



वार्षिक प्रतिवेदन

ANNUAL REPORT

2009-10



राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो (भा.कृ.अनु.प.), नागपुर -440010 National Bureau of Soil Survey and Land Use Planning (I.C.A.R.), Nagpur - 440010



ANNUAL REPORT





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Prakash Ambekar

CITATION:

NBSS Staff (2010) Annual Report, 2009-10 NBSS&LUP Publ., Nagpur-440 010, India.

For further information and to obtain copies of this report Please write to:

Director

National Bureau of Soil Survey and Land Use Planning (NBSS&LUP)

Amravati Road, NAGPUR-440 010.

Tel : (0712) 2500386; 2500226; 2500545; 2500664

Telefax : +91(0)712-2500534 E-mail : director@nbsslup.ernet.in

sarkardeepak@rediffmail.com

ISSN : 0970-9460

July, 2010



Preface

THE National Bureau of Soil Survey and Land Use Planning (ICAR), Nagpur, in continuation of its journey for inventorising natural resources for land use planning with special reference to soils, focused on soil survey and mapping activities at the levels of village, block, watershed and district during 2009-10.

The institute is also engaged itself in two research programmes of the National Agricultural Innovative Project (NAIP). The first one is on developing a georeferenced soil information system in two most important food growing zones of the country, namely, the Indo-Gangetic Plains and Black Soils Region (under Component 4) and is first of its kind ever undertaken in the country and the other is on addressing livelihood issues in selected clusters of villages in three disadvantaged districts of Maharashtra (under Component 3).

The year has been especially significant for the institute in that it was involved in three important network projects, two of them being intra-institutional, involving the HQrs. and all the regional centres. The projects are namely, district level land use planning and improvising methods for soil survey and its interpretation for land evaluation. The latter will bring uniformity in the methods of inventorising natural resources. Besides, the institute HQrs. also worked as a cooperating centre in the ICAR network project on climate change, its influence in agriculture.

The present report briefly mentions the research achievements of this institute in the fields of soil survey and mapping, remote sensing and GIS, pedology, soil carbon, land evaluation and land use planning.

As many as 42 research papers were published including a few in international journals. Besides, 31 book chapters, 9 research bulletins and soil survey reports were also published. In recognition of outstanding research contributions, a number of scientists were honoured by various professional bodies.

The institute was actively involved in human resource development through imparting training in soil survey as well as deputing its staff for various training programmes and conducting teaching and research programmes for M.Sc. and Ph.D. students of different State Agricultural Universities.

I acknowledge the sincere efforts put in by my staff in achieving the work target. I also compliment the members of the Editorial Committee for bringing out the report in time.

I take this opportunity to put on record the overwhelming support received from the ICAR in accomplishing our target.

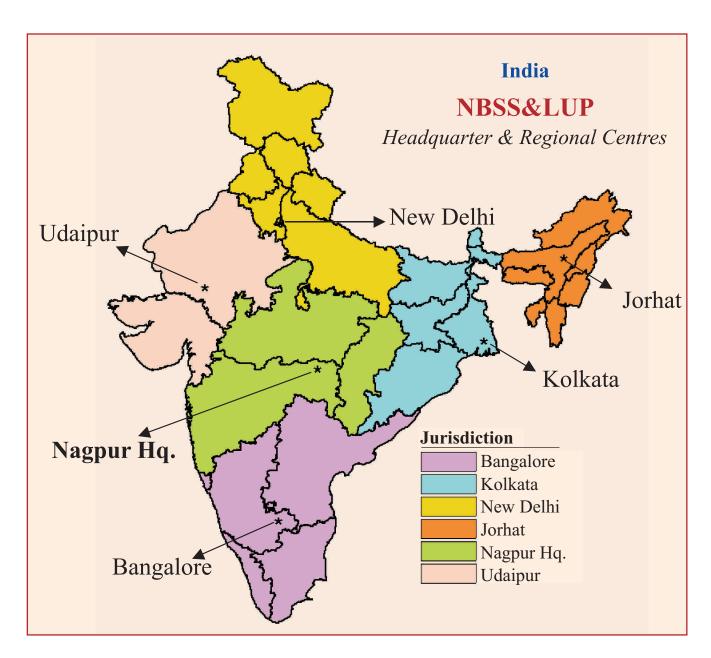
It gives me immense satisfaction in placing the Annual Report (2009-10) for public scrutiny.

July, 2010 Nagpur (DIPAK SARKAR) DIRECTOR



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Contact Addresses

NAGPUR [Headquarter]

Director, NBSS&LUP

Amravati Road, Nagpur-440 010

: 0712-2500386, 2500319 (O)

0712-6451643 (R)

: 0712-2500534

E-mail: director@nbsslup.ernet.in

BANGALORE

Regional Head, NBSS&LUP

P.B.No.2487, Hebbal, agricultural

Farm P.O. Bangalore-560 024 : 080-23412242, 23415683,

23410993 (O) 080-23532641, 23331499 (R)

: 080-23510350

E-mail: nbsslup@vsnl.net

KOLKATA

Regional Head, NBSS&LUP

Salt Lake, D.K. Block, Sector-II,

Bidhan Nagar, Kolkata-700 091

: 033-23586926,23590727 (O) Tel.

033-24301461 (R)

: 033-23215491 Email: nbsscal@wb.nic.in

NEW DELHI

Regional Head, NBSS&LUP IARI Campus, NTC Building

New Delhi-110 012

: 011-25840166, 25841624 (O)

011-25833471 (R)

Fax: 011-25840166

E-mail: nbsslup_rcd@yahoo.com

UDAIPUR

Regional Head, NBSS&LUP Bohra Ganesji Road,

University Campus Udaipur-313 001

: 0294-2471421 (O)

0294-2464754 (R) : 0294-2471326

Email: nbsslup_udaipur@rediffmail.com

JORHAT

Regional Head, NBSS&LUP NER Centre, Jamujuri Road Rawriah, Jorhat-785 004

: 0376-2340089, 2932372 (O)

0376-2341164 (R) : 0376-2340089

Email: nbssjorhat@rediffmail.com

कार्यकारी सारांश

प्राकृतिक संसाधन प्रबंधन के अंतर्गत मृदा सर्वेक्षण, मृदा वर्गीकरण, सह-संबंधन और मानचित्रण के कार्य हेतु संस्थान का मुख्यालय, नागपुर और उसके पांच क्षेत्रीय केन्द्र कार्यरत हैं। संस्थान मुख्यालय और उसके पांच क्षेत्रीय केन्द्रों में कार्यरत वैज्ञानिकों का मुख्य ध्येय मृदा सर्वेक्षण से प्राप्त आंकड़ों का मुल्यांकन करना और भूमि उपयोग हेतु उनका उपयोग करना है। इसके साथ-ही-साथ राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो कुछ समसामयिक मुद्दे जैसे मौसमी परिवर्तन और उससे मृदा-कार्बन और उसके पृथक्करण का प्रभाव और फसल की पैदावार पर उसके असर का भी अध्ययन करता है। इन प्रयासों के और दुरगामी सफल परिणाम देखने को मिलते हैं जब मुदा कार्बन और फसल पैदावार पर बने संगणीकृत नमूनों पर उनका उपयोग होता है। राष्ट्रीय मुदा सर्वेक्षण द्वारा देखे जा रहे अन्य ज्वलंत मूद्दे हैं कृषि जलवायु मण्डलों की सीमाओं का पुन:निर्धारण, मृदा निम्नीकरण और किसानों की जीविका सुरक्षा हेतु आधुनिक सुदूर संवेदन और भौगोलिक सूचना प्रणाली तकनीक का उपयोग कर सहायता प्रदान करना है। ब्यूरो द्वारा डॉ. पंजाबराव कृषि विश्वविद्यालय, आकोला के सहयोग से स्नातकोत्तर और पी.एच.डी. (भूमि संसाधन प्रबंधन) के छात्रों को स्टेट ऑफ आर्ट सूचना का प्रसारण किया जा रहा है। संस्थान के कर्मचारियों को अपनी निपुणता और तकनीकी ज्ञान और अधिक परिष्कृत करने हेत् विभिन्न प्रशिक्षण कार्यक्रमों में सहभागी होने हेत् भेजा जाता है।

अनुसंधान की विशिष्टताएँ

मुदा सर्वेक्षण और मानचित्रण: वर्ष 2009 से 10 तक की अवधि में देश के विभिन्न जिलों, खण्डों, गांवों और जल-विभाजकों का मुदा सर्वेक्षण विभिन्न मुदा एवं विषयी मानचित्रों को बनाने हेत् किया गया।

यवतमाल जिले के मृदा दत्त सामग्री को 1:50,000 पैमाने पर बनाया गया। कुल मिलाकर 28 मृदा श्रेणियों की पहचान की गई जिसे मृदा क्रम वर्टीसॉल्स, इन्सेप्टीसॉल्स और इन्टीसॉल्स में रखा गया।

- जबलपुर जिले का मृदा सह-संबंधन कार्य हुआ। 23 भू-आकृति ईकाइयों में कुल 42 मृदा श्रेणियों को पहचाना गया। 21 मृदा श्रेणियों के सहयोग से मृदा मानचित्रण का कार्य हुआ।
- उप्पम मण्डल के 64 गाँवों का विस्तृत मुदा सर्वेक्षण कार्य सम्पन्न हुआ। 14 मृदा श्रेणियों का प्रतिनिधित्व करते 141 प्रावस्थाओंयुक्त मृदा मानचित्रों का निर्माण कार्य किया गया जो कि मुदाओं के पोषक स्तर को दर्शाता है कि लभ्य फासफोरस निम्न से मध्यम मात्रा में है, जबकि जिंक निम्न से अव्यल्प मात्रा में है।
- पंजाब के जालंधर जिले के कुल 2.624 लाख हेक्टेयर क्षेत्र का सर्वेक्षण किया गया। मृदा मानचित्रण के कार्य हेतु कुल 16 मृदा श्रेणियों को पहचाना गया।
- उत्तर प्रदेश के मथुरा जिले का लगभग 3,33,824 लाख हेक्टेयर क्षेत्र का सर्वेक्षण किया गया जिससे इस क्षेत्र का यथार्थ भूमि उपयोग नियोजन का कार्य किया जा सके। इस जिले का 50% क्षेत्र निम्न फासफोरस वाली मुदा का है तथा प्राप्त पोटेशियम मध्यम से उच्च श्रेणी का है इसके साथ ही इस जिले में फसल उपयुक्तता को पहचानने का कार्य किया गया।
- ढोली सूक्ष्म जल-विभाजक का विस्तृत मृदा सर्वेक्षण का कार्य किया गया, तदहेतु निचले भागों के कुछ गाँवों को सर्वेक्षित किया गया। एकचरी सांख्यकी परिणामों द्वारा यह जानकारी मिली कि धान के अधीन मुदा में पी.एच. उच्च है जबिक परली तरफ की मुदा जिसमें जंगल और चाय बागान है वहाँ अपेक्षाकृत कम।
- आसाम के कामरूप जिले के 4.354 लाख हेक्टेयर क्षेत्र का मृदा सर्वेक्षण का कार्य किया गया। कुल 40 मृदा श्रेणियों को पहचानकर उनमें से 33 मृदा श्रेणियों को मानचित्रण हेतु चुन गया।

C 7. C	~	• ~	· `	, , , , ,	•
समयावधि में कि	ए गए महा सर्वक्षण	ात मानीचत्रण	(क्षेत्रफल के साथ) को नीचे दशीया	गया द्रे∙—
71.1.41.41.41.1.1.1.1.1.1.1.1.1.1.1.1.1.	/ 1/ Jd1 /1941.1	19 11 11 99 1	(4121 1/1 4/ 1114	<i>)</i> -14 11 4 4 5 11 -11	1-11 6.

क्र.सं.	राज्य (जिला)	जलविभाजक/फार्म/गाँव	मानचित्रण का पैमाना	सर्वेक्षित क्षेत्र (हेक्टेयर में)
1.	राजस्थान (चित्तोडगढ़)	_	1,50,000	70,000
2.	राजस्थान (चित्तोडगढ़)	सुरजपुरा, दौलतपुरा, सोहनखेड़ा	भू–कर मानचित्र स्तर	1200
3.	महाराष्ट्र (यवतमाल)	_	_	10,10,000
4.	महाराष्ट्र (औरंगाबाद)	करकशिल	1:10,000	666.32
		कानाद्गम	1:10,00	381.95
5.	महाराष्ट्र (धुले)	लाघाडवल	1:10,000	900
6.	महाराष्ट्र (गोन्दिया)	देवरी	1:10,000	900
7.	केरल (तिरूवनंतपुरम)	तिरूपुरम, कोन्जीसामकुलम कन्डीनाकुलम	1:10,000	4000

इस विस्तृत मृदा सर्वेक्षण से 5 मृदा श्रेणियों की पहचान हुई। इसमें प्राकृतिक संसाधन से प्राप्त सूचनाओं का उपयोग कर इसे क्षेत्र के किसानों को नारियल और उससे प्रप्त होने वाले अन्य उत्पादों से ज्यादा-से-ज्यादा लाभ कमाने के मुख्य उद्देश्य को लेकर बनाया गया।

- ब्यूरो के सभी छ: स्थलों में एक ही साथ एक परियोजना को आरंभ किया गया जिसमें भू-कर और खण्ड स्तर पर एक समान कार्य प्रणाली का उपयोग कर सर्वेक्षण किया गया। इसके अंतर्गत लिए गए क्षेत्रों के नाम है — लाभामाजरा खंड, हरियाणा (दिल्ली केन्द्र), चिक्का - अन्नीनाकेरेलबोली, कर्नाटक (बेंगलोर केन्द्र), तुली जलविभाजक, नागालैण्ड (जोरहाट केन्द्र), बादुआ जलविभाजक, बिहार (कोलकाता केन्द्र) पारासिवनी खंड, महाराष्ट्र (मानचित्र ईकाई, नागपुर) और डुंगला तहसील का कुछ भाग, राजस्थान (उदयपुर केन्द्र)।
- आसाम के तीन जिलों मोरीगाँव, डिबरूगढ़ और तिनसुखियाँ के उन प्रदुषित स्थलों के मानचित्रण का कार्य हुआ जहाँ भारी धातु प्रदूषण देखा गया है।
- विभिन्न मृदा भू-भागों में बी.एस.आर. 353 मृदा अधिमुखों के भौतिक, रासायनिक, सूक्ष्मजीवीय गुणों को ध्यान में रखकर मृदा सूचनाएँ और भू-भागों का आंकड़ा आधार बनाया गया।
- मृदा गुणवत्ता जाँच करने हेतु 13 बी.एस.आर और 14 आई.जी.पी. बैन्चमार्क वाले प्रमुख स्थलों पर पुन: जाकर मृदा का नमूना लेकर उनके मृदा पैमानों का निर्धारण किया गया।

मृदा उत्पत्ती और सह-संबंध

- बेंगलुरू जिले में किए गए भू-आकृतिक अध्ययनों से ज्ञात हुआ है कि भू-आकार स्थान एवं मृदा मापदण्डों के मध्य घना संबंध विद्यमान है। यह संबंध वास्तविक ढलान अनुक्रम पर पाया गया है और परत एवं अवधित वादी फर्श के मध्य समकोण धारण किये हुए है।
- संतृप्त द्रवीय चालकता एवं दूसरे मृदा परिवर्तीत गुणों, उदाहरणार्थ-मित्तिका, विनिमय सोडियम प्रतिशत, सोडियम अधिशोषण अनुपात आदि के मध्य संबंध स्थापित करने हेतु मृदा अंतरण प्रकार्यों को विकसित किया गया है। थोक गहनता को आंकने के लिए तंत्रकीय मृदा अंतरण प्रकार्यो व्युतपन्नित किया गया है। जिन मृदा अंतरण प्रकार्य उत्तम थे उनमें मूल औसत वर्गीय दोष एवं महत्तम परमदोष की मात्राएँ न्यूनतम थी एवम् समानता की श्रेणी और आर-टू गुण उच्चतम थे। कुछ अन्य मृदा अंतरण प्रकार्यों को भी विकसित किया गया जिनका विकास करने के लिए अनुमानित पिरवर्तीय गुणों का चयन किया गया (उदाहरणार्थ-गाद मित्तिका पीएच, जैविक कार्बन चूना विनियमी सोडियम प्रतिशत, विनियमी मैग्नेशियम प्रतिशत, विनिमयी केलिशयम प्रतिशत, विनिमयी केलिशयम/ मैग्नेशियम इत्यादि) यह प्रकार्यों, कारण एवं परिणाम के बीच के संबंध के आधार पर मध्य भारत की सिकूड़ने-फूलने वाली मृदाओं के लिए विकसित किए गये। कुछ अपवाद को छोड़कर रेती की मात्रा एवं व्युत्तपत्तिक मृदा प्रतिबिंबन के मध्य सहसंबंध गुणांक की सकारात्मक सह-संबंधता उल्लेखनीय पायी गई। परंतु नागपुर जिले के गाद एवं मित्तका के नमुनों में इस गुणांक के व्यवहार में प्रखर विषमता पाई गई। मृदा प्रतिबिंबन के दत्त सामग्री वर्गों से मृदाओं के गुणों का पूर्वानुमान लगाने हेतु अंशाकन प्रतिमानों का विकास किया गया।

- राष्ट्रीय कृषि अनुसंधान प्रणाली के वर्तमान में लागू प्रबंधन हस्तक्षेपों के सूक्ष्म सम स्वरण की मदद करने के लिए गंगीय समतल क्षेत्र के एतैहासिक मृदा-जलवायु-फसल दत्त सामग्री के कोश का विकास किया गया। इन दत्त सामग्री की मदद से मित्तिका कणों के चलन को अवरूद्ध करने एवं उनका संचय करने में घुलनशील केलिशयम एवं चूने की भूमिका का महत्व कम है ऐसा दिखाया गया है। गत 5000 वर्षों से अधिक समय से गंगीय समतल क्षेत्र में अशुद्ध मित्तिका मृदा लक्षणों एवं मृदाजित कार्बोनेट थे ऐसे दो समकालीन मृदा जितत प्रतिक्रियाएं है जिनको शुष्क एवं आई जलवायु क्षेत्रों में मृदा जितत सीमा रेखा की वास्तिवकता के उदाहरण के रूप में मान्य किया जाना चाहिए।
- विजयपुरा की लोहजनीत मृदाएं जो कि निर्देश चिन्हित मृदाएं हैं, इनमें केओलीनाईट प्रधान खनीज है एवं माईका उप-प्रधान खनीज है, ऐसा तथ्य एक्स-रे विवर्तन अध्ययनों से प्रकाशित हुआ है। परन्तु यह अवलोकन जामाखंडी एवं बीजापुर श्रेणी की लोहजनीत मृदाएं होते हुए भी नहीं पाया गया। इन मृदाओं के मित्तिका कणों में सेम्कटाईट श्रेणी के खनीज प्रधान रूप से पाए गए। केन्द्रीय बरानी खेती अनुसंधान संस्थान के अंतर्गत हयात नगर खेती भूमि की मृदाओं के मित्तिका कणों में उपस्थित स्मेकटाईट खनीज केओलीन खनीज से अंतरस्तरिकृत है जो कि जामाखंडों एवं बीजापुर श्रेणी की मृदाओं से समानता रखते हैं।
- मृदाओं एवं तलछ्टों में उपस्थित तत्वों का निर्धारण विवेचनात्मक रूप से युग्मित प्लाझमा स्पेक्ट्रोमेट्री पद्धित से करने के लिए मृदाओं की पाचन क्रियाओं के आदर्श पत्रों का विकास किया।
- आंतरतलीय भू-गर्भीय समयमान अध्ययन, तलछट विज्ञान एवं भू-रसायन शास्त्रों के अध्ययन से पता चला है कि मध्य एवं दक्षिण गंगीय समतल क्षेत्र के तलछटों तथा उत्तर एवं दक्षिण गंगा-यमुना तलछटों में समानता है। परन्तु स्मेकट्राईट श्रेणी के खनीजों का हाईड्राक्सी अंतरस्तरीय स्मेक्टाइट खनीज में रूपांतर केवल अम्लीय मृदा वातावरण में संभव है और इन हायड्रॉक्सी अंतरस्तरीय स्मेकटाईट की वर्तमान में उपस्थिती जलवायु परिवर्तन का प्रबल एवं चित्ताकर्षक उदाहरण है।
- बारह राज्यों की 28 मृदा श्रेणीओं का राष्ट्रीय मृदा श्रेणी पंजीका में समावेश होने से इस पंजीका की सम्पन्नता में वृद्धि हुई। प्रतिवेदन के समय तक इस पंजीका में कुल 253 मृदा श्रेणीयों का समावेश हुआ। वर्तमान में एक मृदा श्रेणियों में सह-संबंध स्थापित करने हेतु संगणीकृत स्फॉटवेयर (solicor) का विकास किया गया जो अभी कड़े परीक्षण से गुजर रहा है।

भूमि मूल्यांकन एवं भूमि उपयोग नियोजन

- प्रारंभ में कुल 170 मृदा श्रेणीयों को 195 मानचित्रण इकाईयों में वर्गीकृत किया गया। इन 165 इकायों को 15 भूमि प्रबंधन इकाईयों में पुन: वर्गीकृत किया गया।
- गोन्दिया जिले में शुद्ध क्षेत्रफल में सीमांत रूप से वृद्धि पाई
 गई जबिक एक से अधिक बार बुवाई के क्षेत्रों में कमी पायी
 गई।
- कर्नाटक राज्य के मैसूर जिले को जिला भूमि उपयोग योजना पत्र के विकास हेतु आदर्श जिले के रूप में चयनित किया गया। इस जिले की खेती प्रणाली के अध्ययन से पाया गया कि इस जिले में पांच प्रधान खेती प्रणालियाँ है। इस जिले में 12 भूमि-प्रबंधन इकाईयों का निरूपण किया गया।
- जोरहाट जिले के मृदा मानिचत्र से 16 प्रधान मृदा श्रेणियों को चयनीत करके 10 वयापक मृदा मानिचत्रण इकाईयों के उपयोग की मदद से 35 मानिचत्रण इकाई वाला भूमि उपयोग मानिचत्र का विकास किया गया।
- मृदा एवं भूमि उपयोग दत्त सामग्री के अर्थ प्रकाशन से सुझाया गया कि प्रबंधन हस्तक्षेपों, उदाहरणार्थ-जल निकासी सुधार, सिचाँई, अजैव एवं जैव सुधारकों की अनुवृद्धि, को ग्रहित करने से अन्तर्निहित उत्पादकता के सुचकांक को उत्तम से अति उत्तम स्तर में परिवर्तीत किया जा सकता है।
- उड़ीसा राज्य के खूरडे खंड के अंतर्गत उत्तकल-समतल एवं पश्चिम बंगाल के छोटा नागपुर सपाट क्षेत्रों के उन्नतांश, ढलान, अधिमुखता एवं वक्रता संबंधी बिन्दुओं को दत्त सामग्री के उपयोग से अंकीय अनन्यन प्रतिमान उत्पन्न किया गया।
- उत्तर गोवा में 95% क्षेत्रफल में फसल वृद्धि अविध का प्रमाण 180-240 दिनों का है इस कारण इस क्षेत्र में फसल वृद्धि अविध प्रमाण का कोई प्रतिबंधन नहीं है। इस जिले में काजू, धान, नारीयल, कृषि पर्यटन एवं मसालों पर आधारित खेती प्रणाली की मुख्य प्रणालियों में पहचान हुई है।
- पंजाब के शहीद भगत सिंह नगर जिले के मृदा एवं भूमि उपयोग दत्त सामग्री से संकेत प्राप्त हुए हैं कि इस जिले की 39 प्रतिशत मृदाओं में उत्कृष्टता से अच्छा सुचांक दर्शाता है कि इन मृदाओं में अच्छी से उत्कृष्ट उत्पादकता अंतर्निहित है।
- राजस्थान राज्य के बुंदी जिले के मृदा एवं भूमि उपयोग मानिचत्रों
 के स्थानीय एकीकृतिकरण से 19 भूमि प्रबंधन इकाईयों का
 उत्पन्न किया गया जिनका विस्तार उल्लेखनीय था (1.0%)।

- महाराष्ट्र राज्य के धूले गुच्छ (गांवों का समूह) में पाया गया कि सुझाये गये धान तीव्रीकरण प्रणाली की प्रक्रिया के अनुग्रहण से 50 प्रतिशत से अधिक मात्रा में धान के बीज के उपयोग में कमी आई।
- औरंगाबाद गुच्छ में मूल्य वृद्धिकरण, मंडी संयोजन एवं सूक्ष्म उद्यम संबंधी प्रशिक्षण शिविर का संचालन किया गया ।

सुदूर संवेदन एवं भौगोलिक सूचना प्रणाली

- महाराष्ट्र राज्य के बुलढाना जिले के अंतर्गत सरस्वती जलग्रहण क्षेत्र में भूमि उपयोग एवं भूमि आवरण कक्षाओं की पहचान हुई जिसमें 81 प्रतिशत जुताई 7.5 प्रतिशत अ-कृषक एवं 8.6 प्रतिशत जंगल क्षेत्रों को दर्शाया गया।
- महाराष्ट्र राज्य के बुलढाना जिले के हायपरआयन संवेदक की दत्त सामग्री के छाया प्रक्रमण ने दर्शाया कि दत्त सामग्री के स्थानिक संरचना एवं रव के मध्य अच्छा पारस्परिक प्रभाव है। 139 बंड हायपरआयन दत्त सामग्री के प्रथम निम्न रव अंश ने शक्तिशाली तेजस्विता के ढलान को दर्शाया है जो कि व्ही.एन.आई.आर श्रेणी के तरंगों के वर्णक्रमों के अनुरूप है। श्याम मृदा क्षेत्र की 1:1 प्रमाण पर एक भू-संदर्भ सूचना प्रणाली विकसित की गई जो 343 दत्त सामग्रीयों को दर्शाती है।

मृदा पोषक तत्व मानचित्रीकरण

- पश्चिम बंगाल के हावड़ा, नाडीया, बीरभूम, उत्तर 24 परघणा एवं हुगली जिलों की पोषक तत्वों की स्थिति को दर्शाने वाले मानचित्र का विमोचन दिसम्बर, 2009 में किया गया।
- आसाम के विभिन्न जिलों से 2500 से अधिक सतह के मृदा नमनों का पृथक्करण करके बृहत एवं सूक्ष्म पोषक तत्वों के मानचित्र बनाए गए।
- लभ्य नाईट्रोजन एवं फास्फोरस के स्थानिक विभिन्नता मानचित्र का विकास किया।

मुदा कार्बन एवं फसल प्रतिमान

- पदयुक्त समाश्रयण के उपयोग से मृदा अंतरण प्रकार्य का गठन किया गया जिसकी सहायता से 200 मृदाओं की संतृप्त द्रवीय चालकता का आकलन किया।
- वर्षा के विराम के बाद पूर्ववर्ती आर्द्रता को आधार बनाकर, संशोधित मृदा अंतरण प्रकार्य की मदद से फसल वृद्धि अवधि के प्रमाण में सुधार किया गया। तत्पश्चात् इसका उपयोग

- मौजूदा ए.ई.एस.आर. की सीमाओं में परिवर्तन लाने हेतु किया
- करीब दो दशकों के अंतराल में पश्चिम बंगाल तरई (नम तथा अति नम) एवं चाय बागान की मुदाओं में मुदा कार्बन की मात्रा की तुलना में धान की मृदाओं में कार्बन का स्तर अधिक सूचित किया गया है।
- रॉथ-सी एवं सेन्चुरी प्रतिमानों के मूल्यांकन से ऐसे संकेत प्राप्त हुए हैं कि उष्णकटिबंधीय क्षेत्र की मृदा के प्रायोगिक दस सामग्री के रूझान को इन प्रतिमानों की मदद से जकड़ा जा सकता है। विषम जैविक जलवायु परिस्थितियों में प्रचलित विभिन्न प्रणालीयों में सेन्चुरी प्रतिमान के प्राचलन के अमल करने से प्रायोगिक दत्त सामग्री एवं कृत्रिम आंकड़े में गहन सहमति प्रदर्शित की गई है।
- इनफो-क्रॉप प्रतिमान उत्पादत के संकेत मिले हैं कि जिन परिदृश्यों में जलवायु परिवर्तन अनुपस्थित है वहां दशकिय त्रृटि 33 प्रतिशत पायी गई जो कि मान तापमान में 0.25 डिग्री के बढ़ोत्तरी के परिदृश्य में घटकर 32 प्रतिशत रह गई। जब वायुमंडलीय सी.ओ.टू में बढ़ोत्तरी 370 से 410 पी.पी.एम. होती है तो इस प्रकार के परिदृश्य के विस्थापन के कारण फसल उपज में अंतर 34 प्रतिशत का हो जाता है। चुंकि गत 50 वर्षों में ज्यादातर विश्वीय जलवायु परिवर्तन सी.ओ.टू. स्त्राव में बढ़ोत्तरी के कारण हुआ है तो ऐसी परिस्थितियों की निरंतरता में चलते फसल की उपज के अंतर में कमी पाने के लिए सिंचाई की मांग बढ़ सकती है।

कृषि जलवायु अंचलीकरण

- प्रतिमाह एवं प्रति सप्ताह दत्त सामग्री के अनुरूप जल संतुलन गणना के लिए एक संगणीकृत सॉफ्टवेयर विकसित किया गया। फसल वृद्धि अवधि प्रमाण एवं फसल वृद्धि में हर सहायक सप्ताह कि संभावना की गणना के लिए क्रमादश भाग भी लिखे गए।
- विभिन्न कृषि पर्यावरणीय क्षेत्रों में उपकर्षित एवं बंजर भूमि 120.4 मि. हेक्टेयर वाला संशोधित उपकर्ष एवं बंजर भूमि मानचित्र बनाया गया।

स्नातकोत्तर शिक्षा

इस शैक्षणीक वर्ष में एम.एस.सी. (एल.आर.एम.) के चार और पी.एच.डी. (एल.आर.एम.) के दो छात्रों ने अपने शोध-प्रबंध प्रस्तुत किए। इसके अतिरिक्त डॉ. पी.डी.के. व्ही., आकोला के सहयोग से एवं उनके द्वारा एम.एस.सी. के चार संशोधित पाठ्यक्रमों एवं पी.एच.डी. पाठ्यक्रम को ब्यूरो द्वारा चलाया जा रहा है।

प्रशिक्षण कार्यक्रम का आयोजन

 इस वर्ष विभिन्न संस्थानों के 65 अधिकारियों को सुदूर संवेदन एवं जी.आई.एस., मृदा सर्वेक्षण मानचित्रण एवं भूमि प्रबंधन क्षेत्र से संबंधित आधुनिक तकनीकी जानकारी प्रदान करने वाले प्रशिक्षण कार्यक्रम के अंतर्गत उन्हें प्रशिक्षण दिया गया।

प्रशिक्षण कार्यक्रम में सहभागिता

 ब्यूरो के 36 अधिकारियों ने विभिन्न क्षेत्रों में प्रशिक्षण प्राप्त किये।

चल रहे प्रकल्प (प्रोजेक्ट)

संस्थागत (चल रहे) : 38

• नए (प्रस्तावित) : 24

डी.एस.टी. : 02

एन.ए.आई.पी. के सौजन्य से चल रहे प्रकल्प : 04

राज्य सरकार के सहयोग से चल रहे प्रकल्प : 06

भा.कृ.अनु.प. के सहयोग से चल रहे प्रकल्प : 01

लिन्केज (अनुबंध)

- एन.बी.एस.एस. एण्ड एल.यू.पी. डॉ.पी.डी.के.व्ही.
- एन.बी.एस.एस. एण्ड एल.यू.पी. सी.आई.सी.आर.
- एन.बी.एस.एस. एण्ड एल.यू.पी. एन.आर.एस.सी
- एन.बी.एस.एस. एण्ड एल.यू.पी. राजकीय कृषि विभाग
- एन.बी.एस.एस. एण्ड एल.यू.पी. आई.एस.एस.
- एन.बी.एस.एस. एण्ड एल.यू.पी. सी.एस.डब्ल्यू.सी.आर.टी.आई.
- एन.बी.एस.एस. एण्ड एल.यू.पी. एस.ए.सी.

प्रकाशन

प्रकाशित अनुसंधान पत्र : 42
 तकनीकी, लोकप्रिय/एक्सटेंशन आर्टिकल्स : 13
 संगोष्ठी/पिरसंवाद पत्र : 27
 मृदा सर्वेक्षण रिपोर्ट/बुलेटिन : 09
 बुक चेप्टर्स : 31
 स्मरणीय/आमंत्रित व्याख्यान : 16

पुरस्कार एवं सम्मान

 यह वर्ष ब्यूरो के लिए उपलिब्धियों वाला रहा संस्थान के वैज्ञानिकों एवं स्टॉफ को कई पुरस्कार मिलें।



Executive Summary

As a part of natural resource management study soil survey, soil classification, correlation and mapping has been the major thrust areas of work both at HQrs., Nagpur and other five regional centres. Utilization of soil survey data sets for land evaluation and land use planning received a focused attention with the initiation of a network project of the institute involving many scientists at HQrs. and regional centres. Besides NBSS&LUP is also addressing the contemporary issues of climate change and its influence in soil carbon and its sequestration and also crop yield. Such effort find more value due to the application of computerized models on soil carbon and crop yield. The other burning issues addressed by NBSS&LUP are revision of agroclimatic zone boundaries, soil degradation and livelihood security of farmers through the modern technologies of remote sensing and GIS. Bureau is also involved in disseminating state-of-art information to post-graduate students of M.Sc. and Ph.D. (Land Resource Management) from Dr. PDKV. Akola. The staffs of this institute were also deputed for various training programmes to improve their skills and technical knowledge.

Research Highlights

Soil Survey and Mapping : Soil survey for different districts, blocks, villages and watersheds were carried out during 2009-10 to generate various soil and thematic maps.

 Soil database of Yavatmal district on 1:50,000 scale was generated. In total 28 soil series were identified representing the soil orders of Vertisol, Inceptisol and Entisol.

- The soils of Jabalpur district were correlated. Total 42 soil series were identified in 23 physiographic units. The soil map was generated with 21 soil series association.
- Detailed soil survey of 64 villages of Kuppam Mandal was completed. Soil maps were developed showing 141 phases representing 14 soil series. Nutrient status shows that available P is low to medium, whereas Zn is low to marginal in these soils.
- Total 2.624 lakh ha area was surveyed for Jalandhar district, Punjab. In total 16 soil series were identified to finalize the soil map.
- Nearly 3.33 lakh ha area was surveyed for Mathura district, Uttar Pradesh for perspective land use planning. About 50% area of the district falls under low soil P category. Available K in soils is medium to high. Suitability of major crops was worked out for the district.
- Detailed soil survey of Dholi microwatershed was carried out for the lower reaches of a few selected villages. The univariate statistical results showed that soils under paddy had higher pH than adjacent soils under forests and tea.
- Kamrup district, Assam was surveyed and 40 soil series were identified to finalise the soil map in 33 soil series association.

Soil survey an	d manning (with	areas) accon	mlished during	the time	period as shown	helow.
Soli Survey all	iu iliappilig (wiu	i areas) accom	ipiisnea auring	me mne	periou as shown	below.

Sr. No.	State (District)	Watershed/Farm/Village	Scale of mapping	Area surveyed (ha)
1.	Rajasthan (Chittaurgarh)	_	1,50,000	70,000
2.	Rajasthan (Chittaurgarh)	Surajpura, Daulatpura, Sohankhera	Cadastral level	1200
3.	Maharashtra (Yavatmal)		1,50,000	10,10,000
4.	Maharashtra (Aurangabad)	Kanaksil Kanadgam	1:10,000 1:10,000	661.32 381.95
5.	Maharashtra (Dhule)	Laghadwal	1:10,000	900
6.	Maharashtra (Gondia)	Deori	1:10,000	900
7.	Kerala (Thiruvananthapuram)	Thirupuram-Konjisamkulam Kadinankulam	1:10,000	4000

Detailed soil survey has resulted in identifying 5 soil series. The information on natural resources will be utilized to address the major objectives of value chain for coconut fibre and its byproducts to enhance economic returns to farmers.

- To provide a common methodology for cadastral and block level survey a network project was undertaken simultaneously at all the six sites of the Bureau. The study areas identified are Labhamajra block, Haryana (Delhi Centre), Chikka-aninakere Lboli, Karnataka (Bangalore Centre), Tuli watershed, Nagaland (Jorhat Centre), Badua watershed, Bihar (Kolkata Centre), Parseoni block, Maharashtra (Cartography Unit, Nagpur) and part of Dungle tehsil, Rajasthan (Udaipur Centre).
- Thematic maps of the contaminated sites in Morigaon, Dibrugarh and Tinsukia districts of Assam were developed to assess heavy metal pollution. The study areas were affected due to coal mining effluents, oil refinery, paper mills and fertilizer effluents.
- Soil information of 353 soil profiles of BSR in terms of physical, chemical, microbiological properties of soils in different terrains in Soil and Terrain database.
- As a part of soil quality monitoring the hotspots of 13 BSR and 14 IGP benchmark sites were revisited and resampled for analyzing soil parameters.

Soil Genesis and Correlation

Geomorphological studies in Bengaluru district shows that a close relationship exists between landform position and the soil parameters on a toe

- slope sequence at right angles to the contour from the waxing crust to the waning valley floors.
- The pedotransfer functions (PTFs) were developed to relate saturated hydraulic conductivity and other soil variables such as clay, ESP and SAR. Statistical and neural PTFs were derived to estimate bulk density. The best functioning PTF (input sand, silt, fine clay and permanent wilting point) showed the lowest RMSE (root mean square error) (0.01), MAE (maximum absolute error) (0.01), and the highest degree of agreement (0.95) and R2 (0.83) values. Predicted variables such as silt, clay, pH, organic carbon, CaCO₃, ESP, EMP, ECP, Exch. Ca/Mg were selected to develop a few other PTFs based on the cause and effect relationships for the shrink-swell soils of central India. Correlation coefficient (r) of sand showed significant positive correlation with derivative soil reflectance at all the wavelengths with some exception. This is in sharp contrast with silt and clay samples of soils in Nagpur district, Maharashtra. Calibration models for predicting soil properties from soil reflectance dataset were developed.
- Historical soil-climate-crop data bank for the Indo-Gangetic Plains (IGP) was developed to help in finetuning the existing management intervention for the National Agricultural Research System. The datasets discount role of soluble Ca2+ ions and the presence of CaCO₃ in preventing the movement and the accumulation of clay particles. The formation of impure clay pedofeatures and pedogenic carbonates are identified as two simultaneously occurring pedogenetic processes in soils of the IGP which may be accepted as an example of pedogenic threshold in both dry and wet climates since the last 5000 year B.P.

- X-ray diffraction studies of Vijaypura benchmark ferruginous soils indicate kaolinite as the dominant mineral along with subdominant proportion of mica. This observation is in contrast with other ferruginous soil i.e. Jamakhandi where smectite is the dominant mineral in the clay fraction. In Hayatnagar farm of CRIDA. Hyderabad the clay smectites are interstratified with kaolin and have similarity with Jamakhandi.
- The protocols for digestion, standards and methods for determining elements in soils and sediments using inductively coupled plasma spectrometry (ICP-ACE) have been developed.
- Interfluves statigraphy, sedimentology and geochemistry of the central and southern Ganga Plains showed similarity of the sediments in southern and northern parts of Ganga-Yamuna interfluves. Interestingly, however, the transformation of smectite to hydroxy-interlayered smectites and few other minerals can take place only in acidic soil environment of humid climate. Thus the preservation of hydroxy-interlayered smectites can be considered as an indicator of climate change.
- The national register for soil series was enriched by the inclusion of 28 soil series representing 12 states. The total number of soil series in the national register is 253 at the time of this report. A soil series correlation software (SoilCor) has been developed which is undergoing tests.

Land Evaluation and Land Use Planning

- Total 170 soil series were initially grouped into 195 mapping units and thereafter regrouped into 15 land management units (LMUs). The revised methodological framework was developed for identifying LMUs in Mysore district of Karnataka.
- In Gondia district net area sown increased marginally, whereas area sown more than once declined.
- Five major production systems were found in Mysore district of Karnataka and 12 land management units were delineated in this district. The potential productivity of paddy indicates a scope of bridging the yield gap of 8-34% in different soils of Mysore district.

- Sixteen dominant soil series were chosen from Jorhat district soil map to develop 10 generalised soil map units which was used to develop a soillanduse map with 35 mapping units.
- Soil and land use data and their interpretation suggested that adoption of management interventions like drainage improvement, irrigation and addition of inorganic and organic amendments may change the potential productivity index of soils from good to excellent level.
- Digital elevation model was generated using point data on altitude, slope, aspect and curvature of two microwatersheds in Utkal Plain, Khurde block of Orissa and Chotanagpur plateau, West Bengal and a landform map was prepared.
- The LGP is not a major limitation in North Goa district as 95% area of the district has LGP of 180-240 days. Six major farming systems such as cashew, paddy, coconut, agri-tourism, spices-based systems are identified in this district.
- Soil and landuse data of Shaheed Bhagat Singh Nagar district, Punjab, indicated that 39% soils have excellent to good index showing good to excellent productivity potential.
- Soil and landuse map of Bundi district, Rajasthan was spatially integrated to generate 19 land management units showing significant coverage (1.0%).
- In Dhule cluster the recommended practice of system of rice intensification (SRI) effected reduction of paddy seed by more than 50% resulting in substantial savings.
- A training on value addition, market linkages and microenterprises was conducted in both the clusters of Aurangabad district.

Remote Sensing and GIS

- Landuse-land cover classes were identified in the Saraswati watershed in Buldhana district of Maharashtra showing cultivated land (81%), scrub land (7.5%), and forests (8.6%).
- Image processing of Hyperion data of Buldhana district, Maharashtra showed good interaction between spatial structure of the data and the noise when the noise good has spatial structure.

First MNF (minimum noise fraction) of 139 band Hyperion data (without destripping) showed strong brightness gradient that corresponds to the spectral (smile) in the VNIR (very near infrared) array.

- A georeferenced soil information system of the black soil region was developed at 1:1 m scale showing 343 datasets.
- The satellite data of IRS LISS IV for the selected six clusters was georeferenced to generate mosaic file for the clusterts.
- Spectral curves of 60 soil samples from Ludhiana and Karnal showed prominent absorption features at 1400, 1900 and 2200 nm. Salt-affected soils of Karnal showed stronger absorption features around 1900 nm as compared to non-saline Ludhiana soils.

Soil Nutrient Mapping

- Soil nutrient status map for the districts of Howrah, Nadia, Burdhamann, Birbhum, North 24 Parganas and Hooghly of West Bengal were completed and released during December, 2009.
- More than 25,000 surface soil samples of various districts of Assam were analysed for developed macro and micro nutrient maps.
- The spatial variability maps of available N, P were generated.

Soil Carbon and Crop Modelling

- Using stepwise regression a pedotransfer function (PTF) for estimating saturated hydraulic conductivity was developed from 200 soil observations.
- Improved PTF helped to correct the length of growing period based on antecedent moisture in the soil after the cessation of rains and subsequently for modifying the existing AESR boundaries.
- The level of soil organic carbon has been reported to increase in paddy and tea soils as compared to forest soils in tarai region (humid to perhumid) of West Bengal over a period of two decades.
- The Roth C and Century model evaluation indicated that these models can capture the trends

- of experimental data in tropical soils. Parameterization of the Century model for applications to different kinds of cropping systems in contrasting bioclimatic conditions showed a close agreement of experimental data with simulated values.
- InfoCrop model output indicated the average decadal (1991-2000) under scenario of no climate change is 33% which decreases to 32% under scenario of increase in minimum temperature of 0.25°C. The scenario shifts to increase in concentration of atmospheric CO₂ from 370 to 410 ppm to indicate yield gap of 34%. Since most of the global climate change over the last 50 years is very likely to have been caused by increased emissions of CO₂, continuation of such climate change shall demand for more irrigation to diminish the yield gap.

Agro-Climatic Zonation

- A software was developed to calculate water balance for both monthly and weekly datasets. Programme modules are also written for LGP and probability of each week favourable for growing
- Degradation and wasteland map of India in different agro-ecological regions showed a revised figure of 120.4 mha as degraded and wasteland.

Post Graduate Education

Four M.Sc. (LRM) and two Ph.D. (LRM) students submitted their thesis during the current academic session. This is in collaboration with Dr. PDKV, Akola. Besides 4 courses each for M.Sc. and Ph.D. were revised in line with Dr. PDKV, Akola.

Training Organised

During the year 65 officials from different organizations were trained in the field of latest techniques of Remote Sensing, GIS, Soil Survey and Mapping and Land Resource Management.

Training Received

Total 36 officials from the Bureau recived training in various fields.

Projects undertaken

Institutional (ongoing) : 38
New (proposal) : 24
DST : 02
Sponsored NAIP Projects : 04
Sponsored (State Govts.) : 06
Network project on Climate : 01 Change (ICAR)

Linkages

- NBSS&LUP Dr. PDKV
- NBSS&LUP CICR
- NBSS&LUP NRSC
- NBSS&LUP State Agricultural Department
- NBSS&LUP IISS
- NBSS&LUP CSWCRTI

- NBSS&LUP SAC
- NBSS&LUP SAU
- NBSS&LUP DST

Publication

Research papers published : 42
Technical / popular/ Leaflets : 13
Seminar/Symposia papers : 27
Soil Survey Reports/Bulletins : 09
Book chapters/ Books : 31
Invited lectures delivered : 16

Awards and Recognition

 This year has particularly rewarding for the Bureau as its scientists and staff were decorated with a number of Awards and Recognitions.

1

Introduction

THE National Bureau of Soil Survey and Land Use Planning has its Headquarters at Nagpur with three research divisions. These are Land Use Planning, Remote Sensing Applications, Soil Resource Studies which undertake fundamental and applied research, remote sensing applications and land use planning. These divisions also extend necessary support to various regional centres. These five regional centres located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur, are involved in soil resource mapping, soil correlation and classification and land use planning.

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, in collaboration with other relevant agencies.
- To impart training and education to create awareness on soil and land resources and their state of health.

Major Research Achievements

The resource inventorisation of soils remain the major focus of the institute during this year. Most of the areas were surveyed in 1:10,000 scale for various farms, villages, watershed, etc. Besides a few districts were surveyed in 1:50,000 scale.

The Bureau has initiated a network project on cadastral and block level survey to provide a common methodology. Besides the HQrs. all the five regional centres are involved in this effort.

As a part of World Bank sponsored National Agricultural Innovation Project (NAIP) (Component 4) soil

information system is being developed for black soil region and the Indo-Gangetic Plains in terms of physical, chemical and microbiological properties.

The Bureau is engaged in another NAIP (Component 3) to develop the package of practice of livelihood security of farmers in few selected clusters of Maharashtra. The Bureau has also initiated a National Network Project on Land Use Planning. Preliminary information on soils and land use have been generated for selected districts across the country.

The Bureau has enriched the National Register for soil series by the inclusion of 28 soil series representing 12 states to make the total number of soil series in the National Register as 253.

The Bureau has been consistently catering to the need of various State Agricultural Universities, State Government Officials and others. In terms of teaching and training, using soil survey data for planning and using various types of soil and crop models.

In total 42 number of research papers were published during this year besides other publication in the form of symposia papers, popular articles, book chapters, bulletins and soil survey reports.

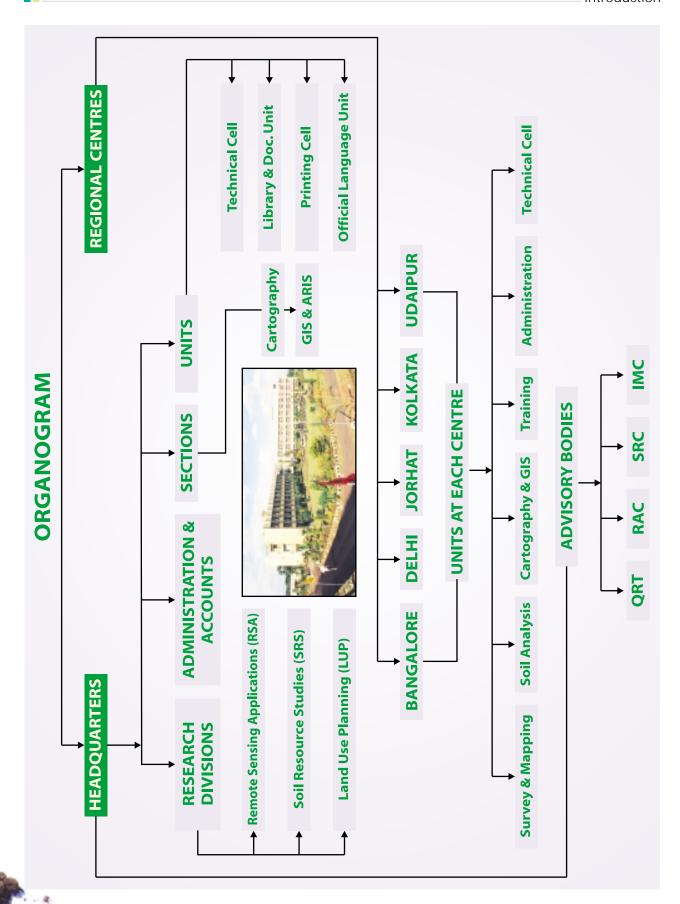
Budget for the year 2009-10

(Rs. In lakhs)

	Budget Sanctioned	Actual Expenditure
PLAN	400.00	400.00
NON-PLAN	3519.28	3473.84
Total	3919.28	3873.84

Staff Strength as on 31.3.2010

Category	Sanctioned Strength	In Position
RMP	01	01
Scientific	99	70
Technical	189	179
Administrativ	ve 72	65
Supporting	94	84
Total	455	399



Research Achievements

2.1

Division of Land Use Planning

2.1a. National network project on district land use planning and policy issues under different agro-ecosystems of the country

Dipak Sarkar (National Coordinator) and Arun Chaturvedi (Principal Investigator)

The objective of the project is to develop a methodology for evaluating the current and future land utilization types considering the components of agriculture as well as allied enterprises under different policy options and technological constraints.

A methodological framework (Fig. 2.1.1) for achieving the targets was developed at the Division and tested in Mysore District involving Regional centre, Bangalore. The case study was presented in a working group meeting at Headquarter in May, 2009.

The soil map of Mysore district with 195 mapping units were regrouped into 15 mapping units through generalization and bio-climate map was superimposed over the generated soil map for delineation of land management units (LMUs). Landform, soil depth, texture and gravelliness were considered as critical variables for land use. A revised methodological framework was developed for identifying land management units (Fig. 2.1.1). It was proposed that one district will be taken up by each regional centre for developing the methodology. The resource persons were identified for each regional centre.

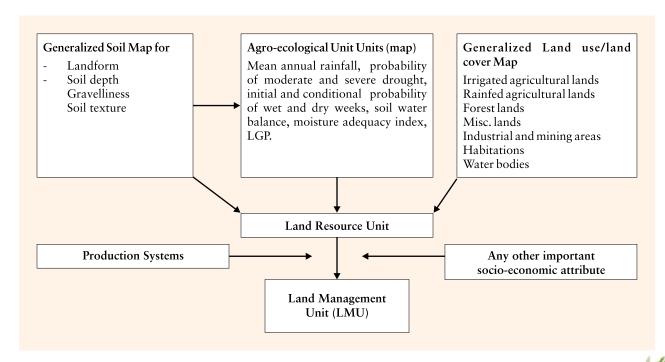


Fig. 2.1.1 Identification of land management units - A revised methodological framework

2.1ai. National network sub-project on development of district level land use plan for Gondia district, Maharashtra

T.K. Sen, S. Chatterji, T.N. Hajare, S.N. Goswami, N.G. Patil, P.N. Dubey, A. Chaturvedi and D. Sarkar

Gondia district has been identified as a target district as it is dominated by tribals who draw their livelihood from forest produce and/or subsistence farming of paddy and millets. It is situated in the Eastern part of Vidarbha, Maharashtra and lies between 80°0' to 80°42' E Longitudes and 20°40' to 21°38' N Latitudes.

The soil resource map of Gondia district has been carved out from that of erstwhile undivided Bhandara district, (1:63,000 scale) prepared by NBSS&LUP (Soil Survey Report No. 520). The soil boundaries are being checked refined, wherever necessary.

Land use change scenario analysis of Gondia district

The change in land use during the period 2000-01 to 2005-06 has been analyzed. The area under forest has declined by 3.69 per cent in 2005-06 as compared to that in 2000-01 (Table 2.1.1). Similarly, waste land has also declined by 6.56 per cent in 2000-01 as compared to that in 2005-06. The decline in forest land and waste land is due to utilization of these lands for nonagricultural purposes. The permanent pasture and other grazing land, land under miscellaneous tree crops and groves and culturable waste land has increased by 38.50 per cent in 2005-06. Current fallow has increased by 1.62 per cent in 2005-06 as compared to 2000-01. Contrary to this, land under other fallow has shown a sharp decline by 94.82 per cent in 2005-06 as compared to 2000-01. Net area sown has shown a marginal increase of 4.88 per cent in 2005-06 as compared to 2000-01, whereas area sown more than once has declined by 5.89 per cent in 2005-06. As a result cropping intensity in 2005-06 has declined to 125.42 per cent in 2005-06 from 128.30 per cent in 2000-01.

Table 2.1.1 Land use change scenario of Gondia district

(Area in ha)

Land use categories	2000-01	2005-06	Percentage increase (+)/ decrease (-)
Total geographical area	585895 (100.00)	585900 (100.00)	
Forest	215115 (36.72)	207500 (35.41)	-3.69
Not for cultivation			
Non-Agril. Land	49467 (8.44)	53200 (9.08)	+7.05
Waste land	22002 (3.76)	13300 (2.27)	-6.56
Other uncultivated land	92087 (15.72)	112000 (11.35)	+38.50
(Permanent pasture + Misc. tree crops and groves + culturable wasteland)			
Fallow land			
Current fallow	10720 (1.83)	10900 (1.86)	+1.62
Other fallow	22365 (3.82)	6100 (1.04)	-267.34
Area under agricultural use			
Net sown area	173959 (29.69)	182900 (31.21)	+4.88
Total cropped area	223198	229400	+2.70
Total (More than once)	49239	46500	-5.89
Cropping Intensity (%)	128.30	125.42	-2.30

Figures in parentheses indicate percentage of reporting area. Source: Socio-economic review of Gondia district, Maharashtra, 2009)

2.1b. Estimating saturated hydraulic conductivity, and bulk density of the Vertisols and vertic intergrades from published research and soil survey data

N. G. Patil, C. Mandal, D. K. Mandal and D. K. Pal

Seven water retention functions were fitted to the measured soil water retention data available in DST project report. Four of them, namely, Brooks-Corey (BC), Campbell, Campbell-Hutson (CH) and Van Genuchten (VG) were found to be acceptable based on statistical criteria. The statistical indices (Table 2.1.2) indicate that the Campbell-Hutson (CH) function described water retention characteristics of the soils better than other functions. However, the difference among the four functions was narrow. All the four functions exhibited RMSE < 0.05 $\rm m^3 m^3$ and hence considered at par.

Table 2.1.2 Statistical indices to judge efficacy of water retention functions

Function	ВС	CAMPBELL	СН	VG
RMSE	0.0279	0.0212	0.0189	0.02356
D	0.9251	0.9609	0.9666	0.93914
ME	0.0992	0.0983	0.0561	0.07206
MAE	0.0203	0.0145	0.0146	0.01977

D-degree of agreement, ME-maximum error,
MAF-maximum absolute error

Statistical regression equations developed to relate saturated hydraulic conductivity (SHC) and other soil properties indicated that the structural properties as well as chemical properties influenced the SHC (Table 2.1.3). However, regression pedotransfer functions (PTF) showed large estimation errors. Robust regressions could not be developed from the data. However it was evident from the regression coefficients presented below that the variables influencing SHC in order of magnitude were clay, sand, ESP and SAR.

Table 2.1.3 Regression coefficients indicating influence on SHC of Vertisols

Soil property	Regression coefficients
Sand	0.32
Silt	0.13
Clay	-0.42
BD	-0.10
COLE	0.07
FC	-0.14
CEC	-0.17
Exch Ca/Mg	-0.12
ECP	-0.09
EMP	-0.10
ESP	0.25
SAR	0.21
PWP	-0.18

Statistical and neural regression PTFs were also derived to estimate bulk density. Five levels of input information were identified for establishing dependencies between basic soil properties and bulk density. Logarithmic transformation was applied to the bulk density values for better representation of the data. Following inputs were used for developing hierarchical PTFs.

- Input level 1 Textural data (data on sand, silt, and clay fraction-SSC)
- Input level 2 Level 1+bulk density data (1+FC)
- Input level 3 Level 2+permanent wilting point (2+PWP)
- Input level 4 Data on sand, silt, FC
- Input level 5 Data on sand, silt, FC and PWP

Evaluation of the performance of PTFs showed that the equations were not in reliance with the data. However, neural PTFs performed better than statistical PTFs. PTF utilizing minimum information (sand, silt, and clay) were of lowest value as indicated by the statistical indices for testing. It was observed that the networks fitted to the observed data well with lower RMSE (0.02) and other errors, d (0.81) and R² (0.52). But, when tested against subset, the magnitude of error(s) increased with poor R² (0.05) and d (0.19). The inclusion of FC as an input variable, the PTF performance declined. In fact, amongst all PTFs, the PTF using textural information and FC was observed.

to be of lowest utility value. Highest prediction error was indicated by RMSE, R², ME and MAE values. The increase in input variables by inclusion of permanent wilting point (PWP) led to reduced RMSE but indices were not better than that of basic PTF based on texture. When clay was excluded as an input variable, there was definite improvement in PTF performance. The best performing PTF included sand, silt, FC and PWP as input variables implying that the measures of structure as well as information on pore structure was essential to predict bulk density accurately. Exclusion of clay as an input variable led to improvement in PTF performance probably due to the fact that the clay content was always above 40% with low coefficient of variation that caused difficulty in training networks. The best performing PTF (input sand, silt, FC and PWP) had lowest RMSE (0.01), MAE (0.01) the highest d (0.95) and R² (0.83) when networks were fitted to the measured data. It also had the lowest RMSE (0.01), MAE (0.01) and the highest d (0.7) and $R^2(0.65)$ when tested for predictive ability (Fig. 2.1.2).

2.1c. Development of pedotransfer functions for estimation of saturated hydraulic conductivity of Vertisols

N.G. Patil

Pedotransfer functions were developed for estimating saturated hydraulic conductivity of Vertisols using available data on soil properties. Soil profile information of 26 representative sites comprising 157 soil samples was used for PTF development. Four levels of input information were used namely, 1) Textural data (data on sand, silt, and clay fraction-SSC) 2) Level 1+bulk density data (SSCBD) 3) Level 2+organic matter (SSCBDOM) and 4) Level 3+organic matter (SSCOM). PTFs for estimating field capacity and permanent wilting point were also calibrated. Irrespective of the input variables (texture, bulk density, organic carbon content etc.), the root mean square error in predicting saturated hydraulic conductivity using PTFs resulted in high magnitude (>2 cm d⁻¹). The PTFs were therefore considered unacceptable.

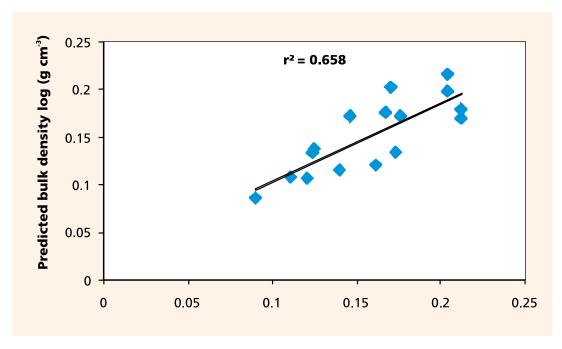


Fig. 2.1.2 Correspondence between measured and predicted bulk density values with sand, silt fractions and moisture constants (FC and PWP) data as an input in derived PTF

2.2

Division of Remote Sensing Applications

2.2a. Development of soil reflectance libraries for characterization of soil properties in Nagpur district, Maharashtra

Rajeev Srivastava, A.K. Maji, M.S.S. Nagaraju and A.K. Barthwal

The soil samples collected were analysed and interpreted to establish relationships between various soil and their reflectance properties:

Correlation between derivative reflectance data and soil properties

The correlation coefficient (r) between different soil properties and derivative soil reflectance data at different wavelength indicate that sand had significant positive correlation with derivative soil reflectance at all the wavelengths except between 1370-1400, 1850-1900, 2130-2200 and 2250-3500 nm where it showed negative correlation. On the contrary, the silt and clay showed negative correlation with soil reflectance at most of the wavelength except 1370-1400, 1850-1900, 2130-2200 and 2250-3500 nm where the correlation was positive.

Soil pH, EC, organic C, CaCO₃, Fe₂O₃, CEC, exchangeable cations (Ca, Mg, Na, K), DTPA-Zn and Cu showed significant negative correlation with derivative soil reflectance at most of the wavelengths whereas the effect of DTPA extractable Fe and Mn was positive on derivative soil reflectance.

Data indicated that most of the soil properties showed high correlation with derivative soil reflectance values near principal absorption features within the visible (400-600 nm) and short-wave infrared (1400, 1900, 2200, 2300, and 2400 nm) wavelength regions.

Prediction of soil properties from soil reflectance data

Development of calibration models for prediction of soil properties from soil reflectance dataset was done by dividing the whole dataset into two viz. calibration dataset and validation dataset. Derivative soil reflectance data of calibration dataset were calibrated with soil properties using stepwise multiple linear regression analysis. The number of samples used for calibration model, standard deviation (s.d.), coefficient of determination (\mathbb{R}^2) and standard error of calibration (SEC) values for different soil properties have been presented in table 2.2.1.

Table 2.2.1 Statistical parameters of calibration datasets and multiple linear regression equations of different soil properties using derivative soil reflectance data

Soil properties	No. of Samples used	s.d.	${f R}^2$	SEC
*Sand (%)	91	22.34	0.87	7.91
*Silt (%)	91	8.80	0.61	6.03
*Clay (%)	91	17.63	0.89	6.81
#Soil pH (1:2.5)	145	0.78	0.79	0.36
*EC (dSm ⁻¹)	145	0.13	0.37	0.13
*OC (%)	140	0.32	0.78	0.15

Cont.

#Ca [cmol (p+) kg-1]	100	13.93	0.85	7.59
#Mg [cmol (p+) kg-1]	100	4.83	0.57	3.79
#Na [cmol (p+) kg-1]	100	0.35	0.63	0.25
#K [cmol (p+) kg-1]	100	0.32	0.80	0.17
#CEC [cmol (p+) kg-1]	100	16.87	0.91	7.99
*CaCO ₃ (%)	116	3.86	0.78	1.89
*Fe ₂ O ₃ (%)	143	1.59	0.64	0.98
#Fe (mg kg ⁻¹)	130	10.22	0.86	3.99
#Mn (mg kg ⁻¹)	130	12.17	0.76	8.33
#Zn (mg kg-1)	130	0.21	0.28	0.20
#Cu (mg kg ⁻¹)	130	1.41	0.71	0.72

^{*}Square root transformation, #Logarithmic transformation

The data indicate that coefficient of determination (R²) values of different models of soil properties ranged between 0.61 and 0.91 with acceptable SEC values. Calibration R² value of <0.50 was considered unacceptable in this study, suggesting that calibration models of EC, and DTPA extractable Zn were poor and was dropped from further validation.

The calibration models of soil properties with R² values of >0.5 were used to predict the soil properties in the validation datasets. The statistical parameters viz. r²,

standard deviation (s.d.), standard error of prediction (SEP) and ratio of performance deviation (RPD) values obtained in the validation datasets for various soil properties are given in (Table 2.2.2).

The application of calibration models on the validation dataset resulted r² values for regression between 0.61 and 0.79 (Table 2.2.2). The scatter plot for observed and predicted values of different soil properties in both calibration and validation datasets are given in figures 2.2.1 and 2.2.2.

Table 2.2.2 Statistical parameters of validation datasets

Variable	No. of prediction Samples	Standard deviation	\mathbf{r}^2	SEP	RPD
Sand (%)	91	22.82	0.74	12.24	1.86
Silt (%)	91	8.69	0.45	6.53	1.33
Clay (%)	91	17.5	0.73	9.43	1.85
Soil pH (1:2.5)	145	0.77	0.72	0.41	1.87
OC (%)	180	0.32	0.70	0.18	1.82
Ca [cmol (p+) kg-1]	82	13.42	0.61	9.1	1.48
Mg [cmol (p+) kg-1]	82	5.22	0.34	4.38	1.19
Na [cmol (p+) kg-1]	82	0.29	0.28	0.25	1.18
K [cmol (p+) kg-1]	82	0.32	0.34	0.22	1.50
CEC [cmol (p+) kg-1]	82	16.84	0.70	7.79	2.16
CaCO ₃ (%)	111	4.05	0.62	2.62	1.54
Fe ₂ O ₃ (%)	147	1.50	0.53	1.05	1.43
Fe (mg kg ⁻¹)	130	9.26	0.79	4.39	2.11
Mn (mg kg ⁻¹)	130	14.26	0.24	14.04	1.02
Zn (mg kg ⁻¹)	130	0.19	0.20	0.17	1.07
Cu (mg kg ⁻¹)	130	1.29	0.77	0.66	1.96

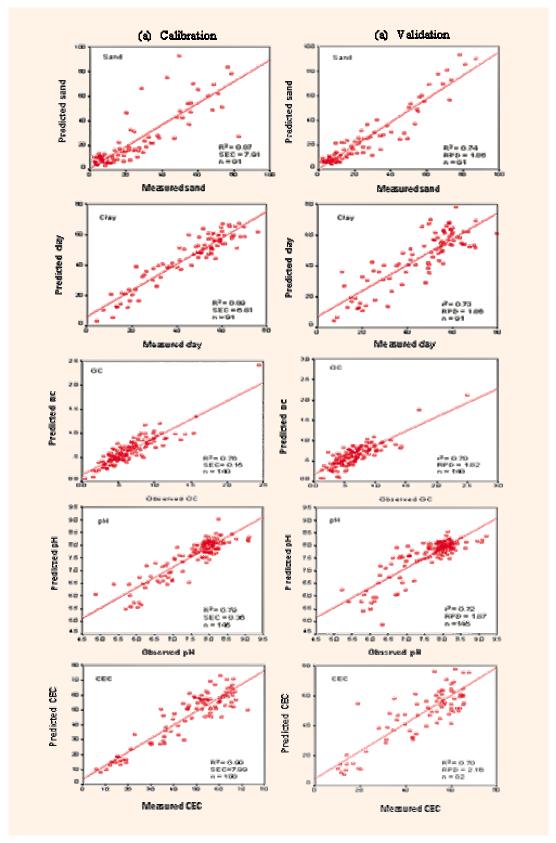


Fig. 2.2.1 Scatter plot of observed and predicted values of different soil properties (sand, clay, OC, pH, CEC) in both (a) calibration and (b) validation datasets

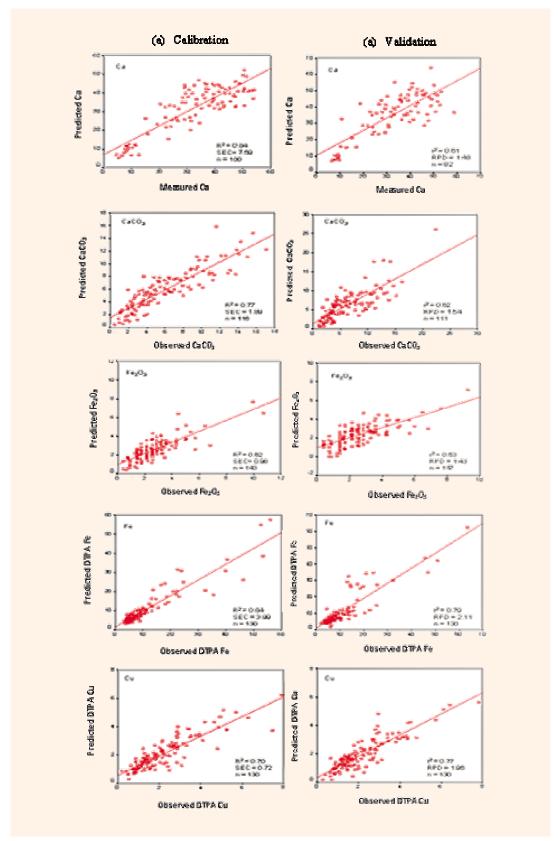


Fig. 2.2.2 Scatter plot of observed and predicted values of different soil properties (Ca, CaCO $_3$, Fe $_2$ O $_3$, DTPA Fe and Cu) in both calibration and validation datasets

Validation r^2 value of <0.50 for silt, EC, exch Mg, Na, K and DTPA-Zn and Mn indicate that the calibration model for these parameters are not suitable for reliable prediction of soil properties.

Usually in most of the spectroscopy techniques, the best calibration model is one which gives high coefficient of determination (r²) and high RPD values and low standard error of calibration (SEP) in the validation dataset. There are some reports which states that NIR reflectance spectroscopy technique had the ability to predict various properties of soil and which used 3 categories based on RPD in the ranges >2.0, 1.4-2.0 and <1.4 to indicate decreasing reliability of the prediction using this technique.

The data indicate that RPD values are more than 2.0 for CEC (2.16) and DTPA- Fe (2.11) which indicates good prediction of these properties from spectral data. The RPD values within 1.4-2.0, for sand (1.86), clay (1.85), soil pH (1.87), org. carbon (1.82), exch. Ca (1.48), Exh. K (1.50), CEC (2.16), CaCO $_3$ (1.54), DTPA-Fe (2.11) and DTPA-Cu (1.96) indicates reliable prediction of these soil properties whereas RPD values less than 1.4 for silt (1.33), exch Mg (1.19), exch Na (1.18), DTPA-Mn (1.02) and Zn (1.07) suggest that the prediction of these properties are not reliable.

2.2b. Integrated approach of remote sensing and GIS in land resources characterization, evaluation and mapping of Saraswati watershed in Buldana district of Maharashtra

M.S.S. Nagaraju, Rajeev Srivastava, A.K. Maji and A.K. Bartwal

Geographically, the Saraswati watershed is located between $19^{\circ}\,09'$ to $20^{\circ}\,01'$ N latitudes and $76^{\circ}\,26'$ to $76^{\circ}\,35'$ E longitudes in Mehkar tehsil of Buldana district, Maharashtra. The total area of the watershed is 10787.4 ha. The study area falls in the SOI Toposheet No. 55 D/12, 55 D/8, 56 A/5 and 56 A/9.

Land Use/Land Cover mapping

Cultivated land

Cultivated land mainly occurs on very gently sloping plateau, very gently sloping and gently sloping pediments, very gently sloping broad valley and narrow valley. On satellite data, crop land exhibits medium to dark gray with pink and red patches with bold checkerboard pattern and occupies an area of 8694.0 ha representing about 80.6 per cent of the total geographic area (TGA) of the watershed (Fig. 2.2.3).

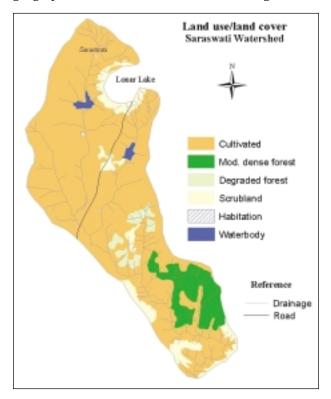


Fig. 2.2.3: Land use/land cover map of Saraswati watershed

Scrubland

On satellite data, scrubland exhibits light to medium gray, irregular shape with medium to coarse texture and occupies an area of 805.1 ha representing 7.5 per cent of the TGA. These are wastelands occurring on plateau and pediments and presently unutilized.

Forest land

Moderately dense forest in normal season exhibits dark red tone on the standard false colour composite (FCC) whereas in the study area it exhibited light to medium gray, irregular shape, medium texture and occupies an area of 926.4 ha representing 8.6 per cent of total watershed. It has been observed that moderately dense forest occurs mainly on plateau and pediments of the watershed. Degraded forest occurs on pediment areas of the watershed. This area exhibits medium gray, irregular shape with medium to coarse texture. It occupies an area of 252.7 ha representing 2.3 per cent of total watershed. The total forest occupies an 1179.1 ha representing 10.9 per cent of the TGA.

Slope

Slope map of the watershed was prepared from contour information available on SOI toposheet and using ground truth information. Two slope classes were identified as very gentle (1-3%) and gentle (3-8%) slope with 73.0 and 26.0 per cent area of the watershed respectively.

Physiography mapping

Based on interpretation of IRS-P6 LISS-III of March, 2008 data and subsequent ground truth verification, four major physiographic units viz. Plateau (P), Pediments (D), Broad valley (B) and Narrow valley (N) were identified. The major physiographic units were further sub-divided into eleven mapping units based on slope and land use/land cover. The physiography map is presented in figure 2.2.4.

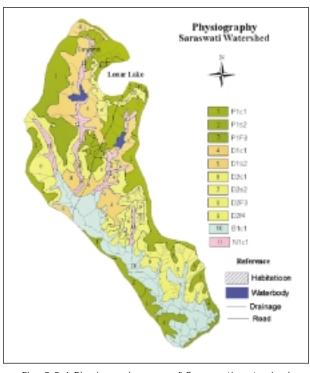


Fig. 2.2.4 Physiography map of Saraswati watershed

Plateau

The plateau is located in the upper reaches of the watershed with very gentle slope (1-3%). The elevation ranges from 540-580 m above MSL. It occupies an area of 3517.6 ha representing 32.6 per cent of the total watershed. The plateau is divided into three sub physiographic units viz. very gently sloping cropland (P1c1) and very gently sloping scrubland (P1s2).

Pediments

The pediment is moderately elevated area occur at middle reaches of the watershed with elevation ranging from 500-540 m above MSL. It is very gently sloping (1-3 %) and gently sloping (3-8%) land and occupies an area of 4571.5 ha representing 42.4 per cent of the total area of watershed. The pediment is subdivided into five sub physiographic units viz. very gently sloping crop land (D1c1), very gently sloping scrubland (D1s2), gently sloping crop land (D2c1), gently sloping scrubland (D2s2) and gently sloping moderately dense forest (D2F3).

Narrow valley

The narrow valley occurs at an elevation ranging from 500-520 m above MSL. It is very gently sloping (1-3 %) land and occupies 648.8 ha representing 6.0 per cent of total geographic area of the watershed. Narrow valley is divided into very gently sloping single crop land (N1c1).

Broad valley

This physiographic unit occurs at lower reaches of the watershed at an elevation ranging from 480-500 m above MSL. It is very gently sloping (1-3%) land and occupies an area of 1940.3 ha representing 18.0 per cent of the total geographic area of the watershed. The broad valley is mainly divided into very gently sloping crop land (B1c1).

2.3

Division of Soil Resource Studies

2.3a. Pedogenic threshold in benchmark soils under rice-wheat cropping sequence in a climosequence of the Indo-Gangetic Plains

D.K. Pal, S. Lal, T. Bhattacharyya, P. Chandran, S.K. Ray, P.L.A. Satyavathi, P. Raja, S.L. Durge and G.K. Kamble

Acquisition of data on the trends of climatic changes setting pedogenic thresholds may have decisive implications in the management of agricultural production of the IGP on the next millennium. For this basic information on soils with regard to their geomorphology and age and also their physical, chemical, mineralogical, micromorphological properties is necessary. Gathering such organized datasets on benchmark soils of the IGP appears to be mandatory to find out yield influencing soil and climatic parameters that would help to build up the future projections for the sustainability of R-W cropping system. At present information available in these areas is unorganized and incomplete. Therefore, a new initiatives in registering the relevant pedogenic thresholds and their interaction in a landscape are necessary to predict the crop behaviour. This way a soil-climate-crop data bank can be established for R-W system. Such data bank will have a unique status and value in providing a basic information platform to develop new and comprehensive system model required for the sustainability of R-W cropping system in the IGP.

The final project report (alongwith RPF III) has been submitted. The project report describes the morphological, physical, chemical, mineralogical and micromorphological properties of 30 benchmark

pedons spread in 7 states (Rajasthan, Punjab, Haryana, Uttarakhand, Uttar Pradesh, Bihar and West Bengal). In addition, information on the soil age is also available. The soils of the Indo-Gangetic Alluvial Plains (IGP) represent a climosequences from hot arid to perhumid climatic regions. The major pedogenic processes that are being operated during the Holocene period are reported. It also correlates the events of tectonic and climate to pedogenic processes leading to soil degradation e.g. development of soil sodicity. The tectonic and climate change events have been identified using tools of mineralogy and micromorphology. These tools have also helped in inferring the role of the rivers sourced in Rajmahal Deccan trap area and their influence in depositing the smectite clay mineral in the formation of soils with vertic character amidst the micaceous parent material brought by the rivers that are sourced in the Himalayan Oregon. These soils are being grown to mainly rice and wheat for the last several years and the use of agricultural implements has been for the last few decades to enhance the productivity. However, the recent trends of either declining or stagnation in the rice-wheat productivity needed an explanation. Investigations has revealed that the use of agricultural implements has caused remarkable enhancement of bulk density of subsoils, leading to impaired drainage of the soils in some cases to the extent of less than 10 mm h⁻¹, even in non-sodic soils. Such situation may help in maintaining the productivity of rice and also in the sequestration of organic carbon. But the impairment of drainage appears to cause the decline in wheat productivity. Use of water for supplemental irrigation has caused the increase in carbonate and bicarbonate ions of soil solution that caused dispersion of clay colloids and as a result drainage was impaired.

Thus this report provides a historical soil-climate-crop databank that may help in fine tuning the existing management intervention for the National Agricultural Research System. It also provides a robust dataset for the system modelers who are associated in research in predicting the future projections on the sustainability issues of the rice-wheat cropping system in the IGP.

Pedogenetic Process and Pedogenic threshold in a climosequence

Out of 30 soils undertaken for the study 4 soils belong to humid tropics (HT), 9 to semi-arid dry, 2 to semiarid moist - sub-humid dry, 2 to sub-humid dry, 10 to semi-arid moist, 1 to humid moist and 2 to perhumid climate. Soils belong to Entisols, Inceptisols, Alfisols and Vertisols. It is observed that irrespective of bioclimate 25 soils are Alfisols with (11 soils) and without (14 soils) vertic character. One soil belongs to Vertisols. The occurrence of variety of soil orders amidst micaceous alluvium of the IGP indicates that both pedogenetic processes and the parent material are not identical in all soils of the IGP under study. Among 30 soils, 2 (Zarifa Viran and Hirapur) still qualify for sodic soils. Sakit soils which were sodic, after reclamation they qualify for Haplustalfs. Similarly Haldi soils which were Mollisols, after about 25 years of cultivation they now qualify for Typic Haplustalfs.

In view of classification of these soils, it is realized that the major pedogenetic processes in these soils during the Holocene are addition and depletion (Haldi soils) of organic carbon, formation of CaCO₃, illuviation of clay particles and argilli-pedoturbation. Majority of the soils indicate their micaceous mineralogy excepting however in soils with vertic character. It is observed that Vertisols (Chunchura) have smectitic mineralogy appears not to have originated from micaceous minerals. Had micas weathered to so much amount of smectite in Chunchura soils, then all other non-vertic soils could have also smectitic mineralogy. The formation of Vertisols (Chunchura) and vertic intergrade (Hanrgram, Konarpara, Madhpur, Sasanga, Mohanpur, Sagar) thus needs to be understood in view of source area of the alluvium and the shifting of the rivers. The Old Fluvial/Deltaic Plain includes the Bhagirathi-Ajay Plain and Ajay-Silai Plain which trend along the northwest-southeast direction. Most of the

rivers originate in the western highlands and flows down the gentle slopes. However, towards southern part of Ajay-Silai Plain, the Dwarkeshwar, Silai and Kasai rivers show an angular drainage pattern and the flood plains of most of the rivers are incised. Moreover, some rivers are currently flowing along the southern margins of their flood plains. The Old Fluvial/Deltaic Plain also includes the Damodar Deltaic Plain which lies between the Damodar river in the west and the Hooghly river in the east. The Vertisols and vertic intergrades are represented by this plain. The Damodar river like other rivers stated above was flowing in the easterly direction to meet Bhagirathi during the middle of the 18th Century had since shifted its mouth 12 km to the south. These rivers flow from the west to the east draining the Rajmahal Trap area. The Rajmahal Traps consist of 2000 feet of bedded basalts or dolerites, with about 100 feet of interstratified sedimentary beds (intertrappean beds) of siliceous and carbonaceous clays and sand stones. The basalt is amygdaloidal filled with chalcedonic varieties of silica, calcite, zeolites or other secondary minerals. The rivers flowing in the vicinity of Rajmahal Trap are perennial in nature and huge amount of smectites were formed presumably due to higher rainfall. Therefore, in view of the geomorphic history and similar nature of smectites between Vertisols of Chunchura and Deccan basalt area, it is most likely that Vertisols of Chunchura and vertic intergrades at other places in Bihar (Ekchari, Sarthua) and West Bengal (Hanrgram, Konarpara, Madhpur, Sasanga, Mohanpur and Sagar) have been developed in the smectite-rich alluvium that has been carried from the Rajmahal Traps by the rivers once flowed towards the east and are flowing toward the south in the Bay of Bengal. Soils with vertic character in Uttar Pradesh (Hirapur, Sakit) and Punjab (Dhadde) might have also received smectite minerals as alluvium brought through rivers originated at base-rich rocks. Details are not known yet.

Weathering of micas, especially of biotite was substantial. Preferential movement of weathered products of biotite (trioctahedral expanding minerals) resulting in decreasing trend of clay mica is a sure test of clay illuviation, even when clay skins are absent. Clay illuviation in soils of the IGP has not always resulted in clay skins or, where present, in pure void argillans. Instead impure clay pedofeatures (ICPFs) are typical in these soils because of impairment of parallel orientation of clay platelets, a specific process different from those described so far for the genesis of less-oriented void argillans. The presence of ICPFs in soils with vertic character brings out a fact that the clay illviation is a more important pedogenetic process than argilli-turbation. Presence of pedogenic carbonates (PC) in soils (except Seoraguri soils) indicates that illuviation of clay particles and their subsequent accumulation in the Bt horizons of soils, especially of dry climate (HT, SAD, SAM, SHD & SHM) have occurred in a favourable pH condition higher than the zero point of charge required for full dispersion of clay, caused by the precipitation of soluble Ca²⁺ ions as CaCO₃. This discounts any role of soluble Ca²⁺ ions and the presence of CaCO₂ in preventing the movement and the accumulation of clay particles. The presence of compound clay pedofeatures (CCPF) bears the testimony to this fact. Thus the formation of ICPF and PC are two pedogenetic processes occurring simultaneously in soils of the IGP as contemporary pedogenetic events and may act as an example of pedogenic threshold in both dry and wet climates since the last 5000 yr BP.

Evidence of climate change and neotectonics

Fluvial landforms and alluvial sediments in the IGP are important Quaternary continental records, which hold potential for the examination of climatic, tectonic and lithological controls over their formation. In response to the global climatic event during the Quaternary, the IGP too witnessed climatic fluctuations, especially in the last post-glacial period. Frequent climatic changes occurred during the Quaternary. This paleoclimatic record has been documented from the NW and SW parts of India. Climatic variations has also been inferred from Holocene soils.

Presence of non-pedogenic carbonates (NPC) in soils of both dry and wet climates indicates its pedorelict features. The ¹⁴C dates of carbonate nodules studied by some authors indicate that soils with Fe-Mn coated glaebules are older than those with white glaebules (PC). PCs are generally formed in dry climates,

suggesting the NPCs were formed in a climate much wetter than the present, which ensured adequate soil water for reduction and oxidation of iron and manganese to form Fe-Mn coatings. During this time, the formation of kaolin as kaolinite-interstratified minerals of kaolinite and HIV/HIS might have occurred as the transformation of vermiculite and/or smectite to kaolin requires much wetter climate. The formation of ICPF and especially CCPF amidst the formation of PC however indicates the occurrence of dry phase in the climate when the clay illuviation was most active.

The presence of disrupted impure clay pedofeatures disrupted clay pedofeatures (DCPFs) in soils (Fig. 2.3.1) was so far considered as features of paleoclimatic significance. However, this does not adequately explain the genesis of DCPFs in soils of the IGP. Hence, the disruption must have been caused by stress and this way may also explain the formation of irregular, elongated, zigzag and broken voids and the poro/ parallel/unistrial/reticulate striation of the plasmic fabric. Such striation of plasmic fabric is observed in cracking clay soils with abundant clay smectite and a COLE >0.06. However, soils of the present study show stress in the plasmic fabric even when COLE < 0.06, which discounts the possibility of stress entirely by shrink-swell. Seismic activity (>5 on Richter's scale) in the IGP has been recorded quite extensively in the past including the Holocene. Compressed meanders and incision of channels identified in the FCC and LISS-II toposheets also indicate tectonic activity in the IGP. There is also support from geodetic observations that an area under tectonic compression undergoes horizontal movements and slow changes in height. This is the most likely factor to modify the otherwise flat terrain to produce a microtopography with microhigh (MH) and microlow (ML) positions. Sodic soils occupy these ML areas, 50-100 cm lower than the MH areas, which have less sodic soils. The DCPFs and irregular/ elongated/zigzag/broken voids could have been caused by the stresses induced by tectonic activity during the Holocene. By creating ML and MH sites, the tectonic activity may also have been ultimately responsible for the formation of more and less sodic soils like Zarifa Viran and Sakit.

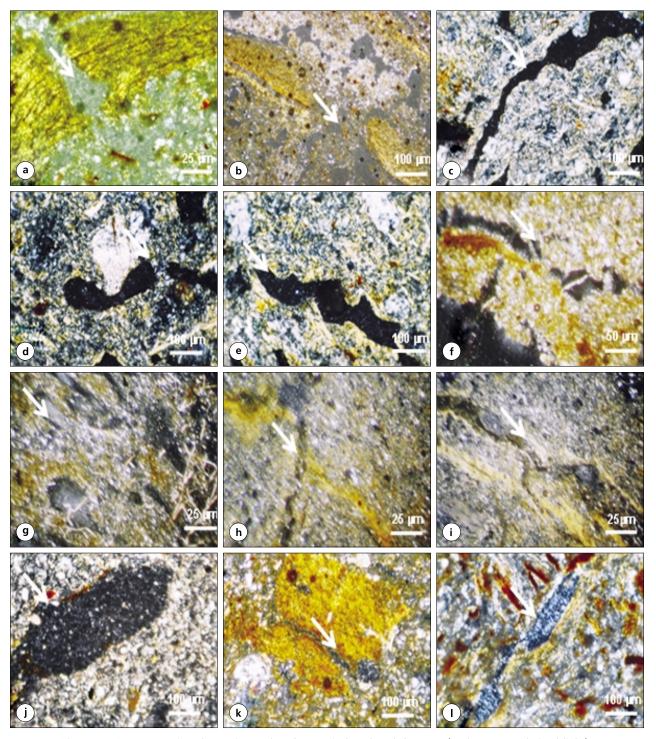


Fig. 2.3.1. Representative photomicrogrphs of stress induced pedofeatures (under cross polarized light)

- a. Clay pedofeatures, stretched and broken in Dhadde soils (Pedon 9, 122-130cm), Punjab.
- b. Impure clay pedofeatures (pf) coated over calcitic pf in unistrial b fabric in Dhadde soils (Pedon 9,122-130cm), Punjab.
- c. Crenulations in pedogenic carbonates in Sakit soils (Pedon 12, 54-62cm), Uttar Pradesh (U.P.).
- d. Zig-zag voids in Simri soils (Pedon 15, 108-116cm), U.P.
- e. Pygmatic folding in Simri soils (Pedon 15,108-116 cm), U.P.
- f. Papules and zig-zag voids in Belsar soils (Pedon 16, 93-101cm), Bihar.
- g. Elongated voids in Sarthua soils (Pedon 18, 106-114cm), Bihar.
- h. Offsetting in argillans of Sarthua soils (Pedon 18, 106-114cm) Bihar.
- i. Compressed argillans in Sarthua soils (Pedon 18,106-114cm) Bihar.
- j. Elongated voids in Konarpara soils (Pedon 23, 19-27cm), West Bengal.
- k. Broken clay pedofeature voids in Konarpara soils (Pedon 23,19-27cm), West Bengal.
- I. Pinch and swell voids in Mohanpur soils (Pedon 27, 82-88cm), West Bengal.

Degradation of soils and sustainability of rice-wheat cropping system

Soils under study had low organic carbon due to high rate of decomposition. In addition, the management interventions of the National Agricultural Research Systems (NARS) has caused depletion of soil organic carbon in erstwhile Mollisol (Haldi soils). The adverse climatic condition and excessive use of well/deep tube well waters induce precipitation of CaCO₂, thereby depriving the soils of Ca2+ ions on the soil exchange complex with a concomitant development of sodicity in the subsoils (Hirapur, Ghabdan, Sakit and Zarifa Viran soils). The subsoil sodicity impairs the hydraulic conductivity (sHC) of soils. The impairment of percolative moisture regime provides an example of a soil where gains exceeds losses. This self-terminating process leads to the formation of sodic soils with exchangeable sodium percentage (ESP) decreasing with depth. After reclamation with gypsum some sodic soils (Sakit) classified earlier as Typic Natrustalfs, now are Oxyaquic Vertic Haplustalfs. Formation of PC, a basic process initiating the development of sodicity, should be considered as a basic and natural process of soil degradation. It is noticed that despite being non-sodic, many of the soils have sHC <10 mm/hr. Impairment of sHC in such soils may possibly be attributed to the increase in bulk density (BD) in the subsoil layers. To produce bumper rice, wheat and potato crops, these soils under cultivation for the last 3 decades used all modern agricultural implements and irrigation. The rise in BD in subsoils may thus possibly be due to the compaction caused by implements used for cultivation. This situation, however, may be helping in maintaining yield of rice in rainy season and also in sequestering more soil organic carbon under sub-merged condition. But the yield of the subsequent crop like wheat is either plateuing or declining due to restriction of entry of air and water in the subsoils. Comparison of the data sets for 1980, 2005 and 2010 indicate an overall increase in soil organic carbon (SOC) stock in these benchmark spots under agriculture for more than two and a half decades. Although the level of soil inorganic carbon (SIC) has increased indicating an initiation of chemical degradation mainly in the wetter climates. Soil degradation in terms of development of sodicity in dry parts and also the rise in SIC and BD inspite of improved of SOC sequestration in such areas is a matter of serious concern. This warrants a fine-tuning of the existing management interventions the high crop productivity regions especially the north-west parts of the IGP following intensive rice-wheat cropping pattern.

In view of stagnating food grain production, the maintenance of the national buffer stock has

become more dependent on the countributions by the states with high crop productivity regions. Thus other states of the IGP deserve immediate attention so as to avoid the pitfalls encountered in the high productivity regions.

2.3b. Genesis and classification benchmark ferruginous soils of India

P. Chandran, S.K. Ray, T. Bhattacharyya, D. K. Pal and D. Sarkar

Ferruginous soils of Karnataka state developed from two different parent materials were studied for chemical as well as mineralogical properties to understand the genesis of these soils.

The Vijaypura soils (Bangalore) are presently in sub-humid dry ecosystem and formed from granitegneiss whereas Jamakhandi (Bijapur dist) soils are developed in the valleys filled in alluvium of sandstone and quartzite under semi-arid climate. Morphological properties indicate that the Vijaypura soils are red with 2.5 YR hue have sandy loam to sandy clay texture with well developed argillic horizons whereas Jamakhandi soils are reddish brown in colour (5YR hue).

Vijaypura soils are very strongly to moderately acid (pH: 4.6-5.6) with low organic carbon of 0.1 to 0.8% and CEC of 4.6 - 5.5 cmol(p)kg-1. In contrast, the soils of Jamkhandi are moderately to strongly alkaline (pH 8.1 to 8.6), medium in organic carbon and high in CEC (15 to 32 cmol p(+)kg-1) with depth wise increasing CaCO₃. These soils have base saturation >65% and dominance of Ca2+ ions on the exchange complex followed by Mg, Na and K. Well developed argillic horizons and high base saturation were reasons for grouping these soils in the subgroups of Alfisols.

X-ray diffraction studies indicate that kaolinite is the dominant mineral in all the size fractions of Vijaypura soils followed by small amounts of mica, whereas the soils of Jamakhandi are dominated by smectite, mica and kaolin along with feldspar. The behaviour of the 0.7nm peak to K-treatment and heating indicate that this mineral is interstratified with smectite. Fine clay smectites of the Bijapur soils are of both high and low charge density.

The climate and geomorphic history of the landscape played an important role in weathering and mineral transformation in these soils. The presence of discrete kaolinite, and absence of feldspars and other 2:1 mineral in Vijaypura soils indicate that these soils were developed on stable plateau surface in an earlier humid tropical climate. However, in the Jamkhandi soils developed in valley fills the presence of kaolin mineral is indicative of earlier humid climate and the presence of smectite and ${\rm CaCO}_3$ indicates the change of climate to arid in the recent past.

Thus it is clear that research endeavours in soil science is required to unravel the geomorphic and climatic history of the landscape wherein soils are being developed. Such studies are indicative of polygenesis of soils that has relevance in managing their nutrition and irrigation requirements.

The analytical work of the project has been completed. The data is being compiled and interpretation of the result and the writing of project report is being done.

2.3c. Detailed Resource Soil Survey of Hayatnagar Research Farm of CRIDA, Hyderabad

P. Chandran, S.K. Ray, P. Raja, U.K. Maurya, S.L. Durge, A. M. Nimkar, D. K. Pal, T. Bhattacharyya, C. Mandal, M.S.S. Nagaraju and D. Sarkar

This project was initiated as per the request from the Director, CRIDA, Hyderabad to generate detailed soil information to carryout field experiments.

The farm was surveyed on 1:5000 scale using IKONOS imagery received from CRIDA. The soil map was finalized. The soils of the farm are shallow to deep, red, sandy loam to clay textured with well developed argillic horizon. These soils are developed from granite gneiss. The truncated soils have a thin A horizon and clay enriched B horizon with well developed argillans.

The laboratory analysis of the samples has been completed. The bulk density of the soils varies from 1.4 to $1.9 \, \text{Mg m}^3$. Available water content of the soil is low and ranges from 2.46 to 12.0%. EC of the soils are low. The calcium carbonate content varies from 0.8 to 8.5%.

The soils have high ESP in subsurface layers. This may be due to the prevailing aridic climate where in carbonate is precipitated from soil solution and the relative proportion of Na in the exchange sample is increasing. CEC of the subsoils are relatively high indicating the presence of active group of minerals. The status of micronutrients DTPA (Cu, Zn, Fe, Mn) indicate that majority of the surface soils are deficient in Zn (<0.5 mg/kg) but adequate in Cu, Fe and Mn.

Mineralogy: The silt and total clay fractions of the soils were subjected to X- ray diffraction analysis to identify the minerals present. X-ray diffraction patterns of the Ca-saturated samples of silt fraction (Fig. 2.3.2) indicate a dominant peak at 1.0 nm followed by 0.7 nm and 1.4 nm along with the peaks at 0.42nm and 0.32 to 0.31 nm. On glycolation, the 1.4 nm peak expands to 1.7 nm indicating the presence of swelling type mineral i.e. smectite. On K treatment, the 1.4 nm peak disappears and reinforces the 1.0 nm peak indicating a high-charge smectite. The intensity of the 1.0 nm peak of mica decreases slightly on glycolation indicating that the interstratifications of 1.0 nm and 1.4 nm mineral. This is more prominent in the fine clay fractions. The persistence of 0.7 nm peaks in glycolated samples and its collapse after heating at 550°C indicate the presence of kaolin. However, the 0.7 nm peak is branched at its tip and has a broad base stretching towards the low angle side. This clearly indicates that this mineral is not a true kaolinite but interstratified with 2:1 mineral. The small peaks at 0.32 to .031 indicate the presence of feldspars.

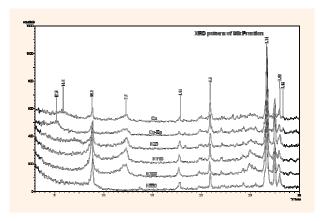


Fig. 2.3.2. Diffraction pattern of silt (Bt horizon) fraction. (Ca=Ca saturated; Ca-EG=Ca-saturated and ethylene-glycol solvated, K25, 110,300 and 500 are K-saturated and heated at 25,110,300 and 500°C respectively; Sm=smectite; M=mica; K=kaolin, Q=quartz, F=feldspars)

The X-ray pattern of the clay fraction (Fig. 2.3.3) indicates the presence of mica (1.0 nm), and kaolin (0.7 nm) along with small amount of 1.4 nm mineral. The 1.4 nm peak on glycolation shifts entirely to 1.7 nm indicating the presence of smectite. On K treatment and subsequent heating, this peak disappears and reinforces the 1.0 nm peak. This confirms that 1.4 nm mineral is a smectite. The decrease in intensities of 1.0 nm and 0.7 nm peaks on glycolation indicate that the mica and kaolin are interstratified with swelling type of minerals. This is more prominent for 0.7 nm

mineral than the 1.0 nm minerals. The presence of 0.7 nm minerals interstratified with 1.4 nm minerals is more common in the ferruginous soils of India.

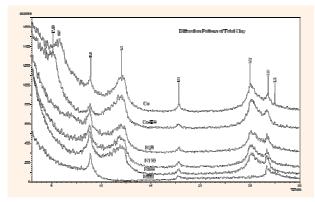


Fig. 2.3.3. Diffraction pattern of total clay (Ca=Ca saturated; Ca-EG=Ca-saturated and ethylene-glycol solvated, K25, 110,300 and 500 are K-saturated and heated at 25,110,300 and 500°C respectively; Sm=smectite; M=mica; K=kaolin, Q=quartz, F=feldspars)

Thus the morphological, physical, chemical and mineralogical properties clearly indicate that due to truncation of the soils developed in the earlier humid tropical climate, the present day soils are the relatively unweathered part of the profile developed on granitegneiss. Thus the present soils have a distinct advantage from the resource point of view and are better placed in terms of water and nutrient management

2.3d. Development of protocols for digestion, standards and methods to determine elements in soil and sediments using Inductively Coupled Plasma Spectrometry (ICP-AES).

S.K. Ray, P. Chandran, T. Bhattacharyya, P.L.A. Satyavathi, D.K. Pal, S. G. Anantwar and P. Raja,

Microwave digestion of soil samples

One of the objectives of the project includes preparation of digestion protocols for analysis in the ICP. We tried this experiment with Si using the following methodology.

1.0 ml of standard 10.000 ppm solution of silica, $0.0540~\rm gm~SiO_2$ (A.R. grade) and 5 ml of clay suspension of known weight were weighed into the different teflon vessels (bombs) of the microwave digestor. Then 4 ml of HF solution (48%) and 2 ml $\rm HClO_4$ solution (70%) were added to each Teflon vessel and then digested in a microwave digester system using following programme (Table 2.3.1).

Table 2.3.1 Programme for digestion of silicon and other clay samples in a microwave digestor*

Stop	Time	Power
1	00.05.00	250
2	00.05.00	400
3	00.05.00	650
4	00.05.00	250

^{*} Vent 00.05.00, Rotor control on, Twist - on

After cooling at air temperature (with the lids closed intact), all teflon vessels were kept in fridge for 24 hours in order to condense the $\mathrm{SiF_4}$ vapours. Then 4% boric acid solution was added and digested in the microwave digestor using the same above programme. After cooling, the contents of the teflon vessel was quantitatively transferred to 100 ml plastic volumetric flask and diluted to the mark with double distilled water.

Analysis on ICP

These extract were read on ICP (Prodigy) (Teledyne Leeman Labs Prodigy High dispersion ICP) for Si following instrument operating conditions shown in table 2.3.2.

Table 2.3.2 Leeman Prodigy's operating parameters.

Parameter	Setting	Wavelength
RF power	1.3 kw	288.158
Torch type	Dual view quartz	251.611
Coolent flow	18 l/min	-
Auxillary flow	0-1 l/min	250
Plasma view	Axial	-
Nebulizer Pressure	36 PSI	_

Maximum plasma position was fixed by using a 10 ppm Mn standard automatically selected by the Prodigy's software (Salsa). After ignition of the plasma, the ICP was calibrated using 2, 6 and 12 ppm Si standard solution and the matrix of the standards were matched to calibrate the standards. Single element standards for Si was used for calibration of the element.

Analysis of high solid containing solution on ICP

Solutions containing high solids and organic extracts were tested on the ICP. High solids include 0.25 N EDTA solution. The high Na in this extract poses problem of spattering of the plasma and ultimately it is put off. A v-groove nebulizer is used for the purpose to enable least obstruction. The EDTA extracts were analysed for Fe, Al, Mg, Ca and K. Standards were used with same concentration of EDTA.

2.3e. Ascertaining the pedogenetic processes for the clay enriched Bss horizons of Vertisols

P.L.A. Satyavathi, S.K. Ray, P. Chandran, P. Raja, S.L. Durge and D.K. Pal

Different size fractions of silt (coarse silt, 50-20 µm; medium silt, 20-6 µm and fine silt, 6-2 µm) and clay (coarse clay, 2-0.6 µm; medium clay, 0.6-0.2 µm and fine clay < 0.2 µm) of a Vertisol from Bhatumbra, Bhalki tehsil, Bidar, Karnataka were studied by means of X-ray diffraction. The pedon is classified as very fine, smectitic, isohyperthermic family of Udic Haplustert.

The results indicate that coarse silt (CS) (Fig. 2.3.4) and medium silt (MS) (Fig. 2.3.5) consists of mainly quartz and feldspars with minor amounts of kaolin, mica, chlorite, vermiculite and smectite. Fine silt (FS) consists of smectite, vermiculite, chlorite, mica, kaolin, quartz and feldspars (Fig. 2.3.6). The coarse clay (CC) fractions contain other layer silicates in addition to the dominant presence of fairly well crystalline smectite (Fig. 2.3.7). Vermiculite, chlorite, mica, kaolin, quartz and feldspars are recognized as accessory minerals. The amount of smectite is more in the medium clay (MC) fractions, which also contain moderate to minor

amounts of vermiculite, chlorite, mica, kaolin and quartz (Fig. 2.3.8). The fine clay (FC) fractions are composed of smectite (Fig. 2.3.9). They do not show any sign of transformation except for hydroxyinterlayering. The degree of hydroxy-interlayering in fine clays has been observed in soils in terms of formation of pedogenic chlorite.

Smectite was the dominant clay mineral in clay size fractions at all depths. Vermiculite was found from traces to 11% in all size fractions except in FC, where it ranged from nil to traces. Such rare presence of vermiculite in the fine clay fractions suggests that mica had no role of mica in the formation of huge amount of smectite. The depthwise distribution of minerals in soil size fractions either does not follow any specific pattern or the variations with depth are slight. The values of feldspars and quartz were high in silt fractions and quite low in clay fractions. Plagioclases dominated over potassic feldspars in the studied soils. Semiquantitative estimates of these minerals are furnished in table 2.3.3.

Silt and clay size fractions (CS, MS, FS, CC, MC and FC) pertaining to the above profiles were made chloride free and were digested in microwave with aqua regia and HF to estimate their chemical composition.

Table 2.3.3 Semi-quantitative estimates of minerals of soils located in village Bhatumbra, Bhalki tehsil, Bidar, Karnataka representing semi-arid (moist) region

Horizon	Depth	Fraction	Smectite	Vermi-	Chlorite	Mica	Kaolin	Quartz	F	eldspars
	(cm)			culite					K	Na & Ca
Ap	0-12	CS	10	1	1	Tr	2	38	15	33
		MS	15	2	2	2	1	38	11	29
		FS	23	1	7	4	4	33	11	17
		CC	35	1	11	9	9	22	_	13
		MC	84	2	9	2	1	2	_	_
		FC	99	_	_	1	_	_	_	_
Bw	12-37	CS	8	1	Tr	1	1	28	10	51
		MS	11	2	1	2	1	35	12	36
		FS	15	5	4	9	6	32	11	18
		CC	35	5	13	7	8	17	_	15
		MC	80	11	4	2	1	2	_	_
		FC	99	Tr	_	1	_	_	_	_
Bss1	37-79	CS	7	Tr	Tr	1	Tr	24	12	56
		MS	12	1	1	3	9	32	15	27
		FS	15	3	4	6	11	29	11	21
		CC	29	4	4	7	15	17	8	16
		MC	76	10	6	2	2	4	_	_
		FC	99	_	_	1	_	_	_	_
Bsss2	79-110	CS	7	2	1	1	2	28	23	36
		MS	10	4	1	2	1	35	18	29
		FS	17	2	9	2	5	31	13	21
		CC	31	7	8	8	10	24	5	7
		MC	74	7	9	3	2	5	_	_
		FC	99	_	_	1	_	_	_	_

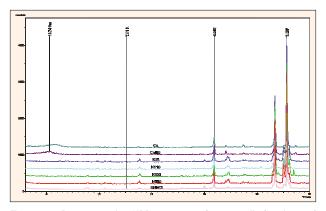


Fig. 2.3.4. Representative XRD patterns of coarse silt fractions of surface (Ap) layer(0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated;6NHCl=6N HCl treated and Ca-saturated

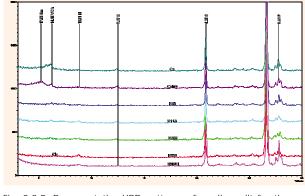


Fig. 2.3.5. Representative XRD patterns of medium silt fractions of surface (Ap) layer(0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated;6NHCl=6N HCl treated and Ca-saturated

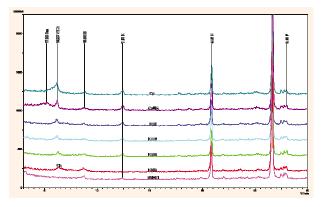


Fig. 2.3.6. Representative XRD patterns of fine silt fractions of surface (Ap) layer (0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated; 6NHCl=6N HCl treated and Ca-saturated

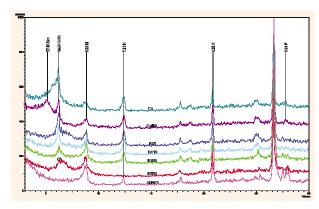


Fig. 2.3.7. Representative XRD patterns of coarse clay fractions of surface (Ap) layer (0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated;6NHCl=6N HCl treated and Ca-saturated

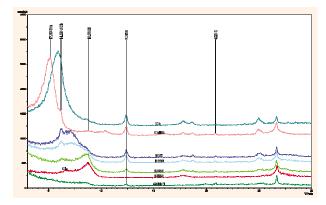


Fig. 2.3.8. Representative XRD patterns of medium clay fractions of surface (Ap) layer(0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated; 6NHCl=6N HCl treated and Ca-saturated

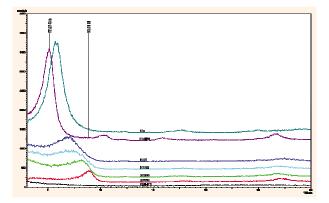


Fig. 2.3.9. Representative XRD patterns of fine clay fractions of surface (Ap) layer (0-12cm) of Bhatumbra soil, Bidar, Karnataka. Sm=Smectite, V=Vermiculite, Ch=Chlorite, M=Mica, K=Kaolin, Q=Quartz, F=Feldspar; Ca=Ca-saturated; CaEG=Ca-saturated and Ethylene glycol solvated; K25/110/300/550° C=K-saturated and heated; 6NHCl=6N HCl treated and Ca-saturated

2.3f. Reconnaissance soil survey in Yavatmal district, Maharahtra

B.P. Bhaskar, M.S. Gaikwad, S.V. Bobade and S.S. Gaikwad

A soil database of Yavatmal district on 1:50000 scale was generated to evaluate the ability of land units to support cotton production. Soil and a topographic map were combined to provide information on spatial variability of soils, terrain type and land use. The low regional cotton yields require relooking into the crop -

soil management program with the knowledge of site variables that affect cotton yield. 10.1 lakh hectares (74% of total area) of area covered during Reconnaissance survey of reporting period and identified 28 soil series. 39 soil mapping units (Series association) are derived to generate soil map. Out of 28 identified soil series, 16 soil series are described and presented selected morphological, particle size and chemical properties in tables 2.3.4 and 2.3.5. These soils are classified upto family level in the soil orders of Entisols, Inceptisols and Vertisols.

Table 2.3.4 Selected morphology, clay, CEC and DTPA extractable iron and zinc contents in soils

Profile	Depth (cm)	Horizon	pН	ECdSm ⁻³	Exchanag	geable bases	s (cmol/kg)	
					Ca	Mg	Na	K
Profile 1. Moho	0-7	A	7.0	0.12	23.50	13.33	0.13	0.28
	7-23	AC	7.3	0.10	26.09	17.97	0.17	0.31
Profile 2. Dhanora	0-13	Ap	8.0	0.23	45.9	7.6	0.16	0.93
	13-30	Bw	8.2	0.18	50.8	6.4	0.17	0.82
Profile 3. Jamwadi	0-20	Ap	7.6	0.12	41.10	14.78	0.11	0.43
	20-40	Bw1	7.5	0.17	47.82	15.07	0.19	0.35
Profile 4. Arunavati	0-19	Ap	8.4	0.17	63.77	10.37	0.21	0.58
	19-55	BCk1	8.5	0.15	74.14	13.96	0.23	0.13
	55-95	BCk2	8.6	0.14	49.30	15.64	0.48	0.09
Profile 5. Pandhurna	0-13	Ap	8.1	0.11	49.14	7.34	0.16	0.28
	13-38	Bw1	8.2	0.12	55.71	7.83	0.22	0.23
	38-62	Bw2	8.2	0.14	52.09	8.70	0.17	0.28
	62-87	Bw3	8.2	0.15	56.55	8.94	0.16	0.19
	87-150	Bw4	8.3	0.25	56.85	12.57	0.20	0.32
Profile 6. Waghari	0-19	Ap	8.2	0.22	54.17	10.99	0.15	0.62
	19-48	Bw	8.4	0.15	71.22	11.27	0.17	0.35
Profile 7. Korta	0-20	Ap	8.0	0.18	43.18	12.83	0.20	0.93
	20-50	Bw	7.8	0.28	46.32	12.14	0.19	0.84
	50-60	Cr	8.3	0.19	55.29	9.38	0.14	0.72
Profile 8. Borgaon	0-16	Ap	8.3	0.23	68.88	7.42	0.10	1.27
	16-35	Bw1	8.3	0.21	72.62	10.20	0.15	0.47
	35-54	Bw2	8.5	0.19	71.82	13.76	0.14	0.71
	54-67	Bw3	8.6	0.17	67.11	14.89	0.13	0.24
Profile 9. Kalambi	0-20	Ap	7.8	0.20	43.63	8.97	0.12	0.86
	20-47	Bw1	8.2	0.20	60.84	7.62	0.13	0.82
	47-89	Bw2	8.3	0.16	70.14	8.31	0.19	1.32
Profile 10. Saykhed	0-19	Ap	8.3	0.34	57.7	6.93	0.40	1.29
	19-47	Bw	8.2	0.20	69.52	6.07	0.45	0.82
	47-82	Bss1	8.6	0.14	74.68	6.09	0.39	0.44
	82-118	Bss2	8.4	0.13	56.64	4.79	0.33	0.29
	118-150	Bss3	8.5	0.13	46.73	5.09	0.29	0.31
								cont

cont...

Drofile 11 Dhonki	0.15	Δn	70	0.00	11 05	7.02	0.15	0.55
Profile 11. Dhanki	0-15	Ap	7.8	0.09	44.85	7.93	0.15	0.55
	15-40	Bw	8.1	0.14	47.01	7.72	0.65	0.41
	40-75	Bss1	8.2	0.12	47.64	8.75	0.64	0.37
	75-115	Bss2	8.3	0.14	50.71	11.52	0.48	0.45
	115-170	Bss3	8.1	0.16	49.05	16.22	0.19	0.48
Profile 12. Wanodi	0-15	Ap	8.2	0.19	50.10	13.25	0.46	0.98
	15-42	Bw	8.3	0.19	49.95	12.86	0.55	0.65
	42-72	Bss1	8.4	0.12	45.13	20.39	0.35	0.50
	72-98	Bss2	8.4	0.13	46.45	25.12	0.31	0.36
	98-152	Bss3	8.3	0.14	50.14	25.81	0.36	0.50
Profile 13. Wani	0-12	Ap	8.1	0.21	51.96	3.39	.015	0.90
	12-42	Bw	8.3	0.16	63.76	2.99	0.14	0.76
	42-70	Bss1	8.4	0.16	67.25	3.67	0.17	1.16
	70-101	Bss2	8.2	0.17	68.20	4.16	0.18	0.82
	101-140	Bss3	8.2	0.17	71.48	5.28	0.24	0.89
Profile 14. Penganga	0-15	Ap	8.4	0.19	52.79	10.48	0.11	2.71
	15-50	Bw	8.3	0.20	50.50	17.39	0.41	0.95
	50-85	Bss1	8.3	0.22	52.23	19.88	0.53	0.92
	85-120	r	8.5	0.19	63.21	19.98	0.62	0.23
Profile 15. Katherwadi	0-12	Ap	8.4	0.14	42.96	17.05	0.73	0.54
	12-28	Bw1	8.6	0.21	52.71	18.91	1.76	0.47
	28-49	Bw2	8.8	0.33	46.97	17.62	4.90	0.59
	49-72	Bss1	9.0	0.46	47.39	19.63	9.36	0.62
	72-96	Bss2	9.3	0.67	41.69	24.36	11.36	0.57
Profile 16. Selodi	0-12	Ap	8.4	0.22	62.71	11.93	0.45	1.48
	12-38	Bw1	8.5	0.21	59.90	13.94	0.90	0.93
	38-71	Bss1	8.8	0.27	59.60	17.63	2.89	0.85
	71-103	Bss2	9.0	0.38	48.41	19.07	5.91	0.90
	103-150	Bss3	9.1	0.48	44.03	26.12	9.40	1.12

Table 2.3.5. Selected chemical properties of soils

Profile	Depth (cm)	Horizon	Matrix colour (moist)	Structure	Clay (%)	Fine clay (%)	CEC cmol (+) kg ⁻¹	DTPA Fe mg/kg ⁻¹	DTPA Zn
Profile 1. Moho	0-7	A	7.5YR3/2	m2sbk	36.9	20.7	53.04	10.53	1.47
	7-23	AC	5YR3/2	gr	53.5	34.2	50.13	10.69	0.88
Profile 2. Dhnora	0-13	Ap	10YR3/2	m3sbk	54.9	15.1	69.5	5.03	1.13
	13-30	Bw	10YR3/2	m3sbk	50.8	17.8	70.3	4.79	1.04
Profile 3. Jamwadi	0-20	Ap	10YR3/2	m2sbk	43.5	25.5	70.43	8.03	1.37
	20-40	Bw1	10YR3/1	m1sbk	54.0	34.8	74.78	7.69	1.69
Profile 4. Arunavati	0-19	Ap	10YR4/3	m1sbk	27.2	9.71	41.73	5.8	0.85
	19-55	BCk1	10YR5/4	m2sbk	26.6	11.3	43.47	5.9	0.66
	55-95	BCk2	10YR5/4	m1sbk	6.5	4.6	31.30	7.6	0.64
Profile 5. Pandhurna	0-13	Ap	10YR3/3	m2sbk	22.6	17.1	56.52	6.06	0.82
	13-38	Bw1	10YR3/3	m2sbk	32.3	18.9	58.26	5.08	0.75
	38-62	Bw2	10YR3/3	m1abk	33.3	26.4	53.91	5.90	0.72
	62-87	Bw3	10YR3/3	m1abk	33.1	15.5	52.17	6.42	0.79
	87-150	Bw4	10YR2/2	c3abk	52.2	34.2	46.08	5.74	0.77

	Profile 6. Waghari	0-19	Ap	10YR3/2	m2sbk	41.3	20.1	71.30	5.91	0.68
		19-48	Bw	10YR3/2	m2sbk	32.5	18.0	64.34	6.74	0.69
	Profile 7. Korta	0-20	Ap	7.5YR3/1	m2sbk	52.5	29.2	79.13	5.58	1.15
		20-50	Bw	7.5YR3/1	m3sbk	53.2	28.3	53.91	5.36	1.07
		50-60	Cr			28.9	10.5	54.78	5.34	0.98
	Profile 8. Borgaon	0-16	Ap	2.5Y4/2	m2sbk	49.5	16.8	70.43	5.60	0.92
		16-35	Bw1	2.5Y3/1	m2sbk	50.7	27.3	57.39	5.68	0.90
		35-54	Bw2	2.5Y5/3	m2sbk	55.3	16.9	43.87	5.64	0.89
		54-67	Bw3	2.5Y6/2	m2sbk	34.3	9.64	46.08	5.52	0.89
	Profile 9. Kalambi	0-20	Ap	10YR3/1.	m2sbk	58.5	28.4	69.5	7.44	1.44
		20-47	Bw1	10YR3/2	m2sbk	56.2	37.4	67.78	6.94	0.97
		47-89	Bw2	10YR4/3	m2sbk	23.1	13.1	53.91	7.62	0.75
	Profile 10. Saykhed	0-19	Ap	10YR3/3	m2sbk	41.9	15.0	63.47	6.09	0.81
		19-47	Bw	10YR3/3	m3abk	43.6	21.11	58.26	5.99	0.77
		47-82	Bss1	10YR3/4	c3abk	38.2	18.0	53.91	5.73	0.69
		82-118	Bss2	10YR4/3	m2sbk	15.1	9.5	41.73	6.72	0.75
		118-150	Bss3	10YR4/3	f1sbk	14.6	8.62	37.39	7.23	0.77
	Profile 11. Dhanki	0-15	Ap	10YR3/2	m2sbk	66.4	46.0	75.65	7.6	0.98
		15-40	Bw	10YR3/2	m3sbk	63.6	41.9	70.43	6.97	0.83
		40-75	Bss1	10YR3/1	c3abk	64.0	44.5	66.95	7.07	0.73
		75-115	Bss2	10YR3/2	c3abk	60.7	54.3	71.30	7.26	0.92
		115-170	Bss3	10YR4/3	m3abk	67.1	58.4	69.56	7.33	0.70
	Profile 12. Wanodi	0-15	Ap	10YR3/2	c3abk	54.2	16.9	57.39	7.49	0.65
		15-42	Bw	10YR3/2	c2abk	61.9	27.9	63.47	7.46	0.21
		42-72	Bss1	10YR3/3	m3abk	58.5	22.8	66.95	7.5	1.08
		72-98	Bss2	10YR3/3	m3abk	58.3	23.0	64.34	7.2	0.73
		98-152	Bss3	10YR3/3	m3abk	54.5	21.3	-		
	Profile 13. Wani	0-12	Ap	10YR3/1	m2sbk	44.1	20.7	58.26	6.03	0.9
		12-42	Bw	10YR3/1	m2sbk	48.6	22.5	57.39	6.14	0.84
		42-70	Bss1	10YR3/1	c3abk	48.9	24.1	60.86	6.09	0.71
		70-101	Bss2	10YR3/1	c3abk	48.5	24.8	56.52	6.16	0.83
		101-140	Bss3	10YR3/1	c3abk	46.5	27.3	52.04	6.45	0.8
	Profile 14. Penganga	0-15	Ap	10YR3/2	m2sbk	43.61	21.4	73.86	5.23	0.98
		15-50	Bw	10YR3/2	m3sbk	66.8	32.2	72.99	5.61	0.92
		50-85	Bss1	10YR3/2	c2abk	70.2	42.6	69.56	5.54	0.85
		85-120	Cr			31.3	16.4	70.40	6.12	0.84
	Profile 15. Katherwadi	0-12	Ap	10YR3/2	m3abk	50.9	22.8	55.65	7.07	0.66
		12-28	Bw1	10YR3/2	m2abk	55.3	26.3	58.26	7.12	0.78
		28-49	Bw2	10YR3/2	m2abk	54.7	28.6	53.91	7.42	0.96
		49-72	Bss1	10YR3/3	m2abk	57.2	30.7	58.26	7.40	0.76
		72-96	Bss2	10YR3/3	m2abk	51.1	21.7	56.5	7.28	0.69
	Profile 16. Selodi	0-12	Ap	10YR4/2	m2sbk	49.8	17.5	62.67	6.94	1.07
		12-38	Bw1	10YR4/2	m3abk	50.2	21.7	64.34	7.14	0.92
		38-71	Bss1	10YR3/2	m3abk	59.6	26.1	66.08	6.94	0.81
		71-103	Bss2	10YR3/2	c3abk	60.3	27.5	67.80	7.27	0.85
		103-150	Bss3	10YR4/2	c3abk	66.9	32.6	68.65	7.17	0.83
b										

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Soil series of Entisols

1. Moho series is a member of loamy, mixed, hyperthermic, family of Typic Ustorthents. This soil has dark yellowish brown (7.5YR 3/2), neutral, sandy clay loam A horizons and dark reddish brown (5YR3/2) AC horizons with partially weatherd basaltic Cr horizons. These soils are moderately shallow, excessively drained and mostly occur on steep slopes (15 to 30 per cent slopes) under thin to moderately dense mixed forest cover of teak, yen, tendu, bharati and palas. Ca(23 to 26 cmol(+)kg-1) is dominanat cation on exchange complex followed by Mg(13 to 17 cmol+kg-1) and potassium (0.28 to 0.31cmol(+)kg-1).

Soil series of Inceptisols

Eight soil series are classified in the subgroups of Inceptisols viz. Lithic Haplustepts (Dhanora and Jamwadi series), Typic Calciustepts (Arunavathi and Pandhurna soil series), Typic Haplustepts (Waghari, Korta and Borgaon series) and Vertic Haplustepts (Kalambi series).

Dhanora and Jamwadi Series are members of fine, mixed, hyperthermic, calcareous, family of Lithic Haplustepts. These soils have very dark grayish brown (10YR 3/2), moderately alkaline in dhanora series but mildly alkaline in Jamwadi series, clayeyA horizons and very dark grayish brown (10YR 3/2, in Dhnora series) to very dark gray(10YR3/1, Jamwadi series), clayey, cambic B horizons. These soils have exchangeable Ca more than 40 cmol(+)kg-1 and high exchangeable K (0.35 coml(+)kg-1 with a lithic contact within 50 cm. These soils are used for jowar, cotton, redgram and soybean cultivation.

Arunavati and Pandhurna series are members of fine, smectitic, hyperthermic, calcareous family of Typic Calciustepts. These soils have brown (10YR 4\3) or dark brown (10YR 3/3) clayey A horizons and dark brown(10YR 3/3) clayey to very dark brown (10YR 2/ 2) clayey B horizons. Arunavati series is strongly alkaline where as pandhurna series is slightly alkaline with low electrical conductivity and high exchangeable Ca of 49 to 74 cmol(+)kg-, Mg of 7 to 12 cmol(+)kg-1 and medium amounts of exchangeable K(0.25 to 0.17 cmol(+)kg-1). Arunavati is deep but pandhrna series is very deep and occurs mostly in flood plains of Pus and Penganga river. These soils are used for jowar-cottonredgram during kharif, wheat, bengal gram in rabi and groundnut in summer.

Waghari, Korta and Borgaon series are members of fine, mixed, montmorillonitic, hyperthermic, calcareous, family of Typic Haplustepts where as Korta **series** is a member of clayey, mixed, hyperthermic family of Typic Haplustepts. Waghari series has very dark grayish brown (10YR 3/2), clayey A horizons and very dark grayish brown (10YR 3/2 M), clayey B horizon where as Borgaon series has grayish brown (2.5Y 5/2), clayey, A horizons and very dark gray (2.5Y 3/1), clayey to light brownish gray (2.5Y 6/2), gravely claye, B horizons and Korta series has very dark gray (7.5YR3/ 1) clay A and B horizons. Moderately deep Korta series developed over granite is mildly alkaline whereas shallow Waghari and deep Borgaon on basalt are moderately to strongly alkaline with low electrical conductivity and high exchangeable Ca and Mg. These soils are well drained and found on upper pediplains having 3-8 per cent slopes. These soils are mostly under the cultivation of cotton, redgram, wheat, sugarcane and groundnut.

Kolambi series is a member of fine, smectitic, hyperthermic family of Vertic Haplustepts. This soil has very dark gray (10YR 3/1) clayey A horizons and very dark grayish brown (10YR 3|2) clayey B horizons possessing wedge shaped shiny pressure faces on ped surfaces. This soil is moderately deep, well drained and occur on moderately eroded middle plateaus having 3 to 5 per cent slopes. They are mostly under cultivation of jowar and cotton.

Soil Series of Vertisols

Seven soil series are classified in the subgroups of Vertisols viz. Typic Haplusterts (Saykheda, Dhanki and Wanodi series), Leptic Haplusterts(Penganga series) and Sodic Haplusterts (Katharwadi and Selodi series).

Saykheda, Dhanki, Wanodi(on basalt) and Wani (on sandstone) series are members of is fine, montmorillonitic, hyperthermic, calcareous family of Typic Haplusterts These soils have dark brown (10YR 3/3) clayey; A horizons and dark brown (10YR 3/3) clayey to dark yellowish brown (10YR 3/4) and brown (10YR 4/3 D) B horizon. These soils have mildly alkaline Ap horizons with moderately alkaline cambic and slickensided horizons. These soils generally found on gently sloping middle plateau tops of basaltic landscapes at an elevation of 380 to 420m above mean sea level. Only patches of plateaus are under the cultivation of pigeon pea, soybean and jowar.

Penganga series is a member of fine, smectitic (calcareous), hyperthermic family of Leptic Haplusterts

This soil has very dark grayish brown (10YR3/2) clay A horizons and. very dark grayish brown (10YR3/2) clay B horizon underlain by Cr horizon. This soil is moderately deep and moderately well drained.. This soil is found on gently to moderately sloping alluvial plains having slopes of 3 to 8 per cent at an elevation of 300 to 420 m above mean sea level. The soils have moderately developed strongly slickensides zone within 1 meter and are mostly cultivated to cotton, jowar, bajra, pigeonpea and soybean in kharif and occasionally to wheat, gram, sugarcane in patches under irrigation. The natural vegetation comprises of thin to moderately dense mixed forest with teak, salai, ber, tembhi, mahua, neem, and palas in upper plateaus. In southern part of Yavatmal (Ralegaon and Hirni areas), these soils occur on stony phase.

Kather wadi and Selodi series are members of fine, montmorillonitic, hyperthermic, calcareous family of Sodic Haplusterts. These soils have very dark grayish brown (10YR 3|2 M), clayey A horizons and very dark grayish brown (10YR 3|2 M), clayey, with well expressed slickensides and sodium enriched strongly alkaline B horizons. These soils are very deep and moderately well drained. They occur on alluvial

upper pediplains with slopes of 3-8 per cent. They are mostly under cultivation of jowar, cotton and pigeon pea.

2.3g. Reconnaissance soil survey, mapping and classification of soils of Jabalpur district, Madhya Pradesh

Jagdish Prasad and A.M. Nimkar

Jabalpur district with TGA of 519700 ha is situated between 22°49' to 24°81' N and 78°21' to 80°50' E. Although the district is associated with diverse geological formations, the soils in general do reflect the geology and majority of soils are shrink-swell in nature owing to sediments running from high basaltic plateaux to lower elements of topography. In general, high plateau has been reported to have 14-22 flows of traps. A total of fifty four soil series were identified but after correlation only forty two have been retained. There were twenty three physiographic units and these units were mapped with twenty one soil series association.

The soil series, their taxonomy (family level) and their land use have been shown in the table 2.3.6.

Table 2.3.6 Soil physiographic relationship

	Soil series association	Taxonomy (at family level)	Land use
Cr		Bijawar series Upper Precambrian Gondawana Superg ary (Dolomite, metabasics, metalawa, shale, sandstone,	
1.	Moderately sloping upper plateau	t	
	Ghunsor- Bamhori	Very fine, smectitic (cal) Typic Haplusterts Fine, smectitic (cal.) Vertic Haplustepts	Cultivated
2.	Gently to moderately sloping low	er plateau	
	Gokla-Umariya	Very fine, smectitic Vertic Haplustepts Very fine, smectitic Typic Haplusterts	Cultivated
3.	Escarpments		
	Amakhoi - Amzarghat	Clayey-skeletal, mixed Typic Ustorthents Clayey-skeletal, smectitic Vertic Haplustepts	Forest
4.	Elongated hills		
	Jamunia-Bhaderi	Loamy-skeletal, mixed Lithic Ustorthents Loamy-skeletal, mixed Lithic Ustorthents	Forest
5.	Subdued hills and ridges		
	Kundwara-II – Kundwara-II	Clayey, smectitic Lithic Ustorthents Fine, smectitic Vertic Haplustepts	Forest
6.	Stony-gravelly waste		
-	oper Gondwana Cretaceous & l granite)	Archean formation (sandstone, shales, conglor	nerates, clay, grit and

cont...

7.	Gently to moderately sloping plate	eau	
	Amjhar - Natwara	Fine, mixed Typic Haplustepts Very fine, smectitic (cal) Typic Haplusterts	Forest/cultivated
8.	Piedmont plain	v v v	
	Parora - Imaliya	Very fine, smectitic (cal) Typic Haplusterts Very fine, smectitic (cal) Vertic Haplustepts	Cultivated
9.	Intervening valley		
	Pariat - Bijapuri	Fine-loamy, mixed Typic Haplustepts Fine, smectitic Vertic Endoaquepts	Cultivated/Bamboo plantations
10.	Flood plain (dissected)		
	Dimarjhojhi - Gubrakalar	Fine, smectitic (cal) Vertic Haplustepts Very fine, smectitic (cal) Vertic Haplustepts	Cultivated
11.	Flood plain (gently sloping)		
	Khairi-Beharkela	Fine, smectitic (cal) Vertic Haplustepts Fine, mixed Vertic Haplustepts	Cultivated/Scrub land
12.	River Island plain		
	Pipariya – Tilwaraghat	Fine-loamy, smectitic Fluventic Haplustepts Fine, mixed, calcareous Typic Haplustepts	Cultivated/Bamboo plantations
13.	Narmada alluvial plain		
	Jodhpur-Narayanpur	Very fine, smectitic Typic Haplusterts Fine, smectitic (cal) Vertic Haplustepts	Cultivated/Orchards
Bas	saltic plateau		
14.	Gently to moderately sloping und	ulating plateau	
	Parasia-Mohani	Loamy, mixed Lithic Ustorthents Clayey, mixed Lithic Haplustepts	Cultivated/forest
15.	Flat topped hills/table land include	ing dissected hills	
	Pipariyafort - Samnapura	Clayey, smectitic Lithic Haplustepts Loamy, mixed Lithic Haplustalfs	Cultivated
16.	Upper piedmont plain		
	Sundradehi-Nayangar	Very fine, smectitic (cal) Vertic Haplustepts Very fine, smectitic Vertic Haplustepts	Cultivated
17.	Lower piedmont plain		
	Devari-Kheri	Fine, smectitic, (cal) Typic Haplusterts Very fine, smectitic Typic Haplusterts	Cultivated
18.	Rock outcrops		
19.	Flood plain (dissected)		
	Bargi-I – Parariya	Fine-loamy, mixed (cal) Typic Haplustepts Fine-loamy, mixed Fluventic Haplustepts	Cultivated/scrub land and pasture land
20.	Flood plain (gently sloping)		
	Kosamghat - Sakri	Fine, smectitic (cal) Fluventic Haplustepts Fine, smectitic Vertic Haplustepts	Cultivated
21.	Isolated hills		
	Hinotia-I – Hinotia-II	Clayey-skeletal, smectitic Lithic Ustorthents Clayey-skeletal, smectitic Typic Haplustepts	Forest
22.	Mesa		
	Bargi-II – Mehgawan	Loamy, mixed Lithic Usorthents Clayey-skeletal, smectitic Typic Ustorthents	Scrub land/Cultivated
23.	Mahanadi flood plain		
	Juhari - Chhitakhudri	Fine-loamy, smectitic Typic Haplustepts Very fine, smectitic Vertic Haplustepts	Forest/pasture/cultivated

The occurrence of clayey-skeletal Vertic Haplustepts on moderately steep slope (15-30%) having a depth of 56 cm underlain by weathered basalt and stones, clay

content (50-54%), surface stoniness (40-75%), fine and coarse gravels (15-25%) and stones (10-20%), as an unique soil, encountered during survey.

2.3h. Development of a soil water balance model for shrink-swell soils of Central India

P. Tiwary, D. K. Mandal and T. N. Hajare

Out of 62 soil profiles, the number of soil profiles used for developing PTFs was 39 with 200 layer observations in case of water retention and 54 with 230 layer observations for saturated hydraulic conductivity. Initially, based on the cause and effect relationship, correlation coefficient between the dependent variable and independent variables, and F values, the soil parameters viz. silt, clay, pH, organic carbon, CaCO₃, exchangeable sodium percentage (ESP), exchangeable magnesium percentage (EMP), exchangeable calcium percentage (ECP) and Ex. Ca/Mg were selected as predictor variables for developing PTFs. These soil parameters greatly influence the movement of soil water and water retention characteristics of a soil.

Using the step-wise regression and test of significance in SPSS, multiple regression models were developed as PTFs for estimating saturated hydraulic conductivity and water retention at 33 kPa and 1500 kPa. The soil parameters used as predictor variables in pedo-transfer functions are given in table 2.3.7.

Table 2.3.7 Predictor variables used in PTFs and R²

PTF	Predictor variables	\mathbb{R}^2
Water retention at 33 kPa	Clay and ECP	0.51
Water retention at 1500 kPa	Clay and ECP	0.56
Saturated hydraulic conductivity	Clay, pH and Ex. Ca/Mg	0.61

2.3i. Characterization and evaluation of carbon (SOC) and sulphur status in soybean growing areas of Dhar district, Madhya Pradesh to suggest an alternate cropping pattern

K. Karthikeyan, Jagdish Prasad, Pushpanjali and Dipak Sarkar

After having a detailed ground truth verification of the soybean growing areas of Dhar district, Madhya Pradesh, three window areas have been marked based on its concentration and its intensity of soyabean cultivation. The whole district comes under two physiographic units i.e., Malwa plateau and Nimad valley, of which Malwa plateau has more area under soybean crop particularly in three tehsils viz. Sardarpur (58,500 ha), Badnawar (55,000 ha) and Dhar (43,315 ha).

Three window areas were demarcated in the above mentioned tehsils i.e. Sardarpur, Badnawar and Dhar. Seven soil profiles were studied based on the physiographic variations as well as the soybean concentrations in the Malwa regions. Surface samples were also collected at regular interval from the window areas to have a depletion pattern of the sulphur and the organic carbon in the soybean growing areas. Physical and chemical analysis of these samples are in progress. Evaluation of alternate cropping pattern is also being worked out.

Geographical Information System (GIS)

2.4a. Design and development of spatial soil database and analysis in GIS

A.K. Maji, G.P. Obi Reddy and Sunil Meshram

The project aimed to generate the spatial database of soils at 1:250,000 scale for different states in the country. Soil information of states generated earlier on 1:500,000 scale were redigitized on a uniform scale of

1:250,000 using SOI toposheets of the same scale as the base in the GIS environment. The state wise soil information for the whole country has been generated. Presently, the compilation of state wise soil information is in progress in GIS to make the soil information of India on 1:250,000 scale in a single file. Corrections for errors in line layer have been completed for all the states except Jammu & Kashmir (Fig.2.4.1) and the work for finalization of database is in progress.

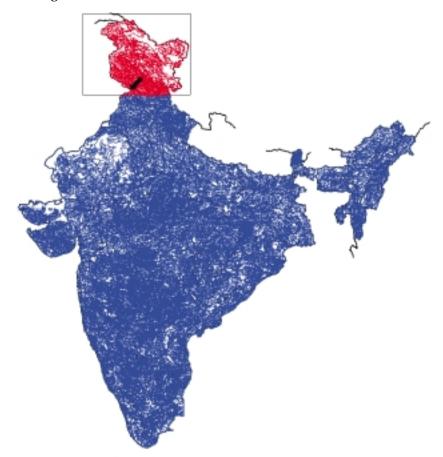
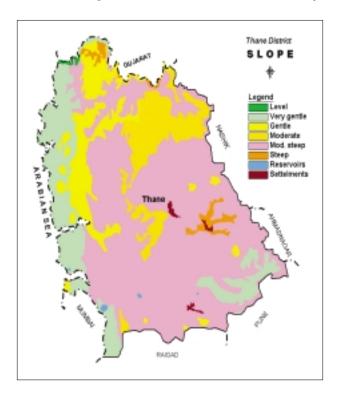
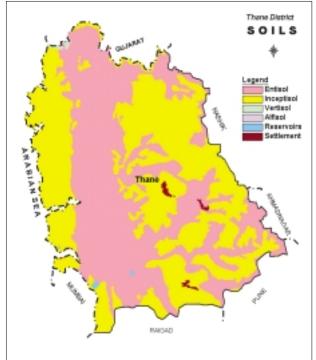


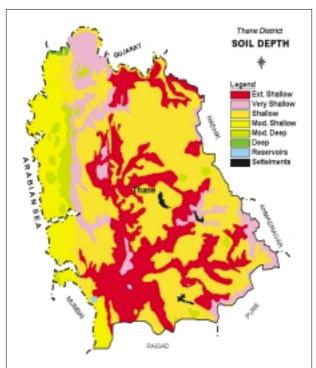
Fig. 2.4.1. Seamless maosaic soil resource database of India on 1:250,000 scale (in progress)

District level soil information: The digital level thematic information for agricultural planning on 1:250,000 scale generated by clipping the state thematic maps based on the district boundary.

Various thematic maps of soil parameters like slope soil depth and soil reaction (pH) generated for Thane district, Maharashtra has been depicted in fig. 2.4.2.







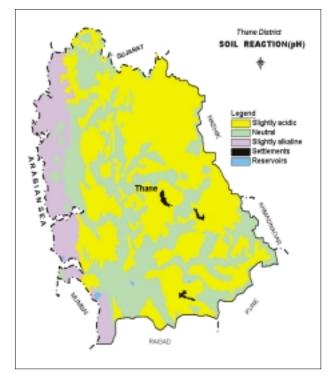
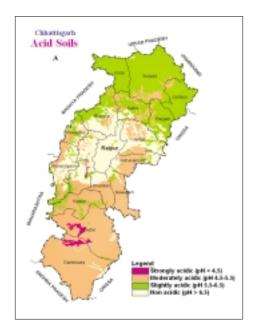


Fig. 2.4.2. Soil information at district level for Thane district of Maharashtra

2.4b. Digital maps of derived soil quality of different states of India

A.K. Maji, G.P. Obi Reddy and Sunil Meshram

The technical report on "Acid Soils of India" alongwith maps of 15 states showing the degree and areal extent of acid soils has been submitted for review. The acid soil map of Chhattisgarh and Arunachal Pradesh is shown in figure 2.4.3. The class wise distribution of acid soils in these two states is shown in figure 2.4.4. The areal distribution of acid soils in these states is reported in tables 2.4.1 and 2.4.2.



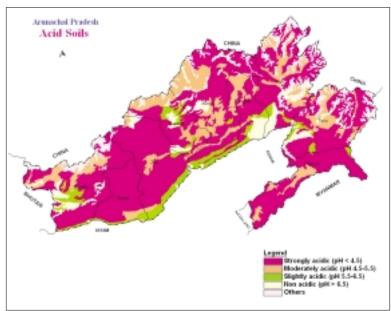
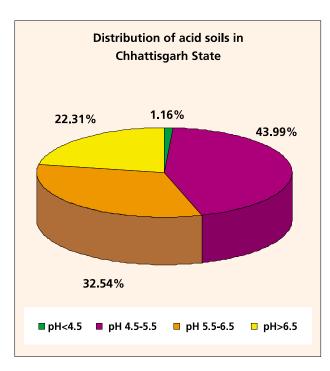


Fig. 2.4.3 Acid soil maps of Chattisgarh and Arunachal Pradesh



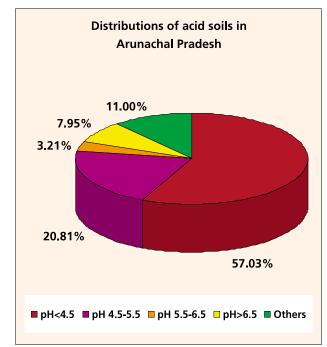


Fig. 2.4.4 Distribution of acid soils in Chattisgarh and Arunachal Pradesh

Table: 2.4.1 District wise area analysis of acid soils in Chhattisgarh state

Area Analysis of Acid Soils of Chhattisgarh State [District wise]

District Stongly acidic		acidic	Moderately acidic		Slightly a	Slightly acidic		idic	Total	
	pH < 4	4.5	pH 4.5-	5.5	pH 5.5-	-6-5	pH> 6	-5		
	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)
Bastar	763.39	0.57	13440.06	9.97	229.17	0.17	161.77	0.12	14599-38	10-83
Bilaspur	0.00	0.00	1253.69	0.93	3774.54	2.80	4327.24	3.21	9355-47	6.94
Dantewad	674.03	0.50	17268.52	12.81	13.48	0.01	485.30	0.36	18441.32	13.68
Dhamtari	0.00	0.00	2615.22	1.94	94.36	0.07	1253.69	0.93	3963.27	2.94
Durg	121.32	0.09	2049.04	1.52	741.43	0.55	5742.69	4.26	8654-48	6.42
Janjgir	0.00	0.00	1779.43	1.32	283.09	0.21	2318.65	1.72	4381-16	3.25
Jashpur	0.00	0.00	363.97	0.27	5594.41	4.15	0.00	0.00	5958.38	4.42
Kanker	0.00	0.00	5001.27	3.71	1577.22	1.17	0.00	0.00	6578-48	4.88
Kawardha	0.00	0.00	1159.32	0.86	1253.69	0.93	943.64	0.70	3356.64	2.49
Korba	0.00	0.00	1792.91	1.33	3370.13	2.50	741.43	0.55	5904-46	4.38
Koria	0.00	0.00	0.00	0.00	5917.94	4.39	0.00	0.00	5917.94	4.39
Mahasamund	0.00	0.00	2857.87	2.12	363.97	0.27	1482.86	1.10	4704-69	3.49
Raigarh	0.00	0.00	606.62	0.45	4515.97	3.35	1712.02	1.27	6834.61	5.07
Raipur	0.00	0.00	5041.71	3.74	539.22	0.40	7225.55	5.36	12806-48	9.50
Rajnandqaon	0.00	0.00	2426.49	1.80	1280.65	0.95	3626.25	2.69	7333.39	5.44
Surguja	0.00	0.00	1644.62	1.22	14316.29	10.62	53.92	0.04	16014-83	11.33
Total	1563.74	1.16	59300.72	43.99	43865.55	32.54	30075.00	22.31	134805	100

Table: 2.4.2 District wise area analysis of acid soils in Arunachal Pradesh state

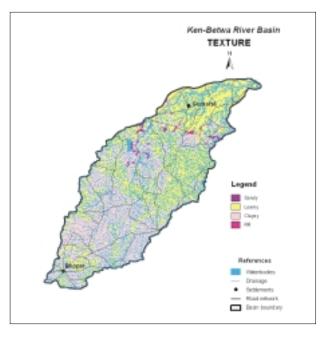
Area Analysis of Acid Soils of Arunachal Pradesh [District wise]

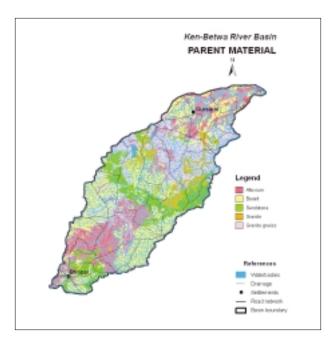
District	Stongly	acidic	Moderatel	y acidic	Slightly	acidic	Non ac	cidic	Others	Total	
	pH < 4.5		pH 4.5	-5.5	pH 5.	pH 5.5-6-5		6-5			
	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area (sq.km)	Area (%)	Area Area (sq.km) (%)	Area Area (sq.km) (%)	
Changlanq	587876	7.02	1046.79	1.25	8.37	0.01	8.37	0.01	0.00 0.00	6942-29 8.29	
Dibanq Velley	5560.54	6.64	2503.92	2.99	259.60	0.31	1272.89	1.52	3533.95 4.22	13130-90 15.68	
East Kameng	4321.14	5.16	200.98	0.24	0.00	0.00	0.00	0.00	0.00 0.00	4522-12 5.40	
East Siang	2219.19	2.65	1105.41	1.32	452.21	0.54	711.82	0.85	53.62 0.07	4547-24 5.43	
Lower Suhamsiri	7595.49	9.07	1565.99	1.87	100.49	0.12	318.22	0.38	267.98 0.32	9848-18 11.76	
Tezu	5929.00	7.08	1699.98	2.03	326.60	0.39	1214.27	1.45	1699.98 2.03	10869-84 12.98	
Upper Subansiri	2721.65	3.25	2596.03	3.10	653.20	0.78	703.44	0.84	870.93 1.04	7545-24 9.01	
West Kameng	5954.13	7.11	1733.48	2.07	778.81	0.93	1180.78	1.41	1272.89 1.52	10920.09 13.04	
West Siang	7578.74	9.05	4974.33	5.94	108.87	0.13	1247.77	1.49	1507.37 1.80	15417-09 18.41	
Total	47758.63	57.03	17426.92	20.81	2688-15	3.21	6657.57	7.95	9211.73 11-00	83743 100	

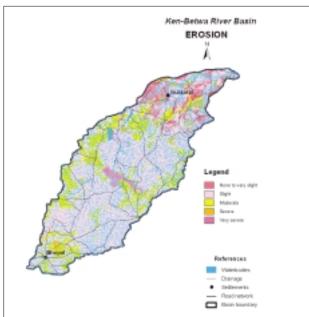
2.4c. Soil resource data and their interpretation for implementation of river link projects - Ken - Betwa river link project

> A.K. Maji, G.P. Obi Reddy, S. Thayalan, M.S.S. Nagaraju and A.K. Barthwal

During the reporting year, the soil resource database for the Ken – Betwa river basin has been derived from the SRM maps of Madhya Pradesh and Uttar Pradesh. The seamless mosaic of master soil resource database has been generated for the area. The soil based thematic maps like slope, soil depth, texture, parent material and soil reaction (pH) were generated (Fig. 2.4.5).







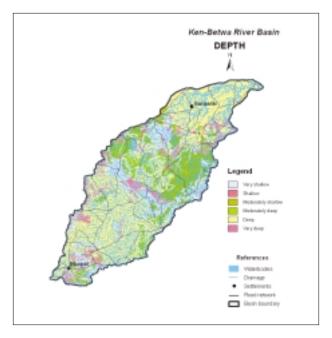


Fig. 2.4.5 Thematic maps of Ken-Betwa River Basin



Cartography Section

2.5a. Generation of digital soil thematic maps and preparation of soil atlas at national level

C. Mandal, D.K. Mandal, T. Bhattacharyya, Jagdish Prasad, R. Srivastava and Associates

The project was initiated during 2003 and completed in Dec. 2009. The objective was to generate maps related to different soils groups and thematic maps. The digital maps generated in this project can be grouped into three parts i.e. maps of physical attribute, climatic attribute and soil attributes.

Some of the thematic maps (slope, soil drainage, soil depth class, black soil, red soil, sandy soil, dominant cropping system and net irrigated to total cropped area) generated in this project and their aerial distribution are depicted in fig. 2.5.1 to 2.5.4 and table 2.5.1 to table 2.5.4.

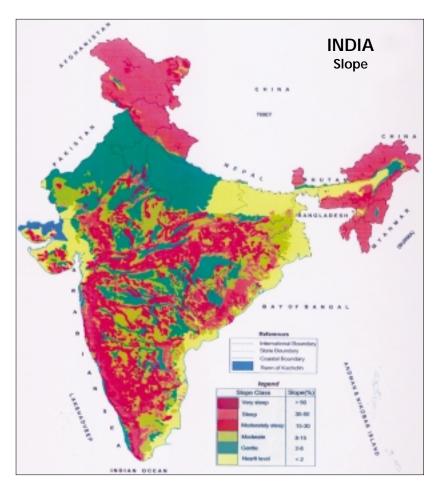


Fig. 2.5.1 Slope map of India

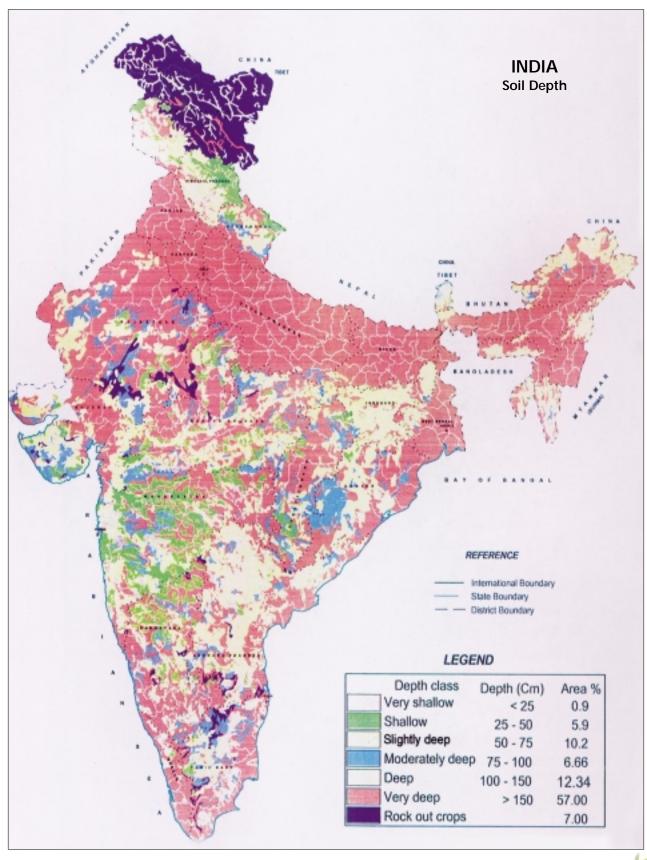


Fig. 2.5.2 Soil depth map of India

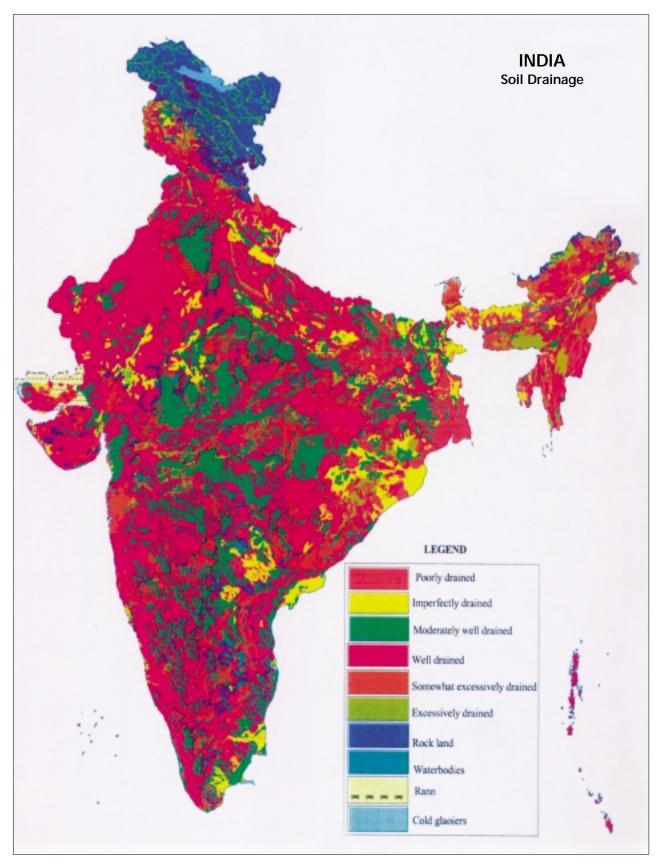


Fig. 2.5.3 Soil drainage map of India

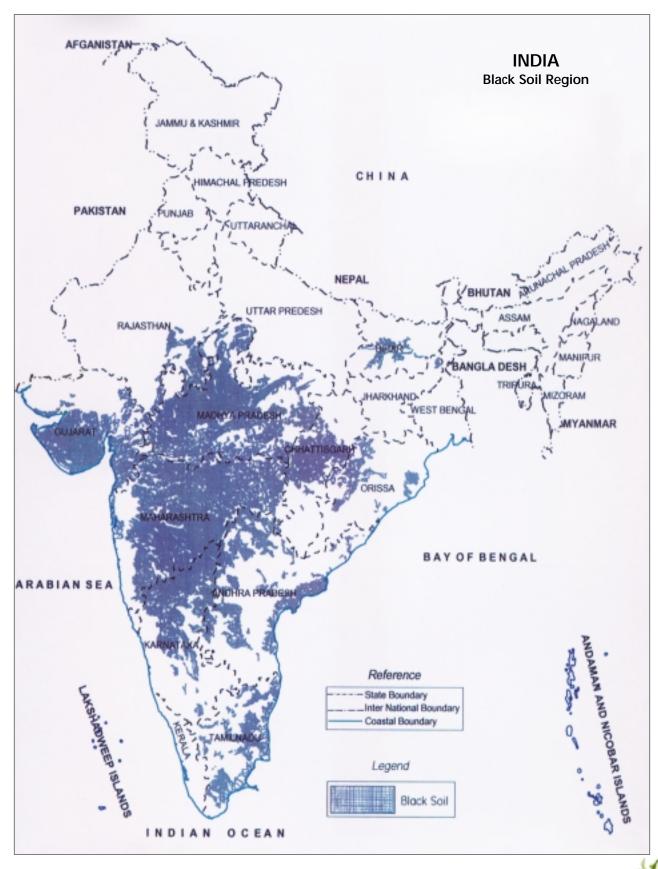


Fig. 2.5.4 Spatial distribution of black soil areas in India

Table 2.5.1 Distribution of black soils in India

(Area in ha.)

State	Black Soils	Dominant Black Soils	Sub-dominant Black Soils	Total
Maharashtra	7877714.6	5057165.2	4276981.9	17211861.0
Madhya Pradesh	9158754.09	2731606.08	1714894.0	13605254.0
Gujarat	2294515.4	3074732.1	2021737.1	7390984.6
Karnataka	3425250.8	1730482.6	724759.3	5880492.7
Andhra Pradesh	3326661.3	939424.3	228624.5	4494710.1
Chhattisgarh	1742571.1	903393.9	964274.4	3610239.4
Orissa	21230.3	479987.3	1052596.4	1553814.0
Rajasthan	653397.68	332379.64	567903.88	1553681.2
Tamil Nadu	1142078.1	73057.2	70402.3	1285537.6
Bihar	-	511168.1	-	511168.1
Jharkhand	53876.4	-	-	53876.4

Table 2.5.2 District wise distribution of black soils in Chhattisgarh

(Area in ha.)

Name of District	Extremely shallow	Very shallow	Shallow	Slightly deep	Moderately deep	Deep to very deep
Bastar	-					6818.49
Bilaspur					2450.65	499403.45
Dhamtari						140493.69
Durg			21939.43	51855.47	16217.21	700113.65
Jahangir Champa					10736.34	393824.64
Kanker						34504.71
Kawardha				52231.15		147670.36
Korba						164189.72
Mahasamund					3439.28	120924.96
Raigarh					14866.49	142252.42
Raipur		1801.92			38323.47	776750.13
Rajnandgaon			20310.20	130999.49	32597.82	262232.28
Sarguja (Ambikapur)						8041.21
Total		1801.92	1801.92	3603.84	7207.68	3397219.71
G. Total						3411635.07

Table 2.5.3 District wise distribution of black soils in Gujarat

(Area in ha.)

Name of District	Extremely shallow	Very shallow	Shallow	Slightly deep	Moderately deep	Deep	Very deep
Ahmeabad			9480.96	4979.03	213065.26	136586.90	36671.36
Amreli		81387.10	27485.84	368638.22	162356.29	511388.52	
Anand					26255.16	43577.68	1208.16
Bharuch			50294.92	15562.59		6409.03	
Bhavnagar		70346.14	106335.02	218879.90	184852.46	112010.22	84578.73
Dahod			32441.88	31921.60	58034.41	15363.99	3609.05

cont...

Gandhinagar					732.84	
Jamnagar	23609.31	392881.30	107496.82	103098.76	6685.60	35797.73
Junagad	31770.25	670.78	366725.93	169300.11		15771.94
Kheda				163.22	114327.73	33940.14
Kuchchh			2100.59	22175.28	155234.16	30981.20
Narmada		114988.05	19348.93	8457.18	9662.61	27510.51
Navasari		7491.94	11981.67			130592.60
Panhmahals		3164.04		13708.75	6160.83	15181.58
Porbandar		2823.54	68134.08	15938.41		70271.83
Rajkot	19332.44	306274.34	350853.14	73547.87	74172.99	
Sabarkantha		3067.69	10898.28	178258.80	50722.23	11786.79
Surat		265984.05	15181.47	2844.19	51152.31	311820.09
Surendranagar	31343.72	39438.58	50496.57	61767.54	356635.55	
The Dangs		152260.15			371.83	
Vadodara		49538.12	37065.36	34385.42		231437.80
Valsad				2340.17	25419.06	132094.47
Total	31343.72	31343.72	62687.44	36725.59	25419.06	363532.3
G. Total						551051.8

Table 2.5.4 Distribution of red soils in India

(Area in ha.)

Sr. No.	State	Red Soils (Pure) (100%)	Dominant Red Soils (60%)	Sub-dominant Red Soils (40%)	Total
1.	Goa	104243.7	66433.5	9481.32	180158.52
2.	Tamil Nadu	2916576.9	8610417.6	795739.88	12322734.38
3.	Andhra Pradesh	5201913.5	20027350.38	1019579.88	26248843.76
4.	Jharkhand	1966795.6	611878.08	1356628.8	3935302.48
5.	West Bengal	1039421.5	275152.08	28168.56	1342742.14
6.	Madhya Pradesh	623188.6	17254636.8	774454.44	18652279.84
7.	Maharashtra	545433.6	1203624.9	131613.4	1880671.9
8.	Orissa	1384942.3	2305348.8	1112984.48	4803275.58
9.	Nagaland	283551.5	27122.16	53860.92	364534.58
10.	Mizoram	-	229632.24	305726.04	535358.28
11.	Manipur	286390.2	7336380.96	850439.6	8473210.76
12.	Assam	482634.0	520965.36	329441.0	1333040.36
13.	Arunachal Pradesh	-	108272.28	261616.68	369888.96
14.	Kerala	2314988.3	815184.06	413170.6	3543342.96
15.	Bihar	227424.3	86771.94	115561.48	429757.72
16.	Chhattisgarh	2418844.5	2122792.02	48314.2	4589950.72
17.	Karnataka	5900537.5	150120.12	704780.24	6755437.86
18	Tripura	-	99511.14	79468.8	178979.94
	Total	25827141.1	61851594.42	8391030.32	96069765.84

2.5b. Documentation and storing of maps and photographs- concept of digital map library

C. Mandal, Pushpanjali, D.K. Mandal, Jagdish Prasad, T. Bhattacharyya, R. Srivastava and D. Sarkar

The project was initiated in January, 2009 to develop a digital database system for storing and retrieval of maps and photographs and preparation of web based library for data transmission (Fig. 2.5.5).

The software and hardware required to run the project has been procured. Nearly 53 documents/maps have already been segregated, scanned and image check and enhancement has been done.



Fig. 2.5.5 Execution process of digital map library –
An overview

2.5c. Land resource inventory for farm planning in Parseoni mandal of Parseoni taluk, Nagpur district, Maharashtra

Pushpanjali, K. Kartikeyan, C. Mandal, Jagdish Prasad, J.D. Giri and Malathi Bommidi

To generate the site-specific database suitable for farm level planning, this project (pilot study) was taken in Parseoni mandal of Parseoni taluk, Nagpur district, Maharashtra. Total area of Parseoni mandal is 16,493 ha and it falls in AESR 10.2. The mean annual rainfall ranges from 1000-1300 mm of which around 80 per cent rainfall is in the month of July to September. Two rivers (Pench and Kanhan), flowing through Parseoni erode uplands which is of serious concern. The problem of water logging and in turn sodicity in canal irrigated area is a common feature. A preliminary traverse of villages have been undertaken using Survey of India toposheets (1:50,000) and cadastral maps to identify the broad landforms and physiographic units occurring in the area and for verifying the boundaries (Fig. 2.5.6)

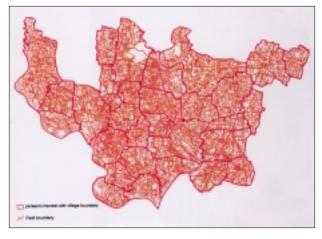


Fig. 2.5.6 Map of Parseoni mandal with village boundaries

Cartographic support: Agro-ecological regions of Uttar Pradesh

In collaboration with Uttar Pradesh Council of Agriculture Research, Lucknow (UPCAR) the project was under taken. The project report along with the map was submitted to UPCAR (Lucknow). During the reporting period, AER map of the state was prepared showing 18 regions within the state (Fig. 2.5.7). The map shows AER with numerals (1,2,3 etc) and the mapping unit within each delineated region has been abbreviated eg. B4D1 indicating physiography (B), Soil (4), Bio-climate (D) and LGP (1).

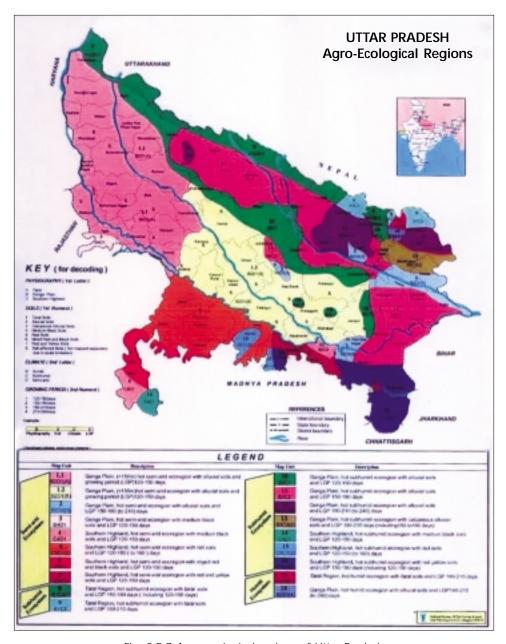


Fig. 2.5.7 Agro-ecological regions of Uttar Pradesh

Cartographic support: (Tobacco project)

Collaborative project was undertaken by National Bureau of Soil Survey and Land Use Planning, Nagpur and Central Tobacco Research Institute, Rajamundry to prepare comprehensive atlas showing the tobacco growing areas and soils, their production and productivity. The project has been completed and the atlas has been prepared depicting the maps at state/district level and data base generated for tobacco development in India.

Cartographic support: (Resource inventory of Vidarbha region)

The project was undertaken with the objective of

preparing Resource Atlas of Vidarbha region. The region has a total area of 97 lakh hectare covering 11 district i.e. Buldhana, Amravati, Akola, Washim, Wardha, Yavatmal, Nagpur, Bhandara, Gondia, Chandrapur and Gadchiroli. Based on soil series data (146 soil series), maps of different soil attributes have been prepared. The other thematic maps has been generated using the socio-economic data in GIS environment. Database generated for surface soil (0-30 cm) properties and maps of NPK status, organic carbon, pH maps have been prepared (Fig. 2.5.8).

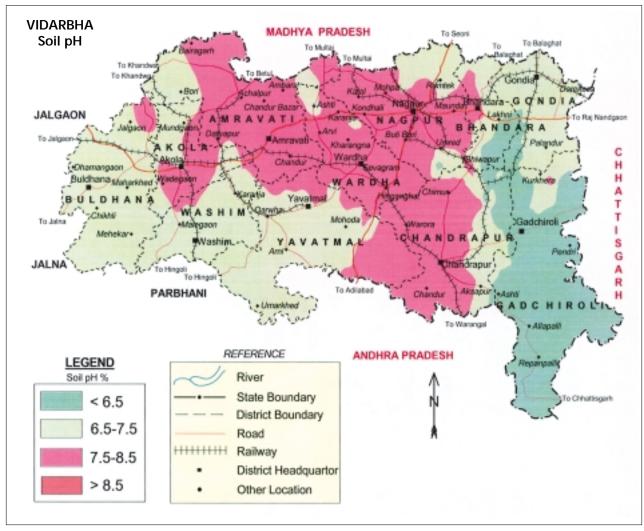


Fig. 2.5.8 Soil pH map of Vidarbha region, Maharashtra

Other miscellaneous work

As a centralized service centre the following work has been undertaken:

Designing work of cover page

- Annual Report-2009-2010
- Agropedology
- Assessment of soil Loss for Priorization of sub watersheds
- Soil Resource Atlas for Tobacco growing area of India
- Perspective Land Use- Puducherry
- Soil Series of India
- Dharti 2008
- Mrida Darpan

- Soil Based Agro Technologies for Livelihood Improvement
- Benchmark Soil Series of India
- Soil Survey Manual
- Soil Taxonomic Database of India and States
- Soil Survey Field Guide
- Study of the Drainage Morphology for Development of Water Resource of the Waghari River Cathment, Yeotmal Distt.
- ICAR Zonal Tournament 2010

Map redesigned for offset printing (CMYK Format in A0 Size)

- Soil Loss (Uttarakhand)
- Soil Loss (Orissa)
- Soil Loss (Jharkhand)

Prepared exhibition posters

- Fourteen Poster designed for printing ready format for flex printing for Delhi Exhibition (Nos. Final art work).
- Nine Poster designed and printed for the different national and international seminar.
- Posters and Banner designed for different programme and national festival celebrated by the Bureau.
- Designs prepared for different material like Invitation card, Certificates, Banner, Display Boards etc. for ICAR Zonal Tournament 2010 organized by the Bureau.

Brochure

- NBSS&LUP Publication
- Services Offered

Plotting and scanning

Total 69 maps (Ao size) were scanned and plotting was carried pertaining to following:

- Soil loss maps of Orissa, Jharkhand and Uttarakhand
- Soil map of Hayatnagar farm, Hyderabad
- Maps of Vidarbha Soil Resource Atlas
- Soils of seed farm Chuchura, West Bengal
- Physiography map of Buldhana district
- Soils of Hugli district, West Bengal

- Mauza maps of Devari tahsil, Bhandara
- Poster for different National and International seminar

Other printing work

Total 4450 prints (A3 and A4 size) was carried out pertaining to following:

- Tobacco Atlas of India
- Agro-ecological regions of UP (draft report)
- Watershed development programme map (Rajkot and Dhule district)
- AESR, LGP, soil, bio-climate, crop feasibility maps of Tamil Nadu state
- Soil series location in India
- Land Resource Atlas of West Bengal
- Field guide for soil survey
- Taxonomic database
- Soil Information System for Resource Management as a case study
- Different media coverage regarding activities and achievement of NBSS&LUP
- Other miscellaneous work

Xeroxing

About 47922 copies (black & white) and 2736 color Xeroxing was done.

Regional Centre, Bangalore

2.6a. Agro ecological zones of Tamil

L.G.K. Naidu, S. Srinivas, A. Natarajan, S. Thayalan, V. Ramamurthy

Tamil Nadu state has been broadly divided into 5 major land forms i.e. Nilgiris, South Sahyadri, Eastern Ghats, Tamil Nadu Uplands and Tamil Nadu Plains. Tamil Nadu plains have 2 distinct topographic situations, namely, Inland plains and coastal plains.

The weekly rainfall data collected from 130 stations were used for assessing length of growing period. The LGP was calculated using PET, soil available water capacity and rainfall as per Thornthwaite and Mather (1955) and Higgins and Kassam (1981) model.

- 1) Nilgiris: Nilgiri hills are extension of Western Ghats and cover an area of 4000 Sq.Km in Udagamandalam and Coimbatore districts. Maximum elevation reaches upto 2700 M. The soils are deep to very deep, clayey and gravelly clay. Length of growing period ranges from 210-270.
- 2) South Sahyadri : South Sahyadri is the southern part of Western Ghats covering an area of 7500 Sq. Km. encomposing part of Dindigul, Madurai, Tirunelveli and Kanyakumari districts all along Kerala state. Soils are shallow to moderately deep, with rocky phases and loamy to gravelly clay soils. Rainfall ranges from 900-1700 mm with LGP of >270 days.
- Eastern Ghats: The Eastern Ghats are dissected into isolated hill ranges trending north east, south west direction in the northern parts of North Arcot, Dharmapuri and Erode districts. The elevation ranges from 1100 to 1600m. Soils are shallow to moderately deep, with rocky phases and loamy to

- clayey soils. The annual rainfall ranges from 750 to 1000 mm and length of growing period ranges from 120-180 days and in small pockets of Shervory and Javadi hills, it exceeds > 240 days.
- Tamil Nadu uplands: Tamil Nadu uplands cover an area of 40,000 Sq.km. with relief ranging from 150 to 450 m. This landform encompasses north and central parts of the state covering parts of North Arcot, Dharmapuri, Salem, Erode, Karur, Coimbatore and Dindigul districts. Soils are moderately deep to deep gravelly loam to gravelly clay soils associated with cracking clay soils in pockets. Rainfall ranges from 600 to 1000 mm. Length of growing period varies from 120 to 180 days in a large extent. There are few very dry pockets in Coimbatore and Erode with LGP of < 90 days.
- **Tamil Nadu plains:** Tamil Nadu plains cover from Kannyakumari in the south to Thiruvallur in the north. Based on the geographic position, the plains are further divided into
 - **Northern plains:** Northern plains covering parts of Tiruchirapalli, South Arcot, Villupuram, Thiruvannamalai, North Arcot and Chengalpattu districts. Dominantly, soils are moderately deep to deep, gravelly loam to gravelly clay soils and also deep to very deep, clayey soils in Perambalur and Villupuram districts. Rainfall varies from 750-1500mm with LGP ranging from 150 to 210 days.
 - **Southern plains**: The southern plains cover the districts of Pudukottai, Sivaganga, Eastern parts of Madurai and Western parts of Thanjavur, Tuticorin and Ramanathapuram as well as Tirunelveli and Kanyakumari districts. Rainfall ranges from 750 to 1000 mm with a wide variability. Soils are moderately deep to

very deep, red and lateritic type in northern parts deep to very deep clayey black soils in Ramanathapuram and Tuticorin districts and gravelly clay to gravelly red loamy soils in Tirunelveli and Kanyakumari districts. LGP ranges from 90 to 120 days in southern parts (Vaigai delta area) and progressively increases to 150-180 days in Thanjavur delta.

c. Coastal plains: Coastal plains is a very narrow strip of land covering from Kanyakumari in the South to Pulicot lake in Thiruvallur district. In the northern portion, especially in Thiruvallur and Kanchipuram districts, soils are deep to moderately deep, sandy gravelly clay to gravelly loam soils. The rainfall ranges from 1000 to 1500 mm with LGP of 180-210 days.

The coastal areas of Pudukottai, Thanjavur, Ramanathapuram, Sivaganga districts have deep sandy and loamy soils. The rainfall is < 1000 mm with LGP ranging from 150-180 days. In the coastal areas of Tuticorin, Tirunelveli and Ramanathapuram (part) districts, sandy soils predominte. LGP is < 90 days in Nagarcoil and Radhapuram areas and 90-120 days in Sathankulam and Thiruchandur areas.

The agro-ecological zones of Tamil Nadu are presented in Fig. 2.6.1

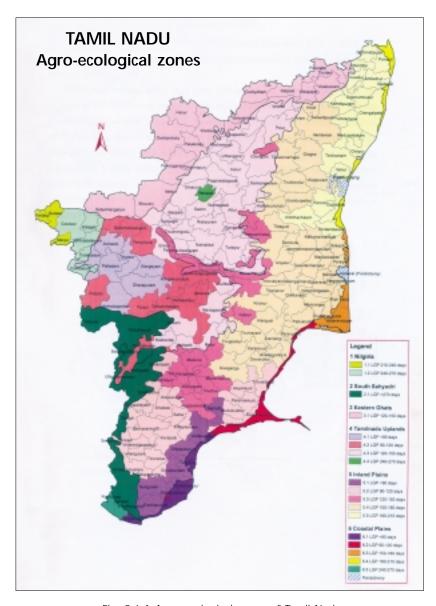


Fig. 2.6.1 Agro-ecological zones of Tamil Nadu

2.6b. Detailed assessment of land and soil resources of Kuppam mandal in Chittoor district of Andhra Pradesh

K.S. Anil Kumar, S.C. Ramesh Kumar, L.G.K. Naidu, A. Natarajan, S. Thayalan, Rajendra Hegde, and S. Srinivas

The detailed soil survey of all 64 villages of Kuppam mandal has been completed, the soil map with 141 mapping units as phases of soil series has been generalized (Fig. 2.6.2). All the soils were developed from granites or its colluvium and alluvium in uplands, midlands and lowlands. Uplands occupy about 15664 ha (36.8 %), low lands 862 ha (2 %), forests cover about 23078 ha (54.1 %) and miscellaneous lands account for 862 ha (7.1 %).

The major series of uplands are Urlavobanapalle (Ulv), Kattimanipalle (Ktp), Guttapalle (Gtp) and Nulkunte (Nlk). Urlavobanapalle, Kattimanipalle and Guttapalle soils are shallow (25-50 cm) where as Nulkunte soils are deep (100-150 cm). Texture ranges from loamy sand in Urlavobanapalle whereas sandy loam to sandy clay loam in Kattimanipalle and Guttapalle. Nulkunte soils are sandy clay in texture.

Ekaralpalle (Erp) and Kopalli (Kpl) soils have been identified in the midlands. These are moderately deep (75-100 cm) whereas Golapalli (Glb) soils are deep (100-150 cm). Texture ranges from sandy loam to sandy clay loam in Ekaralpalle and Kopalli. Golapalle soils are heavier and are sandy clay to clay in texture.

The major soils of low lands are Guttapanayanpalle (Gtn), Kotha Indlu (Ktl), and Gundalapalle (Gdp). Gundalapalle soils are shallow (25-50 cm). Guttapanayanpalle and Kotha Indlu soils are very deep (>150 cm). Texture ranges from sandy loam to sandy clay loam in Kotha Indlu and Gundalapalle where as Guttapanayanpalle soils are loamy sand in texture.

Different thematic maps have been generated to delineate the potentials and problems of the soils for crop production and land use planning. Soil depth map (Fig. 2.6.3) shows dominance of moderately shallow soils, followed by shallow and moderately deep soils. Suitability of the soils for different crops has been assessed. Land suitability for finger millet, a dominant crop of the mandal is given in figure 2.6.4, which indicates that soils are marginally to moderately suitable for ragi. Status of major (NPK) nutrients shows that available P is low to medium and the Zn is low to marginal in these soils (Fig. 2.6.5). The final report has been submitted.

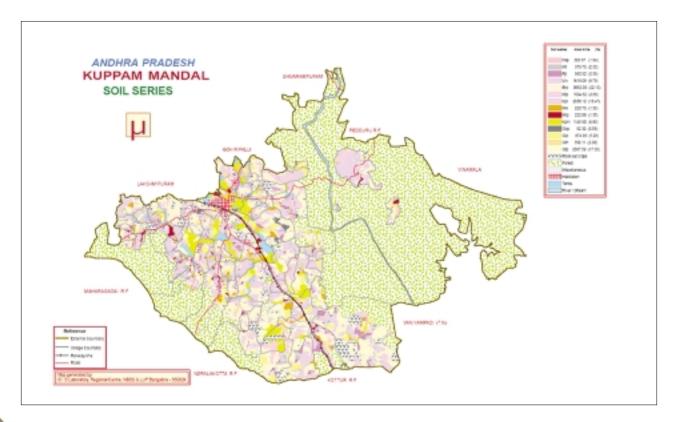


Fig. 2.6.2 Soil map of Kuppam mandal

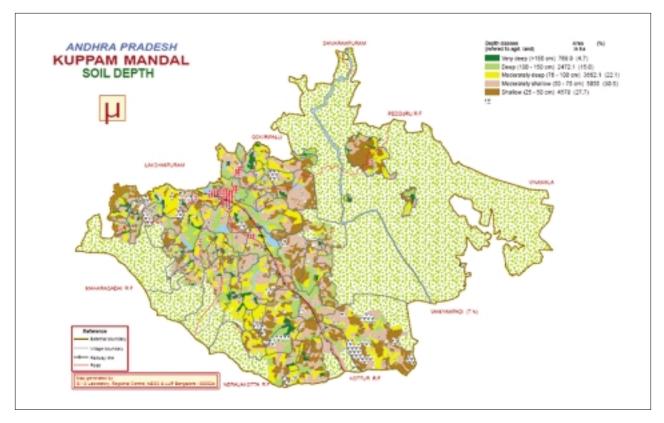


Fig. 2.6.3 Soil depth classes of Kuppam mandal

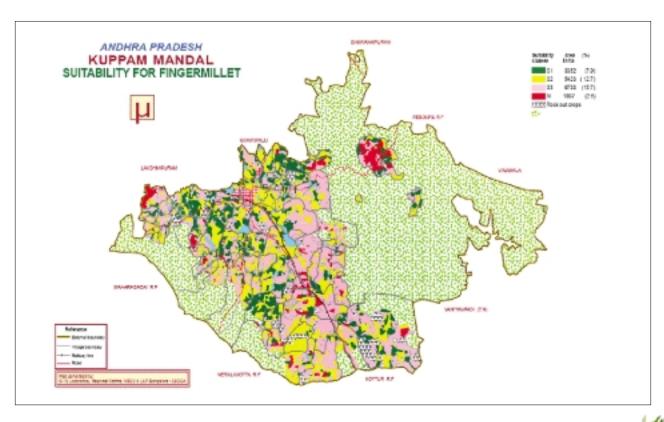


Fig. 2.6.4 Soil suitability for finger millet in Kuppam mandal

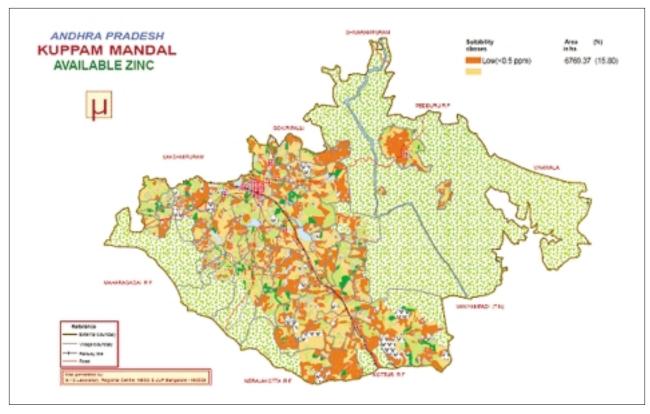


Fig. 2.6.5 Available zinc status in Kuppam mandal

2.6c. Assessment of land and soil resources of Malappuram district (part) at 1:50,000 scale for land use planning

K.S. Anil Kumar, S. Thayalan, K.M. Nair, S.Srinivas, Rajendra Hegde, S.C. Ramesh Kumar and L.G.K. Naidu

Reconnaissance survey was carried out in 2.81 lakh ha, out of 3.53 lakh ha area of the district. The remaining area has been surveyed during Rubber Consultancy Project. Major physiographic delineations are charnockite highlands, charnockite midlands, charnockite valleys, archaean granite and gneissic highlands, archaean granite and gneissic midlands, Archaean granite and gneissic valleys, laterite midlands, low lands such as kayal lands, sandy plains, coastal sandy plain and beaches/sand bars. Soil series associations are used as mapping units.

Dominant soils occupying on very steeply sloping charnockite highlands are very deep, fine-loamy and strongly acidic (Karuvarakundu series) in association with deep gravelly clay, very strongly acid soils (Lahai series) and shallow, very gravelly clay, very strongly acid soils (Manimala series).

Major soils of the charnockite midland side slopes having moderate slopes are very deep, gravelly clay, very strongly acid soils (Vijayapuram series) in association with very deep, gravelly clay, extremely acid soils (Kanjirappally series) and deep, gravelly clay, very strongly acid soils (Lahai series). Dominant soils occurring on charnockite uplands with gentle slopes are deep, gravelly clay, very strongly acid soils (Lahai series) in association with moderately deep, gravelly clay, strongly acid soils (Chelikuzhi series) and shallow, coarse-loamy, very strongly acid soils (Perinthalmanna series).

In very steeply sloping archaean granite gneiss highlands, the dominant soils are very deep, gravelly clay, very strongly to extremely acid soils (Pallipadi series) in association with moderately shallow, clayey, strongly acid soils (Edannur series) and rocky areas with less than twenty per cent soil (Rockland).

Major soils occupying on moderately steeply sloping archaean granite gneiss midland side slopes are Pallipadi series in association with moderately deep, very gravelly clay, very strongly acid soils (Kaloor series) and Rockland.

Dominant soils occurring on moderately sloping archaean granite gneiss uplands are deep, very gravelly clay very strongly acid soils (Ezhallur series) in association with Pallipudi series.

Soils occurring on rolling laterite mound side slopes are moderately shallow, very gravelly clay, very strongly acid soils (Kaipuzha series) in association with deep, gravelly clay, strongly to very strongly acid soils (Kalady series).

Soils occurring on gently sloping laterite uplands are very deep, clayey, strongly acid to very strongly acid soils (Anayadi series) in association with moderately deep, very gravelly clayey, very strongly to extremely acid soils (Mannanam series) and very deep, very gravelly clay, strongly acid to very strongly acid soils (Chingavanam series).

Soils in valleys in general are very deep, moderately well drained, silty-clay and strongly acid soils (Kolathur series) and very deep, moderately well drained, fine-loamy and moderately acid soils (Atavanadu series).

Soils of low lands of kayal (water logged soils connected to sea) origin are very deep, imperfectly drained, clay and very strongly acid soils (Mangattur series) associated with very deep, imperfectly drained, fine-loamy and very strongly to strongly acid soils (Changaramkulam series).

Soils in sandy plains are very deep, well drained, coarse-loamy and very strongly acid (Keraladisapuram series).

Soils in coastal sandy plains are very deep, moderately well drained, loamy and slightly acid (Pallipuram series).

Dominant soils of beaches/sand bars are very deep, moderately well drained, sandy and strongly acid to moderately acid (Parivarapuram series).

Soil map of Malappuram district (a part) and corresponding legend are given in Fig. 2.6.6 and Table 2.6.1.

Table 2.6.1 Soil legend of Malappuram district (Ponnani Taluk)

Map Unit	Series name	Descriptive legend	
87	Laterite mound side slopes (3-5 %)		
	Mannanam (Mnn)	Moderately deep, welldrained, extremely acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 60 $\%$ gravel, very strongly acid and extremely acid, gravelly sandy clay and gravelly clay subsoil layers with 35 to 70 $\%$ gravel.	
	Kaladi (Kld)	Deep, welldrained, very strongly acid, gravelly clay surface layer with 15 to 30 $\%$ gravel and very strongly acid and strongly acid gravelly clay subsoil layers with 15 to 30 $\%$ gravel.	
88	Laterite mound side slopes ((5-10 %)	
	Kaipuzha (Kpa)	Moderately shallow, welldrained, very strongly acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 65 $\%$ gravel and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 35 to 70 $\%$ gravel.	
	Panachikkad (Pck)	Deep, welldrained, very strongly acid gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 70 $\%$ gravel and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 30 to 70 $\%$ gravel.	
	Kaladi (Kld)	Deep, welldrained, very strongly acid, gravelly clay surface layer with 15 to 30 $\%$ gravel and very strongly acid and strongly acid gravelly clay subsoil layers with 15 to 30 $\%$ gravel.	
97	Laterite uplands on very ger	atle slopes (1-3 %)	
	Veliyangode (Vlg)	Very deep, welldrained, strongly acid, loamy sand surface layer and very strongly acid sandy clay loam and sandy loam subsoil layers.	
	Anayadi (Ayd)	Very deep, welldrained, very strongly acid, sandy loam or sandy clay loam surface layer with 5 to 10 $\%$ gravel and strongly acid and very strongly acid sandy clay loam, clay and sandy clay subsoil layers with 5 to 15 $\%$ gravel.	
		cont	

cont...

	_		
100	Laterite uplands on gentle slopes (3-5 %)		
	Panachikkad (Pck)	Deep, welldrained, very strongly acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 70 $\%$ gravel and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 30 to 70 $\%$ gravel.	
	Kaipuzha (Kpa)	Moderately shallow, well drained, very strongly acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 65 $\%$ gravel and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 35 to 70 $\%$ gravel.	
	Mannanam (Mnn)	Moderately deep, welldrained, extremely acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 60 $\%$ gravel and very strongly acid and extremely acid gravelly sandy clay and gravelly clay subsoil layers with 35 to 70 $\%$ gravel.	
102	Panachikkad (Pck)	Deep, welldrained, very strongly acid, gravelly sandy clay loam, gravelly sandy clay or gravelly clay surface layer with 30 to 70 $\%$ gravel and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 30 to 70 $\%$ gravel.	
	Chingavanam (Cgn)	Very deep, welldrained, very strongly acid, gravelly sandy clay loam, gravelly clay loam, gravelly sandy clay or gravelly clay surface layer with 25 to 60 $\%$ gravel and strongly acid and very strongly acid gravelly sandy clay and gravelly clay subsoil layers with 35 to 70 $\%$ gravel.	
106	Laterite valleys		
	Atavanadu (Atn)	Very deep, moderately welldrained, very strongly acid sandy clay loam surface layer and moderately acid sandy clay loam subsoil layers.	
107	Low lands- Kayal lands		
	Mangattur (Mgt)	Very deep, imperfectly drained, very strongly acid clay surface layer and very strongly acid clay subsoil layers.	
	Changaramkulam (Cgk)	Very deep, imperfectly drained, strongly acid sandy loam surface layer and very strongly acid and strongly acid sandy clay loam subsoil layers.	
108	Changaramkulam (Cgk)	Very deep, imperfectly drained, strongly acid sandy loam surface layer and very strongly acid and strongly acid sandy clay loam subsoil layers.	
	Mangattur (Mgt)	Very deep, imperfectly drained, very strongly acid clay surface layer and very strongly acid clay subsoil layers.	
109	Low lands- Sandy plains		
	Keraladisapuram (Kdp)	Very deep, welldrained, strongly acid loamy sand surface layer and very strongly acid loamy sand and sandy loam subsoil layers.	
111	Pallippuram (Plp)	Very deep, moderately welldrained, very strongly acid sandy loam surface layer and slightly acid sandy loam and sandy clay loam subsoil layers.	
113	Low lands- Beaches/sandba	rs	
	Parivarapuram (Prp)	Very deep, moderately welldrained, moderately acid sand surface layer and strongly acid and moderately acid sand subsoil layers.	

Coverage of area under each series in the map unit is 80-100 per cent if single, 60:40 if two soils and 50:30:20 if three soils.

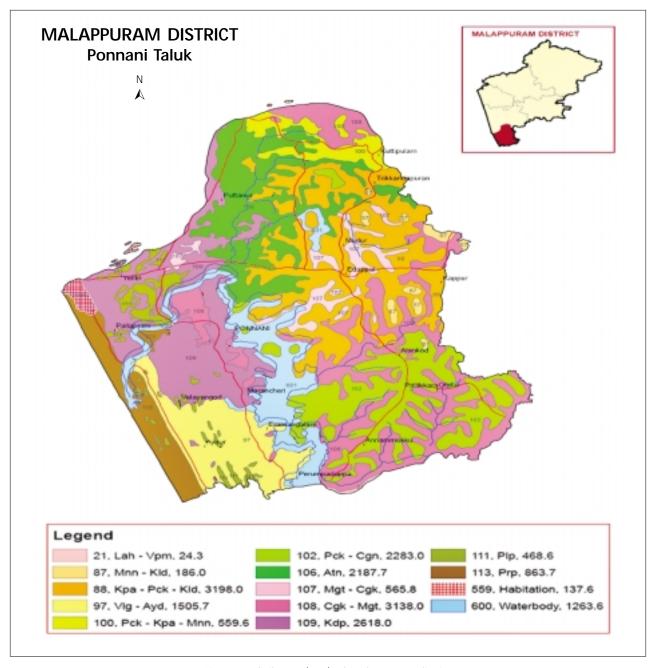


Fig. 2.6.6 Soil map (part) of Malappuram district

2.6d. Development of software modules for land evaluation and agro-climatic analysis

S. Srinivas, K.M. Nair, L.G.K. Naidu, Rajendra Hegde and V. Ramamurthy

Agro climatic analysis for preparation of agroecological zones/units map requires calculation of LGP (Length of Growing Period) which is done based on water balance calculation. As part of software development project, water balance calculation for both monthly and weekly data sets using Thornthwaite and Mather method was programmed using Dbase IV software. The software takes input of Rainfall, Potential Evapotranspiration (PET) and Available Water Capacity (AWC) of soil and calculates the period of favorable moisture availability (LGP). Program modules are also written for Length of Growing Period (LGP) and probability of each week favorable for growing crops.

2.6e. Development of district level land use plan for Mysore district, Karnataka

V. Ramamurthy, K.M. Nair, S.C. Ramesh Kumar, S. Srinivas, L.G.K. Naidu, S. Thayalan

In Mysore district about 96 land units were delineated by spatial integration of external land features, soils, agro-ecology, present land use and administrative divisions.

Farming system data were collected from all the major land units and found that five major production systems are prevailing (Table 2.6.2) in Mysore district.

Land units were further grouped into homogenous land management units (LMUs) based on similar farming/ cropping systems. Methodology used for identifying the LMUs is presented in the following flow diagram (Fig. 2.6.7). 12 LMUs were delineated in Mysore district (Fig. 2.6.8). LMUs are the land areas which behave and respond similarly for a given set of management practices. The list of LMU identified and their characteristics are presented in table 2.6.3.

Table 2.6.2 Major production systems prevailing in Mysore district

Sl. No.	Production systems						
	Irrigated						
1.	Rice and Sugarcane production system (Dairy)						
2.	Rice and Maize production system (Dairy + Sericulture)						
	Rainfed						
3.	Tobacco-Ragi/Pulses based production system						
4.	Cereal (Ragi, Jowar, Maize) based production system						
5.	Cotton and Cereal based production system						
In rainfed	In rainfed situation, integrated mixed farming system is dominant (2-3 cows/buffaloes+pair of bullocks, 8-10 sheep/goats)						

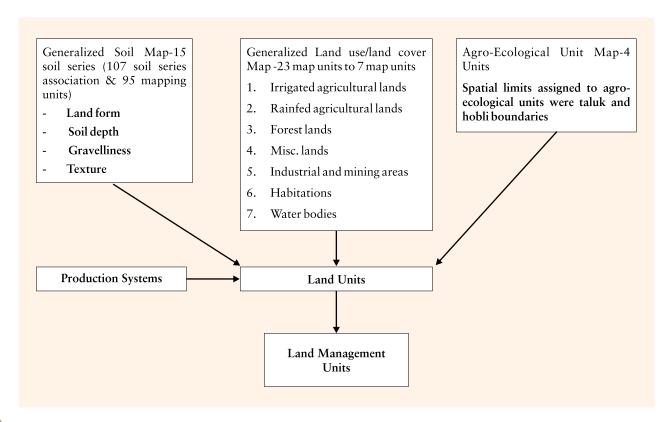


Fig. 2.6.7 Identification of Land Management Units

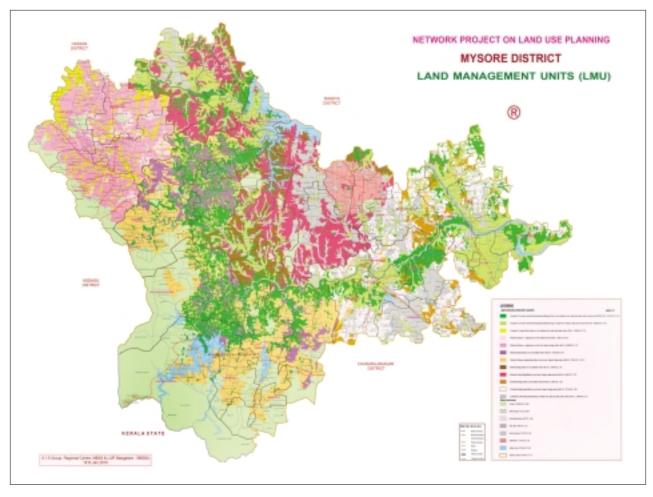


Fig. 2.6.8. Land management units of Mysore district

The 12 LMUs identified in Mysore district are

- Irrigated (Command area); Rice/sugarcane/banana/ vegetables production systems on red, shallow, moderately deep and deep soils occurring in AEU II, III & IV
- Irrigated (Command area); Rice/sugarcane/ Banana/Vegetables production systems on black, moderately deep to deep clayey soils in AEU II, III and IV
- 3. Irrigated (Ground water); Rice/maize production systems on red, shallow, moderately deep and deep soils in AEU I
- 4. Rainfed, Tobacco -Ragi/pulses production systems on red and shallow soils in AEU I
- Rainfed; Tobacco-Ragi/pulse production systems on red, moderately deep to deep soils in AEU I

- 6. Rainfed, ragi based production systems on red and shallow soils in AEU II
- Rainfed; Tobacco-ragi/pulses/cotton production systems on red, moderately deep to deep soils in AEU II
- 8. Rainfed; Ragi/Jowar/Cotton production systems on red, shallow soils in AEU III
- 9. Rainfed; Cotton/ragi/Jowar production systems on red, moderately deep to deep soils in AEU III
- 10. Rainfed; Ragi/Jowar/Maize production systems on red, shallow soils in AEU IV
- 11. Rainfed; Pulses-Ragi/Jowar/cotton production systems on red, moderately deep to deep soils in AEU IV
- Rainfed; Cotton/Ragi/maize/Jowar production systems on black, moderately deep to deep clayey soils in AEU III & IV

Table 2.6.3 Details of Land Management Units identified in Mysore district

LMU	Major crops/Cropping systems	Land Form	Soil depth (cm)	Gravelliness	Area (ha)
1.	Sesamum/cowpea/Bl.gram/G.gram/ green manure-rice, Rice-rice, Rice-rice, Rice, Sugarcane, Ragi, Banana, Vegetables, Mulberry	G-VG slope	50 to >100	25-35%	94164.5 (14.9)
2.	Sesamum/cowpea/Black gram/Green gram/ green manure-rice, Rice-rice-rice, Rice-rice, Rice, Sugarcane, Ragi-rice/pulses, Rice-Black gram/ Green gram	VG sloping	>100	Non-gravelly	68004.6 (10.8)
3.	Rice, Maize, Mulberry	G-VG sloping	50 to >100 Black soils	25-35%	13642.6 (2.2)
4.	Tobacco-ragi/Horse gram/Field bean, Ragi + Field bean, Horse gram, Maize	Mod. sloping	25-50	>35%	5892.1 (0.9)
5.	Tobacco-ragi/H.gram/F.bean/cowpea, Maize/ cowpea-ragi, Ragi+F.bean/R.gram, Maize, G.nut	ModG sloping	50 to >100	25-35%	48990.5 (7.7)
6.	Ragi, Jowar,H.gram, cotton, Tobacco- H.gram/F.bean	Mod. sloping	25-50	>35%	17443.1 (2.7)
7.	Tobacco-ragi/H.gram/F.bean/cowpea, Sesamum/cowpea-ragi, Cotton, Maize, G.nut	G-VG sloping	50 to >100	25-35%	72335.3 (11.4)
8.	Ragi, Ragi+F.bean/R.gram, Jowar, Cotton, Tobacco, Maize, H.gram	Mod G sloping	25-50	>35%	13854.9 (2.1)
9.	Cotton, Ragi+R.gram, Jowar, Tobacco-ragi/ F.bean/H.gram, Maize	G-VG sloping	50 to >100	25-35%	45921.6 (7.3)
10.	Ragi+F. bean/R.gram, Jowar, H.gram, Maize	ModG sloping	25-50	>35%	9981.8 (1.6)
11.	Sesamum/Cowpea-Ragi+F.bean, Jowar, Cotton, Maize, G.nut, H.gram, Coriander	G-VG sloping	50 to >100	25-35%	37194.9 (5.9)
12.	Cotton, Sesamum/cowpea-ragi, Ragi+F.bean, Jowar, R.gram, Tobacco-Ragi/F.bean/ H.gram, Maize	VG sloping	>100	Non-gravelly	57669.4 (9.1)

Note: G= Gently sloping (3-5%); VG=Very gentle (1-3%); Mod-moderately sloping (5-10%)

Potential crops under irrigated agricultural production system

In this production system rice, sugarcane, banana, tomato, cabbage and mulberry are being grown predominantly. The major crops and cropping systems of irrigated LMUs are presented in table 2.6.4. LMU 1, 2 and 3 were assessed for rice suitability (Fig. 2.6.9) and productivity of rice in farmers fields and research stations was collected and presented in table 2.6.4. Highly suitable areas for rice is more in LMU 1

(90, 000 ha) and LMU 2 (68,000 ha), which is more than the target area earmarked for 2009-10 in the district. In LMU 2, the productivity of paddy was highest (45.4 q/ha) as compared to LMU 1(44.4 q/ha) and LMU 3 (31.9 q/ha). The productivity of rice in these two LMUs is comparable to that of research stations. Therefore, more focus should be given to improve the productivity of rice in a sustainable way in Hunsur, H.D.Kote, K.R.Nagar, Mysore, T. Narsipura and Nanjangudu taluks. Highest net returns from paddy were recorded in LMU 1 followed by 2 and 3.

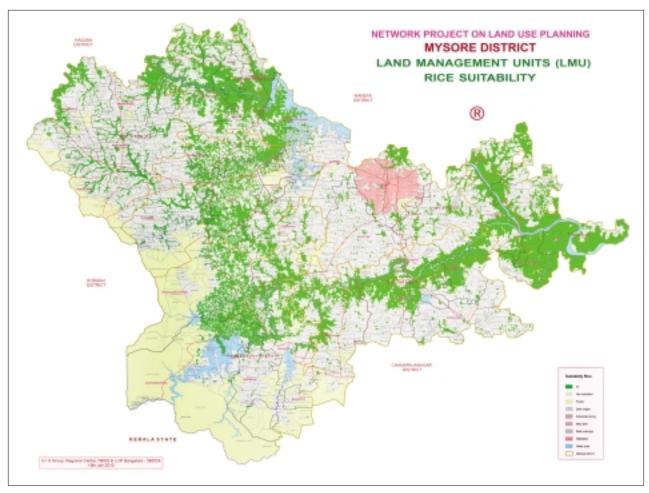


Fig. 2.6.9 Suitable areas for rice production in Mysore district in LMU 1, 2 and 3 $\,$

Table 2.6.4 Potential area for paddy production under irrigated production system

LMU	Suitable	area for Rice (ha)		Productivity (q/ha)			
	S1	S2	FF*	RS*	YG*	At FF	
1	90000.0	4164.0	44.4	48.0	3.6	24148.8	
2	68004.6	-	45.4	48.0	2.6	21017.5	
3	13042.0	600.6	31.9	48.0	16.1	1356.5	
Total	1, 71, 046.6	4764.6					
Target area for 2009-10		8, 400					

^{*}FF=Farmers Field; RS=Research Station; YG=Yield Gap

Specific problems related to paddy production in LMU 1, 2 and 3 are

- High incidence of blast and BPH
- Non availability of irrigation water in time
- Non-availability of late planting varieties with resistance to diseases
- Labour scarcity
- Non remunerative price for produce
- Lack of saline resistant HYV in LMU 3

Potential crops under rainfed agricultural production system

Under rainfed production system, tobacco, cotton, ragi, maize, horsegram, sesamum, field bean, jowar, cowpea and groundnut are the major crops. Potential areas for ragi cultivation was assessed under rainfed production system in the following LMUs 4, 5, 6, 7, 8, 9, 10, 11 and 12. The areas suitable for ragi in different LMUs and their productivity and net returns is presented in table 2.6.5. Highly suitable areas for ragi production are occurring in LMU 5 and LMU 7 (Fig. 2.6.10) and targeted area earmarked for ragi cultivation in 2009-10 was 60090 ha. Since LMU 7 has higher productivity and net returns from ragi, more focus on ragi production and related programmes can be implemented in LMU 7, which comprises of Hunsur and H.D.Kote taluks.

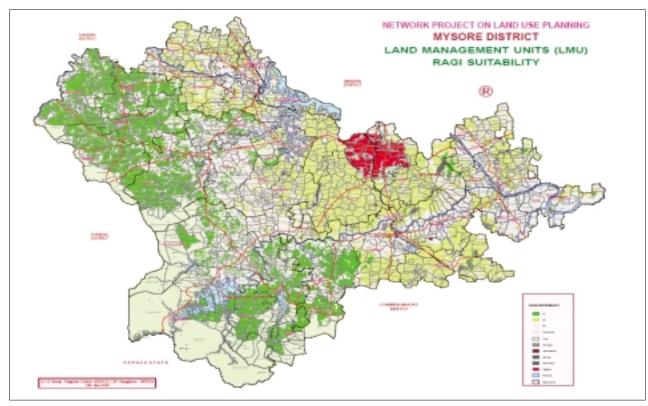


Fig 2.6.10 Suitable areas for ragi production in Mysore district

Table 2.6.5 Potential areas for ragi production under rainfed production system

LMU	S	Suitable area for 1 (ha)	ragi		Productivity (q/ha)			
_	S1	S2	S3	FF	RS	YG		
4	-	-	5892.1	18.0	25.0	7.0	4114.0	
5	48990.5	-	-	30.0	33.8	3.8	8362.0	
6	-	-	17443.1	19.2	26.2	7.0	4347.0	
7	72335.3	-	-	30.0	33.8	3.8	13810.0	
8	-	-	13854.9	12.0	30.0	18.0	4529.0	
9	-	45921.6	-	27.5	30.0	2.5	6192.0	
10	-		9981.8	11.3	25.0	13.7	3356.0	
11	-	37195.0	-	20.5	22.0	1.5	5714.0	
12	-	57669.4	-	18.0	23.0	5.0	4529.0	
Total	121325.8	1,40,786.0	47171.9					
Target area for 2009-10		60090						

Specific problems related to ragi production in different LMUs are presented in table 2.6.6.

Table 2.6.6 Specific problems related to Ragi production system

LMU 4	LMU 5	LMU 6	LMU 7	LMU 8	LMU 9	LMU 10	LMU 11	LMU 12
Shallow soils	Late kharif crop	Shallow soils	Late kharif crop	Shallow soils	Erratic RF	Shallow soils	Erratic RF	Erratic RF
Gravelly condition	Finger blast	Gravelly condition	Finger blast	Gravelly condition	-	Gravelly condition	-	-
Finger blast	Intermittent dry spells	Finger blast	Intermittent dry spells	Finger blast	-	Finger blast	-	-
Late onset and intermittent dry spells	Lack of HYV for late kharif	Late onset and intermittent dry spells	Lack of HYV for late kharif	Late onset and intermittent dry spells	Late onset of monsoon	Late onset and intermittent dry spells	Late onset of monsoon	Late onset of monsoon
Low input usage	Low input usage	Low input usage	Low input usage	Low input usage	Low input usage	Low input usage	Low input usage	Low input usage
Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures	Lack of SWC measures
-	Tobacco- main crop	-	Tobacco & cotton-main crop	-	Cotton- main crop	-	-	-

SWC=Soil and water conservation

Analysis of potential crops and identification of potential areas in each LMU is in progress. Socioeconomic data collected from farmers representing major soil series have been linked to LMUs.

2.6f. Land use planning for North Goa district, Goa

Rajendra Hegde, K.S. Anil Kumar, S.C.Ramesh Kumar and S. Srinivas

A study on identification of constraints affecting diverse rural enterprises, inputs, technologies and funds required for addressing the constraints and for preparing district level LUP for North Goa district of Goa state is undertaken.

- A. Sector wise contribution to GDP: Agriculture, forestry and fisheries all together contribute only 10 percent to the GDP. Manufacture and tertiary sectors (service sector) contribute substantially to the GDP in the state. Over the years, due to several factors the contribution of primary sector to GDP is declining.
- **B.** Ecological zones of Goa: For protecting the ecological assets in the Goa, the local government has classified the lands into two ecologically sensitive zones (Table 2.6.7). In the sensitive zone 1 (54% of total area), forests, water bodies and Khazan lands are included. The

conversion of these lands for other uses is prohibited by law. In the Eco-zone 2 (26% of area), orchards, cultivated lands saltpans and mudflats are included.

Table 2.6.7 Ecological zones of Goa

No.	Land use category	Area in sq. km	Per cent area
1	ECO zone I		54
a	Forests & wild life sanctuaries	1315	35.62
b	Mangrove forests	5.64	0.15
c	Private forests	45	1.22
d	Water bodies	197	5.32
e	Paddy fields/Khazan lands	431.63	11.66
2	ECO zone II		26
a	Orchards	843	22.77
b	Cultivable lands	123	3.32
c	Salt pans	2.34	0.06
d	Fish farms/mud flats	5	0.13
3	Settlements	526.31	14.22
4	Industries	41.96	1.13
5	Transport	151	4.08
6	Miscellaneous	15.22	0.41

C. General land utilization pattern in Goa: Forests occupy largest portion of geographical area. Paddy lands (including Khazan lands), orchards and

cultivated lands occupy 38 per cent area. Orchards consisting of cashew, coconuts and arecanut are major source of livelihood for rural mass. Khazan lands are the lands that get inundated with brackish water from the nearby backwaters of rivers and these form the very important land use. Only Kharif rice is cultivated here when the salt concentration gets reduced due to monsoon rains. Paddy productivity is quite satisfactory here. Settlements occupy 14 per cent of the area as Goa is famous for tourism and industries. Recent trend reveals that mines occupy nearly 4 per cent of the land area in the state and are expanding very rapidly in various parts and causing alarmingly high levels of ecological damage.

D. Area under major crops: Rice, cashew and coconut are the major crops (Table 2.6.8). Goa is dependent on other states for the food and animals products.

No	Стор	Total area (ha)	Per cent area	Irrigated area (ha)
1a	Rice (Kharif)	35112	20.61	-
1b	Rice (Rabi)	17065	10.03	17065
2	Ragi	441	0.27	-
3	Maize	100	0.07	-
4	Pulse	10978	6.45	10525
5	Ground nut	3312	1.95	2962
6	Areca nut	1641	0.96	1641
7	Coco nut	25312	14.86	4410
8	Cashew nut	55021	32.31	-

- **E. Fisheries**: Fisheries is one of the traditional sources of livelihood for the coastal people. Inland fishery is also practiced as the traditional cuisines of Goa need fish as the main ingredient of daily food requirement. Over the years, the fish catch is increasing due to technological advances. There seems to be good scope for expanding the inland fisheries as the region receives good amount of rainfall and brackish water is also available in inlands and Khazan lands.
- **Tourism scenario of the state:** Tourism is expanding exponentially in the state. Domestic tourists are also visiting Goa in quite big numbers. The sector has very significant effect on the economy, employment and ecology of the region.
- **G. Climate of Goa:** Being a coastal state, the temperature variations are less and the range is 18 (minimum) to 34°C (maximum). State receives rainfall during

- all most all the months. Maximum rainfall is received during May to October months. The mean total annual rainfall is 3500 mm. Total annual rainfall received is in the range of 2500 to 4800 mm. Number of rainy days varies from 91 to 123.
- H. Length of growing period: LGP is not a major limitation in the region as the region receives good amount of rainfall. 96 percent of the area has LGP of 180 to 240 days (Fig. 2.6.11).

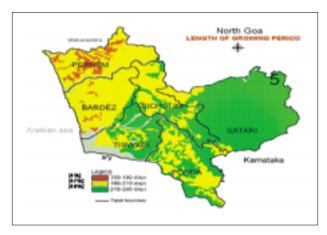


Fig. 2.6.11 LGP in North Goa

- **Population distribution and projections:** High level of urbanization has taken place here. In North Goa, 55 per cent of the population is rural as compared to 72 per cent at all India level. The trend of urbanization is quite fast in Goa as compared to other states. The present population of 13.5 lakhs is likely to increase to 18 lakhs by 2021. The rate of growth is less compared to all India figures due to high level of literacy. However due to availability of employment, migration of people from other states is increasing and Goa is becoming truly cosmopolitan state.
- Major farming systems prevailing in North Goa: About six farming systems are identified in Goa. Brief details are given below.
 - Cashew based systems: Mainly in up lands and hilly areas.
 - Paddy based systems: Low lying areas in valleys and river mouths.
 - 3. Coconut based systems: Homesteads and small plantations surrounding the houses and paddy fields and coast line.
 - 4. Agri-tourism based systems: Concentrated in coastal lines.

- **5. Spices based systems:** Orchards surrounding homes and as intercrop between coconuts and arecanut gardens
- **6. Animal husbandry based systems:** Associated with other farming systems.
- **K.** Land management units: By over laying land use types on the soils 12 land management units were arrived for the entire districts (Fig. 2.6.12). Land use planning exercise shall be undertaken for these LMUs.



Fig. 2.6.12 Land Management Units of North Goa district

- 1. Coconuts of mudflats of beaches: All along the coast and river mouths, this LMU can be noticed. Fish farming is another activity in the unit
- **2. Swamps:** These occupy around 1900 ha area and are infested with weeds and partly with mangrove vegetation.
- **3. Salt pans:** This unit occupies only 333 ha and is used for salt production from sea water.
- 4. Rice fields of Khazan lands: This unit occupies 7300 ha area and due to salt water inundation during Kharif season only rice is grown here. The productivity levels of these fields are also quite high.
- 5. Cashews of flat topped mountains: This unit occupies significant area and is owned by private as well as government. Cashew is grown along with forest species.
- **6. Cashew and forests of hill slide slopes**: Unit is similar to number 5 and is eroded and poor in productivity.
- **7. Coconuts of lateritic coast**: This unit occupies significant area of the coastline and soils are lateritic in nature due to heavy rains in the region.

- **8. Cashew and forests of restricted mountains**: Forests and cashew are mixed in these regions and are found in isolated places in the district.
- Rice fields of interhill basins: This unit is used for rice cultivation in Kharif and pulses, vegetables and groundnuts in the rabi. Large tracts of such units are now converted for arecanut cultivation.

10. Rock out crops

11. Cashew and coconuts on lower hills: This unit is found as homesteads everywhere in the district.

12. Water bodies

L. Operational holdings: About 82 per cent of the holdings in North Goa are small and marginal and they hold 32 per cent of the agricultural lands. 470 number of large holdings (above 7.5 ha) hold nearly 30 per cent of the lands.

M. Potentials of the district in general

- Homesteads provide better opportunity for diverse farming based enterprises.
- Productivity levels of many crops can be enhanced.
- Bright scope for agricultural tourism.
- Sufficient LGP& extensive rice fallows provide good scope for double cropping.
- Water is not a constraint to take up water dependent farming enterprises.
- Availability of cosmopolitan consumers provides bright scope for variety of high tech as well as organic farming enterprises.

N. Constraints identified in general

- Extensive areas are going for urban and tourism development.
- Large parts of agricultural lands are under homesteads.
- Single crop areas dominate and very little area is under double crop.
- Region is vulnerable for climate changes.
- Due to heavy rainfall fertility loss is rapid.
- Expanding Mining industry has become major threat to land resources.

2.6g. Assessment of stakeholder needs and economic evaluation of land use types for land use planning of Mysore and North Goa districts

S.C. Ramesh Kumar, V.Ramamurthy and Rajendra Hegde

In order to assess the needs of the stakeholders (farmers and agricultural department) two separate types of questionnaires were designed for data collection. The soil variability (1:50,000 scale) was the basis for collecting the data from the farm households.

Mysore district is located at the southern most part of Karnataka state. The district has seven takuks viz., H.D. Kote, Hunsur, K.R. Nagar, Mysore, Periyapatna, Nanjangud and T.Narasipura. There are 1216 inhabited and 124 uninhabited villages. Agriculture is the main occupation in the district. The total number of farm households are 630032 of which marginal (< 1 ha) and small (1-2 ha) farmers accounts for 16 and 20 per cent to total farm households.

In Mysore district, about 38 soil series associations representing 80 per cent of areas were studied. A total of 342 farm households were interviewed for collecting data on different land use types. Under canal irrigated land dominant crops were paddy and sugarcane. Under rainfed condition tobacco, cotton, ragi, maize, fieldbean, horsegram, redgram, cowpea and groundnut were grown along with dairy and sheep enterprises.

Assessment of stakeholders requirements

The details and scale at which the soil information needs for the department of agriculture was assessed with the Agricultural Officers, Assistant Directors of Agriculture and Joint Directors of Agriculture. In the beginning of the stakeholders meeting the officers were explained the purpose of the meeting and about NBSS&LUP activities and its roles in land evaluation and land use planning activities. A questionnaire was given to the officers to list the details of information required and the scale at which it is required for implementing the agricultural programmes. About sixteen soils themes and the scale of soil information was reported (Fig. 2.6.13).

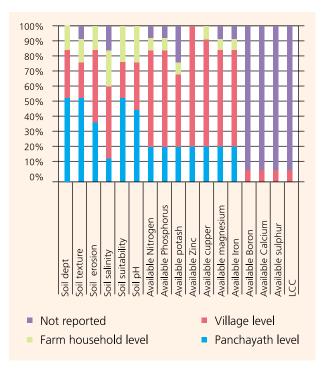


Fig. 2.6.13. Soil information needs for State Agricultural department

From this analysis it was found that the agricultural department is concerned about the soils, nutrients management and conservation programmes. The information needs on macro nutrients (NPK) and micronutrients status (Zn, Cu, Mg, Fe) were required at village and farm households level. The information on soil depth, texture and erosion and soil pH were required at panchayat and village level. It was also reported that department officials are not feeling/finding the need for information on micro nutrients like boron, calcium and sulphur and general land capability classification of soils.

Economic evaluation of soils

The economic evaluation of different types land uses carried out on soils of Mysore district is given in table 2.6.9. In Mysore, paddy and sugarcane are the dominant crops under irrigated condition. Paddy is cultivated on all types of soils. The per hectare net returns in paddy cultivation was maximum on deep red loamy soils (Rs. 43,775) and was minimum on deep alluvial loamy soils (Rs. 15100). In case of sugarcane cultivation per hectare net returns was found maximum on deep red gravelly clay soils (Rs. 2, 08,725) and was minimum in shallow red loamy soils (Rs. 67,800).

Table 2.6.9 Economic land evaluation for different crop enterprises in Mysore district

(Net returns Rs/ha)

				Sc	oils (Area in h	ıa)			
Crops	Deep Alluvial Loamy Soils (82003)	Deep Black Soils (17617)	Deep Red Gravelly Clay Soils (26133)	Deep Red Loamy Soils (22555)	Medium Deep Red Gravelly Clay Soils (60683)	Medium Deep Red Gravelly Loamy Soils (45843)	Shallow Red Gravelly Clay Soils (38653)	Shallow Red Loamy Soils (28248)	District Average value
Banana			204050			250100	302500		252217
Cabbage						12275			12275
Cotton		15425	19425		21744		8700	12421	16576
Cowpea			13975		8300	41575			21283
Field bean					8025		38550		23288
Groundnut						21800			21800
Horsegram				7650		10113	6125	9788	8419
Maize	24500					14225	14788	21020	20916
Paddy	15100	33671	16985	43775	25481	24497	29119	37621	26642
Ragi	15456	15988	24788	17175	12366	4523	16238	10220	13319
Sesamum				8375	7741				8375
Sorghum						10888	2938		6913
Sugarcane	176688		208725				74950	67800	132041
Tobacco	55588		122813		54229		141621		85696
Tomato						4425	-8075		-1825
Mean value	57466	21694	87251	19244	22541	37262	63553	26478	39781

Among the rainfed crops, ragi is the predominant crop followed by tobacco and cotton. The per hectare net returns for ragi was maximum on deep red gravelly clay soils (Rs. 24,788) and was minimum on medium deep red gravelly loamy soils (Rs. 4,523). In case of tobacco, the per hectare net returns was maximum on shallow red gravelly clay soils (Rs. 1,41,621) and was minimum on deep alluvial loamy soils (Rs. 55,588). In case of cotton, the per hectare net returns was maximum on medium deep red gravelly clay soils (Rs 21,744) and minimum on shallow red gravelly clay soils (Rs. 8,700).

Yield gap analysis

The difference between the potential productivity as per the package of practices recommended by University of Agricultural Sciences, Bangalore and farmers yield levels are compared to arrive at yield gap. The productivity potential and yield gap analysis was assessed for different soils of Mysore district.

The potential productivity of paddy and the yield obtained on different soils is presented in figure 2.6.14. There is scope for bridging the yield gap of 8 to 34 per cent on different soils of Mysore district. In case of tobacco farmers are getting near to potential yield levels of 15 quintal on all the soils except on medium deep, red, gravelly clay soils (Fig. 2.6.15).

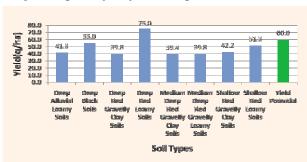
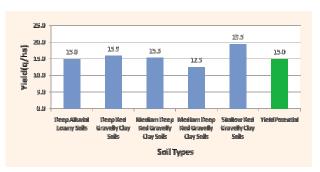


Fig. 2.6.14 Paddy productivity and yield potentials on different soils



2.6.15 Tobacco productivity and yield potentials on different soil types

2.6h. Land resource inventory for farm planning in different agro-ecological regions of India

A. Natarajan, Jaya N. Surya, R.S. Meena S.K. Reza, S. Bandyopadhyay, S. Dharmarajan, Pushpanjali, Karthikeyan and T.P. Verma

The present project aims to provide the required site-specific database needed for farm planning, in selected blocks located in six regions of the country as a pilot study. The detailed database generated at village level will form the basis and provide the required information needed for prioritising, initiating and executing any land-based developmental programmes by the line departments, extension officers, soil testing labs and others in the blocks surveyed under this project. So, this network project has been taken up simultaneously in all the five centres of the Bureau to provide a common methodology and platform for all the scientists of the Institute to work as a team not only in specifying the protocols for undertaking cadastral level survey but also to come out with a realistic work plan to take up this work in all the blocks of the country.

Blocks/mandals identified in different regions for Land Resource Inventory Project

Northern region	Delhi Centre	Lakhamajra block, Rohtak dist, Haryana, 16000ha
Southern region	Bangalore Centre	Chikka-Arsinakere hobli, Mandya dist., Karnataka 17000 ha
North eastern region	Jorhat Centre	Tuli watershed, Nagaland, 5000 ha
Eastern region	Kolkata Centre	Badua Watershed, Bihar, 1064 ha
Central region	Nagpur	Parseoni Block, Nagpur dist., Maharashtra 16493 ha
Western region	Udaipur Centre	Dungla tehsil (a part), Chittorgarh dist., Rajsthan 15,000 ha

Survey and mapping of soils in Chikka-Arsinakere hobli, Mandya dist, Karnataka state has been completed. Laboratory characterization of soil samples and the GIS work are in progress. In all the other blocks selected in different regions of the country, the soil survey and mapping work has been initiated and the survey work is in progress.

2.6h(i). Land resource inventionary for farm planning in Chikk-Arsinkere hobli of Maddur taluk, Mandya district of Karnataka

R. S. Meena, A. Natrajan, S. Thayalan, S. C. Ramesh Kumar, V. Ramamurthy, S. Srinivas

Total area of Chikarsinkere Hobli of Moddur taluk is 16,873 ha. Major part of the area (7,478 ha) is under canal irrigation. Rainfed area occupies about 4,367 ha. It is one of the four hoblis of Maddur taluk in Mandya district (Fig. 2.6.16). The climate of the hobli and district is hot moist semi arid with average annual rainfall of 770.9 mm. September and October are the wettest months receiving about 45% of the total rainfall of 771 mm. The mean annual temperature varies from 20 to 27°C.

Geology of the area is dominantly of granite. Major part of the hobli is under Kaveri and Hemavathi canal irrigation. The major crops of the area are rice and sugarcane in the irrigated track and ragi, pulses and oilseeds in uplands under rainfed conditions.

Soil survey was carried out using base map of scale 1: 8000. A detailed traverse of the area was made to identify the physiographic units like uplands, midlands and lowlands. Pedon sites were located in transects along the slope from the upper slope to lower slopes. About 700 profiles were studied for mapping of soils, based on variation in morphological characteristics and soil development in relation to physiography. On the whole, 14 soil series were identified as per the criteria given in soil survey manual and their phases were identified and mapped.



Fig. 2.6.16 Location map of Chikka-Arsinakere Hobli in Mandya district

Out of 14 soil series, 6 series were identified in uplands and 8 series in mid and lowland area. A brief description of the soil series is given below and soil-site characteristics are presented in table 2.6.10.

Sl.	Soil		Site c	haracteristic	s		Soil char	acteristics		Calcareo	usness
No.	series	Slope	Erosion	Drainage	Depth (cm)	Text Surface	ure Sub surface	Coarse fr Surface	agments Sub surface	Surface	Sub surface
1.	Cak	A	e1	MW	>150	c	c	nil	nil	e	e
2.	Kgt	Α	e1	MW	>150	scl	sc	nil	nil	es	e
3.	Tbl	В	e1	WD	75-100	scl	sc	15	20-60	nil	Nil
4.	Dak	A	e1	MWD	>150	scl	c	nil	nil	nil	Nil
5.	Hlr	A	e1	MW	>150	sl	scl	10	15-20	nil	Nil
6.	Hgl	A	e1	MWD	100-150	sc	c	nil	nil	es	ev
7.	Hnl	A	e1	MWD	50-75	c	sc	10	10-30	nil	Nil
8.	Mnl	A	e1	MWD	>150	ls	sc	nil	nil	es	Ev
9.	Mgr	В	e1	WD	50-75	sl	sc	35	60	nil	Nil
10.	Kgr	A	e1	WD	100-150	sc	c	nil	30	nil	Nil
11.	Kkh	Α	e1	MWD	89-110	scl	scl	nil	nil	es	Nil
12.	Ydh	Α	e1	WD	100-150	cl	c	35	35-60	nil	Nil
13.	Bdh	A	e1	MWD	75-100	sc	c	20	30	nil	Nil
14.	Avl	Α	e1	WD	>150	sc	c	nil	nil	nil	nil

Table 2.6.10 Soil-site charaterstics of Chikk-arsinakere hobli

Note: Slope: A 0 - 1 %, B 1 - 3 %, Erosion: e1 - slight, e2 - moderate, Drainage: WD - well drained, MWD - moderately well drained, Texture: Is - loamy sand, sI - sandy lopam, scI - sandy clay loam, sc- sandy clay, c - clay

- 1. Honnanaya Kanahalli (Hnl): Moderately shallow (50 75 cm), well drained, reddish brown sandy clay loam to sandy clay surface followed by dark red to dark reddish brown, sandy clay to clay subsoil with 10 to 30 per cent gravel developed on weathered granite occurring on nearly level to very gently sloping mid and uplands.
- 2. Manigere (Mgr): Moderately shallow (50-75 cm), well drained, dark brown to dark reddish brown, sandy loam to sandy clay loam surface followed by dark brown to dark reddish brown, gravelly sandy clay to gravelly clay with 35 to 60 per cent gravel, occurring on nearly level to very gently sloping mid and uplands developed from weathered granite.
- 3. **Bidarahalli (Bdh)**: Moderately deep (75-100 cm), well drained, dark brown to reddish brown, sandy loam to sandy clay loam surface followed by dark red to dark reddish brown, sandy clay to clay with < 35 per cent gravel, occurring on nearly level to very gently slopping uplands and developed from weathered granite.
- **4. Torebommanahalli (Tbl)**: Moderately deep (75-100 cm), well drained dark grayish brown to

- very dark grayish brown, sandy clay loam to sandy clay surface followed by yellowish red to dark reddish brown, sandy clay to clay with 35 to 60 per cent gravel occurring on nearly level to gently sloping uplands developed from weathered granite.
- 5. **Kudagere (Kgr)**: Deep (100-150), well drained, dark reddish brown to yellowish red loamy sand to sandy clay loam surface followed by yellowish red to dark reddish brown, sandy clay to clay subsoil with gravelly horizon occurring between 50 to 100 cm depth, occurring on nearly level to very gently sloping uplands from weathered granite.
- **6. Yadaganahalli (Ydh)**: Deep (100-150 cm), well drained, reddish brown to dark reddish brown, sandy loam to sandy clay loam surface followed by dark red to dark reddish brown, sandy clay to clay sub soil with 35 to 60 per cent gravel occurring on nearly level to very gently sloping uplands, developed on weathered granite.
- 7. Hagalhalli (Hgl): Deep (100-150 cm), moderately well drained, brown to dark reddish brown, sandy loam to sandy clay surface horizon followed by dark yellowish brown to grey, sandy clay to clay.

calcareous subsoil occurring on nearly level to very gently sloping midlands developed on granite.

- 8. Kyathaghatta (Kgt): Deep (100-150 cm), moderately well drained, very dark grayish brown to very dark grey sandy loam to sandy clay surface followed by brownish yellow to very dark grey sandy clay loam to sandy clay calcareous subsoil horizon occurring on nearly level to very gently sloping midlands developed from granite.
- 9. Aravanahalli (Avl): Very deep (>150 cm), well drained, dark brown to yellowish red loamy sand to sandy clay loam surface followed by dark red to dark reddish brown sandy clay to clay subsoil occurring on nearly level to very gently sloping uplands developed from granite.
- 10. Doddarasinkere (Dak): Very deep (>150 cm), moderately well drained somewhat poorly drained to dark brown to very dark grey, sandy loam to clay, calcareous surface followed by yellowish brown to very dark grey, sandy clay to clay, calcareous subsoil occurring on nearly level low lands developed from alluvium.
- 11. Chikka-Arsinkere (Cak): Very deep (>150 cm), moderately well to somewhat poorly drained, brown to very dark grayish brown, sandy clay to clay, calcareous surface followed by dark yellowish to brown to very dark grey clay, calcareous subsoil and with pressure falls occurring on nearly level low lands, developed from alluvium.
- **12. Honnalagere (Hlr) :** Very deep (>150), moderately well to somewhat poor drained, brown to dark grayish brown, sandy clay loam to sandy clay surface horizon followed by yellowish brown to dark grayish brown, sandy loam to clay loam subsoil horizon occurring on nearly level low lands developed from alluvium.
- 13. Madenahalli (Mnl): Very deep (150), moderately well drained to somewhat poorly drained, very dark grayish brown to dark gray, sandy clay loam to sandy clay, surface horizon followed by light olive brown to very dark gray sand to clay stratified soil, calcareous subsoil horizon occurring on nearly level low land developed from alluvium.
- 14. Kadakothanahalli (Kkh): Deep (100-150), moderately well drained, very dark grayish brown clay surface horizon followed by very dark grayish brown to dark brown clay, calcareous subsoil with slightly developed slickenside and occur on nearly level midlands of uplands.

2.6i. Correlation of soil series of India and their placement in National Register - Southern states (AP, Karnataka, Kerala, Tamil Nadu, Goa, Puducherry and Lakshadweep)

> L.G.K. Naidu, A. Natarajan, K.M. Nair, K.S.Anil Kumar and R.S.Meena

During the period under report 10 soil series were correlated and forwarded to Soil Correlation Committee for incorporation in the National Soil Series Register. Out of these, two Aisandra and Arikunte are entered in National Registor. Short description of these series are given below.

- 1. AISANDRA SERIES: The Aisandra series is a member of loamy-skeletal, mixed, isohyperthermic family of Lithic Ustorthents. Aisandra soils are shallow, reddish brown to dark reddish brown, slightly acid, gravelly sandy clay loam horizons, and dark reddish brown slightly acid, gravelly sandy loam AC horizons over chlorite schist. Extensively distributed (about 4,000 ha) in Bangarpet taluks of Kolar district, Karnataka
- **ARIKUNTE SERIES:** The Arikunte series is a member of clayey-skeletal, mixed, isohyperthermic family of Oxic Haplustepts. Arikunte soils are moderately deep, yellowish red to red, moderately acid to neutral, gravelly clay B horizons over laterite. Extensively distributed (about 38,600 ha) in Kolar, Chintamani, Srinivaspur, Mulbagal, Sidlaghatta and Malur taluks of Kolar district, Karnataka
- 2.6i. Geomorphological analysis and study on landform - soils - land use relationships in Karnataka State.
 - S. Thayalan, L.G.K. Naidu, A. Natarajan, K.M. Nair, K.S. Anil Kumar, S.C. Ramesh Kumar, V. Ramamurthy and R.S. Meena

Ghatti Subramanya area of Doddaballapur taluk, Bengaluru Rural district was selected for understanding the landform-soil variability (Fig. 2.6.17). It extends from 13° 20'to 13° 25' N Latitude and 77° 30' to 77° 35' E Longitude and covers a total area of about 150 sq km. Geologically, it belongs to the Archaeans consisting of peninsular gneiss and granites, which forms the basement complex. The northern half of the study area consists of Clospet granites, which are of later intrusions, whereas, the southern half belongs to the ancient gneissic complex. This is clearly reflected in the landforms identified as well. The first four landforms namely, structural hills and ridges, isolated hills and local rises, rolling lands and undulating terrain belongs dominantly to the Clospet granite group, while the gently sloping terrain and majority of the narrow valley floor falls under the gneissic complex. Elevation wise the gently sloping terrain has a range of 900 to 920 m above MSL, whereas the landforms of the closepet granites reach up to 1000 m above MSL. Numerous dolerite dikes cutting across the northern parts indicate later intrusions and its influence on regional metamorphism (Fig. 2.6.18). Subareal spheroidal weathering and the process of its exhumation resulted in the formation of ruwars, which is reflected in the availability of numerous Tor boulders and castellated domical rises. Granular disintegration, joint plan expansion, shattering and exfoliation are the dominant geomorphic processes prevalent among the closepet granites. On the basal knicks of the isolated hills and local rises, however, an interesting weathering process has been identified. The underside of the tor boulders develop numerous gnammas and pans which are further enlarged to stone-lattice (Fig. 2.6.19a&b). Since the granites are rich in feldspars, the selective weathering of this permits a loosening of the less soluble components, which are then dispersed mechanically, leaving corroded surfaces, the larger ones frequently exhibit thin, canopy-like overhangs leading to tafoni or alveolar weathering.

In order to understand the landform-soil and crop variability, a measured cross-section was studied in detail near Durgenahalli/Tubagere villages adjoining a local rise on the gently sloping terrain. Using a Suunto Clinometer the slope angles were measured at 10 to 20 m intervals between the elevation of 950 and 920 m above MSL, for a distance of 320 m trending W-E from the crest of the local rise towards the nearest thalweg, an incipient valley floor. The measured slopes were grouped together and based on the angular discontinuity five landform subunits were identified on toposequence. They are distinctly different from one another in their slope form, composition and surficial materials. Soil profiles were exposed exactly in the centre of the indentified landforms and they were studied for their morphology. Fig. 2.6.20 shows the measured cross-section and the five pedons studied in sequence.

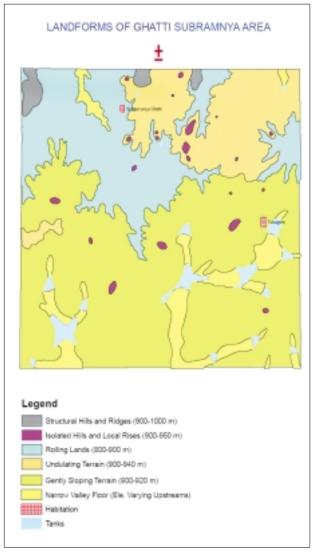


Fig. 2.6.17 Landforms of Ghati Subramanya, Doddaballapur taluk, Bangalore rural district



Fig. 2.6.18 Granite Rolling lands with steeply dipping dikes in the centre



Fig. 2.6.19a Formation of gnammas leading to stone-lattice and alveolar weathering

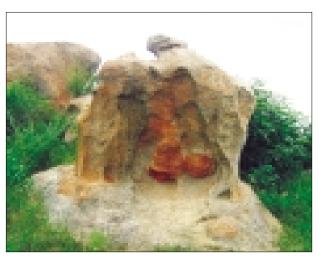


Fig. 2.6.19b Formation of Alveolae (Tafoni) leading to cavernous weathering

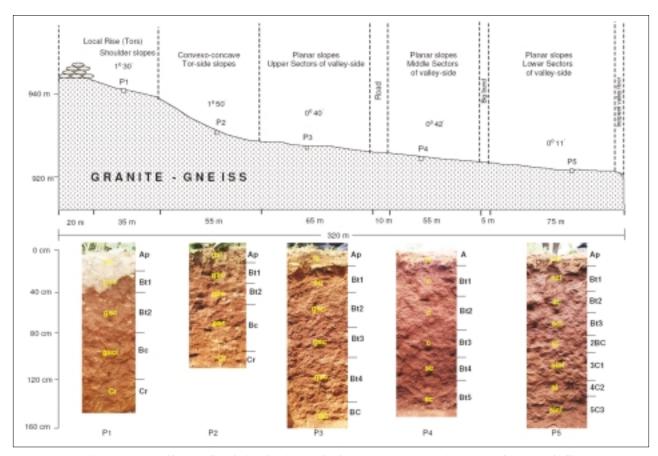


Fig. 2.6.20 Landform-soils relationship in gently sloping granite-gneissic terrain of Durgenahalli

Pedon-1 is situated on the centre of the shoulder slopes adjoining the Local Rises. It has an average slope of 1° 30' and the slope length is 35 m. The solum depth itself is around 80 cm followed by BC horizon to 120 cm and the colour is dominantly of 2.5 YR hue. Highly weathered granite is exposed upto 150 cm. The texture

of the surface horizon is loamy sand and the subsurface is dominantly of sandy clay. The lighter texture on the surface indicates that the processes of slope wash and sheet wash are very active there by the finer particles are removed continuously. The presence of argillans in the sub surface horizons confirms the process of illuviation. Fine gravels of quartz and feldspar dominantly available on the surface (c. 50%) decreases to (c. 35%) on the BC horizon. The existing cropping pattern is finger millet intercropped with field beans.

Pedon-2 is positioned on the centre of Convexo-concave Tor-side slopes having the average slope of 1° 50′ and the slope length is 55 m. The solum depth is 100 cm with a well defined Bt horizon up to 55 cm. The colour of the soil is in 2.5 YR hue. Highly weathered granite is available after 100 cm. The texture is dominantly of gravelly sandy clay with the surface being gravelly sandy loam with the fine gravel content being 55 per cent. Thin patchy cutans are present in the sub surface horizons. The decreased solum depth may be related directly to its position on the toposequence wherein the slope is slightly increased. The existing cropping pattern is finger millet and field beans as intercrop.

Pedon-3 is situated on upper sectors of the valley-side, which is the starting point of planar slopes. Here the slope is drastically reduced (0° 40') and becoming much shallower when compared to the above occurring Torside slopes. However, the slope length is increased to about 65 m. The pedon studied here is well developed with a solum depth of 160 cm. The colour is dominantly of 2.5 YR hue and the texture being gravelly sandy clay. The texture of the surface horizon is loamy sand with less gravel content. However, in the subsurface horizons the gravel content is between 35 and 45 per cent. Thin, patchy cutans are available throughout the sub surface horizons including the BC horizon and this confirms the process of illuviation. The existing cropping pattern is horse gram and finger millet.

Pedon-4 is positioned on the centre of the Middle Sectors of the Valley-side, which is rectilinear in nature. The average slope is similar to that of the Upper Sectors and the slope length is also reduced to about 55 m. However, the middle position of this unit, half way between the Local Rises and that of the incipient valley floor, makes this unique with respect to soil development. The solum depth is 150 cm with well developed argillic horizons. The colour is in the hue of 2.5 YR. The texture is dominantly of clay to sandy clay in the sub surface. However, the surface has a

lighter texture of clay loam but when compared to the above occurring pedons of 1, 2 and 3, it has a heavier texture indicating the process of entrainment. Another remarkable feature of this pedon is the total absence of quartz and feldspar gravels indicating the process of disintegration, decomposition and assimilation. Thin to thick patchy cutans are available in the sub surface horizons, further confirming the process of clay illuviation and enrichment. The existing land use is finger millet and field beans as inter crop.

Pedon-5 is excavated on the centre of the Lower Sectors of the Valley-Side planar slopes, very nearer to the margin of the incipient valley floor. The studied pedon shows remarkable changes in soil development. Though the colour is dominantly of 2.5 YR hue except the surface horizon where it is in the hue of 5 YR, there are lot of changes with respect to texture and other morphological characters. Up to a depth of 80 cm the pedon resembles that of the middle sector profile, with texture ranging from sandy clay loam to sandy clay with the development of thin, patchy cutans indicating illuviation. However, below 80 cm the pedon shows remarkable changes showing alternate light and heavy texture and the heavy presence of mica makes the texture feel towards silt. The presence of loamy sand layer in between silty clay loam horizons indicates the effect of flash floods. The existing land use is maize and finger millet.

Taxonomically, the Pedons 1 and 2 belong to clayey-skeletal family of Kandic Paleustalfs; Pedon-3 is classified as clayey-skeletal, Typic Paleustalfs; Pedon-4 belongs to Fine, Typic Paleustalfs and the Pedon-5, situated near the incipient valley floor is a Fine-loamy, Dystric Haplustalf.

The study reveals that a close relationship exists between landform position and that of the soil variability on a true slope sequence at right angles to the contour from the waxing crust to the waning valley floors, on the gently sloping terrains of the Bangalore pleateau. Similar landform-soil relationship studies at Western Ghats, besalt terrain of North Karnataka will be taken up in due course of time.

2.7

Regional Centre, Delhi

2.7a. Dynamics of land use and its impact on soil development in Nawanshahar (Shaheed Bhagat Singh Nagar) district, Punjab state.

G.S. Sidhu, Jaya N. Surya, Tarsem Lal, D. K. Katiyar and J. P. Sharma

The soil map was interpreted and reclassified into different thematic maps viz., land irrigability, land capability, erosion, drainage, particle-size, soil reaction, productivity index, productivity potential, suitability for wheat, rice and potato. The data was also interpreted for temporal change (1959, 1983 and 2008) in soil properties.

Land Irrigability map (Fig. 2.7.1) indicate that classes 1, 2 and 3 occupy 19.5, 34.1 and 34.8%, respectively. Class 4 lands occupy 1% area, whereas class 6 lands mostly in Siwaliks occupy 9.1% area associated with steep slopes topography. Class II and III lands occupy

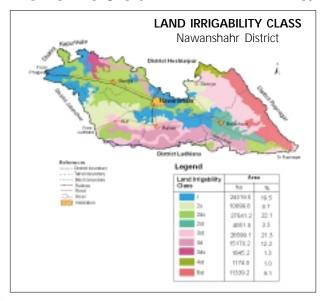


Fig. 2.7.1 Land irrigability class

61.9% and 27.7% area, respectively. Class IV and V lands cover 1 and 9.1% areas, respectively. Nearly 74.2% in area of TGA have nil to slight soil erosion. Moderate and severe/very severe erosion occupy 14.3 and 10.0% areas, respectively mostly on hilly and foot hill areas.

The status of soil drainage map (Fig. 2.7.2) shows that large tract (72.9%) of the district is well to excessively drainage and 29.2% is moderately well drained. Poorly drained soils occupy 6.4% area. Fine loamy soils occupy maximum area (49.7%) followed by sandy (27%) and coarse loamy soils (21.1%). The neutral to moderately alkaline soils occupy 67.5% area, strongly to very strongly alkaline soils occupy 31.1% area (Fig. 2.7.3).

Productivity index (Fig. 2.7.4) of the soils indicate that 39.4% of the soils have excellent to good index, followed by poor to extremely poor (31.1%) and average (27.7%). Productivity Potential of soils is good to excellent in 61.7% area followed by average (19.5%) and poor/extremely poor (17.1%).

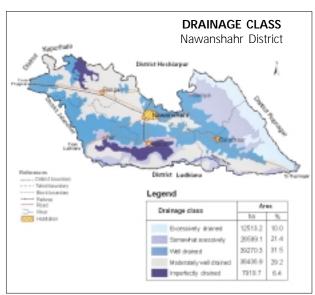


Fig. 2.7.2 Drainage class

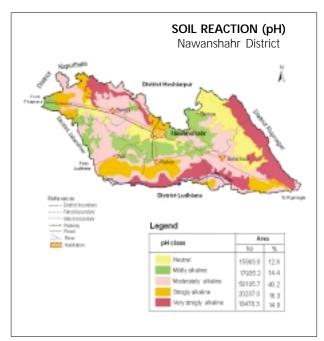


Fig. 2.7.3 Soil pH

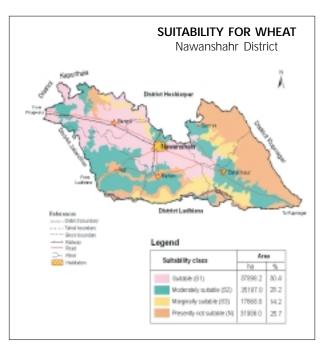


Fig. 2.7.5 Suitability for wheat

Soil suitability for crops

The data indicate that 58.6% of the area is suitable (S1) to moderately suitable (S2) for growing wheat (Fig. 2.7.5) followed by 14.2% as marginally suitable (S3) and 25.7% as presently not suitable (S4) which include hilly areas. Nearly 37.3% area is suitable to moderately suitable for growing rice (Fig. 2.7.6). Marginally

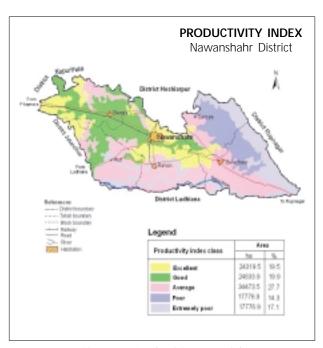


Fig. 2.7.4 Productivity Potential

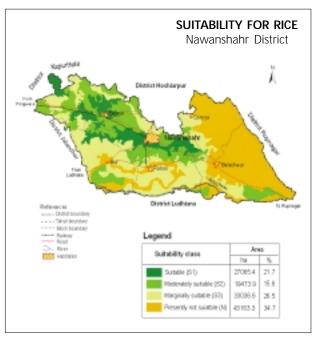


Fig. 2.7.6 Suitability for rice

suitable area is 26.6% and remaining 34.7% area is presently not suitable for rice crop. Maize can be grown in 39.4% area (S1 and S2). Nearly 21.2% area is marginally suitable (S3) for growing maize crop and remaining area is presently not suitable (S3). The data indicated that 48.2% area is suitable to moderately suitable for potato. Nearly 12.4% area is marginal suitable and remaining area presently is not suitable.

Dynamics of land use and its impact on soil properties

The data indicate that the area under rice crop increased from 9% in 1959-60 to 30% in 1996-97 and 40% in 2006-07 (Fig. 2.7.7). The area under wheat decreased from 78% in 1959-60 to 45% in 1996-97 and increased to 63% in 2006-07. The decrease in acreage is due to reorganization of district by merging non-wheat areas during 1996-97. On the other hand, the area under maize deceased from 42% during 1959-60 to about 11% in 1996-97 and 2006-07. The area under sugarcane crop decreased from 18% in 1959-60 to 11% in 1996-97 and 4% in 2006-07. The increase in area under rice crop is mainly due to corresponding decrease in area under maize crop during the period under study.

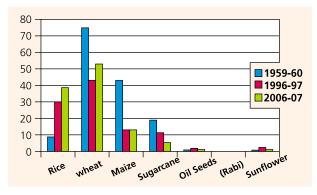


Fig. 2.7.7 Dynamics of land use change in Nawanshahr district

Impact of land use change on soil properties

Soil organic carbon: In Naura series, the organic carbon(OC) was more than 1% in surface soils during 2008 as compared to 0.3 and 0.4% during 1959 and 1983 respectively (Fig. 2.7.8). The build-up of O.C. was due to extensive practice of rice-wheat cropping system. In sub-surface soils, the O.C. was observed to be less than 0.2%.

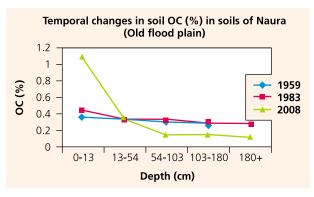


Fig. 2.7.8 Temporal change in organic carbon

Soil electrical conductivity (E.C.): The EC was relatively high (0.36 dSm⁻¹) in surface soils during 2008 which has decreasing trend (0.1%) in sub-surface soils than 0.2 to 0.3% during 1959 and 1983. The high EC in surface soils may be due to salt accumulation through application of chemical fertilizers during 2008 as compared to 1959 and 1983.

Soil pH: There was decreasing trend in soil pH (Fig. 2.7.9) during 2008 (pH 7.0) than 1959 (pH 7.2 to 7.3) and 1983 (pH 7.4 to 7.6). The rice-wheat system might have contributed towards lowering of soil pH.

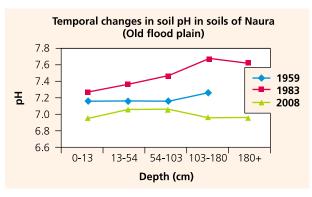


Fig. 2.7.9 Temporal change in soil pH

Soil microbiological properties

The data indicated that maximum microbial biomass was found in sugarcane-wheat-pea cropping system, followed by the forest, fallow land and wheat sugarcane cropping system (Fig. 2.7.10).

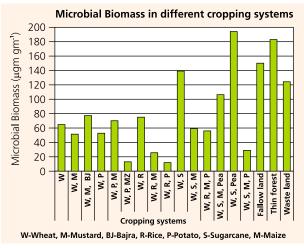


Fig. 2.7.10. Soil microbial biomass under different cropping systems in Nawanshahr district

Minimum biomass was in wheat-potato-maize and wheat-rice-potato systems. The forest soils and pea crop in rice-wheat and sugarcane contributed maximum biomass in soils.

2.7b. Dynamics of land use and its impact on soil development in Jalandhar district, Punjab state

G.S. Sidhu, Jaya N. Surya, Tarsem Lal, Dharam Singh and J. P. Sharma

The soil map (Fig. 2.7.11) of the district has been finalized. Sixteen soil series have been mapped into twenty five soil series associations i.e. mapping units. (Table 2.7.1).

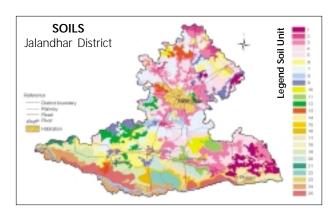


Fig. 2.7.11 Soil map of Jalandhar district, Punjab

Table 2.7.1 Brief Description and taxonomy of soil series identified in Jalandhar district of Punjab

Map unit No.	Soil series association	Soil series	Brief description	Taxonomy (Sub group)	Area Ha (%)
Soils	of old flood Plain				
1.	Suleman - Adampur	Suleman	Very deep, well drained, dark grayish brown to dark yellowish brown, sandy loam to loam, slight effervescence, 0-1% slopes	Typic Haplustepts	10474.0 (3.99)
		Adampur	Very deep, well drained, brown to grayish brown, fine sandy loam to loamy sand, strong effervescence 0-1% slopes	Typic Ustifluvents	
2.	Partabpura-Ughi	Partabpura	Very deep, moderately well drained, dark grayish brown to dark yellowish brown, loam to clay loam, slight effervescence, 0-1% slopes	Typic Haplustepts	4997.0 (1.90)
		Ughi	Very deep, well drained, dark grayish brown to brown, sandy loam, 0-1% slopes	Udic Haplustepts	
3.	Darapur-Nurpur	Darapur	Very deep, well drained, dark grayish brown to dark yellowish brown, sandy loam, 0-1% slopes	Udic Haplustepts	33630.5 (12.82)
		Nurpur	Very deep, moderately well drained, dark grayish brown to dark yellowish brown, sandy loam to loam, 0-1% slopes	Udic Haplustepts	
4.	Nurpur-Darapur	Nurpur Darapur	Same as in 3 Same as in 3		21134.0 (8.05)
5.	Adampur-Suleman	Adampur Suleman	Same as in 1 Same as in 1		20117.0 (7.67)
6.	Adampur-Darapur	Adampur Darapur	Same as in 1 Same as in 3		24167.3 (9.21)
7.	Darapur-Singhpura	Darapur Singhpura	Same as in 3 Very deep, excessively drained, brown to dark yellowish brown, loamy sand, 1-3% slopes	Typic Ustorthents	25890.1 (9.87)
8.	Nurpur-Singhpura	Nurpur Singhpura	Same as in 3 Same as in 7		4667.0 (1.78)
9.	Singhpura-Suleman	Singhpura Suleman	Same as in 7 Same as in 1		10472.0 (3.99)
10.	Bharduaji-Nurpur	Bharduaji	Very deep, well drained, very dark grayish brown to dark yellowish brown, loam to clay loam slight effervescence, 0-1% slopes	Typic Haplustepts	4589.7 (1.75)
		Nurpur	Same as in 3		
					cont

11.	Bharduaji-Suleman	•	Same as in 10		6115.5
10	Habi Cinabaaaa	Suleman	Same as in 1		(2.33) 8242.8
12.	Ughi-Singhpura	Ughi Singhpura	Same as in 2 Same as in 7		(3.14)
	of old flood plain w	ith sandy pa			
13.	Darapur-Gorsian Nihal (Inclusion of Madehpur)	Darapur Gorsian Nihal	Same as in 3 Very deep, well drained, brown, sandy loam to loamy sand, slight effervescence, 0-1% slopes	Typic Ustorthents	4873.6 (1.86)
Caila	•			Cotor therito	
3011S	of old flood plain w. Gorsian Nihal-	<i>un om ievee</i> s Gorsian	Same as in 13		3241.1
14.	Shankar (Inclusion		Same as in 13		(1.24)
	of Talwan)	Shankar	Very deep, well drained, dark grayish brown to brown, sandy loam to loamy sand, slight effervescence, 0-1% slopes	Typic/ Fluventic Haplustepts	
15.	Talwan - Gorsian	Talwan	Very deep, well drained, brown to yellowish brown,	Typic	2962.5
	Nihal	Gorsian	loamy sand to sand, slight effervescence, 0-1% slopes Same as in 13	Ustifluvents	(1.13)
		Nihal	Suite as in 15		
16.	Talwan- Shankar	Talwan	Same as in 15		1699.8
		Shankar	Same as in 14		(0.65)
	of recent flood plain				
17.	Shankar-Mundhala	Shankar Mundhala	Same as in 14 Very deep, well drained, dark grayish brown to	Fluventic	7374.8 (2.81)
		Withinia	brown, loam to clay loam/loamy sand, slight effervescence, 0-1% slopes	Haplustepts	(2.01)
18.	Shankar-Madhepur		Same as in 14		6269.5
		Madhepur	Very deep, excessively drained, brown to grayish brown, light grayish brown, loamy sand to sand, violent effervescence, 1-3% slopes	Typic Jstipsamments	(2.39)
19.	Mehatpur-Shankar	-	Very deep, excessively drained, dark grayish brown to dark yellowish brown, loamy sand, slight effervescence, 0-1% slopes.	Typic Haplustepts	9693.8 (3.69)
		Shankar	Same as in 14		
20.	Mundhala-Shankar	Mundhala Shankar	Same as in 17 Same as in 14		14749.8 (5.62)
21.	Gidar Pindi-		Very deep, well drained, dark grayish brown to brown,	Typic	690.02
	Shankar			Haplustepts	(0.26)
	~	Shankar	Same as in 14		
22.	Gidar Pindi- Talwandi	Gidar Pindi Talwandi	Same as in 21 Very deep, well drained, very dark grayish brown,	Typic	5173.1 (1.97)
	2427742242		sandy loam to loamy sand, stratified slight	Ustifluvents	(1.07)
~			effervescence, 0-1% slopes		
	of Active Flood Plain				00704
23.	Madhepur- Talwandi	Madhepur Talwandi	Same as in 18 Same as in 22		3250.1 (1.24)
24.	Talwandi -	Talwandi	Same as in 22		11018.0
	Madhepur	Madhepur	Same as in 18		(4.20)
25.	Talwandi-Shankar		Same as in 22		12452.1
		Shankar	Same as in 14		(4.75)
			Habitation		640.0 (0.24)
			River/water bodies		3815.0
					(1.45)
			Total		262400
					100

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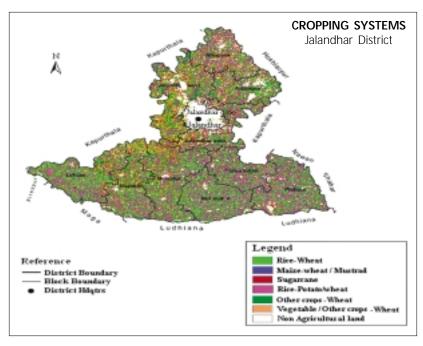


Fig. 2.7.12. Cropping systems in Jalandhar district

The data indicated that 237488 ha area is under agriculture, 289 ha under other plantation crops, 909 ha under water bodies and 24514 ha under other uses including wastelands. Area under rice crop is 57.8%, maize (1.32%), vegetables (10.11%) and other crops occupy 25.34% of the area in *kharif*. In *rabi* wheat occupy 64.95% followed by vegetables (22.88%), and pulses (0.13%) and other crops (6.61%). In summer, other crops occupy 15.56% and current fallow occupy 79.01% area. In general, 5.43% area is under sugarcane (Fig. 2.7.12).

2.7c. Soil resource mapping of Mathura district of Uttar Pradesh for perspective land use planning

S.K. Mahapatra, Jaya N. Surya, Tarsem Lal, G.S. Sidhu and J.P. Sharma

Soil resource data has been interpreted to generate various thematic maps (Fig. 2.7.13) in GIS to cater the needs of different user agencies.

Soils in large part of the district are sandy loam (53.6%) followed by loam (24.9%), loamy sand (13.0%), sand (5.2%), clay loam (3.1%) and gravelly sandy loam (0.2%). Soils with moderately alkaline reaction occupy maximum area of 229232.1 ha (70.7%), followed by strongly alkaline soils with 51628.5 ha (15.9%), neutral 39751.0 ha (12.3%) and very strongly alkaline 3498.4 (1.1%) area in the district. About 154088 ha (46.1%)

area is well drained followed by 116488 ha (34.8%) moderately well drained, 53138 ha (15.9%) somewhat excessively drained and 688 ha (0.2%) excessively drained; Soil organic carbon has been categorized into three classes viz. low (< 0.4%), medium (0.4-0.75%) and high (> 0.75%). About 68 per cent area of the district falls under low soil organic carbon followed by medium (23%) and high (9%) respectively. Available phosphorus content in soils are grouped into three categories i.e. low (< 12.5 kg ha⁻¹), medium $(12.5 - 22.5 \text{ kg ha}^{-1})$ and high (> 22.5 kg ha⁻¹). About 50 per cent area of the district falls under low phosphorus followed by 29 per cent area in medium and 21 per cent area in low phosphorous categories. Available potassium is mostly in medium and low categories. About

60.2 per cent area of the district falls under medium (135-335 kg ha⁻¹) followed by low (< 135 kg ha⁻¹) and high (>335 kgha⁻¹) potassium categories respectively.

The suitability of major crops of Mathura district has been worked out on the basis of soil-site characteristics and the suitability criteria of some important crops and fruit crop (mongo) grown in the district (Fig. 2.7.14).

About 155228 ha (46.5 %) area is rated as under moderately suitable followed by 107014 ha (32%) as marginally suitable, 41217 ha (12.4%) as suitable and 20643 ha (6.2%) area as presently unsuitable class respectively. For cultivation of maize, 134609 ha area (40.3%) is found to be marginally suitable, 98061 ha (29.4%) moderately suitable, 70788 ha (21.2%) suitable and 20643 ha (6.2%) area presently unsuitable. For cultivation of pigeon pea, 118264 ha area (35.4%) is found to be marginally suitable, 111095 ha (33.3%) suitable, 70458 ha (21.1%) moderately and 21062 ha (6.3%) area presently unsuitable. About 114753 ha (34.4 %) area falls under marginally suitable class for followed by 101681 ha (30.4%) under suitable, 80413 ha (24.1%) under moderately suitable and 27275 ha (8.2%) area under presently unsuitable class respectively for mustard. About 115714 ha (34.7 %) area is grouped as marginally suitable followed by 111704 ha (33.5%) as suitable, 49822 ha (14.9%) as moderately suitable and 46862 ha (14%) area under presently unsuitable for mango plantation.

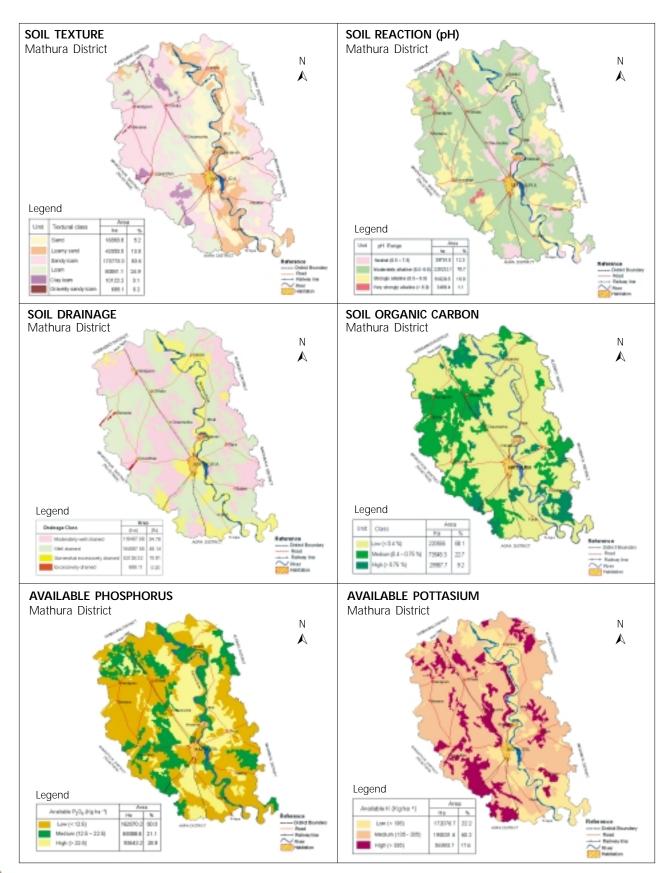


Fig. 2.7.13. Thematic maps of Mathura district

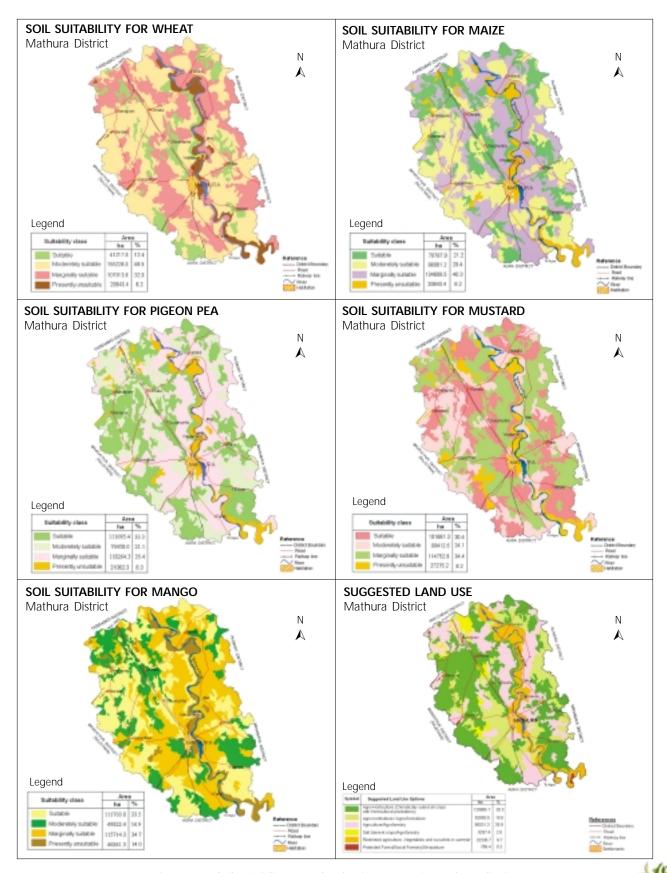


Fig. 2.7.14. Soil suitability maps for dominant crops in Mathura district

2.7d. Land resource inventory for farm planning in Lakhan Majra block of Maham-Rohtak Tehsil, Rohtak district, Haryana

Jaya N. Surya, Tarsem Lal, G.S.Sidhu, S.K. Mahapatra, Dharam Singh and J.P. Sharma

The present project was taken up as a pilot study in Lakhan Majra Block of Maham Rohtak Tahsil in Rohtak district of Haryana to prepare land resource inventory of the block and to provide the site-specific database for farm level planning.

The study area Lakhan Majra block is located between 28° 55' to 29° 55' N latitudes and 76° 35' E to longitudes covering an area of 16,690 ha. The block is a part of Maham and Rohtak tehsils, comprising of fourteen village, namely Gugaheri, Kharak Jatan, Bainsi, Lakhan Majra, Kharanti, Chandi, Indragarh Nandal, Chiri, Kharak and Churangla, Gurauthi, Titoli, Sasrauli Sunderpur. Out of total geographical area of the block, 13124 ha (79%) is cultivated and 11590 ha is irrigated mainly under canal irrigation. The main

crops are wheat, rice, mustard, sugarcane, pearl millet and maize. The area has major problems of salinity/sodicity and waterlogging (Fig. 2.7.15). Coarser texture soils occur in patches in the eastern part of study area.

The whole area is grouped into eight physiographic units viz., undulating sloping dunes, gently to moderately sloping aeolian plain, gently sloping upland plain, nearly level old alluvial plain, nearly level old alluvial plain with saline patches, nearly level old alluvial plain with concave slope and nearly level old alluvial plain with low-lying land/depressions.

The physiography of the study area is nearly level to very gently sloping old alluvial plain and they are subdivided into eight physiographic units viz., undulating sloping dunes (3-5%); gently to moderately sloping Aeolian plain (1-3%); gently sloping aeo-fluvial plain (1-3%); gently sloping upland plain (1-3%); nearly level old alluvial plain with saline patches (01%); nearly level old alluvial plain with concave slope (01%); nearly level old alluvial plain with low-lying land/depressions (01%).





Fig. 2.7.15 Salt affected soils - Lakhan Majra Block, Rohtak District, Haryana

2.8

Regional Centre, Jorhat

2.8a. Natural resource management in Dholi micro-watershed for optimum land use planning

Utpal Baruah and S.K. Reza

The main objectives of the study are to create natural resource database using remote sensing and conventional techniques and development of alternate land use system based on prospect and limitations of existing natural resources.

Detailed soil survey

Detailed soil survey has been carried out by using cadastral map (1:4000 scale) in the lower ridges of the watershed covering Chungi, Namchungi and Barbam Chungi villages. Traversing has been done in the selected villages to identify the landforms. There were three types of landform namely recent flood plain, gently sloping upland and very gently sloping upland (Fig. 2.8.1). After careful delineation of the various landforms on the cadastral map, the cadastral sheets with new permanent features were updated and familiarization of the area has been made with survey numbers and field boundaries. Intensive traversing of each landform (like ridges, uplands, lowlands/valleys etc.) was undertaken to select representative areas for profile study. The results show that Chungi soils have brown, strongly acidic silty clay A horizon and gray to brown, strongly acidic silty clay B horizon whereas Nam Chungi soils are light brownish gray, very strongly acidic, silty clay A horizon and gray to light brownish gray, strongly acidic, silty clay B horizon.

Descriptive statistics of soil physicochemical variable under Native forests, Tea and Paddy at 0-25 cm and 25-50 cm depth:

Surface (0-25 cm) and subsurface (25-50 cm) soil samples have been collected from three predominant land use (native forest, tea and paddy) systems of the study area. The data generated from this study will help in assessing the soil quality variation in the watershed and determining the land suitability for different crops which will ultimately help in land use planning of the study area.

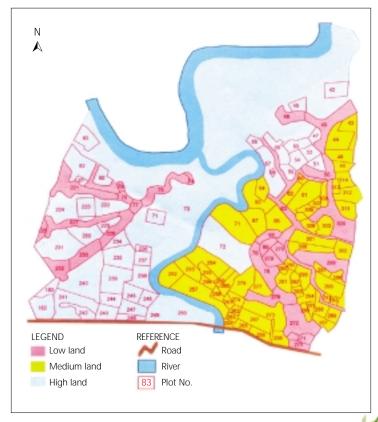


Fig. 2.8.1 Landform map of Chungi village

The univariate statistical results for native forest, tea and paddy soils at 0-25 cm and 25-50 cm depths are given in tables 2.8.1 and 2.8.2. It is observed that the soils under paddy cultivation had higher pH than adjacent soils under forests and tea for the two different depths. The highest pH values occurred at 25-50 cm soil depth for the paddy soil. The result shows that conversion of the natural forest into tea gardens and paddy fields resulted in reduction of stocks of soil organic matter (SOM) for the two sampling depths. SOM at 0-25cm depth of the paddy soils was lower than the corresponding values for tea and forest soils. The highest SOM was observed at 0-25 cm depth of forest soils.

Table 2.8.1 Descriptive statistics of soil physiochemical variables at 0-25 cm depths under three land uses

Variables	Mean	Minimum	Maximum	Standard deviation	Coefficient of variation (%)
		Paddy			
pH	5.14	4.80	5.40	0.18	3.50
SOM (%)	1.98	0.90	3.38	0.65	36.11
CEC (cmol/kg)	10.63	7.39	17.02	2.68	25.21
Base saturation (%)	29.33	21.16	39.50	5.54	18.89
Exchangeable K (cmol/kg)	0.10	0.06	0.16	0.03	30.00
Exchangeable Ca (cmol/kg)	2.43	1.72	3.72	0.51	20.98
Exchangeable Mg (cmol/kg)	0.34	0.06	1.34	0.32	94.11
Exchangeable Na (cmol/kg)	0.18	0.04	0.29	0.07	38.88
Exchangeable Al (cmol/kg)	1.20	0.28	2.20	0.50	41.67
Exchangeable H (cmol/kg)	0.29	0.07	1.01	0.23	79.31
Bray P (mg/kg)	1.42	0.32	2.94	0.77	54.22
		Tea			
pH	4.76	4.20	5.60	0.41	8.61
SOM (%)	1.92	0.99	3.20	0.60	31.25
CEC (cmol/kg)	10.34	5.60	15.90	3.33	32.20
Base saturation (%)	22.05	7.67	44.25	9.94	45.07
Exchangeable K (cmol/kg)	0.17	0.08	0.45	0.11	64.70
Exchangeable Ca (cmol/kg)	1.45	0.57	3.43	0.86	59.31
Exchangeable Mg (cmol/kg)	0.39	0.02	1.51	0.33	84.61
Exchangeable Na (cmol/kg)	0.22	0.08	0.46	0.11	50.00
Exchangeable Al (cmol/kg)	1.91	0.34	4.31	1.14	59.68
Exchangeable H (cmol/kg)	0.26	0.01	1.19	0.26	100.00
Bray P (mg/kg)	6.86	0.35	26.36	6.54	95.33
		Forest			
pH	5.01	4.80	5.20	0.11	2.19
SOM (%)	2.01	1.60	2.46	0.24	11.94
CEC (cmol/kg)	5.81	4.28	7.85	1.09	18.76
Base saturation (%)	33.36	21.13	43.03	6.10	18.28
Exchangeable K (cmol/kg)	0.21	0.13	0.36	0.06	28.57
Exchangeable Ca (cmol/kg)	0.68	0.44	1.10	0.18	26.47
Exchangeable Mg (cmol/kg)	0.83	0.66	1.10	0.15	18.07
Exchangeable Na (cmol/kg)	0.16	0.08	0.28	0.05	31.25
Exchangeable Al (cmol/kg)	2.47	0.60	3.57	0.65	26.31
Exchangeable H (cmol/kg)	0.46	0.15	1.18	0.29	63.04
Bray P (mg/kg)	2.35	0.82	5.09	1.27	54.04

Cation exchange capacity (CEC) is used for overall assessment of the potential fertility of a soil and its possible response to fertilizer applications. The highest CEC was found in the paddy soil. The CEC at 25-50 cm depth is higher than that at 0-25 cm in all the land use classes. The difference in silt and clay content in soils under forest, tea and paddy shows that there is large variation in CEC. Soils under forest have low CEC due to loamy texture whereas paddy soils have more CEC due to silty clay loam texture. This suggested

that some of the minerals containing the cations are in the silt fraction. The paddy soil had highest exchangeable cations, whereas the forest soils exhibited the lowest. As in agricultural soils, Ca was the dominant cation in the exchangeable complex. Generally, the base saturation values are low indicating that the soils are potentially less fertile with a possible Al toxicity. In acid environment, the dominant cation is exchangeable Al. The tea garden soils had high exchangeable Al followed by forest and paddy soils.

Table 2.8.2 Descriptive statistics of soil physiochemical variables at 25-50 cm depths under three land uses

Variables	Mean	Minimum	Maximum	Standard deviation	Coefficient of variation (%)
		Paddy			
pH	5.43	5.20	5.70	0.16	2.94
SOM (%)	0.65	0.18	1.26	0.33	50.7
CEC (cmol/kg)	12.29	7.17	19.26	2.89	23.51
Base saturation (%)	32.75	15.77	49.54	9.36	28.58
Exchangeable K (cmol/kg)	0.07	0.05	0.10	0.01	14.28
Exchangeable Ca (cmol/kg)	2.91	1.72	4.00	0.67	23.02
Exchangeable Mg (cmol/kg)	0.73	0.05	3.01	0.84	115.06
Exchangeable Na (cmol/kg)	0.22	0.07	0.42	0.08	36.36
Exchangeable Al (cmol/kg)	1.68	0.01	5.96	1.46	86.90
Exchangeable H (cmol/kg)	0.20	0.01	0.83	0.19	95.00
Bray P (mg/kg)	1.68	0.43	3.85	1.12	66.67
		Tea			
pН	4.72	4.10	5.60	0.40	8.47
SOM (%)	0.99	0.32	1.98	0.46	46.46
CEC (cmol/kg)	9.37	5.60	16.80	2.92	31.16
Base saturation (%)	21.98	8.55	56.25	12.11	55.55
Exchangeable K (cmol/kg)	0.13	0.05	0.62	0.13	100.00
Exchangeable Ca (cmol/kg)	1.19	0.22	3.72	0.99	83.19
Exchangeable Mg (cmol/kg)	0.53	0.05	1.33	0.35	66.03
Exchangeable Na (cmol/kg)	0.22	0.10	0.63	0.13	59.09
Exchangeable Al (cmol/kg)	2.94	0.18	6.05	1.57	53.40
Exchangeable H (cmol/kg)	0.17	0.01	0.46	0.13	76.47
Bray P (mg/kg)	1.83	0.11	8.05	2.34	127.86
		Forest			
pH	5.05	4.80	5.30	0.13	2.57
SOM (%)	1.49	1.10	1.83	0.21	14.09
CEC (cmol/kg)	5.55	4.04	7.37	0.91	16.39
Base saturation (%)	35.44	19.58	51.93	8.11	22.88
Exchangeable K (cmol/kg)	0.20	0.06	0.38	0.07	35.00
Exchangeable Ca (cmol/kg)	0.66	0.22	0.88	0.17	25.76
Exchangeable Mg (cmol/kg)	0.92	0.44	1.54	0.28	30.43
Exchangeable Na (cmol/kg) 0.1		0.04	0.21	0.05	35.71
Exchangeable Al (cmol/kg)	2.11	1.19	2.97	0.58	27.48
Exchangeable H (cmol/kg)	0.58	0.15	1.48	0.31	53.44
Bray P (mg/kg)	1.87	0.92	5.19	1.00	53.47
. 5 0					_

Coefficient of variation (CV) for all variables at two depths under three land uses was very different (Tables 2.8.1 and 2.8.2). The greatest variation (127.9%) may observed for Bray P under tea soil and smallest variation (2.6%) for pH was observed in forest soil at 0-25 cm depth. Similarly at 25-50 cm depth, greatest (100%) for exchangeable H under tea soil and smallest variation (2.2%) for pH were observed under forest.

2.8b. Soil resource mapping of Kamrup district (1:50,000 sacle) of Assam for land use planning

T.H. Das, Utpal Baruah and S.K. Reza

Kamrup district in the state of Assam lies between 25°28' 48" to 26°48' 32" N and 90°39' 25" to 92°09' 32" E covering an area of 4,35,400 ha. The climate of the district is sub-humid tropical with mean annual air temperature of 24°C with average annual rainfall of 1800 mm. Semi detailed soil survey was carried out using Geo-coded satellite imagery in conjunction with Survey of India Toposheets on 1:50,000 scale. Forty soil series were identified and mapped in 33 soil series association. The soils of the district belong to 4 soil orders, 7 sub-orders and 13 great groups and 20 subgroups. Inceptisols were the dominant soil order (34.09% of TGA) followed by Entisols (29.89% of TGA), Ultisols (16.03% of TGA) and Alfisols (14.11% of TGA). About 41% area of Kamrup district was level to nearly level (0-1% slope). Steep to very steep sloping areas (>50%) cover an area of 19.38%. Nearly 19% of total geographical area of the district is under slight erosion, 30% area under moderate erosion and 13% under severe to very severe erosion class. The soil series association map is shown in fig. 2.8.2 and description of soil mapping units is given in table 2.8.3.

Land Capability Class: The soil mapping units in the district have been grouped into 5 land capability subclasses based on the dominant soils in a unit. The different capability subclasses with their extent are given in table 2.8.4. The most extensive class is IVsw (25.81%) occurring mostly in alluvial plain and flood plain. VIes class dominantly belongs to hilly region of the state.

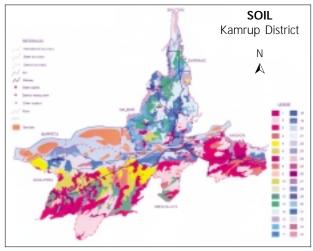


Fig. 2.8.2 Soil series association map of Kamrup district

Table 2.8.3. Description of soil mapping units of Kamrup district

Physiographic	Soil map unit	Soil series association	Brief description of soil series	Area (ha) % of TGA
A. Hill	1	Maliyata- Bhalumara	Maliyata: Moderately shallow, somewhat excessively drained, brown to red, sandy clay loam to sandy loam in control section (0-70) on moderately steep hill slope with moderately acidic sandy loam surface and severe erosion.	10585 (2.43)
H1			Bhalumara: Moderately shallow, somewhat excessively drained, yellowish red, sandy loam texture in control section (0-65) with moderately acidic sandy loam surface and moderate erosion.	
H2+H5	2	Amchang RF- Garbhanga RF	Amchang RF: Deep, somewhat excessively drained brown to reddish brown, silty clay loam to silty clay in control section on steep side slope of hills with moderately acidic silty loam surface and moderate erosion.	39477 (9.08)
			Garbhanga: Deep, somewhat excessively drained, reddish brown, silty clay in control section (0-100 cm) on steep side slope of hill with moderately acidic silty loam surface and severe erosion.	
				cont

Physiographic	Soil map unit	Soil series association		Area (ha) % of TGA
H3+H7	3	Mammon RF- Kamalajara- Longdadong	Mammon RF: Very deep, somewhat excessively drained, reddish brown to yellowish red, silty clay loam to clay loam in control section (0-100 cm) on very steep side slope of hill with slightly acidic sandy clay loam surface and severe erosion.	44731 (10.29)
			Kamalajara: Very deep, somewhat excessively drained, red to dark red, clay loam to sandy clay loam in control section (0-100 cm) on very steep side slope of hills with moderately acidic sandy loam surface and moderate erosion.	y
			Longdadong: Deep, somewhat excessively drained, dark reddish brown to dark red, sandy clay loam to sandy loam in control section (0-100cm) with moderately acidic silty clay loam surface and moderate erosion.	
H4+H6	4	Barbitli- Garbhanga	Barbitli: Deep, somewhat excessively drained, dark reddish brown to reddish brown, silty loam to silty clay loam texture in control section (0-100cm) on moderately steep side slope of hill with moderately acidic sandy loam surface and severe erosion.	9150 (2.10)
			Garbhanga: As as above.	
B. Upper Alluvial plain	5	Jamlaigaon- Dekapara	Jamlaigaon: Deep, moderately well drained, dark gray to dark reddish brown, clay to clay loam in control section (0-100 cm) on very gently sloping alluvial plain with grey, moderately acidic silty clay surface and moderate erosion.	
OA1			Dekapara: Very deep, moderately well drained yellowish brown to light yellowish brow gray, silty clay loam to silty clay in control section (0-100cm) with moderately acidic silty loam surface and moderate erosion.	11968 (2.75)
OA2	6	Rangingpara- Ambari- Dekapara	Rangingpara: Deep, moderately well drained, dark yellowish brown to yellowish brown, clay loam in control section (0-100cm) on very gently sloping alluvial plain with dark brown, moderately acidic loamy surface and moderate erosion.	11303 (2.60)
			Ambari: Deep, moderately well drained, light brownish gray to yellowish brown, sandy clay loam to clay loam in control section with moderately acidic sandy loam surface and moderate erosion.	
			Dekapara: Same as above.	
OA3	7	Lampara- Ambari	Lampara: Very deep, moderately well drained, light yellowish brown to pale brown, clay loam to sandy clay loam in control section (0-100 cm) on very gently sloping pasture land with light brownish grey, moderately acidic silty clay loam surface and slight erosion.	10462 (2.40)
			Ambari: Same as above.	
OA4	8	Barduar- Hekura- Tuksibari	Barduar: Very deep, moderately well drained, brownish yellow to dark yellowish brown, sandy clay loam to sandy loam in control section (0-100 cm) on very gently sloping alluvial plain with light brownish grey, moderately acidic, sandy loam surface and slight erosion.	13249 (3.04)
				cont

Physiographic	Soil map unit	Soil series association	Brief description of soil series	Area (ha) % of TGA
			Hekura: Deep, moderately well drained, dark grey to grey, clay to loam in control section (0-100 cm) on very gently sloping alluvial plain with dark grey, slightly acidic clayey surface and slight erosion.	
			Tuksibari: Very deep, moderately well drained, gray to dark brown, clayey in control section (0-100 cm) with light brown gray moderately acidic; silty clay loam surface and moderate erosion.	
OA5	9	Nichalamari- Moindra- Nogabil	Nichalamari: Moderately shallow, moderately well drained yellowish brown to yellowish red, clayey in control section (0-70cm) on very gently sloping alluvial plain with dark yellowish brown, moderately acidic clay loam surface and moderate erosion.	1445 (0.33)
			Moindra: Moderately shallow, moderately well drained, dark grayish brown to dark grey, silty clay loam to clay in control section (0-70 cm) with dark grayish brown, moderately acidic, sandy clay loam surface and moderate erosion.	
			Nogabil: Deep, moderately well drained, very dark gray to grayish brown, clay to sandy clay in control section (0-100 cm) on gently sloping interhill valley with very dark grayish brown, moderately acidic clayey surface and moderatege erosion.	
OA6	10	Hekura- Deeperbil	Hekura: Same as above. Deeparbil: Deep, imperfectly drained, brown to grey, silty clay loam to silty clay in control section (0-100 cm) on nearly level alluvial plain with geryish brown, slightly acidic, loamy surface.	3572 (0.82)
AO7+AO8	11	Bhehua- Jamlaigaon	Bhehua: Deep, imperfectly drained, brown to yellowish brown, clay loam to sandy clay loam in control section with dark grayish brown, moderately acidic clay loam surface.	2980 (0.68)
			Jamlaigaon: Same as above.	
AO9	12	Nampathar- Singara- Rangingpara	Nampathar: Deep, well drained, dark grayish brown to reddish brown, sandy loam to sandy clay loam in control section (0-100 cm) on very gently sloping alluvial plain with modeterately acidic loamy surface and moderate erosion.	25225 (5.80)
			Singara: Deep, moderately well drained, grayish brown to yellowish red, loam in control section (0-100 cm) on 1-3% alluvial plain with slightly acidic, loamy in surface and moderate erosion.	
			Rangingpara: Same as above.	
C. Alluvial plain	13	Dhalkuchi- Bamunbari- Naogaon	Dhalkuchi: Deep, imperfectly drained, grey, silty loam to silty clay loam in control section(0-100 cm) on nearly level alluvial plain with dark grey, slightly alkaline silty loam surface.	11616 (2.67)
A1 + A8			Bamunbari: Deep, imperfectly drained, brown to grayish brown, silty loam to sand in control section (0-100 cm) on nearly level alluvial plain with grayish brown, slightly acidic loamy surface and moderte erosion.	
				cont

cont...

Physiographic	Soil map unit	Soil series association	Brief description of soil series	Area (ha) % of TGA
			Naogaon: Very deep, imperfectly drained, very dark grayish brown to gray, clay to clay loam in control section (0-100 cm) with grey, moderately acidic clay loam surface and slight erosion.	
A2	14	Kulhati- Nijabangarh- Sanyasirkhat	Kulhati: Deep, imperfectly drained, light grey to grey, silty loam to sand in control section (0-100cm) on nearly level alluvial plain with grey, slightly acidic silty loam surface.	22290 (5.13)
			Nijabangarh: Deep, imperfectly drained, grey, sandy loam in control section with gray, moderately acidic surface.	
			Sanyasirkhat: Deep, imperfectly drained, grayish brown to grey, silty loam in control section (0-100 cm) on nearly level alluvial plain with dark grayish brown, slightly acidic silty loam surface.	
A3+A9+A10	15	Lorkhund- Kandalpara- Nijabangarh	Lorkhund: Deep, imperfectly drained, grey, sandy loam to silty clay loam in control section (0-100 cm) on nearly level alluvial plain with dark grey, slightly acidic clay loam surface.	45233 (10.41)
			Khandalpara: Deep, imperfectly drained, dark grayish brown to dark reddish brown, sandy in control section (0-100 cm) on nearly level flood plain with dark grey, slightly alkaline, silty clay loam surface.	
			Nijabangarh: Same as above.	
A4	16	Bhogpur- Nanara	Bhogpur: Deep, moderately well drained, dark grey to grayish brown, silty clay loam to silty clay in control section (0-100 cm) on nearly level alluvial plain with dark gray, slightly acidic, silty clay loam surface.	13297 (3.06)
			Nanara: Deep, moderately well drained, gray to light brownish gray loam to clay loam in control section (0-100 cm) on very gently sloping alluvial plain with grayish brown, slightly acidic loam surface and moderate erosion.	
A5	17	Bardhodhi- Bhehua	Bardhodhi: Deep, imperfectly drained, dark grayish brown to reddish brown, silty loam to silty clay loam in control section with grayish brown, moderate acidic silty loam surface.	5424 (1.24)
			Bhehua: Same as above.	
A6	18	Nanara- Jamlaigaon	Nanara: Same as above. Jamlaigaon: Same as above.	20419 (4.69)
RA1	19	Belguri- Nampathar- Deeporbil	Belguri: Same as above Nampathar: Same as above Deeporbil: Same as above	1986 (0.45)
RA2	20	Nijabangarh- Kandalpara	Nijabangarh: Same as above. Kandalpara: Same as above.	1432 (0.32)
E. Piedmont P1	21	Bhogpur- Ambari- Barduar	Bhogpur: Same as above Ambari: Same as above Barduar: Same as above	3067 (0.70)
				cont

Physiographic	Soil map unit	Soil series association	Brief description of soil series	Area (ha) % of TGA
P2	21	Sanyasirkhat- Bhogpur- Nijabangarh	Sanyasirkhat: Same as above Bhogpur: Same as above Nijabangarh: Same as above	2508 (0.57)
Р3	23	Singara- Sanyasirkhat	Singara: Same as above; Sanyasirkhat: Same as above	1736 (0.39)
P4	24	Dhpuguri- Ambari- Jarukuchi	Dhupguri: Very deep, moderately well drained, yellowish red to gray, clay loam to silty clay loam in control section (0-100cm) on gently sloping piedmont with grayish brown, moderately acidic, sandy loam surface and moderate erosion.	1541 (0.35)
			Ambari: Same as above	
			Jarukuchi: Same as above	
Pi1 + Pi2	25	Dhupguri- Singara	Dhupguri: Same as above Singra: Same as above	1874 (0.43)
F. Interhill valley V1	26	Tuksibari- Belguri	Tuksibari: Same as above Belguri: Same as above	9486 (2.18)
V2	27	Luki-Jarukuchi- Nogabil	Luki: Deep, moderately well drained, yellowish brown to dark yellowish brown, sandy loam to sandy clay loam in control section (0-100 cm) on gently sloping interhill valley with dark brown, slightly acidic clayey surface and moderate erosion.	9322 (2.14)
			Jarukuchi: Very deep, moderately well drained, brown to strong brown, silty loam to clay in control section (0-100 cm) with gray, slightly acidic clayey surface and moderate erosion.	
			Nogabil: Same as above.	
G. Active flood plain	28	Barapara- Tarabari	Barapara: Deep, moderately well drained, dark grayish brown to brown, sandy loam to clay loam in control section (0-100 cm) on nearly level flood plain with light brownish grey, neutral loamy sand surface.	8979 (2.06)
AF2 + AF6			Tarabari: Deep, imperfectly drained, dark yellowish brown to dark brown, sandy loam to loam in control section (0-100 cm) with dark grayish brown, slightly acidic sandy loam surface.	
AF3 + AF5	29	Bamunbari- Borapara	Bamunbari: Same as above; Barapara: Same as above	3260 (0.75)
AF4 + AF1	30	Nogabil + Khandalpara	Nogabil: Same as above Khandalpara: Same as above	10100 (2.32)
G. Recent flood plain RF1 + RF4	31	Barapara- Tarabari	Barapara: Same as above Tarabari: Same as above	14437 (3.32)
RF2 + RF3	32	Khandalpara- Barapara	Khandalpara: Same as above Barapara: Same as above	19803 (4.55)
RF5 River and misc. + A7	33	Tarabari- Noagaon	Tarabari: Same as above Noagaon: Same as above	5202 (1.19) 25452 (5.85)

Table 2.8.4. Land capability classes

Sl. No.	Map unit	Area (ha)	% of TGA
1.	IIIe	98945	22.77
2.	IIIw	51547	11.86
3.	IIIs	29867	6.87
4.	IVsw	112174	25.81
5.	VIes	103943	23.92
6.	River & misc.	25452	5.85

The organic carbon status of surface soils in the district have been grouped into 4 classes (Table 2.8.5) and their extension and distribution are shown in fig 2.8.3. Total 79.47% area of the district belongs to high category.

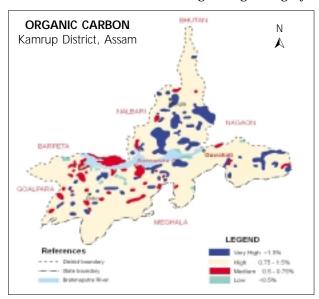


Fig. 2.8.3 Organic carbon status (surface soil) map of Kamrup district

Table 2.8.5. Soils under different organic carbon classes (surface)

Class	Description	Area (ha)	% of TGA
Very high	>1.5 g kg ⁻¹	36625	8.42
High	0.78-1.5 g kg ⁻¹	345310	79.47
Medium	0.5-0.75 g kg ⁻¹	22472	5.17
Low	$<0.5~g~kg^{-1}$	4641	1.06
River & Misc.		25452	5.85

2.8c. Correlation of soil series of North-Eastern States (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura) (part of correlation of soil series national project of NBSS&LUP, Nagpur)

T.H. Das, S. K. Reza and Utpal Baruah

Soil series identified during reconnaissance soil survey (in 1:50,000) of Sibsagar (12 series), Morigaon (19 series) of Assam, Esat Khasi Hills (17 series), Ri-Bhoi (7 series) of Meghalaya, Lungei (20 series) of Mizoram, Tirap (7 series) and Lohit (12 series) of Arunachal Pradesh, Imphal (7 series) of Manipur and 48 series of Tripura have been correlated for finalization of soil series description at the national level. Out of 149 series identified and mapped, 34 soil series were finalized for listing in National Soil Series Register. The soil site characteristic of two soil series of broad division of NE Region are given in table 2.8.6.

Table 2.8.6. Soil site characteristics of two series of broad division of NE region

Broad division	Soil series	Area (ha)	Landform	Depth	Texture	Taxonomy
Brahmputra	Sonari	68547	Flood plain	Very deep	Sandy clay loam	Aquic Dystrudepts
valley	Morigaon	16662	Alluvial flood plain	Very deep	Sandy loam	Typic Fluvaquents
Eastern Himalaya	Aituilo	2154	Middle slope of medium hills	Shallow	Silt loam	Lithic Hapludalfs
	Longsom	8054	Rolling hill slope	Moderately shallow	Loam	Typic Dystrudepts
Purvanchal	Kathalia	44327	Flat toppedhill	Deep to very deep	Sandy loam	Typic Kandiudalfs
Himalaya	Shibbari	30899	Hill slopes and parallel ridges	Deep to very deep	Clay loam	Typic Kandihumults
Meghalaya Plateau	Mawlyndair	484500	Steep to very steep escarpments	Very deep	Sandy loam	Humic Dystrochrepts
	Lailad	78704	Moderately steep to steep hills	very deep	Clay	Typic Kanhaplohumults

2.8d. Assessment of heavy metal pollution and its mapping in soils of contaminated areas of Morigoan, Dibrugarh and Tinsukia districts of Assam

S.K. Reza, S.K. Ray and Utpal Baruah

The study was carried out in four contaminated areas viz., Ledo, Digboi, Jagiroad and Namrup of the Assam state. Ledo is famous for underground coal mining and Digboi for petroleum industry in Tinsukia district. Similarly, Jagiroad in Morigaon district and Namrup in Dibrugarh district of Assam are famous for paper mill and fertilizer industry, respectively. The effluents from these industries are either released to channels or disposed off on land and are used for irrigation due to non-availability of fresh water. So, there is a chance of accumulation of heavy metals in soils. With a view to understand the heavy metal dynamics, the present study was carried out to identify the heavy metal contaminated areas in Morigoan, Dibrugarh and Tinsukia district of Assam state on 1:50,000 scale, and the vertical distribution of heavy metal in contaminated areas, to study the interrelationship of such heavy metal

accumulation in soil with important physico-chemical properties of contaminated soils, map heavy metal pollutions and assess risks.

The extent of heavy metal contaminated areas in Morigoan, Dibrugarh and Tinsukia districts of Assam state have been identified on the 1:50,000 Survey of India topographical sheets through discussion of local people, administration, industrial worker and literature. Maps of contaminated sites with road, river/nala, railways and village boundary are prepared and their areas were calculated. Finally grid maps were prepared using a square 500 m × 500 m grid and total numbers of grids for each identified areas were collected. The area affected due to coal mining effluents (1968 ha & 83 grids) are Monglang, Margherita, Bansbari, Kalpara and Aerodram (Fig. 2.8.4), Oil refinery industry effluents (2378 ha & 100 grids) are Lakhipathar, Barbil No.3, Kanduguri, Balijan and Barjan (Fig. 2.8.5), Paper mill effluents (4605 ha & 188 grids) are Tarang Bil, Khar Bil, Jan Bil, Donga Bil and Bangalbari village (Fig. 2.8.6) and Namrup Fertilizer effluents (6110 ha & 252 grids) are Balmira, Gariabam, Golaigaon, Doanigaon, Saru Kheramia, Parbatpur, Paniduria, Nagagaon, Rongagora villages and Rukang T.G (Fig. 2.8.7).

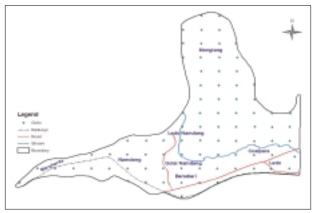


Fig. 2.8.4 Grid map of Ledo Coal mining area, Tinsukia district

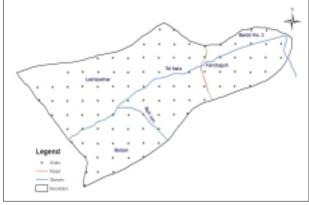


Fig. 2.8.5 Grid map of Digboi Oil refinery area, Tinsukia district

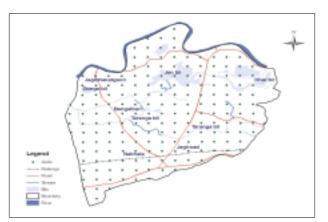


Fig. 2.8.6 Grid map of Jagiroad Paper mill area, Morigaon district

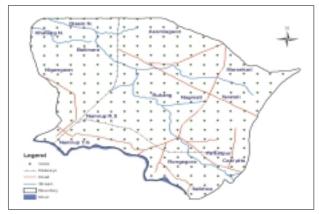


Fig. 2.8.7 Grid map of Namrup Fertilizer area, Dibrugarh district

2.8e. Development of district level land use plan for Jorhat District in Assam under rain-fed ecosystem (Part of National Network project on district level land use planning and policy issues under different agroecosystem of the country)

S. Bandyopadhyay, S.K. Reza and Utpal Baruah

Developing district level land use plan of Jorhat requires integration data sets on land resources and socio-economic aspects in relation to the land use objectives. Geographical Information System recommends digital integration of datasets on land resources for delineating Land Management Units (LMUs). Preparation of LMU involved four basic stages of operations, namely, (i) preparation of generalized land use map,

(ii) preparation of soil map from soil series association map, (iii) generation of agro-ecological map from climatic data and finally (iv) combination of all three maps by overlay/union operation in Arc GIS 9.3.1.

Precision Geo-coded IRS P6 LISS-III imageries of Jorhat district (83E/16, 83F/1, 13-14, 83J/1-12) (November, to February, 2008-09) and its corresponding SOI toposheets at 1: 50,000 scale have been delineated to identify different land use/land form units. A preliminary traversing of Jorhat district has been carried out in six different representative sample areas covering all land use, land cover and landform units. Land use and land cover in the satellite imageries were identified as per standard legends (Gautam, 2006; CLUMA, National Land use/Land cover Classification System, 2004). Land use/land cover units of Jorhat district have been classified up to level-II as depicted in table 2.8.7 and shown in fig. 2.8.8.

Table 2.8.7 Land use/Land cover Classification of Jorhat district

Land use/Land cover units (Level-I)	Land use/Land cover units (Level-II)	Signature in imagery
Built-up areas	Urban built-up (I)	Blue & green tone, mixed pattern, irregular shape, unsmooth texture, fain pink patches
Built-up areas	Rural built up with orchards plantation and horticulture (II)	Red tone mixed with bottle green grains, mixed pattern, irregular shape, unsmooth texture
Agricultural land	Mono cropping (Paddy) (III)	Greenish blue tone, irregular shape, unsmooth texture
Agricultural land	Multi-cropping lands (IV)	Faded pink & green tone, mixed pattern, irregular shape, rough texture and also in bottle green tone
Agricultural land	Tea gardens (V)	Red to faint pink tone, smooth texture, regular shape, definite pattern
Forested area	Open forest (VI)	Red tone with dark grey grains densely spread over, mixed pattern, irregular shape, unsmooth texture
Forested area	Hilly forested area on steeper slopes (VII)	Very dark intensified red tone, irregular shape, unsmooth texture
Waste lands	Low lying Shrubs areas (VIII)	Faded red to pink tone, smooth texture, irregular shape
Waste lands Wet lands/marshes and swamps/bils	Bar lands (IX) Wet lands (X)	Shiny white, smooth texture, irregular shape Dark grey and sky coloured, unsmooth texture, indefinitely rounded pattern, irregular shape

16 dominant soil series were chosen from the Soil series association map (23 map units) of Jorhat district. Based on similarities in salient soil characteristics from the dominant soil series affecting the land use viz., soil drainage, slope, pH, SOC and texture, soils were grouped into 10 different map units. Henceforth, the soil map was generalized from 23 map units to 10 numbers.

The salient features of soil characteristics of the dominant series have been described in table 2.8.8 and the generalized soil map units of Jorhat district has been described in table 2.8.9 and shown in fig. 2.8.9. The generalized soil map was overlaid on land use map of Jorhat district to obtain combined soil-land use map with 35 mapping units as shown in table 2.8.10.

Table 2.8.8 Salient soil characteristics for soil map generalization

Landform factor (slope)	Bio-chemical factor pH	soc	Particle size factor	Soil drainage factor (presence of mottles)
10-15% - Moderately steep	3.5-4.5-Extremely acidic	>1.6- High	Loamy Sand - Coarse loamy	Excessively well/ Well drained-no mottles
3-8% - Dissected gently sloping	4.5-5.0-Very strongly acidic	0.8-1.6- Medium	Loamy-Coarse loamy	Moderately well drained- mottles below 75cm
1-3% - Very gently sloping	5.0-5.5-Strongly acidic	<0.8- Low	Sandy loam-Coarse loamy	Imperfectly drained/ somewhat poorly drained- mottles within 50-75cm
0-1% - Level to nearly level	6.5-7.5 - Neutral	-	Silty loam/Silty clay loam-Fine loamy	Poorly drained-mottles within 25-50cm

Table 2.8.9. Generalized soil map unit description of Jorhat district

Generalized Soil Map units	Description
A	Fine loamy soils of excessively well drained, strongly acidic in reaction, low in organic carbon content on moderately steep sloping landform
В	Coarse loamy soils of well drained, very strongly acidic in reaction, low in organic carbon content on dissected gently sloping landform
С	Fine loamy soils of moderately well drained, neutral in reaction, medium in organic carbon content on gently sloping landform
D	Coarse loamy soils of imperfectly drained, strongly acidic in reaction, medium in organic carbon content on nearly level plain
E	Fine loamy soils of moderately well drained, strongly acidic in reaction, medium in organic carbon content on very gently sloping landform
F	Fine loamy soils of moderately well drained, extremely acidic in reaction, medium in organic carbon content on very gently sloping landform
G	Fine loamy soils of somewhat poorly drained, strongly acidic in reaction, low in organic carbon content on very gently sloping landform
Н	Fine loamy soils of poorly drained, strongly acidic in reaction, medium in organic carbon content on nearly level plain
I	Loamy soils of poorly drained, strongly acidic in reaction, low in organic carbon content on very gently sloping landform
J	Coarse loamy soils of imperfectly drained, neutral in reaction, high in organic carbon content on very gently sloping landform

Table 2.8.10. Soil-land use overlay

LU/	LC units	Landforms	Soil map units	Combined mapping units (total 35)
I.	Urban built-up	Lower piedmont, dissected gently sloping upland, very gently sloping plain	Isolated unit (Urban built-up)	I
II.	Rural built up with orchards plantation and horticulture	Upper piedmont and undulating upland, lower piedmont, very gently sloping plain, lower flood plains, Lower and upper terraces, active flood plains	B, C, D, E, F, G, H, I, J	IIB, IIC, IID, IIE, IIF, IIG, IIH, II-I, IIJ
III.	Mono cropping (Paddy)	Upper piedmont and undulating upland, lower piedmont, inter-hill valley, very gently sloping plain, lower flood plains, upper and lower terrace, active flood plains	B, C, D, E, F, G, H, I	IIIB, IIIC, IIID, IIIE, IIIF, IIIG, IIIH, III-I
IV.	Multi-cropping lands	Very gently sloping plain, Lower flood plains, active flood plains, Lower and upper terraces	G, J	IVG, IVG
V.	Tea gardens	Upper piedmont and undulating upland, lower piedmont, dissected gently sloping upland, very gently sloping plain	C, D, E, F, G	VC, VD, VE, VF, VG
VI.	Open forest	Upper piedmont and undulating upland, dissected gently sloping upland	A, B, E	VIA, VIB, VIE
VII.	Hilly forested area on steeper slopes	Moderately steep to steep hills, upper piedmont and undulating upland	A	VIIA
VIII.	Low lying-shrubs areas	Lower flood plains, active flood plains, lower terrace, bar lands	G, J	VIIIG, VIIIJ
IX.	Bar lands	Bar lands, marshes and swamps	G, J	IXG, IJ
X.	Wet lands	Active flood plain, upper and lower terraces, Marshes and swamps	G, J	XG, XJ

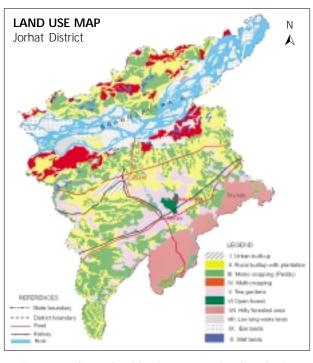


Fig. 2.8.8. Generalized land use map of Jorhat district

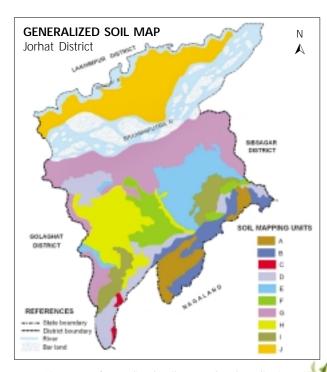


Fig 2.8.9. Generalized soil map of Jorhat district

2.8f. Land resource inventory of Katonigaon Panchayat of Titabar Block, Jorhat district (Part of land resource inventory for farm planning in different agroecological regions of India)

S.K. Reza, S. Bandyopadhyay, A. Natarajan and Utpal Baruah

Information on soil and related properties obtained from the soil survey and soil classification can help in identification and delineation of homogeneous management zones. The objectives of this study are to delineate similar areas, which respond or are expected to respond similarly to a given level of management and group similar areas (fields or survey numbers) based on soil-site characteristics into management units and showing their extent and distribution on a suitable base map.

The cadastral map (1:4,000 scale) of six villages under Katonigaon pachayat, namely, Nagajanka, Bochbihari gaon part-1, Bochbihari gaon part-2, Kharimia gaon, Jungle Block No. 38 part-1, Jungle Block No. 38 part-2 have been collected from State Agricultural Department. A detailed soil survey was carried out at cadastral map level (1:4,000 scale). Broad physiographic divisions and cultural features (Fig. 2.8.10) have been delineated by very intensive traversing for Nagajanka, Bochbihari gaon part-1and

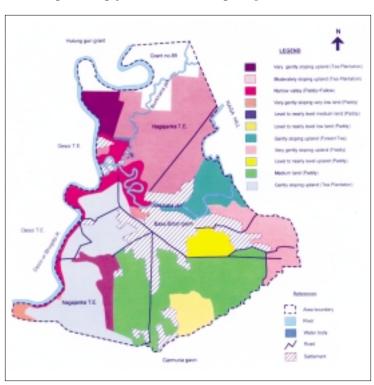


Fig. 2.8.10 Landform and Land use map of the study area

Bochbihari gaon part-2 .Within each physiographic division, the various landforms like the moderately sloping upland, gently sloping upland, nearly level to level upland, very low land, valley land are identified and their boundaries checked by traversing and corrected. After careful delineation of the various landforms on the cadastral map, updated the cadastral sheets with new permanent features and familiarisation of the area with survey numbers and field boundaries, intensive traversing of each landform was undertaken to select representative areas for profile study. 160 ha have been surveyed and soils are found to be very deep with the solum 18 to 180 cm thick. The A horizon is 15 to 18 cm thick. The colour is in hue of 2.5YR to 10YR, value 4 to 6 and chroma 1 to 8. The texture is sandy loam to silty clay loam and structure sub-angular block. The B horizon is 74-127 cm thick. Its colour is in hue 10YR, value 4 to 6 and chroma 2 to 6.

2.8g. Land resource inventory of East Lahing gaon panchayat of East-Jorhat development block, Jorhat district, Assam (Part of land resource inventory for farm planning in different agroecological regions of India)

S. Bandyopadhyay, S.K. Reza, A. Natarajan and Utpal Baruah

The East Jorhat Development Block is situated in the geographic setting between 94°202 E to 94°372 E longitude and 26°352 N to 26°512 N latitude. East Lahing G.P. is situated in the North frontier part of the Block. The general physiography of East Lahing G.P. is a plain land and no distinct variability in landforms has been reflected in the toposheets (83 J/5, 9). Three horizontally connected villages of East Lahing G.P. have been selected as the study area, namely, Changmai (231 ha), Sengsoa (287 ha) and Chetiagaon (240 ha) with a total area covering 760 ha. The area has been traversed with the help of cadastral map (16 inch= 1 mile) of each village to identify the variability in micro-relief features. The area has been delineated with four landform units, namely, (i) very gently sloping plain of Brahmaputra, (ii) flood plain with occasional flooding hazards, (iii) lower flood plain of frequent flooding hazards and (iv) upper terrace in the river bank of Janzi. The study area has been mapped by delineating the village boundaries, different landforms units and land use features as shown in fig. 2.8.11.

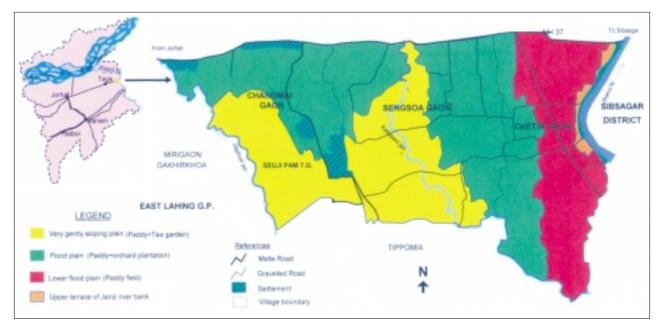


Fig. 2.8.11 Land use and landform map of the study area

Description of landform units

1. Very gently sloping plain of Brahmaputra

A major part of the village Sengsoa and almost the entire part of Changmai villages comprise this landform with major land use of tea associated with paddy and orchard plantation. The tea gardens have been noticed interspersed with the adjacent paddy fields along with plantation trees, mostly, bamboo, jackfruit, mango, arecanut, acacia and other deciduous species. Soils in the very gently sloping plain were fine loamy in texture (silt-loam to silty clay loam), very deep, hyperthermic, mixed mineralogy, moderately well drained, alluvium derived with great groups, namely, Dystrudepts, and Eutrudepts.

2. Flood plain with occasional flooding hazards

Parts of both Sengsoa and Chetiagaon and a small fraction of Chagmai cover this landform with paddy being the dominant Sali (kharif) crop with orchard plantation in the rural built-up areas with occasional vegetable farming. Soils in the flood plains were coarse loamy in texture (sandy loam),

very deep, imperfect to poorly drained, alluvium derived with great groups, namely, Endoaquepts and Fluvaquents.

3. Lower flood plain of frequent flooding hazards

The eastern part of Chetiagaon covers this landform with land use kharif paddy only. Soils in the lower flood plains are often stagnated with water for more than three consecutive months and hence water table is high (< 1.5m). Dominant great groups are Fluvaquents and Endoaquepts.

4. Upper terrace in the river bank of Janzi

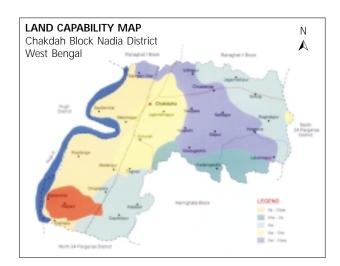
In course of continuous sedimentation loaded by Janzi from the source of Brahmaputra in the monsoon period (May to October) the upper terrace has been developed in the eastern part of the village Chetiagaon on the river bank of Janzi. The area has some rural built-up with dense bamboo plantation and shrubs. Occasional cultivation has been noticed in the small farming plots. Soils are coarse loamy textured, with loose and friable structure with fluctuating water table. Dominant great groups are Endoaquents and Fluvaquents.



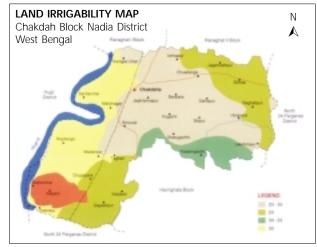
Regional Centre, Kolkata

2.9a. Land use planning at block level in two agro-ecological sub-regions of West Bengal

D.C. Nayak and Dipak Dutta



The land capability, land irrigability, Storie Index and Riquier's Productivity Index (actual and potential) were used to develop rational land use plan of Chakdah block, Nadia district, West Bengal (Fig. 2.9.1).



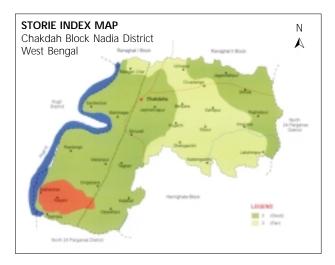




Fig. 2.9.1. Land evaluation for rational land use plan of Chakdah block, Nadia, West Bengal (Agro-ecological sub-region 15.3)

The land capability and irrigability classification indicated that the soil units 1,2,3,6 were good cultivable land with some limitations of drainage and loamy sand to sandy texture in the sub-surface horizons. These were ranked good and fair based on the evaluation of Storie index. Riquier's Productivity Index (actual and potential) was good based on nine soil properties, viz. effective soil depth, texture, base saturation, soluble salts, organic carbon, CEC, mineral reserves, drainage and soil moisture content. However, potential productivity Index of soil units (2, 3 and 5) may change from II (good) to I (excellent) with the adoption of management intervention like, drainage improvement, irrigation, addition of organic matter and fertilizer management.

2.9b. 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

Dipak Dutta and D.C. Nayak

The study was undertaken to evaluate the effect of various land uses on total soil organic carbon as well as on its active pool over a period of little over two decades (1987-2009) in different soils of Tarai region (humid to perhumid eco-region) of West Bengal. Soil samples from four soil series, namely, Paharpur series, Berubari series and Kumargram series in Jalpaiguri district and Simulbari series in Darjiling district were collected at the depth of 0-20 and 20-40 cm. The soils were analyzed for some important properties viz. pH, organic carbon, particle size classes and bulk density (Table 2.9.1).

The observations made in change in Soil Organic Carbon (SOC) status over the aforementioned period are as follows.

- Paharpur series (cultivated) showed decline in SOC by 15%.
- Berubari series (cultivated) and Kumargram series (Tea garden) showed a rise of SOC by 15.8% and 29%, respectively.
- Simulbari series (forest) showed decline in SOC by 1.5%.

The status of soil organic carbon (SOC) observed under different land uses was in the order, forest> fallow> tea> paddy> sesame in Simulbari series.

2.9c. Soil- based approach towards rational land use planning using GIS and remote sensing

S. Mukhopadhyay and T. Banerjee

Soil productivity of Raipur and Ranibandh blocks in Bankura district was evaluated by using parametric approaches viz. Storie land productivity index and Riquier's soil productivity index (Figs. 2.9.2 & 2.9.3). Both the systems of evaluation indicated that lower reaches (9 % of the study area) of Bhairabanki and Tarafini rivers were good and could be utilized for the cultivation of a wide range of crops. Lower and upper plains and a part of pediment plains (332 sq km, 40 % of the study area) were evaluated as soils of Grade II. The central part of the study area, occupying 32 % of the total geographical area was ranked fair for the agricultural purposes. Hills, steep slopes and dissected plateaus were observed not suitable for agriculture in the present set of conditions and this type of land covers about 10 % area.

Table 2.9.1. Important properties of soils (Range)

Soil series	pH (1:2.5)	Bulk density gcm ⁻³	Particle size class	Organic carbon (%)
Paharpur (Paddy)	6.2-6.4	1.50-1.60	silt loam	0.25-0.96
Berubari (Paddy/Jute)	5.2-5.4	1.32-1.42	loam to clay loam	1.57-2.12
Kumargram (Tea)	4.0-4.1	1.35-1.49	silt loam to silty clay loam	1.33-1.65
Simulbari (Forest)	4.6-5.4	1.23-1.26	loam	1.98-3.32

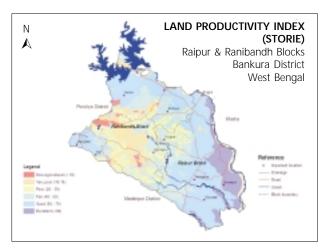


Fig. 2.9.2. Land productivity index (Storie index) of Raipur & Ranibandh blocks

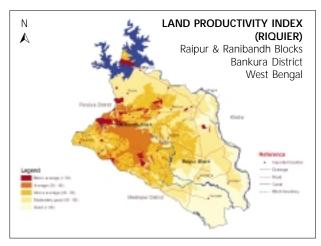


Fig. 2.9.3. Soil productivity index (Riquier's index) of Raipur & Ranibandh blocks



S.K. Singh, A.K. Sahoo, D.C. Nayak, K. Das, S.K. Gangopadhyay, K.D. Sah, D. Dutta, T. Chattopadhyay, S. Mukhopadhyay and T. Banerjee

Five soil series namely, Dumar Pat, Siskari Pahar, Bagru, Hirhi, Chalho in Lohardaga district, Jharkhand and three soil series namely, Amarda, Andheri and Kochilakunti in Mayurbhanj district, Orissa were correlated and finalized for incorporation in the National Soil Series Register.

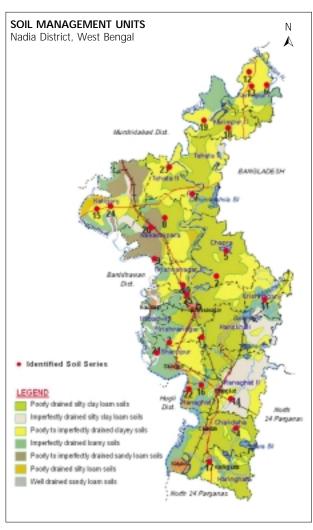


Fig. 2.9.4. Soil management units of Nadia district, West Bengal

2.9e. Development of district level land use plan for Nadia District in West Bengal under irrigated ecosystem

A.K. Sahoo, S.K. Singh, D.C. Nayak and T. Banerjee

For developing Land management Units (LMUs), representing a part of landscape similar in soil attributes, drainage and land use, the management units were defined. For the exercise, the reclassified attribute map of soil texture and drainage, the most crucial properties for the region was prepared. The attribute maps were combined in GIS for developing soil management units having distinct properties of management (Fig.2.9.4). The figure also presents the location of the dominant soil series in the district. The sequence of horizons and soil classification for each of them are elucidated in table 2.9.2.

Table 2.9.2. The sequence of horizons and classification of soils of Nadia district

	Location	Classification	Horizons sequence
1.	Dharmadaha	Fine, Typic Endoaquepts ¹	Ap-Bwg1-Bwg2-2Cg1-2Cg2-2Cg3-2Cg4
2.	Panditpur	Very fine, Vertic Endoaqualfs	Ap-Btg1-Btg2-Btg3-Btg4-Btg5
3.	Tehabali	Fine, Typic Endoaqualfs	Apg-Btg1-Btg2-Btg3-Btg4-BCg
4.	Solakir Bill	Fine, Typic Endoaqualfs ¹	Apg-Ag2- Btg1-Btg2-Btg3-Btg4
5.	Padmamala	Very fine, Vertic Endoaqualfs	Ap-Btg1-Btg2-Btg3-Btg4-BC
6.	Bilasisa	Very fine , Typic Endoaquepts	Ap-Bw-Bwg1- Bwg2- Bwg3-Bwg4-2Cg
7.	Khaspur	Fine, Vertic Endoaquepts	Ap-Bwg1-Bwg2-C1-C2-C3
8.	Naobhanga Sonatala	Fine loamy, Typic Endoaqualfs	Apg-Btg1-Btg2-Btg3-C1-C2
9.	Karakaria	Fine silty, Aeric Endoaquepts	Ap-Bw1- Bw2- C1-C2-2C3
10.	Hansdanga	Fine loamy, Aeric Endoaquepts	Ap-Bw1-Bw2-BC-C
11.	Gauri	Fine silty, Aeric Endoaquepts	Ap-Bw1-Bw2-Bw3-Bw4-Bw5
12.	Harekrishnapur	Clayey over loamy, Aeric Endoaquepts	Ap-A2-Bwg-2C1-2C2-2C3
13.	Sundalpur	Fine silty, Fluventic Haplustepts	Ap-Bw1-Bw2-Bw3-C1-C2
14.	Raynagar	Clayey over fine silty Areic Endoaquepts	Apg-Bwg1-Bwg2-BC-C1-C2
15.	Akundabaria	Clayey over fine silty, Areic Endoaquepts ¹	Ap-Bwg1-Bwg2-2Cg1-2Cg2-2Cg3-2Cg4
16.	Kasinathpur	Fine loamy over sandy, Typic Haplustepts	Ap-Bwg-BCg-2Cg
17.	Panchpota	Coarse silty, Typic Ustifluvents	Ap-C1-C2-C3-C4-C5
18.	Kathalia	Clayey over fine silty, Typic Ustorthents	Ap-A2-2Cg1-2Cg2-2Cg3-2Cg4
19.	Narayanpur	Coarse silty, Typic Ustifluvents	Ap-A2-C1-2C2-3C3-3C4-3C5
20.	Nakashipara	Coarse loamy, Aeric Endoaquepts ¹	Apg- Bwg1- Bwg2- Bwg3-2Cg1-2Cg2
21.	Bahadurpur RF	Fine loamy over sandy, Typic Haplustepts 1	A-Bw1-Bw2-BC-2C
22.	Lakshminathpur	Fine silty, Typic Ustifluvents	Ap-C1-C2-C3-C4-C5
23.	Sureshnagar	Fine silty, Typic Ustifluvents	Ap-A2-C1-C2-C3-C4
24.	Panchdanra	Fine, Fluventic Haplustepts	Ap-Bw1-C1-C2-2Cg1-2Cg2
25.	Tegharia	Fine, Fluventic Haplustepts ¹	Ap- Bwg1- Bwg2-2Cg1-2Cg2-2Cg3

¹ Non-calcareous soils

2.9f. Land resource inventory for farm planning in Chinchura- Mogra and Polba-Dadpur block, Hugli district, West Bengal

S. Dharumarajan, S.K.Gangopadhyay, A. Natarajan and S.K.Singh

For standardizing methodology of detailed soil survey, about 18983 hectare area was selected in the lower part of Indo-Gangetic alluvial plain. It is located between 22° 52′ 06″ to 23° 04′07″ north latitude and 88° 09′ 01″ to 88° 24′54″ east longitude in Chinchura-Mogra and Polba-Dadpur block, Hugli district. The area showed the assemblage of new and old levee; younger and older alluvial plain.

New levees are under rice-rice cropping sequence, whereas old levee are covered with banana and mango plantations. Younger alluvial plains with paleochannels are used for paddy-potato/mustard cropping sequence, whereas the older alluvial plains are used for rice-rice cropping sequence.

Eight profiles were studied, two on each landform, for establishing soil-physiographic relationship and developing tentative legend for detailed soil survey (Fig. 2.9.5). The results indicated that soils of older levee were deep, imperfectly drained, silty clay loam to silty clay in texture. The soils of new levee were deep, imperfectly drained, silty loam to silty clay in texture with additional distinct features of slickensides and pressure faces. The recent alluvial soils were deep, well drained sandy loam to sandy clay loam textured, resting on coarse sandy material whereas soils of older alluvial plains were deep, imperfectly drained, silty clay in texture. There has been fair degree of pedogenesis as evident from well developed medium, moderate sub angular blocky structure in soils of older alluvial plains.

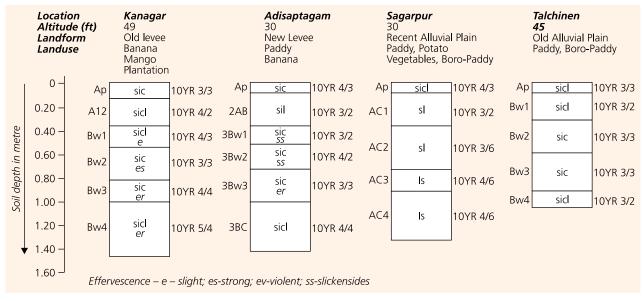


Fig. 2.9.5. Soil physiographic relationship in lower part of Indo-Gangetic plain

2.9g. Identification and characterization of benchmark soils of Orissa and Bihar for agro-technology transfer

S.K.Singh, T. Chattopadhyay, D.C. Nayak, A.K. Sahoo and K.D. Sah

Benchmark soils of Orissa have been identified by utilizing existing soil resource database of the state. The distribution of benchmark soils is shown in fig. 2.9.6 and the salient characteristics of each of them are elucidated in table 2.9.3.

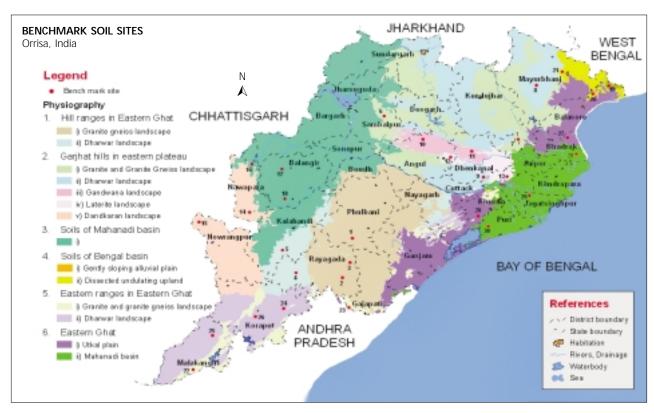


Fig. 2.9.6. Benchmark soil sites of Orissa

Table 2.9.3 Salient characteristics of Benchmark soils of Orissa

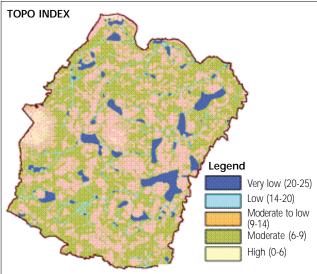
			D4l-			C
Benchmark soils	Landforms	Area (000'ha)	Depth class	Particle Size	Surface class	Constraints texture
Soils of hil	U ranges in east		nite gneiss landscap	na Araz 2218 A		
Typic Rhodustalfs ¹	Hills	625.8	Very deep	M	loam	erosion
Ultic Paleustalfs ¹	Hills	342.0	Very deep Very deep	F	loam	erosion
Vertic Halaquepts ²	Inter-hilly val		Very deep	F	clayey	flooding
			Dharwar landscape,	Area 601.43. S	3 3	
Typic Haplustepts ¹	Hill	202.4	Deep	M	loam	erosion
Typic Haplustalfs ²	Hill	113.7	Mod.deep	M	loam	erosion
			e and granite gneis			
Typic Ustorthents ¹	Hills	316.7	Deep	M	loam	erosion
Typic Ustorthents Typic Haplustepts ²	Uplands	204.8	Deep	M	loam	erosion
<u> </u>			Dharwar landscap			
Typic Haplustepts ¹	Hills	764.7		F		erosion
Lithic Ustorthents ²	Hills	386.4	Deep Mod. shallow	r L	loam loam	erosion
			Gondwana landsca	*		
Typic Haplustepts ² Vertic Haplustepts ²	Upland	61.0 32.6	Deep Very deep	F F	loam loam	erosion
	Upland		<u> </u>			.,
		_	(Laterite landscap			
Typic Haplustepts ¹	Upland	61.6	Deep	K	loam	erosion
Aeric Halaquepts ²	Upland	28.8	Mod. shallow	M	loam	erosion
			u (Dandkaran land	-		
Typic Rhodustalfs ²	Plain	182.2	Deep	M	loam	erosion
Typic Haplustalfs ²	Plain	193.7	Deep	F	loam	erosion
		Mahanadi bas	in, Area 3139.26 (SRM units 81-9	07)	
Typic Haplustepts ²	Upland	377.3	Mod. shallow	M	laom	erosion
Typic Haplusterts ²	Valley	325.1	Deep	F	clayey	salinity
Typic Haplustalfs ²	Valley	206.8	Deep	F	clayey	erosion
			oping alluvial plaid		RM unit 98)	
Vertic Halaquepts ²	Plain	5.6	Very deep	F	clayey	flooding
Soils	of Bengal basin	(Dissected un	dulating upland, A	rea 198.29, SR	M unit 99-104)	
Typic Haplustalfs ²	Upland	64.5	Mod. shallow	M	loam	erosion
Aeric Ochraqualfs ²	Upland	36.1	Very deep	L	loam	erosion
Soils of eastern	ranges in easter	n ghats (Gran	ite and granite land	dscape, Area 48	1.40, SRM unit 10	05-111)
Ultic Haplustalfs ¹	Hills	94.9	Mod.shallow	M	sandy	erosion
Rhodic Paleustalfs	Pediment	100.2	Very deep	M	loam	erosion
Soils of east	tern ranges in ea	astern ghats (I	Dharwar landscape,	Area 1100.49,	SRM units 112-12	26)
Typic Ustorthents ¹	Hills	124.4	Mod. shallow	K	sandy	erosion
Typic Ustropepts ²	Upland	162.9	Very deep	M	loam	erosion
Kandic Paleustalfs ¹	Hills	90.7	Very deep	M	loam	erosion
	Soils of easter	n coast (Utka	l plain, Area 1128.	7, SRM units 12	27-143)	
Aeric Endoaquets ²	Inland basin/	228.4	Very deep	M to F	Loam to clayey	drainage
	coastal plain/					_
Vertic Endoaquepts ²	Inland basin/	303.0	Very deep	F	clayey	drainage
	coastal plain					
S	Soils of eastern c	oast (Mahana	di Delta, Area 117	0.43, SRM unit	s 144-159)	
Typic Fluvaquents ²	Upper delta	118.8	Very deep	M	loam	flooding
Vertic Fluvaquents ²	Lower delta	108.5	Very deep	F	clayey	flooding
Vertic Endoaquepts ²	Lower delta	108.8	Very deep	F	clayey	flooding
¹ . Aariculture: ² . Forest: Pa	article size class l	F- fine M- fine	loamy R-coarse lo	amv K-loamv-sk	celetal I ₋ loamy: Δr	ea-000 ha

¹. Agriculture; ². Forest; Particle size class F- fine, M- fine loamy, R-coarse loamy, K-loamy-skeletal, L-loamy; Area-000 ha; mod-moderately; SRM-Soil resource mapping.

2.9h. Geomorphic and hydrological evaluation of a micro watershed in Chhotanagpur Plateau, West Bengal for sustainable utilization of soil and water resources

T. Banerjee, S.K. Singh, K. Das and Dharumarajan, S.

Droghtiness and scarcity of water are the major constraints for the small and marginal farmers in Chotonagpur plateau region of West Bengal, Jharkhand and Orissa (with prevailing rice-rice cropping system) in securing livelihood. Undulated topography, diverse slope and severe erosion further accentuate the water



DWARKESHWAR MICROWATERSHED (Rn7h)

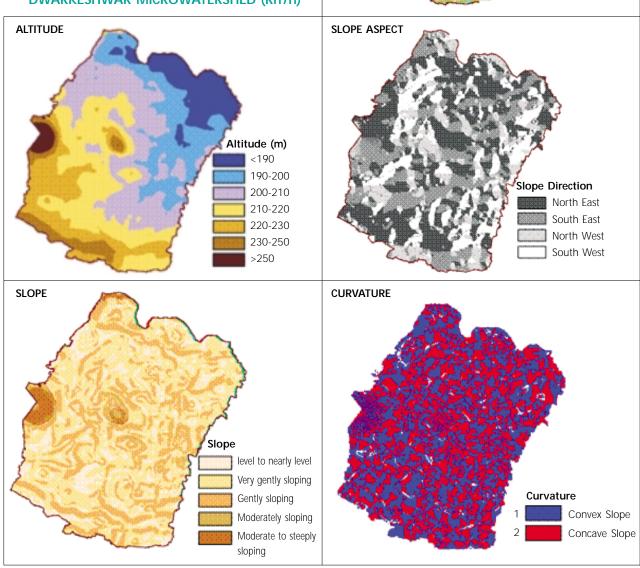


Fig. 2.9.7. Dwarkeshwar micro-watershed

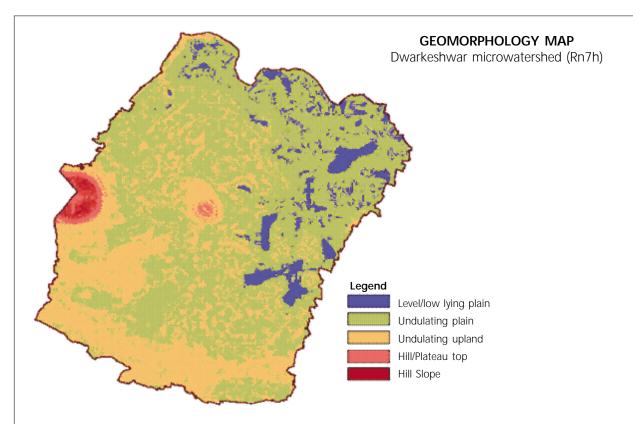
crisis. The Department of Agriculture, Govt. of West Bengal and the farmers of the region attempted to resolve the issues of water stress and erosion by constructing contour bunds, based on some qualitative information and personnel experience of geomorphological, soils and hydrological properties of the terrain. However, more such constructions and scientific interventions are needed based on quantification of these properties to come out with an alternative land use plan for the holistic development of the area. Therefore, to address the problem the present investigation has been undertaken with the following objectives

- To evaluate geomorphometric parameters and hydrological properties of micro watershed
- To develop sustainable land use plan by effective utilization of soil and water resources under

the prevailing socio-economic conditions of the farmers.

A micro-watershed covering an area of 948.61 ha between 23° 24' to 23° 26' north latitude and 86° 33' to 86° 35' east longitude was selected in the eastern fringes of Chhotanagpur plateau in Puruliya district of West Bengal.

Digital elevation model (DEM) was generated at 9 metre resolution using point data collected from Google-Earth and line data from ASTER GDEM for collecting quantified information on altitude, slope, aspect and curvature of the watershed (Fig. 2.5.7). A landform map was prepared by combining slope, curvature, altitude and aspect in GIS (Fig. 2.9.8) that will be utilized for developing quantitative soil landform relationship in the project.



Geomorphic division and their morphometric character

Geomorphic Divisions	Altitude	Curvature	Topo Index Slope	
Level / lowlying plain	<200m	Convex & concave	Very low (14-25)	level to very gently sloping plain (0-3%)
Undulating plain	170-230m	Convex & concave	Moderate to very low (6-25)	level to very gently sloping plain (0-3%)
Undulating upland	200-250m	Convex & concave	High to low (0-20)	Gentle to moderately sloping land (3-15%)
Hill / plateau top	220-375m	Convex & concave	High to moderate (0-9)	Gentle to moderately sloping land (3-15%)
Hill slope	<250m	Convex & concave	High (0-6)	Moderate to steeply sloping (<15%)

Fig. 2.9.8. Geomorphological map of Dwarkeshwar micro-watershed

2.9i. Natural resource assessment using RS and GIS - A case study in Badejore Nala micro watershed in Utkal Plain of Orissa

K. Das, T. Banerjee, and S.K.Singh

Another micro-watershed located between 20°10' to 20°15' north latitude and 85°35' to 85°45' east longitude on 596.12 hectare area in Khurda block of Orissa State under hot & dry sub humid climate (1438.34 mm mean annual rainfall with mean

summer temperature of 29.3°C and mean winter temperature of 23.1°C) was selected for developing optimum land use plan based on quantified geomorphological, soils and hydrological properties of the terrain.

Digital elevation model was generated based on the elevation extracted from Google image and ASTOR GDEM of 30 m resolution data. From digital elevation model slope and flow path of water in the watershed were derived (Fig. 2.9.9). The present land use map of the watershed was also attempted (Fig. 2.9.10)

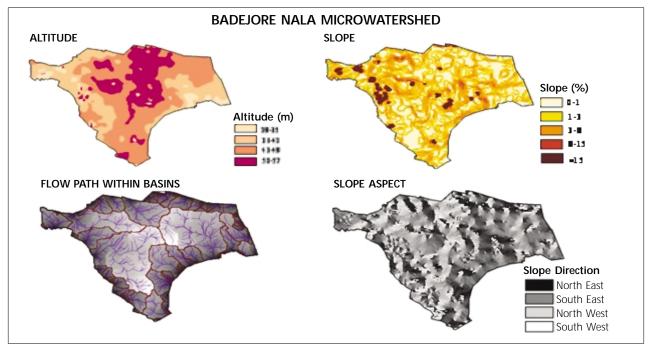


Fig. 2.9.9 Digital elevation model and slope parameters of Badejora Nala micro watershed

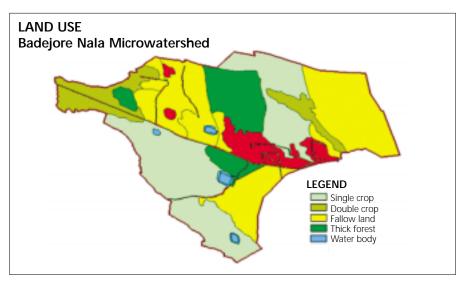


Fig. 2.9.10 Land use map of Badejora Nala micro-watershed

2.9j. Soil resource inventory and land evaluation of Aurangabad district, Bihar (1: 50,000 scale)

S.K. Gangopadhyay, D.S. Singh, K. Das, S. Mukhopadhyay, S.K. Singh and S. Dharumarajan

Aurangabad district in south Bihar consists of two subdivisions and eleven blocks. It covers an area of 3305 km² between 24°17′ 03″ to 26°07′ 46″ north latitude and 84°0′ 26″ to 84°53′ 05″ east longitude. Climate of the district is dry sub-humid subtropical with a high mean summer and winter temperature of 41°C and 10°C, respectively. The annual rainfall ranged from 1000 to 1200 mm. The district represents the transition geology between Chhotanagpur plateau and Vindhyan range. There is a fringe of Chhotanagpur plateau in the southern part and alluvial plain of Son river in the western side after Kimur plateau. Thus Son river is trapped between these two geological formations. The elevation varies from 50 to 450 m above MSL.

Based on the Survey of India Toposheet (1:50,000 scale), interpretation of the geocoded FCC (Fig.2.9.11) of IRS ID LISS III (1: 50,000 scale) and thorough traversing, eight broad physiographic units were identified and delineated (Table 2.9.4). Soil physiographic relationship was established and shown in fig. 2.9.12.

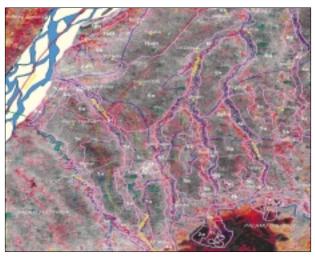


Fig. 2.9.11. IRS ID LISS III image of part of Aurangabad district, Bihar

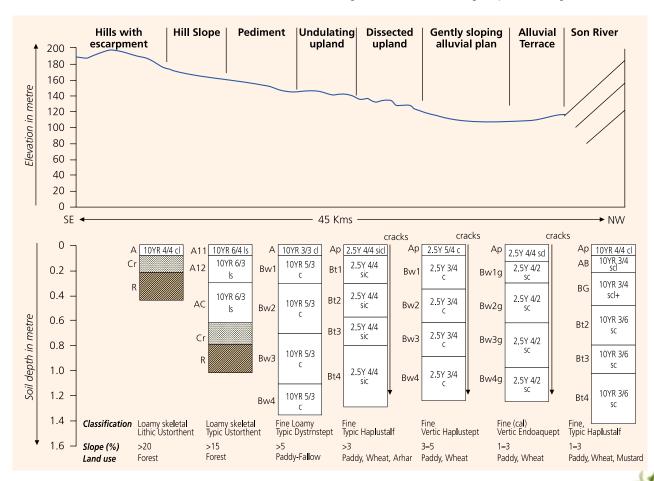


Fig. 2.9.12. Soil-landscape relationship in Aurangabad District, Bihar

Shallow, yellowish brown to grayish brown gravelly sandy loam soils characterized the back and side slopes of hills whereas moderately deep, yellowish brown gravelly sandy loam soils predominantly constituted the pediment surfaces. Both geomorphic units in the district support different kinds of woody forest vegetation. The upper part of the undulating uplands support paddy in the summer, wheat and pulses in the winter. The soils were deep to very deep, very dark grey brown (10 YR 3/3) to dark grey brown (10 YR 4/2) with sandy loam surface and sandy clay loam to silty clay loam subsurface. The lower part of the undulating plain is partly dissected and has gray brown to very dark gray brown soils with sandy loam surface and sandy clay to silty clay loam sub-surface. These were calcareous, extensively cracked at places and support mustard and pulses in the winter season on stored residual moisture after paddy. Surface and sub-surface texture of soils of alluvial plain and in the narrow valleys were similar to the lower part of undulating plain. However, dark brown to olive brown colour and redoximorphic features separated these soils from their previous counterparts.

Table 2.9.4 Description of the interpreted units of Aurangabad district

Map units	Landforms	Image characteristics
1. Alluvial to	erraces	
ai	Upper	Dominantly white grey and red mixed tone
aii	Middle & lower	Dominantly greenish white, grey and red mixed tone
2. Eastern pla	ateau	
a	Steep hills	Dark brownish red tone
b	Escarpment	Dark brownish red and dull red mixed tone
c	Moderately sloping hill slope	Dark brownish red mixed with red and grey tone
4. Pediments		
a	Moderately sloping	Dull red mixed with grey, white tone
b	Gently sloping	Dominantly grey mixed with dull red tone
5. Undulating	g upland with isolated hillocks	
a	Gently sloping	Mixed red, white blue and grey mixed tone
b	Very gently sloping	Whitish blue mixed with pink and grey
c	Nearly level	Light blue with red and white spots
d	Nearly level with slight dissection	Glossy white, red and grey mixed
f	Narrow valley	Blue, grey and red mixed
h	Residual hillocks	Dark grey, brown mixed
6. Dissected a	alluvial plain	
a	Gentle sloping – upper part	Dominantly blue with white and red mixed
b	Very gently sloping-middle part	Dominantly bluish white and red mixed tone
d	Nearly level, lower and middle part	Glossy white with red mixed tone
f	Nearly level slight to moderately dissected narrow valley	Whittish blue mixed with red tone
g	Nearly level moderately eroded	Dominantly whitish grey mixed tone

Regional Centre, Udaipur

2.10a. Soil resource inventory and land evaluation of Chittaurgarh district for land use planning

T.P.Verma, A.K.Singh and R.L.Shyampura

About 70,000 ha area in toposheet 45L/6 and 45L/5 comprising Bhadesar, parts of Dungla and Kapasan tehsils were surveyed and mapped at soil series association level. The soils of area are developed on Gneiss, Schist, phyllites and alluvium of Banas, Berach, Wagon, Gambhiri, Jakham rivers and its tributaries.

The major soils of eastern Rajasthan upland in toposheets 45L/6 and 45L/5 are briefly described as below:

Soils of dissected hill and ridges: Soils of the landform are very shallow to shallow, excessively drained, brown to strong brown (7.5YR5/4 to 4/6), calcareous gravelly sandy loam to loamy sand on 8 to 15% slope with gravelly sandy loam surface, severe to very severe erosion and strong stoniness/gravellyness and classified as loamy skeletal, Lithic Ustorthents associated with rock out crops. They are mostly barren with scrubs and used as pasture.

Soils of pediments: These are shallow, somewhat excessively drained, dark brown to dark yellowish brown (7.5YR4/4 to 10YR4/6), calcareous sandy loam on 3-8% slopes with sandy loam surface, severely erosion and strong stoniness and classified as loamy skeletal, Lithic Ustorthents associated with moderately shallow, calcareous coarse loamy with sandy loam surface and slight stoniness and classified as Typic Ustorthents. They are under barren used as pasturing and maize crop at places.

Soils of dissected river valley: Soils in dissected river valley are deep, well drained, dark yellowish brown (10YR4/4), calcareous, sandy loam, on 3-8% slope with severe erosion, moderate stoniness and classified as coarse loamy, Typic Haplustepts and associated with dark brown (10YR3/3), calcareous loam to sandy clay loam with loam surface, moderate erosion and slight stoniness and classified as fine loamy, Typic Haplustepts. They are cultivated to maize and wheat.

Soils of gently to moderately sloping land with monodnocks (plain)

- (a) Gently to moderately sloping plain: Soils of this landform are predominantly moderately shallow, well drained, dark brown to brown (10YR3/3 to 4/3), calcareous sandy clay loam with sandy clay loam surface with slight erosion and classified as fine loamy, calcareous, Typic Haplustepts and associated with moderately shallow/moderately deep, dark yellowish brown (10YR4/4), loam to sandy loam with sandy loam surface with slight erosion and slight stoniness and classified as fine loamy, Typic Haplustepts. They are under maize, groundnut and wheat cultivation.
- (b) Gently to undulating sloping plain: Soils are dominantly shallow, somewhat excessively drained, dark yellowish brown (10YR3/4), calcareous sandy loam with severe erosion and strong stoniness/ gravellyness and classified as loamy skeletal, (cal.), Lithic Ustorthents associated with moderately shallow, well drained, brown to dark brown (10YR3/3), calcareous sandy clay loam with moderate erosion and slight stoniness and classified as fine loamy, Typic Ustorthents. They are under barren (scrub) and pasture. Moderately shallow, brown to dark brown, calcareous loamy skeletal, Typic Ustorthents occupy sizable area of this landform.
- (c) Nearly level to gently sloping plain: Soils of the landform are moderately shallow, well drained

brown to dark yellowish brown (10YR5/3 to 3/4), sandy loam to clay loam with sandy loam surface, slightly eroded and classified as fine loamy, Typic Haplustepts associated with moderately shallow, dark yellowish brown (10YR3/4), calcareous sandy loam with sandy loam surface, moderately eroded and moderate stoniness and classified as coarse loamy, calcareous, Typic Haplustepts. They are cultivated to maize, wheat and mustard. Moderately deep, very dark gray to gray (10YR3/ 1to 5/1), calcareous clay loam with clay loam surface and classified as fine, Vertic Haplustepts are also occur in association. They cultivated to cluster bean (guar), maize, wheat and pea.

- (d) Very gentle to gently sloping plain: Soils are generally moderately deep, dark yellowish brown (10YR3/4), calcareous coarse loamy, Typic Haplustepts and moderately deep, very dark grayish brown to grayish brown (10YR3/2 to 3/ 3), calcareous fine, Vertic Haplustepts associated with moderately shallow, dark brown to dark yellowish brown, sandy loam to clay loam Typic Haplustepts. They are under pasture, maize, wheat, soybean and barley.
- (e) Nearly level sloping plain: Soils are moderately deep to deep, moderately well drained, very dark gray to very dark brown (10YR3/2 to 2/2), calcareous, clayey and classified as fine, Typic Haplusterts. They are cultivated to maize, wheat, mustard and ajwain.

2.10b. Land resource inventory for farm planning different agroecological regions of India - Bhadesar tehsil (cluster of 10 villages) in Chittaurgarh district (Rajasthan)

> T.P. Verma, R.S. Singh, A.K. Singh and R.L. Shyampura

The detailed survey has been carried out in clusters of 10 villages of Bhadesar Tehsil for preparation of land resource inventory for farm planning of Chittaurgarh district. Mapping of three villages, namely Daulatpura, Surajpura and Sohankhera comprising about 1200 ha have been completed. Three major landform units viz. gently to undulating land with hillocks, upland and plain have been delineated which has been further subdivided into different physiographic units based on slope, tone, texture. The area was traversed, transects were marked in different landform units, soil pedons were studied, major soils identified and random checking was done to draw boundary of different soils mapping units. In Daulatpura village, nine soil series were identified and mapped into 17 mapping units (phases of different soil series). The soils on gently to moderately sloping subdued hills are shallow to moderately shallow, somewhat excessively drained to well drained, lighter in colour (7.5YR3/3 to 10YR4/4), calcareous, loamy sand to sandy loam in texture and have sandy loam surface texture, severely eroded and moderately to strongly in stoniness. They are under pasture or barren. On gently sloping upland, soils are moderately shallow, well drained, medium in colour (10YR3/3 to 3/4), calcareous, sandy clay loam to loam with loamy in surface with moderate erosion and slight stoniness/gravelliness. A single maize crop is grown in kharif. The soils on plain are moderately shallow to deep, darker in colour (10YR3/2 to 2/2), calcareous sandy clay loam to clay with sandy clay loam in surface and very slightly to moderately eroded. These soils are mostly under double crop (maize, wheat, mustard, cotton and opium) with irrigation (Table 2.10.1 and Fig. 2.10.1).

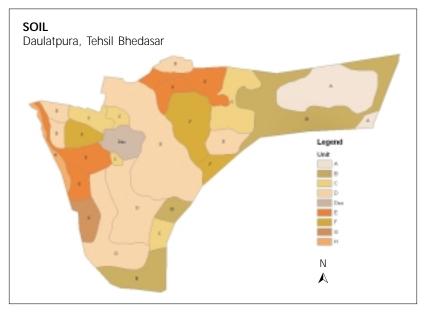


Fig. 2.10.1 Soil map of Daulatpura village, Bhedasar Tehsil, Rajasthan

Table 2.10.1 Description of soils in Daulatpura village of Bhadesar Tehsil

Map unit	Depth (cm)	Colour	Surface texture	PSC	Land use	Taxonomy	Area ha (%)
_		Gently to undulati	ng land with	hillocks	: (a) Moderately sloping subdu	ued hill	
Dp-A	25-50	7.5YR3/4 to 4/4	Sl	lsk	Barren/pasture	L. Ustorthents	29.40 (12.06)
(b) Gently to undulating land (pediments)							
Dp-B	50-75	7.5YR3/4 to 10YR4/4	Sl	lsk	Mostly pasture and maize/ sesame at places	T. Ustorthents	45.52 (18.68)
Gently sloping upland							
Dp-C	50-75	10YR3/3 to 3/4	Sl, l	Fl	Mainly maize and pasture at places	T. Haplustepts	23.54 (9.66)
Nearly level to gently sloping Plain : (a) Very gently sloping plain							
Dp-D	50-75	10YR3/2 to 3/3	L, scl	Fl	Maize/ground nut and wheat	T. Haplustepts	82.98 (34.05)
			(b) nea	ırly level s	sloping plain		
Dp-E	75-100	10YR3/2 to 3/3	Cl, sc	F	Maize, wheat and mustard	V. Haplustepts	25.56 (10.49)
Dp-F	>100	10YR3/2 to 2/2	Cl, c	F	Maize, wheat and pasture	T. Haplusterts	22.28 (9.14)
			(c) Nearly le	evel to ge	ntly sloping plain		
Dp-G	75-100	10YR4/3 to 3/3	sl	Cl/s	Maize and sesamum	T. Ustifluvents	5.20 (2.13)
Dp-H	75-100	10YR3/3 to 3/2	cl	Fl/cl	Mostly pasture and maize at places	F. Haplustepts	2.66 (1.09)
				Habita	tion		6.58 (2.70)

2.10c. Development of district level land use plan for Bundi district (Rajasthan) under semi arid ecosystem

R.S. Singh, A.K. Singh and R.L. Shyampura

Soil resource map generated during district mapping project on 1:50,000 scale were used to prepare generalized soil map and soil map index. Existing land use map was prepared with the help of remote sensing data in conjunction with survey of India toposheet to study the land use - soil attribute relationships and the land use/land cover map prepared by the NRSC, Hyderabad using multi temporal AWIFS data. Maps of generalized soil, present land use and census (literacy) have been integrated in GIS for the delineation of the land management units (LMU).

Natural resources assessment

Census and socio-economic pattern

Some of important census demographic and other variables of the district have been presented in table-2.10.2. As per the district census 2001, total

population of the district is 783058 persons distributed in 856 settlements (villages) with the population density of 173 person per sq km. The density of population in Nainwa and Kehsoraipatan tehsils are lower than the district average whereas Hindoli tehsil has highest density of population (186 persons). Population density in Bundi and Indergarh is comparable to those for districts. The density of population is marginally higher as compared to the state. Nearly half of the population (51.56 percent) of the district is literate which is low as compared to the state average (60.40%). In the district, forest covers 24.24 per cent area and 45.96 per cent area is cultivated of which 61.38% area is irrigated. About 13.3% area is culturable waste whereas 16.54% area is not available for cultivation. Forest cover is highest in Bundi and Hindoli tehsil whereas it is lowest in Kehsoraipatan tehsil. About 67 to 73 per cent of the net sown area in Bundi, Hindoli and Kehsoraipatan is irrigated mainly canals and wells. The per capita availability of land for agriculture is 0.52-0.62 ha in Indergarh, Bundi and Keshoraipatan tehsil whereas Hindoli tehsil has 0.34 ha land available for agriculture.

Table 2.10.2 Important census and socio-economic features of the Bundi district

Socio-economic attributes			Tehsil			District
	Bundi	Hindoli	Indergarh	Keshoraipatan	Nainwa	
Total Geographical area (ha)	192227	118995	66065	70618	134038	581943
Population	258916	189290	79564	99061	156227	783058
Population Density	175	186	172	169	160	173
No. of Village	269	174	121	112	180	856
Average no. of Household per Village	168	192	118	149	152	160
Literacy (%)	51.48	49.49	53.20	53.10	51.66	51.46
Forest (%)	27.82	31.02	18.22	16.04	19.45	24.24
Culturable Waste (%)	12.36	14.29	15.00	13.70	12.29	13.26
Cultivated land (%)	42.37	39.17	49.26	51.52	53.63	45.96
Irrigated land (%)	29.23	29.23	28.08	37.36	24.00	28.21
Irrigated Cultivatable land (%)	69.00	67.46	57.01	72.51	44.74	61.38
Per capita availability for agriculture (ha)	0.54	0.34	0.52	0.62	0.49	0.49

Hydrogeology

Basic data (hydro-geological map with benchmark wells) including chemical data of water and average discharge of wells were collected from the State Groundwater Department, Rajasthan for the year 1996 and 2006. Attributes of each well were integrated in GIS. The chemical data provide information on water quality for agriculture and human consumption. Annual pumpage of existing wells in Keshoraipatan, Indergarh and Bundi tehsil occurring predominantly in alluvium and shales/limestones/sandstones geological formations are greater as compared those (Hindoli and Nainwa tehsil) on phyllites and limestones/shales (Table.2.10.3 & Fig. 2.10.2). The average discharge (m⁻³ per day) of wells with pump and tubewells are 45 to 180 and 55 to 200 in Keshoraipatan/Indergarh while it is 60 to 170 and 70 to 180 in Bundi tehsil indicating higher groundwater potential of these tehsils. However, values of average discharge remains identical without pump irrespective of geology.

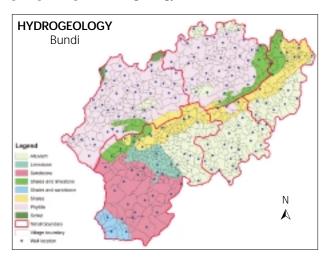


Fig. 2.10.2 Hydrology of Bundi district of Rajasthan

Table 2.10.3 Quantitative assessment of annual pumpage from the existing wells in Bundi district

Tehsil	Dominant Geology	Type of wells	Av. Discharge (m³per day)
Hindoli	Phyllite & limestone	With pump Without pump Tubewell	65-70 30 70-75
Nainwa	Phyllite & shales/limestone	With pump Without pump Tubewell	55-60 30 65-70
Keshoraipatan and Indargarh	Alluvium & shale/limestone	With pump Without pump Tubewell	45-180 30 55-200
Bundi	Alluvium, sandstone & shale/limestone	With pump Without pump Tubewell	60-170 30 70-180

Soils: Soil map of the Bundi district has been prepared as association of dominant and subdominant soil series with or without inclusion and mapped in 61 map units of soil series associations. These mapping units have been described for major soil attributes such as depth, particle size class, texture, slope, erosion and other phases.

Generalized soil map: The soil map often has large number of map units. These have to be generalized to manageable (and meaningful) number of entities before combining with other spatial data sets. The dominant soil series have been considered for the preparation of generalized soil map. Most significant soil and site parameters of the series, such as soil depth, particle size class (soil family) and slope class, have been selected for this purpose. Five depth class (<25, 25-50, 50-75, 75-100 and >100 cm) and four slope class (<1, 1-3, 3-8 and 8-15%) have further been reduced to three depth class (<50, 50-100 and >100 cm) and slope class (<3, 3-8 and 8-15%) by broadening the limits of soil and site attributes whereas no generalization is made in respect to particle size class (loamy skeletal, loamy, fine loamy and fine).

The generalized soil map consist 13 map units including one under rock outcrops (Table 2.10.4 and Fig. 2.10.3). Deep, fine soils on nearly level to very gentle slope cover an area of 27.6 per cent followed by shallow loamy soils (18.25%) and deep fine loamy soils (15.3%).

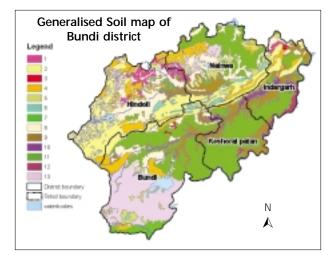


Fig. 2.10.3 Generalised Soil map of Bundi district

Soil map index

The generalized soil map prepared taking into consideration only dominant series masking features of sub dominant and inclusion resulting in high degree of extrapolation for spatial distribution. The soil map index is derived by calculating an area weighted soil map index of each map unit by multiplying the rating of each parameters of the series by area of the soil series within the unit followed by summing the weighted value and dividing by the total area of the map unit. Each soil parameters of dominant, sub-dominant and inclusions is rated on the scale of 1 to 5 based on their quality and responsiveness to management. Values of dominant, subdominant and inclusion were averaged to derive single index for a map unit and presented at physiography and tehsil level.

Generalized		Soil and site parameter	S		Area	Per cent of
Soil Unit	Soil depth (cm)	Particle size class (PSC) (Family)	Slope (%)	LGP (days)	(ha)	total area
1	Shallow (<50)	Loamy skeletal	3-8	90-105	11845	2.04
2	Shallow (<50)	Loamy skeletal	8-15	90-105	77282	13.28
3	Shallow (<50)	Loamy	<3	90-105	1124	0.19
4	Shallow (<50)	Loamy	3-8	105-120	106216	18.25
5	Medium (50-100)	Fine loamy	<3	105-135	20608	3.54
6	Medium (50-100)	Fine loamy	3-8	105-135	7378	1.27
7	Medium (50-100)	Fine loamy	8-15	105-120	7764	1.33
8	Deep (>100)	Fine loamy	<3	120-135	89061	15.30
9	Deep (>100)	Fine loamy	3-8	105-135	58752	10.10
10	Deep (>100)	Fine loamy	8-15	120-135	7429	1.28
11	Deep (>100)	Fine	<3	120-135	160659	27.61
12	Deep (>100)	Fine	3-8	120-135	3448	0.59
13	Rock outcrops		3-8	90-105	13679	2.35

Table 2.10.4 Generalized soil map units of Bundi district

Soil map index of the district (Table 2.10.5) indicates that around 60 per cent are of the district have high (3.0-4.0) and very high (>4.0) index rating. Soil index is low in 10.56 per cent area of the district concentrated in northern part of Hindoli and Nainma and southern region of Bundi tehsil (Fig.2.10.4). The soil map index is higher in Vindhyan region as compared to eastern plain. In Nainwa, Indergarh and Keshoraipatan tehsil, index rating is high to very high (Table 2.10.5).

Land use pattern

The existing land use in the district has been delineated using remote sensing data (IRS-ID) and Survey of India (SOI) topo-sheets with sufficient ground truths (over 700 observations) collected during the soil resource mapping of the district on 1:50,000 scale. Forest boundaries have been extracted from the toposheets as demarcated on sheets such as the reserved, protected and mixed open jungle (forest). Other land use types separated with the help of imageries in conjunction with toposheets.

In the district 30 per cent area is under forest. These are mainly confined in Bundi, Hindoli and Nainwa tehsils whereas Kehoraipatan and Indergarh tehsils are almost devoid of any forest cover. Open scrub with ravines are concentrated in Indergarh and Keshoraipatan and open scrubs with agriculture in Bundi, Hindoli and Nainwa tehsils. Area under agriculture is 46.6 percent. It is predominant in Nainwa and Keshoraipatan tehsils covering over 60 per cent area of tehsil. Vindhyan land from has greater area

under forest and agriculture as compared to the eastern plain. Forest occupy mainly in southern part of Bundi tehsil, western and south western part of Hindoli tehsils and runs from south west to north east across the district (Fig. 2.10.5).

Land Use Land Cover (2006-07) of the district (Fig. 2.10.6) is carved out from the map prepared by the NRSC, Hyderabad during the rapid assessment of the national level land use land cover-India using multitemporal AWIFS data. LULC map will be used to delineate and refine existing land use especially double/triple cropped and irrigated area. There is some variation in area under land use classes because of methodology and approach (Table 2.10.6).

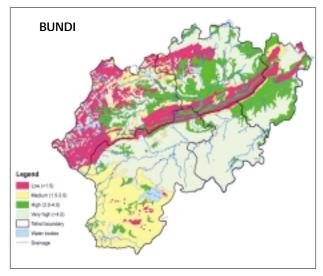
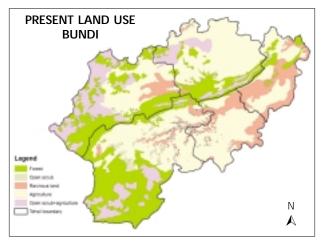


Fig. 2.10.4 Soil map index of Bundi district

Table 2.10.5 Soil map Index in Bundi district

Tehsil			Soil Map	Index	
		Low	Medium	High	Very High
		<1.5	1.5-3.0	3.0-4.0	>4.0
Bundi	ha	10816	78803	35946	61144
	%	5.6	41.0	18.7	31.8
Hindoli	ha	18713	48695	22630	25153
	%	15.7	40.9	19.0	21.1
Indergarh	ha	9075	8599	27457	18443
	%	13.7	13.0	41.5	27.9
Keshoraipatan	ha	1253	2863	25249	38960
	%	1.8	4.0	35.7	55.2
Nainwa	ha	21568	14943	88120	6584
	%	16.1	11.1	65.7	4.9
District	ha	61424	153903	199402	150284
	%	10.5	26.4	34.3	25.8



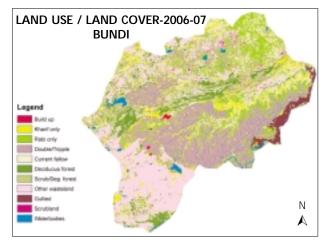


Fig. 2.10.5 Present land use of Bundi district

Fig. 2.10.6 Land use/land cover map of Bundi district

Table 2.10.6 Land Use Land Cover (LULC) and Land Use of Bundi district

Land Use (NBSS)	Per cent	LULC - NRSC-06-07	Per cent
Reserved forest (26.96%)	19.59	Deciduous forest (32.06)	5.79
Protected forest	6.21	Scrub/Deg. forest	5.64
Open mixed jungle	1.16	Other wasteland	20.60
Open scrub	0.76	Scrubland	1.72
Open scrub with ravines	10.55	Gullied	2.19
Agriculture	46.61	Kharif only	9.80
Open scrub with agriculture	12.25	Rabi only	13.13
		Double/Tripple	28.31
		Current fallow	9.66
Habitation	0.67	Build up	0.11
Waterbodies	2.20	Waterbodies	3.06

Land management unit

Generalized soil map and land use

Soil and land use maps were spatially integrated to generate a land management unit (LMU) map depicting the relationship of soils and land use. The generalized soil and land use map are integrated through the overlay process. The vector overlay resulted in large number of slivers (spurious polygons). These were eliminated through careful editing and merger to adjoining units by specifying tolerance limits. Units having similar soils and land use have been grouped. These delineations form the Land Management Units (LMU's) for the district. As a result of the spatial integration, 49 LMUs have been identified (Fig. 2.10.7). Out of which only 19 LMUs have significant coverage (>1.00 per cent).

Deep, fine loamy to fine soils on nearly level to very gentle slope delineated as LMU 30 and 42, occupying 36.8 per cent area, are mostly under irrigated agriculture and distributed in Bundi, Keshoraipatan, Indergarh and Nainwa tehsil tehsil. Agriculture is also associated with the LMU of shallow, loamy and loamy skeletal soils and cover about 4 per cent area though these soils are predominantly (21.82%) associated with forest in LMU 2-4 with variable slopes. LMU No. 3, 7 and 15 are characterized by shallow, loamy/ loamy skeletal soils under open scrub with agriculture (rainfed) occupy 7.0 per cent area of the district. LMU under ravinous land are found to occur in about 11 per cent area and mainly associated with deep, fine loamy soils in Keshoraipatan, Indergarh, Bundi and Nainwa tehsil.

Soil map index and land use

The land management units developed through the intersection of soil map index and land use resulted in 19 LMU. Predominant LMUs are the combination of high to very high soil index with agriculture as land use (29.37%) followed by the association of forest and soil index of low (8.04%) and medium (16.08%). Agriculture is almost negligible (0.90%) in units of low soil index. LMUs consisting of open scrub with agriculture occupy sizable area (11.83%) of the district and are found to occur irrespective of soil map index. Ravinous land use are associated with high to very high soil index and represented by LMU12 (13.89%) and LMU17 (7.22%).

2.10d. Development of district level land use plan for Nagaur district (Rajasthan) under arid ecosystem.

Aditya Kumar Singh, R.S. Singh, T.P. Verma and R.L. Shyampura

Natural resources assessment

Census and socio-economic pattern

Nagaur district comes under arid ecosystem having

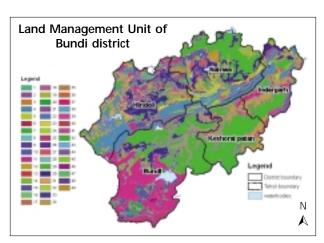


Fig. 2.10.7 Land management unit map of Bundi district

total area of 17718 sq.km. An analysis of census data of ten year interval has been done for better land use planning interpretation (Table 2.10.7). Total numbers of villages were 1396 during 1991, villages have increased to 1500 in 2001. In the district household with access to electricity has increased from 30.70% (1991) to 53.94% (2001). Similarly safe drinking water availability has also increased from 49.0% to 77.35%.

Table 2.10.7 Nagaur district at a glance

District information	Year		
	1991	2001	
Total area (sq. km)	17718	17718	
Total villages	1396	1500	
House hold status (%)			
House hold with access to electricity	30.70	53.94	
Safe drinking water	49.00	77.35	
Total population	2144810	2775058	
Rural population (%)	84.00	82.80	
Urban population (%)	16.00	17.20	
Male population (%)	51.50	51.35	
Female population (%)	48.50	48.65	
% Population of Scheduled caste	19.70	19.65	
% Population of Scheduled tribe	0.20	0.23	
Density (per sq. km)	121	157	
Education			
Literacy rate all (%)	31.80	57.28	
Literacy rate (M)	49.40	74.10	
Literacy rate (F)	13.30	39.67	
Literacy rate (Rural) (M)	55.80	72.46	
Literacy rate (Urban) (M)	67.60	81.67	
Literacy rate (Rural) (F)	9.80	36.85	
Literacy rate (Urban) (F)	32.50	53.41	

Rural population has remained around 82.8%, and it did not changed much in span of ten years from 1991 to 2001. In comparison of male population of 51.35%, the female population was 48.35%. In district scheduled caste population was 19.65 %, while scheduled tribe population was only 0.23%. The population density in the district was 151 (per sq. km). The overall literacy rate has increased from 31.69 % to 57.28 %. The literacy rate increase was very high for men from 49.40% in 1991 to 74.10% during 2001. While the literacy rate for women have increased from low of 13.30% in 1991 to 39.67% during 2001. The gap of literacy rate of men and women of urban and rural both has reduced. In case of male rural population to urban population the gap has lowered from 11.8% (1991) to 9.21% (2001), while in women it reduced from 22.70% (1991) to 16.56% (2001).

Soils

Soils of the district have large variability with respect to their morphological characteristics, depth to underlying strata, hummockiness and height and density of the dunes. The northwestern part is covered with high dunes and large interdunal flats which have fine, sandy, moderately deep to deep soils, underlain by lime concretionary horizon at 60 to 80 cm depth. The northeastern part, extending upto middle of the district, is moderate to highly hummocky with fine sand, brown, very deep soils devoid of $\rm CaCO_3$. Alluvial sediment, deposited by number of streams rising from the Aravalli hills and flowing through the southern part, have given rise to a variety of medium and fine textured soils (Fig. 2.10.8).

Land use

Average land holdings have come down from 5.96 ha (1995-96) to 5.35 ha during 2000-01 (Table 2.10.8). Similarly cropping intensity has also come down from 131.39 (1997-98) to 118.26 (2005-06). On the other hand the forest area has increased from 0.80% (1995-96) to 1.04% (2005-06). Net sown area has increased from 72.50% (1998-99) to 84.56% (2005-06). Similarly the gross irrigated area of the district has also increased from 17.40% (1998-99) to 25.88% (2005-06).

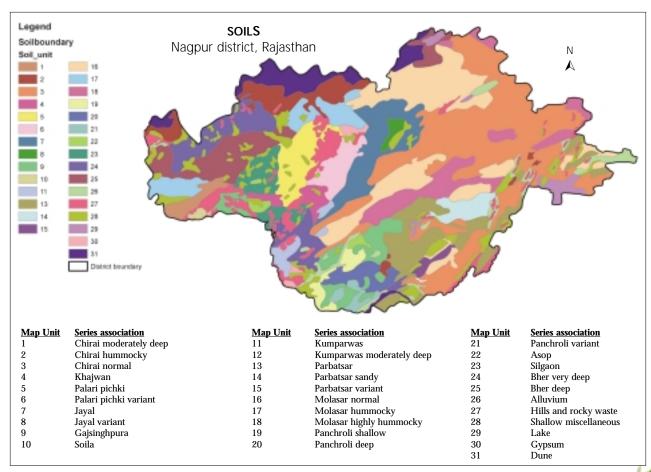


Fig. 2.10.8 Soils of Nagaur district, Rajasthan

Table 2.10.8 Land use of Nagaur district

LAND USE	1995-96	2000-01
Average land holding (ha)	5.96	5.35
Forest area according to land utilization %	0.80	1.04
	1997-98	2005-06
Cropping intensity	131.39	118.26
	1998-99	2005-06
Net area sown %	72.50	84.56
Gross irrigated area %	17.40	25.88

Agricultural indicators and position of principal crops (2006-07): In Nagaur district the forest area is only 1.05% as against 7.87% forest area of the state. Similarly the net irrigated area to net area sown and gross irrigated area to gross area sown is also less than state average (Table 2.10.9).

Except pearlmillet and sorghum which are grown during kharif season the percentage area of cropped area sown by other crops was less than state average. For rabi crops which are mostly taken with the help of irrigation, the area in the district was less as compared to state average.

Crop wise total area (2006-07) of Nagaur district of Rajasthan

In the district the cereal crops grown are pearlmillet, sorghum, wheat and barley. The major pulse crops grown are moong, cowpea, moth, gram, pea and guar whereas major oilseed crops are groundnut, sesamum, taramira and rapeseed and mustard. Besides the field crops the district also has some area in condiments and spices like red chillies, fennel, cumin, methi, onion, isabgol etc. (Table 2.10.10). Cotton is cultivated wherever irrigation facilities exist.

Table 2.10.9 Agricultural indicators and position of principal crops

	Nagaur	Rajasthan
Percentage of		
Forest area to reporting area	1.05	7.87
Net area to reporting area	60.88	28.45
Double crop area to net area	15.29	28.45
Net irrigated area to net area sown	22.26	38.75
Gross irrigated area to gross	25.51	36.96
area sown		
Percentage of cropped area sown by	y crops	
Pearl millet	32.49	22.80
Sorghum	3.78	3.07
Maize	0.01	4.79
Wheat	5.37	11.91
Barley	0.84	1.08
Gram	1.23	4.69
Rape seed and mustard	6.93	14.39

Table 2.10.10 Crop area of Nagaur district

Crop	Area, ha	Av. Yield (kg/ha)	Crop	Area, ha	Av. Yield (kg/ha)
Sorghum	53787	413	Moong	211791	396
Pearl millet	461777	775	Cowpea	17735	342
Maize	129	(-)	Moth	196461	211
Wheat	76384	2162	Gram	17454	1270
Barley	11916	2512	Pea	2232	(-)
Total cereals	603995		Guar	155820	(-)
<u>Oilseeds</u>		<u>.</u>	Condiments and spic	<u>ees</u>	
Groundnut	18269	1096	Red chillies	731	(-)
Sesamum	10837	167	Fennel	1173	(-)
Taramira	5708	572	Cumin	12424	138
Castor	152	(-)	Methi	4249	847
Rape & mustard	98538	1178	Isabgol	31628	382
Fibre crop					
Cotton	9223	1261			
<u>Vegetables</u>					
Sweet potato	680	(-)			
Onion	8151	(-)			

2.10e. Crop yield modelling under varying soil moisture in different types of soils

A.K. Singh, R.S. Singh and R.L. Shyampura

Constraint analysis: Moisture was considered to be the most crucial factor that influenced production of different crops in varying types of soils. The dynamics of available water capacity (AWC) was evaluated with number of irrigations for determining the yield potential. For this exercise, separate soil samples from 0-15, 15-30, 30-50 and 50-80 cm depths were drawn at weekly interval and analyzed for moisture content and the variation in the yield for shallow, medium, deep and very deep soils were interpreted.

Soil suitability evaluation

Multi-linear regression model

A multiple regression model was developed to relate crop production to a set of independent variables which is the direct extension of polynomial regression equation of one independent variable. Factors which had significant correlation with different crop yield such as soil depth, soil texture, soil slope, AWC, number of irrigations and agronomic management were chosen for regression model. These were individually significant at 5% level of significance. These factors together accounted for 99% variation in yield of different crops. The multilinear regression developed was as follows:

Maize: Factors which have significant correlation with maize yield such as soil depth, texture, AWC, irrigation, field leveling and management were chosen for regression model.

Maize yield (q/ha)

Y= 22.12574 - 174253 (Soil depth, mm) - 21.8661 (Soil texture) - 46.7682 (slope) + 64.34714 (AWC) + 12.20755 (irrigation) +12.35456 (drainage) + 18.12657 (management).

The predicted yield values developed by model have a difference of 0.7-13.3% from actual, as the crop was taken during kharif season.

Soybean: Factors which have significant correlation with soybean yield such as soil depth, texture, AWC, irrigation, field leveling and management were chosen for regression model.

Soybean yield (q/ha)

Y= -18.9611-28.2587 (Soil depth, mm) + 23.63523 (Soil texture) + 25.18136 (AWC) +9.932669 (irrigation) +8.412177 (field leveling) + 18.29615 (management).

In clay loam/clay soils, due to their higher water holding capacity higher yield of 21.9 gha-1 was observed. The predicted yield values as per model have difference of 1.9-7.0% from observed crop yield as the crop was taken without irrigations.

Groundnut: Factors which have significant correlation with groundnut yield such as soil depth (r=0.54), texture (r=0.50), slope (r=0.40), AWC (r=0.54), rainfall (r=0.57), drainage (r=0.71) and management (r=0.89)were chosen for regression model. These were individually significant at 5% level of significance. These factors account for 98% variations in groundnut yield.

Groundnut yield (q/ha) = 3.475171- 6.59235 (Soil depth, mm) - 4.60455 (Soil texture) - 7.69649 (slope %) +39.38491 (AWC, mm) -23.9893 (rainfall) + 0.80525 (drainage) +17.51469 (Management).

The closeness of the relationship between the observed and predicted yield indicated that the model is highly suitable for sandy loam to loam soils under rainfed situations (rainfall 400-600 mm). The regression model didn't work well under clay loam and clay soils of similar situations.

Mustard: Factors which have significant correlation with mustard yield such as soil depth, texture, slope, AWC, irrigation, root penetration and management were chosen for regression model.

Mustard yield (g/ha) = -9.463 - 8.099 (Soil depth, mm) + 4.277 (Soil texture) + 2.644 (slope %) +14.557 (AWC, mm) +28.034(no. of irrigations) +10.346 (Management). R2 = 0.99

A deviation of 1.6 to 2.9% in predicted and observed yield values was observed and the relationship was found with climate-specific regression between a soil indicator and average yields. The selected soil indicator was available water capacity (AWC).

Wheat: Factors which have significant correlation with wheat yield such as soil depth, texture, AWC, irrigation, sowing time and field leveling were chosen for regression model.

Wheat yield (q/ha) = 13.73 + 0.099867 (Soil depth, mm) + 10.28 (Soil texture) + 12.83 (AWC) +19.92 (irrigation) +14.68 (Sowing time and management) + 1.06 (field leveling). $R^2 = 0.99$.

In shallow sandy loam/sandy clay loam soils, six irrigations were required for getting potential yield of 56.3 qha⁻¹. In moderately deep to deep sandy loam/sandy clay loam soils, five irrigations, whereas, in clay loam/clay soils four irrigations were required. When the observed yield was compared with predicted yield developed by model, it was found that values had difference of 0.3 to 1.0%.. In wheat also, selected soil indicator was AWC. In this study, a strong relationship existed between AWC, soil texture, number of irrigations, sowing dates and field leveling with crop yield.

2.10f. Correlation of soil series in western region (Gujarat & Rajasthan)

R. L. Shyampura, R. S. Singh, A. K. Singh and T. P. Verma

Soil series, identified during the soil resource mapping of Bhilwara, Ajmer and Bundi district on 1:50,000 scale, have been correlated for the finalization of soil series description at the national level. Out of 10 finalized soil series, two soil series namely Baland and Kajlodiya series have got entered into the national register (No. 241 and 242 with the state code of RJ023 and RJ024). Brief description of soil series are as follows.

Baland Series: (National Series Register Page No 781-784) The Baland series is the member of the fine-loamy, mixed (calcareous), hyperthermic family of Typic Haplustepts. Typically, Baland soils have dark yellowish brown, strongly alkaline sandy loam A horizons and

brown to dark yellowish brown sandy clay loam to clay loam mildly to strongly alkaline B horizon underlain by Ck horizons.

The soils of Baland series are moderately deep, calcareous, sandy loam to clay loam in texture and have moderate water holding capacity and nutrient retention capacity. These soils are moderate to marginally suitable for sorghum, maize, groundnut, sunflower, cotton, wheat, barley and mustard.

Kajlodiya series: (National Series Register Page No 785-788) The Kajlodiya series is the member of the fine-loamy, mixed, hyperthermic family of Typic Haplustepts. Typically, Kajlodiya soils have dark yellowish brown, strongly alkaline sandy loam A horizons and dark yellowish brown, moderately alkaline, sandy loam to sandy clay loam B horizons underlain by Cr horizons of weathered rock fragments.

The soils of Kajlodiya series are deep, sandy loam to clay loam texture and marginal in water holding capacity and nutrient retention capacity. These soils are suitable for all climatically adopted with amendments and with proper soil and water conservation.

The description of series Atoli and Nayagaon have been revised as per the protocol for listing in the National Register. The Atoli series is the member of fine, smectitic (calcareous), hyperthermic family of Sodic Haplusterts and occur on the alluvium of the Aravalli in the Rajasthan Upland. The Nayagaon series is the member of fine, smectitic (calcareous), hyperthermic family of Typic Haplusterts developed on the alluvium of the Vindhyan landscape. These are extensively distributed in Bhilwara and bundi district of Rajasthan.

Externally Funded Projects

2.11a. Interfluve stratigraphy, sedimentology and geochemistry of the central and southern Ganga plains (DST-ESS Project)

D.K. Pal, T. Bhattacharyya, P. Chandran, S.K. Ray, P.L.A. Satyavathi, P. Raja, S.L. Durge, A.M. Nimje, C.K. Likhar and S.W. Thakre

The Ganga Plains (GP) of the northern India constitute one of the world's most extensive alluvial tracts traversed by big rivers (Ganga-Yamuna) that are sourced in the Himalayan Oregon, as well as rivers such as Betwa, Chambal, Ken and Son that are sourced in the central Indian Craton and many smaller rivers sourced within the plains. The underlying Ganga Basin contains upto several kilometers of alluvial strata. The GP are of great significance from academic standpoint as they hold important clues regarding the tectonic and climatic factors. Understanding the landforms of the GP, their origin, development and dynamic imprints are therefore of critical significance to plan effective and sustainable development of the region. It is necessary to study the GP to track changes in the alluvial landscape on different time scales. For a comprehensive understanding of the plains, multiple approaches need to be adopted that can combine modern process studies, Holocene environmental development in the shallow sub-surface (~100 m depth).

Physical and chemical properties

Bhognipur core (BHOG K): The cross section details of the core are detailed in the Fig. 2.11a.1 that describes sedimentological details and paleopedological details. Paleopedological details of the paleosol-bearing horizons are based on varying depth functions of macro- and micromorphological features, and degree of development of pedofeatures that led to recognition of 10 paleosols in the ~ 50 m sequence of the Bhognipur core. The depth distribution of pH, EC, CaCO₃, organic carbon and particle- size distribution (psd) throughout the entire core comprising of the 10 paleosols and the intervening sediments are presented. The core samples up to the depth of about 1.5 m are neutral to slightly alkaline representing Bh1 (Bhognipur 1) paleosol with Inceptisol characters. However, below this depth remaining part of the core with 9 paleosols (Bh2-Bh9; Bhognipur 2 to 9) having Inceptisol, Vertisol and Alfisol characters are moderately to highly alkaline with a very low concentration of soluble salts. The entire core with 10 paleosols is calcareous and maximum amount of CaCO₃ about 20% was found in sediments between

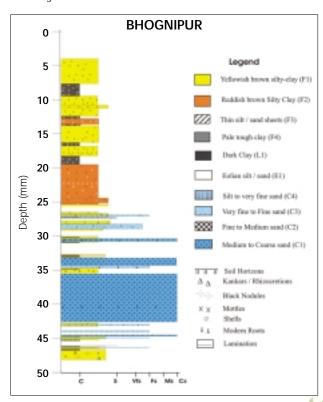


Fig. 2.11a.1. Textural and other details of Bhognipur core.

Bh1 and Bh2 paleosols at about 3.5 m, but content of organic carbon is considerably low (<0.5%). The texture of the core varies from sandy loam to clay with moderate to high content of clay fraction in some of the paleosols. There is appreciable increase of clay between the depths of 1.55 to 1.86 m, 3.54 to 8.27 m 8.37 to 10.90 and 12.13 to 13.84 m that correspond to Bh1, Bh2 and Bh3 paleosols. The Bh3 paleosol occurring between 10-14 m depth is marked by strongly developed argillic and vertic horizons whereas others (Bh1 and Bh2) are marked by weakly developed pedofeatures. The paleosols below 15 m depth are marked by the large amount (>30%) of clay that does not appear to have any relationship with pedogenic development and the paleosols (B4-Bh10; Bhognipur 4 to 10) are marked by weakly developed syndepositional pedofeatures.

IIT, Kanpur core (IIT K)

The cross section of core with sedimentological and paleopedological details are given in the figure 2.11a.2. This core is marked by the development of 13 paleosols with characters ranging from weakly developed paleosols corresponding to Inceptisol (It1-It11 and It13) and strongly developed paleosol corresponding to

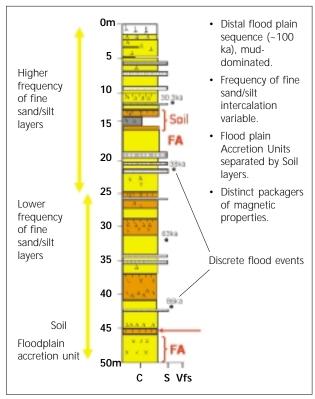


Fig. 2.11a.2. Textural and other details of the IIT, Kanpur core

Alfisol (It12). The entire core with 13 paleosols and the intervening sediments is slightly to moderately alkaline, calcareous (2-24%) and non-saline and also impoverished in OC (<0.5%). The texture of the core is relatively uniform throughout which is primarily silt loam. In some secion an increase in clay with depth was observed at 0.4-3.4 m, 12.0-15.0, 17.5-20.8, 40.0-46.2 m that correspond to It1, It2, It6, It7 and It12 paleosols with weakly to strongly developed pedofeatures.

Mineralogical properties

Bhognipur core: The mineral assemblage of the silt (50-2 mm) fraction determined by XRD analysis is marked by mica, mixed-layer minerals (1.0 - 1.4 nm), vermiculite, pedogenic chlorite (PCh), hydroxyinterlayered vermiculite (HIV) and smectite, kaolin, quartz and feldspars. A semi-quantitative estimate of these minerals indicates that none of the layer-silicate mineral was dominant (>50%) in this fraction. The depth distribution of mica indicates that the upper 2.66 m of the core with weakly developed It1 and It2 paleosols have more amount of mica than the lower part of the core with It3-It13 paleosols showing weakly to strongly developed pedofeatures. The mica is consisted of both muscovite and biotite as evident from the ratio of 001/002 reflection of 1.0 nm peak of which is more than unity. The content of smectite increases with depth. The nature of the smectite up to a depth of 28 m in the core is trioctahedral and high charge smectite type (HCS). In the XRD diffractogram it is characterized by the collapse to 1.0 nm peak at Ksaturation and heating to 110°C that also gets destroyed in the HCl treatment. The smectite beyond the depth of 28 m shows the character of low charge smectite (LCS). Pedogenic chlorites (PCh) are also present.

The mineral assemblage in the coarse clay (2-0.2 mm) fraction is similar to those in silt fraction. In upper 20 m depth of the core none of the clay minerals is dominant (≥50%) but the content of mica shows a relative increase upwards to the surface. In this upper part of the core the smectite is predominantly high charge type (HCS) as evidenced from its collapse to 1.0 nm peak region with K-saturation at 25°C and with heating at 110°C and its destruction in the HCl treatment. Below 20 m depth the content of smectite increases and it becomes a dominant mineral (>50%). The smectite in the lower part (below 20 m depth) consists of both high (HCS) and low charge (LCS) density and the proportion of LCS increases with depth and becomes dominant beyond 35 m depth.

The fine clay fractions (<0.2 mm) contain mica, vermiculite, HIV, PCh, smectite and kaolin. In the upper 3.78 m depth of the core none of these minerals is dominant (>50%). But beyond this depth mica decreases and smectite increases to become a dominant mineral (>50%). The smectite in the upper 3.78 m depth consists of both HCS and LCS but it is dominated by high charge density smectite. The LCS becomes dominant below 4 m depth with occasional presence of PCh and hydroxy-interlayered vermiculite (HIV). The presence of both HCS and LCS in the upper 4 m depth of the core and almost exclusive presence of LCS beyond this depth in the remaining core indicates change of provenance.

IIT, Kanpur core: The XRD analysis shows dominance of mica in the silt (50-2 mm) fraction that also contains mixed-layer minerals, smectite, vermiculite, HIV, PCh, kaolin, feldspar and quartz. The depth distribution of these minerals indicates a relatively higher amount of mica in this core than in the Bhognipur core. The smectite is dominantly HCS in nature and is marked by an increase with depth. Coarse clay (2-0.2 mm) fractions have the similar mineralogy as those of the silt fractions. However, the content of smectite is higher in this fraction than that in the silt. The depth distribution of mica does not show any trend with depth whereas HCS increases with depth.

The fine clay fractions (<0.2 mm) are dominated by the mica and smectite that also contain vermiculite, HIV, PCh and kaolin. The depth distribution of mica in upper 24 m is marked by an increase and below this depth it shows a relative decrease. The smectite is predominantly LCS and dioctahedral in nature and it is marked by an increase below 24 m depth in the core. However, the content of LCS is much less than that of Bhognipur LCS.

Clay minerals as evidence of provenance changes

In comparison to Bhognipur core, the IIT K core is more micaceous as evident from the content of mica in the silt, coarse and fine clay fractions. The upper 10 m part of Bhognipur core has more amount of silt, coarse and fine clay mica than beyond this depth. The dominant presence of LCS in the silt fractions (beyond 28 m depth), coarse clay (beyond 35 m depth) and fine clay (beyond 4 m depth) fractions of Bhognipur core, and dominant presence of fine clay LCS in IIT K core, indicate that the alluvium at IIT K and that of Bhognipur core is mineralogically different in a subtle way. As the biotite mica can not yield both trioctahedral HCS and dioctahedral LCS simultaneously, the genesis of LCS and its accumulation in these two cores needs to be viewed in terms of the influence of weathering product of the plagioclase present in both Deccan basalt of Central Indian Craton and micaceous Ganga-Yamuna river sediment. The plagioclase of the Deccan basalt yields dioctahedral LCS as the first weathering product. This smectite must have carried through rivers (Betwa, Chambal, Ken and Son) sourced in the Central Indian Craton and also in the Ganga-Yamuna river system and spread the smectitic alluvium in Bhognipur and Kanpur areas in the past.

The depth distribution of silt, coarse and fine clay HCS and LCS in two cores indicates that the Bhognipur core was primarily influenced by the weathering product of the Deccan basalt whereas IIT K core by the sediment of Himalayan rivers, as evident from the presence of silt and coarse clay LCS at depth beyond 28 m of Bhognipur core. In IIT K core more amount of silt and clay micas as compared to those of Bhognipur core and the exclusive presence of silt and coarse clay HCS suggests the influence of mica carried through rivers sourced in the Himalayan Oregon in the development of IIT K core. The presence of more amount of silt, coarse and fine clay micas in the upper 10 m depth and also the presence of small amount of fine clay HCS in the upper 4 m depth of Bhognipur core suggest the influence of mica sourced in the Himalayan Oregon during the development of Bhognipur core in recent times.

Clay minerals as evidence of climate changes

The mineralogical composition of the silt, coarse clay and fine clay fractions of both the cores is similar. The decreasing amount of mica, vermiculite and the increasing amount of HCS from the silt to the clay fractions suggest in the early stages of weathering biotite was weathered to mixed-layered minerals containing vermiculite layers. As more interlayer regions were affected by weathering there was a progressive formation of vermiculite and HCS. Previous studies indicated that HCS of trioctahedral type is generally an alteration product of biotite mica even in presence of muscovite and can be regarded as an alteration product in semi-arid and arid climate. Such alteration in core samples might not have occurred totally during the post-depositional period. However, wherever the sediments had an adequate time such

alteration can be considered as a part of pedogenetic process in semi-arid climate. The formation of HCS and LCS simultaneously from mica is very unlikely as muscovite do not weather in presence of biotite. Moreover, in dry environments of sub-humid and semiarid climate that induces primarily the formation of CaCO₃, micas may not yield so much amount of LCS as observed in both the cores. This suggests that the main source of the sediment containing LCS is other than the mica. The occurrence of huge amount of LCS appears to form in an earlier humid climate at the source area because LCS could be the alteration product of plagioclase. Plagioclase feldspars are present in both the Deccan basalt of the Central Indian Craton and also in the Ganga-Yamuna river sediments, which contains sufficient silica to form smectite in tropical humid climates. However, there is impoverishment of plagioclase in Ganga-Yamuna river sediments as compared to Deccan basalt. The formation of smectite from biotite is quite unlikely in humid climates because this climate removes silica and cations and induce separation of layers precluding the formation of clay minerals more siliceous than biotite itself. Thus the HCS existing in arid climate is the alteration product of biotite which survived earlier weathering. The presence of HIS, HIV and PCh in the fine clay fractions, and HIV and PCh in the silt and coarse clay fractions indicate that the hydroxy-interlayering in the vermiculite and smectite interlayers did occur when positively charged hydroxy-interlayer materials such as $[Fe_3(OH)_6]^{3+}$, $[Al_6(OH)_{15}]^{3+}$, $[Mg_2Al(OH)_6]^+$, [Al₂(OH)₄]⁵⁺, entered into the inter-layer spaces at pH much below 8.3. The pH of the sediments of both the cores are mildly to moderately alkaline and in this chemical environment 2:1 layer silicates suffer congruent dissolution, discounting hydroxyinterlayering of smectites. The hydroxy-interlayers in vermiculite and smectite and the subsequent transformation of vermiculite to PCh are not the part of contemporary pedogenic process in the prevailing dry climatic conditions. However, the crystallinity of LCS is being preserved in the non-leaching environment of the arid climatic conditions. This suggests that the presence of HIS and also HIV, and PCh in arid and semi-arid climatic environments could be used as an indicator of climate change from humid to arid. The alkaline chemical reaction, formation of CaCO₃, formation of trioctahedral HCS, preservation of HIS,

HIV and PCh, indicate the role of climate change from humid to arid during the development of soils within the cores. Wherever the sediment rested for a longer time and did not experience any tectonic stress, the pedogenetic process mainly the illuviation of clay has been possible.

This study shows that although the core at Bhognipur in the southern and the core at IIT Kanpur (IIT K) in the northern parts of the Ganga-Yamuna Interfluves (GYI) occur in the Himalayan Foreland, the qualitative mineral composition of the core samples is similar. This may apparently suggest the influence of micaceous sediments of the Himalayan Oregon in the development of both the cores. The fine clay fraction of both the cores contain hydroxy-interlayered low charge dioctahedral smectite (HIS) as the dominant mineral (>50%) in this fraction. Formation of huge amounts of LCS at the expense of biotite of neither Himalayan nor Vindhyan sediments and also the hydroxyinterlayering in smectite interlayers are probable in the alkaline soil environments of the present day semi-arid climate. The HIS is the weathering product of plagioclase feldspars of the Deccan Basalt of the Central Indian Craton and also of the sediment of the Himalayan rivers during the earlier humid climate that created acidic soil environment. As parent material HIS was deposited in the GYI areas and was extended upto Kanpur.

During the acidic soil environments of humid climate vermiculite also became hydroxy-interlayered (HIV) and it then transformed to pedogenic chlorite (PCh). Weakly developed to matured paleosols were formed in the later sub-humid to semi-arid climate. The drier phase during this climate caused more formation of pedogenic CaCO₃ that created conducive conditions for illuviation of clays towards the formation of of argillic (Bt) horizon.

While the formation of vermiculite, high charge trioctahedral smectite (HCS), CaCO₃ and soil alkalinity is possible due to climatic aridity, the transformation of smectite to HIS, vermiculite to HIV and HIV to PCh can only take place in acidic soil environment of humid climate. Thus preservation of HIS, HIV and PCh in soils of semi-arid climate can be considered as an indicator of climate change from humid to sub-humid to semi-arid.

2.11b. Predicting soil carbon changes under different cropping systems in soils of selected benchmark spots in different bioclimatic systems in India (DST sponsored Project)

> T. Bhattacharyya, D.K. Pal, S.K. Ray, P. Chandran, C. Mandal, A.S. Deshmukh and R.R. Deshmukh

Roth C-26.3 is a model for the turnover of organic carbon in top soils that allows for capturing the effects

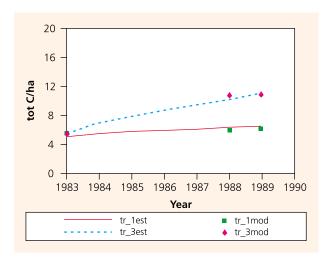


Fig. 2.11b.1. Modelled and estimated soil carbon over time in Roth C for treatment 1 i.e. control (no fertilizer, no manure) and treatment 3 (N30+FYM) in Long Term Fertilizer Experiment at Sarol, Madhya Pradesh (tr = treatment, mod = modelled, est = estimated).

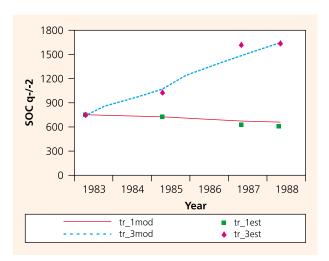


Fig. 2.11b.2. Modelled and estimated soil carbon over time in Century for treatment 1 i.e. Control (no fertilizer, no manure) and treatment 3 (N30+FYM) in Long Term Fertilizer Experiment at Sarol, Madhya Pradesh (tr = treatment, mod = modelled, est = estimated).

of soil type, temperature, moisture content and plant cover on the turnover process. Century model allows the simulation of complex agricultural management systems which include crop rotation, tillage practices, fertilization, irrigation, grazing and harvesting. Century uses a monthly time step utilizing average monthly maximum and minimum temperature and precipitation.

Roth C and Century models were used to capture changes in SOC content of selected benchmark (BM) spots representing Long Term Fertilizer Experiments (LTFE). RothC model was used to simulate the changes in SOC content in soils of five benchmark spots (Sarol, Teligi, Nabibagh and Panjri from black soil region (BSR), Gaupur from Indo-Gangetic Plains (IGP). The results showed an increase in TOC content when external organic inputs were applied as compared to control and only inorganic fertilizers' treatments. The study showed that Roth C model can capture the trend of the experimental data in tropical soils (Fig. 2.11b.1). A separate study was undertaken to parameterize century model for application to different kinds of cropping systems in contrasting bioclimatic conditions for four sites (Mohanpur from IGP and Akola, Sarol and Teligi from BSR). Both these models can simulate the treatment effects of different bio-climatic systems in terms of predicting SOC change, as shown in figure 2.11b.2 with Sarol LTFE as an example.

2.11c. Developing Georeferenced Soil Information System for Monitoring Soil and Land Quality for Agriculture (NAIP Component-4 subproject)

D.K. Pal, Dipak Sarkar, T. Bhattacharya, D.K. Mandal, Jagdish Prasad, G.S. Sidhu², A.K. Sahoo³, K.M. Nair⁴, R.S. Singh⁵, T.H. Das⁶, M.V. Venugopalan⁷, A.K. Shrivastava⁸, D.K. Kundu⁹, C. Mandal, R. Shrivastava, T.K. Sen, S. Chatterji, P. Chandran, S.K. Ray, G.P. Obireddy, N.G. Patil, S.K. Mahapatra², K. Das³, A.K. Singh⁵, S. Shrinivas⁴, S.K. Reza⁶, P. Tiwary, K. Velmourougane⁷, K.K. Meena⁸, K.G. Mandal9, Mrunmayee Lokhande, Khushal Wadhai, Vishakha Dongare, B. Mohanty⁹, Supriya Majumdar³, K.V. Ganjanna⁴, R.S. Garhwar⁵, D. Hazarika⁶, Apeksha Sahu⁷, Suchitra Mahapatra⁹, A. Kumar⁸

National Bureau of Soil Survey and Land Use Planning (NBSS &LUP), Nagpur (MS)2 NBSS&LUP, New Delhi,

³ NBSS & LUP, Kolkata, ⁴ NBSS & LUP, Bangalore, ⁵ NBSS & LUP, Udaipur, ⁶ NBSS & LUP, Jorhat, ⁷ Central Institute for Cotton Research, Nagpur (MS), ⁸ National Bureau of Agricurally Important Microorganisms, Mau (UP), ⁹Directorate of Water Management, Bhubaneshwar (Orissa)

Sustainability of agriculture is a major concern of the 21st century in view of soil degradation and climate change. Proper agricultural land use planning and monitoring of soil and land quality parameters are essential for sustainable agriculture. In India, there is an excellent repository of soil information and maps at both large and small scales, but they are unable to provide georeferenced information in spatial domain for researchers engaged in natural resource management, crop and environmental modeling. Considering the multitude roles performed by soils in agriculture, environmental, economic, social and cultural activities, it is necessary to develop an agroecological subregion (AESR) base Georeferenced Soil Information System (GeoSIS) for monitoring the soil and land quality induced by dynamic land use changes. Georeferenced soil information system (Geosis) with spatial domain provided a robust platform for the researchers and managers engaged in natural resource management, crop and environment modeling to monitor the changes in soil properties induced by dynamic land use changes. Different components viz. soil, water, climate, animal, forestry and environment play a significant role in land use planning for sustainable agriculture. Assessment of land quality and the direction of change with time is the primary indictor of sustainable land management. The most important link between farming practices and sustainable agriculture is the health of soils that require regular monitoring. Identification of relevant indicators and fixing baseline (reference level) will help in forewarning the consequences of non-compatible land uses on land quality.

The study is being carried out in 15 AESRs of Indo-Gangetic plains representing mainly the rice-wheat cropping systems and 17 AESRs of Black Soil Region representing cotton based cropping system.

Study Area

The Indo-Gangetic Plains and Black Soil Region of India were selected to monitor soil and land quality for the agriculture covering an area about 43 and 63 m ha respectively. The study area includes 7 AERs and 14 AESRs from the IGP and 6 AERs and 17 AESRs from the BSR and covered 13 and 19 % respectively of total geographical area (TGA) of the country. The already established benchmark soil series were revisited for the assessment of land quality and the temporal changes in the primary soil quality indicators for sustainable land management.

Field survey is being conducted for collecting information on soil, water, climate, land use and types of yield of crop for identified benchmark spots (one spot for each AESR) for determining threshold values of soil parameters for developing land quality indicators.

Work done

From each hotspot, two sites were selected viz., low management (LM) and high management (HM). Soil samples were collected from each horizon for laboratory analysis and other soil-site data and land management data were also collected. The soil samples were analyzed for physical, chemical and microbiological properties using standard methods.

The unknown values of soil parameters viz. saturated hydraulic conductivity have been estimated by developing pedo-transfer function (PTF). The estimated values of saturated hydraulic conductivity were used for the refinement in the calculation of length of growing period (LGP) and in the modification of AESR boundaries. Soil and Terrain (SOTER) digital database software is being used for creating datasets on soil, water, climate, land use, and terrain information.

Due to changes in research output with time which are soils and site data, characteristic of the boundaries of the AESRs may change. Most of the soil properties are not feasible to analyze in the laboratory such as hydraulic conductivity.

Using stepwise regression, a pedotrasnfer function (PTF) for estimating saturated hydraulic conductivity (sHC) was developed from 200 soil layer observations of 49 soil pedons with available and feasible data having R² value of 0.67. The estimated values of sHC were used for generating quantitative drainage map of the study area. The derived formula to calculate the saturated hydraulic conductivity is

 $\Delta HC = 120.637-13.094 * (pH)-0.102 * (total clay)+1.151 * Ex(Ca/Mg)$ $(R = 0.82, r^2 = 0.673, Ad. R^2 = 0.668, SE = 4.3317)$

This would help to correct the length of growing period (LGP) based on antecedent moisture in the soil after the cessation of rains and subsequently, in the modification of existing AESR boundaries. For the generation of database for the study, SOTER software have been used. SOTER is composed of sets of files for use in a Relational Database Management System and Geographic Information System. The major differentiating criteria are applied in step-by- step manner, each step leading to a closer identification of the concern area. A SOTER unit can be defined progressively into terrain, terrain components and soil components. For the development of thematic maps and attribute data linking with the map entities, various GIS softwares were used.

Soil information of 353 soil profiles of BSR were georeferenced and their properties viz. physical, chemical and microbiological, and terrain information were linked as attribute table created by SOTER. The soil samples and land use information were collected from 13 spots of BSR and all the 14 spots of IGP by

various co-centres and sent to other Centres as well as Lead Centre for analysis. These samples are being analyzed for physical, chemical and microbiological properties of the soils.

- Based on Soil Resource Map (SRM) information, a soil map of the black soil region (BSR) was prepared on 1:1,00,000 scale (subgroup association).
- The total area under the black soil region is about 63.66 mha. The major soils orders belong to Vertisols and Inceptisols and Alfisols in patches. The total number of soil polygons in the BSR is 14,623 of which 6114 are unique polygons. Each polygon exhibits the occurrence of dominant (60%) and sub-dominant soils (40%).
- The total state covered under BSR are 13 which includes, Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka, Chhattisgarh, Tamil Nadu, Orissa, Rajasthan, Punjab, Bihar, West Bengal and Assam.

- The total are under black soils is about 17.21 mha in Maharashtra followed by 13.06 mha in Madhya Pradesh and 7.39 mha in Gujarat.
- The soil information of BSR was collected from different sources which includes Bench-mark established soil series and other soil information from published reports and Ph.D and M.Sc theses of LRM student of NBSS&LUP.
- Total 343 point data were collected, georeferenced and placed on the BSR map (Fig. 2.11c.1).
- Each point data placed on the map were attached with their morphological, physical and chemical data as per horizons and also as layered data (0-30, 0-50, 0-100 each).
- The AESR map was superimposed on the BSR map and it was found that it covered about 27 AESR (Fig. 2.11c.2)

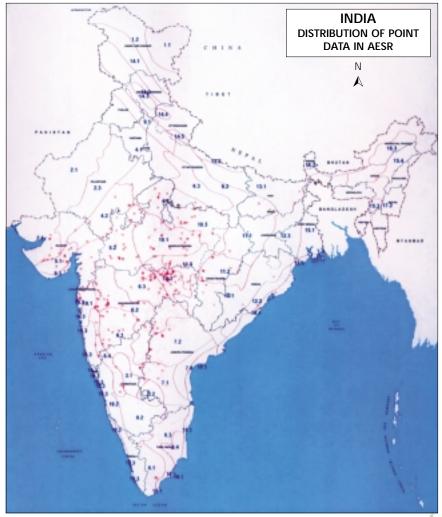


Fig. 2.11c.1 Distribution of Point data in AESR

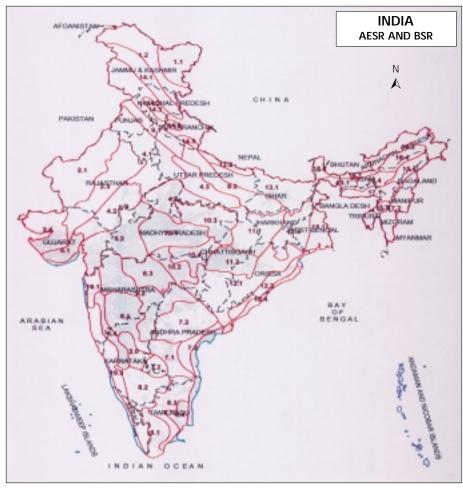


Fig. 2.11c.2 AESR and BSR, India

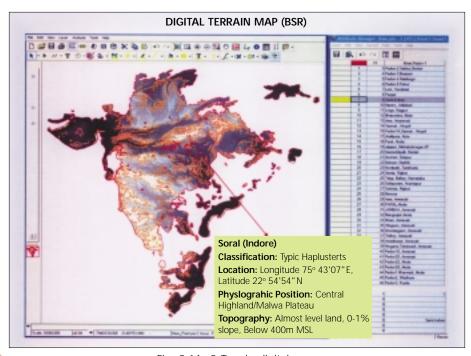


Fig. 2.11c.3 Terrain digital map

 The weighted mean of major soil properties were calculated for 0-30 cm, 0-50 cm and 0-100 cm and plotted on the map as layered data.

Preparation of terrain map

Using 90m resolution SRTM (Shuttle Radar Topographic Mission) data, the terrain map of BSR was prepared, the information contour generated was used for preparing the Digital Elevation Model (DEM). The soil information (point) was transferred on the DEM in order show their relative physiographic position on the (map showing distribution of point data) shown in Fig. 2.11c.3.

Soil samples from 12 soil profiles representing six Benchmark soils of north western and northern IGP have been collected for laboratory characterization. Out of these soils, two soils are salt-affected (Zarifa Viran and Sakit Series), three normal (Fatehpur, Naura and Haldi Series) and one water stagnated soil (Itwa Series). Zarifa Viran soil is in the state of almost being reclaimed. The soils of Fatehpur series are coarse textured soils and that of Naura heavy textured. Haldi soils are high in organic carbon. The bulk density (BD) of different horizons of these soils (undisturbed) has been done by core sampling. Water contents (%) on oven dry basis have been estimated from the core samples.

In Zarifa Viran soils (high management level), bulk density (BD) in sub-surface soils was as high as 1.53 Mg m⁻³ as compared to surface layer where it is 1.25 Mg m⁻³. At low management level, this change was not so perceptible. Heavy machinery and puddling may have resulted in high BD in sub-surface layers. In normal soils (Naura series), this impact was more perceptible. In Itwa soils (under low management level), the BD at the sub-surface layer was 1.41 Mg m⁻³ compared to 1.39 Mg m⁻³ at the surface. There was build up of organic carbon (>1%) at the surface of Zarifa Viran soils under rice-wheat system. These waterlogged soils crack when water recedes. In Sakit series the effect of management system is conspicuous from the depth of occurrence of calcareous layer which was near to the surface in case of low management and at greater depths in case of high management.

In the eastern part of IGP six soil series have been identified namely Ekchari (Bihar), Madhpur, Gopalpur, Seoraguri, Singhbhita (West Bengal) and Nayanpur (Tripura). Two soil profiles (P1 and P2) were studied in Nayanpur soil series under intensive agriculture and agriculture with minimum inputs respectively have been studied. Similarly soils representing Saoraguri soil series (P3 and P4) Cooch Behar and Singivita (P5 and P6) in Darjeeling district of West Bengal under level of high management and low management respectively have been studied.

Nayanpur soils under high management practices are very deep, gray to light brownish gray in colour and mottle colour varies from dark brown to very yellowish brown. Soil pH varied from 5.51 to 6.07 with organic carbon contents 0.36 to 1.12%. Exchangeable acidity varied from 0.4 to 1.2 cmol(+) kg-1. Bulk density of soils varied from 1.27 to 1.52 Mg m⁻³. Nayanpur soils under low management are very deep, gray to grayish brown in colour and mottle colour varies from brown to strong brown. Soil pH varied from 5.1 to 6.1 with organic carbon contents from 0.5 to 0.6%. Exchangeable acidity varied from 0.2 to 0.9 cmol(+) kg-1. Bulk density of soils that varied from 1.30 to 1.52 Mg m⁻³ (Table 2.11c.1).

Table 2.11c.1 Physical and chemical properties of IGP soils from Tripura and northern West Bengal

Soils	Depth(cm)	pН	O.C (%)	B.D (g/cm ³)
Nay	vanpur Series (F	ligh ma	nagement) -	Tripura
P1/1	0-17	5.6	1.1	1.27
P1/2	17-48	6.1	0.3	1.37
P1/3	48-68	5.5	0.3	1.27
P1/4	68-87	5.9	0.4	1.34
P1/5	87-115	5.9	0.4	1.42
P1/6	115-150	6.0	0.4	1.52
Na	yanpur Series (I	Low mai	nagement) -	Tripura
P2/1	0-15	5.1	0.6	1.47
P2/2	15-38	5.5	0.5	1.52
P2/3	38-62	6.1	0.6	1.36
P2/4	62-90	6.1	0.8	1.34
P2/5	90-130	6.1	0.5	1.30
Seora	guri Series (Hig	h manag	gement) – V	Vest Bengal
P3/1	0-14	5.3	0.7	1.55
P3/2	14-34	6.1	0.4	1.39
P3/3	34-58	6.1	0.3	1.34
P3/4	58-84	6.1	0.1	1.05
P3/5	84-107	6.2	0.4	1.25
P3/6	107-150	6.1	0.4	1.45
Seora	guri Series (Lov	v manag	gement) – W	est Bengal
P4/1	0-12	5.3	0.7	1.15
P4/2	12-40	6.1	0.4	1.22
P4/3	40-73	5.9	0.2	1.17
P4/4	73-98	5.8	0.5	1.39
P4/5	98-120	6.1	0.1	1.22
P4/6	120-168	5.9	0.1	1.20
Singi	vita Series (Higi	h manag	gement) – W	est Bengal
P5/1	0-16	5.4	1.2	1.34
P5/2	16-42	5.7	0.8	1.22
P5/3	42-73	5.3	0.5	1.29
P5/4	73-99	5.5	0.4	1.24
P5/5	99-133	5.5	0.04	1.27
Singi	vita Series (Low	v manag	ement) – W	est Bengal
P6/1	0-23	5.2	1.5	1.17
P6/2	23-46	5.5	0.9	1.27
P6/3	46-80	5.6	0.5	1.20

Seoraguri soils under high management are very deep, dark grayish brown to light yellowish brown in colour and mottle colour varied from brown to strong brown. Soil pH varied from 5.3 to 6.1 with organic carbon content from 0.1 to 0.7%. Exchangeable acidity varied from 0.1 to 0.5 cmol(+) kg⁻¹. Bulk density of soils varies from 1.05 to 1.55 Mg m⁻³. Seoraguri soils under low management are very deep, very dark grayish brown to light brownish gray in colour and mottle colour varies from brown to strong brown. Soil pH varied from 5.3 to 6.1 with organic carbon content from 0.1 to 0.7%. Exchangeable acidity varied from 0.1 to 0.4 cmol(+) kg-1. Bulk density of these soils varied from 1.20 to 1.39 Mg m⁻³.

Singivita soils under high management are deep, grayish brown to brown in colour and mottle colour varied from brown to strong brown. Soil pH varied from 5.3 to 5.6 with organic carbon content from 0.04 to 1.2%. Exchangeable acidity varied from 0.7 to 1.2 cmol(+) kg⁻¹. Bulk density of soils varied from 1.2 to 1.4 Mg m⁻¹ ³. Singivita soils under low management are moderately deep, gray to pale brown in colour, mottle colour varies from yellowish red to brown. Soil pH varied from 5.2 to 5.6 with organic carbon content from 0.5 to 1.5%. Exchangeable acidity varied from 0.2 to 0.6 cmol(+) kg-1. Bulk density of these soils varied from 1.17 to 1.27 Mg m⁻³.

The representative soils from Madhpur, Ekchari and Gopalpur series for morphological, physical and chemical properties. These soils are developed on almost level to very gentle sloping lands of lower Indo-Gangetic plains and are deep to very deep and moderately to poorly drained. These soils are grayish brown to dark grayish brown, silt clay loam to clay in nature. The pH of the soils ranged from 7.4 to 8.1. The organic carbon content varies from 0.09 to 1.55 and The bulk density from 1.27 to 1.67 Mg m⁻³.

In the black soil region hotspots such as Nabibagh, Nimone, Vasmat and Sarol were analysed for the particle-size distribution which showed the dominance of clay in these soils. The soils of Nabibagh, Nimone, Vasmat, Paral, Kassireddipalli, Panjari, Gulguli and Singpura were analysed for bulk density by core method which ranges from 0.97 to 2.09 Mg m⁻³. Coefficient of Linear Extensibility (COLE), water dispersible clay (WDC) and clay carbonate have been done for the soils of Nabibagh, Nimone, Vasmat and Sarol. These soils are moderately alkaline to strongly alkaline in nature and the electrical conductivity low to be of any consequence.

The microbiological analysis was done at NABIM, Mau, U.P. for the Kolu and Thar soil series. The data indicated that the bacterial and fungi counts are more in low management than high management soils and increased with the depth. The actinomycetes population were more in high management than low management soils. The dehydrogenase activity was higher in low management soil than high management whereas no significant difference in the Urease activity in soils collected from two sites.

2.11d. Efficient Land Use Based Integrated Farming System for Rural Livelihood Security in Aurangabad, Dhule and **Gondia Districts of Maharashtra (NAIP Component-3 Sub-project)**

> Arun Chaturvedi, T.N. Hajare, T.K. Sen, S. Chatterji, S.N. Goswami, N.G. Patil, Jagdish Prasad, B.P. Bhaskar and G.P. Obireddy

The project has been undertaken with the following objectives.

During the reporting year the satellite data of IRS LISS-IV for the selected six clusters (two each in Aurangabad, Dhule and Gondia districts) was geo-referenced and the mosaic files for the clusters were generated. The satellite data has been interpreted using information on contours, land use and topobase to generate landform maps for the six clusters identified. The information generated for these clusters are as follows.

Khultabad clusters

Detailed soil survey of Kanakshil village (661.32 ha) and Kanadgaon village (381.95 ha), Khultabad cluster, Aurangabad district was undertaken on 1:10,000 scale. Ten soil series (tentative) and two miscellaneous land types were identified in Kanakshil village, seven soil series and one miscellaneous land type in Kanadgaon village.

Dhule clusters

The total area surveyed in Laghadwal village of Dhule cluster, Dhule district is about 900 ha on 1:10,000 scale. Seven soil series were tentatively identified in this village.

Gondia clusters

Detailed soil survey of different villages of Deori and Goregaon clusters, Gondia district, was undertaken on cadastral scale. The total area surveyed in these two clusters is 900ha and 20 soil series were identified (tentatively) in 6 villages of Gondia cluster.

Crop based Interventions

Aurangabad clusters

In Aurangabad clusters, three different farming systems were implemented viz., cotton-dairy-horticulture/vegetable, cotton-dairy-agro-processing and goat-poultry-forest produce value addition. Urea was applied in cotton (40 acres), maize (160 acres) and pearl millets (40 acres) by the farmers under the guidance of NAIP team. During *rabi* season, the beneficiaries were provided wheat, gram, onion, and okra seeds. Wheat, gram and okra were raised on 50, 64, 10, 8 and 11 hectares of land respectively.

Dhule clusters

In the *kharif* season, the beneficiary farmers were guided in cultivation of rice, soybean, maize and pearl millet. Recommended practices (by MPKV) were implemented and inputs were provided. Intensive monitoring of agro-managements resulted in an increased yield of 31 to 100% (Table 2.11d.1).

Due to adoption of System of rice intensification (SRI) method, the seed rate of paddy was reduced by more than 50 % resulting in substantial savings. The advantage of adopting improved technology has been emphatically reflected in the yield data (Table 2.11d.2).

During the *rabi* season, gram and wheat crops were grown by 87 beneficiaries under the guidance of NAIP team, whereas fodder crop, Stylo was also cultivated in the Common Property Resources (CPR) covering an area of 0.40 ha. Isabgol was introduced in

Dhule cluster during *rabi* season covering an area of 0.70 ha.

Gondia clusters

The farmers in the Gondia clusters were mobilized to utilize scarce water resources by adopting community paddy nursery preparation and thereby optimally use rainwater during the *rabi* season. This ensured timely transplanting of the crop and better growth. SRI method of paddy cultivation was introduced in the target areas along with improved varieties of seeds of paddy viz., Sindewahi1; HMT and PKV Khamang. Traditional method of ponding rainwater in paddy field was discouraged and moisture level in the fields was maintained at field capacity or saturation level. Conoweeder was introduced to overcome weed problem as a consequence of no-ponding practice adopted. Upto 30% increase in yield has been observed (Table 2.11d.2). Due to better water management, early harvest of *kharif* paddy left more residual soil moisture and hence rabi crop could be raised. There is a 30 % increase in area under *rabi* crop. Life saving irrigations were provided to the *rabi* crops (approx. 100 ha area) with the help of oil engines purchased under the project and being used by the cultivators as a common property resource (CPR) with responsibility of maintenance. To reduce water losses along 300 m length in conveyance, irrigation pipes were provided in Bagadband village. Drip irrigation method was introduced in the clusters and farmers are growing watermelon in the tank beds during summer season. The crops raised during rabi include gram, linseed, safflower, lathyrus, mungbean, lablab, etc.

Table 2.11d.1 Results of improved technology demonstrations in Dhule cluster during Kharif season

Crops	Improved technology demonstrated	No. of benefi- ciaries	Total area covered (ha)	Average grain Post intervention	yield (q ha Farmers' practice	increase over local
Rice (Irrigated)	Variety - Bhogavati, SRI method	20	7.80	30	20	50
Rice (Rainfed)	Variety- Karjat-3 with improved package of practices	08	2.60	21	16	31
Soybean	Variety- JS-335, INM, improved package of practices	20	11.00	18	9	100
Maize	Hybrid- 900 M Gold with improved package of practices	10	4.40	55	35	57
Pearlmillet	Variety-Tulaja-1579	08	4.00	22	14	57

Table 2.11d.2 Yield of paddy under SRI method of cultivation

Variety	Av. yield (Last 20 years) (q ha-1)	Variety	No of beneficiaries	Av. yield (2009-10) q ha ⁻¹
Local	16.20	Khamang	36	34.40
		Sindewahi-1	22	29.10
		HMT	36	25.30
				and the second s

In rabi season, due to inadequate irrigation facilities and uncontrolled grazing, the farmers in Gondia cluster used to keep their land fallow. The farmers were convinced to take up crops in rabi. Some social regulations were decided regarding the grazing of animals. In both the clusters, around 200 farmers were included covering an area of 80 hectare land for gram crop (cv Vijay and Chafa). The seeds of gram were sown immediately after the harvesting of paddy in order to utilize the residual soil moisture. This intervention has led to around 30 % increase in the area sown under second crop which was meager in the past years.

Livestock Interventions

Aurangabad clusters

Under the livestock interventions, 28 farm families were provided with chicks of Kalinga brown breed of poultry alongwith the poultry feed and equipments (Fig. 2.11d.1). This has resulted in income generation among landless farm families. Apart from this, 31 units of Osmanabadi goats were also provided to the beneficiaries (Fig. 2.11d.2).

Gondia clusters

Sixty farmers (beneficiaries) in Gondia cluster were provided with five to seven week old chicks of Giriraj and Vanraj breed. The beneficiaries were also supplied with chick feed and grower feed for the initial period. The birds have gained a weight of approximately 1-1.5 kgs in a span of two months.

In addition to the poultry interventions animal health check-up, deworming and vaccination camps were held in both the clusters of Gondia district in synergy with officials of the State Animal Husbandry Department.

Drudgery Reduction

Aurangabad clusters

With regards to the drudgery reduction interventions, Cotton picking aprons were provided to ladies (beneficiaries). Besides, 60 fertilizer broadcasters, 400 serrated sickles and 113 smokeless chullah were supplied to the beneficiaries.



Fig. 2.11d.1. Distribution of chicks of Kalinga brown breed of poultry among famers in Aurangabad clusters



Fig. 2.11d.2. Distribution of Osmanabadi goats among farmers in Aurangabad clusters

Dhule clusters

Improved implements like Cycle hoe, Vaibhav Sickles, Cotton stalk puller and maize seller were introduced in the target villages of Dhule cluster under the drudgery reduction programme to reduce human labour and increase the efficiency of work.

Gondia clusters

Use of low cost (less than Rs. 1500/-) smokeless balloon gas is now being actively promoted to replace local Chullah. The balloon gas will give relief to the ladies from their otherwise tedious schedule of cooking using the firewood and help in reducing the injurious smoke. The methodology of setting up the gobar (balloon) gas unit is very cheap, simple and requires no skills. The materials required are good quality plastic sheet, cow dung slurry, 2 plastic pipes for inlet and outlet pipes 3-4 feet long and having a diameter of 2.5 cm and a knob to regulate the flow of gas, a gas burner/stove and pipe to carry gas from the balloon to the gas stove. This gobar (balloon) gas will help in saving the forest fuel wood as well as in drudgery reduction. About 100 units (50 units in each cluster) of smokeless balloon gas have been introduced in both the clusters of Gondia district.

Soil and Water Resource Development

Aurangabad clusters

Keeping in view the need for availability of water during *rabi* season, construction of 50 farm ponds in Khultabad cluster have been sanctioned by State Dept. of Agriculture.

Capacity Building (Training and Workshops)

Aurangabad clusters

A training on value addition, market linkages and micro enterprises was conducted in both the clusters of Aurangabad district. The farmers were also given training regarding INM practices in cotton at cluster level.

Dhule clusters

Short term vocational training on honey bee rearing was organized at Central Bee Research and Training Institute, Pune to facilitate enhanced off farm income and employment generation for beneficiaries through supplementary enterprises through capacity building. A training on Value Addition and Post Harvest



Fig. 2.11d.3. Hands on training of lady farmers in Tomato processing

technology in Tomato, cotton, rice, maize, gram, wheat and medicinal plants was organized at cluster level.

Gondia clusters

As a part of integrated approach for sustainable livelihood, the community tanks in the target villages were leased. A group of farmers were provided with improved and disease-free fish seeds of Catla, Rohu and Mrigal. The farmers were trained at CIFE, Hoshangabad (M.P.) for seven days. Nearly 56-60 kg fish was harvested from community tank in Salegaon. There are two perennial tanks one in each cluster which are expected to yield minimum Rs. 300000/- additionally.

As a part of imparting soft skills for sustenance, selected farmers in all the six villagers were trained in pisciculture, value addition, micro enterprises, market linkages, sericulture etc. Number of crop specific trainings were also conducted. State departments, SAUs and other agencies were also involved in this work.

Backyard Kitchen Gardening

A package of kitchen gardening was introduced in clusters to make the cluster women acquainted with the latest and high yielding varieties of vegetables to meet their day to day needs from their own backyard. The package contained seeds of vegetables like bitter gourd, bottle gourd, lady's finger, pumpkin, maize, cluster beans and ridge gourd, etc. These women were given guidance related to growing of these vegetables in the backyard using household inputs and manure. These interventions led to a drastic change in the availability of vegetables in the villages. It also resulted in an increased intake of vegetables among the villagers which, in turn, has helped them in meeting their nutritional requirements from their own backyard at no additional cost.

2.11e. Development of soil reflectance methods and variable rate inputs in precision farming (NAIP-PAU)

Rajeev Srivastava and Dipak Sarkar

Spectral reflectance characteristics of 60 soil samples collected from Dehlon block of Ludhiana and 10 samples from salt affected soils of Karnal area were studied under laboratory condition between 350-2500 nm using ASD spectroradiometer. The spectral reflectance characteristics of soil samples collected from Dehlon block, Ludhiana and salt affected soils of Karnal are shown in figures 2.11e.1 and 2.11e.2.



Fig. 2.11e.1. Spectral reflectance characteristics of soils of Dehlon Block, Ludhiana

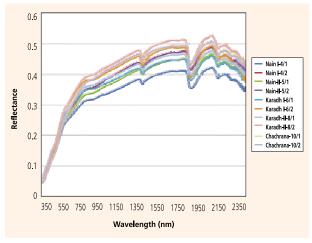


Fig. 2.11e.2. Spectral reflectance characteristics of soils of salt affected soils of Karnal

The spectral curves of all soils showed prominent absorption features at 1400, 1900 and 2200 nm. These features are mainly associated with free and lattice OH feature of the clay minerals. Relatively higher reflectance

in soils of Karnal appears to be due to high salt content. Further, salt affected soils of Karnal showed stronger absorption feature around 1900 nm as compared to the soils of Ludhiana which are non-saline.

The statistical correlation between soil reflectance and organic carbon content were studied with limited data. Prior to statistical analysis, the raw spectral reflectance data were resampled at every tenth-nanometer value from 350-2500 nm using integration technique. This was done to reduce the volume of data for analysis and to match it more closely to the spectral resolution of the instrument (3 to 10 nm). The reflectance values were then transformed with first derivative processing (Fig. 2.11e.3). Derivative transformation is known to minimize variation among samples caused in grinding and optical set-up. Wavebands in regions of low signal to noise ratio or displaying noise because of splicing between the individual spectrometers (Analytical Spectral Devices Inc.) were omitted leaving 198 wavebands for analysis. The omitted bands were 350 through 380 nm, 970 through 1010 nm and 2460 through 2500 nm.

The correlation between organic carbon and derivative soil reflectance at different wavelength in soils of Ludhiana is shown in figure 2.11e.3.

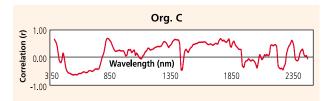


Fig. 2.11e.3. Correlation between organic carbon and 1st derivative soil reflectance at different wavelength in soils of Ludhiana

Attempts have also been made with limited datasets to calibrate individual soil variables against the 198-derivative reflectance wavebands through stepwise multiple linear regression (SMLR). The dataset was randomly divided into two sets wherein 30 samples each were used for calibration and the remaining 30 samples were used for validation of the model. Good calibration (Fig. 2.11e.4) were obtained for Org. C ($R^2 = 0.90^{**}$), soil pH ($R^2 = 0.91^{**}$), available P ($R^2 = 0.95^{**}$). The application of calibration model for given soil attribute also resulted in good validation r^2 (0.62^{**} to 0.78^{**}). This indicates that soil reflectance properties could be used as a potential tool to provide information on wide range of soil properties.

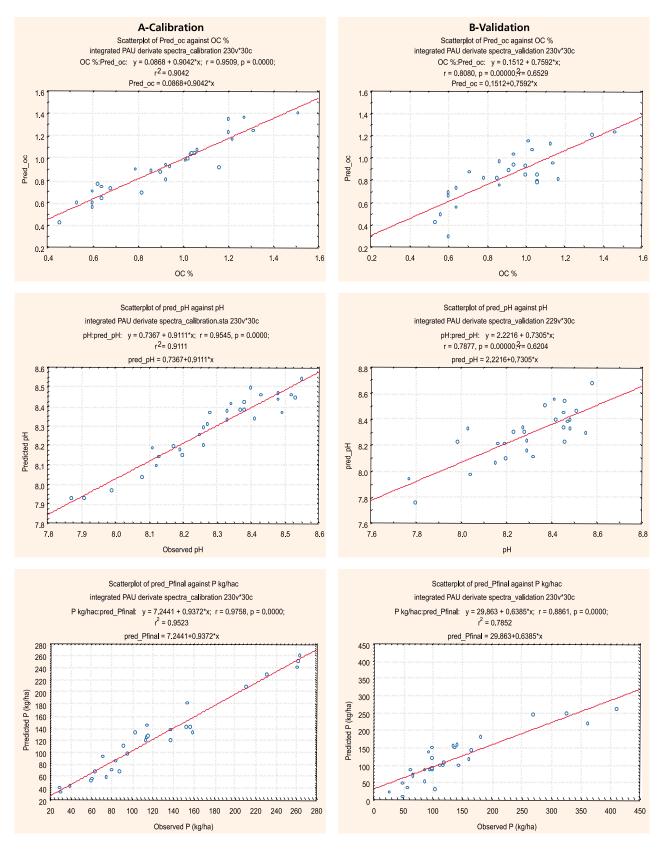


Fig. 2.11e.4. Scatter-plot comparison of measured and predicted values of different soil properties for calibration (A) and validation (B) datasets

2.11f. Assessment of Quality and Resilience of Soils in Diverse Agro-ecosystems (NAIP)

T. Bhattacharyya, D. Sarkar, P. Chandran, S.K. Ray, C. Mandal, D.K. Pal, and B. Telpande

To assess the quality and resilience of soil in diverse agro-ecosystems, four AESRs were selected. These are 15.1, 7.2, 10.1 and 4.1 respectively. These AESRs represent Bankura and Hooghly from West Bengal, Warangal and Nalgonda from Andhra Pradesh, Vidisha and Sehore from Madhya Pradesh and Roopnagar and Ludhiana from Punjab respectively.

Two benchmark soil series namely Kantaban and Bhulanpur represent Bankura districts and Baligori and Harit soils represent Hooghly district. All these four soil series were selected from AESR 15.1. Two districts in Andhra Pradesh (Warangal and Nalgonda) represent AESR7.2. Similarly two districts each were selected from AESR 10.1(Vidisha and Sehore) and 4.1 (Ludhiana and Roopnagar).

The characterization of these AESRs in terms of climate, soils and crops are shown in table 2.11f.1. The digitization of soil maps of Bankura, Warangal, Nalgonda and Sehore districts have been completed. An example of Bankura district is shown in figure 2.11f.1.

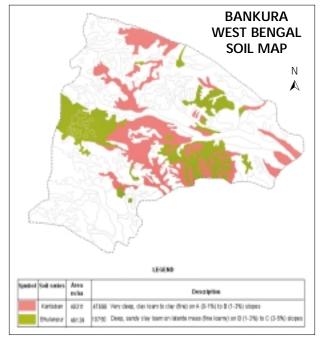


Fig. 2.11f.1. Soil map of Bankura district of West Bengal

Table 2.11f.1 Study area for Assessment of Quality and Resilience of Soils in Diverse Agro-ecosystems (National Agriculture Innovation Project)

State (districts)	Climate		Soils	Crops
	MAT (°C)	MAR (mm)		
AESR 15.1: Bengal basin and North I soils, medium to high AWC ² and LGF			umid ESR ¹ with deep loamy to clayey, a	alluvium derived
West Bengal (Bankura and Hooghly)	25-26	1300-1600	Typic Haplaquepts (Kantaban series) Ultic Haplustalfs (Bhulanpur series) Aeric Fluvaquents (Baligori series) Typic Endoaquepts (Harit series)	Paddy-Wheat
AESR 7.2: North Telangana Plateau, medium to very high AWC and LGP			rith deep loamy and clayey mixed Red	and Black Soils,
Andhra Pradesh (Warangal and Nalgonda	25-29	700-1000	Vertisols	Rice-Sorghum
AESR 10.1: Malwa Plateau, Vindhyar clayey Black Soils (shallow loamy Black			Valley, hot dry, sub humid ESR with m AWC and LGP 150-180 days	edium and deep
Madhya Pradesh (Sehore and Vidisha)	24-25	1000-1500	Vertisols and associated shallow shrink-swell soils	Wheat-Wheat
AESR 4.1: North Punjab Plain, Ganga- derived soils (occasional Saline and So			an Upland, hot semi-arid ESR with deep and LGP 90-120 days	loamy alluvium-
Punjab (Ludhiana and Roopnagar)	25	600-800	Inceptisols and Entisols	Maize-Wheat

¹ESR: Eco sub region; ²AWC: Available water capacity; ³LGP: Length of growing period; MAT – mean annual temperature; MAR - mean annual rainfall; AESR - agro-ecological subregions.

2.11g. Changes in Soil Carbon Reserve as Influenced by Different Ecosystem and Land Use in India (ICAR Network Project)

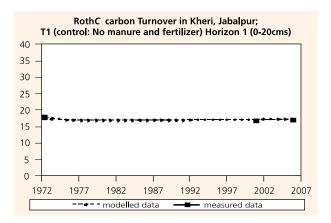
T. Bhattacharyya, D.K. Pal, P. Chandran, S.K. Ray, C. Mandal, D. Sarkar, M.V. Venugopalan, A. M. Nimje and D. Das Gupta

Models are mathematical equations and represent reactions which occur between the soils, plants and its environment. Owing to the complexity of the system it becomes impossible to completely represent the system in terms of a single model. The complicacy is further enhanced by the prevailing trends in global warming which is expected to have certain impact on crop yield and rate of change in soil organic carbon. To evaluate the performance of models in Indian scenario, Roth *C* and InfoCrop models were used.

Roth *C* model used on Long Term Fertilizer Experiment (LTFE) site at Kheri (M.P.) turnover of SOC in top soils that allows capturing the effects of soil type, temperature, moisture content and plant cover on the turnover process and is The results showed that there was an increase in total organic carbon (TOC) content with the addition of FYM along with recommended dose of fertilizer as compared to control (Fig. 2.11g.1).

Soils are layered structure (horizons), where process such as respiration produces CO₂ at various depths while diffusion and convention transport CO₂ between the soil layers and out of soil. Soil management practices can either emit CO₂ or sequester carbon. Roth C model has been adopted to study the effect of global warming (increase in mean annual temperature of 0.25°C per decade over 100 years from 1990 to 2090) on the TOC content of soils. The results of Roth C model showed TOC, held within top 100 cm, decreased by 7.85 % in single layer when compared to a fall of 7.39 % as the same soil was modelled assuming it as an entity of five different layers (Fig. 2.11g.2). Treating soil as a homogenous unit thus greatly overestimate effects of global warming in accelerating decomposition of soil C and hence release of CO₂ from soil organic matter. Thus combination of different layers will project actual effects of global warming in accelerating decomposition of soil carbon and the resultant release of CO₂ from soil organic matter.

Info Crop is a generic crop model designed to replicate the effects of weather, soil and agronomic management on crop yields. InfoCrop model first considers the influence of weather, followed by effects soil factors. Hence for execution of the model weather files for Kovilpatti, Raipur, Bangalore, Bhopal, Coimbatore, Hyderabad and Jabalpur and soil files for Nabibagh, Kheri, CICR Nagpur, Vijayapura and Palathurai were prepared. The model was executed to simulate the yields for soybean-wheat (Nabibagh), rice-wheat (Kheri), cotton (CICR Nagpur) for commonly cultivated variety for scenarios of no climate change and climate change. The result obtained by using the model for simulating rice production in Kheri is given in table 2.11g.1.



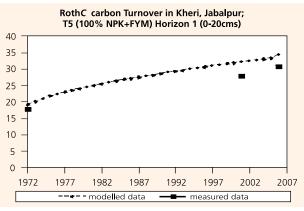


Fig. 2.11g.1. Representing the effect of carbon turnover in control (No fertilizer and manures) and 100%

NPK+FYM treatment

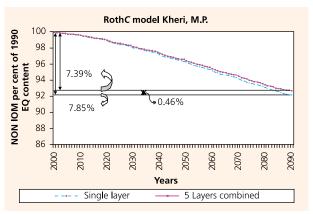


Fig. 2.11g.2. Modelled total organic carbon stocks at Kheri site subjected to an increase of 2.5°C during 1990 to 2090

Table 2.11g.1 Yield under potential and water stress condition under situations of no climate change
and climate change in Kheri, Madhya Pradesh.

	No Cli	mate Change		Climate Change ¹ (Temperature change)			imate Change ² (CO ₂ change)		
Year	Potential Yield kg/ha	Water Limited Yield kg/ha	Yield Gap %	Potential Yield kg/ha	Water Limited Yield kg/ha	Yield Gap %	Potential Yield kg/ha	Water Limited Yield kg/ha	Yield Gap %
1991	2404.0	426.35	82.3	2183.3	449.42	79.4	2865.1	437.3	84.7
1992	3213.8	1065.3	66.9	3124.3	1118.3	64.2	3760.1	1021	72.8
1993	2684.9	2547.4	5.1	2591.7	2350.1	9.3	296.9	2992.2	0.2
1994	1682.6	756.75	55.0	1649.9	788.63	52.2	2003.4	774.82	61.3
1995	3101.5	1407.5	54.6	2922.2	1467.2	49.8	3643.4	1356.3	62.8
1996	2366.6	2066.6	14.5	2199.6	1969	10.5	2734.7	2465.5	9.8
1997	4398.5	3574.6	18.7	3997.6	3602.3	9.9	4977.9	3512.9	29.4
1998	3921.9	3847.9	1.9	3903.3	3773.9	3.3	4391.9	38714	11.9
1999	2172.1	2142	1.4	2132.3	2065.4	3.1	2563.4	2508.2	2.2
2000	4384.3	765.7	82.0	4296.1	824.5	80.0	4973.3	810.7	83
Average	Yield Gap %		33			32			39

¹ minimum temperature decadal change by 0.25°C

The result can be used to estimate yield gap by subtracting the values of water limited yield from potential yield. The deduced yield gap shows that the average decadal yield gap (1991-2000) under scenario of no climate change is 33%. Under scenario of increase in minimum temperature by 0.25°C the yield gap is 32%. But when the scenario shifts to increase in concentration of atmospheric CO, from 370 to 410 ppm, the yield gap rises to 39%. Since most of the global climate change over the past 50 years is very likely to have been caused by increased emissions of carbon dioxide, continuation of such climate change is likely to intensify the demand for irrigation to diminish the yield gap.

2.11h. Assessment and mapping of some important parameters including macro and micronutrients for the state of West Bengal (1:50,000 scale) towards optimum land use plan (State **Sponsored Project)**

Dipak Sarkar, S.K. Singh, D.C. Nayak, A.K. Sahoo, S.K. Gangopadhyah, K.Das, K.D.Sah. Dipak Dutta, T. Chattopadhyay, S. Mukhopadhyay and T. Banerjee

Eleven thousand four hundred fifty soil samples were collected at one kilometer grid interval. Sampling scheme was designed in such a fashion that it covers the variability in nutrient status induced on account of landforms (swamp, marshes, shifting dunes and alluvial plains), prevailing crops and cropping sequences (Ricerice, Rice-mustard) in the coastal West Bengal (East Medinipur and South 24-Parganas). Macro and micronutrient analysis of soils of Haora, North 24-Parganas, Nadia, Puruliya, Bankura, Maldah, Uttar Dinajpur, Koch Bihar, Jalpaiguri, Dakshin Dinajpur and South 24-Parganas districts were completed.

Databases comprising various physical, chemical and fertility properties were prepared for Haora, Nadia, Barddhaman, Birbhum, North 24-Parganas and Hugli districts. Land use and management history for the sampling sites have also been included in the database.

Soil nutrient status maps for the districts Haora, Nadia, Barddhaman, Birbhum, North 24-Parganas and Hugli were released by the Honorable Chief minister of West Bengal, Shri Buddhadev Bhattacharya on 9th December, 2009. Some of the salient findings are described below.

(i) Multiple nutrient deficiencies in Birbhum district

Deficiency of phosphorus, potassium and zinc occurs either individually or in combination (of

² increased CO₂ concentration from 370 ppm to 410 ppm

two or three). Common critical areas of low availability of these nutrients were delineated by the intersection of the respective theme maps in GIS. The results (Fig.2.11h.1) indicated that low availability of phosphorus, potassium and zinc together occurred in 37.4% area of the district, whereas low availability of the two nutrients, phosphorus and potassium; phosphorus and zinc; and zinc and potassium in a group was observed in 15.9, 14.4 and 11.7% area of the district. Area, exclusively deficient in phosphorus, potassium and zinc occupied 5.5, 3.7 and 6.3% area, respectively. It is concluded that about 97.4% area of the district suffer either from single or multiple nutrient deficiencies.

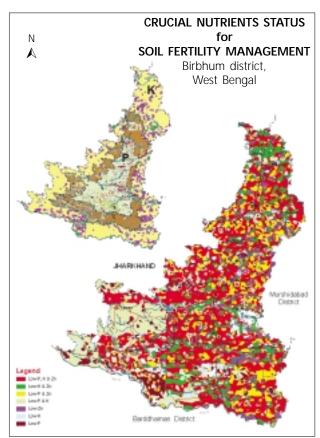


Fig.2.11h.1. Single and multiple deficiencies of nutrients in Birbhum district

(ii) Extensive problems of soil acidity

Low soil pH is one of the dominant problems in the eastern region. About 52.3 to 81.8% area in the reported six districts was affected with slight to strong acidity. The problem of acidity is most severe and critical in Barddhaman district where the soils affected with strong acidity were the highest (8.4%). Such soils were the lowest (0.07%) in Nadia district. The extent of moderate acidity was the highest (48.4%) in Birbhum district and the lowest (2.2%) in Nadia district. The area affected with slight acidity was maximum (40.5%) in Hugli and minimum (8.7%) in Nadia district (Table 2.11h.1).

(iii) Widespread outcropping of sulfidic material

The isolated spots of high concentration (Fig. 2.11h.1) of sulphur indicated the localized deposition of sulfidic material. Perhaps these are linked with past climate before rise of Ganga delta sometimes during twelfth to sixteenth century. Subsequently as a result of intensive agriculture, these seems to have been exposed to air. The problems of sulphur outcropping were extensive in Haora and North 24-Parganas.

Table 2.11h.1 Extent and severity of acidity (area '000 hectares)

Districts	Extent and severity of acidity					
	Strong (pH <4.5)	Moderate (pH 4.5-5.5)	Slight (pH 5.5-6.5)			
Barddhaman	58.8 (8.4)	266.1 (37.9)	149.3 (35.5)			
Hugli	7.8 (2.5)	90.3 (28.7)	127.4(40.5)			
Nadia	2.8 (0.7)	8.6 (2.2)	34.2 (8.7)			
North 24-Parganas	24.8 (6.1)	24.7 (6.01)	76.8 (18.8)			
Birbhum	9.8 (2.2)	220.2 (48.4)	164.9 (36.3)			
Haora	2.7 (1.8)	15.6 (10.8)	58.2 (39.7)			

() Per cent area of the district

(iv) Extensive potassium mining

About 55 to 92.9% area in the reported districts (Table 2.11h.2) is under potassium stress. Probably, nitrogen based agriculture in prevailing rice-rice or rice-vegetable or rice-potato cropping sequence may be one of the reasons for such extensive withdrawal of potassium. The area affected with low to medium available potassium was the highest 92.9 in Birbhum, and the lowest 55% in North 24-Pargana. The extent of potassium depletion ranged from 80 to 85% area in Barddhaman and Hugli districts, whereas its stress was marked in 66 to 75% area in Nadia and Haora districts.

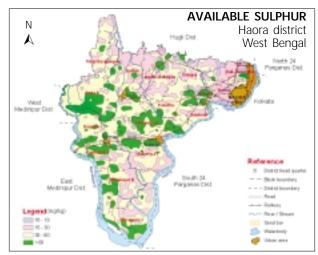


Fig.2.11h.2. Extensive outcropping of sulphidic material in Haora district

Table 2.11h.2 Area distribution under low and medium availability of potassium ('000 ha)

Districts	Level of potassium K ₂ O (kg ha ⁻¹)						
	Low (<200)(1)	Medium (200-350)(2)	Total (1+2)				
Barddhaman	402.8 (57.4)	194.7 (27.7)	597.5 (85.1)				
Hugli	111.9 (35.6)	141.0 (44.6)	252.9 (80.2)				
Nadia	89.4 (22.8)	202.8 (51.6)	292.2 (74.4)				
North 24 Parganas	142.7 (34.9)	82.2 (20.1)	224.9 (55.0)				
Birbhum	312.2 (68.7)	110.2 (24.2)	422.4 (92.9)				
Haora	12.8 (8.7)	85.4 (58.2)	98.2 (66.9)				

() Per cent area of the district

(v) Prevalent phosphorus mining

Phosphorus depletion is again one of the miseries of present nitrogenous fertilizer based agriculture. Birbhum district (88.3% area) was the worst affected, whereas Nadia (54.3% area) and Hugli (48.4% area) were the least affected districts. Extent of phosphorus depletion was 75.7, 74.5 and 77.5% in Barddhaman, North 24-Parganas and Haora districts, respectively (Table 2.11h.3).

Table 2.11h.3 Area distribution under low and medium availability of phosphorus ('000 ha)

Districts	Level of phosphorus P ₂ O ₅ (kg ha ⁻¹)					
	Low	Medium	Total			
	(<45)(1)	(45-90)(2)	(1+2)			
Barddhaman	351.1 (50)	180.2 (25.7)	531.2 (75.7)			
Hugli	87.6 (27.8)	64.7 (20.6)	152.3 (48.4)			
Nadia	101.5 (25.8)	112.8 (28.7)	214.3 (54.5)			
North 24-Parganas	211.6 (51.7)	93.5 (22.8)	305.1 (74.5)			
Birbhum	332.5 (73.7)	68.8 (15.1)	401.3 (88.3)			
Haora	879.4 (60)	25.7 (17.5)	905.1 (77.5)			

) Per cent area of the district

(vi) Rampant depletion of zinc

Like phosphorus and potassium, low availability of zinc could also be explained on account of fertilizer consumption scenario of the districts as well as the state as a whole. Among the reported districts, Birbhum (83.3% area) was the most affected with low availability of zinc. Barddhaman district has the least zinc deficient area (59.7%). Zinc depleted area in the remaining districts ranged from 61 to 81% (Table 2.11h.4).

Table 2.11h.4 Area distribution under low and medium availability of zinc ('000 ha)

Districts	Level of zinc (mg kg ⁻¹)					
	Low (<0.6)(1)	Medium (0.6-1.0)(2)	Total (1+2)			
Barddhaman	229.9 (32.7)	189.6 (27)	419.5 (59.7)			
Hugli	114.8 (36.5)	87.6 (27.8)	202.4 (64.3)			
Nadia	101.0 (25.7)	153.5 (39.1)	254.4 (64.8)			
North 24- Parganas	273.9 (66.9)	55.2 (13.5)	329.1 (80.4)			
Birbhum	316.8 (69.7)	62.6 (13.6)	379.4 (83.3)			
Haora	23.6 (16.1)	66.1 (45.1)	89.7 (61.2)			

() Per cent area of the district

(vii) Excessive availability of iron

Presumably, submergence for fairly long time in the year may be the cause of exceptionally higher availability of iron in the reported districts. Iron rich area was the highest (92.8%) in Bardhdhaman and the lowest (62.3%) in North 24-Parganas districts. The area having relatively high range of iron availability in other districts ranged from 87 to 91% (Table 2.11h.5).

Table 2.11h.5 Area distribution under high and very high availability of iron ('000 ha)

Districts	Level of iron (mg kg¹)					
	High (10-100)(1)	Very high (>100)(2)	Total 1+2)			
Barddhaman	458.8 (65.3)	193.2 (27.5)	652.0 (92.8)			
Hugli	108.2 (34.4)	177.5 (56.4)	285.7 (90.87)			
Nadia	297.5 (75.7)	41.5 (10.6)	339.0 (86.3)			
North 24-Parganas	249.3 (60.9)	60.6 (1.4)	309.9 (62.3)			
Birbhum	358.4 (78.8)	41.2 (9.1)	399.6 (87.9)			
Haora	768.3 (52.4)	519.3 (35.4)	1287.6 (87.8)			

() Per cent area of the district

(viii) Low potentiality of organic carbon (SOC) sequestration

Organic carbon in soils maintains equilibrium and oscillates between minima and maxima in a set of conditions governed by soils, climate and modified to some extent by land use and management. SOC sequestration takes place with good management practices on shifting of equilibrium from minima to maxima and vice versa. Based on the above notion, it is concluded that soils (79.9%) of North 24-Parganas have the maximum potentiality for carbon sequestration with support of good management practices, whereas the scope of carbon trading is very limited with soils of Haora district (Table 2.11h.6). It is further concluded that about 20.1 to 45.6% areas in the remaining districts have potentiality for carbon sequestration provided good management practices are adopted.

Table 2.11h.6 Area distribution under low to medium organic carbon content ('000 ha)

Districts	Organic carbon (%)					
	Low (<0.50)(1)	Medium (0.50-0.75)(2)	Total (1+2)			
Barddhaman	93.4 (13.3)	150.2 (21.4)	243.6 (33.7)			
Hugli	20.1 (6.4)	41.5 (13.7)	61.6 (20.1)			
Nadia	53.5 (13.6)	66.5 (22.0)	120.0 (35.6)			
North 24-Parganas	207.9 (50.8)	118.4 (28.9)	326.3 (79.7)			
Birbhum	52.3 (11.5)	154.6 (34.0)	206.9 (45.5)			
Haora	3.7 (2.5)	6.7 (4.6)	10.4 (7.1)			

() Per cent area of the district

2.11i. Assessment and mapping of some important soil parameters including macro and micro nutrients for 13 priority districts of Assam state towards optimum land use planning (State Sponsored Project)

Utpal Baruah, Dipak Sarkar, T.H. Das, S.K. Reza, S. Bandyopadhyay, T. Chattopadhyaya, and Dipak Dutta

The main objective of the project is to prepare districtwise maps of pH, organic carbon, available N, P, K and micro-nutrients (Cu, Zn, Mn and Fe) on 1:50,000 scale for agricultural development towards land use planning. The base maps (1 km interval grid point) on Police Station map showing village boundary Published by Assam Survey, Govt. of Assam, incorporated by Survey of India toposheets of 1:50,000 scale were

prepared for the districts of Tinsukia, Nalbari, Darrang, Sonitpur, Udalguri, Lakhimpur, Dhemaji, Morigaon and Nagaon for the field work and sample collection. A total of 10,708 soil samples (0-25 cm) have been collected covering an area of 25,890 Km² during the year. Boundary of 3 newly created districts viz. Chirang, Baksha and Udalguri have been verified at Land Records, Govt. of Assam Office. Soil sample analysis for Goalpara district for pH, organic carbon, available N,P and K have completed and mapped for its spatial variability using Arc GIS 9.3.1 version.

The Goalpara district of Assam lies between 25°53"-26°30"N, 90°-91°05"E. The base map of the district has been prepared using 1:50,000 scale toposheets (78J/8, 78/T12, 78J/16, 78K/13, 78K/9, 78K/5 and 78O/1) and Police Station (P.S) maps showing village/block boundary, river, road and place names. The climate is humid subtropical. The maximum temperature is 33°C during July and August; a minimum temperature falls up to 7°C in the month of January. Annual rainfall is 2169 mm and about 80% of rainfall is from South West monsoon.

According to soil survey report, there are eight broad soil subgroups in the district namely Aeric Fluvaquents, Aeric Haplaquepts, Aeric Haplaquents, Typic Udifluvents, Typic Kandihumults, Typic Haplumbrepts, Dystric Eutrochrepts and Typic Paleudults. Nearly fourteen hundred surface soil samples were collected from a depth of 0-25 cm using a square (1km×1km) grid covering a total area of 1953 km². Samples were then kept in labeled plastic bags and brought back to the laboratory for further analyses. The soil samples were air-dried and sieved to pass 2 mm sieve. Soil samples were analyzed for pH, organic carbon, available P, available K and available N.

The spatial variability map for soil reaction in the study area is shown in fig. 2.11i.1. Soil pH values of Goalpara district have been grouped into eight classes viz., extremely acidic (< 4.5), very strongly acidic (4.5-5.0), strongly acidic (5.0-5.5), moderately acidic (5.5-6.0), slightly acidic (6.0-6.5), neutral (6.5-7.0), slightly alkaline (7.0-7.5) and moderately alkaline (7.5-8.0). Soil pH of the Goalpara district ranged from 4.0 to 7.8. About 86.4% area of the district was classified as acidic, 9.4% area was neutral and 4.2% area was in the alkaline range. The organic carbon distribution map (Fig. 2.11i.2) of the district shows that maximum area (51.1%) was medium in organic carbon content followed by high (32.7%) and low (16.2%) of the district.

The spatial variability maps of available N (Fig. 2.11i.3), available P (Fig. 2.11i.4) and available K (Fig. 2.11i.5) show that the available N of the soils of Goalpara district are classified as low (7.7%), medium (67.9%) and high (24.4%) area. Similarly the available P content classified as very low (90.6%), low (8.9%) and medium to high (0.5%) area of the district. The spatial content of the available K showed that about 57.5% area of the district is low in available K and 42.5% area is medium in available K.

The correlation matrix (Table 2.11i.1) between different soil parameters revealed a highly significant positive correlation between pH and available P (0.201^{**}) , pH and available K (0.194^{**}) and organic carbon and available K (0.120^{**}) . Organic carbon was found to be significantly and negatively correlated with pH (-0.434^{**}) and available P (0.204^{**}) .

Table 2.11i.1. Correlation matrix between different soil parameters

Soil parameters	рН	Organic carbon	Avail- able N	Avail- able P	Avail- able K
pН	1.000				
Organic carbon	-0.434**	1.000			
Available N	0.037	-0.010	1.000		
Available P	0.201**	-0.204**	-0.032	1.000	
Available K	0.194**	0.120**	0.009	0.037	1.000

^{**}Correlation is significant at the P=0.01 level

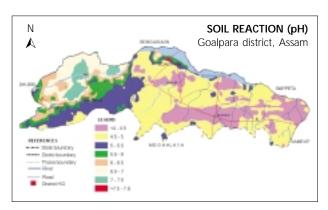


Fig. 2.11i.1 Spatial distribution map of pH

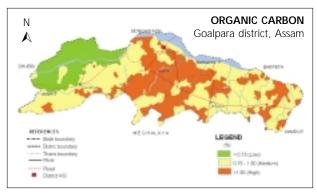


Fig. 2.11i.2 Spatial distribution map of organic carbon

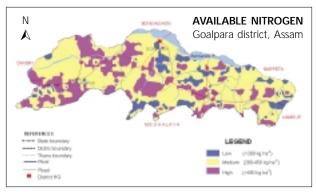


Fig. 2.11i.3 Spatial distribution map of available N

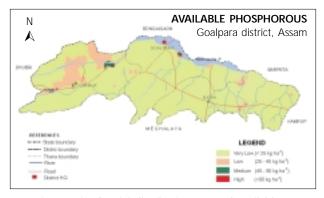


Fig. 2.11i.4 Spatial distribution map of available P

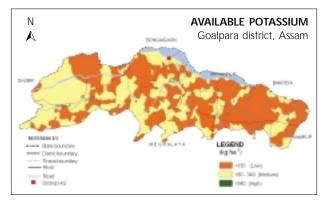


Fig. 2.11i.5 Spatial distribution map of available K

COLLABORATIVE PROJECT/ EXTERNALLY FUNDED

2.11j. A Value chain for coconut fiber and its byproducts: Manufacture of diversified products of higher value and better marketability to enhance the economic returns to farmers (Sponsored by T.N. Natural Research & Development Centre)

K. M. Nair, S. Thayalan, K.S. Anil Kumar, L.G.K. Naidu and Dipak Sarkar

T.M. Natural Resource Research and Development Centre (NGO), a consortium partner of the project has sponsored detailed study of soils of three panchayats of Thiruvananthapuram district to NBSS&LUP, Regional centre, Bangalore. Thirupuram, Kanjiramkulam and Kadinamkulam panchayats covering nearly 4000 ha form the study area. To document the soil variability in the three panchayats, a detailed soil survey was undertaken and samples were drawn for assessment of soil qualities including macro and micro nutrient availability. Detailed soil survey has resulted in identification of 5 soil series and mapping of soils with phases of soil series as map units. The landscape is undulating with broad uplands and narrow valleys. Major crop of upland is coconut inter cropped with a variety of annual crops like plantain, tapioca etc. The upland soils are very deep, well drained, dark red, clay loam in texture. The strongly acidic, poor base, non-gravelly laterite soils are specific to southern parts of Thiruvanathapuram district and extends to Kanniyakumari district of Tamil Nadu. These soils are distinct from lateritic soils of other parts of Kerala state by absence of laterite gravel in the solum. The climate of the area is moist sub humid with mean annual precipitation of 1884 mm. However soil moisture deficit is experienced only for around three months by virtue of well distributed rainfall. The soil series identified and mapped as Neyyattinkara series is best accorded the status of Benchmark series because of the uniqueness of the soil, extensive coverage in a specific geographical area and experiencing unique climate.

2.11k. Soils variability mapping and fertility zonation using Hyperspectral data (A collaborative project between NBSS&LUP and SAC, Ahmedabad)

A.K. Maji, Rajeev Srivastava, M.S.S. Nagaraju, D.S. Singh, A.K. Barthwal and R.L. Mehta (SAC, Ahmedabad)

The project was undertaken in collaboration with SAC Ahmedabad to study the applicability of hyperspectral data (hyperion sensor data) in mapping soils variability and delineating soil fertility zones. For the present investigation, a study area was selected in Buldhana district, Maharashtra from latitude 19° 45' to 20° 15' N and longitude from 76° 26' to 76° 37' E.

Image processing of Hyperion data

The Hyperion VNIR sensor has 70 bands, and the SWIR has 172 bands providing 242 potential bands. A number of the bands were intentionally not illuminated and others (mainly in the overlap region between the two spectrometers) correspond to areas of low sensitivity of the spectrometer materials. The non-illuminated bands (1 to 7, 58 to 76, and 225 to 242) were removed leaving 198 bands. Among the 198, there are four remaining bands in the overlap between the two spectrometers. These are VNIR bands 56 (915.7 nm) and 57 (925.9 nm) and SWIR bands 77 (912.5 nm) and 78 (922.6 nm). On eliminating two of these, 196 unique bands are obtained. In the present study, the unique 196 bands selected were bands 8 to 57 and 79 to 224.

From these 196 bands, atmospheric water vapor bands (between 1356 and 1417 nm, 1820 and 1932 nm) that absorb almost all of the incident and reflected solar radiation (Band 121-127 and 167-178) and the bands showing significant striping (bands 8, 9, 10, 57, 79, 80, 81, 98-100, 119, 133, 134, 164, 183, 184, 218-221) were removed. Thus, remaining 139 bands (Table 2.11k.1) were used for further processing.

Table 2.11k.1 Hyperion bands used for atmospheric correction

Region	Band number	Wavelength (nm)
VNIR	11 to 56	457.3 to 915.2
SWIR	82 to 97	962.9 to 1114.2
	101 to 118	1154.6 to 1326.1
	135 to 163	1497.6 to 1780.1
	188 to 217	2032.3 to 2324.9

Abnormal pixels correction: Hyperion L1R image contains dark vertical stripes in the image. One possible reason for the abnormal pixels could be that the calibration of the detectors in the detector array becomes unbalanced. The Hyperion system acquires data in pushbroom mode, in which there is a separate detector to gather data for each column. If the detectors are not calibrated properly striping artifacts could easily be generated. These vertical stripes in the data were removed through vertical stripe removal programme in the ENVI. The visual effect of the same is depicted in figure 2.11k.1.

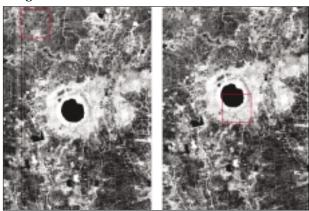


Fig. 2.11k.1. Original Hyperion image (left) shows prominent vertical stripes in Band 56 destriped image (right) has no vertical stripes

The effects of destriping on Hyperion were tested using the Minimum Noise Fraction (MNF) transformation. The MNF technique responds to interactions between the spatial structure of the data and that of the noise when the noise has strong spatial structure. It is observed that first MNF of 139 band Hyperion data (without destriping) showed strong brightness gradient that corresponds to the spectral "smile" in the VNIR array. However, in the destriped image no such gradient was observed (Fig. 2.11k.2).

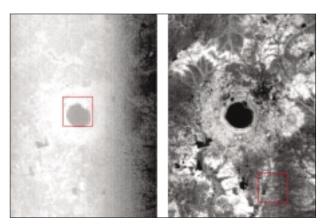
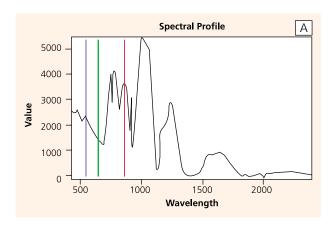


Fig. 2.11k.2. MNF Band 1 of the Hyperion 139 bands without destriping (left) and after destriping (right)

Atmospheric correction: Atmospheric correction of hyperspectral data is required for conversion of radiance data into reflectance unit. Reflectance information is more favorably compared than radiance information. This is because reflectance information from a feature would relatively similar anywhere in the world, while radiance information is affected by various factors in the atmosphere. Reflectance information also enables the identification of features in the image by comparing its reflectance signature to reference reflectance signature stored in spectral library. Additionally, the atmospheric correction reduces the effects of the atmosphere, solar illumination, sensor viewing geometry, and terrain that might alter the information being sensed by the sensors. Therefore, accurate surface reflectance could be extracted from the imagery.

In the present investigation, FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes) was used for the conversion of radiance image into spectral reflectance image. The radiance and spectral reflectance profile of vegetation in the study area is shown in figure 2.11k.3.



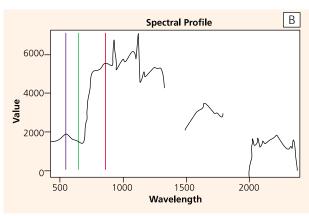


Fig. 2.11k.3. The radiance (A) and spectral reflectance (B) profile of vegetation

Geo-rectification: Since Hyperion images comes as radiometric corrected only, georectification procedure were required to assign coordinate into it. Georectification of hyperion data was using SOI (Survey of India) toposheet available on 1: 50,000 scale.

Physiographic interpretation

Physiography map of the study area was prepared through visual interpretation of processed and geo-rectified Hyperion data FCC in conjunction with SOI (Survey of India) toposheets (1:50,000). Since the Hyperion data of June 2007 was cloudy at many places, IRS-1C FCC of May 2008 was also used to delineate the physiographic units in the cloudy and shadowed area.

The area has been grouped into six dominant landform/physiography viz. plateau, mound, escarpments, pediment narrow valley and broad valley. These physiographic units have been further sub-divided based on slope, landuse and image characteristics. The physiogaphy interpretation legend is given in table 2.11k.2 and the map of the area is shown in figure 2.11k.4.

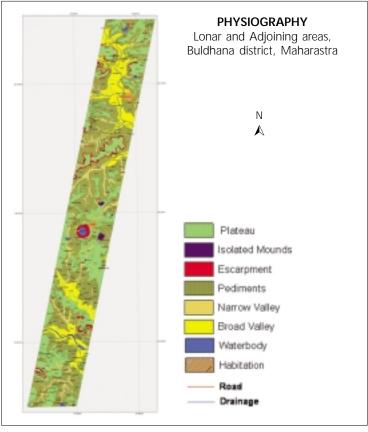


Fig. 2.11k.4. Physiography map of Lonar and adjoining area

Table 2.11k.2 Physiography, Lonar and Adjoining areas, Buldhana dist., Maharashtra

Physiography (Symbol)	SlopeClass (Symbol)	Landuse (Symbol)	Image Characteristics (Symbol)
Plateau (P)	Very Gently Sloping (1)	Cropland (c)	Dark gray+ bold checker board pattern (1)
Mounds (M)	Gently Sloping (2)	Mod. dense forest (F)	Dark red+ grayish pink + irregular shape (2)
Escarpments (E)	Moderately Sloping (3)	Degraded forest (f)	Greenish-gray + diffused checker board pattern (3)
Pediments (D)	V. Steeply Sloping (4)	Scrubland (s)	Greenish-yellow + diffused checker board pattern (4)
Narrow Valley (N)			Greenish-yellow + irregular shape (5)
Broad Valley (B)			Medium gray+ bold checker board pattern (6)
			Medium gray + pink patches + bold checker board pattern (7)
			Pinkish-gray + diffused checker board pattern (8)
			Pinkish-gray + irregular shape (9)
			Pinkish-white + irregular shape (10)
			Pinkish-yellow + irregular shape (11)
			Red + gray+ bold checker board pattern 12)

Physiography - soil relationship

The relationship between physiography and soil has been widely recognized and has great significance on soil variability mapping. Field work was carried out to collect soil data using physiographic unit map as base map in conjunction with SOI toposheets. After systematic study of soils in different physiographic units, physiography-soil relationship was developed (Table 2.11k.3).

The data obtained indicates changes in important soil properties viz. depth, physical and chemical properties, profile development, etc. with the variation in physiographic unit. Fourteen soil series were tentatively identified in the area and mapped as association of soil series. The soil map of the area has been presented in figure 2.11k.5. The salient physical and chemical characteristics of the soils are given in Tables 2.11k.4 and 2.11k.5 respectively.

The soils vary from very shallow to very deep, moderately well drained to excessively drained, and have clay-loam to clay soil texture. The soil colour varies between hue of 7.5YR and 10YR. The Smectite is the dominant clay mineral in these soils. According to Soil Taxonomy, the soils belong to subgroups of Lithic Ustorthents/Haplustepts (shallow soils), Typic/Vertic Haplustepts (Medium deep soils) and Typic Haplusterts (deep to very deep black cotton soils).

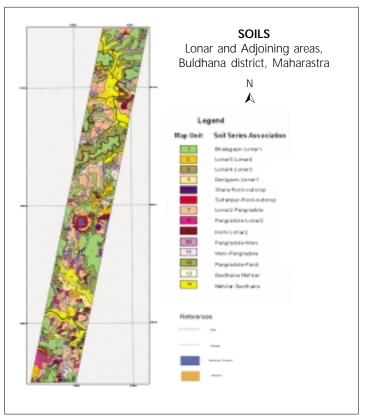


Fig. 2.11k.5. Soil map of Lonar and adjoining area of Buldhana district, Maharashtra

Table 2.11k.3 Physiography-soil relationship

Physiography Symbol	Soil Series Association	Map Soil Symbol	Soil Taxonomy
P1c1,P1c6,P1c7, P1c12	Bhalegaon-Lonar1	1	Fine, Vertic Haplustepts - Clayey, Typic Haplustepts
P1c3,P1c4	Lonar3-Lonar4	2	Loamy, Typic Ustorthents - Clayey-skeletal, Lithic Ustorthents
P1c8	Lonar4-Lonar3	3	Clayey-skeletal, Lithic Ustorthents - Loamy, Typic Ustorthents
P1s5,P1s9,P1s10	Deolgaon-Lonar1	4	Clayey, Lithic Haplustepts - Clayey, Typic Haplustepts
M3c3,M3s10	Shara-Rock-outcrop	5	Clayey-skeletal, Lithic Ustorthents - Rock-outcrop
E3s9,E3s10,E4F2	Sultanpur-Rock-outcrop	6	Clayey-skeletal, Lithic Ustorthents - Rock-outcrop
D1c1,D1c6,D1c7, D1c11,D1c12	Lonar2-Pangradole	7	Clayey, Typic Haplustepts - Clayey-skeletal, Typic Ustorthents
D1c3,D1c8	Pangradole-Lonar2	8	Clayey-skeletal, Typic Ustorthents - Clayey, Typic Haplustepts
D1s10,D2s9, D2s10	Kinhi-Lonar2	9	Loamy, Lithic Ustorthents - Clayey, Typic Haplustepts
D2c1,D2c12	Pangradole-Weni	10	Clayey-skeletal, Typic Ustorthents - Loamy-skeletal, Typic Ustorthents
D2c3	Weni-Pangradole	11	Loamy-skeletal, Typic Ustorthents - Clayey-skeletal, Typic Ustorthents
D2c6,D2c8,D2f11	Pangradole-Pardi	12	Clayey-skeletal, Typic Ustorthents - Clayey, Lithic Ustorthents
N1c6,N1c7,N1c12	Deothana-Mehkar	13	Fine, Vertic Haplustepts - Very-fine, Typic Haplusterts
B1c1,B1c6,B1c7, B1c8,B1c12	Mehkar-Deothana	14	Very-fine, Typic Haplusterts - Fine, Vertic Haplustepts

Table 2.11k.4 Physical characteristics of soil series of Lonar and adjoining area

Name of series	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Water ret	ention (%)	AWC (%)
					33 kPa	15 kPa	
Bhalegaon	0-16	3.0	31.6	65.4	36.4	23.8	12.6
	16-35	2.4	31.2	66.4	35.8	23.4	12.4
	35-55	2.2	31.1	66.8	36.3	23.5	12.8
Sultanpur	0-6	20.9	34.5	44.6	34.7	20.4	14.3
Pardi	0-10	18.9	34.9	46.2	41.9	29.5	12.4
	10-22	18.8	35.4	45.8	41.0	28.9	12.1
Weni	0-21	44.8	40.3	15.0	19.8	9.1	10.7
Shara	0-15	7.8	29.3	62.9	36.5	24.2	12.3
Lonar-4	0-21	24.6	39.5	35.9	34.7	22.6	12.1
Pangradole	0-18	16.4	33.0	50.5	33.4	22.1	11.3
Lonar-3	0-14	42.7	35.3	22.0	25.0	11.3	13.7
	14-25	38.4	38.5	23.1	24.1	11.9	12.2
Lonar-2	0-16	33.3	41.5	25.2	24.6	11.7	12.8
	16-28	30.6	40.0	29.4	26.0	16.3	9.7
Lonar-1	0-16	8.0	32.7	59.3	39.2	26.6	12.6
	16-42	8.1	31.2	60.7	39.8	29.7	10.1
Deolgaon	0-10	26.2	43.6	30.2	26.7	14.8	11.9
	10-30	27.7	41.4	30.9	24.2	14.0	10.2
Deothana	0-20	16.7	29.5	53.8	30.8	20.9	9.8
	20-51	10.9	27.2	61.9	36.7	25.3	11.4
	51-70	19.5	26.3	54.2	37.0	24.5	12.5
Kinhi	0-9	48.5	35.0	16.5	19.9	10.0	9.9
Mehkar	0-20	4.1	38.8	57.1	33.9	24.3	9.7
	20-50	2.9	35.1	62.0	33.9	23.2	10.7
	50-78	2.3	38.0	59.7	35.3	23.6	11.7
	78-117	2.5	33.9	63.6	39.4	27.2	12.1
	117-150	2.2	38.2	59.6	39.8	25.5	14.3

Table 2.11k.5 Chemical characteristics of soil series of Lonar and adjoining area

Name of Series	Depth (cm)	pH (1:2.5)	EC (dSm ⁻¹)	OC (%)	CaCO ₃ (%)	Avail. N	Avail. P Kg ha ⁻¹	Avail. K
Bhalegaon	0-16	8.3	0.1	1.0	8.4	284.5	10.7	571.9
	16-35	8.3	0.1	0.9	5.9	288.9	8.9	391.1
	35-55	8.3	0.1	0.7	9.3	246.2	8.7	324.9
Sultanpur	0-6	7.1	0.1	1.6	2.2	216.7	8.9	328.8
Pardi	0-10	8.2	0.1	0.3	4.9	192.2	9.9	288.8
	10-22	8.3	0.1	0.2	5.4	126.3	6.6	198.6
Weni	0-21	8.4	0.1	0.4	9.7	234.3	8.8	88.6
Shara	0-15	6.5	0.1	1.2	1.9	377.8	16.4	177.0
Lonar-4	0-21	7.7	0.1	0.6	2.9	238.4	23.2	398.2
Pangradole	0-18	7.5	0.1	0.8	2.3	265.4	21.9	200.4
Lonar-3	0-14	8.4	0.1	0.5	17.2	290.5	9.8	155.0
	14-25	8.4	0.1	0.5	18.4	222.7	6.7	125.6

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Name of Series	Depth (cm)	pH (1:2.5)	EC (dSm ⁻¹)	OC (%)	CaCO ₃ (%)	Avail. N	Avail. P Kg ha ⁻¹	Avail. K
Lonar-2	0-16	8.4	0.1	0.3	19.0	206.3	3.3	98.8
	16-28	8.4	0.1	0.6	6.6	266.9	3.4	202.7
Lonar-1	0-16	8.5	0.1	0.6	9.4	199.8	3.3	75.3
	16-42	7.4	0.1	0.8	3.4	426.8	62.2	375.1
Deolgaon	0-10	7.8	0.1	0.7	3.6	267.2	23.6	254.8
	10-30	7.2	0.1	0.9	2.9	256.1	6.1	146.1
Deothana	0-20	7.6	0.0	0.6	2.9	193.6	2.1	72.3
	20-51	8.5	0.1	0.5	19.7	182.7	4.4	348.4
	51-70	8.8	0.1	0.3	20.0	170.3	13.1	233.9
Kinhi	0-9	8.9	0.2	0.1	21.7	41.5	6.6	140.0
Mehkar	0-20	8.6	0.2	1.0	11.5	251.5	8.9	631.8
	20-50	8.6	0.2	0.6	10.7	205.5	6.7	279.6
	50-78	8.7	0.2	0.6	9.5	196.4	4.5	247.1
	78-117	8.8	0.2	0.6	10.8	132.7	3.3	265.9
	117-150	9.0	0.3	0.5	12.1	182.3	4.4	265.5

2.111. Assessment of Degraded lands and Wastelands Datasets of India -GIS Based **Approach**

(A Collaborative Project between NBSS&LUP, NRM Division (ICAR), NAAS, CSWCR&TI, CSSR, CAZRI and NRSA)

A.K. Maji, G.P. Obi Reddy and Sunil Meshram

During the reporting year, the degradation and wasteland map of India in different agro-ecological regions has been generated (Fig. 2.11l.1). The class wise distribution of degraded and wastelands in India is shown in table 2.11l.1.

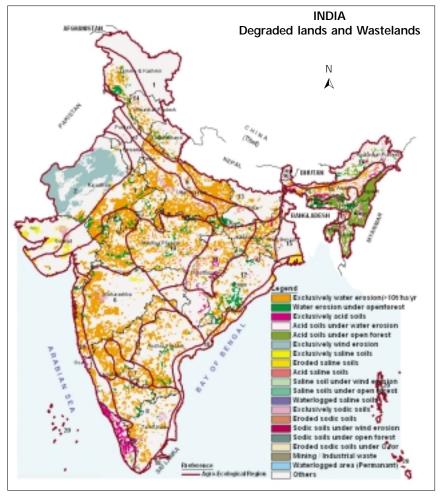


Fig. 2.11I.1. Degraded lands and wastelands of India at AER

Table 2.11I.1. Area under degraded and wastelands under different AERs of India

National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur Area under Degraded Lands and Wastelands of India under different AERs

S. No	. AERs						Ι	Degraded La	ands and	l Wastela	ands Class	ses (000'	ha)								Total
	Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Area (000'ha)
1.	1	19.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.50
2.	2	638310	123.39	0.00	0.00	0.00	11414.09	1106.11	6.16	0.00	110.03	60.05	0.11	405.29	1.34	30.03	0.00	0.00	7.72	7.03	13909.44
3.	3	2340.59	76.08	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.00	0.00	0.00	74.92	47.28	0.00	0.00	0.00	20.30	0.00	2559.88
4.	4	12109.06	1024.32	0.00	1.01	0.00	5.94	366.56	7.49	0.00	0.00	0.00	0.00	928.65	423.40	0.00	1.04	11.23	14.09	67.85	14960.63
5.	5	6455.04	983.18	3.08	21.89	0.00	0.00	183.90	2.22	0.00	0.00	0.00	0.00	25.20	15.41	0.00	0.00	4.53	5.89	0.00	7700.34
6.	6	10374.06	257.12	0.00	0.19	0.00	0.00	170.57	6.15	0.00	0.00	0.00	0.00	268.79	174.76	0.00	0.00	0.71	17.37	0.00	11269.71
7.	7	4375.95	464.96	11.59	6.89	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	7903	15.29	0.00	0.00	1.13	30.83	0.00	4985.94
8.	8	4412.07	391.37	272.19	151.20	60.07	0.00	2.60	0.63	0.00	0.00	0.00	0.00	287.21	35.85	0.00	16.53	1.98	48.00	5.42	5685.12
9.	9	3122.13	377.75	3.28	2.65	0.00	0.00	2.25	3.32	0.00	0.00	0.00	0.00	367.56	292.56	0.00	1.83	0.37	8.65	88.75	4271.10
10.	10	6934.31	821.98	119.04	307.89	28.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.49	20.47	0.00	0.62	0.09	21.11	0.00	8289.09
11.	11	3842.55	514.46	652.56	726.45	158.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.71	3.18	0.00	0.00	0.00	16.37	0.10	5924.98
12.	12	4916.54	1512.38	469.45	1089.12	142.22	0.00	2.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.51	24.17	8193.89
13.	13	3802.89	48.10	41.38	41.21	0.00	0.00	39.92	8.63	0.00	0.00	0.00	4.71	2.23	24.11	0.00	0.00	0.00	0.60	162.96	4176.67
14.	14	4009.32	1025.35	75.15	288.82	222.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.06	0.00	0.00	0.00	0.00	4.40	61.47	5696.79
15.	15	2010.61	213.31	646.57	1229.10	328.12	0.00	63.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	242.09	4733.95
16.	16	576.39	229.32	274.87	651.45	782.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.94	2523.98
17.	17	209.90	992.32	439.39	516.30	5329.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.29	30.75	7519.63
18.	18	927.52	47.66	42.93	11.71	3.26	0.00	573.80	4.28	0.00	0.00	0.00	25.10	114.87	6.35	0.00	0.00	0.00	10.43	83.45	1851.37
19.	19	2943.55	186.96	2028.53	674.15	75.75	0.00	40.29	1.19	20.03	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	14.84	76.02	6061.41
20.	20	0.00	0.00	0.00	0.00	0.00	0.00	77.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	77.00
	Total	74020.03	9290.00	5080.02	5720.02	7130.01	11420.03	2630.03	40.07	20.03	110.03	60.05	30.02	2610.01	1060.00	30.03	20.01	20.04	260.00	860.00	120410.43

Others*=>Chandigarh, D. & N. Haveli, Daman & Diu, Lakshadweep and Pondicherry

Note: Snow coverd / Ice Caps & Barren rocky / Stone waste classes are not included in emtimation of degraded lands and wastelands of India.

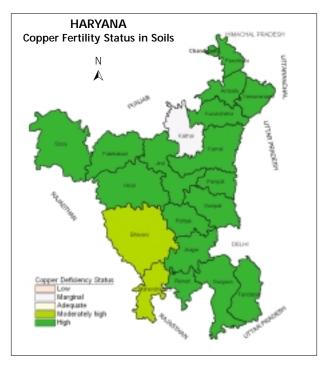
<u>S. No.</u>	Classes	<u>S. No.</u>	Classes	<u>S. No.</u>	Classes
1	Exclusively water erosion (>10t/ha/yr)	8	Eroded saline soils	15	Spdoc soils under wind erosion
2	Water erosion under open forest	9	Acid saline soils	16	Sodic soils under open forest
3	Exclusiverly acid soil (pH <5.5)	10	Saline soils under wind erosion	17	Eroded sodic soils under open forest
4	Acid soils under water erosion	11	Saline soils under open forest	18	Mining / Industrical waste
5	Acid soils under water erosion	12	Water logged saline soils	19	Waterlogged area (Permanent)
6	Exclusively wind erosion	13	Exclusively sodic soils		
7	Exclusively saline soils	14	Eroded sodic soils		

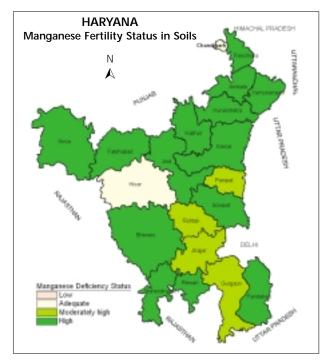
2.11m. Micronutrient Mapping (IISS, Bhopal and NBSS&LUP, Nagpur)

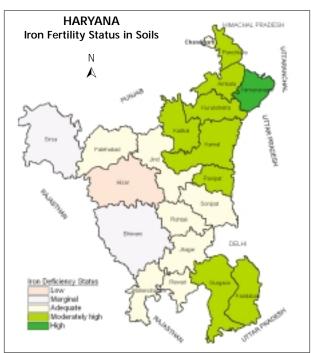
A.K. Maji, G.P. Obi Reddy and Sunil Meshram

During the reporting year, under the collaborative

project on 'Micro Nutrient Mapping' with IISS, Bhopal, maps showing areas of deficiency of zinc, copper and manganese have been generated in GIS environment. The district wise micronutrient maps of Haryana state are shown in figure 2.11m.1.







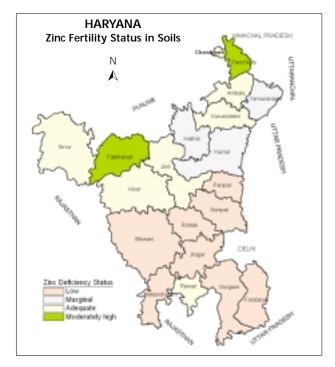


Fig. 2.11m.1. Micro-nutrient maps of Haryana state

2.11n. Development of GIS
Based Seamless Mosaic
of SRTM Elevation Data of
India to Analyze and
Characterize the Selected
Geomorphic Parameters

(Inter institutional project between NBSS&LUP and RRSSC, Nagpur)

G.P. Obi Reddy, A.K. Maji, S.N. Das and Rajeev Srivastava

This inter-institutional project was taken up to develop a seamless mosaic of SRTM digital elevation data (90m) for India. Further, it was aimed to analyse and characterize the selected geomorphological parameters. During the reporting year, 35 digital elevation scenes were downloaded and a seamless mosaic in Arc GIS was developed, after necessary correction in the database. The generated database can be used for other important national projects like enrichment of land degradation database and development of Georeferenced soil information system (NAIP Project). The generated seamless digital elevation data of India is shown in figure 2.11n.1.

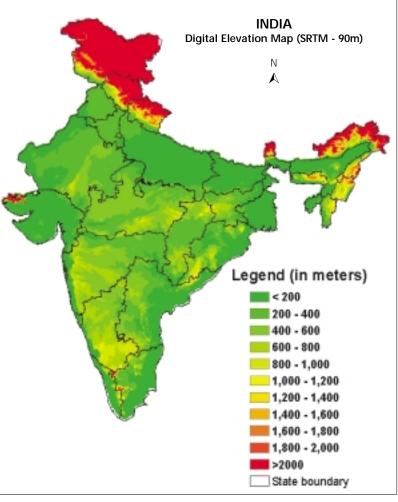


Fig. 2.11n.1. Digital Elevation Map of India

2.110. Enrichment of land degradation datasets with soils datasets of different states of India (NBSS-NRSC Inter Institutional project)

NBSS&LUP: Dipak Sarkar (Coordinator), G.P. Obi Reddy, Rajeev Srivastava, G.S. Sidhu, A.K. Sahoo, K.S. Anil Kumar and Siladitya Bandyopadhyay

NRSC: P. S. Roy (Coordinator) T. Ravisankar, K. Srinivas, G. Sujatha and M.A. Fiazy

This inter institutional project is aimed to enrich the land degradation maps on 1:50,000 scale generated by NRSC with soil/soil loss parameters of NBSS. Further, it is also aimed to finalise the state wise land degradation maps of India. The main activities involved in the project are (i) projection transformation of soil/soil loss datasets to make it compatible with land

degradation datasets, (ii) appending the identified soil/soil loss parameters contributing towards the land degradation to enrich land degradation datasets using the suitable option in GIS, (iii) reconciliation of the enriched land degradation datasets, and (iv) finalization of the state wise enriched land degradation maps. During the reporting year, the enrichment of land degradation datasets of Orissa state is collated.

2.11p. Human Resource development in Remote sensing and GIS in Natural Resource Management - NNRMS (ISRO) - NBSS&LUP Collaborative Project

A.K. Maji, Arun Chaturvedi, G.P. Obi Reddy and Head RC's

Remote sensing and Geographic Information System (GIS) are essential tools for natural resources mapping,

monitoring, planning and management. Keeping this in view NNRMS (ISRO) and NBSS&LUP jointly formulated a project to organize a series of training programmes at different Regional centers and Head Quarters of NBSS&LUP. The main objectives of the joint effort are (i) capacity building in the field of RS and GIS application in natural resources management, (ii) enhance expert manpower to cater to the needs of agricultural universities, state departments and district developmental agencies, and (iii) to pave the way for inter institutional collaboration towards spatial database creation and management. So far six training programmes have been conducted and 103 trainee officers from ICAR, SAU's, State Govt. departments and Academic institutions were trained. Two training programmes are planned to be organized in the year 2010-11.

2.11q. Land Resource Inventory and GIS Database for Farm Planning in 10 Blocks of Tamil Nadu (II phase)

A. Natarajan, K.S. Anilkumar, S. Thayalan, V. Ramamurthy, K.V. Niranjana, B.A. Dhanorkar, Arti Koyal, D.H. Venkatesh, and S. Srinivas

Collaborating Organisations: Soil Survey and Land Use Organisation, Coimbatore, Agricultural Engineering Department, Govt. of Tamil Nadu, Tamil Nadu Agricultural University, Coimbatore.

This project is planned to provide the required site-specific database suitable for Farm level planning in 10 blocks of the priority districts identified by the Govt. of Tamil Nadu which covers 3.6 lakh ha. The blocks surveyed are: Thirumanur, Annur, Pappireddipatti, Ottanchadram, Uthangarai, Rasipuram, Perambalur, R.S.Mangalam, Veerapandi and Gingee.

Field work has been completed in all the ten blocks of the state. Scanning, digitization and preparation of village-wise soil maps and analysis of the soil samples are in progress. All the field survey, laboratory and GIS work are being done by the Department of Agriculture and TNAU.

2.11r. Assessment of Land Resources for growing Horticultural Crops in selected districts of Tamil Nadu under the National Horticultural Mission **Project**

A. Natarajan, V. Ramamurthy, S. Thayalan, S. Srinivas, K.V.Niranjana, M.Ramesh, D.H. Venkatesh and S. Vadivelu

Collaborating Organisations: Soil Survey and Land Use Organisation, Coimbatore, Department Agriculture, Govt. of Tamil Nadu

Project is aiming to assess the suitability of existing land resources for the cultivation of horticultural crops in 14 districts identified under the National Horticultural Mission project in Tamil Nadu by using the information available from the earlier soil survey work.

The soil database were compiled for the 14 district and suitability assessment was carried out and maps generated. Identified the potential areas by limited field checks. Also identified site and area specific constraints for the cultivation of horticultural crops grown in the district.

2.11s. Nutrient Indexing and soil fertility Assessment of Kole lands

K. M. Nair, K. S. Anil Kumar, S. Srinivas, L.G.K. Naidu and Dipak Sarkar

"Kole" is a wet land ecosystem below mean sea level in coastal Kerala spread over Thrissur and Malappuram districts. One crop of rice is taken on these lands after flushing off the sea water by monsoon rains. The current project envisages assessment of soil reaction, soil salinity and macro-and micro-nutrients of the Kole lands and development of plant nutrient management plan for land parcels. NBSS & LUP had been entrusted with the task of evolving scheme of soil sampling and post processing of data generated in spatial frame work using a GIS for preparation of soil fertility maps. KAU is undertaking soil sampling and analysis. Fig. 2.11s.1 depicts the spatial distribution of Kole lands.

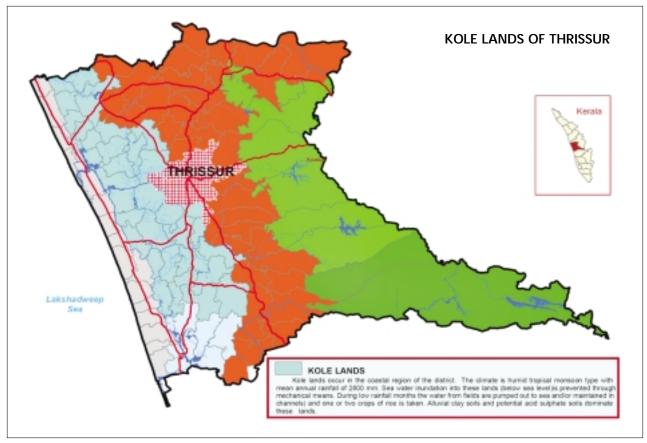


Fig. 2.11s.1. Kole lands of Thrissur district





Fig. 2.11s.2. Kole lands, below sea level, remain flooded for most parts of the year and are cultivated to single crop of rice during rabi season by pumping out water

2.11t. Agro-ecological Units of Kerala

K.M. Nair, Champa Mandal, Arun Chaturved, S. Thayalan, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas. L.G.K. Naidu and Dipak Sarkar

The Kerala State Planning Board sponsored this project for the National Bureau of Soil Survey and Land Use

Planning to develop an agro-ecological unit map for Kerala State and district-wise maps for all 14 districts. During the reporting period state and district-wise agroecological units maps were finalized.

The concept of agro-ecological units was developed by FAO (1975) with strong emphasis on comparable agro-climatic parameters to delineate agriculturally

potential areas for particular crop or combinations of crops so that optimum production potential is achieved. The method suggested by FAO with modifications to suit local conditions was adopted for delineating agroecological units for the state. Primary data sets employed were climatic data from 206 stations, soil data, geomorphology, hydrology and land use. Spatial data sets were generated for said parameters and integrated in a GIS environment to prepare the agro-

ecological units. Five agro-ecological zones and 23 agro-ecological units were delineated for the state.

The State Planning Board has already initiated use of the map for agricultural developmental planning.

The state agro-ecological units map with abbreviated legend is presented in Fig. 2.11t.1 and full legend for the map is provided in table 2.11t.1. An example of district map with AEZ units is presented in Fig. 2.11t.2.

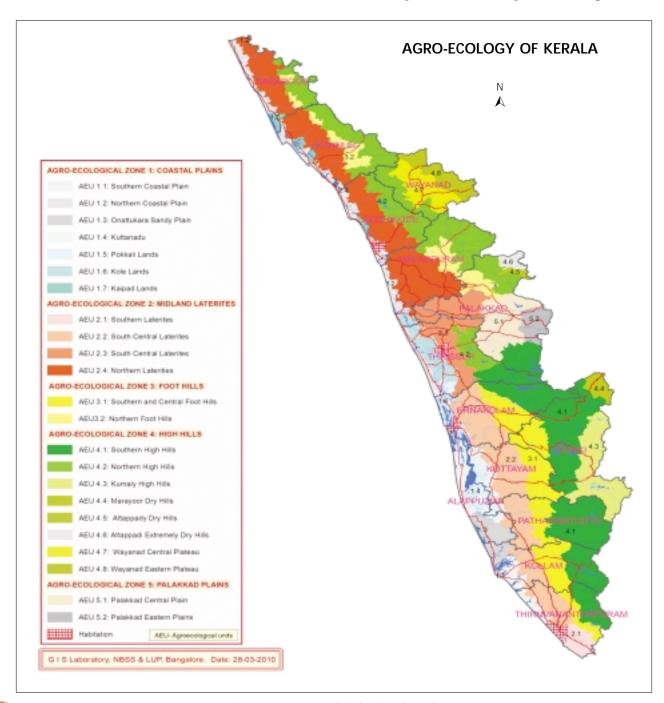


Fig. 2.11t.1 Agro-ecolgical units of Kerala

Table 2.11t.1 Descriptive legend for the map agro-ecology of Kerala

AGRO-ECOLOGICAL ZONE 1: COASTAL PLAINS

Coastal plain comprises the narrow strip of nearly level land along the coast line. Included in the zone arc the lands subject to sea water inundation, back waters and sandy plains. The coastal plain has been divided into six agro-ecological units based primarily on land, soil and climate features.

Agro-ecological Unit 1.1: Southern coastal plain

This unit comprises coastal plains adjacent to coast line from Thiruvananthapuram to Alappuzha district. The climate ranges from moist sub-humid to humid, in south-north direction. Mean annual rainfall is 2264 mm. Soil moisture availability is adequate for plant growth from mid April to mid December. **Dry period is four months.**

Soil are deep, acidic, sands except for southern parts where laterite soils extend very near to beach. The dominant land use is coconut plantations inter-cropped to a variety of perinncal and annual crops.

Agro-ecological Unit 1.2: Northern coastal plain

This unit comprises the coastal plain adjacent to coast line from Thrissur to Kasaragod. The climate is humid with mean annual rainfall of 3190.6 mm. Soil moisture is adequate for plant growth from mid May to mid December. **Dry period is five months.**

Sandy soils dominate the coastal plain in Thrissur district whereas in the other districts coastal laterites arc the dominant soils with sands confined to beach. Land use is coconut plantations inter-cropped with a variety of other perennial and annual crops.

Agro-ecological Unit 1.3: Onattukara sandy plain

Forty two panchayats spread over coastal Kollam and Alappuzha districts constitute this unit. The climate is humid with mean annual rainfall of 2582 mm. Soil moisture is adequate for plant growth from mid April to mid December. **Dry period is four months.** Sandy soils cover most area of the unit. Land use is coconut plantation in uplands and rice in low lands.

Agro-ecological Unit 1.4: Kuttanadu

Kuttanadu comprises those lands which arc for most part of the year inundated with water. These lands are below sea level. Rice cultivation is made possible in these lands by preventing the entry of sea water and pumping out water from the fields during dry months.

Hydromorphic and potential acid sulphate soils developed from alluvial deposits and marine sediments dominate the land. Rice is the only crop grown. Draining these soils completely can result in the development of acid sulphate soils and consequent extremely acid soils and water.

Agro-ecological Unit 1.5: Pokkali lands

Pokkali lands start from northern coastal part of Alappuzha, cover the entire coast of Emakulam and southern most part of Thrissur. The land is permanently submerged under saline water. Unlike Kuttanadu there are no structures to prevent entry of sea water.

Rice cultivation is practiced in these lands, after the flushing out of salt water during monsoon floods, by adopting special cultivation methods and using salt tolerant rice verities. Fishery is another land use.

Agro-ecological Unit 1.6: Kole lands

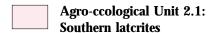
Kole lands occur in the coastal region of Thrissur and southern coast of Malappuram district. Like in Kuttanadu sea water inundation into these lands (below sea level) is prevented through mechanical means. During low rainfall months the water from fields arc pumped out (to sea and/or maintained in channels) and one or two crops of rice is taken. Alluvial acid, clay soils and potential acid sulphate soils dominate these lands.

Agro-ecological Unit 1.7: Kaipad lands

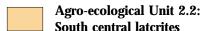
This unit comprises these lands which arc for most part of the year inundated with water, in Kozhikkodc, Kannur and Kasargod districts. These lands are Hushed with sea water and fresh water periodically. The soils developed from alluviar and marine deposits are very deep, acidic, saline. These lands are cultivated to rice for one season.

AGRO-ECOLOGICAL ZONE 2: MIDLAND LATERITES

Midland latcrites extend as a strip of land bound on west by coaslal plain and foot hills or hills on the eastern side. These lands have rolling uplands with narrow valleys and occasional low hills and gently sloping plateaus. Three agro-ecological units were delineated in the zone primarily based on the length of dry period and the nature of soils.



This unit covers the south western part of Thiruvananthapuram district. Climate is moist subhumid tropical monsoon type with mean annual precipitation of 1884 mm. Soil moisture is adequate from May to January of subsequent year. Dry period is three months. Soils are deep, red, strongly acid, loam to clay loam. Land use is dominantly coconut plantations. Narrow valleys are cultivated to rice vegetables, tapioca and banana.



This unit covers the midland latcrites from Thiruvananthapuram to Ernakulam districts. The climate is humid, except for southern half of Thiruvananthapuram wherein it is only moist subhumid. The mean annual precipitation is 3145 mm. Rainfall increases in south to north direction (1974 in Vamanapuram to 3 178 mm in Perumbavoor). Soil moisture availability is adequate from mid April to end of December. Dry period is three and half months.

Soils arc deep, strongly acid, red loamy whereas in the other parts it is deep, strongly acid. red. very gravelly clay. Land use of midland latcrites in Thiruvananthapuram is dominantly coconut. In other

parts rubber has replaced most of the coconut and annual cropped areas. The narrow valleys arc cultivated to rice. However, most of the rice fields arc currently being converted to fields of other crops like tapioca, banana and vegetables.



Agro-ecological Unit 2.3: North central latcrites

This unit covers the midland laterites of Thrissur and Palakkad districts. Climate is moderately humid to very humid. Mean annual precipitation is 2823 mm. Soil moisture availability is adequate from mid May to end of December.

Soils are deep, strongly acid, red, very gravelly clay. Occasional laterite outcrops are also seen. Land use is mainly coconut inter-cropped with perennial and annual crops and rubber plantations. The valleys are cultivated to rice. Dry period is four and half months.

Agro-ecological Unit 2.4: Northern laterites

This unit covers the midland laterites of Malappuram, Kozhikodc, Kannur and Kasargode districts. Climate varies from moderately humid to extremely humid. Mean annual rainfall is 3162 mm. Soil moisture is adequate for crop growth from mid May to mid December. Dry period is five months.

Soils arc moderately deep to deep. strongly acid, red, very gravelly clay. Laterite outcrops and areas with shallow soil cover are extensive in the unit. Their extent increases from south to north. Such areas are often barren with scanty vegetation cover. The slopes of the rolling lands are cultivated to coconut and cashew with many intercrops. The valleys have rice and arcca nut as major crops.

AGRO-ECOLOGICAL ZONE 3: FOOT HILLS



Agro-ecological Unit 3.1: Southern and **Central foot hills**

This unit covers the foot hills of Thiruvananthpuram to Ernakulam districts of the state. Climate varies from humid to per-humid. Mean annual rainfall is 3664.5 mm. Soil moisture is adequate from April to mid January. Dry period is two and half months.

Soils are very deep, strongly acid, gravelly clay. The land use is dominanlly rubber plantation. The valleys used for rice production in earlier days are currently under tapioca, banana, vegetable and pine apple production systems.

Agro-ecological Unit 3.2: Northern foot hills

This unit covers the foot hills of Palakkad. Malappuram. Kannur and Kasargode. Climate in humid, except for Malampuzha region (Palakkad) wherein it is moist subhumid. The mean annual rainfall is 2486 mm. Soil moisture is adequate from mid May to end of December. Dry period is four and half months.

Soils arc deep, strongly acid, gravelly clay. Dominant crop production systems in the sloping uplands arc coconut, rubber and pepper. The low lands have rice, arcca nut, banana and vegetables.

AGRO-ECOLOGICAL ZONE 4: HIGH HILLS

The hills of Western Ghats and Wynad plateau constitute the high hill agro-ecological zone. They occur in all districts of the state except for Alappuzha and Kottayam. Elevation in most parts are more than 400 meters above mean sea level. Eight agro-ecological units were delineated in the zone based primarily on the length of dry period.



Agro-ecological Unit 4.1: Southern high hills

The unit covers high hills of Thiruvananthpuram, Kollam. Palhanamlhitta. Idukki. Ernakulam and hills in the south-eastern parts of Thrissur and southern part of Palakkad. Climate is for most part per-humid with mean annual rainfall of 3548.5 mm. Soil moisture is adequate from mid April to mid February (of next year). Dry period is two months. Soils are deep, strongly acid, clay. Dominant land use is forests. Plantations of tea, cardamom, coffee and pepper are the other major land use.



Agro-ecological Unit 4.2: Northern high hills

This unit covers the high hills of Thrissur, northern Palakkad, Malappuram. Kozhikode, Kannur and Kasargode. Climate is humid and per-humid. Mean annual rainfall is 3256.6 mm. Soil moisture is adequate from May to December. Dry period is four months. Soils are deep, strongly acid, clay. Land use in dominantly forest with occasional plantations of coffee and tea.



Agro-ecological Unit 4.3: **Kumaly dry hills**

This unit comprises the eastern and south-eastern parts of Idukki district which experience drier climate (slightly to moderately humid) compared to the central and western parts of the district. Mean annual rainfall of the unit is 1809 mm. Soil moisture is adequate from May to January (of next year). Dry period is three months. Soils are deep, acidic, clay. Land use is forests and plantations of tea and cardamom.



Agro-ecological Unit 4.4: Marayoor dry hills

The unit cover the north eastern part of Idukki experiencing dry sub-humid climate. Mean annual rainfall is only 1276 mm. Soil moisture is adequate from June to mid February (of next year).

Dry period is three and half months. Soils are deep. neutral, clay loam. Land use besides forest and

plantations include many temperate vegetable crops and sugarcane.



Agro-ecological Unit 4.5: Attappady dry hills

This unit covers a narrow strip of land in the eastcentral half of the Attappadi hill region of Palakkad district. Climate is dry sub-humid to moist sub-humid. Mean annual rainfall is 1482 mm. soil moisture is adequate from June to January (of next year). Dry **period is four months.** Soils are deep, neutral, clay. Land use is mainly annual crops on uplands and rice in vallev.



Agro-ecological Unit 4.6: Attappadi extremely dry hills

This unit covers the north eastern part of Attappadi hills of Palakkad district. The climate is semi-arid with mean annual rainfall of 855.6 mm. North east monsoon contributes most of the rain. Soil moisture is adequate for crop growth only for three and half months from mid September to end of December.

Dry period is eight and half months. The hills are mostly covered with dry decidous forests and thorny bushes. Soils arc shallow and gravelly.



Agro-ecological Unit 4.7: Wayanad central plateau

This unit comprises the central region of the Wayanad plateau. Climate is very humid to per-humid. Mean animal rainfall is 2659 mm. Soil moisture is adequate from mid April to mid January. Dry period is three months. Soils are deep, acidic, clay loam. Uplands are mostly under plantations of coconut, coffee and tea. Extensive valley lands arc cultivated to rice and banana.



Agro-ecological Unit 4.8: Wayanad eastern plateau

This unit comprises the eastern part of Wayanad plateau. Climate is moist to dry sub-humid with mean annual rainfall of 1394 mm. Soil moisture is adequate from start of May to end of December. Dry period is four months.

Soils of the unit are deep, neutral to alkaline, clay. Swell-shrink black soils occur to some extent in the unit. The land use besides forest is mainly annual crops. Valleys are cultivated to rice and banana.

AGRO-ECOLOGICAL ZONE 5: PALAKKAD PLAINS

This zone comprises the plains of Palakkad in the gap region of Western Ghats. Two distinct agro-ecological units were delineated based on the length of dry period.

Agro-ecological Unit 5.1: Palakkad central plain

The unit covers the central part of Palakkad plains comprising Kuzhalmannam, Alathur, and Palakkad taluks, and parts of Malampuzha and Kollengode taluks. The climate is moist sub-humid to sightly humid. The mean annual rainfall is 1971 mm. Soil moisture is adequate from June to end of December. However, a break in soil moisture availability occurs from mid August to end of September. Dry period is six and half months. Soils arc deep, moderately acid, clay and clay loam. Uplands arc cultivated to coconut and valleys

rice. Extensive irrigation facilities ensure double crop of rice in most parts.

Agro-ecological Unit 5.2: Palakkad eastern plains

This unit covers the eastern dry region of the district. The climate is dry sub-humid. Mean annual rainfall is 1339.5 mm. Soil moisture is adequate from mid June to end of December. However, there is a break in soil moisture availability, from mid August to mid October. Dry period is seven and half months.

The soils are deep, neutral to alkaline, clay. Swellshrink black soils are extensive in the unit. Land use is annual crops like sugarcane, jowar, maize, rice, groundnut and vegetables. Mango and coconut plantations are also extensive.

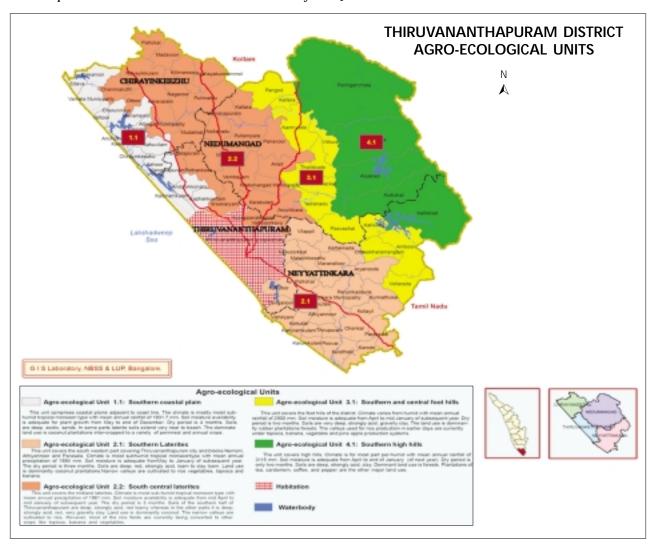


Fig. 2.11t.2. Agro-ecological units of Thiruvananthapuram district

2.11u. Rain and flood damage to soil resources and crops in north Karnataka districts [During the period from 29.09.09 to 3.10.091

Collaborator: NBSS & LUP, Regional Centre, Bangalore - A. Natarajan CSWR&TI, Bellary Centre - A. Raizada, R.N.Adhikari, S.L. Patil Director of Water Management, Bhubaneshwar - A. Raian

ICAR has constituted a committee to assess the flood damage in Karnataka during the period from 29.09.09 to 3.10.09. Team comprising of above scientists traversed the flood affected areas of the state and a report was prepared and submitted to the council. The report was presented to the Department of Agriculture and Co-operation on 14.1.10. The salient observations along with the amelioration measures suggested for the affected areas are given below.

Out of the total geographical area of 19.1 m.ha in Karnataka, about 10.8 m.ha in northern districts of the state has been affected by the heavy downpour and unprecedented floods that occurred between the last week of September and first week of October 2009. This has caused severe damage to the natural endowments in 13 districts of Northern Karnataka, particularly in Raichur, Bijapur, Bellary, Gulbarga, Bagalkot, Koppal, Gadag and Belgaum districts.

Rainfall distribution in September and October, 2009

The total amount of rainfall received in short period from 29.09.09 to 03.10.09 (less than a week's time) has no parallel in the recent past. In just about five days time, this region has received about 70 per cent of the total annual rainfall of this area.

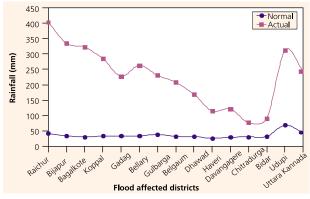


Fig. 2.11u.1. Rainfall in flood affected districts of Karnataka (from 29.09.09 to 03.10.09)

Sudden heavy downpour has caused severe damage to soils, crops and infrastructure facilities in the catchment and command areas of Krishna and Thunga bhadra rivers, the two major river systems of the state, and their tributries. Out of the 13 districts affected, the severity of damage was more in Raichur, Bijapur, Bellary, Gulbarga, Bagalkot, Koppal, Gadag and Belgaum districts. The crop loss, occured in around 22 lakh ha (DES, Govt. of Karnataka), which is more in Bijapur, Gulbarga, Belgaum, Raichur, Haveri and Davanagere districts.

In addition to the excess rainfall received in the catchment areas of Krishna and Tungabhadra rivers and their tributaries, the other factors responsible for the large scale devastation are:

- Nature of the soil, predominantly of fine textured, erosion prone black soils
- Poor infiltration (in black soils) and consequent high surface runoff
- Longer slope lengths, which accelerates the rate of erosion
- Improper soil and water conservation measures followed/adopted in the catchment and command areas
- Encroachment and cultivation in river beds and stream and water courses
- Thick growth of *prosophis* sp. (Bellary jali) in the stream courses/riverbeds/banks and consequent blockage of the stream flow
- Lack of drainage facilities in the command areas, particularly in the Thunga Bhadra command areas, and consequent waterlogging

All the above factors resulted in very high flow in hundreds of small streams and seasonal rivers, causing heavy floods with severe damage to the standing crops and siltation in water ways.



Fig. 2.11u.2. Rill and gully erosion in black soils near Kalmali village, Raichur district



Fig. 2.11u.3. Severe gully erosion (60 cm depth) at Kalmali village, Raichur District



Fig. 2.11u.4. Sand deposition along the Hagari river



Fig. 2.11u.6. Removal of salts by floods in salinity patches



Fig. 2.11u.5. Sand deposition along Dhoni river near Tallakote, Bijapur district



Fig 2.11u.7. Abandoned paddy fields (salt affected) near Albanur village, Sindhanoor taluk, Bellary District

Amelioration measures suggested for catchment area

- 1. Proper soil and water conservation measures need to be adopted in this region.
- 2. Deep and wide gullies need to be plugged.
- 3. In red soil, deep rills and gully is commonly observed, need proper soil conservation measures.
- 4. Treatment of the whole catchment area with comprehensive soil and water conservation measures to reduce the severity of erosion.
- 5. Identification of priority areas for treatment at village/watershed level, preparation of a comprehensive treatment plan based on soil-site characteristics and monitoring their implementation will go a long way in reducing the impact of soil erosion.

The measures to minimize further crop loss and yield reduction in flood affected areas

- Drain out excess water from the stagnated fields, to save the standing crops and to facilitate *rabi* sowing wherever possible.
- Harrowing to level or fill up minor depressions in the rainfed upland areas, particularly in the black soils, to facilitate timely sowing of sorghum, bengal gram and sunflower in the *rabi* season.
- Deep ploughing and incorporation of lodged/ withered crops that have wilted in the field due to floods and excess rainfall and to mix the sand and silt with the clayey soil.
- Removal of excess sand deposits along the river courses and spreading them in the adjoining fields having heavy clay texture.
- Repairing and strengthening of the field bunds, wherever they are breached

Measures for areas affected by river bank erosion

To prevent further stream bank erosion the following short and long term measures are suggested.

- Identification of critical areas along major tributaries
- Construction of wired guided banks and gabion structures along critical points
- Construction of embankments and loose boulder structures at weak points and turns of streams and rivulets
- Establishment of erosion resistant species like bamboos along the banks of small rivers

 Removal of Prosopis juliflora thickets and other thistles, which are obstructing the natural flow of water in streams, rivulets and seasonal rivers

Restoration of the original river beds specially in the low lying areas

FARMS SURVEYED

Detailed Soil Survey of Coffee Research Sub-station-Chattalli, North Kodagu, Karnataka

Detailed field investigation of Coffee Research Station (CRSS), Chattalli in Coorg district was surveyed by studying 14 profiles covering an area of 120 ha area and identified 4 series (3 series in uplands and 1 series in lowland) and mapped into 10 mapping units. Two monoliths one from CRSS, Chattalli and another from TEC Gonikoppa were collected and displayed. The soil samples from master profiles and 38 fertility samples were collected for laboratory investigation. A sum of Rs. 66,000 has been generated as reenue to the Institute.

2.11v. Assessment and mapping of some important soil parameters including macro & micro nutrients at block level of Dumka, Jamtara and Hazaribagh districts for optimum land use plan

A.K. Sahoo, Dipak Sarkar, S.K. Singh, T. Banerjee and D.C. Nayak

Block level nutrient mapping has been initiated at Dumka, Jamtara and Hazaribagh districts of Jharkhand in collaboration with Birsa Agriculture University, Ranchi, and Jharkhand. Conceptual model for the project is given in flow chart (Fig. 2.11v.1). The project aims at addressing the problems of low productivity of prevailing rice-wheat, maize-wheat, maize-mustard and pulses-wheat cropping sequences.

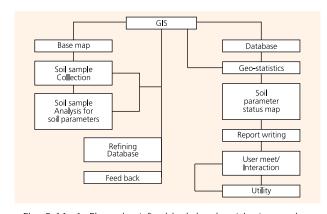


Fig. 2.11v.1. Flow chart for block level nutrient mapping



Education and Training

3.1 Post Graduate Education in Land Resource Management (LRM)

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

At the HQrs, Nagpur, this programme is coordinated by the Division of Land Use Planning, NBSS&LUP, Nagpur. The programme witnessed two major developments, namely, signing of revised memorandum of understanding (MOU) between the two institutions and revision of course curricula of both M.Sc. and Ph.D. progammes.

The programme has two major components.

- Teaching
- 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 2008-09	103	17	-	-	-	-	-	-	-	-
On Roll	6	03	-	-	-	-	-	-	-	-

3.1a HQrs. Nagpur

3.1a (i) Post Graduate Teaching

Courses offered for M.Sc. programme: The following courses are offered at NBSS&LUP, Nagpur

Course No.	Title	Credit	Course Leader & Associates
SSAC-517	Introduction to Land Resource Management	(2+0)	Course Leader : Dr. T.K. Sen Associates : Dr. Jagdish Prasad Dr. B.P. Bhaskar Dr. N.G. Patil Dr. T.N. Hajare Dr. P. Chandran
SSAC-518	Land Evaluation	(2+1)	Course Leader : Dr. A.K. Maji Associates : Dr. Jagdish Prasad Dr. D.K. Manda Dr. S. Chatterji Dr. S.N. Goswami

cont...

Course No.	Title	Credit	Course Leader & Associates
SSAC-519	Techniques in Land Resource Management	(1+1)	Course Leader : Dr. Jagdish Prasad Associates : Dr. R. Srivastava Dr. D.K. Mandal Dr. S.K. Ray Dr. N.G. Patil
SSAC-505	Seminar	(0+1)	Course Leader : Dr. S. Chatterji Associates : Dr. S.K. Ray Dr. M.S.S. Nagaraju
Courses offe	ered for Ph.D.		
SSAC-802	Advanced Soil Genesis	(2+0)	Course Leader : Dr. D.K. Pal Associates : Dr. Sohan Lal Dr. T. Bhattacharyya Dr. S.K. Ray Dr. P. Chandran
SSAC -805	Visual and digital interpretation Techniques in Soil Mapping	(2+1)	Course Leader : Dr. A.K. Maji Associates : Dr. R. Srivastava Dr. M.S.S. Nagaraju
SSAC -806	Geo-information and Land Information Technique	(2+1)	Course Leader: Dr. A.K. Maji Associates: Dr. A. Chaturvedi Dr. (Mrs.) C. Mandal
SSAC -810	Advance Soil Mineralogy	(2+1)	Course Leader: Dr. D.K. Pal Associates: Dr. T. Bhattacharyya Dr. P. Chandran Dr. S.K. Ray
SSAC -890	Seminar	(0+1)	Course Leader : Dr. S. Chatterji Associates : Dr. S.K. Ray Dr. M.S.S. Nagaraju

3.1a (ii) Research

M.Sc. Programme

The following M.Sc. (LRM) students were admitted in 2007 at Dr. PDKV, Akola and later joined NBSS&LUP in Sept. 2008 for their specialized course in LRM and have completed their courses and have submitted their theses.

S. No.	Name of student	Name of Chairman	Thesis Title
1.	Ms. Chetna K. Likhar	Dr. Jagdish Prasad	Characterization and productivity assessment of some orange growing soils developed on different parent materials in Nagpur district, Maharashtra.
2.	Ms. Deepali V. Balbudhe	Dr. T. Bhattacharyya	Some paddy growing soils of eastern Vidarbha : their genesis, mineralogy and classification.
3.	Ms. Vrushali V. Deshmukh	Dr. S.K. Ray	Determination of layer charge after removal of hydroxy-interlayers in some shrink-swell soil clays of Maharashtra.
4.	Mr. Amol Gaikwad	Dr. T.K. Sen	Soil-landscape relationship in Bhandara district, Maharashtra.

The following M.Sc. (LRM) students were admitted in 2008 at Dr. PDKV, Akola who later joined NBSS&LUP in July, 2009 for their specialized courses in LRM. They have completed their course work and are, at present, engaged in research work for their theses. Names of the students and their guides are mentioned below along with the thesis title.

S. No.	Name of student	Name of Guide	Thesis Title
1.	Mr. Ninad S. Wagh	Dr. D.K. Mandal	Characterization of soils and agro-climate of sunflower growing areas in eastern Vidarbha.
2.	Mr. Ganesh H. Bamble	Dr. M.S.S. Nagaraju	Characterization and evaluation of land resources in Saraswati Watershed of Buldhana district of Maharashtra.
3.	Ms. Nilima S. Sadashiv	Dr. S. Chatterji	Application of crop model for quantification of yield gap of cotton in Wardha district of Maharashtra.
4.	Ms. Ashwini H. Kolhe	Dr. P. Chandran	Characteristics and genesis of red, swell-shrink soils of Hingoli district of Maharashtra.

Ph.D. Programme

The following students have submitted their theses.

S. No	. Name of student	Name of Guide	Thesis Title
1.	Ms. Preeti C. Solanke	Dr. Rajeev Srivastava	Spectral reflectance characteristics of Vertisols and associated soils in Nagpur district of Maharashtra.
2.	Mr. R.A. Nasre	Dr. A.K. Maji	Land evaluation of Karanji watershed of Yavatmal district, Maharashtra using remote sensing and GIS techniques.

New admission

Six students registered for M.Sc. (LRM) course during the 2008-09 academic session. They are currently pursuing coursework at Dr. P.D.K.V., Akola.

The salient findings of the research work carried out by the M.Sc. (LRM) students of 2007 batch are given below.

☐ Soil-landscape Relationship in Bhandara District, Maharashtra

Student : Mr. Amol Gaikwad

Chairman: Dr. T.K. Sen

- An attempt was made to establish soil-landscape relationship in a transect of Bhandara district, Maharashtra. Five physiographic units namely plateau, ridges, upper piedmont, lower piedmont and old flood plain were identified
- Morphological, physical and chemical properties of soils showed variation in pedogenic development of the soils with respect to their physiographic

position. Land use was also observed to be governed by the soil-landscape relationship. The soils occurring on different physiographic units were Lithic Ustorthents (Plateau), Typic Haplustepts (Upper Piedmont), Vertic Haplutsepts (Upper Piedmont), Typic Haplusterts (Lower piedmont), and Fluventic Haplustepts (Flood Plain).

Determination of layer charge after removal of hydroryl-inter layers in some shrink-swell soil clays of Maharashtra

Student : Ms. Vrushali V. Deshmukh

Chairman : Dr. S.K. Ray

- Removal of hydroxy-interlayering by 0.25 (N)EDTA solution (pH 7.0) has been very effective for the fine clays of Seloo and Saikhindi soils.
- The layer charge of the fine clays decreased compared to that of the original after removal of hydroxy-interlayers.
- The method enabled one to estimate the actual layer charge of fine clay smectites of Seloo and

Saikhindi soils of alkylammonium method, the value of which may otherwise be incorrect due to hinderances from hydroxy-interlayers materials.

☐ Paddy growing soils of eastern Vidarbha: their genesis, mineralogy and classification

: Ms. Deepali V. Balbudhe Student Chairman: Dr. T.Bhattacharyya

- Similarity exists in mineral make-up in soils of the humid part of the western Ghats and the present study shows similar mode of mineral transformation (Sm→Sm/K) and soil formation in the eastern Vidarbha.
- The dissimilarity lies in the formation of CaCO₃ in the soils of eastern Vidarbha when compared to soils of the western Ghats (Plateau), which indicated change in climate and initiation of soil degradation.
- ☐ Characterization and productivity assessment of some orange- growing soils developed on different parent materials in Nagpur district, Maharashtra

Student : Ms. Chetna K. Likhar Chairman: Dr. Jagdish Prasad

- The physical and chemical properties of soils were greatly influenced by different parent materials.
- The soils developed over basaltic/mixed alluvium although have deeper solum associated with higher clay but pose problem of drainage and sub-soil sodicity and these resulted in alternate bearing. Contrary to this, shallow soils provide better drainage owing to underlying saprolite that induce flowering (regular flowering) but low weathering front limit the water/nutrient availability (unless externally supplied) thus significantly affecting the longevity of plants.
- The Riquier productivity index appears to be more reliable as compared to Storie index, notwithstanding that these ratings are not in reliance with the Sys method and proposed suitability evaluation and yield of oranges realized.

3.1b Regional Centre, Bangalore

- Four M.Sc and one Ph.D students from Dept. of Soil Science, UAS Bangalore, are working under the guidance of NBSS Scientists.
- Mr. Mohammed Feizian, the PhD. Scholar is working under Dr. K.M. Nair's supervision is carrying out his research work on Soil Salinity and

- Alkalinity in parts of Tumkur and Chitradurga districts, Karnataka
- Mrs. Kumari Roopa, the PhD. Scholar is working under Dr.A. Natarajan's guidance was awarded doctorate degree in 2009.
- Ms Sheela Rani and Ms. Nalina Postgraduate student from Department of Soil Science, GKVK is carrying out research in NBSS lab under the guidance of Dr. K. S. Anil Kumar.

3.1c Regional Centre, Kolkata

The Regional Centre, Kolkata signed a TMOU with Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Dist. Nadia, West Bengal to undertake a joint collaborative project on Post Graduate teaching under the discipline of Soil Science and Agricultural Chemistry with specialization in land resource management (LRM). The course is continuing with BCKV since 1999 and following courses offered to M.Sc. (Ag.) students.

The Regional Centre, Kolkata undertakes a collaborative programme with Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal on Post Graduate teaching in Soil Science and Agricultural Chemistry with specialization in land resource management (LRM). The programme is continuing with BCKV since 1999 and following courses offered to M.Sc. (Ag.) students.

(a) Title of the course: Soil Genesis and

Classification

Course No. : ACSS-508

Course Leader : Prof. P.K. Mukhopadhyay,

BCKV

Instructor : Dr. D.C. Nayak, NBSS&LUP Associates : Dr. Dipak Dutta, NBSS&LUP

Total Number of : 14

students

students

Name of the

: 1.

Ms. Ruma Das

2. Sh. Amit Phoglosa Sh. Sudip Pukhait

Sh. Arindam Sarkar

5. Sh. Subhra Jyoti Das

Sh. Avik Basu 6.

7. Sh. Sujan Kumar Ghosh

Sh. Indrajit Ghosh

Ms. Sanchita Biswas 10. Sh. Mamunur Rasid

11. Sh. Saibal Mitra

12. Sh. Santosh Kumar Roy

13. Kh. Chandra Kumar Singh

14. Sh. Allan Perry Ch. Momin

(b) Title of the course: Remote Sensing and its

Application

Course No. : ACSS-754

Course Leader : Prof. S. Mallick, BCKV

Instructor : Dr. S.K. Gangopadhyay,

NBSS&LUP

Associates : Prof. S.S. Sahu, BCKV

: Dr. D. S. Singh, NBSS & LUP

: Dr. D. C. Nayak, NBSS &LUP

Total Number of : 2

students

Name of the : 1. Ms. Samprikta Biswas students 2. Sh. Subhashis Soren

3.1d Regional Centre, Udaipur

Scientists of the centre are associated with Maharana Pratap University of Agriculture and Technology, Udaipur with post graduate teaching and research guidance to M.Sc., B.E., M.E. and Ph.D. students.

3.2 Training Organized

Summer School at Regional Centre, Bangalore

• ICAR sponsored Summer School on "Land Resource Variability and its Appraisal for precision farming in Indian Agriculture" was organized from 30th June to 20th July 2009 for the period of 21 days at Regional Centre, Bangalore. In all 15 participants from Maharashtra, Andhra Pradesh, Kerala, Tamil Nadu and Karnataka states attended in the winter school.

Winter School at Regional Centre, Bangalore

 ICAR sponsored Winter school on "Technological Advances in Land Resource Appraisal, Planning and Management" was organized from 21st October to 10th November, 09. 21 participants from Gujarat, Maharashtra, Andhra Pradesh, Kerala, Tamil Nadu and Karnataka states attended in the winter school.



Dr. Dipak Sarkar, Director on inauguration day of winter school (21st October, 09)

Winter School at H.Qrs., Nagpur

 ICAR sponsored Winter school on "Advances in Remote Sensing, GIS and GPS Applications in Watershed Management" was organized between 12th November and 2nd December, 2009. In the training, 17 officers from different ICAR institutes and SAU's participated.



A view of the inaugural function



View of the valedictory function of the programme

Other need based trainings organized

- Organized two days training program from 24-25th February 2010 to the newly recruited Assistant Directors of Agriculture of Karnataka government on Land resources of the state.
- ICAR sponsored Summer school training program on "Land resources variability and its appraisal for precision farming in Indian Agriculture" was organized from 30th June to 20th July 2009. About 15 participants from Assam, Uttar Pradesh, Tamil Nadu, Kerala, Puducherry, Karnataka and Andhra Pradesh attended the training programme.
- Organized soil monolith preparation training to Technical Assistants of Bureau from 9-18th September 2009. Ten participants from Delhi, Jorhat, Kolkata, Udaipur and Nagpur Centres of the Bureau attended the training.
- Eleven newly recruited scientists and technical officers of NBSS&LUP had undertaken Orientation Training in Soil Survey and Mapping. They visited Regional Centres, Delhi, Udaipur and H.Qrs. at Nagpur. In all the three centres soils were studied in typical land form area and the existing soil-landform relationships were explained to them.

Interaction Meeting

Scientists Interaction Meet was organized from 8-12th Oct. 2009 to give orientation to have common survey methodology among the scientists of Bureau.



Inauguration of Interaction Meet



Field visit at Doddaballapur, Bangalore district

3.3 Training received

The training attended by scientist/technical officers are as follows:

S. No.	Name	Training programme	Dates	Duration
1.	Dr. G.P. Obi Reddy, Sr. Scientist	Microwave Remote Sensing	24 Feb. to 05 Mar. 2010	2 weeks
2.	Dr. S. Srinivas, Sr. Scientist	Recent Advances in Web Technologies for information management in Agriculture	16 Feb. to 08 Mar. 2010	3 weeks
3.	Dr. S. Bandyopadhyay, Scientist Sh. P.K Dutta, T-4 Sh. P.R. Gogoi, T-4 Mrs. S. Chetiyar, T-3 Sh. V. Mohan, T-4 Sh. A. Baruah, T-1	TNT Mips	14-16 Sept. 2009	3 days
4.	Sh. Nirmal Kumar, Scientist Sh. S.S. Sharma, T-5 Sh. V. Mohan, T-4	Remote sensing and GIS technology and application	14 Dec. 2009 to 05 Mar. 2010	3 months
5.	Dr. G.P. Obi Reddy, Sr. Scientist Sh. Sunil Meshram, T-4	Professional training of ER-Mapper/ERDAS imagine software		5 days

S. No.	Name	Training programme	Dates	Duration
6.	12 Technical Officers	Preparation of Micromonoliths	9-18 Sept. 2009	2 weeks
7.	Sh. Sunil Meshram, T-4	Web design methodologies and Protocols	8-18 Sept. 2009	10 days
8.	Dr.Manoj Kumar Mahla, T-7	Field orientation	20 Feb. 2009 to 07 May 2009	2 weeks
9.	Dr. S.S. Sharma, T-5	Remote sensing & GIS Technology & Applications organized by National Remote Sensing Centre, ISRO, Hyderabad	14 Dec. 2009 to 05 Mar. 2010	12 weeks
10.	Mr. D.L. Oad, T-4	Preparation of Monolith	09 Sep. 2009 to 18 Sep. 2009	10 days
11.	Mr.N.R. Ola, T-3	Preparation of Monolith	09 Sep. 2009 to 18 Sep. 2009	10 days

Interview and radio talks

- Rajendra Hedge gave a radio talk on "Significance of world meteorological day" (23rd March 09), AIR Bangalore.
- Rajendra Hedge gave radio interview on "Composting of organic wastes for the organic farming" (23-9-2009), AIR, Bangalore Farm and Home section.



Technology Assessed and Transferred

- The district and theme based atlases and district soil resource reports provide database on natural resources to formulate soil and water conservation programme, watershed management and crop planning.
- Pedological studies on soil genesis and mineral transformation helps comprehending basics of soil information to develop model understanding for soils of the Indo-Gangetic Plains (IGP) and Black Soil Regions (BSR).
- Evaluation of soil-site suitability criteria for specific crop will benefit in choosing on scientific footing and economically viable crops and cropping systems in a given area to ensure sustainability

- To reduce the emission of CO₂, carbon capture and storage (CCS) techniques is an important option. NBSS&LUP has developed the technique to show that soil can act as a potential medium for CCS.
- Soil, carbon and crop modelling techniques help in preparing set of management interventions for better crop planning.
- Agro-ecological zoning helps in crop planning based on growing period concept to overcome the adverse effects of drought, manifested through intermittent dry spell and early withdrawal of rains or delayed monsoon. This has been validated by daily/weakly rainfall and other climatic data of few sites.

Section and Unit

5.1 TECHNICAL CELL

5.1a The following jobs were undertaken and accomplished

- Monitoring day-to-day Technical/Scientific work and achievements of the Bureau
- Collection, storing and dissemination of scientific and technical information on soils to the various institutes as per demand
- Maintenance of scientific/technical files, consultancy projects and QRT files
- Necessary action on various technical papers/ letters received from Director
- Preparation of Bureau's reports for DARE and **ICAR Annual Report**
- Preparation of Quarterly target and progress report
- Monitoring of progress of research project of each scientists (six monthly) i.e. from Jan-June 2009 and July-Dec. 2009
- Preparation of scientific papers and computerized slides for presentation by the Director at National/ International Seminars and Workshops organized by the different Scientific Societies/Institutions

- Preparation of material for Directors' Conference held at Council
- Providing audio visual support during Seminars/ Workshops
- Preparation of tables, charts and other display materials on the activities of the Institute
- Compilation and finalization of Annual Report of the Institute
- Technical inputs for finalization of publications of the research bulletins, technical reports etc.

Monitoring of Bureau's research projects mentioned below

- On going projects (Institutional) 62
- DST sponsored 02
- Externally aided consultancy projects 07
- NAIP Projects (4)
 - As Consortium Lead Institute 02
 - As Consortium Partner : 02

5.2 LIBRARY & DOCUMENTATION UNIT

Library Resources Development

- The Library & Documentation Unit procured 202 documents including 54 books; and 148 annual reports. The total collection of the library as on 31.3.2010 was 14995 including bound journals.
- The unit subscribes 27 foreign and 32 Indian
- journals for Hqrs., besides 16 journals for Regional Centre libraries. The total collection of bound journals as on 31.3.2010 was 2927.
- During reporting period, 758 readers visited the library. A total of 3440documents were issued, 3735 documents were returned and 5392 documents were consulted.

Documentation Services

Current Titles Announcement Service (CTAS)

It is a fortnightly in-house publication based on receipt of current journals in the library. The content page of all subscribed journals are photocopied and distributed to all Centres/Divisions/Sections of the Bureau; this keeps the scientific and technical staff abreast of the latest information received in the library. Twenty four issues were brought out during 2009.

Library Automation Software

Library Automation Software, SOUL (Software for University Libraries) developed by UGC is being used for library automation work. Data input of each book in the software is completed. Generation of Barcode labels for each book is also completed. Computerised issue - return service is in operation.

Marketing of Information Services

We are marketing our in-house information product viz Current Title Announcement Service (CTAS) as an effort to consolidate, compile and distribute information among perspective customers.

CD-ROM Service

International bibliographic database viz, CABI, AGRIS, and AGRICOLA in CD-ROM is updated this year also. Tulsient CD Mirror Server has been installed and under LAN, the CD-ROM databases are accessed through 10 nodes spread over two buildings of the Bureau.

Following CD-ROM databases are available

•	CABI Database	(1972 to present)-CABI,

U.K.

AGRIS Database (1975 to present)-FAO,

AGRICOLA Database (1970 to present)- USDA,

USA

SOIL CD (1973 to present) CABI, U.K.

These databases have been extensively used by research staff, M.Sc., Ph.D. students and others from different institutes in and around Nagpur City. The user agencies in the country have been informed about availability of these databases. Search and retrieval services have been provided at nominal charges both hard and soft copy format.

ISBN to NBSSLUP Publications

NBSSLUP publishes wide variety of publications in the form of annual report, research/technical bulletins and thematic maps of India as well as different states.

Till date, ISBN/ISSN numbers were allocated to 146 NBSS publications and copies of each of these are sent to concerned agencies for inclusion in their database. The publications were sent to prominent journals, abstracting/indexing services for review purpose in order to facilitate wider information dissemination.

News Paper Clipping Service

The library is receiving 7 newspapers and two periodicals. The relevant paper clipping are brought to the notice of the staff of the Bureau.

Centralised Services

The Unit provides centralised services like photocopying comb/thermal binding and lamination of documents/ map sheets, etc.

Photocopying services provided to library visitors (other than bureau's staff) fetched amount of Rs. 1470.00.

Library Services through LAN

- Five Computer nodes have been provided for access to library information system from where bibliographic searching with various query mode is available. E-Mail and Internet facilities have also been provided to two computers.
- Browsing of international libraries through Internet is in full operation. Subscribed online electronic journals and down loading was done using Internet facility. It is planned to go into subscription of more number of electronic journals in the coming years.
- CD-ROM reading/writing facility has been installed in the library for downloading electronic journals, articles and access to publisher's catalogues.
- Online agricultural statistics database "Indiastat.com" was subscribed during the period. The readers made extensive use of this database.

On-line Portals/Journals through CeRA (NAIP)

CeRA (Consortium of e-Resources in Agriculture) is consortium of e-journals (full text), a project under NAIP, ICAR which provides access to 123 libraries of National Agriculture Research System (NARS) for the years 2008-10. The Bureau is also one of the beneficiaries

of this initiative. Presently, a total of 1342 on-line full text journals of following publishers are available on CeRA.

- **i. Springer link:** It is a platform of Springer and provides on-line access to 1314 journals on different subjects published by Springer.
- **ii. Annual Reviews:** Annual Reviews are authoritative, analytic reviews on 34 focused disciplines within the Biomedical, Life Sciences,

Physical Sciences, and Social Sciences. Users can access the full text of articles from 1990 onwards.

iii. CSIRO (Australia): Australia's Commonwealth Scientific and Industrial Organization (CSIRO) provides access to full text of articles.

The above e-resources can be accessed by visiting URL: http://www.cera.jccc.in through Local Area Networking facility (LAN) of NBSS&LUP.

5.3 PRINTING SECTION

Technical and Scientific Publications

1. NBSS&LUP Publications 1976-2008 (updated)

Publ. No. 18

Print Order - 200 copies

Volume of work – XVII + XIV + 142 pages of text in Black & White

2. Soil Taxonomic Database of India and the States (1:250,000 scale)

Publ. No. 143

Print Order – 500 copies

Volume of work XII + 266 pages of text all in 4 colours

3. Soil based Agro Technologies for Livelihood Improvement

Publ. No. 144

Print Order – 500 copies

Volume of work XII + 44 pages of text all in 4 colours

4. Soil Survey Manual

Publ. No. 146

Print Order – 500 copies

Volume of work XII + 400 pages of text all in 4 colours

5. Field Guide for Soil Survey

Print Order - 500 copies

Volume of work VIII + 74pages of text all in 4 colours

Annual Report

NBSS&LUP 2008-2009 Print Order – 350 copies Volume of work XVI + 184 pages of text all in 4 colours

Brochure/Catalogue

- Services Offered by NBSS & LUP
 Print Order 1000 copies
 Volume of work 12 + IV All in 4 colours
- NBSS & LUP Publication Catalogue Print Order – 1500 copies Volume of work –IV + 8 All in 4 colours

Map

- 1. Uttarakhand Soil Loss Map
- 2. Jharkhand Soil Loss Map
- 3. Orissa Soil Loss Map

Newsletter

NBSS&LUP Jan-June 2009, Print Order – 300 NBSS&LUP July-Dec. 2009, Print Order – 300

Stationery

Director's Letterhead – A-4 – 1000 copies

Director's Letterhead – B-5 – 1000 copies

Letterhead of Regional Centre, Kolkata for Head –500 copies

Letterhead of Regional Centre, Kolkata for AAO –500 copies

Letterhead of Regional Centre, Kolkata for Office –500 copies

Pedon Description form – Site Characteristics (new format) – 1500 copies

5.4 PUBLICATION SALE UNIT

Sale of NBSS Publications for the period from 1.4.2009 to 31.3.2010

SRM Map and Bulletin

Sr. No.	Name of SRM Map+Bull.	Sold Map	Sold Bulletin	Amount Received
1.	West Bengal	4set	4bull	18000/-
2.	Puducherry.& Karaikal	2set	2bull	4000/-
3.	Gujarat	6set	6bull	27000/-
4.	Haryana	4set	4bull	10000/-
5.	Punjab	5set	5bull	12500/-
6.	Tamil Nadu	4set	4bull	18000/-
7.	Karnataka	4set	4bull	18000/-
8.	Kerala	2set	2bull	5000/-
9.	Orissa	3set	3bull	13500/-
10.	Bihar	8set	8bull	36000/-
11.	Rajasthan	3set	3bull	19500/-
12.	Meghalaya	4set	4bull	6000/-
13.	Maharashtra	13set		78000/-
	Marathi version		7bull	700/-
14.	Arunachal Pradesh	3set	3bull	7500/-
15.	Manipur	3set	3bull	4500/-
16.	Himachal Pradesh	5set	5bull	12500/-
17.	Madhya Pradesh	7set	7bull	66500/-
	Hindi version		6bull	600/-
18.	Sikkim	2set	2bull	9000/-
19.	Andaman - Nicobar		1bull	500/-
20.	Jammu & Kashmir	4set	4bull	18000/-
21.	Tripura	4set	4bull	14000/-
22.	Assam	3set	3bull	7500/-
	Nagaland	3set	3bull	4500/-
24.	Uttar Pradesh	3set	3bull	19500/-
25.	Andhra Pradesh	3set	3bull	19500/-
26.	Lakshadweep		1bull	500/-
27.	Delhi	5set	5bull	7500/-
28.	Goa	2set	2bull	5000/-
29.	Mizoram	3set	3bull	4500/-
30.	Soil Map of India	2set	2bull	24000/-
	A. Map+Bull	114 set	+ 115bull	4,91,800/-

Technical Bulletin: 1.4.2009 to 31.3.2010

Sr. No.	Name of Research Tech. Bulletin	No. of Bulletin	Amount Received
1.	AESR-Bull.No.35	5 set	10000/-
2.	Soil Series Criteria & Norms-36	2 bull	50/-
3.	Soil Climatic Database53	5 bull	3000/-
4.	Soil Climatic Envi. in India-58	2bull	200/-
5.	Soil Based Land Use Planning Series-63	1bull	100/-
6.	Soil Monoliths-64	1bull	100/-
7.	Madhubani-76	-	100/
8.	Bhopal Atlas-77	_	_
9.	Soil Series of M.P-78	4bull	800/-
10.	Soil Series of M.S-79	17bull	2550/-
11.	Guna Atlas-80	-	2000/
12.	Agro-ecological assessment of soil reso.of Rajasthan-81	_	_
13	Soil Erosion of M.S82(E.V.)	9set	3600/-
10	Soil Erosion of M.S82(M.V.)	6 bull	600/-
14.	Climatic change and polygenesis in Vertisols-no.83	3 bull	150/-
15.	Soil Series of Chhattisgarh-85	2bull	300/-
16.	Significance of minNBSS RS-1	6bull	750/-
17.	Soil Resource Atlas Betul Distt.no -86	-	-
18.	Sukli Bull.No.87	_	_
19.	Soils of Hugli-No.88	_	-
20.	Soil Series of WB-89	4bull	480/-
21.	Dhar Atlas-90	1bull	250/-
22.	Soil Series of Goa-92	1bull	125/-
23.	Soil Resource Atlas Bilaspur-95	-	-
24.	Soil Series of Rajasthan-96	3bull	675/-
25.	Soil Erosion Map of Tripura-97	2set	300/-
26.	Soil Series of Bihar-98	2bull	300/-
27.	Soils of Ajmer dist.Bull.No.99	-	-
28.	Soil Resource Atlas Chhindwara Distt.no -100	_	-
29.	Soil Series of Assam-101	1bull	200/-
30.	Soil Erosion. Rajasthan-102	1set	400/-
31.	Soil Ero.of Chhattisgarh-103	4set	800/-
32.	Jagdalpur Atlas-104	-	<u>-</u>
33.	Soil Series of Sikkim-105	3bull	450/-
34.	Soil Erosion of M.P-106	3set	750/-
35.	Soil Resource Atlas Jorhat -107	-	-
36.	Salt affected Etah dist. no.108	-	-
37.	Soil Series of Nagaland109	3bull	300/-
38.	Soil Series Tripura-111	3bull	300/-
39.	Soil Series of Delhi -112	1bull	150/-

Sr. No.	Name of Research Tech. Bulletin	No. of Bulletin	Amount Received
40.	Udaipur bull. No.113	-	-
41.	A.P. Erosion,-114	-	-
42.	Wardha Atlas-116	1bull	350/-
43.	Assam Erosion-118	3set	300/-
44.	Soil Series of Orissa -119	7bull	1050/-
45.	Soil Series of Gujarat-120	11bull	2200/-
46.	Soil Series of Meghalaya-121	1bull	150/-
47.	Soil Erosion of Bihar-125	-	-
48.	Soil Erosion of Orissa-126	-	-
49.	Soil Series of Medak distt (A.P.) no.127	1bull	100/-
50.	Benchmark soils of A.P128	6bull	600/-
51.	Manual soil-site suitability-criteria for Major crops-129	16bull	3200/-
52.	Land use planning of Cherrapunji-131	-	-
53.	Soil Series of Manipur-134	3bull	300/-
54.	Land Resources of Medak dist791	1bull	350/-
55.	Soil Reso.for land use planning Balaghat dist.M.P827	-	-
56.	Gujarat Erosion Map-	-	-
57.	Karnataka Erosion Map	-	-
58.	Soil Erosion of W.B. (bull)117	6set	1200/-
59.	Soil Resource-Jalna dist-122	-	-
60.	Soil Series of Kerala, no.136	2bull	300/-
61.	Management of Acid soils in NEH Region	1bull	75/-
62.	Soil of Bhilwara no-135	-	-
63.	Soil Erosion Manipur (bull)-138	-	-
64.	Optimising Land Use of Birbhum Distt. (W.B.) -130	4bull	800/-
65.	Land Resource Management N.B.S.S -133	6bull	1500/-
66.	Soil Loss of Kerla Map	-	-
67.	Soil Loss of Tamilnadu Map	-	-
68.	Perspective Land Use Plan of Puducherry publl.no142	4bull	2000/-
69.	Mineralogy of Benchmark Soil W.B Bull.no.139	6bull	1500/-
70.	Soil Based Agro Technologies for Livelihood Improvement no.1	44 5bull	1000/-
71.	Soil Loss of Uttarakhand	-	-
72.	Soil Loss of Jharkhand	-	-
73.	Soil Survey Manual publ.no. 146	-	-
74.	Field Guide for Soil Survey	-	-
	B. Total	179 bull	44,655/-
	C. Payment received from HRC		1,43,290/-
	D. Soil Analysis Charges		94,979/-
	E. Grand Total (A+B+C+D)		7,74,724/-

List of New Publication received during the year 2009-10

Sr. No	Name of the publication	Publ. No.	Printed copies
1.	Mineralogy of Benchmark Soil West Bengal	139	244
2.	Soil Based Agro Technologies for Livelihood Improvement	144	499
3.	Soil Loss of Uttarakhand	-	250
4.	Soil Loss of Jharkhand	-	250
5.	Soil Survey Manual	146	489
6.	Field Guide for Soil Survey	-	490

During the period from 01.04.2009 to 31.03.2010 organized two Sales and Publication Committee meeting and fixed the prices of New Publication, review the cost of old publications.

5.5 ARIS CELL

The main activities of ARIS cell are maintenance and providing e-mail, internet facility, developing and maintenance of Institute website and video conferencing systems and other computer related work including system management in the Institute.

Management of Network

- Management of Internet and E-mail services. Monitoring the Server, client machine and signal of network and protect the system against viruses, trojan and spyware etc.
- Management of Institute network, server end and client end.
- Maintenance of Internet Server, E-mail Server, Firewall Server and Cyberoam system [Unified Threat Management].

LAN Network

Replacement of Internet switches of server room and old building i.e. Server Room CISCO Gigabit SX-LC mini-GBIC with SC-LC fiber patch cord and HP ProCurve-1700-24 port Gigabit Switches - 3 no. and installation of one Hp ProCurve-1700 switch in RSA division. Laying of UTP Cat-6 cable 305 mtrs, Fixing of communication 6U Rack, Laying of 100 mtrs. casing & PVC pipe, network project (communication rack), Cable Identification/Proper SMB, Fixing cable labeling at the front SMB & Jack Panel/Cable dressing.

New Connection of Internet

Five new connections to the users i.e. two each in the Divisions of Soil Resource Studies and Remote Sensing Application and one in Cartographic Unit were provided.

Internet Service

Provided support to different users on three aspect i.e. Antivirus & Antispam, Web & Application filter and Intrusion detection & Prevention (IDP). Configuration of Server and 50 users in the Cyberoam. Create users of Cyberoam in the server for accessing the internet services, creating user accounts, modification of users account in the server, creating the internet access policies in the server.

Management of Institute website

The staff of GIs section are also involved in designing and updating of the institute website.

Maintenance of Video conferencing system

Video Conference Unit was maintained with frequent checks on the incoming/outgoing link. The IP based video conferencing system was installed in the institute under the system signal receiver at ARIS cell, Video codec and plasma panel were installed in the committee room. Under this system two locations can be connected to see and hear the other end of the communication site.

5.6 हिन्दी अनुभाग

राजभाषा अधिनियम, 1963 और उसके अंतर्गत बने राजभाषा नियम, 1976 के अनुपालन एवं राजभाषा विभाग (भारत सरकार)/भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली द्वारा समय-समय पर जारी किए जाने वाले 'वार्षिक कार्यक्रम' में निर्धारित लक्ष्यों को पूर्ण करने के उद्देश्य से ब्यूरो (मुख्यालय), नागपुर में **'हिन्दी अनुभाग'** कार्यरत है।

हिन्दी प्रकाशनः वार्षिक हिन्दी कृषि पत्रिका 'मृदा दर्पण' वार्षिक हिन्दी पत्रिका 'धरती' का प्रकाशन इस वर्ष के अंतर्गत किया गया।

हिन्दी सप्ताह का आयोजनः ब्यूरो (मुख्यालय), नागपुर तथा उसके 5 क्षेत्रीय केन्द्रों (नई दिल्ली/उदयपुर/बैंगलुरू/कोलकाता एवं जोरहाट) में 'हिन्दी सप्ताह समारोह' (दिनांक: 14-20 सितम्बर, 2009) का आयोजन किया गया और इस सप्ताह के अंतर्गत राजभाषा (हिन्दी) से संबंधित विभिन्न प्रतियोगिताओं का भी आयोजन बड़े उत्साहपूर्ण वातावरण में किया गया, जिसमें संस्थान के अधिकांश अधिकारियों/ कर्मचारियों ने सक्रिय रूप से भाग लिया।

संयुक्त राजभाषा कार्यान्वयन समिति की बैठकें: संस्थान में राजभाषा (हिन्दी) की प्रगति एवं त्रैमासिक रिपोर्ट की समीक्षा करने हेतु तथा राजभाषा विभाग (भारत सरकार)/भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली द्वारा जारी 'वार्षिक कार्यक्रम' में 'क', 'ख' एवं 'ग' क्षेत्रों हेतू निर्धारित लक्ष्यों को पूर्ण करने के उद्देश्य से इस वर्ष समिति की तीन बैठकों का आयोजन किया गया।

1. दिनांक : 12.04.2009 2. दिनांक : 31.07.2009 3. दिनांक : 24.11.2009

हिन्दी कार्यशाला

1. वैज्ञानिक/तकनीकी एवं प्रशासनिक संवर्ग के कार्मिकों हेत् क्षेत्रीय केन्द्र, बैंगलुरू में एक दिवसीय 'हिन्दी कार्यशाला' का सफल आयोजन किया गया।

प्रोत्साहन योजना: वर्ष 2009 में अपना सरकारी काम-काज मुल रूप से हिन्दी में कर रहे अधिकारियों/कर्मचारियों को **'प्रोत्साहन योजना'** के अंतर्गत निम्नानुसार नकद पुरस्कार वितरित किए गए।

श्रीमती एस.के. हयात, पी.ए.	प्रथम-1	रु. 800∕-
श्रीमती विमल खराबे, उच्च श्रेणी लिपिक	प्रथम-2	रु. 800/-
श्री एम.एम. भगत, क्षेत्रीय सहायक (टी-1)	द्वितीय-1	रु. 400/-
श्री टी.टी. रामटेके, निम्न श्रेणी लिपिक	द्वितीय-2	रु. 400/-
श्रीमती गिरीजा रंगारी, सहायक प्रशा अः	द्वितीय-3	रु. 400/-
(क्षे.के., उदयपुर)		
श्री आर एन. झांबरे, वाहन चालक (टी-3)	तृतीय-1	रु. 300/-
श्री आर.एम. तोहगांवकर, वाहन चालक (टी-5)	तृतीय-2	रु. 300/-
श्री एम.डी. कढ़व, वाहन चालक (टी-3)	तृतीय-3	रु. 300/-
श्री अम्बा लाल भोई, वाहन चालक (टी-1)	तृतीय-4	₹. 300/-
श्री ए.एन. पवार, वाहन चालक (टी-5)	ततीय-5	रु. 300/-
	श्रीमती विमल खराबे, उच्च श्रेणी लिपिक श्री एम.एम. भगत, क्षेत्रीय सहायक (टी-1) श्री टी.टी. रामटेके, निम्न श्रेणी लिपिक श्रीमती गिरीजा रंगारी, सहायक प्रशा.अ. (क्षे.के., उदयपुर) श्री आर.एन. झांबरे, वाहन चालक (टी-3) श्री आर.एम. तोहगांवकर, वाहन चालक (टी-5) श्री एम.डी. कढ़व, वाहन चालक (टी-3) श्री अम्बा लाल भोई, वाहन चालक (टी-1)	श्रीमती विमल खराबे, उच्च श्रेणी लिपिक प्रथम-2 श्री एम.एम. भगत, क्षेत्रीय सहायक (टी-1) द्वितीय-1 श्री टी.टी. रामटेके, निम्न श्रेणी लिपिक द्वितीय-2 श्रीमती गिरीजा रंगारी, सहायक प्रशा.अ. द्वितीय-3 (क्षे.के., उदयपुर) श्री आर.एन. झांबरे, वाहन चालक (टी-3) तृतीय-1 श्री आर.एम. तोहगांवकर, वाहन चालक (टी-5) तृतीय-2 श्री एम.डी. कढ़व, वाहन चालक (टी-3) तृतीय-3 श्री अम्बा लाल भोई, वाहन चालक (टी-1) तृतीय-4

पुरस्कार

राजिष टंडन राजभाषा पुरस्कारः नई दिल्ली स्थित राष्ट्रीय कृषि विज्ञान केन्द्र के ए.पी. शिन्दे सभागार में माननीय डॉ. मगंला राय, सचिव, कृषि अनुसंधान एवं शिक्षा विभाग, कृषि मंत्रालय (भारत सरकार), नई दिल्ली तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद् की अध्यक्षता में एवं श्री अनिल कुमार उपाध्याय, सचिव, भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली की विशेष उपस्थिति में परिषद् के "स्थापना दिवस" (दिनांक: 16 जुलाई, 2009) के सुअवसर पर आयोजित परिषद् के गरिमामय 'वार्षिक पुरस्कार समारोह' में राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो, नागपुर को 'क' एवं 'ख' क्षेत्र के अन्य संस्थानों की श्रेणी में वर्ष 2008 के दौरान सरकारी कामकाज में हिन्दी के प्रयोग में उल्लेखनीय योगदान देने हेतु समारोह के मुख्य अतिथि माननीय डॉ. फारूक अब्दुल्ला, केन्द्रीय ऊर्जा मंत्री नवीन एवं नवीनीकरण (भारत सरकार) के करकमलों द्वारा "राजर्षि टंडन राजभाषा पुरस्कार - 2008" (द्वितीय पुरस्कार) से सम्मानित किया गया।



संस्थान की ओर से यह पुरस्कार डॉ. दीपक सरकार, निदेशक, रा.म्.सर्वे. एवं भू.उ.नि.ब्यूरो, नागपुर एवं डॉ. महेन्द्र कुमार तेजलाल साहू, तकनीकी अधिकारी (हिन्दी) ने ग्रहण किया।

"धरती" को सर्वोत्कृष्ट हिन्दी गृहपत्रिका का "प्रथम प्ररस्कार": राष्ट्रीय प्रत्यक्ष कर अकादमी, नागपुर के सभागृह में भारत सरकार, गृह मंत्रालय, राजभाषा विभाग के अंतर्गत गठित नगर राजभाषा कार्यान्वयन समिति, नागपुर के गरिमामय 'वार्षिक हिन्दी पुरस्कार वितरण समारोह (दिनांक 28.1.2010)' में नागपुर स्थिति विभिन्न केन्द्रीय कार्यालयों द्वारा प्रकाशित किए जाने वाली हिन्दी गृह पत्रिकाओं को श्रेणी में राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो (भा.कृ.अनु.प.), अमरावती रोड, नागपुर को उसकी सर्वोत्कृष्ट वार्षिक हिन्दी गृह पत्रिका "धरती-2008" के लिए **'प्रथम पुरस्कार'** से मुख्य अतिथि श्री जी जी शुक्ला, महानिदेशक, राष्ट्रीय प्रत्यक्ष कर अकादमी, नागपुर के कर कमलों द्वारा सम्मानित किया गया।



संस्थान की ओर से यह पुरस्कार डॉ. जगदीश प्रसाद, प्रधान वैज्ञानिक एवं सह-सभापति, संयुक्त राजभाषा कार्यान्वयन समिति (रा.मृ.सर्वे. एवं भू.उ. ब्यूरो, नागपुर), श्री राकेश कुमार, वरिष्ठ प्रशासनिक अधिकारी एवं प्रधान संपादक (धरती) तथा उक्त पत्रिका के संपादक डॉ. महेन्द्र कुमार साह्, तकनीकी अधिकारी (रा.भा.) ने ग्रहण किया।

Awards and Recognitions

- Dr. Dipak Sarkar, Director, NBSS & LUP, Nagpur has been honoured with SCSI Special Award 2009 for outstanding leadership on Soils and Agricultural Sciences towards Land Resources Research, Mapping and Planning at national level by Soil Conservation Society of India (SCSI), New Delhi
- Dr. D.K. Pal, Principal Scientist & Head, has been elected as Fellow of the National Academy of Agricultural Sciences, New Delhi in the year 2010.
- Dr. Dipak Sarkar, Director, NBSS&LUP has been elected as a Fellow of the "Indian Society of Agricultural Chemists, Allahabad" for his meritorious contribution towards Indian Agriculture in general and Soil Science in particular.
- Dr. S.K. Ray, Principal Scientist has been elected Fellow of the Maharashtra Academy of Sciences in the field of Agricultural Sciences in the year 2009.
- Dr. A.K.Sahoo has been elected as a fellow of the Institution of Chemists (India) during December 2009.

- Dr(s). T. Bhattacahryya, D.K. Pal, A.M. Ninmje, S.K. Ray, P. Chandran, Mrs. C. Mandal, M. V. Venugopalan, A.S. Deshmukh, B. Telpande and R.R. Deshmukh received Best Poster presentation Award at the National Symposium on "Climate Change and Rainfed Agriculture" for the poster entitled "Effect of global warming on carbon reserves in Kheri soils, Madhya Pradesh" in the thematic area "Climate Change and Natural Resources: Soil, Water and Biodiversity" at CRIDA, Hyderabad during 18-20th February, 2010.
- Dr. (Mrs) Jaya N. Surya et al received Best Poster Presentation Award for the research paper entitled "Land Resources Assessment in Irrigated Agroecosystem for Micro Level Land Use Planning" at Platinum Jubilee Symposium on "Soil Science for Meeting Challenges of Food, Nutritional and Environmental Quality" organized by Indian Society of Soil Science, held during 22-25 December, 2009 at IARI, New Delhi.
- Dr. A.K. Sahoo, Principal Scientist elected as Councilor for 2010-2011 of Indian Society of Soil Science, New Delhi.

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Reports/Bulletins

Anil Kumar, K.S., Ramesh Kumar, S.C., Dhanorkar, B.A., Vadivelu, S., Naidu, L.G.K. and Dipak Sarkar. (2009). Detailed assessment of land and soil resources of Kuppam mandal, Chittoor District, Andhra Pradesh NBSS Publ. No.1030.

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- 4) Jal sandharan NAIP leaflet No. 4
- 5) Matsyasheti NAIP leaflet No. 5
- 6) Harbara lagwad va vyavassthapan NAIP leaflet No. 6
- 7) Adhik dudh utpadanasathi hirvya charyache mahatva NAIP leaflet No. 7
- Success stories (NAIP)

Popular articles

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Interview and radio talks

- Rajendra Hedge gave a radio talk on "Significance of world meteorological day" (23rd March 09), AIR Bangalore.
- Rajendra Hedge gave radio interview on "Composting of organic wastes for the organic farming" (23-9-2009), AIR, Bangalore Farm and Home section.

Book Chapters/Books

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- Prasand S. Thenkabail, Chandrashekhar M. Biradar, Praveen Noojipady, Venkateswarlu Dheeravath, Manohar Velpuri, Obi Reddy P. Gangalakunta and Xueliang L. Cai (2009). A History of irrigated areas of the world. In: Remote Sensing of Global Croplands for Food Security (Eds: S.T. Prasand, J. G. Lyon, T. Hugh and C.M. Biradar), Tylor and Francis Series in Remote sensing Applications (Book Series Editor: Qihao Weng), CRC Press, London, pp 14-40.
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- Ravisankar, T. and Srivastava, Rajeev (2009) Satellite Imagery- their Interpretation and Applications. In: Soil Survey Manual (Eds. T. Bhattacharyya, Dipak Sarkar and D.K. Pal) NBSS&LUP Publ. No. 146, India, pp. 59-71.

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- Sidhu, G.S., Yadav, R.P. and Sharma, J.P. (2009) Soil erosion status in Himachal Pradesh for land use planning. Published in Conservation Farming, Post Publication of 2nd International Conference (Eds. Suraj Bhan, R. L. Karale, Shamsher Singh, V. K. Bharti and J.S. Bali). Published by Soil Conservation Society of India, pp 259-268.
- Singh, A.K. and Singh, R.S. (2009). Soil suitability for crop productivity. Agrotech Publishing Academy. 190 pp.
- Singh, S.K. and Tarafdar, J.C. (2009). Soil quality management in arid region of India. In: Fundamentals and management of Soil Quality (Eds. Ramesh Chandra and Satish Kumar) Westville Publishing House New Delhi, pp-183-206.

- Sinha, A.K. and Nair, K.M. (2009). Digital processing of soil survey information. In :Soil Survey Manual. (Eds. T. Bhattacharyya, Dipak Sarkar, and D.K. Pal). NBSS&LUP Publication No 146. PP 188-201.
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- Velayutham, M. and Bhattacharyya, T. (2009). Soils, In: Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi pp. 181-233.
- Walia, C.S. and Singh, S.P. (2009). Soil-physiography relationship in Indo-Gangetic plain. In: Soil Survey Manual (Eds. T. Bhattacharyya, Dipak Sarkar and D.K. Pal) NBSS&LUP Publ. No. 146, India, pp. 258-276.

Lecture delivered

- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Soil and Land Use Interaction Scenario for Livelihood Security in Tripura in connection with one day seminar on Soil Nutrient Status for Efficient Soil Health Management in Tripura on 21st August, 2009.
- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Soil Resource Inventory for Future Land Use Planning in connection with Brain Storming Session on Natural Resource Management: Lesson Learnt and Task Ahead organized by Kolkata Chapter of the Indian Society of Soil Science held at NBSS & LUP (ICAR). Regional Centre, Kolkata on September 7, 2009.
- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Management of Natural Resources towards Optimising Agricultural Production (M.N. De Memorial Lecture) in connection with 42nd Annual Convention of the Indian Society of Agricultural Chemist organized by Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during November 27-28th, 2009.

- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Alternate Land Use Planning in the Changing Scenario of Climate and Demography in connection with Platinum Jubilee Celebration of Indian Society of Soil Science during 22-25th December, 2009 at New Delhi.
- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Soil Resource Inventory for Land Use Planning in connection with State Level Seminar on Soil Resource Management for Sustainable Soil Health and Food Security organized by Akola Chapter of Indian Society of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. during January 2-3, 2010.
- Dr. Dipak Sarkar, Director attended and delivered invited lecture on Land Degradation and its Impact on Agriculture in connection with Shri Vasantrao Naik Memorial National Agriculture Seminar on Soil Security for Sustainable Agriculture at College of Agriculture, Nagpur, Maharashtra during February 27-28, 2010.
- Dr. C.S. Walia, Principal Scientist delivered lecture on "Spectural Reflectance Characteristics and Spectral Library of Indian Soils" and "Remote Sensing Application in soil survey" to the M.Sc. students Geographic Information Science & Technology, Centre of Excellence for Natural Resources Data Management System of Uttarakhand, Kumaon University, SSJ Campus, Almora during 9-10 Nov. 2009.
- Dr. G.S. Sidhu, Principal Scientist delivered a lecture on "Natural resource data for land use planning at different levels by using latest techniques" at PAU, Ludhiana on 13th October 2010.
- Dr. Ashok Kumar, Scientist delivered a lecture on Weed Control in Seed Crops (in Hindi) during farmers' training conducted by Seed Production Unit, IARI, New Delhi on 30th March, 2010.
- Dr. S.K. Singh Principal Scientist and Head, Regional Centre, Kolkata delivered a lecture on "Soil nutrient mapping as a tool for fertilizer management" in Winter School in the Institute of Agricultural Sciences BHU Varanasi on 13th Jan.
- Dr. A.K. Sahoo, Principal Scientist delivered a lecture on "Watershed: Its concepts, characteristics

- and management on 13th Jan. 2010 during the Winter School in the Institute of Agricultural Science, BHU, Varanasi.
- Dr. L.G.K. Naidu delivered a lecture on soil site requirements for fish farming in Cauvery Command area in Mandya district during a one day Workshop on 'Fish farming in Saline/Sodic Soils' held at Mandya on 26th August 2009.
- Dr. A.K. Maji delivered a lecture on "Land Evaluation and Decision Support Systems" in Workshop on Remote Sensing and GIS techniques for Decision Support in Agriculture held on 18th June, 2009 at IASRI, New Delhi.
- Dr. G.P. Obi Reddy delivered lecture on Morphometric analysis in watersheds in ICAR sponsored Winter School on Advances in Remote Sensing, GIS and GPS Application in watershed management on 12th Nov. to 2nd Dec. 2009.
- Dr. G.P. Obi Reddy delivered an invited lecture on "Morphometric analysis at watershed scales" in Tutorials of ISRS Annual Convention and National Symposium on "Advances in geospatial technologies with special emphasis on sustainable rainfed Agriculture" held on 15th -16th October, 2009 at RRSSC, Nagpur.
- Obi Reddy, G.P. delivered invited lecture on "GIS based agro-informatics in precisely characterized land use systems and their dynamics in farm scale and heterogeneous landscape" in 2nd National Conference on Agro informatics and Precision Farming" at UAS, Raichur from 2nd to 3rd December, 2009.
- Dr. A. K. Maji delivered an invited lecture on "Land Information System" in Tutorials of ISRS Annual Convention and National Symposium on "Advances in geospatial technologies with special emphasis on sustainable rainfed Agriculture" held on 15th -16th, October, 2009 at RRSSC, Nagpur.
- Dr. D.S. Singh, Dr. Rajeev Srivastava, Dr. J.D. Giri and Dr. M.S.S. Nagaraju delivered lectures and conducted practicals in Remote Sensing and GIS in the ICAR sponsored Winter School (12th November to 2nd December, 2009) held at NBSS&LUP, Nagpur.
- Dr. T.H. Das, Principal Scientist, Dr. S.K. Reza and Dr. S. Bondyopadhyay, Scientist attended training/ interaction meet on "Detailed soil survey and mapping" held at Bangalore Centre from 8th to 12th October, 2009.

Seminar/Symposia abstracts/Conference papers

Platinum Jubilee Symposium on Soil Science for Meeting Challenges of Food Security, Nutritional and Environmental Quality organized by Indian Society of Soil Science, at IARI, New Delhi during 22-25 December 2009

- Ahmed, Nayan, Walia, C.S., Datta, S.C. and Sharma, R.K. (2009). Pedogenic Progression of soils developed on different parent materials in Khumaun Himalayas. Abstracts p 8.
- Bhattacharyya, T. and Mandal, B. (2009). Soils Information System of the Indo-Gangetic Plains for resource management.
- Deshmukh, V.V., Ray, S.K., Chandran, P., Bhattacharyya, T. and Pal, D.K. (2009). Hydroxy-interlayering in soil clay smectites: An indicator of climate change.
- Gangopadhyay, S.K. and Sahoo, A.K. (2009). Soils of Kitajhuri micro-watershed under Subarnarekha catchments West Bengal for land use planning.
- Kadupitiya, H.K., Sahoo, R.N., Gupta, V.K., Ahmed, N., Ray, S.S., Surya, J.N. and Sidhu, G.S. (2009) Estimation of Soil Parameters: A Hyper spectral Remote Sensing Approach. Abstracts p44.
- Karthikeyan, K., Chandrasekar, K., Pushpanjali and Sarkar, D. (2009). Studies on LULC analysis of different agro-ecological regions of Tamil Nadu: A GIS approach.
- Mandal, D.K. and Mandal, C. (2009). Agro-ecological sub regions for increased oilseed production.
- Nayak, D.C., Das, K. and Singh, S.K. (2009). Potassium availability of red and lateritic soils of West Bengal in relation to mineralogy.
- Raja, P., Maurya, U.K., Ray, S.K., Chandran, P., Bhattacharyya, T. and Pal, D.K. (2009). Clay pedofeatures as indicator of neotectonic stress in the soils of Indo-Gangetic Plains. (Abstract).
- Sahoo, A.K., Sarkar Dipak, Gangopadhyay, S.K. and Butte, P.S. (2009). Soils of Lohardaga district of Jharkhand-their characteristics, potentials and limitations.
- Srivastava, Pushpanjali, Kartikeyan, K. and Sarkar, Dipak. Harmonization of LULC Map: A geospatial approach.

- Surya N. Jaya, Singh, S.P. and Jat R.S. (2009). Land Resource Assessment in Irrigated Agro-ecosystem for Micro Level Land Use Planning. Abstracts p130.
- Walia, C.S, Surya, J.N. Dhankar, R.P. Sharma, J.P., Singh, Harjit and Soni, K.M. (2009). Watershed characterization using remote sensing and GIS in Kumaun Himalayas for land use. Abstracts p31.

National Symposium on 'Advanced Geospatial Technologies with Special emphasis on Sustainable Rainfed Agriculture' and Annual Convention of ISRS held at RRSSC, Nagpur from 17-19th September, 2009

- Ardak Shweta A., Nagaraju, M.S.S., Srivastava, R., Jagdish Prasad, Maji, A.K. and Barthwal, A.K. (2009) Characterization and Evaluation of Land Resources in Khapri Village of Nagpur District, Maharashtra using High Resolution Satellite Data and GIS.
- Bante R. R., Srivastava, R., Nagaraju, M.S.S., Jagdish Prasad, Maji, A.K. and Barthwal, A.K. (2009). Utility of remote sensing and GIS in characterization and evaluation of land resources in Taroda watershed of Nagpur District of Maharashtra.
- Maji, A.K. (2009). GIS based Assessment of wastelands/degraded lands of northeastern region of India. Abstracts pp.75-76.
- Obi Reddy, G.P. (2009). Satellite remote sensing and GIS applications in terrain characterization for landform and soil resource mapping in semi-arid ecosystem of central India. Abstracts, pp. 71.

National Conference on 'Frontier in Plant Physiology towards Sustainable Agriculture' held at Assam Agricultural University, Jorhat from October 5-7, 2009.

- Baruah, U. (2009). Soil Survey for Optimum Land Use Planning
- VIIIth Global Conference on Environmental Education Panjim, Goa. November 4-8, 2009.
- Bhaskar, B.P., Sarkar, Dipak and Baruah, Utpal (2009). Inventory and assessment of wetland resource for sustainable agriculture in Majuli Island, Assam, India. Abstracts, pp.22.

International Conference on Nurturing Arid Zones for People and the Environment: Issues and Agenda for the 21st century CAZRI, Jodhpur, Nov. 24-28

Bhattacharyya, T., Pal, D.K., Chandran, P., Ray, S.K., Mandal, C., Wani, S.P. and Sharawat, K.L.

- (2009). Identifying systems for carbon sequestration and increased productivity in semi-arid tropical environments.
- Singh, A.K., Singh, R.S. and Shyampura, R.L. 2009. Deficit irrigation scheduling in wheat crop under varying types of soils in Udaipur (Rajasthan).
- Singh, R.S., Singh, A.K., Tailor, B.L. Rameshwar Singh and R.L. Shyampura. (2009). Land Use-soil parameters relationship in Bundi district of Rajasthan.

National Symposium on Climate Change and Rainfed Agriculture at CRIDA, Hyderabad during 18-20th February, 2010

- Bhattacharyya, T., Pal, D.K., Deshmukh, A.S., Deshmukh R.R., Ray, S.K., Chandran, P., Mandal, C., and Telpande B. (2010) Roth *C* Model-its evaluation for soil carbon reserve in selected long term fertilizer experimental sites. (extended summary) pp. 316-318.
- Bhattacharyya, T., Pal, D.K., Nimje, A.M., Ray, S.K., Chandran, P., Mandal, C., Venugopalan, M.V., Deshmukh, A.S., Telpande B. and Deshmukh R.R. (2010) Effect of global warming on carbon reserves in Kheri soils, Madhya Pradesh, (extended summary)

97th Indian Science Congress, Kerala University, Thiruvananthpuram India on 3-7 Jan. 2010. Agriculture and Forestry Sciences Section

Das, K. and Singh, S.K. (2009) Potassium dynamics of some soils of dry sub-humid agro-ecozone of West Bengal.

International symposium on "Carbon management and climate change and role of applied geochemistry in mineral exploration." November 25 to 27, 2009

Raja, P., Bhaskar, B.P., Malpe, D., Anantwar, S.G. and Tapaswi. P.M. (2009). Geochemistry of salt affected soils in Purna valley, Maharashtra, India: Their paleoclimatic implication. Abstracts pp.50.

National Workshop on Rainwater Harvesting and Reuse through farm Ponds, held at CRIDA, Hyderabad during 21-22 April, 2009

Ramamurthy, V. Patil, N.G. and Sarkar, Dipak (2009) Impact of water harvesting structure on water availability – A case study of Kokarda watershed, Nagpur district of Maharashtra.

Participation of Scientists in Conferences, Meetings, Workshops, Symposia etc. in India and abroad

Workshops/Seminar/Symposia attended

National Seminar on Challenges and opportunities of Bio-Industrial wasteland development for prosperity of the farming community organized by Soil Conservation Society of India and Watershed development department, Govt. of Karnataka, 25-27 June 2009.

- Dr. L.G.K. Naidu
- Dr. A. Natarajan
- Dr. V. Ramamurthy

National workshop cum Brainstorming session on "Rainwater harvesting and Reuse through Farm Ponds: experience, issues and strategies" at CRIDA, Hyderabad from 21-22nd April, 2009

Dr. V. Ramamurthy

One day Workshop on 'Fish farming in Saline/Sodic Soils' held at Mandya on 26th August 2009

Dr. L.G.K. Naidu

International Conference on nurturing arid zones for people and the environment: issues and agenda for the 21st century to be held at CAZRI, Jodhpur during November 24-28, 2009.

- Dr. R.S. Shyampura
- Dr. D.K. Pal
- Dr. T. Bhattacharyya
- Dr. R.S. Singh
- Dr. A.K. Singh

National Seminar on Geospatial Technologies for Defence Operations at New Delhi during 23-25 June, 2009.

- Dr. J.P. Sharma
- Dr. D. Martin

National Symposium on 'Advanced Geospatial Technologies with Special emphasis on Sustainable Rainfed Agriculture' and Annual Convention of ISRS held at Nagpur from 17-19th September, 2009.

- Dr. A.K. Maji
- Dr. R. Srivastav
- Dr. M.S.S. Nagaraju
- Dr. G.P. Obi Reddy
- Sh. A.K. Barthwal

Launching Workshop and 1st Consortium Advisory Committee (CAC) meeting of the NAIP Project 'Development of spectral reflectance methods and low cost sensors for real-time application of variable rate inputs in precision farming' held on 4th August 2009 at PAU, Ludhiana.

Dr. Rajeev Srivastava

Paper presented in the Agriculture and Forestry Sciences Section of 97th Indian Science Congress at Kerala University, Thiruvananthpuram India on 3-7 January 2010.

- Dr. S.K. Singh
- Dr. S.K. Mahapatra
- Dr. K. Das
- Dr. T. Bhattacharyya

National Seminar on "Wealth from Waste" organized by National Environmental Science Academy, Kolkata Chapter at Bose Institute Auditorium during September 5-6th, 2009.

- Dr. A. K. Sahoo
- Dr. K. Das

Platinum Jubilee Symposium and 74th Annual Convention, 2009 of the Indian Society of Soil Science, New Delhi at IARI, New Delhi during 22nd -25th December, 2009.

Dr. Dipak Sarkar	Dr. T. Bhattacharyya
Dr. D.K. Pal	Dr. T.H. Das
Dr. J.P. Sharma	Dr. D.C. Nayak
Dr. S.K. Singh	Dr. A.K. Sahoo
Dr. R.L. Shyampura	Dr. S.K. Gangopadhyay
Dr. S. Chatterji	Dr. S.K. Ray
Dr. Mrs. Jaya Surya N.	Dr. Jagdish Prasad
Dr. G.S. Sidhu	Dr. S.C. Rameshkumar
Dr. C.S. Walia	Dr. K. Karthikeyan
Dr. S.K. Mahapatra	Mrs. Pushpanjali
Dr. D.K. Mandal	Dr. N.C. Khandare
Dr. K. Das	Sh. S.S. Nimkhedkar
Dr. A.P. Nagar	Dr. P. Raja

National Symposium on Climate Change and Rainfed Agriculture for the poster at CRIDA, Hyderabad during 18-20th February, 2010

- Dr. D.K. Pal
- Dr. T. Bhattacharyya

VIIIth Global conference on Environmental Education. Panjim, Goa. November 4-8, 2009

Or. B.P. Bhaskar

International symposium on "Carbon management and climate change and role of applied geochemistry in mineral exploration." November 25 to 27, 2009.

Dr. P. Raja

National Conference on 'Frontier in Plant Physiology towards Sustainable Agriculture' held at Assam Agricultural University, Jorhat from 5th to 7th October, 2009.

Dr. Utpal Baruah

2nd National Conference on Agro informatics and Precision Farming" at UAS, Raichur from 2nd to 3rd December. 2009.

Dr. G.P. Obi Reddy

ISRS Annual Convention and National Symposium on "Advances in geospatial technologies with special emphasis on sustainable rainfed Agriculture" held on 15th –16th, October, 2009 at RRSSC, Nagpur

- Dr. A. K. Maji
- Dr. G.P. Obi Reddy

Meetings Attended

Launching Workshop of NAIP Project entitled "Georeferenced soil information system for land use planning and monitoring soil and land quality for agriculture" (Component 4) at H.Qrs., Nagpur during 08.05.2009 (F/N) and 09.05.2009 (A/N)

- Dr. D.S. Singh
- Dr. D. C. Nayak
- Dr. A.K. Sahoo

Planning Commission Team meeting on 16-12-09 at National Bureau of Agriculturally Important Insects (NBAII), Bangalore

Dr. L.G.K. Naidu

NSDI-9 workshop on "G-Governance" at Pune from 21st to 25th Dec. 2009

- Dr. A.K. Maji
- Dr. G.P. Obi Reddy

First NDEM Nodal Officers meeting as a representative from NBSS&LUP at New Delhi on 15th October 2009

Dr. G.P. Obi Reddy

National Workshop for the Sensitization of ARIS Incharges about the websites at NBPGR, New Delhi on 19th March 2010

Dr. G.P. Obi Reddy

Remote sensing in soil resource mapping at different scales – an overview in User Interaction Workshop-2010 at NRSC, Hyderabad from 2nd to 5th Feb. 2010

Dr. G.P. Obi Reddy

Launching Workshop and 1st Consortium Advisory Committee (CAC) meeting of the NAIP Project 'Development of spectral reflectance methods and low cost sensors for real-time application of variable rate inputs in precision farming' held on 4th August 2009 at PAU, Ludhiana

Dr. Rajeev Srivastava

Meeting at Department of Agriculture (Govt. of Karnataka state) on "National Mission on soil health and soil fertility" on 25-1-2010

- Dr. L G K Naidu
- Dr. Rajendra Hegde



Meeting with the officials of the State Department of Agriculture Govt. of West Bengal for the execution of field work in the project "Soil nutrient mapping of the state of West Bengal" with reference to Purba Medinipur district organized by Deptt. of Agriculture, Govt. of West Bengal at Principal Agricultural Office, Purba Medinipur on 20th May, 2009

- Dr. D. C. Nayak
- Dr. A. K. Sahoo

Meeting with the officials of the State Department of Agriculture Govt. of West Bengal for implementation of project "Soil nutrient mapping of the state of West Bengal" with reference to Purba and Paschim Medinipur districts organized by Deptt. of Agriculture, Govt. of West Bengal at Principal Agricultural Office, Paschim Medinipur on 10th November, 2009

- Dr. S.K. Singh
- Dr. D. C. Nayak
- Dr. A. K. Sahoo

Meeting with the state officials for execution of the project entitled "Development of District Level Land Use Plan for Nadia District in West Bengal under Irrigated Ecosystem" organized by Dy. Director of Agriculture, Nadia district at Principal Agricultural Office, Krishnanagar, Nadia on 10th February, 2010.

- Dr. A. K. Sahoo
- Mrs. T. Banerjee

Approved On-going Projects

- 1. Assessment of land resources for growing horticultural crops in selected districts for Tamil Nadu under the National Horticultural Mission project
 - A. Natarajan, V. Ramamurthy, S. Thayalan, S. Srinivas, K.V. Niranjana, M. Ramesh, D.H. Venkatesh. S. Vadivelu
- 2. Land resource inventory for farm planning in different agro-ecological regions of India
 - A. Natarajan, Jaya N. Surya, R.S. Meena, S. Dharumarajan, Pushpanjali, P. Nideesh
- 3. Agro-ecological zoning of Tamil Nadu
 - A.Natarajan, S. Srinivas, V. Ramamurthy, S. Thayalan
- 4. Agro-ecological units of KeralaModified title: Agro-Ecological units of 14 districts of Kerala
 - L.G.K. Naidu, K.M. Nair, Champa Mandal, A. Chaturvedi, S. Thayalay, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas
- 5. Development of alternate laboratory techniques for speedier routine soil analysis for soil survey laboratories
 - S.L. Budihal
- 6. Land use planning for North Goa District, Goa
 - Rajendra Hegde, Anil Kumar, S. Srinivas, A. Natarajan, Ramesh Kumar, K.M. Nair, L.G.K. Naidu, K.V. Niranjana
- 7. Detailed assessment of land and soil resources of a **Kuppam Mandal in Chittoor district of Andhra Pradesh**
 - K.S. Anil Kumar. S.C. Ramesh Kumar. B.A. Dhanorkar

- 8. Land resource inventory for farm planning in Chikarsinkere Hobli, Maddur Taluk. Mandya District, Karnataka - a subproject of the main project Land resource inventory for farm planning in different agro-ecological regions of India
 - R.S. Meena, S. Thavalan, A. Natarajan, S.C. Ramesh Kumar, V. Ramamurty, S. Srinivas
- 9. Development of software modules for land evaluation and agro-climatic analysis
 - S. Srinivas, K.M. Nair, L.G.K. Naidu, R. Hegde, V. Ramamurthy, D.S. Venkatesh
- 10. Assessment of land and soil resources of Malappuram district (part) of Kerala at 1:50,000 scale for land use planning
 - Anil Kumar, K.S., K.M. Nair, R. Hegde, S.C. Ramesh Kumar, S. Srinivas, S. Thayalan, L.G.K. Naidu
- 11. Identification and characterisation of Benchmark soils of Bihar and Orissa for agro-technology transfer
 - Dipak Sarkar, T. Chattopadhyay, D.C. Nayak, A.K. Sahoo, K.D. Sah.
- 12. Assessment and mapping of some important soil parameters including macro and micro nutrients for the state of West Bengal (1:50,000 scale) towards optimum land use planing
 - Dipak Sarkar, K. Das, A.K. Sahoo, D.S. Singh, D.C. Nayak, S. Mukhopadhyay, M. Swamiathan
- 13. Soil resource inventory and land evaluation of Aurangabad district, Bihar (1:50,000 scale) for land use planning
 - S.K. Gangopadhyay, D.S. Singh, K. Das S. Mukhopadhyay, U.K. Maurya, D. Sarkar

- 14. Natural resource assessment using RS & GIS-a case study in Badajorenala Microwatershed in Utkal **Plain of Orissa**
 - K. Das, S.K. Singh, T. Banerjee, S. Dharumarajan
- 15. Land resource inventory for farm planning in Chinsurah-Mogra and Polba-Dadpur Block, Hugli **District, West Bengal**
 - S. Dharumarajan, K.D. Sah, Tapati Banerjee, S.K. Singh
- 16. Geomorphometric and hydrological evaluation of micro watershed in Chhotnagarpur plateau, West Bengal for sustainable utilization of soil and water resources
 - Tapati Banjeree, S.K. Singh, K. Das, S. Dharumarajan
- 17. Soil resource inventory and land evaluation of Rohtas district, Bihar (1:50,000 scale) for land use planning
 - T. Chattopadhyay, A.K. Sahoo, S. Mukhopadhyay, M. Swaminathan, Dipak Sarkar
- 18. Soil based approach towards rational land use plan using remote sensing and GIS
 - S. Mukhopadhyay, Tapti Banerjee, Dipak Sarkar
- 19. Land use planning at block level in two agroecological subregions of West Bengal
 - D.C. Nayak, D. Dutta, Dipak Sarkar
- 20. Effect of different land uses on total soil organic carbon (SOC) and its active pools in humid to per humid ecoregion of West Bengal
 - D. Dutta, D.C. Nayak, Dipak Sarkar
- 21. Land resource inventory of Mawmaram microwatershed of East Khasi Hills district, Meghalaya
 - S. Bandyopadhyay, S.K. Reza, Ashok Kumar, U. Baruah
- 22. Reconnaissance soil survey of Bhareli river basin, Assam and Arunachal Pradesh for Land Use **Planning**
 - T.H. Das, U. Baruah, D.P. Dutta, A.C. Kalita
- 23. Assessment and mapping of some important soil parameters including macro and micro nutrients for the sixteen (16) priority districts of Assam state (1:50,000 scale) towards optimum land use planning
 - U. Baruah, T.H. Das, A. Kumar, S.K. Reza, R.S. Meena, two scientists for RC, Kolkata, one scientist from SRS Divn. HQrs., Nagpur

- 24. Correlation of soil series of North-Eastern States (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura)
 - U. Baruah, T.H. Das., S.K. Reza, S. Bandyopadhyay
- 25. Soil resource mapping of Sultanpur district (U.P.) for perspective land use planning
 - Jagat Ram, S.P. Singh, B.K. Kandpal, R.P. Dhankar, Ram Gopal
- 26. Soil resource mapping of Tehri Garhwal district of Uttaranchal on 1:50,000 scale for perspective land use planning
 - C.B. Sachdev, D. Martin, Jagat Ram, Tarsem Lal, S.P. Singh
- 27. Soil resource mapping of Almora district of Uttaranchal on 1:50,000 scale for perspective land use planning
 - S.K. Mahapatra, D. Martin, Jagat Ram, R.P. Dhankar, S.P. Singh, B.D. Sharma
- 28. Soil resource mapping of Pauri Garhwal district of Uttaranchal on 1:50,000 scale for perspective land use planning
 - S.K. Mahapatra, D. Martin, Jagat Ram, R.P. Dhankar, S.P. Singh, B.D. Sharma
- 29. Dynamics of land use plan and its impact on soil properties in Nawan Shahr district, Punjab state
 - G.S. Sidhu, Tarsem Lal, Jaya N. Surya, J.P. Sharma
- 30. Dynamics of land use plan and its impact on soil properties in Jalandhar district, Punjab state
 - G.S. Sidhu, Tarsem Lal, Jaya N. Surya, J.P. Sharma
- 31. Land resource inventory for farm planning in Lakhan Majra, Block of Maham - Rohtak tahsil, Rohtak district, Haryana
 - Jaya N. Surya, G.S. Sidhu, Tarsem Lal, Dharam Singh, S.K. Mahapatra, J.P. Sharma
- 32. Land resource inventory of Phod Disong Marpna Microwatershed of East Khasi Hills District, Meghalaya
 - S.K. Reza, S. Bandyopadhyay, Ashok Kumar, U. Baruah
- 33. Assessment of heavy metal pollution and its mapping in soils of contaminated areas of Morigaon, Dibrugarh and Tinsukia districts of Assam
 - S.K. Reza, S.K. Ray, U. Baruah

34. Soil resource mapping of Kamrup district (1:50,000 scale) of Assam for land use planning

T.H. Das, U. Baruah

35. Agro-ecological units map of Madhya Pradesh and Chhatisgarh state (on 1:1 m scale) SRM data base

D.B. Tamgadge, K.S. Gajbhiye, Dr. (Mrs) C. Mandal, W.V. Bankar

36. Reconnaissance soil survey, mapping and classification of soils of Jabalpur district, Madhya Pradesh

J. Prasad and S.R. Singh

37. Estimating saturated hydraulic conductivity and bulk density of the Vertisols and Vertic Intergrades from Published Research and Soil Survey Data

N.G. Patil, C. Mandal, D.K. Mandal, D.K. Pal

38. Progressive reconnaissance, soil survey, mapping, soil-correlation and classification of a hot-moist and semi-arid subregion of Yavatmal district, Maharashtra

B.P. Bhaskar, S.R. Singh

39. Characterization and evaluation of carbon (SOC) & sulphur status in soybean growing areas of Dhar district, Madhya Pradesh to suggest an alternative cropping pattern

K. Karthikeyan, J. Prasad, Pushpanjali, S.R. Singh, D. Sarkar

40. Soil resource inventory and land evaluation of Chittaurgarh district for land use planning

T.P. Verma/J.D. Giri, R.L. Shyampura

41. Land resource inventory for farm planning in different agro-ecological regions of India

T.P. Verma, R.L. Shaympura, R.S. Singh, A.K. Singh

42. Development of district land use plan for Nagaur and Bundi districts (Rajasthan) under arid and semi-arid ecosystem

R.S. Singh, A.K. Singh, R.L. Shyampura

43. Soils, land use and perspective land use planning of Nagpur district

A. Chaturvedi, Mrs. C. Mandal, Rajeev Srivastava, D.K. Mandal, T.N. Hajare, S.N. Goswami, N.C. Khandare, R.S. Gawande

44. Development of a soil water balance model for shrink-swell soils of Central India

Pramod Tiwary, D.K. Mandal, M. Vemnugopalan, T.N. Hajare

45. Integrated approach of remote sensing and GIS in land resources characterization, evaluation and mapping in Saraswati watershed in Buldhana district of Maharashtra

M.S.S. Nagaraju, R. Srivastava, A.K. Maji, A.K. Barthwal

46. Land use/land cover dynamics in different geomorphological settings of Chandrapur district, Maharashtra for sustainable land resource management

S. Thayalan, A. Chaturvedi

47. Interfluve stratigraphy, sedimentology and geochemistry of the central and southern Ganga Plains (DST-ESS Project)

D. K. Pal, T. Bhattacharyya, P. Chandran, S.K. Ray, P.L.A. Satyavathi, P. Raja, S.L. Durge

48. Predicting soil carbon changes under different cropping systems in soils of selected Benchmark spots in different bioclimatic systems in India (DST sponsored project)

T. Bhattacharyya, S.K. Ray, P. Chandran, D.K. Pal, Mrs. C. Mandal

49. Changes in soil carbon reserve as influenced by different ecosystems and land use in India (ICAR Network Project on Climate Change)

T. Bhattacharyya, P. Chandran, D.K. Pal, S.K. Ray, C. Mandal, D. Sarkar

50. Assessment of Quality and Resilience of soils in Diverse agro-ecosystems (NAIP)

T. Bhattacharyya, D. Sarkar, P. Chandran, S.K. Ray, Mrs. C. Mandal, D.K. Pal, Research Associates

51. Genesis and classification of Benchmark ferruginous soils of India

P. Chandran, S.K. Ray, T. Bhattacharyya, D.K. Pal, Pankaj Srivastava, P.N. Dubey, K.S. Gajbhiye, P. Krishnan, D. Sarkar 52. Detailed soil resource survey of Hayatnagar farm of CRIDA, Hyderabad

P. Chandran, S.K. Ray, P. Raja, S.L. Durge, A.M. Nimkar, D.K. Pal, T. Bhattacharyya, C. Mandal, M.S.S. Nagaraju, D. Sarkar

53. Development of protocols for digestion, standards and methods to determine elements in soil and sediments using Inductively Coupled Plasma **Spectrometry (ICP-AES)**

S.K. Ray, P. Raja, P. Chandran, T. Bhattacharyya, P.L.A. Satyavathi, D.K. Pal

54. Human resource development in remote sensing and GIS in natural resource management -NNRMS (ISRO) & NBSSLUP collaborative project

A.K. Maji, A. Chaturvedi, G.P. Obi Reddy

55. Multi criteria based decision making for land evaluation and land use planning at district level

A.K. Maji

56. Digital maps of derived soil quality maps of states and of India

A.K. Maji, G.P.Obireddy, Heads RCs

57. Building of an expert system for land use planning at state/AEZ level

A.K. Maji, N.D.R. Krishna, C.V. Srinivas

58. Development of GIS based seamless mosaic of SRTM elevation data for India to analyze and characterize the selected geomorphometric parameters (NBSS&LUP and RRSSC **Collaborative Project)**

G.P. Obi Reddy, A.K. Maji, R. Srivastava, S.N. Das

59. Enrichment of land degradation datasets with soils datasets of different states of India (Inter-Institutional Collaborative project between NBSS&LUP-NRSC)

G.P. Obi Reddy, T. Ravisankar, G.S. Sidhu, A.K. Sahoo, K.S. Anil Kumar, Siladitya Bandyopadhyay, NRSC: T. Ravisankar, K. Srinivas, G. Sujatha, M.A. Fyzee

60. Soil resource atlas of Chhatisgarh state

A.K. Maji, D.B. Tamgadge, C.V. Srinivas, G.P. Obi Reddy

61. Spatial assessment of soil erosion of different states of India using grid point data in GIS

A.K. Maji, C.V. Srinivas, G.P. Obi Reddy

62. Documentation and storing maps and photographs - concept of digital map library

C. Mandal, Pushpanjali, D.K. Mandal, J. Prasad, R. Srivastava, T. Bhattacharyya, D. Sarkar

63. Land resource inventory for farm level planning in Parseoni Mandal of Parseoni Taluk, Nagpur district, Maharashtra

Pushpanjali, K. Karthikeyan, C. Mandal, J. Prasad, J.D. Giri, Malathi Bommidi

NATIONAL NETWORK PROJECT OF LAND USE **PLANNING**

National Network project on District Level Land **Use Planning under Different Agro-ecosystems of** the Country

D. Sarkar

64. Development of district level land use plan for Nadia district in west Bengal under Irrigated **Ecosystem**

A.K. Sahoo

65. Development of district level land use plan for Puruliya district in West Bengal under rainfed ecosystem

PI: D.C. Nayak, D. Sarkar, D.S. Singh and S.K. Singh, D.C. Nayak, D. Dutta, S. Mukhopadhyay

66. Development of district level land use planning for Jorhat district, Assam under rainfed eco-system

D. Sarkar, U. Baruah, Siladitya Bandyopadhyay, S.K. Reza, U. Baruah

67. Development of district level land use plan for East Khasi Hill district in Meghalaya under hill and mountain ecosystem

S.Bandyopadhyay (PI), D. Sarkar, U. Baruah, S.K. Reza (Sub-Project Leader), S. Bandyopadhyay

68. Development of district level land use plan for Nagaur district (Rajasthan) under arid ecosystem

A.K. Singh (PI), D. Sarkar, A.K. Singh, R.L. Shyampura

- 69. Assessment of stakeholder needs and economic evaluation of land use types for land use planning of Mysore and North Goa Districts
 - S.C. Ramesh Kumar, V. Ramamurthy, Rajendra Hegde
- 70. Development of district level land use plan for Mysore district, Karnataka state
 - V. Ramamurthy, K.M. Nair, S.C. Ramesh Kumar, S. Srinivas, L.G.K. Naidu, S. Thayalan
- 71. Development of district level land use plan for Shahjahanpur district in Uttar Pradesh under Irrigated Ecosystem
 - Dharam Singh, S.K. Mahapatra, Jaya N. Surya, Ashok Kumar
- 72. Development of district level land use plan for Almora district in Uttarakhand under hill and mountain ecosystem
 - S.K. Mahapatra, Jaya N. Surya, Dharam Singh, Ashok Kumar

CORRELATION OF SOIL SERIES OF INDIA

- 73. Correlation of soil series of Eastern States (Bihar, Jharkhand, Orissa, Sikkim, A&N Islands and West Bengal)
 - A.K. Sahoo, D.C. Nayak, K. Das, S.K.Gangopadhyay, K.D. Sah, D. Dutta, T. Chattopachyay, S. Mukhopadhyay, T. Banerjee
- 74. Correlation of soil series of India and their placement in the National Register Western States (Gujarat & Rajasthan)
 - R.L. Shyampura, R.S. Singh, A.K. Singh, Nideesh, P.
- 75. Correlation of soil series of India and their placeme3nt in the National Register: Southern States (Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Goa, Puducherry and Lakshadweep)
 - L.G.K. Naidu, A. Natarajan, K.M. Nair, K.S. Anil Kumar, R.S. Meena

10

Consultancy, Patents, Commercialisation of Technology

- Assessment and mapping of some important parameters including macro and micro nutrients for the state of West Bengal (1:50,000 scale) towards optimum land use plan.
- Assessment and mapping of important soil parameters including macro and micronutrients for the state of Assam (1:50,000 scale) towards rational land use planning

Dissemination of soil information/services to user agencies

- Land resource information of Prakasam district, Andhra Pradesh was given to Associate Director of Research, Lam, NARP zone of ANGRAU.
- Soil information of Ramanagaram and Magadi Taluks of Ramanagaram district of Karnataka was provided to Ph.D. Scholar from Tata Energy Research Institute, Delhi for planning sustainable water resources development
- Soil Testing Services provided to
 - National Bureau of Agriculturally Important Insects (formerly PDBC), Bangalore.
 - Jamanalal Bajaj Seva Ashram, Trust, Bangalore.
 - Pest Control of India, Bangalore

- Provided three success stories information (Azolla cultivation, Velvet bean cultivation, and coconut mite menace management) to Dr. Meenakshi Srinivas, Principal Scientist, IIHR for NAIP project on mobilizing and sharing mass media support.
- Soil information pertaining to high power transmission lines across Tumkur, Tiptur, Madhugiri, Koratagere, Sira and Pavgada taluks of Tumkur district was provided to Executive engineer, Karnataka Power Transmission Limited, Tumkur
- 52 Agricultural Divisional atlases belonging to Kadapa, Mahabubnagar, Chittoor, Prakasam, Nalgonda and Anantapur districts of A.P. were supplied to Roshni Bio Tech Pvt. Ltd, Hyderabad for planning pongamia plantations (Bio-fuel) in marginal lands.

Soil Macromonoliths preparation and establishment of soil museum

 Four soil monoliths for Kerala Forest Research Institute (KFRI), Peechi were prepared for their soil museum.

Meetings

S. No.	Name of meeting	No. of meeting	Date	Venue
1.	Institute Management Committee	1	26 th October 2009	Kolkata
2.	Institute Research Council (IRC) Meeting of the Bureau	1	10 th to 12 th August 2009	Nagpur
3.	Institute Joint Council	2	29 th April 2009 28 th October 2009	Udaipur Jorhat
4.	Heads of Regional Centres, Divisions and Sections	1	22 nd January 2010	Nagpur

Workshops, Seminars, Farmers' Day and other events

A. Workshop

Hosted Brain Storming Session on "Natural Resource Management: Lesson Learnt and Task Ahead" in collaboration with Indian Society of Soil Science Kolkata Chapter on September 7 -2009.



- First Hindi Karyashala on 'Takniki Karyon Mein Hindi avum computer ka Prayog" was organized at Regional Centre, Delhi on 11th September, 2009 for Technical and Field Assistants
- Second Hindi Karyashala on "Rajbhasha Neeti avam Karyanvayan" was organized at HQrs., Nagpur on 12th September, 2009 for the staff of Administration Section
- Third Hindi Karyashala on "Hindi Mein Vayagyanik Lekhan" was organized at Regional Centre, Delhi on for the scientists
- Fourth Hindi Karyashala on "Rajbhasha Karyanvayan Ke Anupalan" was organized at Regional Centre, Delhi
- Scientists Interaction Meet was organized at Regional Centre, Bangalore during October 8-12, 2009 to give orientation to have common survey methodology among the scientists of Bureau. Organized 2 field traversing trips for the participants for studying profiles at Doddaballapur, Bangalore (Rural district) and Maddur, Mandya district in Karnataka.

A meeting on Optimal Land Use and Water Resource Management & Pulse Production in Central India with special reference to Vidarbha Region was held on 22 and 23 Feb 2010 under the Chairmanship of Dr. K. Kasturirangan, Member (Science), Planning Commission and with other high officials viz. Dr. Saumitra Chaudhary, Member, Planning Commission, Dr. V.V. Sadamate, Advisor (Agri) and Dr. Vandana Dwivedi, Jt. Advisors (Agri), Planning Commission, Directors and representatives from different NRM Institutes of ICAR. This important meeting was conceived based on the opinions and views expressed in many meetings on "Land use and water management" as a key issue to discuss in detail. On water resources, the institutes like CRIDA, CWS and Vice-Chancellors from different universities of Maharashtra had given brief note on the subject. A review on pulse production system in India with special reference to Vidarbha region of Maharashtra and adjoining areas was also presented.



Dr. K. Kasturirangan and Dr. Saumitra Chaudhery, Members, Planning Commission, Dr. Dipak Sarkar, Director, NBSS&LUP, Dr. V.V. Sadamate, Advisor (Agri.), Planning Commission, Dr. V.M. Mayande, Vice-Chancellor, Dr. PDKV, Akola and other invitees involved in the discussion related to Optimal Land Use and Water Conservation at NBSS&LUP, Nagpur

Dr. Dipak Sarkar, Director, Dr. Utpal Baruah, Head, and Dr. T.H. Das, Principal Scientist had a meeting with Mr. Asang Jamir, Director and other officials of Directorate of Soil & Water Conservation, Govt. of Nagaland, Kohima on 18th March, 2010 regarding various issues on Soil Resource Mapping towards Land Use Planning of Nagaland state and future action plan.

B. Farmers' Day

- The Regional Centre, Jorhat participated in the Kishan Mela organized at Assam Agricultural University at Titabar, Jorhat district on 3rd November, 2009. Soil map at different levels (State/ District/Watershed) as well as various Reports/ Bulletins were displayed at the stall.
- Regional Centre, Delhi participated in "PUSA KRISHI VIGYAN MELA-2010" held at IARI, New Delhi, during 4-6 March 2010 and displayed various maps, publications & activities of the Bureau besides involving in interaction with scientists, farmers and other visitors.



Participation of NBSS & LUP in Krishi Vigyan Mela at IARI, New Delhi, during 4- 6 March, 2010.

C. Other Events

 Release of Soil Nutrient Map for Bardhdhaman, Nadia, Birbhum, North 24-Parganas, Haora and Hugli by Shri Buddhdeb Bhattacharyjee, Honourable Chief Minister of West Bengal in presence of Shri Narendra Nath De, Agriculture Minister, West Bengal and Shri Asim Das Gupta, Finance Minister, Govt. of West Bengal on 9th December, 2009. Dr. Dipak Sarkar, Director, NBSS&LUP, Nagpur; Dr. S. K. Singh, Head, NBSS&LUP, Regional Centre, Kolkata and Scientists of the Regional Centre were also present on the occasion.



Dr. A.K. Singh DDG (NRM) ICAR Inaugurated Children Park and release of NBSS&LUP publication on 7th September, 2009 in a function at NBSS& LUP Regional Centre Kolkata. Dr. R.K. Samanta Vice Chancellor BCKV Mohanpur Nadia, Dr. Dipak Sarkar Director NBSS&LUP Nagpur and Dr. S.K.Singh Head NBSS&LUP Regional centre Kolkata were also present on the occasion.



Distinguished Visitors

H.Qrs. Nagpur

- Dr. K. Kasturirangan, Member, Planning Commission, Govt. of India, New Delhi
- Dr. S. Chaudhary, Member, Planning Commission, Govt. of India. New Delhi
- Dr. V.V. Sadamate, Advisor (Agri.), Planning Commission, Govt. of India, New Delhi
- Dr. V.M. Mayande, Vice-Chancellor, Dr. PDKV, Akola
- Dr. A.K. Singh, DDG (NRM), ICAR, New Delhi
- Dr. S.M. Virmani, Ex-Head (Soil), ICRISAT, Hyderabad
- Shri Sanjay Mukherjee, IAS, Chairman, NIT, Nagpur
- Dr. G. Narayanaswamy, Ex-Head, Soil Science and Agril. Chemistry, IARI, New Delhi
- Dr. Kaushik Majumdar, Director, IPNI, Gurgaon
- Dr. P.K. Sharma, Director, Punjab State Remote Sensing Centre, Ludhiana
- Dr. Mruthyunjaya, Former National Director, NAIP, New Delhi
- Dr. A.K. Bandyopadhyay, National Director, NAIP Component 4, New Delhi
- Dr. N. Panda, Chairman, CAC, NAIP Component 4. New Delhi
- Dr. P.N. Takkar, Chairman, CAC, NAIP Component 3, New Delhi
- Dr. R.P. Dhir, Member, CAC, NAIP Component 4, Jodhpur
- Dr. D.K. Das, Member, CAC, NAIP Component 4, New Delhi

- Dr. R.K. Samanta, Vice-Chancellor, BCKVV, Mohanpur, West Bengal
- Dr. A. Subba Rao, Director, IISS, Bhopal
- Dr. M.V. Singh, Project Coordinator, Micronutrient Project, IISS, Bhopal
- Ms. Diya Dutt, Deputy Director, SIEF, New Delhi

Regional Centre, Bangalore

- Dr. Rabindra, Director, NBAII (ICAR), Bangalore
- Dr. Rajanna, Director, Agriculture, Government of Karnataka
- Dr. R.S. Kulkarni, Director of Extension, UAS Bangalore
- Mr. K.H.Gopalakrishane Gowda, Commissioner for Watershed Development, Govt. of Karnataka
- Dr. S.B. Dandin, Special Officer, University of Horticulture, Bagalkote
- Dr. Edward Raja, Head, Soil science, IIHR Bangalore
- Dr. Palaniappan, consultant at Zuari Agrochemicals, Bangalore
- Dr. M. Prabhakar, Principal Scientist, IIHR, Bangalore.
- Sri Shreepadre, Journalist and promoter of Rain water Harvesting, Editor, Adike Patrike, Puttur, Karnataka
- Dr. Prakash Rao, Head, CIMAP (CSIR) Bangalore
- Dr. Shamsundar Joshi, Professor (retd), UAS Bangalore
- Dr. Sudhir, Professor and Head, Dept. Soil Science, UAS, GKVK, Bangalore

Regional Centre, Kolkata

- Dr. A. K. Singh, DDG (NRM), ICAR, New Delhi.
- Dr. H. S. Sen, Ex.Director, CRIJAFT, ICAR, Barrackpore.
- Prof. S. K. Sanyal, Vice Chancellor, BCKV, West Bengal.
- Prof. A. K. Das, Vice Chancellor, UBKV, West Bengal.
- Dr. Pradip Sen, Joint Director of Agriculture (Research), Govt. of West Bengal
- Dr. R. K. Samanta, Ex.Vice-Chancellor, BCKV, Mohanpur, West Bengal
- Dr. S.S.Magar, Ex.Vice Chancellor Konkan Krishi Vidyapeeth Dapoli Maharastra and Member, IMC
- Dr. S.V. Sarode Director Research, Dr. PDKV, Akola and Member IMC
- Sri Basudeb Acharya Member of Parliament and Parliamentary Standing Committee on Agriculture.
- Sh. Prakash Pohare, Editor, Deshonnatti Marathi Newspaper and Member IMC

Regional Centre, Delhi

- Dr. A.N. Singh, Former Director, UPRSAC and Consultant BMGF Supported STRASA Programme, IRRI – India Office, Dr. Andy Nelson, Scientist GIS specialist, Cartograpic Information System Social Sciences Division, IRRI, Los Bathos, Laguna, Phillippines visited the Regional Centre, Delhi.
- Dr. P.K. Sharma, Director Punjab Remote Sensing Application Centre, Ludhiana visited the Regional Centre. Delhi.

- Dr. V.N. Sharda, Director, CSWCR&TI, Dehradun visited the Regional Centre, Delhi.
- Dr. A.K. Tiwari, Principal Scientist & Head, CSWCR&TI, Regional Station, Chandigarh visited the Regional Centre, Delhi.
- Dr. V.K. Suri, Former Vice Chancellor, CSAUA&T,
 Kanpur visited the Regional Centre, Delhi.

Regional Centre, Jorhat

- Dr. B.C. Bhoumick, Acting Vice-Chancellor of Assam Agricultural University, Jorhat
- Dr. S.V. Ngachan, Director, ICAR Complex, Barapani, Shillong.
- Dr. R. Medhi, Director, NRC Orchid, Pakyong, Sikkim.
- Mr. B.C. Sarmah, SDO, Department of Agriculture, Nagaon, Assam.
- Dr. K.Z. Ahmed, Scientist, Production Division, Tocklai Experimental Station, Jorhat

Regional Centre, Udaipur

- Dr. B.S. Chundwat, Ex V.C. Sardarkrushinagar-Dantiwada Agriculture University, Gujarat
- Dr. S.L. Mehta, Ex V.C. MPUA&T, Udaipur.
- Dr. S.S. Tomar, Professor and incharge KVK, MPUA&T, Kota.
- Dr. P.M. Jain, Director Extension, MPUA&T, Udaipur.
- Dr. S.C. Bhandari, Dean PGS, MPUA&T, Udaipur.
- Dr.P.C. Kanthalia, Head, Soil Science and Ag. Chemistry, MPUA&T, Udaipur.
- Dr.B.L. Jain, Ex Principal Scientist, Regional Centre, NBSS&LUP, Udipur

Personnel (Managerial Position)

DR. DIPAK SARKAR

Director

Dr. D.K. Pal: Division of Soil Resource Studies

Principal Scientist (Pedology) and Head

Dr. Arun Chaturvedi : Division of Land Use Planning

Principal Scientist (Geography) and Head

Dr. A.K. Maji : Division of Remote Sensing Applications and GIS

Principal Scientist (Pedology) and Head

Dr. L.G.K. Naidu : Regional Centre, Bangalore

Principal Scientist (Pedology) and Head

Dr. J.P. Sharma: Regional Centre, Delhi

Principal Scientist (Pedology) and Head

Dr. Utpal Baruah : Regional Centre, Jorhat

Principal Scientist (Geography) and Head

Dr. D.S. Singh : Regional Centre, Kolkata

Principal Scientist (Geography) and Head (Acting) (upto 13.05.2009)

Dr. S.K. Singh Principal Scientist (Pedology) and Head (w.e.f. 14.05.2009)

Dr. R.L. Shyampura : Regional Centre, Udaipur

Principal Scientist (Pedology) and Head

Dr. (Mrs) C. Mandal : Cartography

Principal Scientist (Geography) and Incharge

Dr. P. Chandran : Technical Cell

Principal Scientist (Pedology) and Incharge

Sh. G.R. Deshmukh: Library and Documentation Unit

Technical Officer(T-9) and Incharge

Dr. N.C. Khandare: Sale and Publication Unit

Technical Officer(T-9) and Incharge

Sh. S.K. Arora: Printing Section

Printing Officer (T-9) and Incharge

Sh. Rakesh Kumar : Administration

Senior Administrative Officer

Sh. O.P. Nagar: Finance and Accounts

Senior Finance and Accounts Officer (w.e.f. 03.07.2009)

Sh. Sachin Agnihotri : Administration

Administrative Officer



Published by Dr. Dipak Sarkar, Director, NBSS&LUP, Nagpur & Printed by Sh. S.K. Arora, In-charge Printing, NBSS&LUP, New Delhi at National Printers, New Delhi-110 028