0.91	0.79
Shikohpur C	0.56	0.71	0.79	0.86	0.73
Shikohpur D	0.55	0.63	0.74	0.79	0.68
Mean	0.58	0.74	0.83	0.89	0.76

SUGGESTED (ALTERNATE) LAND USE OPTIONS

Alternate land use options vis-à-vis existing cropping systems are presented in table 2.5.10.

Table 2.5.8 : Alternate land use options in identified soil series vis-a-vis existing cropping system for Shikohpur

Particulars	Existing cropping system		Alternate land use options for sustainable cropping		
	Kharif	*Rabi*	*Kharif*	*Rabi*	Alternative other than crop
Shikohpur soil series A	Bajra	Wheat	Clusterbean, Pigeonpea, greengram	Mustard, barlay,gram	Mary gold flower, Alluvera, Sunflower in 3 years rotations
Shikohpur soil series B	Bajra	Wheat	Clusterbean, Pigeonpea	Mustard, barlay, gram	Sunfloer in 3 years rotations
Shikohpur soil series C	Bajra	Wheat	Clusterbean, Pigeonpea, greengram	Mustard, barlay, gram	Sunfloer in 3 years rotations
Shikohpur soil series D	Bajra	Wheat	Clusterbean, Pigeonpea, greengram	Mustard, barlay, gram	Sunfloer in 3 years rotations
Shikohpur soil series E and F	N2	N2	N2	N2	Horti pasture, jujube, grape, gooseberry, aegle marmelos, alluvera

Table 2.5.9 : Average yield of crops based on land right (q/acre)

Size group	Marginal	Small	Semi medium	Medium	Large	Total
With Land Rights						
Chilli	15.00	42.50	80.00			44.17
Cotton	2.49	1.78	0.33	2.88		2.09
Horse gram	1.82	2.09	1.25	2.42		1.81
Sorghum	2.49	2.22	2.54	1.52		2.31
Tomato	154	155	256	104	125	156
Without Land Rights						
Chilli		18.52				18.52
Cotton		0.50				0.50
Horse gram	3.00	1.50	1.50			1.88
Sorghum	1.78	2.50	1.00			1.89
Tomato		26.32				26.32

Table 2.5.10 : Alternate land use options						
Soil	Soil description	Suggested crops				
		Marginal	Small	Semi-medium	Medium	Large
bB1g1	Loamy sand Very gently sloping slight erosion gravelly		Chilli (3.39), Tomato (1.24), Sorghum (0.57), Coconut (0.49)		Tomato (1.65)	
bB1g2	Loamy sand Very gently sloping slight erosion very gravelly	Horsegram (2.13), Sorghum (0.9), Coconut (0.65)	Coconut (2.18), Horsegram (1.72), Sorghum (1.34), Horsegram (2.47), Sorghum (1.17), Cotton (0.45)	Horsegram (3.66), Mulberry (3.51), Banana (1.34), Sorghum (1.26), Coconut (1.07), Tomato (1.07)	Banana (4.6), Beans (3.03), Tomato (1.79), Watermelon (1.65), Horsegram (1.42), Sorghum (1.03), Cotton (0.9), Coconut (0.31)	
bB2g2	Loamy sand Very gently sloping moderate erosion very gravelly	Mulberry (2.71), Tomato (2.0), Horsegram (1.98), Chilli (1.63), Sorghum (0.63), Coconut (0.6)		Chilli (4.17), Tomato (3.35), Horsegram (0.86), Cotton (0.44), Sorghum (0.33)	Coconut (1.46), Sorghum (0.85)	Coconut (4.92), Tomato (2.13), Watermelon (1.75)
cB1g1	Sandy loam very gently sloping slight erosion gravelly		Tomato (3.82) Chilli (1.29), Coconut (0.89)	Tomato (4.21), Horsegram (1.01), Sorghum (0.97), Coconut (0.85)	Coconut (2.2), Turmeric (1.9), Tomato (1.41)	
cB1g2	Sandy loam very gently sloping slight erosion very gravelly	Cotton (0.83)	Horsegram (1.09), Castor (0.65), Sorghum (0.63)	Sorghum (1.04)	Coconut (3.25), Castor (3.03), Tomato (2.02), Watermelon (1.61)	
cB2g2	Sandy loam very gently sloping moderate erosion very gravelly				Coconut (7.5), Horsegram (1.16)	
hB1g1	Sandy clay loam Very gently sloping slight erosion gravelly	Coconut (3.09), Tomato (1.8)	Sorghum (1.54), Chilli (1.5), Horsegram (1.45), Tomato (0.83)	Horsegram (2.15), Sorghum (0.95), Coconut (0.32)	Horsegram (1.81), Cotton (1.27), Sorghum (0.75)	
hB2g1	Sandy clay loam Very gently sloping moderate erosion gravelly	Coconut (2.25)		Coconut (0.93)		
iAg1	Sandy clay nearly levelled gravelly	Horsegram (0.52)	Coconut (2.11)	Coconut (2.67), Sorghum (1.68), Horsegram (1.38)		
iB1g1	Sandy clay very gently sloping slight erosion gravelly		Mulberry (3.35), Tomato (2.74), Chilli (2.0), Sorghum (1.73), Horsegram (1.71), Coconut (1.47)	Sorghum (1.36), Coconut (0.99)		

( ) Parenthesis denotes B:C ratio

SOIL BASED TRANSFER OF TECHNOLOGIES

H.D. Kote, Mysore

Activities under taken are presented in Fig. 2.5.14. Soil survey was conducted; phases of soil series was delineated depending upon socio-economic profile of the land, owners' mutually agreed land use plan was developed (Table 2.5.11). Performance of different interventions was tested and the economics of each of them was calculated on the farmer's field. Crop wise performance of cotton + pulses and cropping system wise (Fig. 2.5.15) chillis and cotton, merigold performance are given in the tables 2.5.12, 2.5.13 and 2.5.14. Cropping system wise economics was also calculated (Tables 2.5.15, 2.5.16 and 2.5.17).

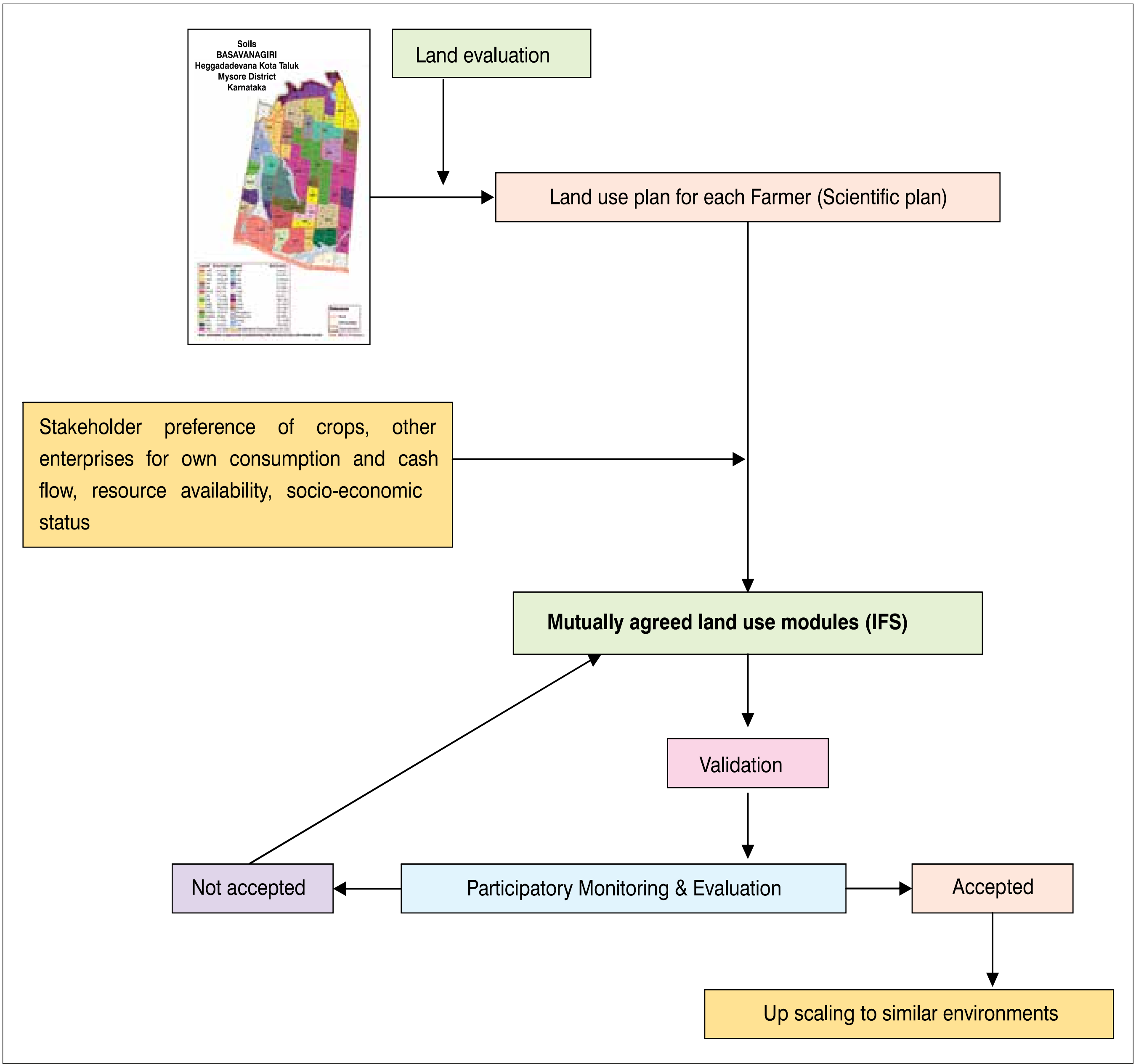


Fig. 2.5.14 : Methodological framework for preparation of integrated land use planning

Table 2.5.11 : Mutually Agreed Land Use Plan for 1 ha land holding (for different sites)												
Farmer/plot No.	Soil suitability Assessment										Existing system	Mutually agreed LUP
	Cotton	FM	Maize	RG	BG	FB	Chilli	Srb	Mango	Amla		
145 (shallow, well drained, gravelly loam soils)	S3	S2	S3	N	S2	S2	N	S2	N	N	Cotton	FM + FB(1Ac), BG -FB(1 Ac), FB (½ Ac), Simarouba
135 (Moderately deep, well drained, gravelly clay soils)	S3	S1	S2	S2	S1	S1	S2	S2	S3	S2	Cotton, Finger millet	FMt + FB(1Ac), Cotton (½ Ac), BG (½ Ac), Sapota + Simarouba, Cotton+ cowpea, Cotton+horsegram
50 (Deep, well drained, gravelly clay soils)	S2	S2	S2	S2	S1	S1	S1	S2	S2	S1	Cotton, Chilli, Marygold	Cotton (1Ac), FMt + FB (1 Ac), BG-FB (½Ac), Cotton+chilli, Chilli+cowpea, Marigold+ cowpea
40 (Deep, moderately well drained cracking clay soils)	S1	S2	S2	S2	S1	S1	S1	S2	N	S3	Cotton	Cotton (1½ AC), FM + Fb (½ Ac), RG (½ Ac), cotton+chilli

Note: FM: Finger millet; RG: Red gram; BG: Black gram; FB: Field bean; Srb: Simarouba (scientific names).

Table 2.5.12 : Performance of cotton + pulses intercropping in moderately deep soils (mean of 2 years 2013 and 2014)						
	Yield (q/ha)			Cost of cultivation (Rs/ha)	Net returns(Rs/ha)	BCR
	Cotton	Cowpea	Horse gram			
Cotton (FP)	6.0			8000	13000	1:1.62
Cotton (IM)	8.0			10000	18000	1:1.80
Cotton + Cowpea	8.0	5.5		12500	29250	1:2.34
Cotton + Horse Gram	8.0		6.0	12500	27500	1:2.20

Note: IM=Recommended dose of fertilizers (150:75:75 kg NPK/ha) & opening furrow at last inter cultivation; FP=Farmers practice; BCR: Benefit cost ratio

1. Chilli and cotton intercropping system in deep soils

Table 2.5.13 : Performance of chilli and cotton intercropping system in deep soils (mean of 2 years)						
	Yield (q/ha)			Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	BCR
	Cotton	Chilli	Cowpea			
Chilli (FP)		50.0		35000	7500	1:0.21
Chilli (IM)		65.0		40000	15250	1:0.38
Chilli + Cowpea		68.0	5.0	42500	27800	1:0.65
Cotton	7.5			10000	16250	1:1.62
Cotton + Chilli	7.0			15000	20750	1:1.38

BCR: Benefit cost ratio

2. Marigold

Table 2.5.14 : Performance of Marigold (mean of 2013 and 2014)						
	Yield (q/ha)		Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	BCR
	Marigold	Cowpea				
Marigold (FP)	300		74000	150000	76000	1:1.03
Marigold (IM)	500		100000	250000	150000	1:1.50
Marigold + Cowpea	300	5.0	75000	162500	87500	1:1.16

ECONOMIC EVALUATION OF SUGGESTED LAND USE PLAN

Cereal-based land use system

Analysis of cereal-based land use system on 4153 ha area (Table 2.5.15).

Table 2.5.15 : Analysis of cereal-based existing and suggested land use			
Existing Land use system		Suggested Land Use Plan*	
Crops/cropping system	Net returns (Rs/ha)	Crops/cropping system	Projected net returns (Rs/ha)
Cotton Tobacco Finger millet Maize Jowar	3000 8500 2000 3500 1000	Finger millet + Field bean Jowar H.gram, Tobacco-Horse gram/Field bean, cotton maize (green cob) Amla, Sapota, Pomegranate, Agro-silvi-horti-pasture, dairy, goatery, backyard poultry, vermicomposting	6500 3000 5000 15000 6500 10,000 12,000

*with improved production technology

Commercial crops based land use system

Commercial crops based land use system (2872 ha) (Table 2.5.16).

Table 2.5.16 : Existing and suggested land use systems analysis			
Existing Land use system		Suggested Land Use System*	
Crops/cropping system	Net returns (Rs/ha)	Crops/cropping system	Projected net returns (Rs/ha)
Cotton Finger millet	10,000 5,000	Cotton Marigold Cotton+chilli Chilli Cotton+field bean/horse gram Finger millet+field bean Maize Tobacco-Horse gram/Field bean Amla, Sapota, Pomegranate, Agro-silvi-horti-pasture, dairy, goatery, backyard poultry, vermicomposting	16,000 1,50,000 20,000 15,000 25,000 10,000 28,000 35,000 15,000

*with improved production technology

Vegetable crops-based land use system

Vegetable crops-based land use system (32816 ha) (Table 2.5.17).

Table 2.5.17 : Existing and suggested land use systems analysis

Existing Land use system		Suggested Land Use System*	
Crops/cropping system	Net returns (Rs/ha)	Crops/cropping system	Projected net returns (Rs/ha)
Cotton Finger millet Cowpea Cabbage Tomato	13,000 4500 3500 10000 15000	Field bean + Tomato + Beans + bhendi + veg. cowpea Bitter gourd Maize (green cob) Coffee+ pepper+ yam+ turmeric, Goatery, backyard poultry, vermicomposting	1,50,000 50,000 30,000

*with improved production technology

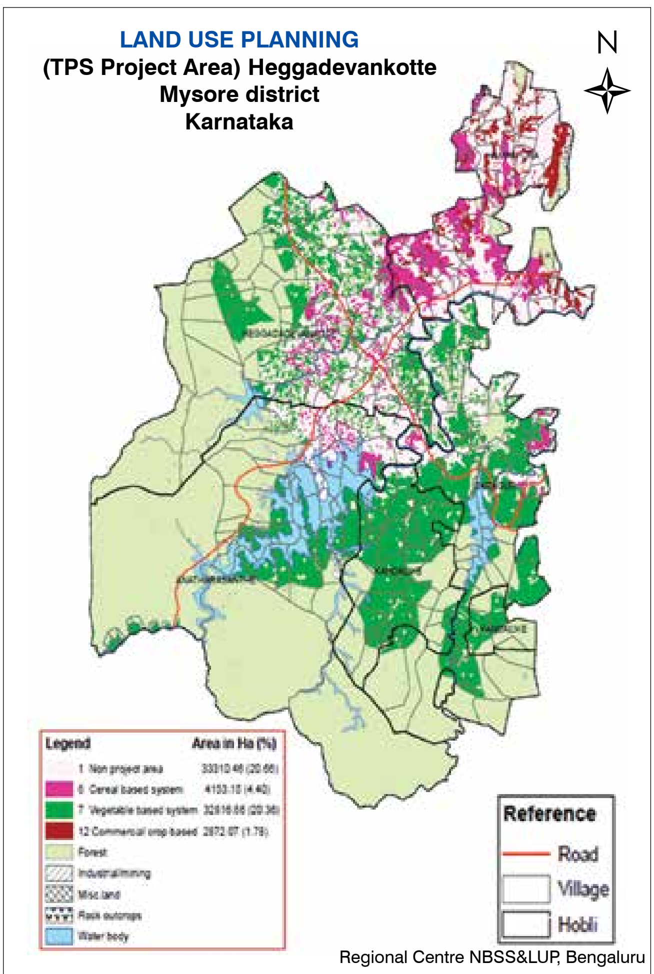


Fig. 2.5.15 : Expected spread of different cropping system in H.D.Kote Taluka, Mysore district

BALI ISLAND OF SUNDARBANS, WEST BENGAL

Based on the soil resource inventory of Bali Island on 1:10000 scales, three soil series were identified. Soil series in Bali village was very deep, silty clay to silty clay loam soils having acid sulphate layers within the soil depth of 80-100 cm. The intervention in the form of land shaping and crop diversification programmes was undertaken initially by three ICAR institutes, NBSS & LUP, Kolkata (Regional Centre), CSSRI, (Regional Station) Canning and CIFA, Kalyani in 7 hectare of land for 15 beneficiaries. Before land shaping treatment, mono cropping of long duration deep water paddy variety was usually grown with return of Rs.10,250/hectare. In most areas, cultivation in *rabi* season was restricted due to the scarcity of irrigation. The farm pond technology was introduced in seven farmers' fields in Bali village. Land shaping treatment involved excavation of a dugout pond upto a depth of 80 cm or less without disturbing acid sulphate layers and raising an embankment all around a low lying field by digging a field drainage channel at a cost of around Rs.3 lakhs /ha (Fig. 2.5.16).

Short duration high yielding variety of paddy was grown in main field with a net income of Rs.8,400/- and other crops like ladies finger e), brinjal, and snakegourd on pond embankment getting a net income Rs. 2160/- during *kharif*. Early release of main field for *rabi* crop allowed cultivation of tomato (net income Rs. 900/-), turnip (net income Rs.130/-), cabbage and cauliflower (net income Rs.660/-); bitter gourd (net income Rs.310/-); palak and amaranthus sag (net income Rs.560/-), Additional income from *rabi* season was Rs.2,560/- (Fig. 2.5.17). Apart for agriculture fish farming in Farm pond fetched additional income. Total income by the farming enterprise has gone up by Rs.9,263/- hectare. There is scope for up scaling of the technologies in the island. Even in Bali Island the farm pond technologies can be successfully upscaled on 336.68 hectare land having similar soil problem of acid sulphate layer between the soil depths of 75 to 100 cm.

BRAHMAPUTRA VALLEY OF ASSAM

Integrated land use plan was implemented at Upar Deurigaon representing 15 per cent soils of Brahmaputra valley of Assam. Soils of the village are mapped in two soil series (Deuri A & B) with three phases. Package of practice for potato and cabbage crops were introduced in the soils of Deuri A series; package and practices for mustard and pea was introduced on the soils of Deuri B series (Fig. 2.5.18). The performance of crops is recorded in the Table 2.5.18 and crop yield is correlated with the soil type.

Fig. 2.5.16 : Farm pond technology application

Fig. 2.5.17 : Diversified agriculture with farm pond technology

Table 2.5.18 : Crop performances in Upar Deurigaon, Jorhat during 2014-15 (under TSP)

Crops	Mustard	Potato	Pea	Cabbage
Area (ha)	27	1.3	13	1.9
Yield at farmers' field (t/ha)	1.56	20	2.8	60
Yield at Research station (t/ha)	0.85-1.00	8.5-10.0	1.0-1.2	50-100
District level yield (t/ha)	0.85	7.5	0.59	25-30
B/C ratio	4.28	1.43	4.09	5.85
Net income (Rs./ha/yr)	60,000/-	1,06,000/-	45,000/-	2,05,000/-
Employment generated (Man-days)	135	210	120	180
No. of benefit. farmers	61	20	38	18
Suitable texture	Silt loam (r = 0.95**)	Sandy loam (r = 0.96**)	Silt loam (r = 0.88**)	Sandy loam (r = 0.92**)

(** Significant at 1% level)

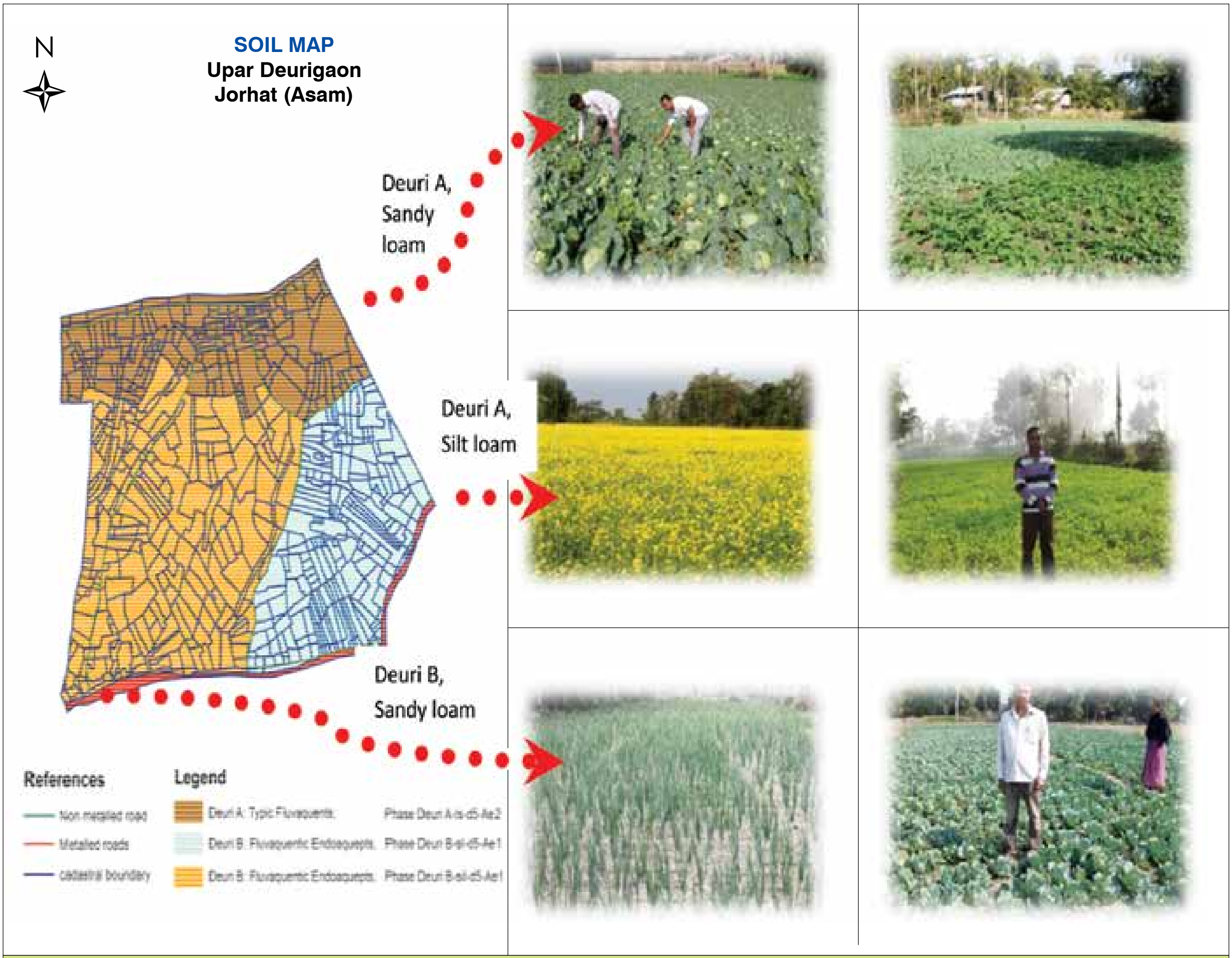


Fig. 2.5.18 Site specific crop planning at Upar Deurigaon

DECISION SUPPORT SYSTEM FOR AGRICULTURAL LAND USE PLANNING

In the project, a decision support system for agricultural land use planning (DESSALUP) is being developed using visual basic programming languages. The DSS will comprise six modules, namely, database manager, land resource assessment, land evaluation, land allocation, socio-economic analysis and scenario analysis (Fig. 2.5.19). A submodule for formulating multi-objective optimization model, to be used in land resource allocation, has been developed (Fig. 2.5.20). The required input parameters are: (i) number and name of objective functions, (ii) number and name of decision variables and their coefficients, and (iii) number of constraint functions and their coefficients.

Through this submodule a user can formulate a multi-objective optimization model with two or more objectives involving required number of decision variables and constraint functions. There is a provision in the submodule to assign weights to the objective functions by selecting the weight assignment option and then pressing 'Weight Assignment' button.

The optimization model can also be formulated in 'Excel Environment' and thereafter, it can be imported into the submodule.

DESSALUP

Module I
Database Manager

Data Input:

Spatio-temporal data of rainfall, climate, land use/crop, soil, socio-economic, etc.

Module II
Land Resource Assessment

1. **Assessment of Soil Resources :** Identification of soil parameter, potential and constraints.
2. **Assessment of Water Quantity and Quality:** Surface water and qroundwater and other

Module III
Land Evaluation

Estimation of Land Productivity Index:
1. Riquier, 1970
2. Ranst, 1991

Module IV
Socio-Economics

Socio-Economic Analysis:
- Categorization of stakeholders/ land users
- Socio-economic priority
- Other management strategies

Module V
Land Allocation

Multi-objective optimization for allocating lands among different agricultural uses/crops.

Module VI
Scenario Analysis

Scenario Generation and Analysis:
1. Scenario based on population growth, economic activities and other management strategies.
2. Climate change scenarios

Fig. 2.5.19 : Modules of the DSS for agricultural land use planning

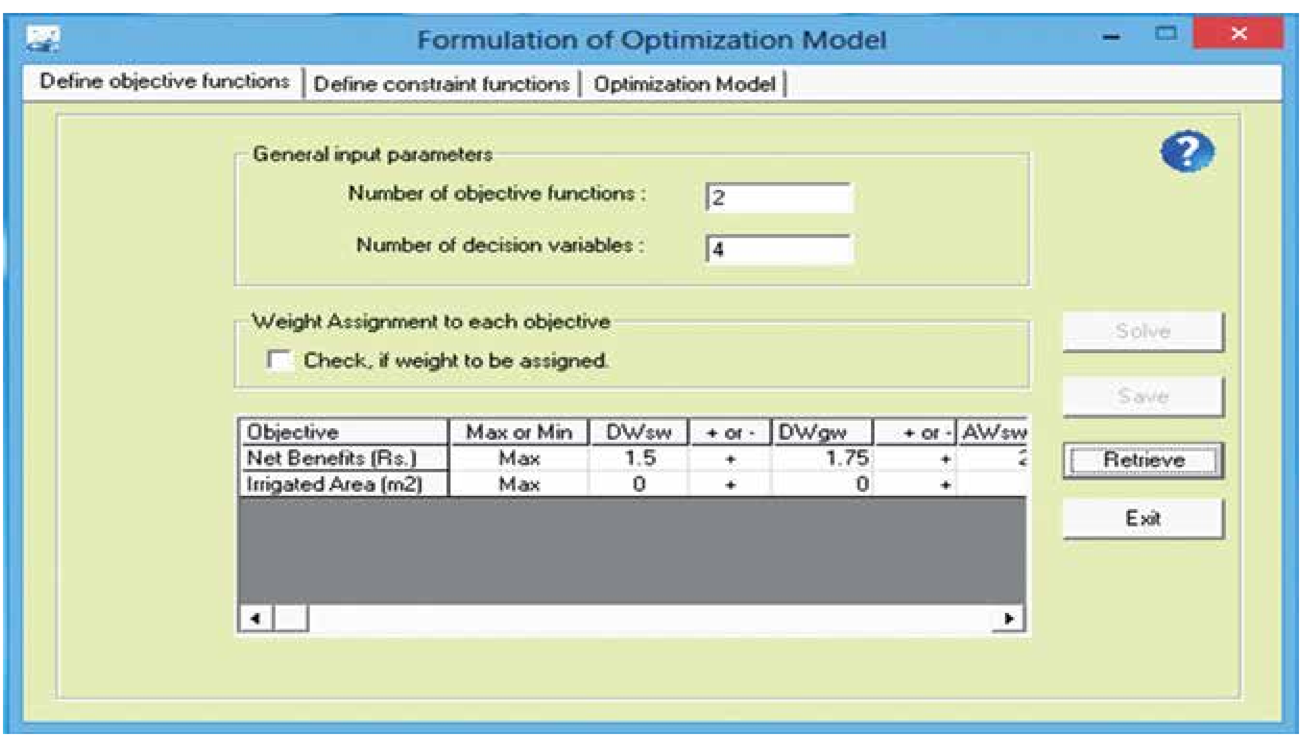


Fig. 2.5.20. Submodule for formulating multiobjective optimization model in the DSS

3 RESEARCH PROGRAMMES

INSTITUTE PROJECTS (ONGOING)

Inventorying Natural Resources

Soil and Land Resource Inventory at 1:10000 scale

- Land resource inventory of Bukkarayasamudrum mandal of Anantapur district, Andhra Pradesh on 1:10000 scale for agricultural land use planning using geospatial techniques
- 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 in Kangeyam block of Thiruppur district, Tamil Nadu for optimal agricultural land use planning, using geospatial techniques
- Land resource inventory of Elamdesom block, Idukki district, Kerala on 1:10000 scale for optimal agricultural land use planning, using geospatial techniques
- Land resource inventory of Tiswadi block of North Goa district, Goa State on 1:10000 scale for agricultural land use planning using geospatial techniques
- Land resource inventory on 1:10000 scale of Nagrota Bagwan block, Kangra district of Himachal Pradesh for agricultural land use planning
- Land resource inventory on 1:10000 scale of Jagner block, Agra district of Uttar Pradesh for agricultural land use planning
- Land resources inventory of Baragaon block of Varanasi district of Uttar Pradesh on 1:10000 scale for agricultural land use planning
- Land resource inventory on 1:10000 scale of Rajpura block, Patiala district of Punjab for agricultural land use planning
- Land resource inventory of Chamba block in Tehri Garhwal district of Uttarakhand on 1:10000 scale for agricultural land use planning
- Land resource inventory of Noa-Dihing river basin (Bordumsa block) of Changlang district, Arunachal Pradesh (at 1: 10000 scale) for agricultural land use planning using geospatial techniques
- Land resource inventory of North West Jorhat Development block, Jorhat district, Assam (at 1: 10000 scale) for agricultural land use planning using geospatial techniques.
- Land resource inventory at 1:10000 scale in Kadwa block of Katihar district, Bihar for optimal agricultural land use planning using geospatial techniques
- Land resource inventory at 1: 10000 scale in Rajnagar block of Birbhum district, West Bengal using geospatial techniques
- Land resource inventory on 1:10000 Scale in Dumka block, Dumka district, Jharkhand using geoinformatics
- Land resource inventory of Borio block of Sahibganj district, Jharkhand on 1:10000 scale for optimal agricultural land use planning using geospatial techniques
- Land resource inventory at 1:10000 scale in Basudevpur block of Bhadrak district, Odisha using geospatial techniques
- Land resource inventory on 1:10000 scale in Mushahari block of Muzaffarpur district, Bihar using geospatial techniques
- Land resource inventory at 1:10000 scale in Ganjam block of Ganjam district, Odisha for optimal agricultural land use planning using geospatial techniques
- Land resource inventory at 1:10000 scale in Titlagarh block of Bolangir district, Odisha using geospatial techniques
- Land resource inventory of Central State Farm Jaitsar, Sriganganagar district, Rajasthan

- Land resource inventory of Dholka taluka, Ahmadabad district, Gujarat on 1:10000 scale for optimal agricultural land use planning, using geospatial techniques.
- Land resource inventory of Deesa taluka, Banaskantha district, Porbandar taluka, Porbandar district and Rapar taluka, Kucchha district Gujarat on 1:10000 scale for optimal agricultural land use planning, using geospatial techniques
- Land resource inventory on 1:10000 scale for agricultural land use planning of Neem Ka Thana tehsil, Sikar district of Rajasthan, using geospatial technique
- Land resource inventory of Fatehgarh block, Jaisalmer district (Rajasthan) on 1:10000 scale for agricultural land use planning, using geospatial techniques.
- Land resource inventory (1:10000 scale) of Gujarat state- A step towards enhancing agricultural productivity and transfer of technology.
- Land resource inventory of Dhanora block, Seoni district, Madhya Pradesh.
- Land resource inventory of Bemetara block, Bemetara district, Chattisgarh State (AESR 11) on 1:10000 scale for optimal agricultural land use planning, using geospatial techniques.
- Land resource inventory of Darwah tehsil in Yavatmal district, Maharashtra on 1:10000 scale for agricultural land use planning using geospatial techniques.
- Land resource inventory of Nanguneri Block, Tirunelveli district, Tamil Nadu (1:10000 scale) for agricultural land use planning using geospatial techniques.
- Land resource inventory of Madahalli and Singanallur micro watersheds of Chamrajnagar district, Karnataka for integrated watershed planning
- Land resource inventory of arable lands of Medziphema block, Dimapur district, Nagaland for agricultural planning
- 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
- Generation of soil resource database of IARI Farm, New Delhi

Soil and Land Resource Inventory at 1:50000 scale

- Soil resource inventory and land evaluation of Chittaurgarh district for land use planning
- Soil resource - their assessment for horticulture in Shimla district (part) of Himachal Pradesh for horticultural plantation

Soil Correlation

- Correlation of Soil Series of India.
- Correlation of soil series of Eastern States (West Bengal, Bihar, Jharkhand, Orissa, Sikkim, and A&N Islands)

Remote Sensing and GIS Applications

- Landform and land use/land cover mapping of some selected blocks using remote sensing and GIS for land resource inventory at 1:10000 scale.
- Landform and land use/land cover mapping of Rajnagar, Dumka and Borio blocks using remote sensing and GIS 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.
- Development of block level soil reflectance hyperspectral libraries for predicting soil properties.
- Revision of agro-ecological regions (AER) Map of India
- Land resource inventory for integrated agriculture planning of Miniwada panchayat, Katol tehsil, Nagpur using high resolution satellite data and GIS
- 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
- Design and development of land resource information system and NBSS Geo-portal for Geo-spatial database management and dissemination
- 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

- Genesis and classification of soils of Bemetara block, Chattisgarh
- 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
- Study the influence of land use system on soil properties under different geomorphic situations in Mahanadi Basin of Bolangir district, Odisha

Soil Survey Data Interpretation and Applications

- Study the influence of land use system on soil properties under different geomorphic situation in Mahanadi basin of Bolangir district, Odisha

Land Evaluation and Land Use Planning

- Socio-economic evaluation of agricultural land use in India –Phase-I
- Agricultural land use planning of Bukkarayasmudrum Mandal of Anantapur District, Andhra Pradesh and Siddipet mandal of Medak district of Telangana using land resources inventory database on 1:10000 scale.
- Development of web based GIS system for real-time field data collection, transfer, storing and retrieval.
- Agricultural land use planning using land resources inventory database on 1:10000 scale of Baragaon block of Varanasi district of Uttar Pradesh
- Land use options for enhancing productivity and improving livelihood in Bali Island of Sundarbans
- Agricultural land use planning for Neem Ka Thana block, Sikar district (Rajasthan) using land resource inventory database on 1:10000 scale
- Agricultural land use planning for Porbandar taluka, Porbandar district using land resource inventory database on 1:10000 scale
- Agricultural land use planning for 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 for Rajnagar Block of Birbhum District, West Bengal using land resource inventory database on 1:10000 scale
- Agricultural land use planning for Basudevpur block of Bhadrak district Odisha using land resource inventory database on 1:10000 scale.
- Agricultural land use planning of Umsning block of Ri-Bhoi district, Meghalaya, Using Land Resources Inventory Database on 1:10000 scale.
- Perspective land use planning of Chandrabhaga Watershed/ Kalmeshwar block, Nagpur district
- Analysis of temporal and spatial land use changes and its impacts in basaltic terrain of Vidarbha region in Maharashtra

- 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 Almora district, Uttarakhand under hill and mountain ecosystem.
- Land use dynamics in rural-urban interface of NCR for regional planning – a case study of NCT-Delhi and Haryana sub regions
- Land use planning of Buraka micro watershed in Mewat district of Haryana under irrigated eco system for integrated development.
- Dynamics of land use plan and its impact on soil properties in Jalandhar district, Punjab state.
- Development of alternate farming system model using soil resource information in the Akna Mirzapur village of Baruipur block (District South 24-Parganas) of West Bengal
- Development of district level Land Use Plan for Gondia district, Maharashtra- A sub project of network project on district level land use planning.
- Evaluation of management practices for different sustainable cropping system in major soils of Shikohpur village in Haryana

Human Resource Development

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

EXTERNALLY FUNDED PROJECT (ON GOING)

Land Resource Inventory

- Land Resource Inventory of selected micro-watersheds in seven backward districts of Karnataka under Sujala-III Watershed development project (World Bank funded project; Rs. 1515.24 Lakhs).
- GIS based Digital Library (DL) for the Land resources of Sujala III watershed development project (Sub Project of Sujala III - World bank funded project)
- Land resource inventory and GIS database for farm planning in coastal region of West Bengal (Department of Agriculture, Govt. of West Bengal; Rs.61.80 Lakhs)
- Detailed Soil survey of Ladhowal Farm, District Ludhiana, Punjab for crop suitability assessment (ICAR; Rs. 1.14 Lakhs)
- Land Resource Inventory of Ri-Bhoi District, Meghalaya at 1:10000 scale for agricultural land use planning using geo-spatial technique (Govt. of Meghalaya; Rs. 35 Lakhs)
- Soil Resource Inventory of National Institute of Biotic Stress Management (NIBSM) farm, Baronda, Raipur, Chattishgarh.
- Land resource inventory of Teelangana state (A step towards enhancing Agricultural Prodictivity)

Issue Based Survey

- 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 (Department of Agriculture, Govt. of Nagaland; Rs. 36.837 Lakhs)
- 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 (Department of Agriculture, FS & AD, Govt. of Sikkim; Rs. 28.18 Lakhs)
- 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 (Department of Agriculture and Cane Development, Govt. of Jharkhand; Rs.106.64 Lakhs)
- Assessment of salt-affected soils of Tamil Nadu and its impact on crop productivity (Tamil Nadu State Land Use Research Board; Rs. 9.70 Lakhs)
- Soil fertility assessment and soil health monitoring in traditional Rubber growing areas of Kerala, Tamil Nadu and Karnataka (Rubber Board, Kottayam, Ministry of Commerce, Govt. of India; Rs. 61.50 Lakhs)
- Soil fertility appraisal and soil health monitoring in traditional coffee growing regions of Karnataka, Kerala and Tamil Nadu (Central Coffee Research Institute, Coffee Board, Govt. of India; Rs. 39.96 Lakhs)
- Fallow lands of Tamil Nadu – cause, effects and measures to arrest the march of fallows (Tamil Nadu State Land Use Research Board; Rs. 9.70 Lakhs)

- Desertification status mapping of India (2nd Cycle) (Space Application Centre, Ahmedabad; Rs. 29.09 Lakhs)

Basic Pedological Research

- Influence of organic and inorganic carbon sequestration on soil and land quality in selected benchmark spots of India (DST-IS-STAC; Rs. 26.568 Lakhs)
- Generation and modeling of carbon datasets in different agro-ecological systems for climate resilient agriculture (NICRA)

Land Evaluation and Land Use Planning

- Assessment of environmental and economic input of the new agricultural policy of Karnataka in land use, land productivity and rural livelihood. (DST; Rs.35.0635 Lakhs)
- 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; Rs. 14.3856 Lakhs)

Tribal Sub Plan (TSP) Programme

- Livelihood improvement of tribal communities in selected hamlets of H.D. Kote, Mysore through integrated land use planning
- Strategy for sustainable management of soil and water resources for enhancing livelihood of farming community in Bali Islands, Sundarbans
- Land resource management for farm planning of Upar Deuri Gaon, North West Jorhat development block, Jorhat, Assam

INSTITUTE PROJECTS (COMPLETED)

Inventorying Natural Resources

- Correlation of Soil Series of India – Northern States
- Correlation of soil series of India and their placement in the National Register for the Western States (Gujarat & Rajasthan)

Basic Pedological Research

- Geomorphological analysis and study on landform-soils-land use relationships in Karnataka
- Development of Indian soil information system (ISIS) (1:250,000 scale) – A Geoportal
- Development of district soil information system (DSIS) on 1:50,000 scale (50 Districts) – A Geoportal

Soil Survey Data Interpretation and Applications

- Effect of land use changes on total soil organic carbon (SOC) and its active pool in humid to per humid eco-region of West Bengal

Land Evaluation and Land Use Planning

- Land use planning of Khuskarani watershed, Birbhum, West Bengal for integrated development
- Development of district level land use plan for Bundi district (Rajasthan) under arid and semi arid ecosystem

EXTERNALLY FUNDED PROJECTS (COMPLETED)

Basic Pedological Research

- Georeferenced soil information system for land use planning and monitoring soil and land quality for agriculture (NAIP; Rs.274.897 Lakhs)

Land Evaluation and Land Use Planning

- Efficient land use based integrated farming system for rural livelihood security in Aurangabad, Dhule and Gondia districts of Maharashtra. (NAIP; Rs.505.1975 Lakhs)
- Delineation of potential areas for commercially important medicinal and aromatic plants in different agro-ecological zones of Karnataka using GIS tools (DST; Rs.19.158 Lakhs)

4 PUBLICATIONS

RESEARCH PAPERS

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Nisha Sahu, Obi Reddy, G.P., Nirmal Kumar, Nagaraju, M.S.S., Srivastava, R. and Singh, S.K. 2015. Morphometric analysis of Miniwada Watershed of Nagpur District using GIS techniques. p. 60.

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Reza, S.K., Baruah, U., Singh, S.K. and Das, T.H. 2015. Mapping risk of zinc efficiency using geospatial approach: A case study of upper Brahmaputra Plains, Assam, India. pp 52.

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Srinivasan, R., Chattopadhyay, T., Das, T.H. and Singh, S.K. 2015. Characteristic and classification of soils of coastal ecosystem – A case study in Canning II Block, South 24-Parganas district of West Bengal pp 47.

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Thayalan, S., Lalitha, M., Dharumarajan, S., Ramesh, M. and Nair, K.M. 2015. Landform assemblages of Tamil Nadu uplands: A case study of Noyyal-Amaravati interfluves. pp. 61.

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Nirmal Kumar, Nisha Sahu, Obi Reddy, G.P., Nagaraju, M.S.S., Srivastava, R. and Singh, S.K. 2015. Predicting soil depth from satellite remote sensing data- A case study in Miniwada Watershed of Nagpur district, Maharashtra.

Meena, R.L., Meena, R.S., Singh, R.S. and Verma, T.P. 2015. Soil-site suitability evaluation for Orange (Citrus reticulata) in soils of Jhalrapatan block, Jhalawar district, Rajasthan.

Meena, R.S., Singh, R.S., Verma, T.P., Meena, R.L. and S.K. Singh 2015. Characterization and classification of soils of Jhalrapatan block, Jhalawar district of Rajasthan.

Sharma, R.P., Verma, T.P., Singh, R.S., Akbari, K.N. and Sutaria, G.S. 2015 Soil application of weathered basalt in groundnut production for management of Vertisols.pp.6

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Sahoo A.K., Singh, S.K. and Nayak, D.C. 2015. Block level soil nutrient mapping of Dumka, Jamtara, Hajaribagh and Ramgarh Districts, Jharkhand.

PAPERS ABSTRACTED

Natarajan. A and Hegde, R. 2014. Land use planning for sustaining soil quality. Proceedings of the workshop on managing the soils for food security and climate change adaptation “World Soils day” 2013. (05-12-2014). Edited by Dr. M. Premachandran, Department of Soil survey and soil correlation. Govt. of Kerala publication. pp.195.

Nirmal Kumar, Obi Reddy, G.P., Chatterji, S. 2015. GIS Modeling to Assess Land Productivity Potential for Agriculture in Sub-Humid (Dry) Ecosystem of Wardha District, Maharashtra, In: The Geospatial Momentum for Society and Environment (Eds.) Anjana Vyas, Franz-Josef Behr, Dietrich Schröder, pp.271-276.

LECTURES DELIVERED

- Dr. S. K. Singh, Director presented invited paper on Land Resource Inventory on 1:10000 scale for micro level land use planning during International Conference on Natural Resource Management for Farming Systems and Rural Livelihood during February 10-13, 2015 at New Delhi.
- Dr. S. K. Singh, Director delivered Platinum Jubilee Lecture on ‘Land Resource Inventory on 1:10000 scale for micro level planning’ in Agriculture Section of the 102nd Session of Indian Science Congress held at Mumbai University, Mumbai during January 3-7, 2015.

- Dr. S. K. Singh, Director presented invited paper on Land Resource Inventory for Micro Level Land Use Planning during National Symposium on Natural Resource Management at BCKV, Kalyani, Mohanpur West Bengal organized by National Academy of Agricultural Science, New Delhi
- Dr. Rajeev Srivastava, Pr. Scientist & Head, Division of Remote Sensing Applications delivered guest lectures on "Introduction to Remote Sensing and "Spectral Properties of Soils" in "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" training programme held at NBSS&LUP, Nagpur from 3rd to 23rd February, 2015.
- Dr. Rajeev Srivastava, Pr. Scientist and Head, Division of Remote Sensing Applications delivered an invited lecture on the topic "Visible-Near Infrared Reflectance Spectroscopy as a Diagnostic Tool for Rapid Characterization of Soils" National Seminar of ISSLUP on "Sustainable Management of Land Resources for Livelihood Security" held on January 28-30, 2015 at Nagpur.
- Dr. Jagdish Prasad Pr. Scientist and Incharge Head, Division of Soil Resource Studies delivered a lecture on "Organic Farming – Myth or Reality" on Science Day (28th Feb., 2015) at ICAR-NBSS&LUP, Amravati Road, Nagpur.
- Dr. S.K. Singh, Director, delivered a seminar lecture organized by ISSLUP, Jorhat Chapter on "Land resource inventory on 1: 10K for micro level land use planning and geo-database" ICAR-NBSS&LUP at Assam Agricultural University, Jorhat on 28 February 2015.
- Dr. Jagdish Prasad delivered ICAR Foundation Day celebration lecture on "ICAR in the service of Nation" on 16th July, 2014 at S.P. Raychaudhuri Hall, ICAR-NBSS&LUP, Nagpur.
- Dr. Jagdish Prasad delivered a lecture on "Degradation in Indian perspective and its corrective measures" in the Department of Soil Conservation & Water Management, C.S. Azad University of Agriculture and Technology on 13th Nov., 2014.
- Dr. Jagdish Prasad delivered an invited lecture on "Participatory and Integrated Land Use Planning" in 21 days winter school (Niche Area of Excellence) at Rajamata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior on 9th Feb., 2015.
- Dr. (Mrs.) C. Mandal, Pr. Scientist Division of RSA delivered a guest lecture on "Use of maps" in "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" training programme held at NBSS&LUP, Nagpur from 3rd to 23rd February, 2015.
- Dr. M.S.S. Nagaraju, Pr. Scientist, Division of Remote Sensing Applications delivered a guest lecture on "Specific dataset for Remote Sensing" in "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" training programme held at NBSS&LUP, Nagpur from 3rd to 23rd February, 2015.
- Dr. Jagdish Prasad, Pr. Scientist and Incharge Head, Division of Soil Resource Studies delivered three lectures on i) Factors of soil farming, ii) Soil survey – concepts, landform – soil relationship, iii) Land use planning to the trainees of TSP sponsored training on "Advances in Land Resource Inventory for Enhancing Productivity through Agrotechnology transfer conducted at NBSS&LUP during 3rd to 23rd Feb. 2015.
- Dr. M.S.S. Nagaraju, Pr. Scientist, Division of Remote Sensing Applications delivered a special lecture on "Remote sensing, GIS and GPS applications in soil resource management" conducted by Indian Science Congress, Nagpur Chapter held at RTM Nagpur University, Nagpur on 13th November, 2014.
- Dr. P. Chandran, Pr. Scientist, Division of Soil Resource Studies delivered two lecture on "Weathering of Rocks and Minerals" and Soil Taxonomy: its Structure and Soil Correlation on 4th and 6th Feb. 2015 during the TSP sponsored training on "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" conducted at National Bureau of Soil Survey and Land Use Planning Nagpur during 3rd to 23rd February 2015.
- Dr. S.K. Mahapatra, Principal Scientist, Regional Centre Delhi delivered Presidential Address on Soil resource based land use planning for sustainable agricultural production at Indian Science Congress, Mumbai on January 4, 2015.
- Dr. S.K. Ray, Pr. Scientist, Division of Soil Resource Studies delivered lectures for GSI scientists for two days on the topics "Weathering of rocks and minerals, soil profile description, soil genesis, classification and correlation, soils of India, soil humus and soil and land quality indices" at GSI, Nagpur during October 27-28, 2014.

- Rajendra Hegde, Principal Scientist, Regional Centre, Bengaluru gave a radio talk on "Landslides, earth slip, soil erosion problems and their management (4-8-2014), from AIR, Bangalore.
- Dr. Rajendra Hegde, delivered a guest lecture on "Land use planning and watershed management" for the PG students of UAS Bangalore (11-9-2014).
- Dr. Rajendra Hegde delivered a guest lecture on "Rain water harvesting: techniques and tools" for the Post Graduate students of UAS Bangalore (18-9-2014).
- Dr. Rajendra Hegde delivered a guest lecture on "Precision farming possibilities in Indian situations" for the Ph.D. students of IARI, New Delhi (18-9-2014).
- Dr. Rajendra Hegde delivered a guest lecture on role of Land Resources Inventory" in scientific land use planning for the 32 International trainee officers from NIRD Hyderabad (2-12-2014).
- Rajendra Hegde, gave a radio talk on plant species facing extinction in Karnataka and measures undertaken by various programs" (22nd January 2015) from, All India Radio, Bangalore.
- Dr. Rajendra Hegde delivered a guest lecture on "Essentiality of Land Resources Inventory in planning land based development programs. For Kerala State officer from Soil conservation department (9-3-2015).
- Dr. G.P. Obi Reddy, Pr. Scientist delivered guest lectures on "Principles and Concepts of Geographic Information System", "Geomorphology & Geomorphic Cycles" and "Geomorphic Process & Landform Evolution" in training programme "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" held at NBSS&LUP, Nagpur from 3-23 February, 2015.
- Sh. Ashok Kumar, Scientist, Regional Centre Delhi delivered a lecture on Integrated Land Resource Planning and Management towards sustainable natural resource management at ICAR-NBSS&LUP, Nagpur on January 29, 2015.
- Dr. S. Bandyopadhyay, Scientist, Regional Centre, Jorhat visited in the Department of Extension Education Institute, AAU, as a resource person to deliver a lecture on the topic "Remote sensing & GIS application in precision agriculture" in the training programme on "Computer application in agriculture for programme assistant" held on 21st March, 2015.
- Dr. S. Chattaraj, Scientist, Division of Remote Sensing Applications delivered guest lecture on "Geostatistics and Digital Soil Mapping" in "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" training programme held at NBSS&LUP, Nagpur from 3rd to 23rd February, 2015.
- Dr. Arun Chaturvedi, Principal Scientist and Head, Division of Land Use Planning delivered key note address on the topic "Geospatial Techniques in Land Use Planning with Special Reference to Uttar Pradesh" National Seminar on "Geospatial Technology & 3-D Application for Sustainable Development of Land Resources" organized by Remote Sensing Application Centre - Uttar Pradesh in collaboration with Uttar Pradesh Land Use Board, Lucknow during 12-13 March, 2015.
- Dr. Arun Chaturvedi delivered Lead Paper on the topic "Natural Resource Management : A Challenge for Sustainable Rural Livelihood Security in Forest and Fringe Villages of Central India" at "International Conference on Natural Resource Management for Food Security and Rural Livelihood Security" at New Delhi during 10-13 February, 2015.
- Dr. Arun Chaturvedi delivered a key note lecture on Sustaining Tribal Livelihood In A Resource Constrained Environment, at National Seminar on "Agrarian Distress in India" organized by Council for Social Development, New Delhi during 11-12 November, 2014 at IIC Centre (Annexe), New Delhi.
- Dr. Arun Chaturvedi was invited as a panelist for the prestigious Lovraj Kumar Memorial Lecture/ Panel Discussion (LKMPD) on "Land Use Planning & Management for Sustainable Resource Regeneration & Improving Livelihoods" at India International Centre, New Delhi organized by SPWD under the chairmanship of Smt Vandana Jena, IAS, Secretary, Deptt of land resources, GOI on 24th September, 2014.
- Dr. N.G. Patil Pr. Scientist, Division of Land Use Planning delivered a keynote lecture on 'Status and Future of Land Use Planning in India' during National Seminar on "Sustainable Management of Land Resources for Livelihood Security" January 28-20, 2015.

- Dr. N.G. Patil delivered a keynote lecture on 'Future water challenges' at Ambedkar college on the occasion of 'World Water Day' 5 March 2015.

INVITED LECTURES ORGANISED

- Invited lecture on the topic "New Technologies in Field Soil Survey" by Dr. David C. Weindorf, Associate Professor and B. L. Allen Endowed Chair of Pedology, Department of Plant and Soil Science, Texas Tech University at NBSS & LUP, Regional Centre, Kolkata at the Indian Society of Soil Survey and Land Use Planning, Kolkata Chapter in collaboration with the Indian Society of Soil Science, Kolkata Chapter and National Bureau of Soil Survey and Land Use Planning, Regional Centre, Kolkata on 12th September 2014.

ORGANISATION OF SOFTWARE DEMONSTRATION

- Dr. R.P. Yadav, Principal Scientist and Head, Scientists and Technical Officers attended a software demonstration by Dr. Pankaj Panwar, Senior Scientist, Research Centre Chandigarh, Indian Institute of Soil and Water Conservation, Dehradun, Database Management Software for online submission and monitoring of research of research activities at Regional Centre Delhi on 24th February 2015.

MISCELLANEOUS

- Jagdish Prasad, G. Ravindra Chary, N. G. Patil and G. P. Obi Reddy 2015. Agropedology Terminologies published by Indian Society of Soil Survey and Land Use Planning, Nagpur.
- N.G. Patil, S. K. Ray, P. Chandran, M. S. S. Nagaraju and P. Tiwary 2015. Abstracts of National Seminar on "Sustainable Management of Land Resources for Livelihood Security" January 28-20, 2015 published by Indian Society of Soil Survey and Land Use Planning, Nagpur.
- Nirmal Kumar, Jagdish Prasad, Srivastava R., Nagaraju, M.S.S., Sahu, M.T. and Singh, S.K. 2014. Mrida Sansadhan Mein Sudoor Sanvedan Ki Upyogita. Presented at Rajbhasha Hindi Mein Takniki Sangoshti, Kshetriya Sudoor Sanvedan Kendra (Madhya Ksheshtra), Nagpur on 30th May, 2014.
- Dr. G.P. Obi Reddy, Pr. Scientist, Dr. S. Chattaraj, Scientist and Dr. Nisha Sahu, Scientist conducted GIS practicals in "Advances in Land Resource Inventory for enhancing productivity through Agro-technology transfer" training programme held at NBSS&LUP, Nagpur from 3rd to 23rd February, 2015.

INVITATIONS FROM DIFFERENT ORGANIZATIONS

- Dr. A. Chaturvedi was invited to attend the Expert Group Meeting for formulating National Land Use Policy" organized by the Department of Land Resources, New Delhi during 11-12 November, 2014 at ICA, Manesar (Haryana).
- Dr. N.G. Patil served as a member of selection committee for 'Radhakrishna Shanti Malhotra Award at MAU, Parbhani.
- Dr N. G. Patil was invited by Director, Dept. of Agriculture, Govt. of Maharashtra to guide formulation of Development Plan of the 'Jalyukta Shivar Abhiyan'.
- Dr. V. Ramamurthy was invited to attend as expert member for Zonal committee member for reviewing NICRA villages programme (Zone-VIII).

5 PARTICIPATION IN CONFERENCE, WORKSHOP, SYMPOSIUM, SEMINAR AND MEETINGS

WORKSHOPS

Date	Details of programme	Participants
2014		
April 16	NSDI National Workshop on "Data Content Standards- A Road map Ahead" at NSDI, New Delhi	Dr. G.P. Obi Reddy
August 18	Workshop on "Terms of Reference (ToR) for developing Digital Library, Geo-Portal and Decision Support System for the Sujala-III Project", It was held at ICAR-NBSS& LUP	Dr. Rajendra Hegde
October 10	NBSSLUP participated in the Sujala–3: Project Empowered Committee (PEC) meeting Chaired by Additional Chief Secretary and Development Commissioner, Govt. of Karnataka and presented the progress of the project and programs envisaged for the next year	Dr. Rajendra Hegde
October 29	NBSSLUP participated in the Project Technical committee (PTC) meeting Chaired by Project Director and Commissioner and discussed about the PERT chart, Procurement plan, Research projects and related issues for the smooth functioning of the project: Sujala-3	Dr. Rajendra Hegde
November 12	National workshop: Participated in the Consultative workshop on "Alignment of National Action Plan (NAP) program for Combating Desertification: 10 years strategy on UNCCD at Institute of Wood Science and Technology (ICFRE)	Dr. Rajendra Hegde
November 12	Consultative workshop on "Alignment of National Action Programme" on Combating Desertification to 10 year Strategy of UNCCD and presented the paper on Desertification/land degradation assessment and change detection over 10 years in Karnataka and Andhra Pradesh at institute of wood science and Technology, Bangalore	Dr. S. Dharumarajan Dr. Rajendra Hegde
November 27	Workshop on *'Geospatial Technology for National Mapping'* at New Delhi	Dr. G.P. Obi Reddy
November 28	NAAS Brainstorming Workshop on *'Soybean Productivity, Production in India-Resource Domain Initiatives'* at New Delhi	Dr. G.P. Obi Reddy
November 29	Sujala project review workshop convened by World Bank Team	Dr. Rajendra Hegde
November 30	Budget review meeting of Sujala project at ICAR-NBSSLUP, Bangalore	Dr. Rajendra Hegde
December 6	Sujala procurement workshop: Participated in the procurement workshop of Sujala at Watershed Development Department at Bangalore	Dr. Rajendra Hegde
December 15	IUFR workshop of Sujala : Participated in Workshop at Watershed Development Department, Bangalore	Dr. Rajendra Hegde

2015		
January 28-30	National Workshop on Sustainable Management of Land Resource for Livelihood Security at ICAR-NBSS & LUP, Nagpur.	Dr. S. K. Singh Dr. T.H. Das Dr. A.K. Sahoo, Dr. S.K. Gangopadhyay Dr. T. Chattopadhyay Dr. S.K. Reza Dr. R. Srinivasan Dr. K.D. Sah Dr. S. Padua Dr. S. Ramachandran Dr. R.P.Yadav Dr. Ashok Kumar Dr. Jagdish Prasad Dr. B.P.Bhaskar Dr. Srivastava, Rajeev
February 2	Workshop on Geo-portal, Digital Library and Decision Support System for Sujala: organized in the chamber of Additional Chief Secretary and Development Commissioner attended by WDD, NBSSLUP and ICRISAT	Dr. Rajendra Hegde
February 19	Workshop on "Hydrological Research and monitoring" under Sujala, at NBSSLUP, Bangalore. IISc, KSNMDC  Hydrological workshop at NBSSLUP 19th Feb 2015	Dr. Rajendra Hegde
March 2	Sujala project progress review workshop at WDD Bangalore and presented the progress	Dr. Rajendra Hegde
March 14	Inaugural workshop of Biodiversity International, at Regional Centre, Bangalore	Dr. Rajendra Hegde

SEMINAR / SYMPOSIUM / CONFERENCE

Date	Details of programme	Participants
2014		
June 8-13	20th World Congress of Soil Science held at Jeju, South Korea	Dr. S.K. Mahapatra Dr. Jaya N. Surya
November 18-20	National Symposium on "Agricultural Diversification for Sustainable Livelihood and Environmental Security" at PAU, Ludhiana, (Punjab)	Dr. Dharam Singh
November 24 -27	79th ISSS National Seminar held at Hyderabad jointly by Prof. Jayashsankar Telankana State Agricultural University (PJTSAU) and N.G. Ranga Agricultural University (NGRAU)	Dr. K.S Anil Kumar

December 9-12	ISPRS-TC-VIII International Symposium on "Operational Remote Sensing Applications, Opportunities, Progress and Challenges" held at Hyderabad	Dr. G.P. Obi Reddy
December 19	Seminar on "Challenges in managing ground water in a heterogeneous aquifer" by Dr Chris Jackson Scientist British Geological survey at Indian Institute of Science, Bangalore	Dr. Rajendra Hegde
December 19-20	International Seminar on Environmental Perspectives and Resource Management, organized by Institute of Landscape, Ecology and Ekistics, Kolkata at Calcutta University, Kolkata.	Dr. A.K. Sahoo Dr. (Mrs.) T. Banerjee
2015		
January 28-31	"Sustainable Management of Land Resources for Livelihood Security" at NBSS&LUP, Nagpur	Dr. K.S Anil Kumar
February 10-13	The International Conference on Natural Resource Management for Farming System and Rural Livelihood during 10.02.2015 to 13.02.2015 Organized by soil conservation society of India at NASC complex New Delhi	Dr. Dharumarajan S
January 3-7	102nd Indian Science Congress 2015 organized by Indian Science Congress Association held at University of Mumbai, Mumbai, India.	Dr. S. K. Singh Dr. S.K. Mahapatra Dr. Jaya N. Surya Dr. K. Das
January, 17	2nd Dr. S.K. Mukherjee and Dr. K.K. Rohatgi – Mukherjee Annual Endowment Lecture on "Indian Agriculture: Transforming the Nation" held at ICAR-CRIJAF, Barrackpore.	Dr. D.C. Nayak Dr. A.K. Sahoo Dr. S.K. Gangopadhyay Dr. K. Das Dr. Dipak Dutta
February 10-13	International Conference on Natural Resource Management for Farming Systems and Rural Livelihood at New Delhi	Dr. S. K. Singh
February 25	Seminar on "Sustaining Soil Health - Need for Reforms in Fertilizer Policy" organized by Fertilizer Association of India, Eastern Region in collaboration with Ramakrishna Mission Divyayan Krishi Vigyan Kendra at School of Agriculture and Rural Development, Ramakrishna Mission Vivekananda University, Ranchi.	Dr. A.K. Sahoo
March 16-17	IFA-FAI, National Seminar on Sustainable Fertilizer Management for Soil Health at New Delhi	Dr. R.P. Yadav Dr. S.K. Mahapatra
	National Symposium on Natural Resource Management organized by National Academy of Agricultural Sciences, New Delhi at BCKV, Kalyani, Mohanpur West Bengal	Dr. S. K. Singh

MEETING

Date	Details of Programme	Participants
2014		
April 7	A meeting on 'Development of Memorandum of Understanding on Land Resource Inventory Project' between NBSS&LUP and NRSC, held at NRSC, Hyderabad	Dr. G.P. Obi Reddy
May 3	Council meeting of Indian Science Congress Association at Kolkata	Dr. S.K. Mahapatra

May 15	Interaction Meet with the Director of Agriculture and other officials of Directorate of Agriculture, Govt. of Nagaland at Kohima for finalizing the "Soil Nutrient Mapping of Nagaland" report.	Dr. U. Baruah, former Head & Principal Scientist, and Dr. S. Bandyopadhyay, Scientist
May 31	Departmental Promotion Committee meeting as an expert at ICAR Research Complex for NEHR, Barapani	Dr. U. Baruah, Former Head & Principal Scientist, Regional Centre, Jorhat
June 2	Mid. Term Review of Regional Committee Meeting at ICAR Research Complex for NEHR, Barapani	Dr. U. Baruah, former Head & Principal Scientist, Regional Centre, Jorhat
June 5	World Environment Day celebration at Raman Science Centre & Planetarium, Nagpur	Dr. Jagdish Prasad
June 25-26	Review meeting of the Programme Advisory & Monitoring Committee (PAMC) of National Programme on Carbon Sequestration (NPCS) Research of DST held at Dayananda Sagar Institute, Bangalore.	Dr. P. Tiwary
July 5	Meeting on "Reconciliation of soil fertility maps" between NBSS&LUP and IISS, Bhopal at HQrs., Nagpur.	Dr. Rajeev Srivastava Dr. (Mrs.) C. Mandal Dr. M.S.S. Nagaraju Dr. G.P. Obi Reddy
July 23 - 24	Meeting on 'Mapping of Natural Resources, Major Crops and Commodities Spatial Databases' at New Delhi	Dr. G.P. Obi Reddy
July 27	Council meeting of Indian Science Congress Association at Mumbai	Dr. S.K. Mahapatra
August 10	Interaction meet with the Director, Department of Agriculture, Govt. of Nagaland towards publication of report on Soil Nutrient mapping of Nagaland project.	Dr. K.D. Sah
August 30-31	Meeting to finalize the Soybean Concept Paper at CRIDA, Hyderabad	Dr. G.P. Obi Reddy
September 15	Interaction meet with the Director, Department of Agriculture, Govt. of Meghalaya towards initiating LRI work at 1: 10,000 scale in Ri-Bhoi district.	Dr. K.D. Sah
September 22-24	Meeting on 'Development of Modalities and Action plan for ICAR Geoportal' at NAARM and NRSC, Hyderabad	Dr. G.P. Obi Reddy
September 30 to October 1	Meeting to discuss the 'Modalities and future course of action for implementation of ICAR Research Data Management Policy' at New Delhi	Dr. G.P. Obi Reddy
October 9-10	Council meeting of Indian Science Congress Association at Mumbai	Dr. S.K. Mahapatra
October 10	Meeting for signing the MoU with Meghalaya Basin Development Authority, Govt. of Meghalaya, Shillong for conducting the LRI project at 1: 10000 scale in Ri-Bhoi district of the state.	Dr. K.D. Sah Dr. S.K. Singh
October 17-18	Regional Committee meeting at Raipur	Dr. Jagdish Prasad
October 30-31	Farmer's Fair organized by NRCC, Nagpur	Dr. Jagdish Prasad
November 28	SOC meeting of ICAR at Hdqrs, New Delhi	Dr. R.P. Yadav

December 4-7	Attended Agro-Vision: workshops, national expo and conference (Innovation in Agriculture) at Reshimbagh, Nagpur.	
December 30	SOC meeting of ICAR in connection with Swatch Bharat Abhiyan at Hdqrs, New Delhi	Dr. R.P. Yadav
2015		
January 2 and 7	Council meeting of Indian Science Congress Association at Mumbai	Dr. S.K. Mahapatra
January 7	General Body Meeting of Indian Science Congress Association at Mumbai	Dr. S.K. Mahapatra
January 12	A meeting regarding activities, facilities and future plan of Regional Centre Delhi, chaired by Dr. S.K. Chaudhary, ADG (SWM), NRM Division, ICARA presentation being given by the Head to Dr. S.K. Chaudhary  A presentation being given by the Head to Dr. S.K. Chaudhary	Scientists and staff of Regional Centre, Delhi
January 21	Meeting on 'Implementation of Research Data Management in ICAR Institutes and Digitization of Agricultural Research' at New Delhi	Dr. G.P. Obi Reddy
January 28	Review Meeting of Committee for Planning and Monitoring of Agricultural Land Use Planning at NBSS&LUP, Nagpur.	Dr. R.P. Yadav
February 23	Technology Platform Meeting on Farming System for Nutrition (FSN) study in Wardha under Leveraging Agriculture for Nutrition in South Asia (LANSA), organised by M.S. Swaminathan Foundation, Chennai at CICR, Nagpur on	Dr. Jagdish Prasad
February 27	SOC meeting to participate in presentation of ICAR Geoportal at Delhi	Dr. G.P. Obi Reddy
March 12	IMC meeting at CICR, Nagpur	Dr. Jagdish Prasad
March 13	Regional Brainstorming Session on 36th IGC "A unique opportunity for Advancement in Geosciences" at Nagpur organised by GSI, Central Region, Nagpur	Dr. Jagdish Prasad
March 21	Council meeting of Indian Society of Soil Science	Dr. Jagdish Prasad
March 24-25	'Technical Programme Workshop' of NICRA project organized at CRIDA, Hyderabad.	Dr. P. Tiwary
	ITMC meeting at ICAR-National Research Centre for Citrus, Nagpur.	Dr. Jagdish Prasad

6 MEETINGS ORGANIZED

RESEARCH ADVISORY COMMITTEE (RAC)

The second meeting of the RAC (2013-2016) was held at its HQrs. during August 22-23, 2014 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. S.S. Magar, member, Mr. Ramesh Jichkar, farmers' representative member and Dr. S.K. Singh, Director, NBSS&LUP, 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 said meeting.

A view of the Research Advisory Committee (RAC) Meeting

INSTITUTE MANAGEMENT COMMITTEE (IMC)

45th Institute Management Committee meeting was held on 16th 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. B.D. Phansal, Member Secretary to discuss scientific, technical and administrative matters of the Bureau.

A view of the Institute Management Committee (IMC) Meeting

INSTITUTE RESEARCH COMMITTEE (IRC)

Institute Research Committee (IRC) Meeting was held during September 4-6, 2014, at NBSS&LUP, Nagpur. Dr. S.K. Singh, Chairman, IRC and Director, Dr. J.S. Parihar, Outstanding Scientist and former Director (RESA), SAC, Ahmadabad and invited expert Dr. S.K. Choudhari, ADG (SWM), ICAR and scientists of the Bureau participated in the meeting.

INSTITUTE JOINT STAFF COUNCIL (IJSC)

Institute Joint Staff Council Meeting was held on 31.12.2014 at Regional Centre, NBSS&LUP, Kolkata to discuss various matters related to the staff of the Bureau under the chairmanship of the Director, NBSS&LUP, Nagpur.

7 MAJOR EVENTS

FOUNDATION DAY CELEBRATIONS AND LAUNCHING OF LAND RESOURCE INVENTORY PROGRAMME

The Bureau observed its **38th Foundation Day on 22nd August 2014.** On this occasion, Dr. S. Ayyappan, Secretary, Department of Agricultural Research and Education (DARE), Govt. of India and Director General, ICAR and Chief Guest launched the mega programme of National importance to agriculture sector entitled, **"Land Resource Inventory (LRI) for Village Level Planning (1:10000 scale) and Development of National Portal on Soils".** Dr. Ayyappan also inaugurated the **Data Centre of the Bureau** in esteemed presence of Dr. A.K. Sikka, Deputy Director General (NRM), ICAR and Dr. V.K. Dadhwal, Director NRSC, Hyderabad. The Data Center would be a repository of soil / land resources information collected over more than three decades and would also accommodate future database that could be accessed by researchers, academicians, students and planners for various soil/land-based uses.

ICAR ZONAL TOURNAMENT (CENTRAL ZONE)

The Bureau organized ICAR Zonal Tournament (Central Zone) 2014 at Nagpur during September 16-20, 2014. In all, 600 officials (sportspersons and other officials) from 19 ICAR Institutes participated in this tournament.


Launching of LRI Programme

Opening Ceremony


Inauguration of Data Center


An athletic event in progress

RELEASE OF BLOCK LEVEL SOIL NUTRIENT MAPS OF DUMKA, JAMTARA, HAZARIBAGH AND RAMGARH DISTRICTS, JHARKHAND

Block level Soil nutrient Maps of Dumka, Jamtara, Hazaribagh and Ramgarh districts, Jharkhand were released on 24.06.2014 by Shri Jogendra Saoji, Hon'ble Agriculture Minister, Govt. of Jharkhand at Conference Hall, SAMEETI, Krishi Bhavan, Ranchi.

Shri Jogendra Saoji, Hon'ble Agriculture Minister, Govt. of Jharkhand releasing Block level Soil Nutrient Mapping of Dumka, Jamtara, Hazaribagh and Ramgarh districts, Jharkhand in presence of Shri Nitin Madan Kulkarni, Director of Agriculture, Jharkhand, Dr. D.P. Shahi, Dr. Jatashankar Chowdhuri, Dr. Prabhakar Sigh, Dr. Rajiv Kumar, Dr. A.K. Agarwal from Birsa Agricultural Universities, Ranchi, Jharkhand, Dr. S.K. Singh, Director and Dr. A.K. Sahoo, Principal Scientist, ICAR-NBSS & LUP, Regional Centre, Kolkata on 24.06.2014.

EXHIBITIONS

Regional Centre Delhi participated in "PUSA KRISHI VIGYAN MELA -20015" held at IARI, New Delhi, during 10th to 12th March 2015,and displayed various maps, publications & activities of the Bureau besides interacting with farmers and other visitors. Leaflets highlighting the mandate, activities, and achievements of the institute (both in Hindi and English) were distributed among the visitors.

Participation of NBSS&LUP Regional Centre, Delhi in Pusa Krishi Vigyan Mela

AGROVISION-2014

Dr. (Mrs.) C. Mandal, Dr. M.S.S. Nagaraju, Dr. Nisha Sahu, Shri A.K. Barthwal, Dr. R.A. Nasre, P.V. Ambekar and N.T. Thawkar participatd in 'AGROVISION-2014' held at Nagpur from February 4-7 December 2014.

WORLD SOIL DAY

ICAR-NBSS&LUP, Nagpur in collaboration with Indian Society of Soil Survey and Land Use Planning observed World Soil Day on 5^{th} December 2014 at Hqrs. Dr. S.K. Singh, Director, NBSS&LUP, Nagpur delivered a lecture on "Land Resource Inventory on 1:10K for Micro Level Agricultural Land Use Planning" on this occasion. Dr. M.S. Ladaniya, Director, National Research Centre for Citrus (NRCC), Nagpur was the Guest of Honour and Dr. Arun Chaturvedi, Head Division of Land Use planning and President ISSLUP presided over the function.

SWACHHA BHARAT ABHIYAN

ICAR-NBSS&LUP, Regional Centre Delhi undertook a cleanliness drive during "Swachha Bharat Abhiyan" programme on New Year's day (January 1, 2015).

FARMER'S DAY

Scientists of Regional Centre, Jorhat, Assam participated in the Farmer's Day held at RARS, Titabar, AAU, Jorhat on 8^{th} November, 2014 at displayed the maps and data products of the Regional Centre, Jorhat.

8 LINKAGES AND COLLABORATIONS

Name of the Institution	Purpose
Department of Agriculture, Govt. of West Bengal.	Soil Survey, Fertility Mapping and Soil Correlation activities.
National Informatics Centre (NIC), Govt. of India.	Development of Web based farmers advisory.
Department of Agriculture and Cane Development, Govt. of Jharkhand.	Block level fertility mapping in Jharkhand.
CIMMYT India.	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.	For developing linkage in Watershed Management in Odisha State.
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
ICAR-Indian Institute of Soil Science, Bhopal	Reconciliation of nutrient maps
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 research
Soil and Land Use Survey of India (SLUSI), Govt. of India	Land resource inventory programme
Dept. of Agriculture, Govt. of Meghalaya	Land resource inventory programme

9 HUMAN RESOURCES DEVELOPMENT

EDUCATION

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

9.1 Post Graduate Education and Research in Land Resource Management (LRM)

A post graduate teaching and research programme is being conducted at the Hqrs. 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. The programme has two 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 2014-2015	127	19	—	—	—	—	—	—	127	19
On Roll	04	08	—	—	—	—	—	—	04	08

9.1a HQrs., Nagpur

9.1a (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)

9.1a (ii) Research

M.Sc. Programme

The following students who have completed their courses and have submitted their thesis.

Sr. No.	Name of student	Thesis Title
1.	Mr. Yogesh T. Waghale	Characterization and evaluation of land resources of Khutamba watershed in Nagpur district of Maharashtra using IRS-P6 data
2.	Mr. Vivek R. Dahihande	Land evaluation for rainfed cotton in selected soils of Akola district using different techniques
3.	Mr. Mahadeo H. Mahale	Characterization of minerals in some selected benchmark soils of western Vidarbha in Maharashtra
4.	Mr. Gite Manik V.	Characterization of chilli growing soils developed on granite-gneiss and basalt in Umred tehsil of Nagpur district
5.	Ms. Varsha V. Bhosale	Characterization of minerals in some typical soils representing different AESR's of eastern Vidarbha in Maharashtra

Ph.D. Programme

The following have submitted their theses

Sr. No.	Name of student	Thesis Title
1.	Ms. Jaya N. Giri	Forms of soil phosphorus in relation to the weathering indices and soil maturity in hot-dry sub-humid ecoregion of Maharashtra
2.*	Ms. Pable Dhanashree S.	Soil quality assessment in rainfed cotton growing environs of two agro-ecological regions of Vidarbha, Maharashtra
3.	Mr. Padekar Deepak G.	Soil quality as influenced by land use management with special reference to irrigation in selected tehsils of Amravati district, Maharashtra

* Ms Pable has been awarded the degree.

The following students have completed their course work. Their respective thesis title is mentioned below.

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

The following Ph.D.(LRM) student was admitted in 2013 at Dr. PDKV, Akola who later joined NBSS&LUP, Nagpur in October 2014 for his specialized course in LRM. He is undergoing the course work along with research work. Name of the student and guide along with the respective thesis title is mentioned below.

Sr.No.	Name of student	Thesis Title
1.	Mr. Indal K. Ramteke	Development of geospatial database of land resources for alternate land use in Bali island of Sunderban Delta, West Bengal

INITIATION OF NEW PH.D. RESEARCH PROGRAMME – COLLABORATION BETWEEN ICAR-NBSS&LUP AND IGKV, RAIPUR

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

The following two students are pursuing their Ph.D. programmes at NBSS&LUP, Nagpur.

1. Shri Rakesh Banwasi
2. Shri Anurag Jagannath Patangray

Dr. G.P. Obi Reddy, Pr. Scientist has guided Ms Rajmita Kar, a M.Sc (Geography) student from University of Madras for her two month internship and project on "Study on impact of urban sprawl on peri-agriculture around Nagpur city, Maharashtra: A Remote sensing and GIS Approach" from 1st May-30th June, 2014.

9.2 Training

For Bureau Officials

Date	Training details and venue	Participants
2014		
May 8 – August 7	Three month Professional Attachment Training at ICAR-CICR, Nagpur	Ms Amrita Daripa
May 9 – August 8	Professional Attachment training on "Basic techniques and process in Remote sensing and Geographic Information System and its application to watershed development and management" at GIS lab, CRIDA, Santosh Nagar, Hyderabad	Dr. B. Kalaiselvi
May 12 – August 11	Three month Professional Attachment Training at ICAR-CAZRI, Jodhpur	Miss Ritu Nagdev
July 14 -20	Training programme on "Financial Management System" at ICAR-NBSS & LUP, Nagpur.	Smt S. Majumdar Miss B. Dutta Smt. Nirmala Kumar
September 8	Training programme on applications of Bhuvan platform and QGIS software by scientists of NRSC, Hyderabad at ICAR-NBSS&LUP, Nagpur	Dr. R.P. Sharma Dr. Dharumarajan S. Miss. Vasundhara R Dr. M Lalitha Dr. M Chandrakala Dr. Kalaiselvi
September 8-12	5 day training programme on "Sustainable Development and Management of Ground Water Resources" at Ministry of Water Resources, River Development & Ganga Rejuvenation and Central Ground Water Board, Eastern Region, Kolkata.	Dr. R. Srinivasan
October 13-18	International crop modeling training workshop: The generic soil-crop model STICS and the RECORD modeling platform in collaboration with Indian Institute of Science, INRA France.	Dr. Sunil Maske Dr. Dharumarajan S Mrs. Vasundhara R Dr. M Lalitha Dr. M Chandrakala Dr. Kalaiselvi
October 24	Demonstration on personal device assistant (PDA) and its functionalities in on-line data transfer	Dr. R.P. Sharma
October 28 – November, 17	21 day training programme on "Recent Advances in Survey Design and Analysis of Survey Datausing Statistical Software" at ICAR- IASRI, New Delhi.	Dr. R. Srinivasan
October 27	Training programmes on Demonstration of Personal Device Assistant for online data transfer at ICAR-NBSS&LUP, Nagpur	Dr. Dharumarajan S

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November 18, 2014 – 17 February 2015	Three month Professional Attachment Training at RRSC, Nagpur	Mr. Prasinjit Ray
November 18, 2014 – 17 February 2015	Three month Professional Attachment Training at RRSC, Nagpur	Mr. P.C. Moharana
November 21	One day training programme on "Hands on PDA for soil survey and on-line data transfer at Regional Centre, Udaipur	Scientists and Tech. officers of Regional Centre, Udaipur
December 3-23	Advances in Land resource inventory for enhancing productivity through Agro-Technology transfer at Regional Centre, Bangalore.	Dr. Kalaiselvi
December 15-17	National Knowledge Network (NKN) Workshop-cum-training at IIT, Guwahati, Assam.	Mr. Sunil Meshram
2015		
January 19-23	Training on "Executive Development programme on Leadership Development" at NAARM, Hyderabad	Dr. S. K. Singh

For others Officials

Date	Topic	Sponsored by	Beneficiary/Number of trainees
2014			
July 14 – 25	LRI field work on generation of Land Resources Inventory for the UAS Bangalore at Chamarajnagara district	Sujala-III project	28 Officials of UAS Bangalore
August 5 – 21	LRI field work on generation of Land Resources Inventory for the UAS Raichur at Yadgir district	Sujala-III project	28 Officials of UAS Raichur
August 18 - 25	LRI field work on generation of Land Resources Inventory for the UAS Dharwad at Koppal district (Balapur watershed)	Sujala-III project	28 Officials of UAS Dharwad
August 19 - 27	GIS for Sujala-III project at Bangalore	Sujala-III project	14 staff of UAS (Bangalore), UAS (Dharwad) and NBSS&LUP
September 12 - 20	LRI field work on generation of Land Resources Inventory for the UHS Bagalkot at Bidar	Sujala-III project	28 Officials of UHS Bagalkot
October 13-18	International crop modeling training workshop on STICS-RECORD at Bangalore 	Indian Institute of Science, INRA France	32 scientists of ISRO, IARI, IISC, WDD officers
October 28 to November 17	21 day training programme on "Advances in land resource inventory for agricultural planning through agro-technology transfer" at NBSS & LUP, Regional Centre, Jorhat	Tribal Sub Plan	17 Officials from MBDA and other state line departments, Govt. of Meghalaya

December 3-23	Advances in Land Resource Inventory for enhancing productivity through Agro-Technology transfer.  Dr. S.K. Singh, Director addressing the participants during valedictory function of Training programme on "Advances in land Resource Inventory for Enhancing Productivity through Technology Transfer" on 23rd December 2014, Dr. N. Nagaraja (2nd in chair from right), Director of Extension, UAS, Bangalore was the chief Guest	Tribal Sub Plan	18 Officers from KVKs/SAUs/ Sate Agricultural Departments
2015			
January 3-24	Training program on "Image interpretation, transect identification, soil profile studies" for the project field staff and Project scientists at respective districts at Bangalore.	Sujala-III project	90 Sujala field staff
January 7-27	21 day training programme on "Advances in Land Resource Inventory for Enhancing Productivity to Agro-Technology Transfer" at Regional Centre, Kolkata	Tribal Sub Plan	11 Officers from ICAR, KVK, SAUs, State Department of Agriculture and State Universities
			
February 3-23	21 day training programme "Advances in Land Resource Inventory for Enhancing Productivity through Agro-technology Transfer'' at H.Qrs.Nagpur. 	ICAR	26 trainee officers from different NRM disciplines from 9 states.

March 3 – 23	Soil Survey and Land Use Planning at Regional Centre, Bangalore	Kerala Government department of soil survey and soil conservation	15 Department of soil survey and soil conservation

For farmers (H.D. Kote, Mysore)

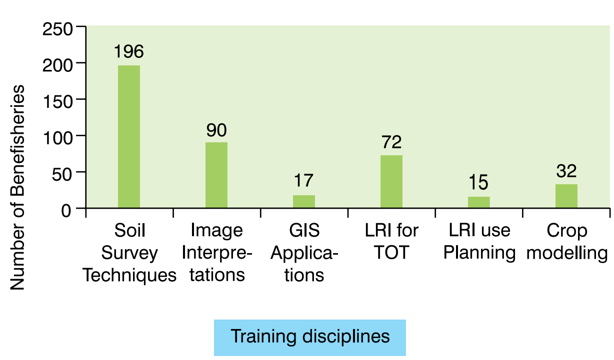
Date	Topic	Sponsored by	Beneficiary/ Number of trainees
2014			
April 10-11	Production technologies for kharif crops at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	75 Farmers
July 10-11	Production technologies of coffee and pepper at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	25 Farmers
July 25	Value addition of ragi and backery items preparation at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	50 Woman farmers
September 25	Tribal medicines for common ailments at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	25 farmers
November 1	Multistoried cropping systems and vegetable production systems in tribal areas at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	350 Farmers
November 22	Paper cover preparation at H.D. Kote, Mysor	Tribal Sub Plan (TSP)	50 Farmers

Self-Employment Training on paper cover making to tribal youths on 22-11-2014

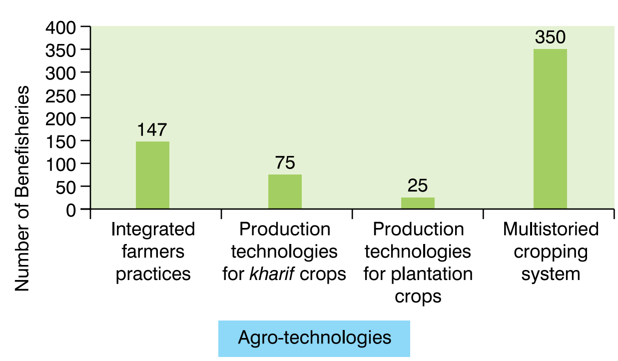
For farmers (Bali Island, West Bengal)

2015			
March 15 to April 15	Tailoring Training at H.D. Kote, Mysore.	Tribal Sub Plan (TSP)	10 Women farmers
March 16 to 19	**Integrated farming practices for the farmers of Bali Islands of Sundarban, Gosaba Block, South 24-Parganas, West Bengal"** at Sashya Syamala Krishi Vigyan Kendra, Ramakrishna Mission Vivekananda University, Narendrapur, West Bengal.	Tribal Sub Plan (TSP)	22 Farmers

Visit of the trainees to Ramakrishna Mission Krishi Vigyan Kendra, Nimpith during the training programme.



Training disciplines vis-à-vis number of beneficiaries



Agro-technologies vis-à-vis number of beneficiaries

10 WORKSHOPS/SEMINARS ORGANIZED

Date	Topic	Venue
	2014	
August 2	Second Hindi Karyashala on “Hindi Vigyan Lekhan me computer ka paryog” was organized at Regional Centre Delhi for the Administrative and Technical Assistants staff.	New Delhi
December 4	Third Hindi Karyashala on “Hindi Lekhan me kathniyano se samadhan” was organized at Regional Centre Delhi for the Technical Assistants and Administrative staff.	New Delhi
December 5	Fourth Hindi Karyashala on “Rajbhasha niyam aur adhiniyami” was organized for the Scientists and Technical Officers.	New Delhi
	2015	
January 28-30	National Seminar on Sustainable Management of Land Resource for Livelihood Security organized by Indian Society of Soil Survey and Land Use Planning, Nagpur	ICAR-NBSS & LUP, Nagpur

11 AWARDS, RECOGNITIONS AND FOREIGN VISITS

AWARDS

Dr. S.K. Singh, Director was felicitated by the Fertilizer Association of India for his contribution in the "Soil Nutrient Mapping of West Bengal"

Dr. Jagdish Prasad, Principal Scientist and In-Charge, Head, Division of Soil Resource Studies was

- Elected as President, Indian Society of Soil Science for two years 2015-2016.
- Inducted as Fellow of Indian Association of Soil and Water Conservationists, Dehradun.
- Conferred Special Honour Award by Soil Conservation Society of India, New Delhi.
- Nominated as member of Site Selection Committee (ICAR Side) for the establishment of additional KVK in Yavatmal.
- Nominated to conduct the interview for SMS (Extension Education at KVK, Pokharni, Nanded).
- A Member, Institute Management Committee of CICR, Nagpur.

Dr. S.K. Mahapatra, Principal Scientist, Regional Centre, Delhi was elected as President of the Section of Agriculture & Forestry Sciences of the 102nd Session of Indian Science Congress for 2014-2015 and also as a Member of the Council of Indian Science Congress Association (ISCA).

Dr. S.K. Mahapatra, Principal Scientist Regional Centre Delhi and President, Agriculture and Forestry Sciences Section with Hon'ble Prime Minister of India Sri Narendra Modi, Hon'ble Governor and Chief Minister of Maharashtra, Union and State Ministers, other High Dignitaries in the Inaugural Session of 102nd Indian Science Congress held at Mumbai University during January 3-7, 2015.

Dr. A. Chaturvedi received "Leadership Award 2014" presented by the Soil Conservation Society of India, New Delhi at the International Conference on "Natural Resource Management for Farming Systems and Rural Livelihood" held during 10-13 February 2015 at New Delhi.

Dr. G.P. Obi Reddy, Principal Scientist, Division of Remote Sensing Applications received 'National Geospatial Award for Excellence 2013' by Indian Society of Remote Sensing for his significant contributions in *Application of Geo-spatial Technologies*. The award consists of a medal, citation and Rs. 50,000/- in cash.

Dr. G. P. Obi Reddy receives 'National Geospatial Award for Excellence-2013' at the hands of Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Govt. of India and Dr. A.S. Kiran Kumar, President, ISRS, and Director, Space Application Centre, Ahmadabad.

BEST POSTER AWARD FOR SCIENTISTS

- Dr. S. Bandhyopadhyay, Scientist, Regional Centre, Kolkata received **Best poster presentation award** for the article "Impact of intrinsic soil properties towards acidity in the soils of Nagaland, India" authored by Bandyopadhyay, S., Padua, S., Ramachandran, S., Jena, R.K., Baruah, U., Sah, K.D. and Singh, S.K. in the National Seminar on "Sustainable Management of Land Resources for Livelihood Security" organised by ISSLUP, held during 28-30th January, 2015 at NBSS&LUP, Nagpur.

- Dr. S. Chattaraj, Scientist, Division of Remote Sensing Applications received **Best Poster Presentation Award** in National Seminar on "Sustainable Management of Land Resources for Livelihood Security" held during January 28-30 at NBSS&LUP, Nagpur for the article *"A Time Efficient Approach for Large Scale Land Resource Inventory under the Framework of Latest Geospatial Techniques"* authored by S. Chattaraj, S.K. Ray, V. Ramamurthy, G.P. Obi Reddy, S. Chatterjee, R. Srivastava, A.K. Barthwal, A. Daripa, K.D. Sah and S.K. Singh.
- **Best Poster Presentation Award** for the article *"Cumin as a major cash crop is boon for Arid and Semi-Arid regions of India: A livelihood prospective"* authored by M. K. Vishal, R.S. Mehta, O.P. Aishwath, Ravindra Singh, Balraj Singh, **G.P. Obi Reddy and Nirmal Kumar** in *National Seminar on "Sustainable Management* of Land Resources for Livelihood Security" held during January 28-30, 2015 at NBSS&LUP, Nagpur.
- **Second best Poster Presentation Award** for the article *"Assam and Meghalaya as potential coriander producing area in North-East States"* authored by M.K. Vishal, R.S. Mehta, Ravinder Singh, O.P. Aishwath, G. Lal, **G.P. Obi Reddy, Nirmal Kumar** and A.K. Yadav in *National Seminar on "Hi-tech Horticulture* for Enhancing productivity, Quality and Rural Prosperity held at NRCCS, Ajmer, Rajasthan.

The Bureau has bagged the **'Rajarshi Tandon Award-2015'** for the best Official language Implementation among the ICAR Institutes in 'B' Region. It got this award for the second time.

Dharti-2013 Hindi House Magazine got **first special Consolation Prize** in the category of **"Outstanding Hindi House Magazine"** in the Annual Hindi Award Function organized by Town Official Language Implementation Committee, Official Language Department, Ministry of Home Affairs, Govt. of India.

FOREIGN VISIT

Dr. S.K. Mahapatra and Dr. (Ms) Jaya N. Surya, Principal Scientists visited South Korea to participate in 20th World Congress of Soil Science during June 8-13, 2014.

Dr(s) S. K. Mahapatra and Jaya N. Surya at the 20th Word Congress on Soil Science

12 DISTINGUISHED VISITORS

HEADQUARTERS, NAGPUR

- Dr. S. Ayyappan, Director General, ICAR and Secretary, DARE, Govt. of India, New Delhi.
- Dr A.K. Sikka, Deputy Director General (NRM), ICAR, New Delhi.
- Dr. S.K. Chaudhari, Assistant Director General (SWM), ICAR, New Delhi.
- Prof. S.K. Sanyal, Former Vice-Chancellor and Chairman, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Dr. J.S. Parihar, Ex- Outstanding Scientist and Deputy Director (EPSA), SAC (ISRO) and Member, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Prof. D.K. Das, Former-Head, Division of Agricultural Physics, ICAR-IARI, New Delhi and Member, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Dr. N.S. Pasricha, Former-Director, PRRI and Member, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Dr. T. Ravishankar, Group Head, Land Resource and Land Use Planning Monitoring Cell, NRSC (ISRO), Hyderabad and Member, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Dr. S .S. Magar, Former-Vice Chancellor, Konkan Krishi Vidyapeeth and Member, Research Advisory Committee of ICAR-NBSS&LUP, Nagpur.
- Sh. Ramesh P. Jichkar, Member, Research Advisory Committee of ICAR- NBSS&LUP, Nagpur.

REGIONAL CENTRE, BANGALORE

- Dr. M.A Shankar, Director of Research, UAS, Bangalore.
- Dr. N. Nagaraja, Director of Extension, UAS, Bangalore.
- Dr. Govinda Krishnan, Project Coordinator, ICAR-CPRI Shimla.
- Beaudoin Nicolas, Professor, INRA-France.
- Dr Shekar Muddu, Professor, Hydrology, Indian Institute of Science, Bangalore.
- Dr. Padmaraju, Vice-Chancellor, N.G. Ranga Agricultural University, Hyderabad.
- Dr. A.K. Sikka, Deputy Director General (NRM), ICAR, New Delhi.
- Dr. B. Shivanna, Vice-Chancellor, University of Agricultural Sciences, Bangalore.
- Dr. K.L.N. Shastry, Scientist and Deputy Project Director, GSD/GSAG/EPSA, Space Applications Centre (ISRO), Ahmadabad.
- Dr. Mahadevappa, Ex. Chairman, ASRB, Krishi Anusandhan Bhavan, Pusa, New Delhi.
- Dr. H. Narayana Gowda, Ex. Vice-Chancellor, University of Agricultural Sciences, Bangalore.
- Dr. James Jacob, Director of Research, Rubber Research Institute of India, Puthuppally, Kottayam, Kerala.
- Dr. Laurent Reeiz: INRA France, Helene Raynal, Faculty, INRA France.
- Dr. Shyam Viswanath, Scientist E, Institute of Wood Science and Technology.
- Dr. Seema Purushothaman Professor and Head, Economics Dept., Azim Premji University of Developmental Sciences, Hosekarahalli, Bangalore.
- Dr. P. Rajasekharan, Chief (Agriculture Division), State Planning Board, Pattom, Thiruvanathapuram, Kerala.
- Dr. P.N. Premachandran, Director, Department of Soil Survey and Soil Conservation, Vazhuthacaud, Thiruvananthapuram, Kerala.

- Dr. S.K. Chaudhari, Assistant Director General (SWM), ICAR, New Delhi
- Dr. Muralidhara Kuruppu, Chief Consultant, Govt. of Meghalaya, Shillong.

REGIONAL CENTRE, DELHI

- Dr. S.K. Sanyal, Former Vice-Chancellor, BCKV and Chairman, Research Advisory Committee, ICAR-NBSS&LUP, Nagpur.
- Dr. O.P. Yadav, Director, ICAR- Indian Institute of Maize Research, New Delhi.
- Dr. P. K. Mishra, Director, ICAR- Indian Institute of Soil and Water Conservation, Dehradun.
- Dr. S.K. Choudhary, Assistant Director General (SWM), ICAR.
- Dr. Dipak Sarkar, Former Director, ICAR-NBSS&LUP, Nagpur.
- Dr. Santosh K. Singh, Agricultural Specialist, United States Department of Agriculture, American Embassy, New Delhi.

REGIONAL CENTRE, JORHAT

- Dr. Girin Hazarika, Director of Research, AAU, Jorhat.
- Dr. Dipti Kumar Borah, Dean Faculty of Agriculture, AAU, Jorhat.
- Dr. I. Hussain, Professor, Department of Meteorology, AAU, Jorhat.
- Dr. R.M. Karmakar, Professor & Head, Division of Soil Science, AAU, Jorhat.
- Dr. D. Bhattacharyya, Professor, Division of Horticulture, AAU, Jorhat.
- Dr. M. Dutta, Asstt. Professor, Division of Soil Science, AAU, Jorhat.
- Dr. Samiron Dutta, Associate Professor, Division of Soil Science, AAU, Jorhat.
- Dr. Pori Das, Asstt. Professor, Department of Civil Engg., Assam Don Bosco University, Guwahati.

REGIONAL CENTRE, KOLKATA

- Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR, Govt. of India, New Delhi.
- Dr. N.K. Krishna Kumar, Deputy Director General (Hort.), ICAR, New Delhi.
- Dr. S.K. Chaudhuri, Assistant Director General (SWM), ICAR, New Delhi.
- Dr. V.N. Sharda, Member, ASRB, New Delhi.
- Dr. S.K. Singh, Director, ICAR-NBSS & LUP, Nagpur.

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. T. Bhattacharyya, Principal Scientist (Soil Science) & Head (upto 01.12.2014)
2. Dr. Jagdish Prasad, Principal Scientist (Soil Science) & in-Charge, Head (From 01.12.2014)
3. Dr. B.P. Bhaskar, Principal Scientist (Soil Science)
4. Dr. P. Chandran, Principal Scientist (Soil Science)
5. Dr. S.K. Ray, Principal Scientist (Soil Science)
6. Dr. (Mrs.) P.L.A. Satyawathi, Senior Scientist (Soil Science)
7. Dr. Pramod Tiwari, Scientist (SWCE)
8. Dr. K. Karthikeyan, Scientist (Soil Science)
9. Sh. Vasu, D., Scientist (Soil Science)

DIVISION OF REMOTE SENSING APPLICATIONS

1. Dr. Rajeev Srivastava, Principal Scientist (Soil Science) & 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. Dr. J.D. Giri, Senior Scientist (Soil Science)
6. Sh. Nirmal Kumar, Scientist (Soil Physics)
7. Dr.(Ms) Nisha Sahu, Scientist (Soil Science)
8. Dr. Sudipta Chattaraj, Scientist (Soil Physics)

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)

REGIONAL CENTRE, KOLKATA

1. Dr. T.H. Das, Principal Scientist (Soil Science) & In-charge Head (upto 31.1.2015)
2. Dr. D.C. Nayak, Principal Scientist (Soil Science) & In-charge Head (from 1.2.2015)
3. Dr. S.K. Gangopadhyay, Principal Scientist (Soil Science)
4. Dr. A.K. Sahoo, Principal Scientist (Soil Science)
5. Dr. Krishnendu Das, Principal Scientist (Soil Science)
6. Dr. Dipak Dutta, Principal Scientist (Soil Science)
7. Dr. S.G. Chaudhary, Principal Scientist (Soil Science)
8. Dr. (Mrs.) Tapti Banerjee, Principal Scientist (Geography)
9. Dr. T. Chatopadhyay, Senior Scientist (Soil Science)
10. Dr. S. Mukhopadhyay, Senior Scientist (Soil Science)

11. Dr. Sah Kausar Reza, Scientist (Soil Science)
12. Sh. R. Srinivasan, Scientist (Soil Science)
13. Dr. (Ms) S. Gupta Chaudhary, Scientist (Soil Science)

REGIONAL CENTRE, BANGALORE

1. Dr. L.G.K. Naidu, Principal Scientist (Agronomy) & Head (upto 31.7.2014)
2. Dr S. Thayalan, Principal Scientist (Geography) (from 1.8.2014 to 30.11.2014)
3. Dr. K.M. Nair, Principal Scientist (Soil Science) (from 1.12.2014)
4. Dr. K.S. Anil Kumar, Principal Scientist (Soil Science)
5. Dr. V. Ramamurthy, Principal Scientist (Agronomy)
6. Dr. Rajendra Hegde, Principal Scientist (Agronomy)
7. Dr. S.C. Ramesh Kumar, Principal Scientist (Agril. Economics)
8. Sh. S. Srinivas, Senior Scientist (Computer Appln.)
9. Sh. S.P. Maske, Scientist (SWCE)
10. Dr. S. Dharamarajan, Scientist (Soil Science)
11. Mrs Vasundhara R., Scientist (Soil Science)
12. Dr. (Mrs) M. Lalitha, Scientist (Soil Science)
13. Ms M. Chandrakala, Scientist (Soil Science)
14. Dr. (Mrs) B. Kalaiselvi, Scientist (Soil Science)

REGIONAL CENTRE, NEW DELHI

1. Dr. Tarsem Lal, Principal Scientist (Geography) I/C Head (upto 4.11.2014)
2. Dr. R.P. Yadav, Principal Scientist (Soil Science) & Head (w.e.f. 5.11.2014)
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)

REGIONAL CENTRE, JORHAT

1. Dr. U. Baruah, Principal Scientist (Geography) & Head (upto 31.7.2014)
2. Dr. K.D. Sah, Principal Scientist (Soil Science) & In-Charge Head (w.e.f. 1.8.2014)
3. Dr. S. Bandopadhyay, Scientist (Soil Science)
4. Dr. Shelton Padua, Scientist (Soil Science)
5. Dr. S. Ramchandran, Scientist (Soil Science)
6. Sh. Roomesh Kumar Jena, Scientist (Soil Science)
7. Sh. Prasinjit Ray, Scientist (Soil Science)

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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. Dr. R.P. Sharma, Scientist (Soil Science)
7. Sh. Roshan Lal Meena, Scientist (Agronomy)
8. Sh. Pravash C. Moharana, Scientist (Soil Science)

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1. Dr. N.C. Khandare, Chief Technical Officer (FFT)
2. Dr. S.S. Nimkhedkar, Chief Technical Officer (FFT)
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4. Dr. R.A. Nasre, Asstt. Chief Technical Officer (FFT)
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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, Senior Technical Officer (FFT)
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14. Sh. P.V. Ambekar, Senior Technical Officer (Photo.)
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17. Sh. T.L. Khobragade, Senior Technical Officer (WS)
18. Sh. K.S. Banasure, Technical Officer (WS)
19. Sh. M.P. Khobradage, Technical Officer (WS)
20. Sh. P.S. Butte, Sr. Technical Officer (FFT)
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23. Sh. D.S. Mohekar, Sr. Technical Officer (FFT)
24. Sh. S.C. Gharami, Technical Officer (LT)
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29. Mrs. Ujwala Tijare, Senior Technical Assistant (WS)
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47. Sh. A.M.G. Sheikh, Technician (FFT)
48. Sh. J.B. Padole, Technician (FFT)
49. Sh. Atul Dankhade, Technician (WS)

Printing Section, Hqrs., New Delhi

1. Sh. S.K. Arora, Chief Technical Officer & In-charge (P&E)
2. Sh. Anil Kumar, Technical Officer (P&E)
3. Sh. Jai Mangal, Senior Technical Assistant (P&E)

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. M.M. Roy, Technical Officer (WS)
5. Sh. B.C. Naskar, Technical Officer (WS)
6. Sh. A.K. Maitra, Senior Technical Assistant (FFT)
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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. G.C. Sarkar, Senior Technician (FFT)
16. Sh. Sukonto Pal, Technician (FFT)
17. Sh. Siddharth Karamkar, Technician (LT)
18. Smt. Zharna Kar, Technician (FFT)

Regional Centre, Bangalore

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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, Technical (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. Mohan Lal, Technical Officer (WS)
7. Sh. K.K. Bharadwaj, Technical Officer (P&E)
8. Sh. V. Mohan, Technical Officer (LT)
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. B.D. Phansal, Chief Administrative Officer
2. Sh. G.C. Prasad, Senior Finance & Accounts Officer
3. Smt. Bhanu Narayanan, Administrative Officer
4. Mrs. Sunanda Lade, Assistant Administrative Officer
5. Smt. Girija Rangari, Assistant Administrative Officer
6. Sh. C.K. Kharche, Assistant Administrative Officer
7. Mrs. S.K.Hayat, Private Secretary
8. Sh. S.S. Vaidya, Assistant
9. Sh. A.P.Tembhurnikar, Assistant
10. Sh. S.C. Kolhe, Assistant
11. Sh. P.B. Kumbhare, Assistant
12. Sh. Wakeel Ahmed, Assistant
13. Sh. A.M. Kosare, Assistant
14. Mrs. Vimal Kharabe, Assistant
15. Sh. Y.L. Misal, Assistant
16. Sh. M.M. Khan, Personal Assistant
17. Sh. S.M. Pathak, Personal Assistant
18. Mrs. W.D. Khandwe, Personal Assistant
19. Mrs. Rohini Watekar, Personal Assistant
20. Sh. S.P. Awale, Upper Division Clerk
21. Sh. U.S. Kapse, Upper Division Clerk
22. Mrs. Shalu Nandanwar, Upper Division Clerk
23. Sh. Nitin Mohurle, Upper Division Clerk
24. Sh. Ajay Meshram, Upper Division Clerk
25. Sh. N.B. Mankar, Upper Division Clerk
26. Mrs. Ranjana Sharma, Personal Assistant
27. Mrs. Vaishali Arbat, Stenographer Gr. III
28. Sh. S.S. Kamble, Lower Division Clerk
29. Sh. S.J. Patil, Lower Division Clerk

Printing Section, Headquarters, New Delhi

1. Mrs. Sunita Mittal,Upper Division Clerk

Regional Centre, Kolkata

2. Sh. A.P. Chaitupune, Assistant Administrative Officer
3. Mrs. Sikha Majumdar, Assistant
4. Sh. R.K. Dutta, Assistant
5. Mrs. Nirmala Kumar, Assistant
6. Ms Bedantika Dutta, Assistant
7. Mrs. Aparna Das, Stenographer Gr. III

Regional Centre, Bangalore

1. Mrs. R. Gayatri Devi, Assistant Administrative Officer
2. Sh. Toran Prasad, Assistant
3. Mrs. P. Prabhavathamma, Private Secretary
4. Mrs. P. Chandrakala, Upper Division Clerk
5. 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. Sh. Deepak Adya, Private Secretary
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. Rajesh Choudhary, Assistant
2. Sh. Harish Rajput, Personal Assistant
3. Sh. Unikrishnan Nair, K.K., Upper Division Clerk
4. Sh. V.S. Sankhla, Upper Division Clerk

SKILLED SUPPORTING

Headquarters, Nagpur

1. Sh. D.B. Mankar
2. Sh. A.B. Bhasme
3. Sh. S.P. Dimote
4. Sh. B.C. Wahane
5. Sh. D.B. Thombre
6. Sh. A.T. Kantode
7. Sh. A.Z. Sarode
8. Sh. R.M. Parate
9. Sh. A.L. Kathikar
10. Sh. D.B. Asarat
11. Sh. G.B. Topre
12. Mrs. Vandana Roy
13. Sh. N.T. Thawkar
14. Sh. S.A. Bhoyar
15. Sh. Ramesh Khawle
16. Sh. Lokesh Sontakke
17. Mrs. S.N. Gajbhiye

Regional Centre, Kolkata

1. Sh. S. Chakraborty
2. Sh. B.K. Singh
3. Smt Usha Kujur
4. Smt Kalpana Biswas
5. Sh. Mahesh Roy
6. Sh. Nandlal Parmanik
7. Sh. V.N. Mishra
8. Mrs. Radha Turi
9. Mrs. Alpana Roy
10. Shr Krishna Guchait

Regional Centre, Bangalore

1. Sh. G.P.N. Hanumaiah
2. Sh. Rudrappa
3. Sh. R. Jairaja
4. Sh. K. Murugesh
5. Sh. M.T.N. Murthy
6. Sh. N. Sampangi
7. Sh. R. Balakrishna
8. Sh. C. Nagraj

Regional Centre, New Delhi

1. Sh. Jagdish Mehto
2. Sh. Prakash
3. Sh. Radhey Shyam
4. Sh. Nanda Ballabh
5. Sh. Ram Sewak
6. Sh. R.B. Mehto
7. Sh. Rakesh Kumar
8. Sh. Harender Singh Rawat

Regional Centre, Jorhat

1. Sh. P.N. Phooken
2. Sh. Maniram Dutta
3. Sh. L. Borchetia
4. Sh. N.C. Saikia
5. Sh. Nirmal Saikia
6. Sh. Raju Balmiki
7. Sh. J.C. Baruah
8. Sh. J.P. Gogai
9. Sh. Dilip Borah

10. Sh. Bipin Gogai
11. Sh. R.C. Rajak
12. Sh. Pabitra Gogai

Regional Centre, Udaipur

1. Sh. J.S. Vasava
2. Sh. G.B. Rathwa
3. Sh. Devilal Prajapat
4. Sh. Mohanlal Meghwal
5. Sh. Shambhulal Meena
6. Sh. Bhanwar Singh Devra

NEW ENTRANTS

- Dr. Amrita Daripa joined as Scientist on 4.4.2014
- Dr. Kalaiselvi joined as Scientist on 7.4.2014
- Ms. Ritu Nagdev joined as Scientist on 7.4.2014
- Sh. Prasenjit Ray joined as Scientist on 13.10.2014
- Sh. P.C. Moharana joined as Scientist on 13.10.2014
- Dr. R.P. Yadav, Principal Scientist & Head, joined on 05.11.2014 at Regional Centre, Delhi

RETIREMENTS

1. Dr. G.S. Sidhu, Principal Scientist & Head, Regional Centre, Delhi retired on superannuation on 30.04.2014.
2. Dr. C.S. Walia, Principal Scientist, Regional Centre, Delhi retired on superannuation on 30.04.2014.
3. Dr. D.S. Singh, Principal Scientist, Regional Centre, Kolkata retired on superannuation on 31.05.2014.
4. Sh. D.K. Nandanwar, P.S. retired on 31.5.2014
5. Sh. N.M. Ramteke, Technical Officer retired on 30.6.2014.
6. Dr. L.G.K. Naidu, Principal Scientist (Agronomy) & Head, Regional Centre, Bangalore retired on 31.7.2014.
7. Dr. Utpal Baruah, Principal Scientist & Head, Regional Centre, Jorhat on 31.07.2014.
8. Shri B.C. Mondal, Tech. Officer (WS) retired on superannuation on 31.07.2014.
9. Sh. C. Srinivasan, Tech. Officer (T-5), Regional Centre, Bangalore retired on 31.7.2014.
10. Mrs. V.S. Sharda, Personal Assistant, Regional Centre, Bangalore retired on 31.8.2014.
11. Sh. U.S. Aglawe, Senior Technical Assistant (WS) on 31.8.2014
12. Sh. M.S. Gaikawad, Chief Technical Officer, Division of SRS, retired on 30.9.2014.
13. Smt. K.B. Burman, SSS, retired on superannuation on 31.10.2014.
14. Sh. Dhanvij, Technical Assistant retired on 31.10.2014
15. Dr. S. Thayalan, Principal Scientist (Geography) & Acting Head, Regional Centre, Bangalore retired on 30.11.2014
16. Dr. Tapas Bhattacharyya, Principal Scientist and Head, Division of Soil Resource Studies (SRS) voluntarily retired on 01.12.2014.
17. Sh. R.S. Gawande, Chief Technical Officer, Division of LUP on 31.12.2014.
18. Mrs. Sukhmoy Das, S.S.S, Regional Centre, Jorhat on 31.12.2014.
19. Dr. T.H. Das, Principal Scientist and Acting Head Regional Centre, Kolkata retired on superannuation on 31.01.2015
20. Smt. Nago Devi, Skilled Supporting Staff retired on superannuation on 31.01.2015 from Regional Centre Delhi
21. Sh. A.K. Barthwal, Chief Technical Officer of the Division of Remote Sensing Applications superannuated on 31.03.2015.
22. Mrs. R. Kanaka, SSS, Regional Centre, Bangalore retired on 31.03.2015.

STUDY LEAVE

- Sh. Nirmal Kumar, Scientist was relieved on 7.10.2014 on study leave to pursue his Ph.D. at IGKV, Raipur.

PROMOTIONS

- Sh. D.S. Mohekar was promoted to the next grade Senior Technical Officer (T-6) w.e.f. 17.11.2013
- Mrs. S. Chetia was promoted to Technical Officer (T-5) w.e.f. 01.01.2014.

- Sh. B.N.M. Reddy was promoted to next higher grade Sr. Technical Assistant w.e.f. 01.01.2014.
- Sh. Priya Shanakar, Tehnical Assistant was promoted to the next higher grade with effect from 03.01.2014.
- Sh. S.C. Gharami was promoted to the next grade, Senior Technical Officer (T-6) w.e.f. 17.02.2014.
- Sh. P.S. Butte was promoted to next higher grade Sr. Technical Officer w.e.f. 01.02.2014.
- Sh. C.K. Kumawat was promoted to next higher grade Sr. Technician w.e.f. 26.02.2014.
- Mr. Someswar Daswas promoted to T-4 w.e.f. 28.02.2014.
- Sh. Sohan Lal Sharma was promoted to next higher grade Sr. Technician w.e.f. 13.03.2014.
- Sh. J.S. Rao was promoted to next higher grade Sr. Technician w.e.f. 13.03.2014
- Dr. S.S. Sharma was promoted to next higher grade Sr. Technical Officer w.e.f. 14.05.2014.
- Dr. S. Chattaraj and Dr. (Ms.) Nisha Sahu, Scientists cleared the probation on 23.01.2015.
- Smt. Ranjana Sharma, Steno Gr. III was promoted to P.A. w.e.f. 11.03.2015
- Sh. Deepak Adya, Personal Assistant was promoted to Private Secretary with effect from 13.03 2015.
- Sh. Harish Rajput, Steno Gr. III was promoted to P.A. w.e.f. 27.03.2015

TRANSFER

- Ms. Shruati Sharma, Assistant, joined Regional Centre Delhi on 27.05.2014 on transfer from, HQrs.
- Mr. K.M. Soni (T-5) was transferred from Regional Centre, Udaipur and joined duties at Regional Centre, Jorhat w.e.f. 14.08.2014.
- Miss Ritu Nagdev, Scientist joined Regional Centre Delhi on 16.09.2014 on transfer from, HQrs.
- Dr. Mrs. Kalaiselvi B., Scientist transferred from HQrs to Regional Centre, Bangalore on 18.9.2014
- Sh. S.S. Yadav, Technical Officer, transferred from Division of RSA, HQrs., Nagpur to Regional Centre, Jorhat on 7.01.2015
- Mr. Prasinjit Ray, Scientist transferred to Regional Centre, Jorhat from HQrs. on 17.02.2015.
- Mr. P.C. Moharana, Scientist was transferred from HQrs. Nagpur to Regional Centre, Udaipur on 23.2.2015

Deceased

- Shri Devendra Giri Goswami, STA(WS), Regional Centre, Udaipur expired on 23.10.2014

14 RFD-RELATED INFORMATION

ANNUAL PERFORMANCE EVALUATION REPORT (APRIL 1, 2014 TO MARCH 31, 2015)

Name of the Division : Natural Resource Management

Name of the Institution : National Bureau of Soil Survey and Land Use Planning, Nagpur

RFD Nodal Officer : Dr. T.K. Sen, Principal Scientist

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weighted Score		
1.	Soil survey, characterisation and mapping at different scales	45	Soil survey field work and laboratory analysis	Soil resource maps developed at different scales	No.	25	10	8	6	4	2	10	100	25	125	Our sincere efforts were aimed at attaining achievable (90%) target. In this endeavour, we exceeded the said target almost at the fag end of the year.
				Benchmark soils identified/ established	No.	12	13	11	9	7	5	13	100	12	118.18	Our sincere efforts were aimed at attaining achievable (90%) target. In this endeavour, we exceeded the said target almost at the fag end of the year.
				Thematic maps developed at different scales	No.	8	16	13	10	7	4	16	100	8	123.07	Our sincere efforts were aimed at attaining achievable (90%) target. In this endeavour, we exceeded the said target almost at the fag end of the year.
2.	Land use planning at different scales	25	Bio-physical and socio-economic resource characterisation, analysis and their integration	Land use plans developed at different scales	No.	25	10	8	6	4	2	10	100	25	125	Our sincere efforts were aimed at attaining achievable (90%) target. In this endeavour, we exceeded the said target almost at the fag end of the year.
3.	Creation of awareness and knowledge	10	HRD & capacity building	Trainings conducted	No.	10	6	5	4	3	2	6	100	10	120	Our sincere efforts were aimed at attaining achievable (90%) target. In this endeavour, we exceeded the said target almost at the fag end of the year.

	Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	8	7	6	5	4	13	100	3	185.71	It was difficult to project the exact number of publications that would figure in NAAS journal with rating 6.0 and above, at the beginning of 2014-15 and an anticipated figure was, therefore, provided.
			Timely publication of the Institute Annual Report (2013-14)	Annual Report published	Date	2	June 30, 2014	July 02, 2014	July 04, 2014	July 07, 2014	July 09, 2014	June 30, 2014	100	2	100	NA
	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	-	100	2	100	NA
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-15 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014	April 29, 2014	100	2	100	NA
			Timely submission of Results for 2013-14	On-time submission	Date	1	May 1, 2014	May 2, 2014	May 5, 2014	May 6, 2014	May 7, 2014	April 23, 2014	100	1	100	NA
	Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	100	100	2	105.26	NA
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1	105.26	NA
	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov. 1, 2014	Nov. 2, 2014	Nov. 3, 2014	Nov. 4, 2014	Nov. 5, 2014	Oct. 31, 2014	100	2	100	NA
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC).	% of Implementation	%	1	100	90	80	70	60	100	100	1	111.11	NA

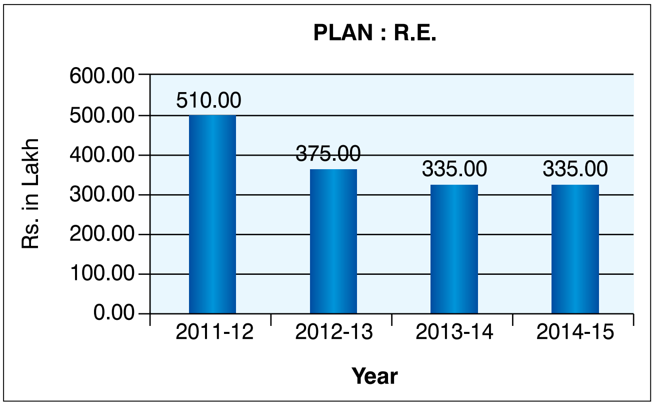
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80	100	100	2	105.26	NA
			Implementation of milestones of approved Innovation Action Plans (IAPs).	% of implementation	%	2	100	90	80	70	60	100	100	2	111.11	NA

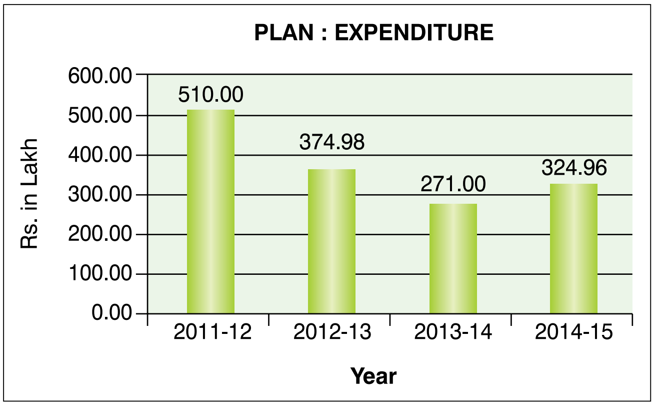
Total Composite Score : 100
Rating : Excellent

Procedure for computing the Weighted and Composite Score
1. Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100
2. Total Composite Score = Sum of Weighted Scores of all the Success Indicators

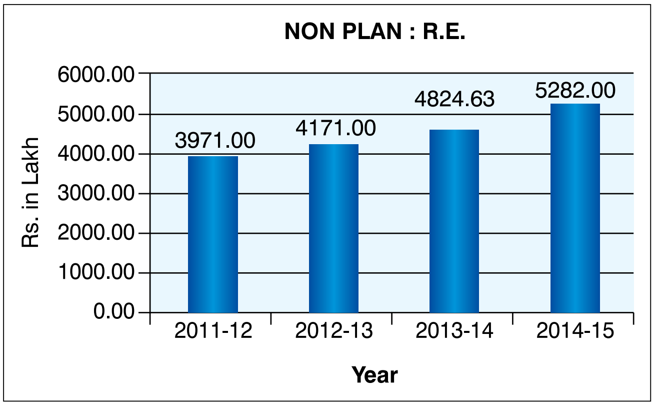
15 BUDGET : A COMPARATIVE ANALYSIS

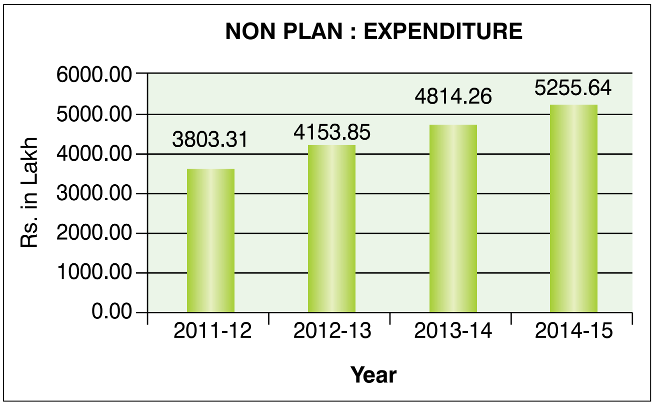
PLAN





NON PLAN





NBSS&LUP IN MEDIA

National » Telangana **THE HINDU**

Published: December 1, 2014 01:57 IST | Updated: December 1, 2014 01:57 IST

TS to have land resources inventory in three years

SPECIAL CORRESPONDENT

A land resources inventory of Telangana containing information on soil types, land use, crop production constraints, water storage capability and suitability of land for different crops will be readied in the next three years. The inventory will be prepared jointly by the Agriculture Department, National Bureau of Soil Survey & Land Use Planning (NBSSLUP), Nagpur, and Professor Jayashankar Telangana State Agricultural University. A memorandum of understanding was signed between the State Government and NBSSLUP.

Commissioner of Agriculture B. Janardhan Reddy stated that a pilot project to prepare the land inventory would be taken up in three mandals, Indarvelli (Adilabad), Tammajipet (Mahabubnagar) and Gajwel (Medak), to begin with. Mapping of land resources would help the farmers to reduce the cost of cultivation as use of fertilizer is among the highest both in Telangana along with AP.

The exercise being taken up for the first time in the country in Telangana would provide information on land use, soil fertility, water and fertilizer management and would also help in preparing plans for proper utilisation of resources, the Commissioner said at a workshop on the survey. Soil testing labs would be strengthened in the State to complement the project. He hoped that the survey would bring down the cultivation cost at least by Rs. 2,000 per acre. Underscoring the need for land inventory, Deputy Director General of natural resources management wing of the Indian Council of Agriculture Research, A.K. Sikka, said the initiative would help micro-level planning of land and soil resources, which are on the wane, for better crop productivity and profitability. Director of NBSSLUP S.K. Singh, Director of CRIDA Ch. Sreenivasa Rao, agriculture university officials D. Raji Reddy and V. Praveen Rao and others spoke.

Printable version | Dec 24, 2014 2:40:23 PM | http://www.thehindu.com/news/national/telangana/ts-to-have-land-resources-inventory-in-three-years/article6649136.ece

The Hitavada Tuesday August 26, 2014 (Nagpur version) **The Hitavada**

SCIENTISTS SHOULD REACH TO FARMERS TO INCREASE PRODUCTIVITY

Dr. S. Ayyappan, Secretary of Indian Council of Agricultural Research (ICAR) urged scientists to reach farmers community with innovative research to increase productivity. Dr. Ayyappan was addressing the 38th Foundation Day and Land Resource Inventory Programme of National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) recently. He also launched mega project of National Importance to agriculture sector entitled, "Land Resource Inventory (LRI) for village level planning (1:10000 scale).

ఈనాడు

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मटा अँकर मृदा सर्वेक्षण विभागाचे संशोधन

धक्कादायक ! यवतमाळातील निम्मी माती कापसाची नाहीच

TheHitavada

THE PEOPLE'S PAPER • SINCE 1911

NAGPUR

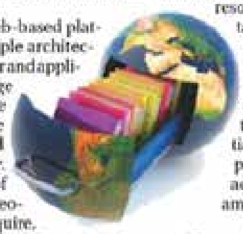
CityLine

ICAR-NBSS & LUP develops 'National Geoportal on Soils'

■ Staff Reporter

THE city-based Natural Resources Management Organizations, ICAR – National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS & LUP) is the first organization in the country to develop a 'National Geoportal on Soils' for the benefit of farmers.

The geoportal is a web-based platform deployed in a simple architecture with database server and application server to manage soil resource database and metadata. The Geoportal is developed under leadership of Dr. S K Singh, Director of NBSS and LUP. The geoportal would help to acquire, process, store, distribute and improve the utilisation and dissemination of geospatial soil resources data. The organization is all set to link the soil geoportal with other related geoportals to widen the scope of its applications.



According to press release, the vast importance of spatial databases, their utility and management in natural resources management is well recognised world over. Timely availability of accurate information on natural resources is key to rationalized decision-making by planners and resource managers towards sustainable agricultural development.

In the wake of several initiatives announced by the Government, use of cost effective and time efficient geospatial tools and techniques is undisputedly becoming integral across country's being one among the foremost. Lack of availability of spatial datasets in readily usable format in geoportal had remained till date a hindrance to developing and implementing plans and policies for optimum utilization of natural (soil) resources of the country.

NBSS&LUP PUBLICATIONS

SOIL RESOURCE MAPS

- *Soil Map of India, scale 1:7 million, 1985.
- **Soil Resource Maps of:**
  - +West Bengal, Bull.27 (Bull. in Bengali Version)
  - +Pondicherry & Karaikal, Bull.28
  - +Gujarat, Bull.29
  - +Haryana, Bull.44
  - +Punjab, Bull.45
  - +Tamil Nadu, Bull.46
  - +Karnataka, Bull.47
  - +Kerala, Bull.48
  - +Orissa, Bull.49
  - +Bihar, Bull.50
  - +Rajasthan, Bull.51
  - +Meghalaya, Bull.52
  - +Maharashtra, Bull.54 (Bull. in Marathi Version)
  - +Arunachal Pradesh, Bull.55
  - +Manipur, Bull.56
  - +Himachal Pradesh, Bull.57
  - +Madhya Pradesh, Bull.59(Bull.in Hindi Version)
  - +Sikkim, Bull.60
  - #Andaman & Nicobar Islands, Bull.61
  - +Jammu & Kashmir, Bull.62
  - +Tripura, Bull.65
  - +Assam, Bull.66
  - +Nagaland, Bull.67
  - +Uttar Pradesh, Bull.68
  - +Andhra Pradesh, Bull.69
  - +Lakshadweep, Bull.70
  - +Delhi, Bull. 72
  - +Goa, Bull. 74
  - +Mizoram, Bull.75

RESEARCH BULLETINS

- * Glossary of Geomorphological Terms, Bull. No.1, 1980.
- * Soils of North Eastern Region, Bull.No.2, 1981.
- * Land Use Plan for Development of Bundelkhand Region based on Land and Soil Resources Survey, Bull.No.3, 1981.
- * Soils and Suggested Land Use of Maharashtra, Bull.No.4, 1980.
- * Soil–Physiographic Relationship in India, Bull. No. 5, 1982.
- * Soil–based Agrotechnology Transfer under Lab–to–Land Programme, Bull.No.6, 1982.
- * Bioclimatic Analysis of India, Bull.No.7, 1982.
- * Soil Survey of ICRISAT Farm and Type Area around Patancheru, Andhra Pradesh, Bull.No.8 (rev.ed.) 1993.
- * Geomorphology, Soils and Land Use of Haryana, Bull.No. 9, 1983.
- + Memorandum of Soil Correlation, Bull.No.10, 1984.
- * The Soils of Mondha Village (Nagpur) for Agrotechnology Transfer, Bull.No.11, 1986.
- + The Soils of Hassan District (Karnataka) for Land Use Planning, Bull.No.12, 1987.
- * Field Manual, Rev. ed. Bull.No.13, 1989.
- * Laboratory Methods, Bull.No.14, 1987.
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