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**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 (July to September 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. Formation of cubical workstation is completed and computerperipherals are procured.

ii. The wall mounted LED TV, furnishing items and camera is procured.

iii. National competitive bid invited for Hyperspectral Spectro-radiometer are in process to finalize. Clarification are invited from vendors regarding post evaluation of bid.

iv. Prize invitation is issued for MIKE SHE and MATLAB software.

v. RFQ are issued thermal imaging camera, A0 scanner, A0 plotter, Soil moisture meter, Generator. The bids are in process.

vi. Contacts are signed for Planimeter and display podium.

## 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 (July– September 2022)**

| S.N | Date | | Training |
|---|---|---|---|
| | From | To | |
| 1 | 08th July | 08th July | A special lecture on "DNA Barcoding of Insects" |
| 2 | 26th July | 26th July | Special lecture on "Growth and development of Environment Management System" |
| 3 | 31th Aug | 20th Sep | Hands on training on RS and GIS software |
| 4 | 21th Aug | 21th Aug | Special lecture on identification of major insects and natural enemies of Kharif crops |
| 5 | 28th Aug | 28th Aug | Awareness program on "Management of pesticide containers" |
| 6 | 16th Aug | 22nd Aug | Parthenium Awareness Week |
| 7 | 01th Sep | 07th Sep | Awareness Program for Kendriya Vidyalaya Students |
| 8 | 27th Sep | 27th Sep | Awareness Program for Peer learning groups of PG and Ph. D. students- Plant protection Group |
| 9 | 28th Sep | 28th Sep | Awareness Program for Peer learning groups of PG and Ph. D. students- Plant science Group |
| 10 | 29th Sep | 29th Sep | Awareness Program for Peer learning groups of PG and Ph. D. students- Big data analysis group |
| 11 | 29th Sep | 29th Sep | Awareness Program for Peer learning groups of PG and Ph. D. students- Natural resource management Group |
| 12 | 26th Aug | 06th Sep | 11 Days cultural workshop *Abhivyakti -2022*" |
| 13 | 16th Sep | 17th Sep | Agricultural conclave 2020-22: Attaining agrarian prosperity by Academia-Industrial Partnership through Alumni. |
| 14 | 26th Sep | 26th Sep | Awareness program on "E-waste management and Environment Engineering" |

## 2. Capacity Building Programme

### 2.1 Hands-on training on Remote Sensing & GIS software

A 21 Days offline Training were conducted for university faculties and PG students where the participants attended the program across different Agriculture University of India. The training entitled as 'Hands-on Training on Remote sensing and GIS software" was organized from August 31$^{st}$, 2022 - September 20$^{th}$, 2022 in Capacity Building Lab, NAHEP-CAAST, JNKVV, Jabalpur. The training was inaugurated by Director Instructions Dr. Abhishek Shukla. 24 participants attended the training which was having an objective to inculcate the proficiency in geospatial software and applied them for Agriculture and natural resource management. It included 14 PhD students and 10 faculty members from different Agricultural Disciplines (i.e. Agronomy, Soil and Water Engineering, Genetics & Plant Breeding, Horticulture, Plant Physiology, Soil Science, Post-Harvest Process and Food Engineering, Farm Machinery & Power Engineering, Agroforestry, Silviculture and Agroforestry, Molecular Biology & Biotechnology).

Eminent scientist across the country were aligned as experts in this program includes Dr. N R Patel, Scientist-G, IIRS Dehradun, Dr. P S Tiwari, Scientist-F, IIRS Dehradun, Dr. V K Sahgal, Principal Scientist, IARI New Delhi and Dr. R P Pandey, Scientist-G, National institute of hydrology, Roorkee.

The training has covered the primary concept and principals of Remote Sensing and exposed the participants to various geo-platforms providing number of information and satellite images in initial phase. Later the participants were introduced to ArcGIS, QGIS and ERDAS imagine software, which is used for satellite image processing. All the activities including downloading of image and activities related to image processing like image corrections, enhancement, Mosaicking, sub setting, band combinations, generation of AOI's, unsupervised and supervised classification LULC maps preparation, crop map preparation and crop yield estimation through RS and GIS were covered in this training program.

The Valedictory Function was chaired by Director Research Services (DRS) Dr. G K Kottu. Director Farms Dr. D K Pahlwan and Dean Student Welfare (DSW) Dr. Amit Sharma were present as special guest and addressed the trainees.

**Training Schedule:**

| Date | Topics covered | | |
|---|---|---|---|
| Time | 10.30–11.30 AM | 12.00 – 1.30 PM | 3.00-5.30 PM |
| 31-08-2022 | Registration and Inauguration Pre Assessment | Basics of Remote Sensing and its application in agriculture | Introduction to GIS |
| 01-09-2022 | Satellites, Sensors, and Resolution | Visual Interpretation of Satellite Imagery | Special Lecture |
| 02-09-2022 | An introduction to different Geoportals (Earth explorer, Bhuvan, Copernicus ESA, etc.) | Special Lecture | Special Lecture |
| 03-09-2022 | Introduction of Satellite image processing software | Downloading process of satellite images | Special Lecture |
| 04-09-2022 | Practical Assignment | Practical Assignment | Practical Assignment |
| 05-09-2022 | Layer stacking of different bands | Layer stacking of different bands | Practice Session |
| 06-09-2022 | Mosaicing of Satellite Image | Subset satellite data with AOI (Area Of Interest) | Practice Session |
| 07-09-2022 | Lecture on Introduction to Land Use Land Cover Classification | Land use Land cover classification (process) | Practice Session |
| 08-09-2022 | Land use Land cover classification (Recoding) | Area calculation of classified data | Practice Session |
| 09-09-2022 | Georeferencing of Map in Arc GIS software | Generation of vector features such as Point, Line, and Polygon, | Practice Session |
| 10-09-2022 | Arc GIS vector operations | Process to fill data in the attribute table and area calculation. | Practice Session |
| 11-09-2022 | Practical Assignment | Practical Assignment | Practical Assignment |
| 12-09-2022 | DEM data processing | Thematic map preparation (Elevation, Slope, Aspect, contour generation) | Practice Session |
| 13-09-2022 | Creation of Map layout in Arc GIS software | Creation of Map layout in Arc GIS software | Practice Session |
| 14-09-2022 | Introduction to different instrument used for spectral measurement in field | Field Visit | Field visit & Practical |
| 15-09-2022 | Introduction to different instrument used for spectral measurement in field | Field Visit | Field visit & Practical |
| 16-09-2022 | Introduction to Crop Map Classification | Crop Map Classification | Practice Session |
| 17-09-2022 | Introduction to Crop Yield Estimation using RS & GIS | Crop Yield Estimation | Practice Session |
| 18-09-2022 | Practical Assignment | Practical Assignment | Practical Assignment |
| 19-09-2022 | Project work | Project work | Project work |
| 20-09-2022 | Post Assessment | Post Assessment | Feedback and valedictory |

| Hands on Training on Remote sensing and GIS Software 31 Aug to 20 Sep | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Number of Participation | | | | | % of participation of diff. Category | | | |
| Gender | UR | SC | ST | OBC | Total | UR | SC | ST | OBC |
| Male | 8 | 0 | 1 | 4 | 13 | 61.5 | 0 | 7.7 | 30.8 |
| Female | 9 | 0 | 1 | 1 | 11 | 82.0 | 0 | 9.0 | 9.0 |
| Total | 17 | 0 | 2 | 5 | 24 | 70.8 | 0 | 8.4 | 20.8 |


Inauguration of training Program
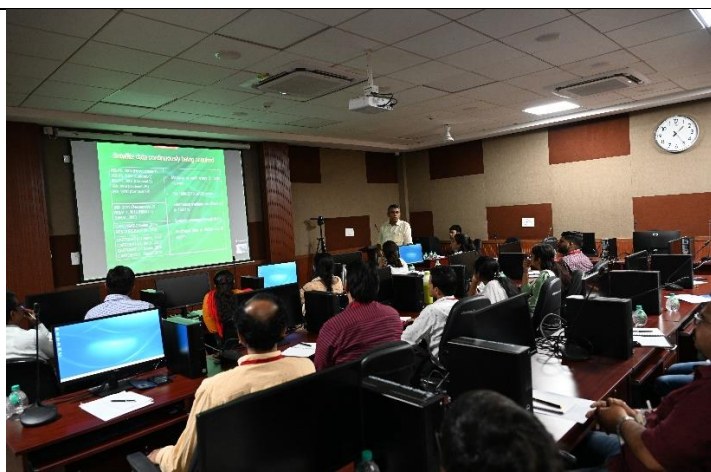

Capacity building program in progress




Observations on crop reflectance in the field

Valedictory function





**Performance Evaluation:**

In order to expose the participants to maximum functionality of RS and GIS software, the training covered as many tool as possible through hands-on activities. To assess the awareness level of participants as well as to evaluate the effectiveness of the 21-day RS & GIS training software, performance was evaluated prior to training and post-training. In the pre-training test, average marks obtained by participants were about 72 percent. The post-assessment indicated an improvement i.e. on an average 90 percent of marks were obtained by the participants.

**Feedback from participants:**

**Topicwise Feedback of Participants**
- LULC — 45%
- Thematic Mapping — 20%
- Crop Yield Calculation — 15%
- All — 20%

**Experience of the Training**
- Excellent — 80%
- Good — 20%

**Training Quality**
- Excellent — 85%
- Good — 15%

**Training content**
- Excellent — 70%
- Good — 30%
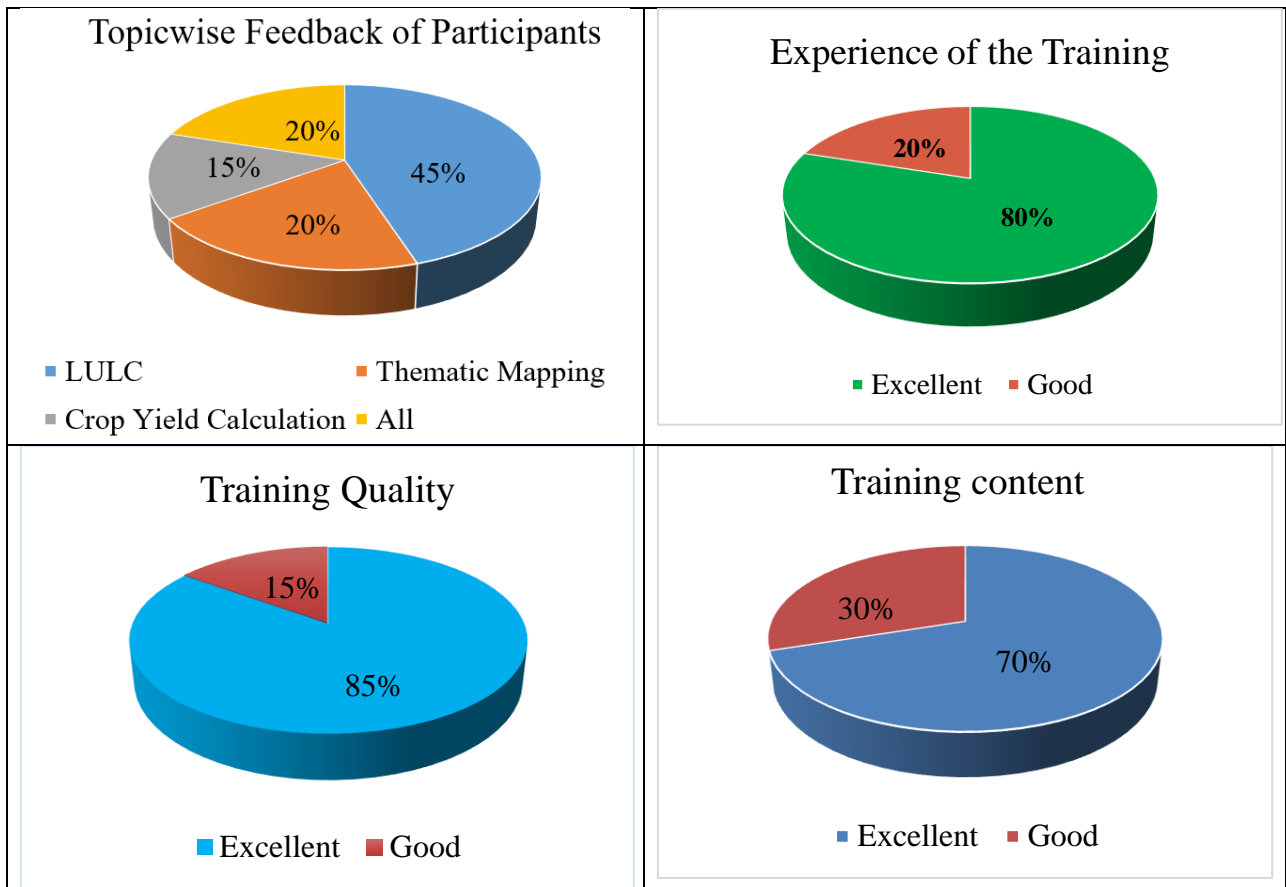
## 2.2 Awareness Program on RS & GIS for School Students

The Awareness Program was organized in Eight Kendriya Vidyalaya located with different central government organizations namely GCF2, COD, 1STC, TFRI, CMM, Gadha, OFK and VFJ of Jabalpur on the theme "Remote Sensing and GIS and career opportunities in Agriculture". Speakers in each school have explained the Remote Sensing Technique, it's working along with a brief about the satellite types and various uses around us. Students were also made aware of the Agriculture domain in their studies and the career opportunities. All the sessions were interactive, students have shown their interest in the topics in the discussion by asking questions starting from the launch of satellites to data capturing, transfer and handling to various insights about the subjects to be studied in agricultural higher studies.

In the end, interaction with students' feedback was taken from the students and teachers present throughout the session, in which they appreciated the initiative to organize such a program for the school students and requested to organize a more detailed program in such a context regularly. The responses to feedback in the form of a questionnaire were as follows:

**Response on Do you find this programme useful in future ?**

- Minimal: 13%
- Not at all: 8%
- Some What: 24%
- Very Useful: 55%

**Response on How was your Experience of the programme**

- Excellent: 39%
- Fair: 8%
- Good: 48%
- Poor: 5%

**Responses on Programme Content**

- Excellent: 58%
- Fair: 6%
- Good: 31%
- Poor: 5%

**Responses on Programme Quality**

- Excellent: 42%
- Fair: 12%
- Good: 39%
- Poor: 7%
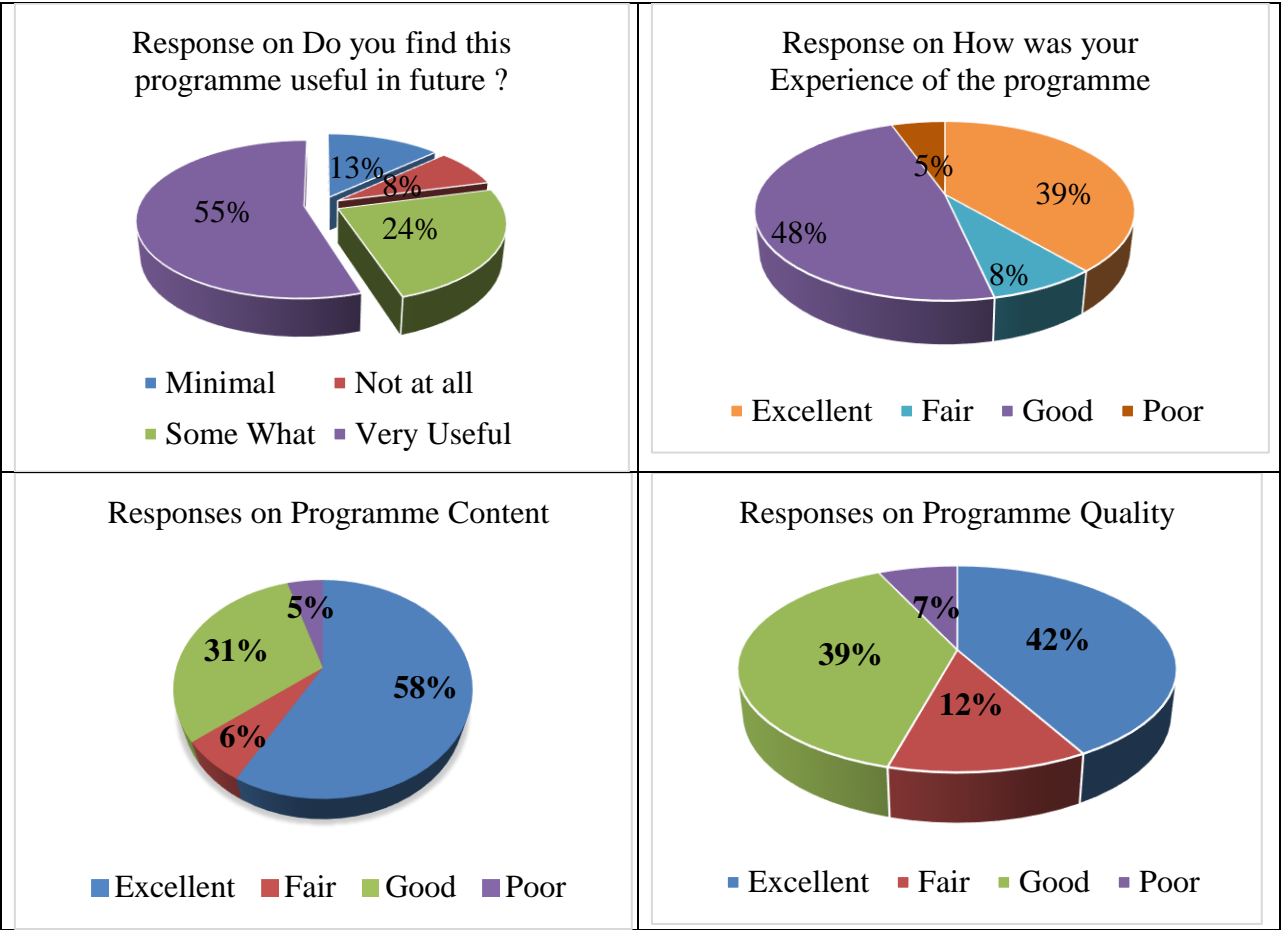
| Awareness Program on Remote sensing and GIS 01st Sept. to 07th Sept. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Participants | | | | | % of participation of diff. Category | | | |
| Gender | UR | SC | ST | OBC | Total | UR | SC | ST | OBC |
| Male | 148 | 61 | 15 | 122 | 346 | 42.8 | 17.6 | 4.3 | 35.3 |
| Female | 159 | 69 | 27 | 116 | 371 | 42.9 | 18.6 | 7.3 | 31.3 |
| Total | 307 | 130 | 42 | 238 | 717 | 42.8 | 18.1 | 5.9 | 33.2 |

## 2.3 Special lecture on DNA barcoding of Insects

A special lecture on "DNA barcoding of Insects" programme was organized on 08th July 2022 by Dr. T. Venkatesan, Principal Scientist ICAR-NBAIR, Bangalore, for PG and PhD Students at the University level. In the session, theoretical exposure was given to the students on Reliable tool for Insect Species Identification, DNA sequencing technologies, cost–effective and rapid DNA analyses and a tool of DNA-based taxonomy to identify known and unknown species on the basis of the pattern of nucleotide arrangement in a fragment of DNA of a particular species.



Students were understanding the methodology and its tools for identification as well as technology of DNA sequencing with help of graphical presentation by Dr Venketasen. After the session, faculty and

students posed pertinent questions, to which they all received satisfactory answers. The session was quite informative for both teachers and students.

| DNA BARCODING OF INSECTS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Number of Participation | | | | | Percentage of participation of Category | | | |
| Gender | UR | SC | ST | OBC | Total | UR | SC | ST | OBC |
| Male | 13 | 4 | 1 | 12 | 30 | 43.3 | 13.3 | 3.3 | 40 |
| Female | 10 | 1 | 1 | 3 | 15 | 0 | 0 | 0 | 0 |
| | 23 | 5 | 2 | 15 | 45 | 51.1 | 11.1 | 4.4 | 33.3 |

## 2.4 Awareness Program on Management of pesticides containers

A one-day Awareness training program entitled Management of pesticides containers was organized on 28th August, 2022 by Dr. S.B. Das, Professor and Head, Department of Entomology, College of Agriculture, Jabalpur in Krishi Vigyan Kendra Jabalpur for farmers and Krishi Kendra dealers of Jabalpur District. Dr. Das, discussed that the current status of agrochemical waste and associated waste. They are often poorly stored, generating toxic chemicals, which leaks into the environment and contaminating water, soil and food. There is need to share knowledge on successful practices for obsolete stock and container management and to raise awareness of the importance of multi approaches. Total 38 dealers attended the session.



In the session, they also request and informed about proper disposal of empty containers to the farmers because most of these are often reused by farmers to contain water and other materials, resulting in serious health problems. At the end of the awareness session also demonstrate the empty containers disposing method for sustainable management of pesticide waste and containers.

**2.5 Special lecture on Identification of major insect pests & natural enemies of *Kharif* crops**

A one-day Special lecture entitled Identification of major insect pests & natural enemies of *Kharif* crops programme was organized on 21st August 2022 by Dr. S.B. Das, Professor and Head, Department of Entomology, College of Agriculture, Jabalpur in Krishi Vigyan Kendra, for Krishi Kendra dealers to aware about major insect pest. Dr. Das interacted with 38 dealers and informed them about different harmful & beneficial insect in *khaif* crops with help of clearly identified images of particular insect pests. Total 41 dealers attended the session.



In the session, the dealers asked about different insects in their area and how to identify them. Dr. Das answered their questions.

**2.6 Awareness program on Parthenium Awareness Week**

The "Parthenium Awareness Week" was celebrated by ICAR-DWR Jabalpur, Madhya Pradesh in every year during 16th August to 22nd August. The various activities have been conducted under this program such as releasing of Mexican beetle, parthenium uprooting, making compost, spraying of herbicides, student's rally, demonstrations and exhibitions. The 17th parthenium awareness week has been conducted at College of Agriculture & Agricultural Engineering under Environmental sustainability plan, NAHEP,

CAAST, CAE, JNKVV, Jabalpur by uprooting and making of compost from parthenium and other weeds, waste stubbles from College campus and Agricultural field.



The program was inaugurated by Dr. S. B. Das, Professor & Head Entomology Department, Jabalpur by uprooting the parthenium grass with NAHEP staff and students. The parthenium awareness week program was attended by 25 participants with uprooting of parthenium and other weed. Uprooted weeds and parthenium were dumped for compost. The awareness was created among participants.

## 2.7 Special lecture on Growth and Development of Environment Management System

The Special lecture on "Growth and Development of Environment Management System" was conducted at College of Agriculture under Environmental sustainability plan, NAHEP, CAAST, CAE, JNKVV, Jabalpur, 26 July,2022. In the session special lecture was delivered by Dr. S. D. Upadhyaya, Ex. Director Instruction, JNKVV Jabalpur. In this session Dr. Upadhyaya covered the topics related to growth and development of environment management system like increase in aviation-related environmental impact, local air quality, ambient noise levels, water quality, energy use and climate change are some of the most prominent impacts of concern.

They also discuss on the Safe work practices of EMS *i.e.*
- Safe Conduct of Work Activities
- Control of Hazardous Materials
- Contractor Selection

The special lecture program was attended by 71 participants. The awareness towards Environment management system was created among participants.

| Number of Participation | | | | | Percentage of participation of Category | | | |
|---|---|---|---|---|---|---|---|---|
| Gender | UR | SC | ST | OBC | Total | UR | SC | ST | OBC |
| Male | 11 | 4 | 12 | 21 | 48 | 22.9 | 8.3 | 25.0 | 43.8 |
| Female | 12 | 4 | 0 | 7 | 23 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 23 | 8 | 12 | 28 | 71 | 32.4 | 11.3 | 16.9 | 39.4 |

## 2.8 Training Programme on Natural and Organic Farming

A one-day training programme on Organic and Natural farming was organized by Department of Agronomy, JNKVV, Jabalpur in collaboration with NAHEP on 08th August, 2022. In this program, 26 postgraduate students, 59 farmers of Kundam and Panagar block of Jabalpur district along with 17 staff members were participated. The training program was inaugurated by Dr. Dhirendra Khare, Dean faculty of Agriculture and Special guest on the occasion was Dr. G.K Kotu, DRS. Dr. A. K. Sawagi Dean college of Agriculture and Dr. Atul Srivastav, Dean College of Agriculture Engineering and Dr. R.K. Nema, PI shared

the advantages of organic and natural farming to the farmers and students. In this training programme, three special lectures on nutrient, weed and insect management in organic and natural farming were delivered by Dr. M. L. Kewat, Professor, Agronomy, Dr. K.K. Agrawal, Professor, Agronomy and Dr. S.B. Das, Head, Department of Entomology. A good interaction between farmers and scientists were made for improving yield of crops under natural and organic farming. The exhibition of the preparation from natural products for fertility and insect management (Jeevamrat, Ghanjeevamrat, Dashparni Ark etc) was organized in the training programme.

## प्रशिक्षण कार्यक्रम – जैविक एवं प्राकृतिक खेती
### भारतीय कृषि प्रणाली अनुसंधान परियोजना
### सस्य विज्ञान विभाग, कृषिमहाविद्यालय, जबलपुर

| समय | कार्यक्रम |
|---|---|
| प्रातः 10:30–11:00 | रजिस्ट्रेषन |
| प्रातः 11:00–11:05 | दीप प्रज्वलन एवं सरस्वती वंदना |
| प्रातः 11:05–11:10 | विश्वविद्यालय कुलगीत |
| प्रातः 11:10–11:20 | स्वागत उद्बोधन तथा जैविक एवं प्राकृतिक खेती पर प्रशिक्षण कार्यक्रम की रूपरेखा |
| प्रातः 11:20–11:30 | विषिष्ट अतिथि, अधिष्ठाता कृषि महाविद्यालय, डॉ ए के सरावगी का उद्बोधन |
| प्रातः 11:30–11:40 | विषिष्ट अतिथि, अधिष्ठाता कृषि अभियांत्रिकी महाविद्यालय, डॉ ए. श्रीवास्तव का उद्बोधन |
| प्रातः 11:40–11:50 | विषिष्ट अतिथि, डॉ आर के नेमा, प्रभारी, नाहेप, कृषि अभियांत्रिकी महाविद्यालय का उद्बोधन |
| प्रातः 11:50– अपरान्ह 12:00 | विषिष्ट अतिथि, संचालक अनुसंधान सेवायें, डॉ जी के कोतू का उद्बोधन |
| अपरान्ह 12:00 – 12:10 | मुख्य अतिथि, अधिष्ठाता कृषि संकाय, डॉ धीरेन्द्र खरे का उद्बोधन |
| अपरान्ह 12:10 – 12:15 | धन्यवाद |
| अपरान्ह 12:15 – 12:30 | समूह चित्र एवं स्वल्पाहार |

### विषय परिचर्चा

| समय | विषय | व्याख्याता |
|---|---|---|
| अपरान्ह 12:30 – 12:50 | जैविक एवं प्राकृतिक खेती में पोषक तत्व प्रबंधन | डॉ के. के. अग्रवाल, प्रमुख वैज्ञानिक, सस्य विज्ञान विभाग |
| अपरान्ह 12:50 – 1:10 | विषयः जैविक एवं प्राकृतिक खेती में खरपतवार प्रबंधन | डॉ एम. एल. केवट, प्रमुख वैज्ञानिक, सस्य विज्ञान विभाग |
| अपरान्ह 1:10 – 1:30 | विषय : जैविक एवं प्राकृतिक खेती में कीट प्रबंधन | डॉ एस. बी. दास, प्रमुख वैज्ञानिक, कीट शास्त्र विभाग |
| अपरान्ह 1:30 – 2:00 | भोजन अवकाष | |
| अपरान्ह 2:00 बजे | प्रक्षेत्र भ्रमण | |

## 2.9 11 Days Cultural Workshop Abhivyakti 2022

The Eleven-day Cultural workshop Abhivyakti 2022 was organized by Dean Student Welfare, JNKVV, Jabalpur in collaboration with NAHEP in the Vivekanand Hall, College of Agriculture, JNKVV, Jabalpur from August 26th to 06th September, 2022. Under the inspiration of Dr. PK Bisen, Vice Chancellor of Jawaharlal Nehru Agricultural University, Jabalpur, under the Amrit Mahotsav of Independence and in the courtesy of National Agricultural Higher Education Project (NAHEP), an 11-day cultural workshop, Expression 2022, organized by Dean Student Welfare, was organized.



223 Students registered for the program, out of which 56% were female and 44% were male. They belong to UR (52%), OBC (33%), SC (12%) and ST (3%) categories

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The Chief Guest of the inaugural occasion, Director of Institution, University, Dr. Abhishek Shukla said that our students are illuminating the name of the University with their passion, skill development and personal development in the national horizon. God has given an invaluable skill to each of our students and students, there is a great need to hone it, you told that in the 11-day workshop, all the students of our university will develop talent in the field of cultural field and will make a national identity. I wish you such good luck.



81 faculties and Students registered for the program, out of which 68% were male and 32% were female. They belong to UR (39%), OBC (37%), SC (15%) and ST (9%) categories

Dr AK Saraogi, Dean, Agricultural College, Jabalpur, the special guest of the program, said that this workshop is an opportunity for every student to know and understand the basic standards, rules of competition of all fields of cultural discipline, so that in the upcoming occasion, their identity and skills in the competition. You can achieve success by performing.



Apart from all the heads of departments and scientists, Dr R K Nema, PI-NAHEP, was present on the occasion of the inauguration of the program.

Cultural workshop coordinator and organizer Dr. Amit Sharma, Dean, Student Welfare, said in the welcome address that in the cultural workshop organized for 11 days training was provided by established eminent artists of cultural, literary, fine arts and theatre. Expression - 2022 program was organized in hybrid mode, in which there has been significant participation of students of all 11 colleges (Rewa, Tikamgarh, Chhindwara, Balaghat, Rahli, Pawarkheda, Balaghat, Jabalpur) under Agriculture University. During the workshop, various events are being organized. In the 11-day workshop, training was provided by expert dance, folk dance Mr. Sanjay Pandey, theater Mr. Rohit Tiwari and



Sandeep Pandey, music Mr. Animesh Tiwari, Lalitkala Dr. Aruna Ana, literature Dr. Sulekha Mishra etc. The participants who excelled in their performance were awarded certificates from the lotus feet of the Vice Chancellor of the University, Dr PK Bisen at the closing ceremony. The program was successfully conducted by Dr. Anupama Verma and the show of gratitude, cultural coordinator Dr. BS Dwivedi.

The Students from all the stream registered themselves for this module. Out of 223 registered participants, 41% were B. Sc. Ag/Horti/Foresty & B. Tech, followed by M. Sc./ M. Tech. (16%) and Ph. D. Scholar (2%). Belonging to different departments like Agriculture Entomology & Plant Pathology, Agronomy, Horticulture, Plant Breeding & Genetics, Plant Physiology, Agriculture Biotechnology & Agroforestry.

Category wise participation

| Participants of 11 Days Cultural Workshop Abhivyakti 2022. | | | | | | | | | |
| Gender | Number of Participation | | | | | Percentage of participation of Category | | | | |
| | SC | ST | OBC | UR | Total | SC | ST | OBC | UR | Total |
| Male | 10 | 13 | 48 | 27 | 98 | 10.2 | 13.3 | 49.0 | 27.6 | 43.9 |
| Female | 9 | 20 | 35 | 61 | 125 | 7.2 | 16.0 | 28.0 | 48.8 | 56.1 |
| Total | 19 | 33 | 83 | 88 | 223 | 8.5 | 14.8 | 37.2 | 39.5 | 100.0 |
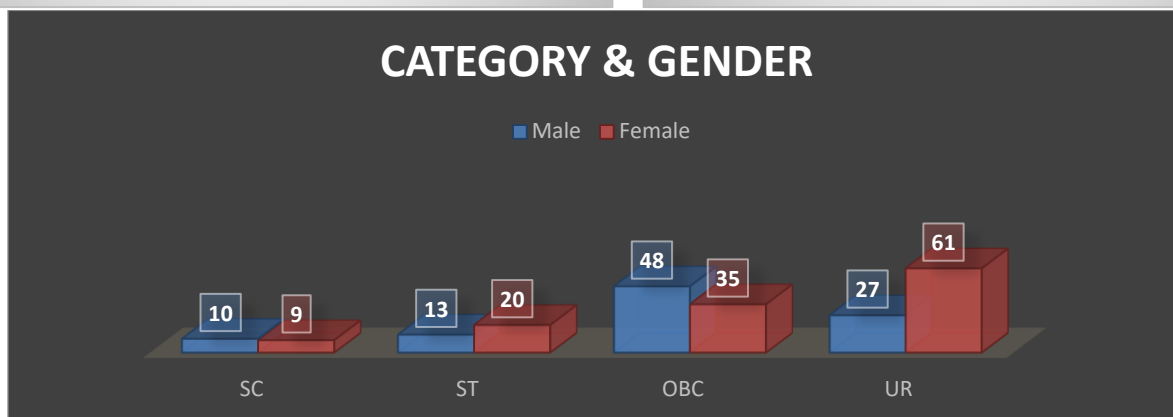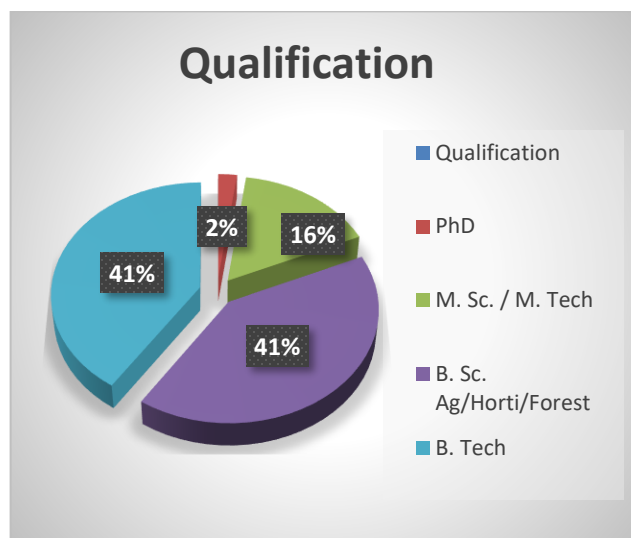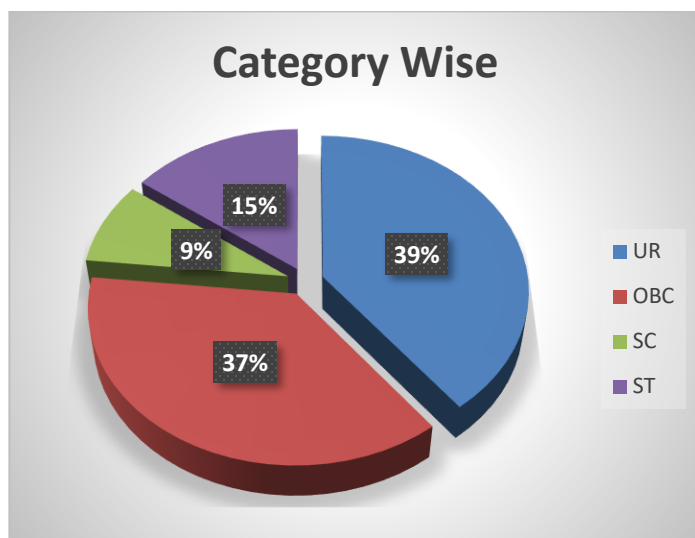


## 2.10 Awareness programme on E-waste management & Environment Engineering

Awareness program entitled on E-waste management & Environment Engineering was held on 26th September 2022 to create awareness of E-waste management & Environment Engineering. This program was organized by Centre for Advanced Agricultural Science and Technology (CAAST), under National Agricultural Higher Education Project, College of Agricultural Engineering, JNKVV Jabalpur in presence of Dr. A. K. Sharma (DSW, JNKVV), Dr. R.K. Nema (PI NAHEP). The program was effectively held under the supervision of Dr. Manoj Kumar Awasthi (Principal Scientist & Co-PI Skill Development ) and coordinated by Dr. R. N. Shrivastava.

In this program, the NSS volunteers organized Nukkad Natak on E-waste management in the college campus and also made posters with slogans about E- waste management.



The Awareness program was attended by 50 participants. The awareness towards E- waste management and Environment Engineering was created among participants.

**2.11 Awareness Program for Peer Learning Group of PG & PhD Students.**

Three Day Offline Workshop for Faculty & Students on "Peer Learning Group of PG & PhD Students" was organized from September 27th to 29th, 2022 to enhance their awareness about spatial data utilization in Agriculture and Natural Resource Management. The awareness programs in geospatial techniques will help and encourage students to explore the cutting edge technology for their research work in various disciplines of agriculture. Programme was organized at Capacity Building Centre, CAE, JNKVV, Jabalpur.

81 participants attended the program, out of which 68% were male and 32% were female. They belong to UR (52%), OBC (33%), SC (12%) and ST (3%) categories.

The topics covered in this program were application of RS & GIS in Plant Protection, Plant Science, Natural Resource Management (NRM) and application of Big Data in Agriculture. The detailed schedule is as below.

| Date | Time | Speaker | Topic |
|---|---|---|---|
| 27th Sep | 04.00 to 06:00 PM | Dr Umakant Rawat, RA Remote Sensing Dr Sumit Kakade, SRF- Plant Protection | RS & GIS application in Plant Protection |
| 28th Sep | 04.00 to 06:00 PM | Dr Devendra Vast, RA - Agriculture Mr Om Prakash Prajapati, SRF- Plant Science | RS & GIS application in Plant Science |
| 29th Sep | 03.00 to 04:00 PM | Dr P. S. Pawar, RA NRM Er Anjali Patel, YP II Computer | Application of Big Data in Agriculture |
| 29th Sep | 04.00 to 06:00 PM | Dr Sourabh Nema, RA NRM Er Aniket Rajput, SRF Agricultural Engineering | RS & GIS application in Natural Resource Management (NRM) |

In this awareness program, the applications of RS and GIS in agriculture domain *i.e.* Identification, area estimation and monitoring of crop, Crop nutrient deficiency detection, Soil mapping, Crop condition assessment, Agricultural draught assessment, Reflectance modelling, Crop yield modelling and production forecasting were presented and discussed with students.

In Plant Protection Group Dr. Bhatt, Dr. A. K. Jain, and Dr. Y. Yadav highlighted the major diseases in Jabalpur and Hoshangabad district and their monitoring concerns. Dr. Nema and NAHEP team also look for find solutions and Remote sensing application for diseases monitoring in a wide area to control and warn the farmers. They also went into various points on monitoring and identifying wheat rust (with a particular on the riverside and canal areas of Hoshangabad) and rice blast diagnosis. The application of Big data in the agriculture was presented and discussed with faculties and students. Awareness was created about the different sources of agricultural data, farmer centric data, remote sensing data, commodity market data available at different platforms. Discussed the techniques available for processing of Big data and facilities available at NAHEP-CAAST-CSDA- JNKVV for Big data analysis.

Out of 81 registered participants, 32% were Ph. D. Scholar, followed by RA/SRF/YP (26%), PG Students (21%), Professor (11%) and Sr. Scientist and Assistant Professor (5%). The participants were from different departments like Plant Protection (Agriculture Entomology & Plant Pathology), Plant Science (Agronomy, Horticulture, Plant Breeding & Genetics, Plant Physiology, Agriculture Biotechnology & Agroforestry), Big Data (Agricultural Economics & Farm Management, Agri-Business Management, Agricultural Extension & Communication and Agricultural statistics) and Natural Resource Management (Soil and Water Engineering, Post-Harvest Process & Food Engineering , Farm Machinery & Power, Agro-meteorology, Soil Science & Agricultural Chemistry and Food Science & Technology)

As far as feedback is concerned out of 43 responses recorded, majority of them reported that the content of the module was Excellent (58.3%) and Good (41.7%) and 91.7% of the participants found that this

module is useful for their professional development.

| Distribution of Participants | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Participation | | | | | Percentage of participation of Category | | | | |
| Gender | SC | ST | OBC | UR | Total | SC | ST | OBC | UR | Total |
| Male | 6 | 1 | 18 | 30 | 55 | 10.9 | 1.8 | 32.7 | 54.5 | 67.9 |
| Female | 4 | 1 | 9 | 12 | 26 | 15.4 | 3.8 | 34.6 | 46.2 | 32.1 |
| Total | 10 | 2 | 27 | 42 | 81 | 12.3 | 2.5 | 33.3 | 51.9 | 100.0 |



## 2.12 Agriculture Conclave 2022

The two-day Agriculture Conclave 2022 concluded in a grand ceremony at Jawaharlal Nehru Agriculture University (JNAU), Chief guest on the occasion was Vice-Chancellor, Dr. Pradeep Kumar Bisen who congratulated the alumni of the university and encouraged them to play a key role in providing a better future to agriculture students and generating new employment opportunities. He emphasized over materializing the vision of Jai Jawan, Jai Kisan, Jai Vigyan and Jai Anusandhan as agriculture sector could not be developed without research.

Dr. Bisen added that even after having negligible resources and facilities, the university has achieved several new dimensions and raised its name in the country and the world. This agriculture conclave will feed a new energy amongst the students to share knowledge and information with alumni members. Special guest on the occasion, Dr Ajay Kaushal, Special Assistant Ministry of Animal Husbandry, Bhopal, said that agriculture students have no need to worry for their future and the alumni members will pave the way for their employment and self-employment opportunities. He expressed also the need of establishing a State Council and utilization of agriculture education to facilitate students. Dean Students Welfare, Dr. Amit Sharma detailed about the proceedings of the programme while Dr. H. K. Raik Principal Scientist addressed the technical session. The programme was conclude with felicitation of alumni members by presenting them shawl, shreephal and mementoes. Alumni members honoring Vice-Chancellor, Dr. P K Bisen during concluding ceremony of the Agriculture Conclave at JNAU.

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

**3.1 Areas identified for RS & GIS applications:** The following areas are identified in realizing process with satellite and ground data with techniques available

- Agricultural drought monitoring and assessment using remote sensing data
- Development of spectral signature of major Rabbi crops

- Soil erosion mapping

- Watershed monitoring and impact assessment

- Watershed prioritization

- Crop suitability mapping

- Identification of areas affected by wheat rust nearby water bodies

- Identification of disease affected citrus plants and leaf curl in chilly

- Proximal remote sensing for varietal identification

- Identification of suitable area for export-oriented crops (Basmati and wheat)

- Crop yield estimation using remote sensing techniques

- Ground based high throughput phenotyping of crop varieties for biotic and abiotic stress

- Land surface temperature using remote sensing

- Remote sensing-based crop phenology

- Rice crop mapping using Sentinel-1 data

- Yellow stem borer infestation in paddy

- Ground Water potential zoning and identification of suitable sites for water recharge structures

- Characterization of Orchards

- Groundwater estimation for river revival

**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 processed.

- 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.

- The IRS remote sensing satellite data ResourceSat-II (LISS IV) has been procured recently from

NRSC-ISRO India for increasing the precision in classification and assessments of various agriculture and natural resource management activities. Henceforth, the studies will be conducted on this high-resolution data and will be compared with other satellite data's, available on other global platforms.

- In order to increase the precision further, the process will be initiated to procure very high-resolution images (0.5 m, 1 m) available from few foreign satellites like QUICKBIRD, IKNOS etc. So, the efficacy of these satellite images and the satellite images which are available freely can be assessed.

**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 andprogress 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 and Water Engineering | Dr. M. K. Awasthi | Ph.D. |
| 3. | Demarcation of Groundwater Potential Zones of Tons Basin using Geoinformatics. | Neelam Bunkar | Department of Soil and Water 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 and Water 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 and Water Engineering | Dr. M.L. Sahu | Ph.D. |
| 6. | Crop suitability Mapping of Jabalpur district | Ghirdhari Lal | Department of Soil and Water Engineering | Dr. R.K. Nema | Ph.D. |

| | | | | | |
|---|---|---|---|---|---|
| 7. | Spatial estimation of green pea in Jabalpur district | Shivam Rathore | Department of Soil and Water 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 and Water 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 and Water Engineering | Dr. M.L. Sahu | M.Tech. |
| 10. | Surface waterbodies change detection of Tikamgarh district using spatial data | Rajnish K. Giri | Department of Soil and Water Engineering | Dr. R.K. Nema | M.Tech. |
| 11. | Identification of Groundwater potential zones of Sone River basin through Remote Sensing and GIS. | Anoop Patel | Department of Soil and Water Engineering | Dr. M. K. Awasthi | M.Tech. |
| 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 inMaize 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 | Rohit kumar kumawat | Department of Plant physiology | Dr. Gyanendra Tiwari | Ph. D. |

| | | Ms. Shweta Tiwari | Department of Plant Breeding and Genetics | Dr. Kanchan Bhan | Ph. D. |
|---|---|---|---|---|---|
| | sensing. | | | | |
| 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. |
| 17 | Genetic Assessment for Morpho-Physiological Traits and Disease Resistance in Mungbean Germplasm | Sunny Thakur | Department of Plant Breeding and Genetics | Dr. Stuti Sharma | Ph. D. |
| 18 | Genetics diversity, quality assessment and molecular disease profiling in Soybean (*Glycine max.* L) | Akash Barela | Department of Plant Breeding and Genetics | Dr M.K. Shrivastava | Ph. D. |
| 19 | Phenotyping and molecular profiling on nutri-rich and disease resistant elite line of Kabuli chickpea (Cicer arietinum L) | Surbhi Pachori | Department of Plant Breeding and Genetics | Dr Anita Babbar | 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. | • Integration of all thematic maps along with their priority ranks of sub-watersheds and combining morphological parameters and LULC factors. Decision making on priority of sub watershed for taking up development activities for soil conservation.<br>• Student has submitted dissertation. |
| 2. | Identification of suitable sites for Artificial Groundwater Recharge using Geoinformatics in Ken River Basin, India. | • Eight thematic maps were integrated.<br>• Groundwater potential zone were demarcated for artificial recharge of groundwater. Critical area identified in Ken Basin for artificial recharge.<br>• Decision Support System (DSS) constructed and applied for suitablesite for groundwater recharge structures.<br>• Student has submitted dissertation. |
| 3. | Demarcation of Groundwater Potential Zones of Tons Basin using Geoinformatics. | • Groundwater potential zones for Tons basin were classified into poor, moderate, good, very good classes.<br>• The results were verified through filed data of well yields and water table fluctuation.<br>• Student has submitted dissertation. |

| 4. | Assessment of Spatiotemporal Groundwater Storage Capacity of Wainganga River Basin of Madhya Pradesh | • Completion of lineament, drainage density and Soil map of Wainganga River Basin.<br>• Integration of thematic maps is in progress. |
|---|---|---|
| 5. | Geospatial planning for enhancing Groundwater Recharge in Chambal basin of Madhya Pradesh | • Analysis of depth to water level data for assessing groundwater recharge at different locations of Chambal basin. |
| 6. | Crop suitability Mapping of Jabalpur district | • Data on soil, crop and weather are collected.<br>• Factors affecting crop suitability were identified.<br>• Details of these factors are being collected for Jabalpur district.<br>• Initiated GIS based maps for preparing input data. |
| 7. | Spatial estimation of green pea in Jabalpur district | • Green pea area in Jabalpur district has been identified, demarcated and measured for last five years.<br>• Changes in pea area are estimated and verified through field data.<br>• A map showing the area of pea crop cultivation has been prepared for three different years.<br>• Student has submitted dissertation. |
| 8. | Assessment of Soil Erosion in Shakkar River Watershed with Universal Soil Loss Equation and Geographic Information System Integration | • Integration and analysis of thematic maps prepared.<br>• Estimation of components of Universal Soil Loss Equation and quantification of soil loss at the outlet.<br>• Verification of results.<br>• Student has submitted dissertation. |
| 9. | Change detection of Vegetative cover of the watershed using RS and GIS technique. | • Vegetation maps were prepared nearby locations of soil and water conservation structures.<br>• Comparative study was made in detection in vegetation near structures and in the area without structures.<br>• Student has submitted dissertation. |
| 10. | Surface waterbodies change detection of Tikamgarh district using spatial data | • Classified LU/LC map of Tikamgarh district was used to demarcate surface water body area using different indices.<br>• Verification of results through available GIS maps of high resolution.<br>• Student has submitted dissertation. |

| 11. | Identification of Groundwater potential zones of Sone River basin through Remote Sensing and GIS. | • Integration of elevation, drainage density, slope map, Soilmap and lineament.<br>• Combined with LU/LC, geomorphology, rainfall and geology map.<br>• Integrated all thematic maps to demarcate gwp zones in Sone basin.<br>• Student has submitted dissertation. |
|---|---|---|
| 12 | Spectral and functional characterization of plant growth regulators application under high-temperature stress in chickpea (*Cicer arietinum* L.) | • Plant growth regulators used in the study are characterized through chemical analysis.<br>• Spectral observations of crop under different treatments.<br>• Observations of physical growth parameters to correlate with the spectral characteristics.<br>• Application of Salicylic acid 200 ppm resulted to maximum yield of chickpea at early date of sowing.<br>• Analysis is under progress. |
| 13 | 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. | • Observations of wheat crop, Seed yield, biological yield, Test weight etc.<br>• Spectral observations of crop under different treatments.<br>• Data analysis is in progress. |
| 14 | Computation of carbon sequestration of mango (*Mangifera indica* L.) orchards of Jabalpur district using geoinformatics. | • Estimation of above ground biomass of mango orchards in Jabalpur region using satellite data.<br>• Verification of results from field data.<br>• Computation of carbon sequestration of mango orchards.<br>• Student has submitted dissertation. |
| 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. | • Detection of genetic variability and character association to their implication in selection for yield improvement in chickpea (*Cicer arietinum* L.).<br>• Spectral observations of crop under different treatments.<br>• Student has submitted dissertation. |

| 16 | Characterization of Fall Army Worm (FAW) Infestation in Maize Crop through Ground Based Hyperspectral Remote Sensing Under Field Conditions. | • Spectral observations of Maize crop under different treatments of infestation through FallArmy Worm (FAW). <br> • Correlation of spectral indices with the area infestation under different treatments. <br> • Student has submitted dissertation. |
|---|---|---|
| 17 | Genetic Assessment for Morpho-Physiological Traits and Disease Resistance in Mungbean Germplasm. | • Crossing program was executed between the selected lines on the basis of yield, early maturity and disease resistance in line x tester fashion. <br> • Field sowing of the germplasm lines was done and then the data was recorded for quantitative and qualitative traits. <br> • Spectral data was recorded for trait Chlorophyll index using SPAD meter. |
| 18 | Genetics diversity, quality assessment and molecular disease profiling in Soybean (*Glycine max.* L) | • The lab work for molecular analysis for YMV disease resistance was done. <br> • The DNA extraction of 47 genotypes of Soybean which includes 20 moderately resistant genotype based on field screening of Soybean genotype was estimated, in next half of the month field trail was conducted on BSP field. <br> • Carried out molecular screening along with collection of remote sensing data on the field during noon shift which included NDVI reflectance data using radiospectophotometer, Crop canopy, LAI using Canopy analyzer and Chlorophyll index using SPAD meter. |
| 19 | Phenotyping and molecular profiling on nutri-rich and disease resistant elite line of Kabuli chickpea (*Cicer arietinum* L) | • The lab work for biochemical analysis of seed sample obtained after first harvesting was done. <br> • The micro nutrient *viz.* (Fe, Zn, Cu and Mn) and macro nutrients *viz.* (N, P, K and Na) of 32 samples each of timely and late sown of kabuli chickpea was estimated. <br> • The ash, carbohydrates, sugars (reducing and non-reducing), and phenol estimation for both timely and late sown condition was done. The seed germination test and Vigour index I and II was also estimated. <br> • Attended the 21 Days- Hands on training on Remote sensing and GIS under NAHEP-CAAST, College of Agricultural engineering, JNKVV, Jabalpur. |

## 4 Preparation of spatial products containing information on special theme
### 4.1 Remote Sensing Based Spatial Monitoring of Agricultural Drought over the Madhya Pradesh

Drought is one of the worst natural disasters globally. The events are often associated with severe economic losses, crop failure, livestock rearing and mortality and reduction in growth domestic product

(GDP). Remote Sensing data and Geographical Information System (GIS) play an important role in the detection, identification and mapping of drought risk prone areas. MODIS satellite data products have been extensively used to assess drought dynamics. In this study, the MOD13Q1 16-day composite Enhanced Vegetation Index (EVI) product at 250 m resolution and 8-day average Land Surface Temperature (LST) dataset (MOD11A1) for the period of 2001-2021 at 1Km spatial scale for the Madhya Pradesh state were downloaded using R programming from the Land Processes Distributed Active Archive Center (LP DAAC) data pool. The EVI dataset was processed to mask cloud-contaminated pixels using pixel reliability data. All EVI and land surface temperature layers for Madhya Pradesh state were stacked to form the time series of the period 2001-2021. The missing values of EVI and LST dataset were estimated and filtered using a two-stage Savitzky-Golay smoothing filter. The processing, layer stacking and gap filling of EVI and LST datasets were carried out using R programming.

The monthly vegetation condition index (VCI), temperature condition index (TCI) and vegetation health index (VHI) were derived to analyze agricultural drought over the Madhya Pradesh state during 2001 to 2021 at pixel level (250m). The derived VCI, TCI and VHI dataset would be used for analyzing and assessing the drought pattern over the Madhya Pradesh. The spatial pattern of drought during the monsoon month in the year 2021 are directed in Fig. 1, 2 and 3. It has been observed that, during the July and August month, west and north part of Madhya Pradesh shows drought condition as compared to June and September month. It may be because of deficient rainfall in the July and August month. The VHI is represented as a linear combination of the VCI and the TCI. Therefore, VHI contains more information about vegetation condition which makes it more suitable for detecting vegetation drought compared with other indices.

$$VCI = \frac{(EVI - EVI_{min})}{(EVI_{max} - EVI_{min})} X100$$

$$TCI = \frac{(LST_{max} - LST)}{(LST_{max} - LST_{min})} X100$$

$$VHI = (\propto x\ VCI) + (\propto -1)\ x\ TCI$$

This dataset will provides insight of agricultural drought and its development pattern over the Madhya Pradesh. This dataset will helps the policymakers and researchers for sustainable solutions and providing comprehensive information regarding the drought-stressed areas.
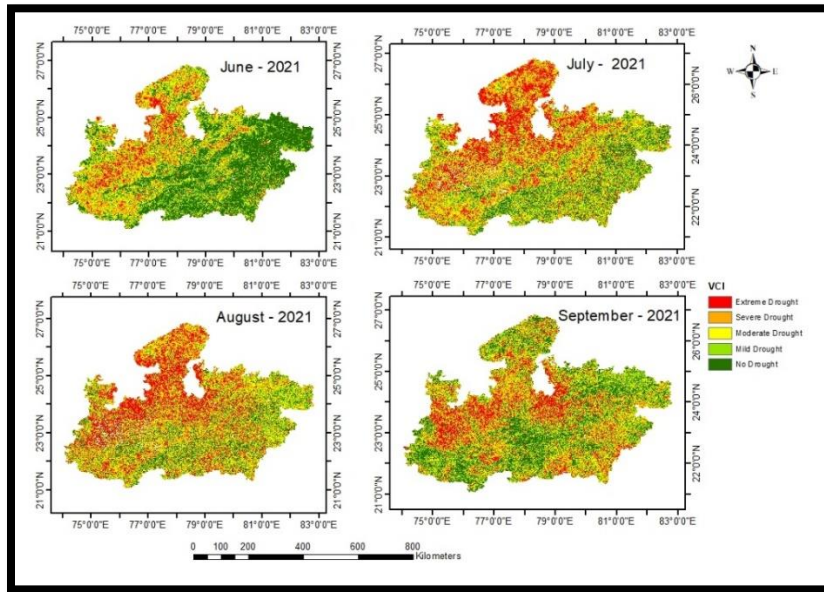
Fig. 1 Vegetation Condition Index (VCI) during monsoon months in the year 2021
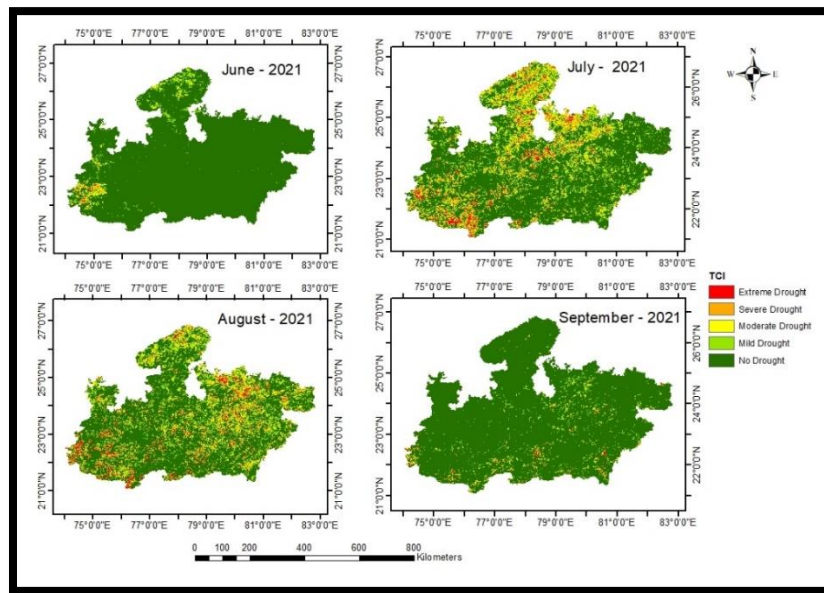


Fig. 2 Temperature Condition Index (TCI) during monsoon months in the year 2021
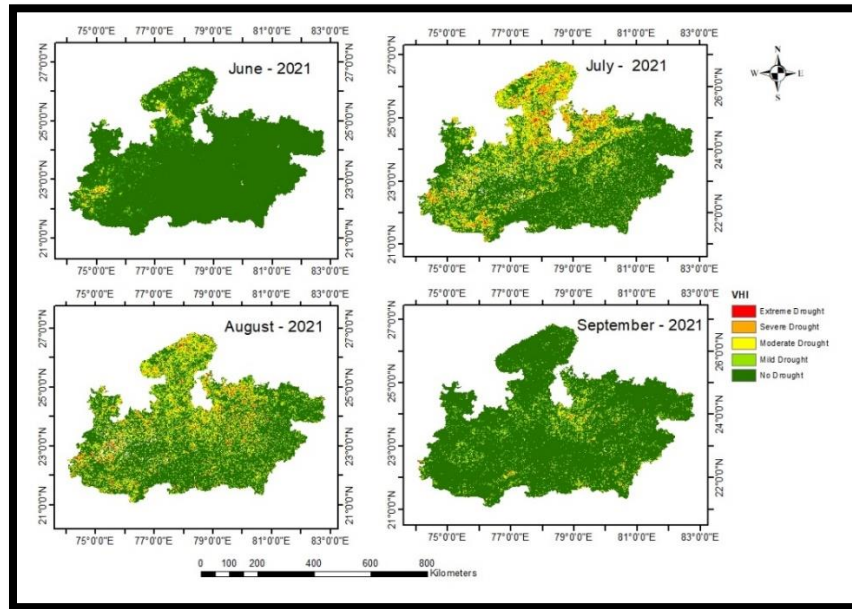
Fig. 3 Vegetation Health Index (VHI) during monsoon months in the year 2021

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

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.

### Normal rainfall Maps

In India, the four monsoon months of June through September account for nearly 75% of total rainfall (CGWB 2014). The extreme hydrological events (widespread drought and floods) caused by the yearly variations in monsoon rains have a serious negative impact on groundwater levels, agricultural output, population, and the national economy. Therefore, measuring basin rainfall is crucial for a variety of natural resource management purposes. Rainfall is a key factor in determining the potential ground water zones in any given place. Because decisions cannot be made based solely on a single year, the last 30 years of IMD rainfall data (0.25 x 0.25) have been taken into account. The Normal rainfall maps of different river basins

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in MP were prepared. e.g. The Maps of Narmada River Basin, Ken River Basin, Tons basin, Tap, Wainganga basin, Mahi Basin, Chambal basin, Sindh basin, Betwa basin, Dhasan basin are given in following section.

## Geomorphological Map

The geomorphological investigations map comprises the delineation and mapping of many landforms, drainage characteristics, and structural aspects that may have a direct influence on the occurrence and flow of groundwater. Geology, geomorphology, and lineaments of an area, which are controlled directly or indirectly by terrain characteristics such as weathering grade, fracture extent, permeability, slope, drainage pattern, landforms, land use/land cover, and climate, must be thoroughly understood for groundwater prospecting, particularly in hard rock terrains. Numerous of these characteristics are conducive to the presence of groundwater and are categorised according to their groundwater potential. In the assessment of infiltration potential, geomorphological study supplemented by GIS mapping is a highly important tool. These regions' geomorphological characteristics give a straightforward and effective method for identifying groundwater and to contribute to the decision-making process.

The geomorphological units such as valley fill shallow and pediplain moderate are very good to good ground water potential zones and considered most favourable zones for groundwater exploration while Pediplain shallow areas are good to moderate, pediment inselberg complex and pediment zones are moderate to poor and denudational hills, residual hills and inselbergs are considered as poor to very poor ground water potential zones. The Geomorphological Map has been prepared for all the river basin of Madhya Pradesh like Narmada River Basin, Ken River Basin, Tons basin, Tap, Wainganga basin, Mahi Basin, Chambal basin, Sindh basin, Betwa basin, Dhasan basin. The maps are given in later section for all the basins.

## Lineament Maps

A lineament is a linear landscape feature that is an expression of a fault or other underlying geological structure. A lineament typically takes the form of a fault-aligned valley, a sequence of fault- or fold-aligned hills, a straight shoreline, or a combination of these features. Using remote sensing data, earth fissures and discontinuities in hard-rock terrains could be defined to improve well-siting tactics in locations where bedrock wells are the dominant source of groundwater. Also Using remote sensing techniques that are sensitive to temperature, vegetation, and water content changes, it may be possible to discover recharge/discharge zones for groundwater. The majority of geologic structures, including bedding planes, foliations, and faults, occur as linear lines known as lineaments, which are sometimes apparent in aerial photographs and remotely sensed photography. Lineaments Maps of different basins have been given in following section.

Normal Rainfall Map of Wainganga Basin

Legend
Rainfall_mm
716 - 831
832 - 954
955 - 1,043
1,044 - 1,155
1,156 - 1,429

Normal Rainfall Map of Tons Basin

Legend
Rainfall_mm
787 - 843
844 - 886
887 - 915
916 - 948
949 - 990

Normal Rainfall Map of Tapi Basin

Legend
Rainfall_mm
695 - 764
765 - 846
847 - 930
931 - 1,021
1,022 - 1,117

Normal Rainfall Map of Son Basin

Legend
Rainfall_mm
821 - 902
903 - 954
955 - 1,004
1,005 - 1,062
1,063 - 1,172

Normal Rainfall Map of Sindh Basin

Legend
Rainfall_mm
489 - 595
596 - 672
673 - 778
779 - 888
889 - 971

Normal Rainfall Map of Narmada Basin

Legend
Rainfall_mm
680 - 813
814 - 952
953 - 1,084
1,085 - 1,239
1,240 - 1,450

Normal Rainfall Map of Mahi Basin

Legend
Rainfall_mm
786 - 857
858 - 909
910 - 959
960 - 1,013
1,014 - 1,094

Normal Rainfall Map of Ken Basin

Legend
Rainfall_mm
637 - 778
779 - 891
892 - 951
952 - 1,020
1,021 - 1,128

Normal Rainfall Map of Dhasan Basin

**Legend**
**Rainfall_mm**
- 644 - 764
- 765 - 834
- 835 - 905
- 906 - 1,004
- 1,005 - 1,130

Normal Rainfall Map of Chambal Basin

**Legend**
**Rainfall_mm**
- 499 - 701
- 702 - 835
- 836 - 897
- 898 - 965
- 966 - 1,059

Normal Rainfall Map of Betwa Basin

**Legend**
**Rainfall_mm**
- 607 - 806
- 807 - 932
- 933 - 1,033
- 1,034 - 1,120
- 1,121 - 1,265

# Normal Rainfall Map of Madhya Pradesh

**Legend**

**Rainfall(mm)**

- 488 - 748
- 748 - 880
- 880 - 986
- 986 - 1,099
- 1,099 - 1,450

0    80    160         320 Kilometers

**Geomorphological map of Mahi Basin**

Legend
- Dam and Reservoir
- Flood Plain
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

**Geomorphological map of Ken Basin**

Legend
- Alluvial Plain
- Dam and Reservoir
- Flood Plain
- Highly Dissected Hills and Valleys
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Piedmont Slope
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

**Geomorphological map of Dhasan Basin**

Legend
- Alluvial Plain
- Dam and Reservoir
- Flood Plain
- Highly Dissected Hills and Valleys
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Piedmont Slope
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

**Geomorphological map of Chambal Basin**

Legend
- Alluvial Plain
- Dam and Reservoir
- Flood Plain
- Highly Dissected Hills and Valleys
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Piedmont Slope
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

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Geomorphological map of Wainganga River Basin



Geomorphological map of Tons River Basin



Geomorphological map of Tapi River basin



Geomorphological Map of Sone Basin

Geomorphological Map of Sindh Basin

Legend
- Alluvial Plain
- Anthropogenic terrain
- Dam and Reservoir
- Flood Plain
- Highly Dissected Hills and Valleys
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

Geomorphological map of Betwa Basin

Legend
- Alluvial Plain
- Dam and Reservoir
- Flood Plain
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Moderately Dissected Plateau
- Pediment Pediplain Complex
- Quarry and Mine Dump
- Waterbodies-Other
- Waterbody - River

Geomorphological map of Narmada River Basin

Legend
- Alluvial Plain
- Dam and Reservoir
- Flood Plain
- Waterbody - River
- Highly Dissected Hills and Valleys
- Highly Dissected Plateau
- Low Dissected Hills and Valleys
- Low Dissected Plateau
- Moderately Dissected Hills and Valleys
- Pediment Pediplain Complex
- Piedmont Slope
- Quarry and Mine Dump
- Waterbodies -Other
- Moderately Dissected Plateau

Lineament Map of Chambal Basin

Lineament Map of Wainganga Basin

Lineament Map of Sone Basin

Lineament Map of Narmada Basin

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Lineament Map of Tapi Basin

Lineament Map of Ken Basin

**Legend**
— Lineament