CONTENTS

ICAR-NAHEP- Center for Advanced Agricultural Science and Technology
COLLEGE OF AGRICULTURAL ENGINEERING
JNKVV, JABALPUR
A center for Spatial Data Application in Agriculture (CSDA)
Quarterly Progress Report (April to June 2022)

Title: "Skill Development to use spatial data for natural resources management in Agriculture"

Objectives:

- To build basic capacity for using RS & GIS techniques applied for betterment of Natural Resource Management particularly in Agriculture and allied sectors.

Activities

1. Awareness programme for students
2. Introductory programme for administrator
3. Executive learning for executives
4. Capacity building for Scientists, Teachers, officials, students, and Young Professionals

- To identify appropriate techniques for integration of spatial and ground data to realize problems related to land, water and vegetation.

Activities

1. Problem identification in realizing process with satellite and ground data techniques available.
2. Making the spatial data maps more precise and accurate using fine-resolution data available with present satellite systems.
3. Students undergoing masters and doctoral degree programmes shall be involved to undertake research projects on related aspects. They shall be provided research fellowship for the same.

- To develop user-friendly spatial data products using identified technologies for policymakers, researchers, field workers and farmers.

Activities

1. Preparation of Theme based maps
2. Preparation of Integrated maps for decision making

1. Administrative Activities

1.1 Creation of Facilities

i. Supply order were issued to concern firm for formation of cubical workstation and computer peripherals.

ii. Quotation were invited for wall mounted LED TV

iii. National competitive bid invited for Hyperspectral Spectro-radiometer.

1.2 Training schedule planned

Training schedule for online/offline mode for students and faculty of various departments was prepared as below:

Schedule of Trainings (April – June 2022)

S.N	Date		Training
	From	To	
1	12th - April-22	12th - April-22	Strengthening Industries academia relationship for promoting entrepreneurship among students.
2	19-May-22	11-June-22	Hands on training on RS and GIS using QGIS
3	30th May 22	03rd June 22	Training in pedagogy to improve the performance of weak students
4	1st June 22	21st June 22	21-day free yoga camp under Ajadi ka Amrit Mahotsava.
5	05th June 22	05th June 22	Online Quiz Program on World Environment Day Celebration
6	13th June 22	13th June 22	Agricultural Engineering Interventions for Sustainable Agriculture
7	29th June 22	29th June 22	Awareness program by byer company

2. Capacity Building Programme

2.1 **Strengthening Industries-Academia Relationship for Promoting Entrepreneurship Among Students**

A one day workshop on "Strengthening Industries-Academia Relationship for Promoting Entrepreneurship Among Students" was organized on 12th April, 2022 under the chairmanship of Prof. PK Bisen, Hon'ble Vice Chancellor, JNKVV. Jabalpur Dr. Suneel Pareek. Head Department of Agriculture & Environmental Sciences (NIFTEM), Sonipat, presided the workshop as Chief Guest Dr. Kailash Gupta, Chairman-Commercial Group of Industries and Shri Ravi Gupta, Chairman, Mahakaushal, Chamber of Commerce & Industries presided the workshop as special guest. Dr. Dinkar Sharma, Director Extension Services, Dr. Atul Srivastava, Dean Faculty of Agril., Engineering, Dr. Abhishek Shukla, Director Instructions, Dr. D. K. Pahalwan, Director Farms, Dr. Sharad Tiwari, Dean, College of Agriculture, Jabalpur, Dr. Amit Kumar Sharma, Dean Student Welfare, Dr. S. B. Nahatkar, Director Agri Business Management, Shri V N. Bajpai, Comptroller, Dr. R. K. Samaiya V/c Registrar JNKVV, Jabalpur and Head of the Departments, faculty members and Ph.D. students of different departments participated in the workshop. One hundred & two participants registered in the interface. The workshop was organized by Dr. Abhishek Shukla, Director Instructions, JNKVV, Jabalpur in collaboration with Dr. R. K. Nema, PI, NAHEP project, JNKVV, Jabalpur.

Following Industry personnel attended the workshop.

1. Dr. Sunil Pareek, Head Department of Agriculture Environmental, Sciences (NIFTEM)
2. Shri Ravi Gupta, Chairman, Mahakaushal, Chamber of Commerce & Industries
3. Dr. Kailash Gupta, Chairman-Commercial Group of Industries
4. Shri Virendra Sharma, Rallis India Ltd. (IA Tata Enterprises)
5. Shri Girish Gagebhica, Bhanu Farm Frozen Peas Company, Shahpura.
6. Shri Manish Choubey, Bayer Crop Science
7. Shri Ajay Naberia, Saibhog Narmada Animal Feed Industry. Panagar
8. Shri Ashish Parashar, IFFDC, Jabalpur
9. Shri Anil Gupta, Jantayu Panchgavya Research Aurveda, Jabalpur
10. Shri Abhishek Sharma, Willowood Chemicals Ltd., New Delhi.
11. Shri Mukesh Jain, Rice Mill, Richhai, JBP
12. Shri Sukhvinder Singh, CNH India Pvt. Ltd., Ecotech-3, Noida
13. Shri Bharath Maheshwari, SRK. Agrotech, Wardh
14. Shri Rajdeep Singh, Richai, Jabalpur
15. Shri Prafulla Pandey, G.M. Mahindra Tractor, Mumbai
16. Shri Ajay Nioday, Vice Chairman, Orient Paper Industries, Amlai
17. Shri Santosh Kumar Kaushal, Eagle Seed Biotech Ltd. Company, Indore
18. Dr. Prabhu Dayal Kumawat, Shriram Fertilizers and Chemicals, (DCM Shriram Ltd.), Delhi
19. Shri Dinesh Kushwaha, Dharti Agroteck, Nagpur
20. Shri Ambika Prasad Patel, Agadyati Herbs and Food Private Limited

21. Shri S. S. Ali, AGM (Mktg), Dugdha Sangh (Sanchi), Jabalpur
22. Pallavi Patel, VAM, Agro Processing, Umariya Dugariya Industrial Area, Jabalpur
23. Shri Rajesh Ranga, Jabalpur
24. Shri Vineet Goklani, ToC, The Oven Classics, Jabalpur
25. Shri Shivam Agro, Shivam Agro Industries
26. Dr. Manish Agrawal, Excellent Bio Research Solutions Pvt Ltd., 1042, Napier Town, Jabalpur
27. Shri Sahil Khanijo, Amba Grains Pvt. Ltd, Jabalpur

The major highlights of the discussions are:

1. Quality testing of different products should be initiated at JNKVV.
2. Traditional education and practical aspects of curricula should be matched by amendments in existing syllabi.
3. Training of students in industries should be promoted.
4. Development of linkage of farmers with industries in collaboration with Director Extension Services, Krishi Vigyan Kendras.
5. Facilitating industries for availing testing of different samples for different activities like quality, microbial population etc. for young entrepreneurs and startups.
6. Creation of facilities for storage and processing plants like Jamun etc.
7. Research areas of students should be focused on industrial requirements.
8. Development of learning instinct and interest in students.
9. Pre-interview conduction of students before industrial attachment.
10. Creation of by-laws between industry and university before engagement of students as trainee in industry in an internship programme or conducting part of research work for partial fulfillment of degree programme.
11. Orientation or induction of students in different departments of industries
12. Provision of providing facilities for conduction of different field trials at university campuses on payment basis and engagement of students as a part of their research topic. This will facilitate regular supervision, timely submission and quality data generation.
13. Regular meeting with industrialists to incorporate the identified research gap incorporation in thesis research.
14. Promotion of natural and organic farming and encashment of heritage crops of Madhya Pradesh
15. Exploration of biodiversity on the basis of nutritional contents and therapeutic values
16. Processing of unique material/active ingredient from agricultural commodities.
17. Automatization and mechanization is required to change the agro ecology
18. Requirement of climate smart agriculture and promotion and validation of indigenous technical knowledge (ITKs).


Workshop on
Strengthening Industries-Academia Relationship for promoting Entrepreneurship among Students
April 12, 2022
Organized by
Directorate of Instruction
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur
in collaboration with
NAHEP
National Agricultural Higher Education Project (NAHEP)
College of Agricultural Engineering, Jabalpur

2.2 Hands-on training on Remote Sensing & GIS using QGIS

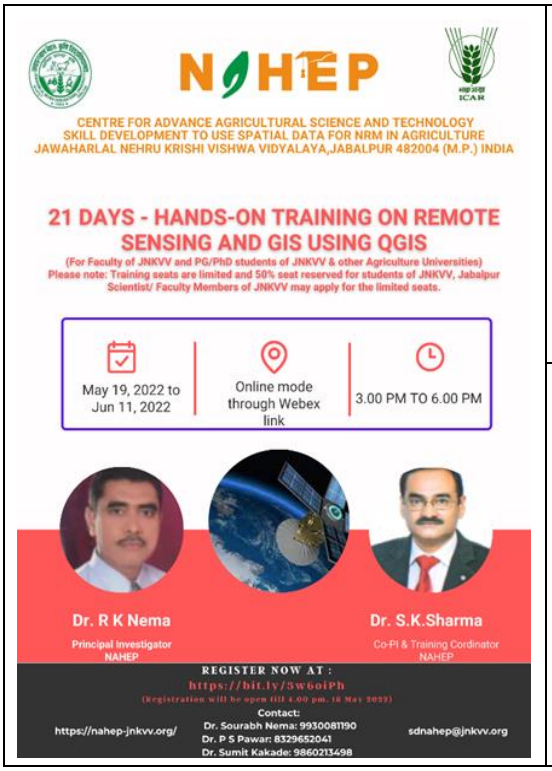
21 days training of remote sensing and GIS using QGIS has been organized for the Student of PG, Ph.D. and faculties from 19 May to 11 June 2022. The training was organized in hybrid mode (online and offline) and it covers Basic of RS &GIS along with QGIS software for satellite image processing. The training program also includes various special lectures on applications of RS in agriculture and allied field, spectral reflectance signatures and spectral indices of vegetation and soils, digital image processing, drought monitoring and management etc.

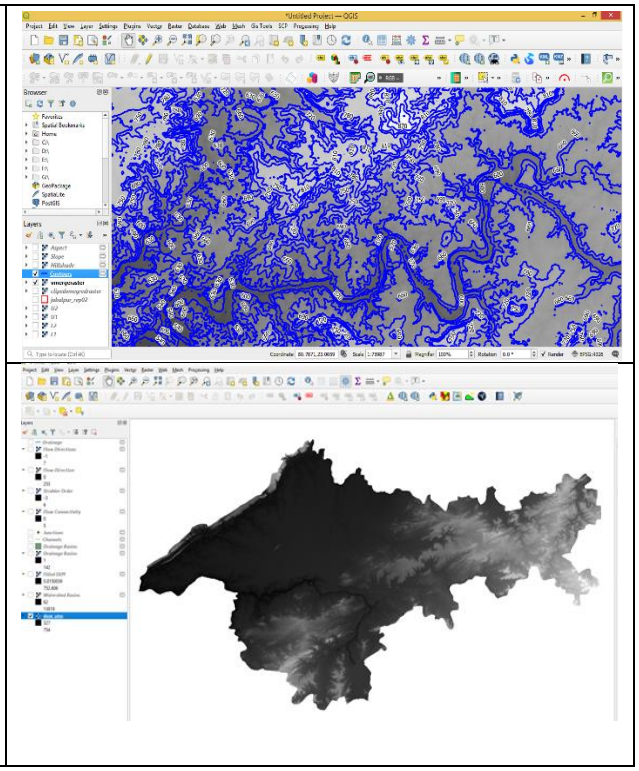
The detailed training schedule is listed below:

Date	Topic
19/05/2022	Inauguration, Interaction with participants, Special lecture on Basics of Remote Sensing andits application in agriculture
20/05/2022	Satellites, Sensors, Resolutions & Visual Interpretationof Satellite Imager.
21/05/2022	Different Geoportals (Earth explorer, Bhuvan, Copernicus ESA, etc.), Introduction to GIS and Special Lecture
23/05/2022	Introduction of QGIS, Downloading & Installation ofQGIS Software
24/05/2022	Introduction of QGIS open- source software & its overview
25/05/2022	Geo referencing of Map
26/05/2022	Generation of vector features such as Point, Line, and Polygon, filling data in the attribute table and area calculation.
27/05/2022	Downloading of Landsat-8satellite dataset and about bands information.
28/05/2022	Layer stacking of differentbands and clipping of Area of Interest (AOI)
30/05/2022	Band combinations for agriculture applications usingFalse Colour Composite
31/05/2022	Pre- Processing of Landsat 8 using SCP
01/06/2022	Region of Interest (ROI) and Creating Training Dataset
02/06/2022	Introduction of Classification, Supervised classification usingMinimum distance algorithm
03/06/2022	Introduction of Classification, Supervised classification usingMinimum distance algorithm
04/06/2022	Supervised classification using Minimum distance algorithm
06/06/2022	Area Calculation ofLU/LC classified data

07/06/2022	Map Layout Creation and Special Lecture
08/06/2022	Installation of Quick OSM plugin and downloading of OSM data
09/06/2022	DEM data processing(Drainage/Watershed Delineation)
10/06/2022	DEM data processing& external thematic maps using WMSlayers and Special Lecture
11/06/2022	Presentation by Participants on LU/LC &Thematic maps Post Training Assessment & Valedictory Function

Participants in Hands-on Training on RS and GIS Using QGIS									
Number of Participation						**% of participation of diff. Category**			
Gender	UR	SC	ST	OBC	Total	UR	SC	ST	OBC
Male	17	6	2	18	43	39.5	14.0	4.7	41.9
Female	10	2	4	9	25	40.0	8.0	16.0	36.0
Total	27	8	6	27	68	39.7	11.8	8.8	39.7





2.3 Workshop on Pedagogy to Improve the Performance of Weak Students.

Five Day Online Workshop on "Pedagogy to Improve the Performance of Weak students" was organized from May 30th - June 03rd, 2022 for Faculty to develop competency to various speaking, writing, soft skills, Personality capacity activities based on classroom teaching through various teaching method and tools to make the complexities of the topic into most simplified manner for better understanding of the topics /concepts among students in the elite of new education policy.

194 faculties registered for the program, out of which 68% were male and 33% were female. They belong to UR (67%), OBC (19.6%), ST (8.2%) and SC (5.2%) categories. Cisco WebEx was used as an online platform.

The topics covered were Modern teaching methods and New education policy, Basics of teaching, Classroom management skills (Micro Teaching skill), Role of teacher - How to use floor, white board, PPTs, time management, Teaching pedagogy and Teaching Skills. The detailed schedule is as below.

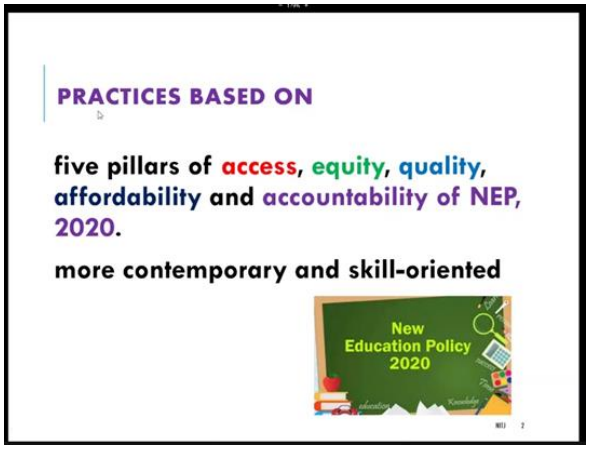
Date	**Speaker**	**Topic**
30th May 2022	Dr Kalyana Chakravarthi, Founder – Knowledge, Attitude and Skills Services (KASS) Hyderabad	Modern teaching methods and New education policy
31st May 2022	Prof. G. Damodar, Vice Chancellor, Chaitanya Deemed University Warangal AP,	Basics of teaching
01st June 2022	Dr Mohd Abdul Nayeem, Associate Professor, IBS Hyderabad,	Role of teacher, How to use floor, white board, PPTs and time management
02nd June 2022	Dr. Kaushal Sharma, Associate Professor – National Rehabilitation University, Lucknow	Teaching pedagogy and Teaching Skills
03rd June 2022	Dr. Sharad Sundaram, Principal, RCPE BEd College, Betul MP	Classroom management skills (Micro Teaching skill)

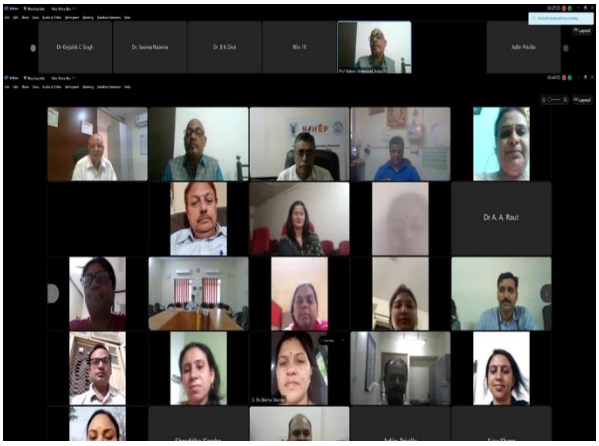
Points discussed were:

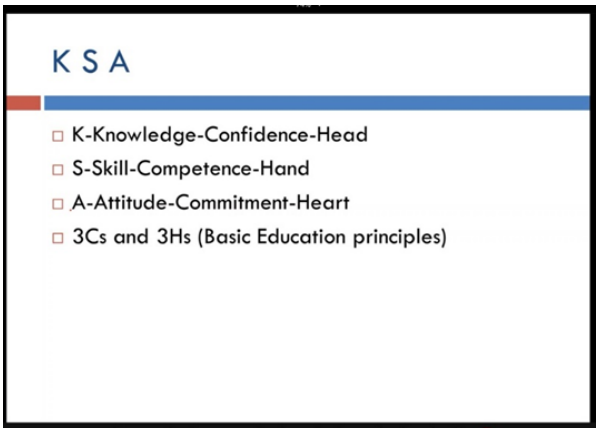
- Modern Teaching Techniques and New education policy
- How teaching styles are differing in different countries
- How to upgrade the education system as per new education policy.
- Fundamentals of teaching methodology
- Basic teaching methodologies and skills
- How a teacher have to upgrade himself
- How to deflect/reflect question raise in the class and
- How to attract students towards the class.

- How to use floor, white board, PPTs and time management lots of illustration of attention span of learners/various type of classroom setting and time management, teaching tools and many websites that are useful to faculty members.
- Positive note in classroom and other ways of managing the classroom activities.
- Micro teaching, Skill of questioning, verbal and non-verbal Reinforcement, using black board technique, and skills of explaining.

Participants of Pedagogy to Improve the Performance of Weak students.										
Number of Participation						**Percentage of participation of Category**				
Gender	SC	ST	OBC	UR	Total	SC	ST	OBC	UR	Total
Male	8	12	26	86	**132**	6.1	9.1	19.7	65.2	68.0
Female	2	4	12	44	**62**	3.2	6.5	19.4	71.0	32.0
Total	10	16	38	130	194	5.2	8.2	19.6	67.0	







The faculties from all the designation registered themselves for this module. Out of 194 registered participants, 50% were Assistant Professor followed by Scientist (16%), Professor (14%), Technical Assistant (6%), Associate Professor (5%) and Sr. Scientist (3%). Belonging to different departments like Plant Breeding & Genetics, Horticulture, Agronomy, Food Science & Technology, Agricultural Extension & Communication and Agricultural Economics & Farm Management etc.

As for as feedback is concerned out of 137 responses recorded, majority of them reported that the content of the module was Good (51.1%) and Excellent (38.7%). 75.9% of the participants found that this module is useful for their professional development.

2.4- 21 Days Training Camp on Yoga for Sustainable life Style

In the celebration of the 75th year of Amrit Mahotsav of Independence, 21 days Yoga Camp was organised. Students, scientists, professors and staff of the university have participated in the camp. They benefitted with the knowledge of yogic practices, pranayama, meditation, neurotherapy & manipulative therapy, acupressure & Acupuncture therapy shared by different field experts. The experts have also shared the benefits of adaptation of regular yoga and pranayama in daily life, i.e. for physical fitness, musculoskeletal functioning, cardiovascular health, management of various disorders in body like respiratory disorder, hypertension, hypotension, reducing depression, fatigue, anxiety and stress. It also helps us in developing a better immune system and better perception of oneself so that the environmental conditions and social factors do not affect adversely. In order to increase enthusiasm among students for yoga, a competition was also conducted in the camp. All the participants were encouraged to continue the regular practice of yoga and pranayama with message from short street play by students.

Date	**Activities**
01/06/2022- 21/06/2022	Prayer, Poses of Regular Movement, Palm Tree Pose, Swinging Palm Tree Pose, Standing Spinal Twist Pose, Tree Pose, Chair Pose Surya Namaskar, Frog Pose, Half Camel Pose, Boat Pose, Half Plough Pose, Bow Pose, Pranayama, Om and Serenity Prayer Acupressure & Acupuncture Therapy by Dr Mayur Jain, Complete health through yoga therapy and meditation by Dr. Rachna Jain Protocal of world yog day by Yogacharya Shri Swami Ganesh Giri

A total of 139 students and faculties of the university registered & participated in training programme. Out of which 57.6% were male and 42.4% were female. They belong to OBC (40.3%), UR (30.2%), SC (12.9%) and ST (16.5%) categories.

The students and faculties from almost all the stream and degree program registered for this event. Out of 139 registered participants B.Sc. Ag. / Horti. were found to be 39% followed by B.Tech. (32%), Ph. D. (12%), M.Sc. Ag/Horti. (9%) and B.Sc. Forestry (8%)

Participants of Yoga for Sustainable life Style										
Number of Participation						Percentage of participation of Category				
Gender	SC	ST	OBC	UR	Total	SC	ST	OBC	UR	Total
Male	10	9	36	25	80	12.5	11.3	45.0	31.3	57.6
Female	8	14	20	17	59	13.6	23.7	33.9	28.8	42.4
Total	18	23	56	42	139	12.9	16.5	40.3	30.2	100

2.5 Celebration of World Environment Day 2022

World Environment Day was celebrated under NAHEP at College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) Jabalpur. On this occasion online quiz competition, Plantation and Nukkad natak was organized on 7th June, 2022 under the Chairmanship of Prof. P. K. Bisen, Hon'ble Vice Chancellor, JNKVV, Jabalpur. The Quiz program was successfully conducted online mode.

Total 403 students of Nine colleges of them online registered for this quiz competition. Out of them **103** students participated in the quiz and attractive prizes with certificates were distributed to students with high performance in the presence of Hon. Vice Chancellor Prof. P. K. Bisen.

Online Quiz Program Participation

Number of Participation						**Percentage of participation of Category**			
Gender	UR	SC	ST	OBC	Total	UR	SC	ST	OBC
Male	15	5	12	33	65	23.1	7.7	18.5	50.8
Female	18	5	3	12	38	0.0	0.0	0.0	0.0
Total	33	10	15	45	103	32.0	9.7	14.6	43.7

2.6 Awareness Program on Technological Interventions for Sustained Agriculture:

A Special lecture on theme "Technological Intervention for Sustained Agriculture" was organized on 13rd June 2022 to make students aware about various revolutionary changes due to the introduction of recent technologies specially robotics and drone applications in agriculture. The renowned speaker Dr N. K. Gontiya Hon VC JAU, Gujrat explained about automation in different agricultural domain, basic concepts of robotics applications in farming, sensor technology & Automation System Architecture. Different Robotics technologies used in abroad i.e. WP5 Robot, Lettuce harvester, Tomato Fruit Cluster Harvesting Robots, MIT Robot Gardener etc. were

Awareness Program on Technological Intervention for Sustainable Agriculture									
Number of Participation						**% of participation of diff. Category**			
Gender	UR	SC	ST	OBC	Total	UR	SC	ST	OBC
Male	10	3	3	21	37	27.0	8.1	8.1	56.8
Female	6	4	1	4	15	40.0	26.7	6.6	26.7
Total	16	7	4	25	52	30.8	13.4	7.7	48.1

elaborated. Various approaches were discussed for crop monitoring & management with the help of drone and its importance to give a technological boost to the agriculture industry. Students, faculty and project staff from different departments attended the program.

2.7 **Awareness Program on Bayer Safe Use Ambassador**

Awareness training on hybrid mode entitled Safe Use of Pesticides and Launching of "BAYER SAFE USE AMBASSADOR" programme was organized on 30th June 2022 at Department of Entomology, College of Agriculture, Jabalpur in collaboration with Bayer Crop Science, Mumbai, for sensitization at the University level. Bayer Crop Science representatives, Mr. Sushil Desai (Associate General Manager) and Dr. Tushar Ghule (Senior Field Development Executive) interacted with 151 students simultaneously in offline and online mode.

Students were exposed on crop protection products, food safety, integrated pest management, resistance management; safe and convenient use of crop protection products, container management and spray application technology by the representatives of Bayer Crop Science. The students were asked to disseminate the technology for safe use of pesticide among the farmers using innovative methods for extension. At the end of the training, safety kits and badge of "Bayer Safe Use Ambassador" were distributed to the students

3. 3. Techniques for integration of spatial and ground data

3.1 Problem Identification: The following problems were identified earlier in realizing process with satellite and ground data with techniques available

- Land surface temperature using remote sensing
- Remote sensing based crop phenology
- Rice crop mapping using Sentinel-1 data
- Yellow stem borer infestation in paddy
- Variation of spectral finger prints of major Rabbi crops
- Ground Water potential zoning
- High temperature stress in Chickpea
- Fall Army Worm infestation in maize crop
- Watershed prioritization

3.2 Precision and Accuracy of satellite data maps:

The fine resolution data available with present earth observing satellites have been used to make the spatial data maps more accurate and precise. Under this activity, it was planned to obtain various thematic information's from present earth observing satellite systems for efficient planning and management of natural resources in relevance to agriculture at micro level, block level, district level and basin level.

- To enhance the precision of remote sensing based maps level III and level IV classification are initiated using fine resolution data for crop classification, assessment of water bodies, watershed studies. The data obtained through IRS LISS-IV, Multi-spectral Imagery from Sentinel are being process.
- High resolution spatial data from IRS LISS-IV, Multi-spectral Imagery from Sentinel, SAR data from Sentinel and their repetitive coverage are used to improve the accuracy of classification in various themes. The work has been reported under various section for research projects through PG & Ph. D. students.

3.3 Students Research Projects: Students of undergoing master and doctoral degree program have been involved to undertake research project on related aspects. Research fellowship have been provisioned for students working on relevant research problems of this particular objective.

These activities will continue in the following years. The details of PG/Ph.D. research topics and progress of work are presented below.

Table 3.3.1 Involvement of students for Post graduate and Doctoral research under NAHEP theme

S. No	Topics	Student	Department	Advisor	Course
1.	Study on Prioritization of Sub-watersheds through Integration of Land Use Land Cover Factors with Morphometric Parameters.	J. Himanshu Rao	Department of Soil and Water Engineering	Dr. S.K. Sharma	Ph.D.
2.	Identification of suitable sites for Artificial Groundwater Recharge using Geoinformatics in Ken River Basin, India.	Deepak Patle	Department of Soil andWater Engineering	Dr. M. K. Awasthi	Ph.D.
3.	Demarcation of Groundwater Potential Zones of Tons Basin using Geoinformatics.	Neelam Bunkar	Department of Soil andWater Engineering	Dr. R.K. Nema	Ph.D.
4.	Assessment of Spatiotemporal Groundwater Storage Capacity of Wainganga River Basin of Madhya Pradesh	Pushplata Arihwar	Department of Soil andWater Engineering	Dr. Y. K. Tiwari	Ph.D.
5.	Geospatial planning for enhancing Groundwater Recharge in Chambal basin of Madhya Pradesh	Priyamda Vaidya	Department of Soil andWater Engineering	Dr. M.L. Sahu	Ph.D.
6.	Crop suitability Mapping of Jabalpur district	Ghirdhari Lal	Department of Soil andWater Engineering	Dr. R.K. Nema	Ph.D.
7.	Spatial estimation of green pea in Jabalpur district	Shivam Rathore	Department of Soil andWater Engineering	Dr. Y. K. Tiwari	M.Tech.
8.	Assessment of Soil Erosion in Shakkar River Watershed with Universal Soil Loss Equation and Geographic Information System Integration	Sahil singh Kaurav	Department of Soil andWater Engineering	Dr. S.K. Sharma	M.Tech.
9.	Change detection of Vegetative cover of the watershed using RS and GIS technique.	Ritesh Mahto	Department of Soil andWater Engineering	Dr. M.L. Sahu	M.Tech.
10.	Surface waterbodies change detection of Tikamgarh district using spatial data	Rajnish K. Giri	Department of Soil andWater Engineering	Dr. R.K. Nema	M.Tech.
11.	Identification of Groundwater potential zones of Sone River	Anoop Patel	Department of Soil andWater Engineering	Dr. M. K. Awasthi	M.Tech.

	basin through Remote Sensing and GIS.				
12	Characterization of the efficacy of plant growth regulators for high-temperature stress mitigation in chickpea (Cicer arietinum L.) through ground based proximal remote sensing.	Supriya Debnath	Department of Plant Physiology	Dr. R. Shiv Ramakrishnan	Ph. D.
13	Characterization of Fall Army Worm (FAW) Infestation in Maize Crop through Ground Based Hyperspectral Remote Sensing Under Field Conditions.	Kumari Pragya	Department of Entomology	Dr. S. B. Das	Ph. D.
14	Deciphering the Mechanism of Resistance for Dry Root Rot and Terminal Heat Stress Resistance in Chickpea applying Genetic, Genomic and proximal remote sensing based phenomics approaches.	Deepak Katkani	Department of Plant Breeding and Genetics	Dr. Anita Babbar	Ph. D.
15	Characterization of the plant growth regulators for alteration of growth, physiology and high temperature stress tolerance mechanism in wheat (*Triticumaestivum*L.) through ground based proximal remote sensing.	Rohit kumar kumawat	Department of Plant physiology	Dr. Gyanendra Tiwari	Ph. D.
16	Application of proximal remote sensing elicited from plant phenomics approaches and characterization of chilli genotype for heat stress.	Ms. Shweta Tiwari	Department of Plant Breeding and Genetics	Dr. Kanchan Bhan	Ph. D.

Table 3.3.2 Progress work in Post Graduate and Doctoral Research

S.N.	Title	Progress
1.	Study on Prioritization of Sub-watersheds through Integration of Land Use Land Cover Factors with Morphometric Parameters.	• Preparation of thematic maps illustrating the priority ranks and priority category of sub-watersheds using morphometric parameters based sub-watershed prioritization using Weighted Sum Approach method. • Preparation of thematic maps illustrating the priority ranks and priority category of sub-watersheds using LULC factors based sub-watershed prioritization.

		• Preparation of thematic maps showing the priority ranks and priority categories of sub-watersheds using the combined influence of morphometric parameters and LULC factors.
2.	Identification of suitable sites for Artificial Groundwater Recharge using Geoinformatics in Ken River Basin, India.	• Mann Kendall test applied to determine the post-monsoon water level trends from the year 2011 to 2020.Post monsoon water level trends map has been prepared. Identified the area where depletion rate is more than 0.10 m/yr. in Ken Basin • Groundwater potential zone were considered for artificial recharge of groundwater. Critical area identified in Ken Basin for artificial recharge. • Decision Support System (DSS) constructed for suitable site for groundwater recharge structures .
3.	Demarcation of Groundwater Potential Zones of Tons Basin using Geoinformatics.	• Review on methods of demarcation of groundwater potential zones and AHP. • Groundwater potential zoning and the overlay analysis • Prepared groundwater decline map of Tons basin of pre and post monsoon season by using IDW tool. • Net groundwater recharge of Tons basin is calculated by water level fluctuation method.
4.	Assessment of Spatiotemporal Groundwater Storage Capacity of Wainganga River Basin of Madhya Pradesh	• Geomorphology map of Wainganga River Basin has been prepared. • Preparation of lineament, drainage density and Soil map of Wainganga River Basin is going on under process.
5.	Geospatial planning for enhancing Groundwater Recharge in Chambal basin of Madhya Pradesh	• Watershed area of Chambal River basin of Madhya Pradesh has been delineated. • Preparation of soil map of Chambal basin. • Depth of water level data has been collected from Madhya Pradesh State Ground Water Data Centre, Bhopal
6.	Crop suitability Mapping of Jabalpur district	• Literature was reviewed on crop suitability mapping • Source of data requirement for soil, crop and weather were identified • Different factors affecting for crop suitability mapping were identified
7.	Spatial estimation of green pea in Jabalpur district	• Ground truth information is collected from various fields. • Sentinel 2 Satellite data is procured from USGS earth explorer for November 2021. • Pre-processed satellite images of Jabalpur district. • Land Use / Land Cover (LULC) map of Jabalpur for district has been prepared.

8.	Assessment of Soil Erosion in Shakkar River Watershed with Universal Soil Loss Equation and Geographic Information System Integration	• Rainfall erosivity factor is estimated by processing gridded rainfall data obtained from IMD. • Georeferencing of soil sheets of MP which was obtained from NBSSLUP. • Soil map of shakkar watershed has been prepared. • soil erodibility factor map is prepared with the help of soil map and K factor value. • Land Use Land Cover (LULC) map has been prepared using unsupervised classification with overall accuracy of 89.38% and kappa coefficient of 0.84.
9.	Change detection of Vegetative cover of the watershed using RS and GIS technique.	• Locations of soil and water conservation structures has been verified manually with the help of google earth pro and khasra map of MP. • After verification of location, year wise point shapefiles have been created with the help of ArcGIS software. • Watershed is delineated and verified with the help of toposheet of study
10.	Surface waterbodies change detection of Tikamgarh district using spatial data	• Prepared LU/LC map of Tikamgarh district • Classified surface water body area of Tikamgarh district using different indices • Verification of results with field data
11.	Identification of Groundwater potential zones of Sone River basin through Remote Sensing and GIS.	• Watershed was delineated using Digital Elevation Mode,Stream and their orders were demarcated • Elevation, drainage density and slope map prepared, Soil map was digitized using NBSSLUP soil data. • Lineaments were digitized using BHUVAN • Prepared LU/LC, geomorphology, rainfall and geology maps and integrated to demarcate gwp zones
12	Spectral and functional characterization of plant growth regulators application under high-temperature stress in chickpea (*Cicer arietinum* L.)	• Different enzymatic estimation (Catalase, peroxidase, Glutathione Reductase) in leaf samples has been completed by using spectrophotometer. • Chlorophyll and carotenoid content in leaf sample has been estimated by Acetone method. • Minerals estimation (Fe, Zn, Mn) from different treatments has been recorded by using Atomic Absorption Spectrophotometer (AOAC,1965). • Using Flame photometer machine, sodium potassium estimation has been recorded for different treated seed sample. • From the biochemical estimation parameters, total sugar percentage in seed samples of different treatments has been completed in laboratory.
13	Characterization of the plant growth regulators for	• Harvesting of wheat crop and recorded final yield and yield traits (Seed yield, biological yield, Test weight.

	alteration of growth, physiology and high temperature stress tolerance mechanism in wheat (*Triticumaestivum*L.) through ground based proximal remote sensing	• Different biochemical and enzymatic estimation (Chlrophyll estimation, Proline, total suger, Catalase, Peroxidase, GR, and SOD) in leaf sample. • Seed Germination Test and seed Quality tests. • Data analysis of different physiological traits. Analysis of remote sensing data
14	Computation of carbon sequestration of mango (*Mangifera indica* L.) orchards of Jabalpur district using geoinformatics.	• Accuracy assessment of estimated area of mango orchards using geoinformatics. • Estimation of above ground area of mango orchards using geoinformatics. • Accuracy assessment of estimated above ground biomass.
15	Deciphering the Mechanism of Resistance for Dry Root Rot and Terminal Heat Stress Resistance in Chickpea applying Genetic, Genomic and proximal remote sensing based phenomics approach	• Harvesting of crop and post harvesting observations based on seed characteristics (DUS guideline) was taken in timely, late and very late planting conditions. • Data interpretation was done. • Computation of Genetic Variability and Divergence Analysis in Advance Breeding Lines of Chickpea. • Detection of genetic variability and character association to their implication in selection for yield improvement in chickpea (Cicer arietinum L.). • Thesis writing started and pre-submission was done.
16	Characterization of Fall Army Worm (FAW) Infestation in Maize Crop through Ground Based Hyperspectral Remote Sensing Under Field Conditions	• Frame development for second trial. • Net stitching for second trial. • Land marking and layout for second trial was established. • Land preparation sowing of second trial was completed. • Data analysis of first trial was completed.

4. Preparation of spatial products containing information on special theme

4.1 Land Surface Temperature Estimation Using Remote Sensing Data

LST defined as hotness of surface of earth, from RS satellite's perspective; the surface is whatever it sees when it looks through the atmosphere to the ground. LST estimation provides information about temporal and spatial variations of the surface equilibrium state and is of fundamental important in many applications. LST is being used in a variety of areas such as evapotranspiration, climate change, hydrological cycle, vegetation monitoring, urban climate and environmental studies, among others. In the present study, the land surface temperature of Jabalpur district was estimated using Landsat-8 data.

Landsat-8 carries two sensors, *i.e.* the operational land imager (OLI) and the thermal infrared sensor (TIRS). Since Satellite-based thermal infrared (TIR) data is directly linked to the LST through the radiative transfer equation. The retrieval of the LST from remotely sensed TIR data has attracted much attention, especially from Landsat-8 TIR bands. Direct estimation of LST from the radiation emitted in the TIR spectral region is difficult to perform with that accuracy, because radiances measured by the radiometers on board satellites depend not only on surface parameters (temperature and emissivity) but also on atmospheric effects. Therefore, besides radiometric calibration and cloud screening, the determination of LSTs from space-based TIR measurements requires atmospheric corrections.

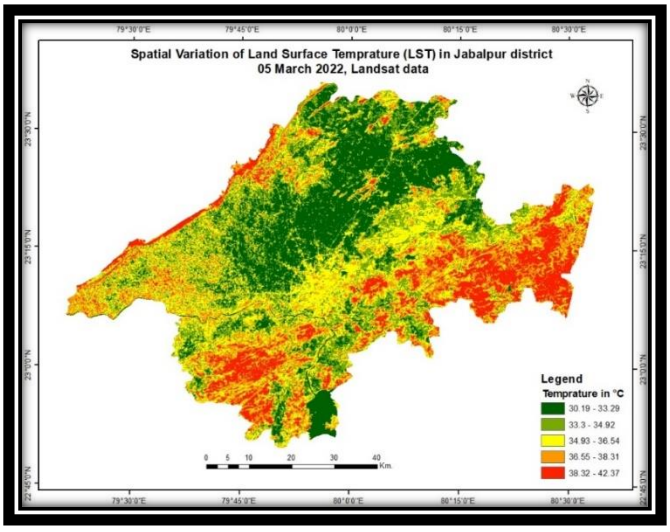


Fig. 4.1 LST map of Jabalpur district for 10, March 2022

LST retrieval process is completed using SW algorithm, which is best-suited algorithm for LANDSAT-8 TIR bands. LST maps are generated for Jabalpur district as shown in Fig. 4.1, for the months March 2022. Degree Celsius (°C) is considered as basic unit for temperature for all the analysis. The temperature in first week of March varies from 30.19 °C to 42.37 °C. As per the ideal yield condition of wheat maturity, the optimum temperature should be between 20-25 °C. However, in this current year, temperature grown significantly from first week of March, could lead into the decrease in wheat yield in few areas of Jabalpur region as compared to previous years. This has been reported by few random farmers in this region as well. It can be concluded with this study that with the help of LST, the impact on yield of crop can be assessed.

4.2 Assessment of Pea crop area in Jabalpur district using remote sensing and GIS.

In this study, spatial data was used with Remote sensing and GIS techniques to estimate green pea areas by adopting supervised maximum likelihood approach for crop classification. Land Use Land Cover map, crop growing period, probable dates of sowing, cropping pattern, field size, different land cover classes and crop calendars for growing seasons of various crops in the study area were analysed before estimation of Pea area. November 2021 was taken as the flowering month for pea. The study area was clipped from a composite FCC image to prepare Land Use Land Cover map by Unsupervised approach in ERDAS Imagine®2020. 501 points were generated to check the accuracy of assessment of the LULC map in GIS environment.

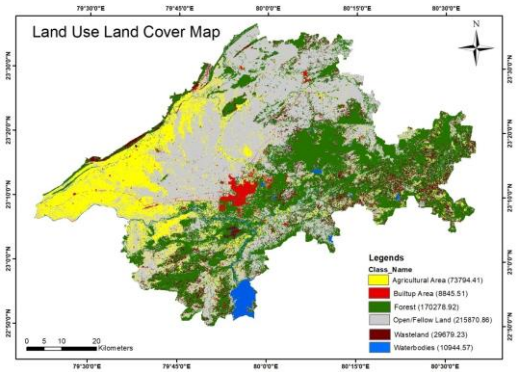


Fig.4.2: Land Use Land Cover Map of Jabalpur district (Nov 2021).

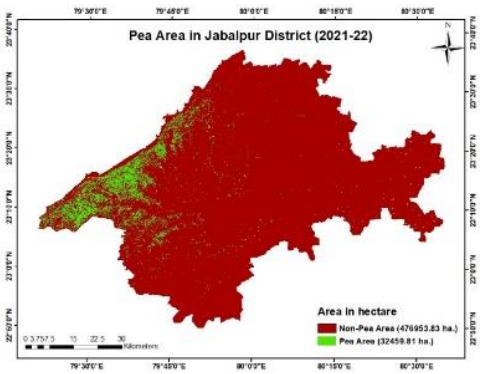


Fig.4.3: Pea crop map of Jabalpur district.

In this study LULC map for Jabalpur is categorized in six classes and their areas in hectares are shown in Fig. 4.2. The overall accuracy of LULC map was found as 88.23% and Kappa coefficient of 0.83. Area under Pea crop is found to be 32459 ha which is at par with record

available with revenue records. The overall accuracy of pea crop classification (Fig. 4.3) was found as 89.16%.

4.3 Crop Phenological Information based on MODIS-EVI Time Series Data for Jabalpur District, Madhya Pradesh

Phenology is the sequence and timing of plant developmental stages and their relationship with climate. Crop phenological information provides essential information for many agricultural applications such as crop classification, crop yield estimation, management of agricultural practices, agricultural water management, drought related studies etc. The vegetation indices such as Normalized Difference Vegetation Index (NDVI) and Enhance Vegetation Index (EVI) are the most widely used vegetation indices derived from satellite images, which can be related to photosynthetic status, relative coverage and plant biomass. The main objective of present study was to extract crop phenological information from MODIS-EVI time series data. The 16 day composite EVI index product of MODIS imagery at 250m spatial resolution (MOD13Q1) for the period 2001 to 2021 were downloaded from NASA Land Processes Distributed Active Archive Center (LP DAAC). The pixel affected by clouds and cloud shadow were removed using MODIS Quality band. Values 0 and 1 (good and marginal data, respectively) from the respective MODIS Quality band were used to exclude cloud affected pixels. The smooth EVI time series were prepared by applying pixel wise gap-filling and smoothing (using Savitzky Golay filtering) methods to reduce the effect of noise. The data downloading, pre-processing, gap-filling and smoothing of EVI imageries were performed using R programming language. The smooth EVI dataset (2001-2021) were prepared for entire Madhya Pradesh state. For extraction of crop phenological information for Jabalpur district, the smooth EVI imageries were clipped to the study area. The phenological information was obtained for the *Rabi* season 2021. Total 10 EVI images from 03 December 2020 to 08 May 2021 were used to extract phenological information (Fig 4.4). The R package "Crop Phenology" was used to compute 15 Phenological metrics from RasterStack of 10 EVI images. The land cover dataset at 10-m resolution for Jabalpur district was obtained from European Space Agency (ESA,2020) using Google Earth Engine platform. The land use/land cover dataset was resampled at 250m resolution and agricultural land was masked from the image. The agricultural land mask was used for masking crop phenological metrics obtained from EVI images of Jabalpur district. The derivation of 15 phenological metrics from NDVI or EVI curve illustrated in Fig. 4.5.

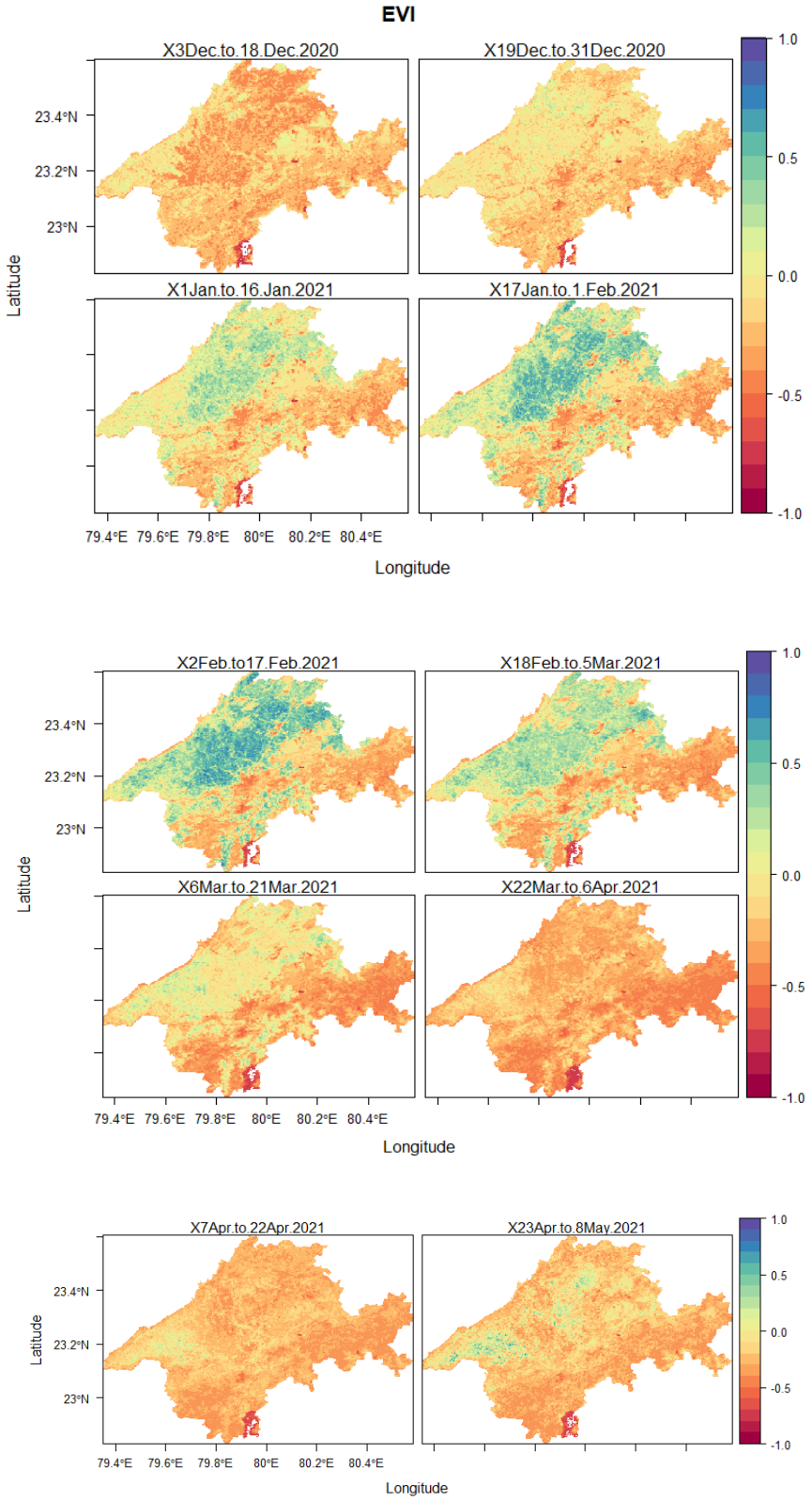


Fig. 4.4. Composite EVI for Jabalpur district from 03 Dec 2020 to 08 May 2021

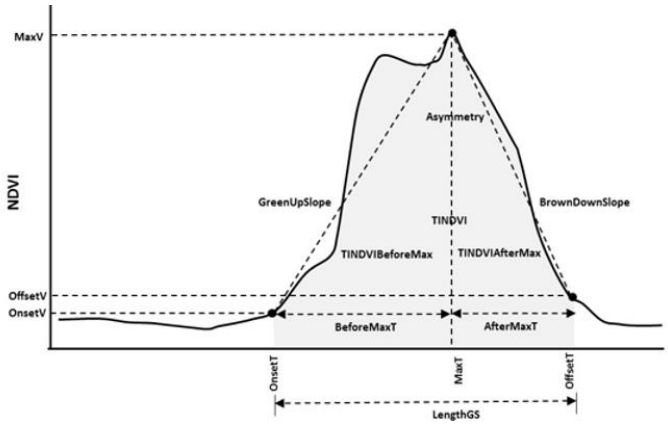


Fig. 4.5. The NDVI dynamics curve illustrate the defined Phenological metrics (*source: https://cropphenology.wixsite.com/package/metrics-definition*)

The pixel wise onset time, offset time and the time of maximum value of EVI achieved in phenological growth period are shown in Fig. 4.6. The time is represented by MODIS image period *e.g.* number "1" represent MODIS image of period 03rd December to 18th December 2020. About 72.57 percent area indicates the onset of crop growth during the period 03rd December to 18th December 2020 (Table 4.1). The onset of crop growth represents initial growth stage of crop *i.e.* development of leaf and canopy emergence. The offset of crop season occurred during the month of March 2021 (in 26.61 % area) and April 2021 (in 72.15% area). Offset of season represents the end of crop growth period or the time when the crop has ripened. 74.9 percent crop area achieved maximum EVI value during the period 17th January to 17th February, 2021. The time of maximum EVI value represents the complete canopy coverage of crop.

Table 4.1. Percentage of crop area at the time of different phenological metrics.

S. No.	Period of image	Cumulative period, Days	Percent crop area		
			At onset (Emergence stage)	At offset (Maturity stage)	At complete canopy coverage
1	03 Dec – 18 Dec 2020	16	72.57	-	11.16
2	19 Dec – 31 Dec 2020	29	14.91	0.06	1.63
3	01 Jan – 16 Jan 2021	45	8.00	0.18	4.67
4	17 Jan – 01 Feb 2021	61	3.60	0.35	39.67
5	02 Feb – 17 Feb 2021	77	0.80	0.30	35.23
6	18 Feb – 05 Mar 2021	93	0.05	0.34	7.36
7	06 Mar – 21 Mar 2021	109	0.02	5.59	0.17
8	22 Mar – 06 Apr 2021	125	0.04	21.02	0.01
9	07 Apr – 22 Apr 2021	141	-	20.64	0.09
10	23 Apr – 08 May 2021	157	-	51.51	-

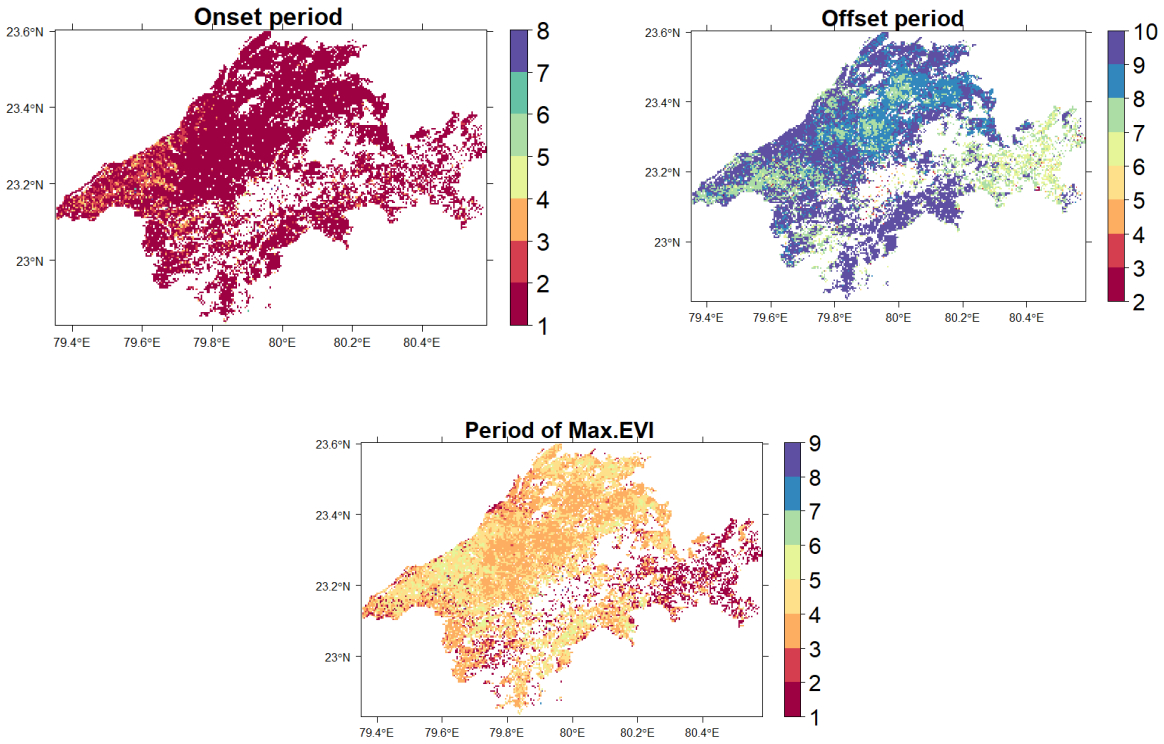


Fig. 4.6. Phenological metrics i.e. onset, offset and period of maximum EVI

The phenological growth period varies from 125 days to 141 days (in 62.4% area), whereas 30.98 percent area having phenological growth period between 93 days and 109 days (Table 4.2 & Fig. 4.7). The phenological growth period represent the duration of time that crop takes to go through all the stages of crop growth (phenological growth period = offset – onset).

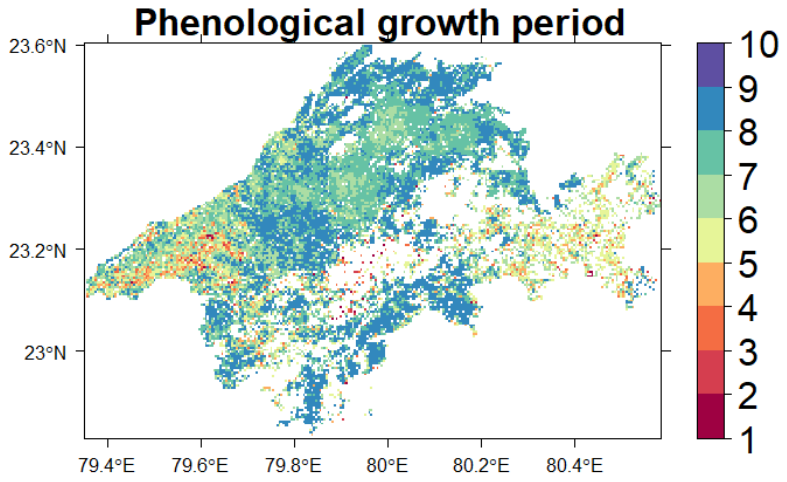


Fig. 4.7 Phenological growth period of crops

Table 4.2. Percentage of crop area under different phenological growth period

Classified area under crops, ha	Phenological growth period, days	Percentage of total crop area
165.13	16	0.049
752.02	29	0.225
1616.51	45	0.483
5214.02	61	1.559
14703.92	77	4.397
38984.31	93	11.657
64926.99	109	19.415
93838.04	125	28.060
114210.04	141	34.152
6.25	157	0.002
Total= 334417.2		100

Figure 4.8 shows the EVI value at the time of onset, offset, full canopy coverage and accumulated EVI value during the growing season. The EVI value at the time of onset rages from -0.024 to 0.589 with coefficient of variation of 29.01 percent (Table 4.3). The mean value of EVI at the time of onset was 0.225 which is greater than 0.2 (usually EVI value below 0.2 represents the bare soil). The maximum EVI value at the time of full canopy coverage varied between 0.064 and 0.853 with mean value of 0.506. Generally, the higher value of EVI at full canopy coverage indicates better growing season and productivity of crop. The values of EVI at offset time varied from 0.047 to 0.601 with mean value of 0.179. The coefficient of variation of EVI values at offset

time was 24.58 percent. The EVI value at offset time represents the minimum value after maximum EVI value (peak). Accumulated EVI value during the growing season ranges from 0.182 to 5.393 and mean value of 3.001. It measures the biomass productivity of cropped area. High accumulated EVI value indicates high crop productivity.

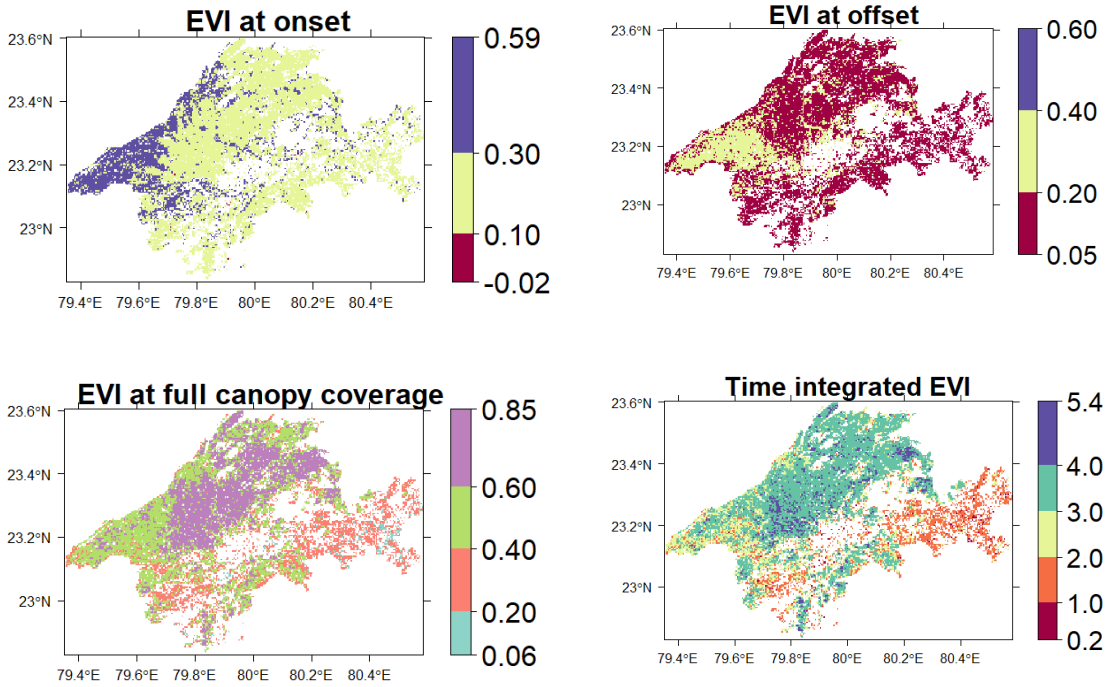


Fig. 4.8. Phenological metrics i.e. EVI value at different stages

Table 4.3. Statistics of EVI values at different stages of growth period

	Enhanced Vegetation Index			
Parameter	**At Onset**	**At Offset**	**At full canopy coverage**	**Integrated for total growth period**
Minimum	-0.024	0.047	0.064	0.182
Mean	0.255	0.179	0.506	3.001
Maximum	0.589	0.601	0.853	5.393
Standard Deviation	0.074	0.044	0.157	0.896
CV (%)	29.01	24.58	31.02	29.85

The variability of EVI values (24.58 to 31.02%) indicates the changes in cropping pattern in the study period. The percentage crop area varies from 11 to 34 percent during the phenological growth periods of 93 to 141 days (Table 4.3). The results of length of phenological growth period indicates, the region has different crops with different growing period. The region has

homogeneity in onset time for *rabi* season, which indicates that the use of remotely sensed vegetation indices has a high potential for use in agricultural management. This information on maturity period of crop may be used for classifying the study area into different crop areas, different crop practices, differently irrigated areas or irrigated vs unirrigated areas with appropriate ground truth information.

4.4 Comprehensive Geo-database development for precise decision making at different levels

GIS is suitable to meet the requirements of synthesizing the available information. The strength of a GIS lies in this capability of storing interpreted and available information as maps and linked their attributes. For developing a GIS application in any decision-making planning, the influential themes need to be considered. Using GIS, the different geologic themes can be integrated using overlay analysis to make a suitable decision plan, either it may be ground water potential zones, hazard assessment, vulnerability assessment or any risk assessment of geologic process. The important parameters that need to be considered for any natural resource evaluation, management and planning is primarily land use/ land cover map, topographic map, slope map, soil map, rainfall map, Lineament map, drainage map, geology and geomorphology map information. These themes help to identifying the region which are vulnerable for potential hazards/landslide, potential availability of natural resources or any risk associated with natural resources/location.

Therefore, considering the above facts, the work has been taken to develop the coherent thematic geodatabase for all the major basin and districts of Madhya Pradesh i.e. Narmada, Chambal, Sindh, Ken, Tawa, Betwa, Dhasan, Son, Wainganga and Mahanadi basin of Madhya Pradesh for land use/ land cover map, topographic map, slope map, soil map, rainfall map, lineament map, drainage map, geology and geomorphology maps.

- **Basin wise soil map**

There is lot of variation of soils in different basins as found in soil map prepared by National Bureau of Soil Survey & Lad Use Classification. It is a tedious and time consuming task to digitize for all the basins at a time. Therefore, the digitization process is undertaken basin wise. The comprehensive map is generated by integrating the digitized information on GIS platform. This soil map is quite useful in planning and decision making in natural resource management. The five attributes were taken for each soil class i.e., porosity, Depth, texture, erosion and stoniness (Fig. 4.9 & 4.10).

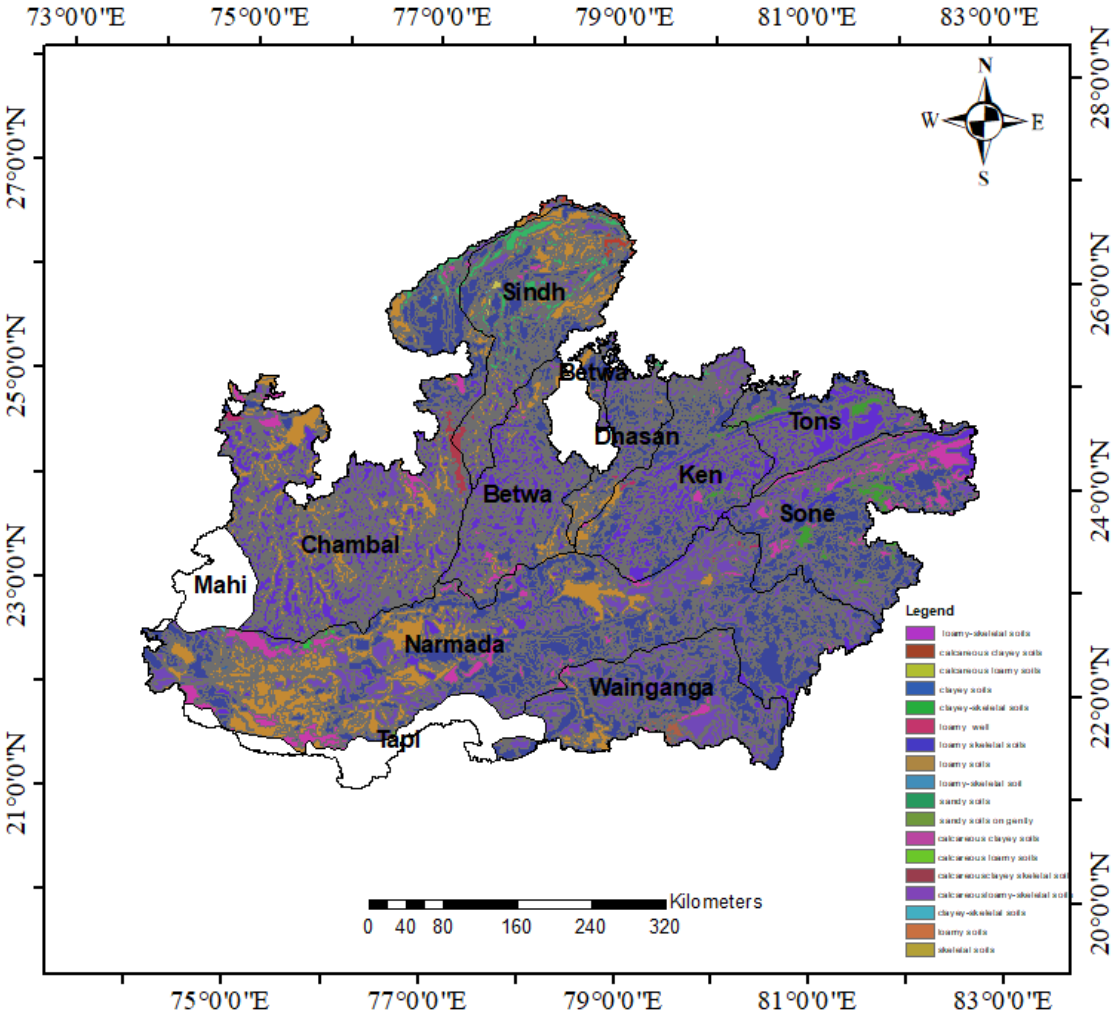
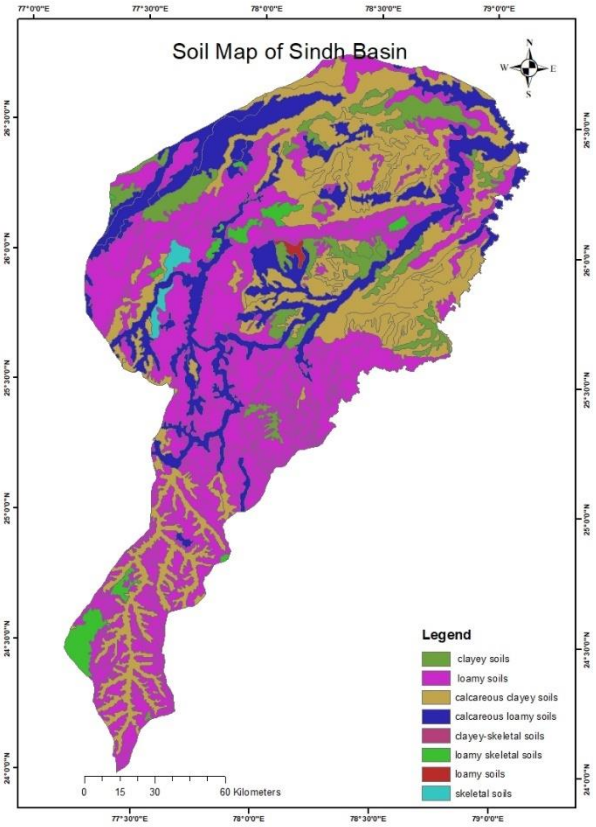
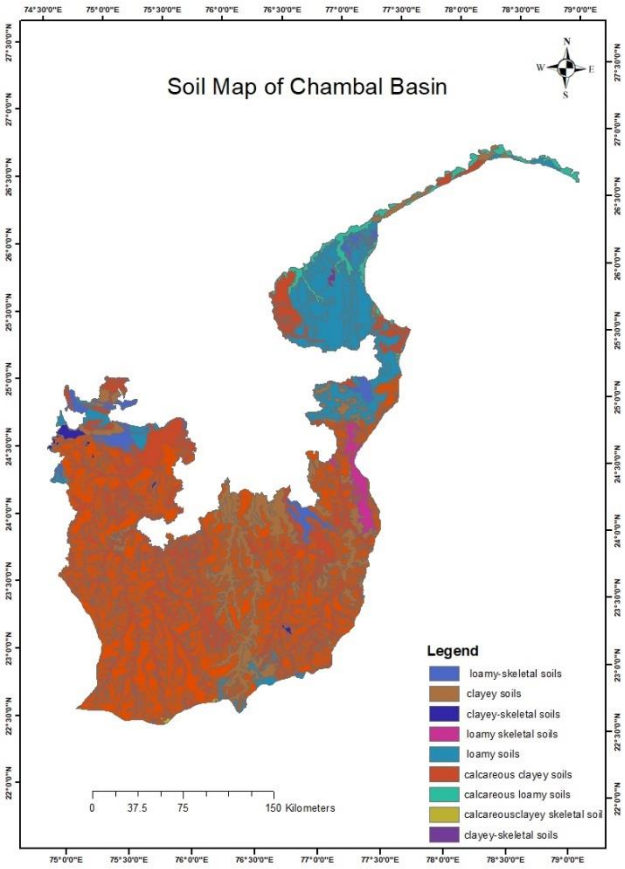
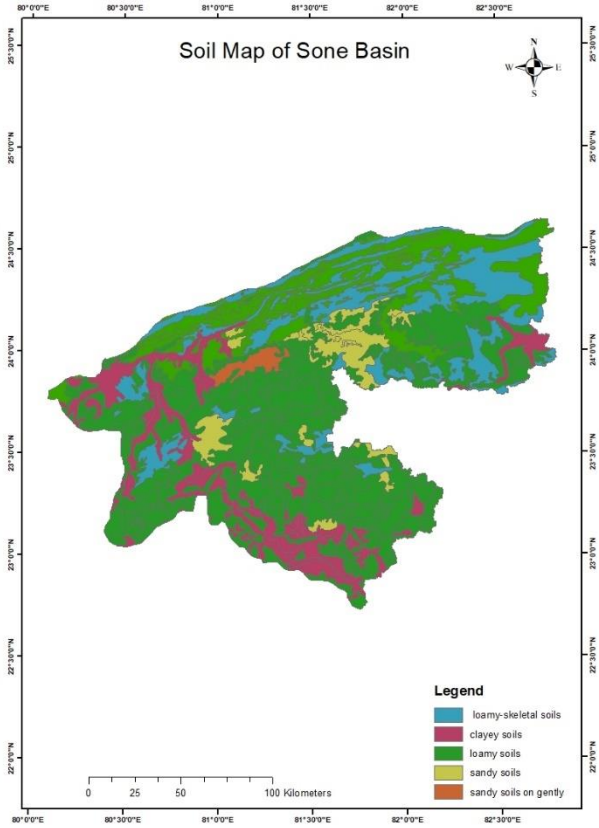
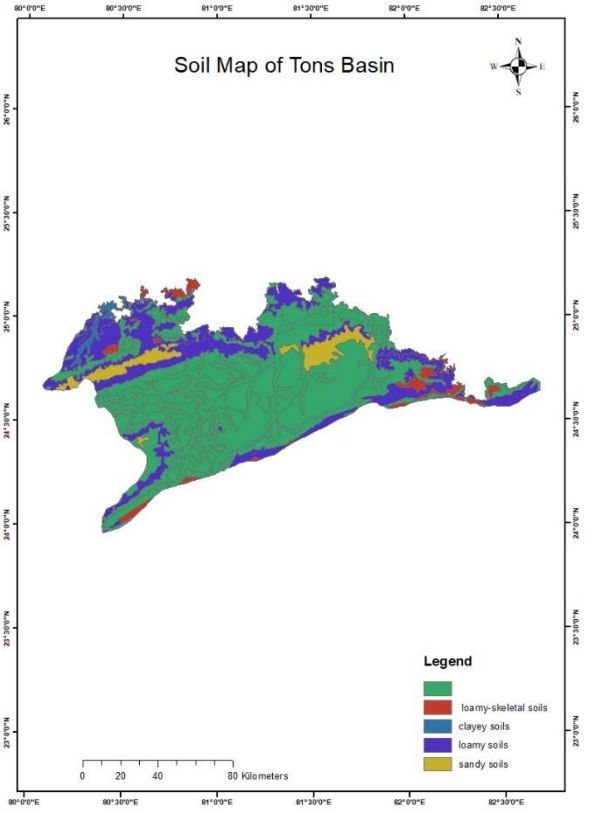


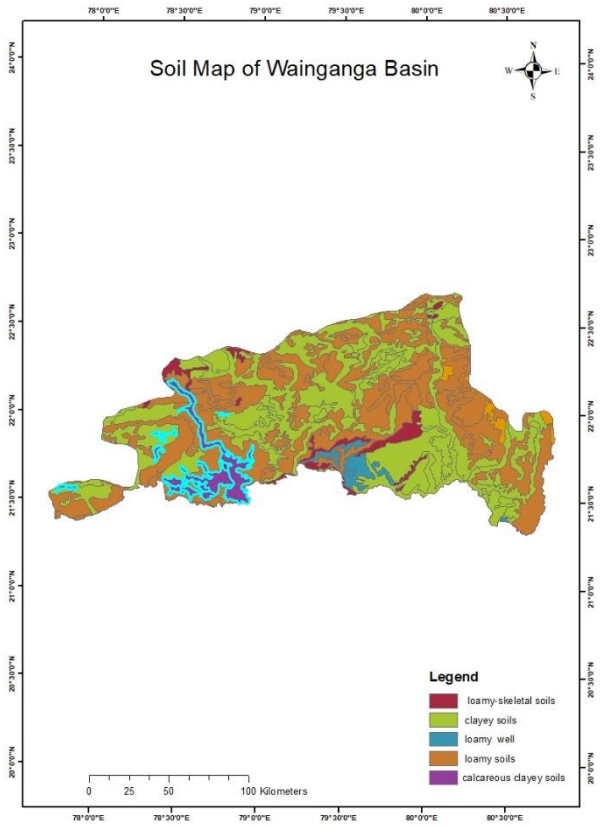
Fig. 4.9 Soils of different Basin in Madhya Pradesh

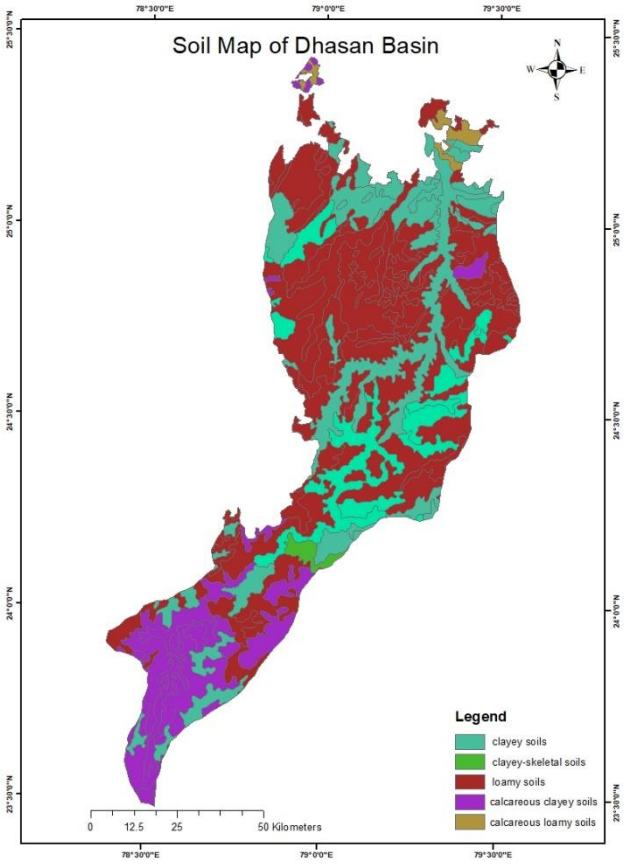

Soil Map of Sindh Basin
Legend
clayey soils
loamy soils
calcareous clayey soils
calcareous loamy soils
clayey-skeletal soils
loamy skeletal soils
loamy soils
skeletal soils
0 15 30 60 Kilometers

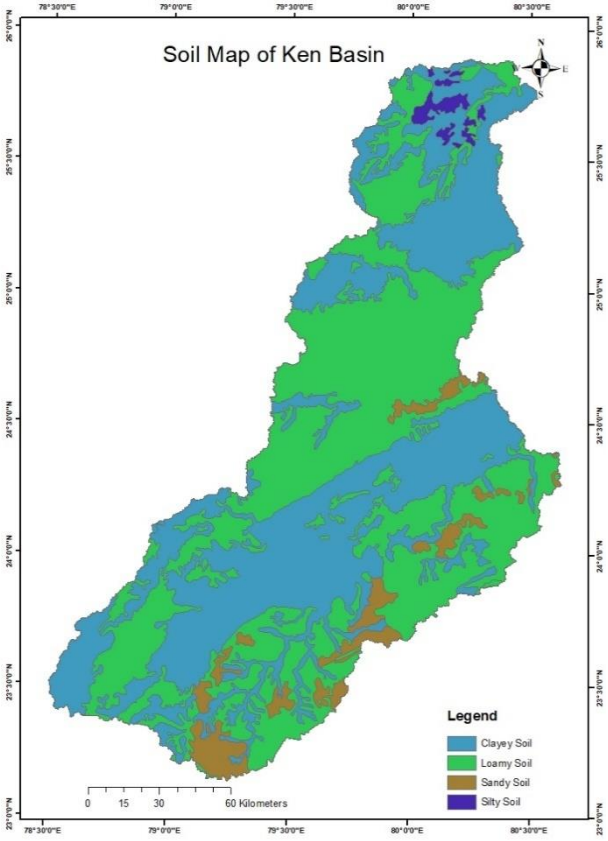

Soil Map of Chambal Basin
Legend
loamy-skeletal soils
clayey soils
clayey-skeletal soils
loamy skeletal soils
loamy soils
calcareous clayey soils
calcareous loamy soils
calcareousclayey skeletal soil
clayey-skeletal soils
0 37.5 75 150 Kilometers

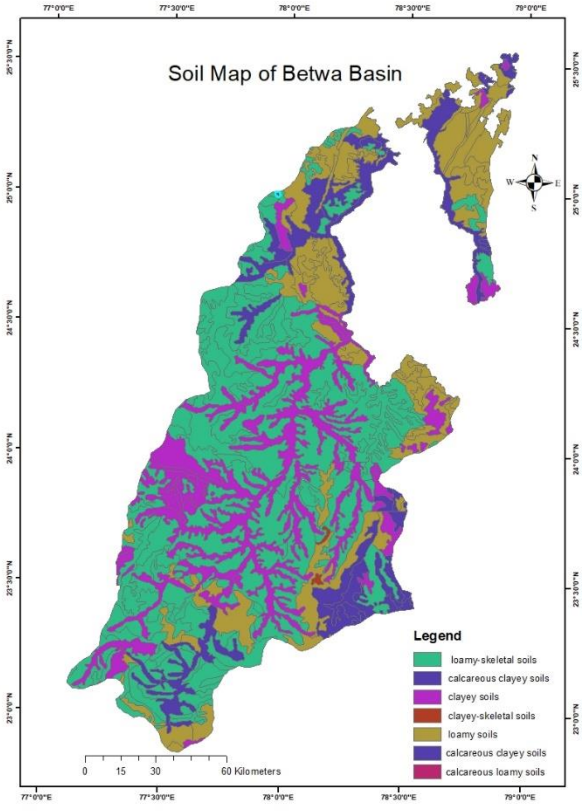

Soil Map of Sone Basin
Legend
loamy-skeletal soils
clayey soils
loamy soils
sandy soils
sandy soils on gently
0 25 50 100 Kilometers


Soil Map of Tons Basin
Legend
loamy-skeletal soils
clayey soils
loamy soils
sandy soils
0 20 40 80 Kilometers


Soil Map of Wainganga Basin
Legend
loamy-skeletal soils
clayey soils
loamy well
loamy soils
calcareous clayey soils
0 25 50 100 Kilometers


Soil Map of Dhasan Basin
Legend
clayey soils
clayey-skeletal soils
loamy soils
calcareous clayey soils
calcareous loamy soils
0 12.5 25 50 Kilometers


Soil Map of Ken Basin
Legend
Clayey Soil
Loamy Soil
Sandy Soil
Silty Soil
0 15 30 60 Kilometers


Soil Map of Betwa Basin
Legend
loamy-skeletal soils
calcareous clayey soils
clayey soils
clayey-skeletal soils
loamy soils
calcareous clayey soils
calcareous loamy soils
0 15 30 60 Kilometers

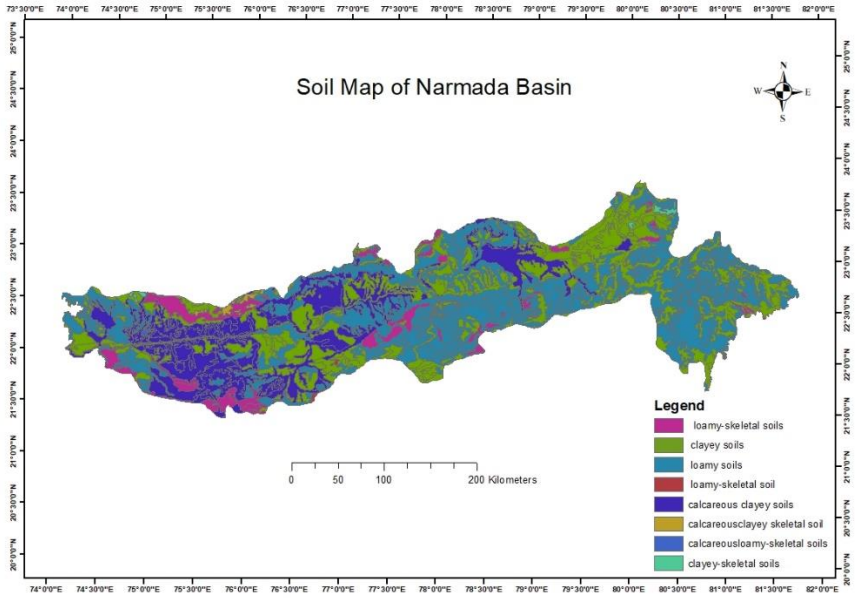


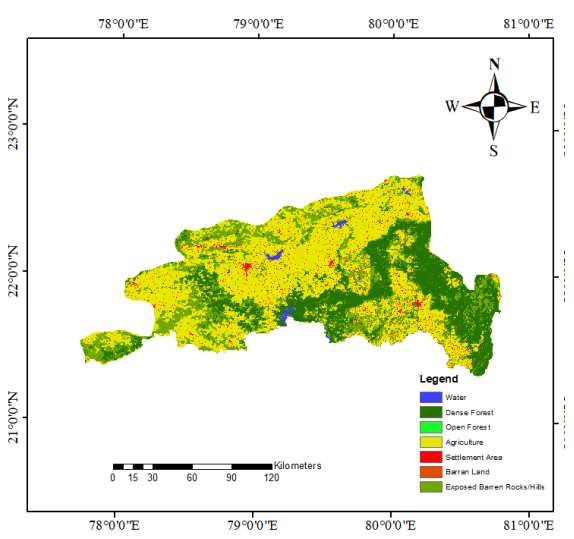
Fig. 4.10 Basin wise soil maps

Table 4.4: Basin wise area of different soils in Madhya Pradesh

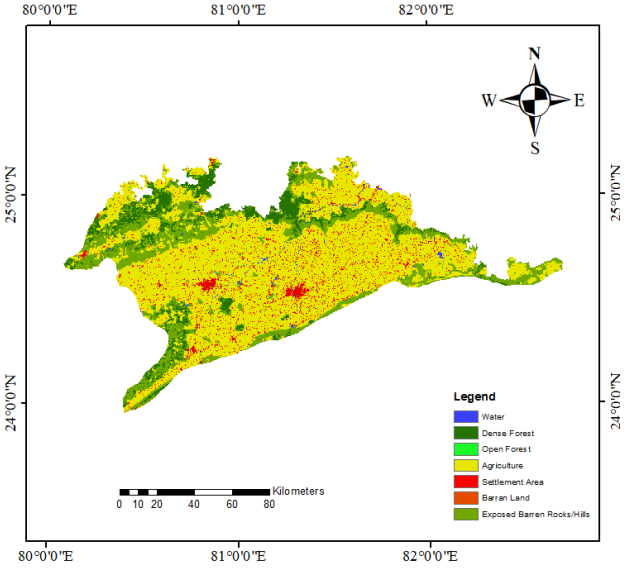
S. N.	Soil class	Area under soil class for different basins, sq.km.								
		Wainganga	Tons	Son	Sindh	Narmada	Ken	Dhasan	Chambal	Betwa
1	Calcareous clayey soils				7592				24608	126
2	Loamy-skeletal soils		479						1652	10270
3	Clayey-skeletal soils					255		69	252	31
4	Clayey soils	10604	9148	1796	1796	25121	13446	2744	6170	4565
5	Loamy skeletal soils	909		583	583	5325			821	
6	Loamy soils	11619	3492	11673	9018	36518	14356	4436	7425	4409
7	Calcareous clayey soils	1115		7592		19086		1206	15365	2575
8	Calcareous loamy soils			4940	4940			102	1270	4
9	Calcareous clayey skeletal soil					308			32	
10	Clayey-skeletal soils								56	
11	Calcareous loamy-skeletal soils					73				
12	Skeletal soils			180	180					
13	Sandy soils		744				1483			
14	Loamy well	512								
15	Silty soil						293			

- **Land use/Land cove maps**

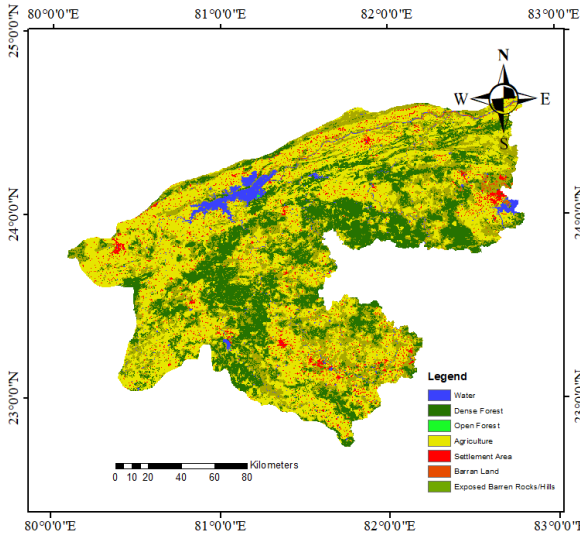
LULC maps of all the basins are derived from the global database available on open platform through Environmental Systems Research Institute (ESRI) an international supplier of geographic information system (GIS) software, web GIS and geodatabase management applications, headquartered in Redlands, California. The database prepared by ESRI have been developed from sentinel-2 satellite image having 10 m spatial resolution. The classified LULC maps for all the basins of Madhya Pradesh are prepared (Fig. 4.11).



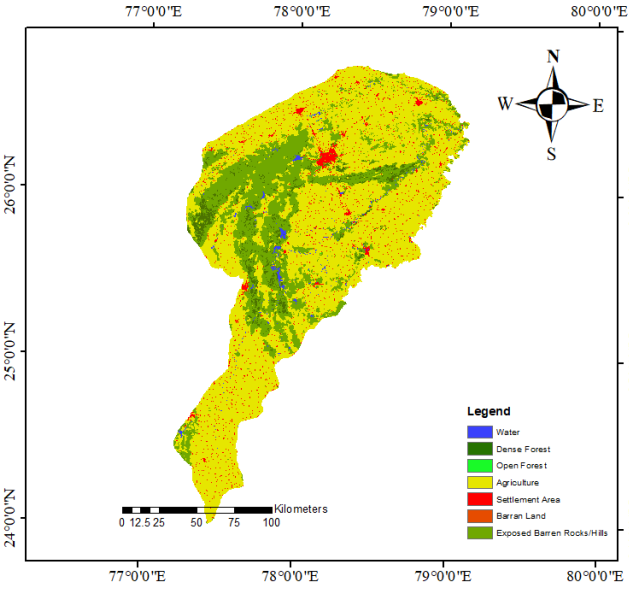
WainGanga Basin



Tons Basin

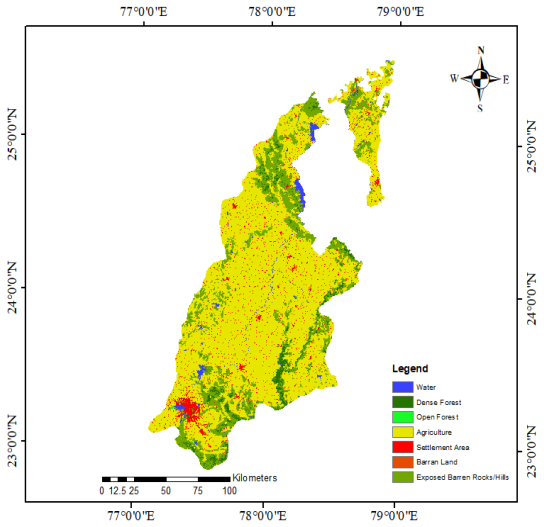


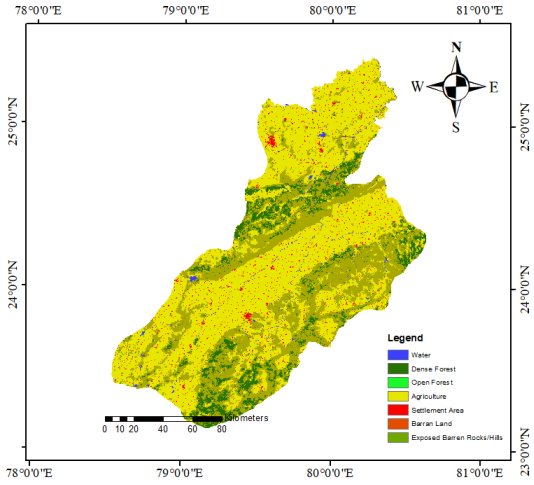
Son Basin

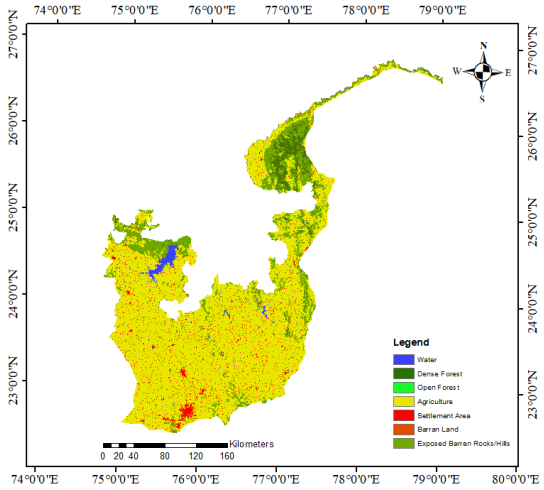


Sindh Basin

Betwa Basin

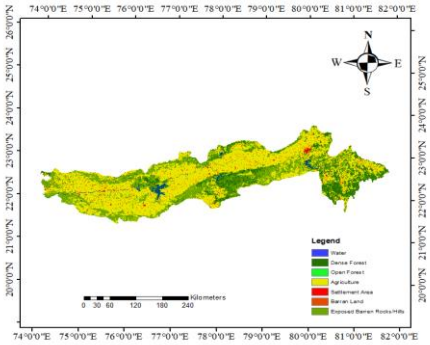






Ken Basin

Chambal Basin



Narmada basin

Fig. 4.11 Land use/land cover all the basin of MP

Table 4.5: River basins and their respective LAND CLASS areas (ha)

S. N.	LULC Class	Waingan ga	Tons	Son	Sindh	Narmada	Ken	Dhasan	Chambal	Betwa
1	Water	34044	9301	79248	22099	195709	22727	9690	97580	37743
2	Dense forest	595078	127580	741747	76886	1108102	201357	35986	172255	67491
3	Open Forest	98	61	434	375	861	14	33	330	865
4	Agriculture	1237437	901946	1248064	1817070	4725803	1398125	559465	4407769	1608734
5	Settlement	69277	81443	106542	97207	220606	58864	31133	233817	95562
6	Barran	1993	325	11017	453	3726	287	27	3011	344
7	Exposed Rock/Hills	537197	278877	760196	633332	2263352	788691	218486	819318	386921

- **Geological map**

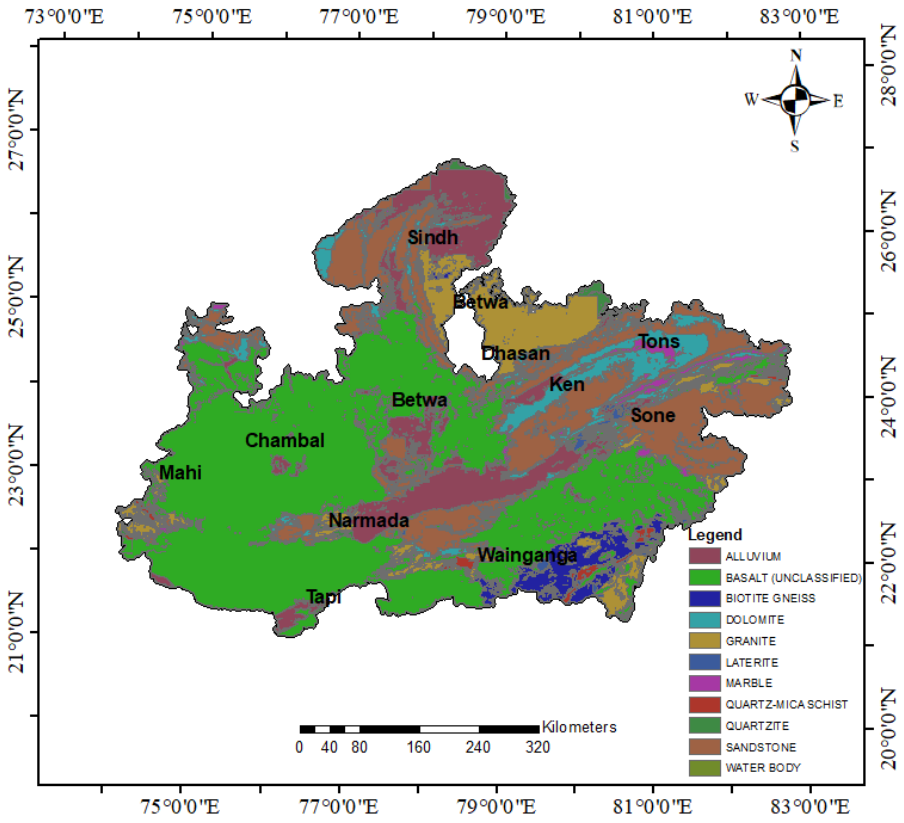
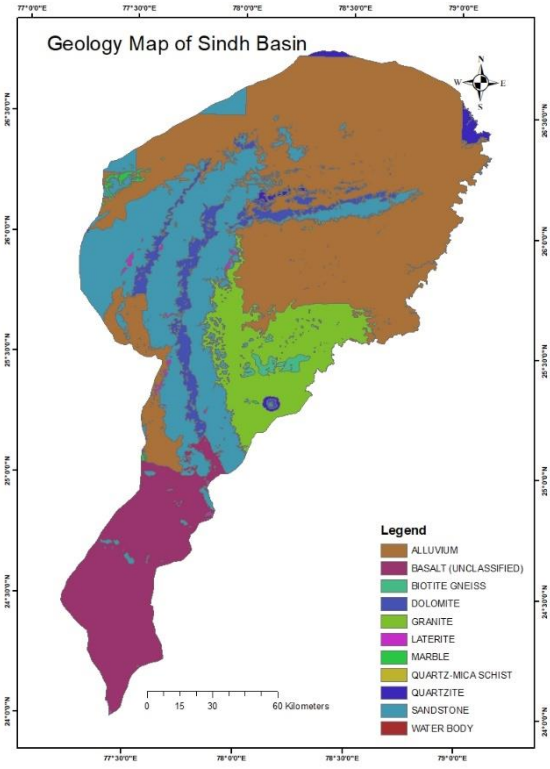
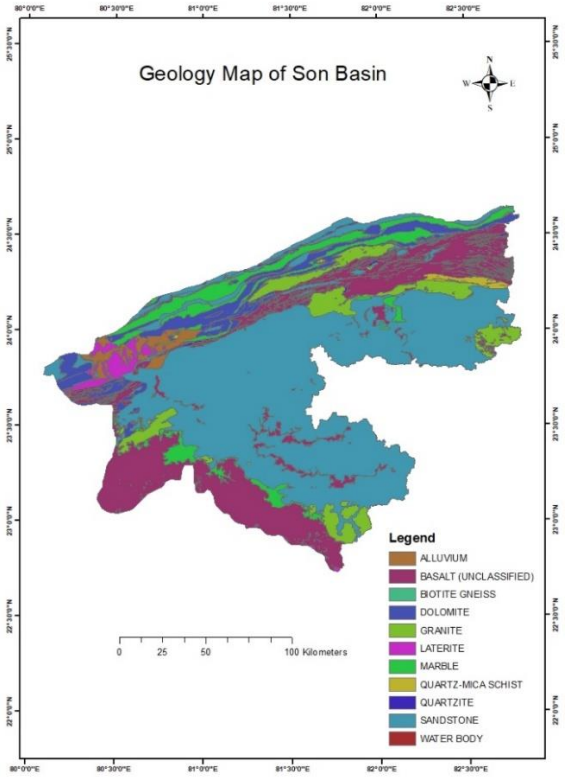
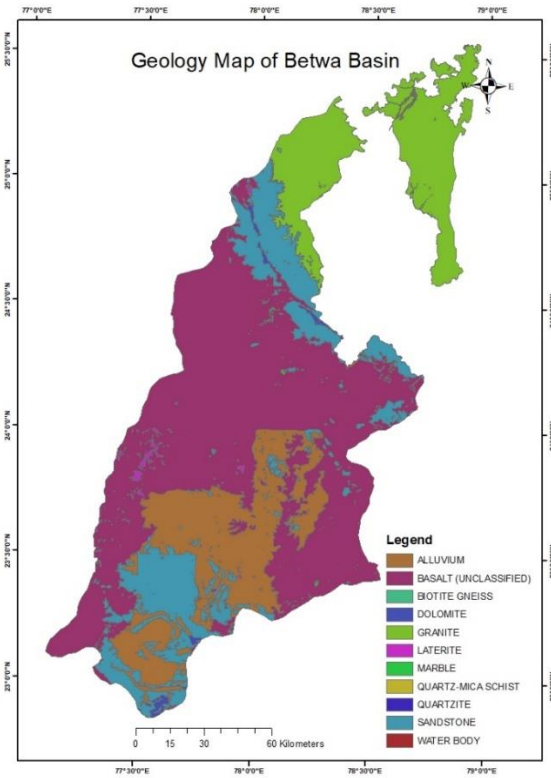


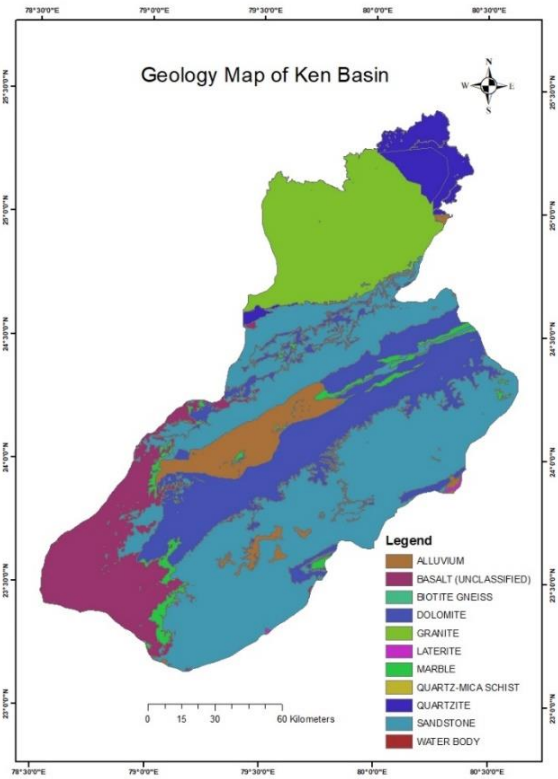
Fig. 4.12 Geological map of River basins of Madhya Pradesh

The geology map has been prepared from basin information available on the website of Geological Society of India. Geological information was available in 50 different categories. It has been digitized in 1:50000 scale and regrouped into 10 major lithologic group (Fig. 4.12).


Geology Map of Sindh Basin
Legend
ALLUVIUM
BASALT (UNCLASSIFIED)
BIOTITE GNEISS
DOLOMITE
GRANITE
LATERITE
MARBLE
QUARTZ-MICA SCHIST
QUARTZITE
SANDSTONE
WATER BODY
0 15 30 60 Kilometers


Geology Map of Son Basin
Legend
ALLUVIUM
BASALT (UNCLASSIFIED)
BIOTITE GNEISS
DOLOMITE
GRANITE
LATERITE
MARBLE
QUARTZ-MICA SCHIST
QUARTZITE
SANDSTONE
WATER BODY
0 25 50 100 Kilometers


Geology Map of Betwa Basin
Legend
ALLUVIUM
BASALT (UNCLASSIFIED)
BIOTITE GNEISS
DOLOMITE
GRANITE
LATERITE
MARBLE
QUARTZ-MICA SCHIST
QUARTZITE
SANDSTONE
WATER BODY
0 15 30 60 Kilometers


Geology Map of Ken Basin
Legend
ALLUVIUM
BASALT (UNCLASSIFIED)
BIOTITE GNEISS
DOLOMITE
GRANITE
LATERITE
MARBLE
QUARTZ-MICA SCHIST
QUARTZITE
SANDSTONE
WATER BODY
0 15 30 60 Kilometers

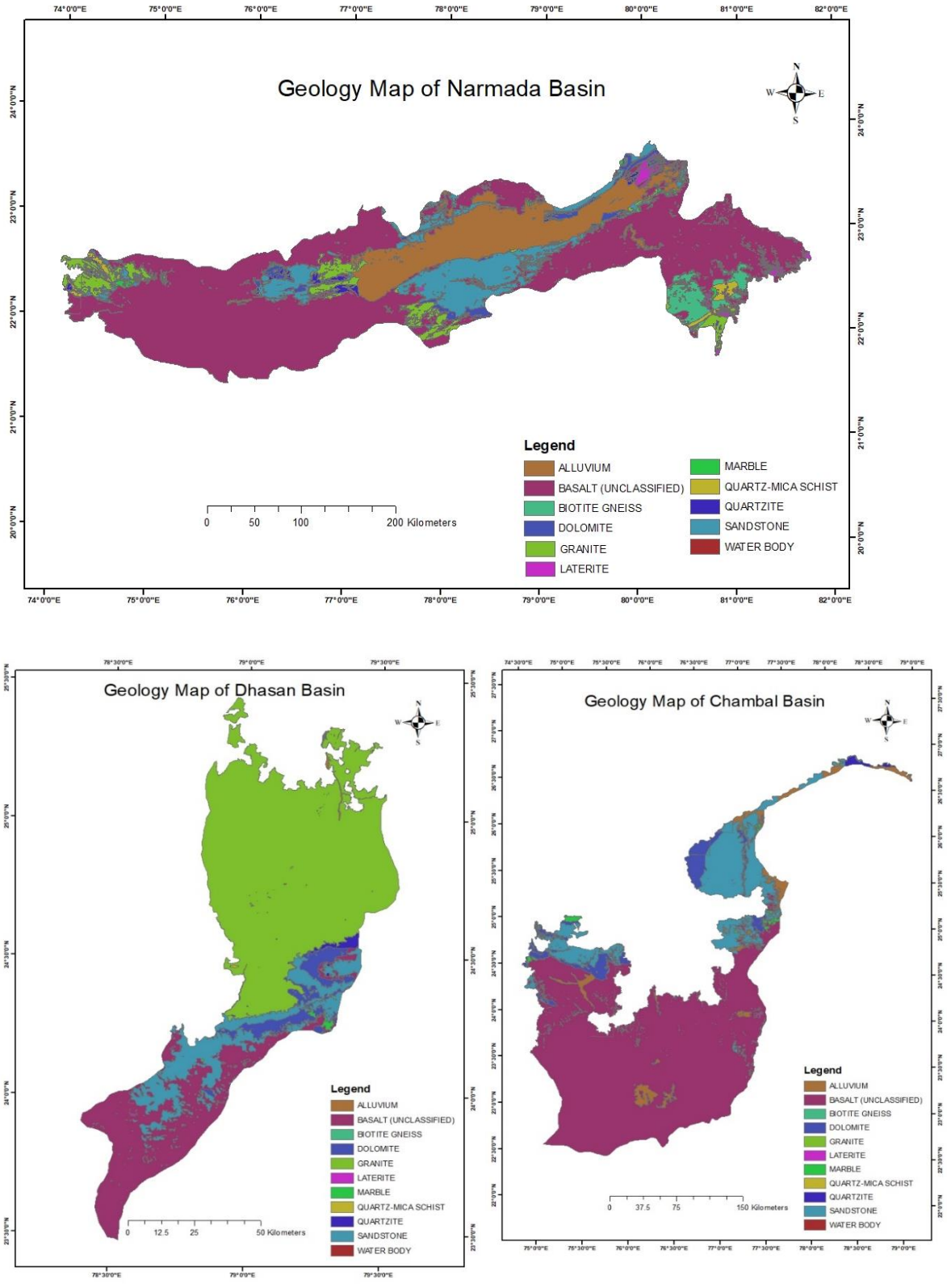


Fig. 4.13 Basin wise geological maps of MP

In Madhya Pradesh which is one of the largest State of the country is underlain by formations in age ranging from Archaean to Recent. One-fifth of the area is occupied by granite gneisses and meta-sedimentary rocks, whereas one tenth by Gondwanas comprising sand stones, lime stones & marbles. The predominant geology of MP is mainly Basaltic rock which is covering over 50% of total geological area in the Madhya Pradesh region. The Deccan Trap covers a larger part of the State whereas the alluvium covers mainly the region of Narmada basin.

The other thematic layers Lineament density, Drainage Density etc. are in process for all the basins. This thematic information will be derived at micro level, block level, district level and basin level for efficient planning and management of natural resources in relevance to agriculture.