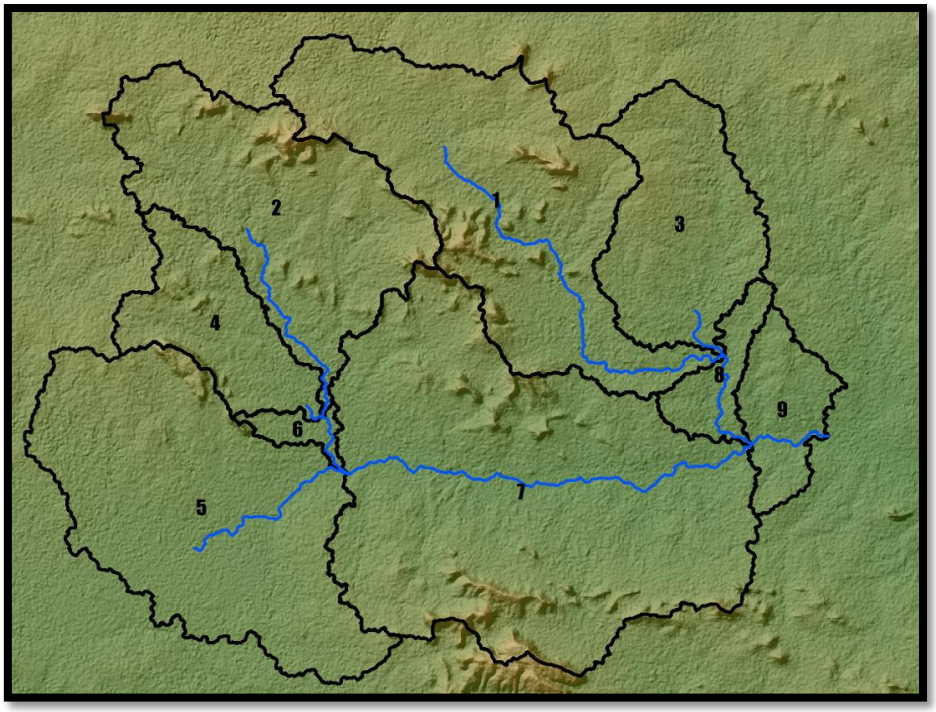
A BRIEF REPORT ON

NHP sponsored
Five-days Online Training Course on

HYDROLOGICAL MODELING USING SOIL AND WATER ASSESSMENT TOOL (SWAT): THEORY AND HANDS-ON

(August 22-26, 2022 at NIH, Roorkee)



Prepared by:

Dr Manish K Nema, Scientist-D
Dr Vishal Singh, Scientist-C

WATER RESOURCES SYSTEMS DIVISION
NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE- 247667 (UTTARAKHAND)
AUGUST-2022

Training Course Organizers

Director	Dr J V Tyagi
Nodal-Officer, NHP	Dr Sanjay Kumar Jain, Scientist-G
Training-Coordinator, NHP	Dr Anil K Lohani, Scientist-G
Course Coordinators	Dr Manish K Nema, Scientist-D mn.nihr@gov.in Dr Vishal Singh, Scientist-C vishal18.nihr@gov.in
Division	Water Resources Systems Division
Organisation	National Institute of Hydrology (NIH) Roorkee - 247667 (Uttarakhand)

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1.0 INTRODUCTION

Water is a vital natural resource. Hydrological modelling is an essential aspect of any development project for planning, designing, executing, and managing water resources efficiently. A hydrologic model simplifies a real-world system (e.g., surface water, soil water, wetland, groundwater, estuary) that aids in understanding, predicting, and managing water resources. Both the flow and quality of water are commonly studied using hydrologic models. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds. This training course was designed to impart and transfer the working knowledge of using a semi-distributed hydrological model called the Soil & Water Assessment Tool (SWAT), which is a small watershed to river basin-scale model used to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change.

SWAT, a river basin or watershed scale model, is a physically-based, spatially distributed, continuous model that operates on a daily time step. It is a product of four decades of modelling efforts by USDA-ARS, USDA-NRCS and Texas A&M University. It was developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods. It can incorporate the effects of tanks and the reservoirs/check dams off-stream as well as on-stream. The significant advantage of SWAT is that it does not require much calibration. Therefore, it can be used on ungauged watersheds and can predict relative impacts of alternative scenarios such as changes in management practices, climate and vegetation on water quality and quantity. Model output includes all water balance components at the level of each watershed and is available at daily, monthly or annual time steps. SWAT model has been extensively used to address water resources and nonpoint-source pollution problems for various scales and environmental conditions across the globe.

SWAT allows several different physical processes to be simulated in a watershed. For modelling purposes, a watershed may be partitioned into many sub-watersheds or sub-basins. Thus a user is able to reference different areas of the watershed to one another spatially. The input information for each sub-basin is grouped or organized into the following categories: climate; hydrologic response units or HRUs; ponds/reservoirs/ wetlands; groundwater and main channel, or reach, draining the sub-basins. HRUs have lumped land areas within the sub-basin that are comprised of unique land cover, soil and management combinations.

SWAT typically uses the ArcSWAT interface to create its inputs that work in the licensed ArcGIS environment. The Quantum GIS (QGIS) is a free and open-source GIS that performs most of the functions of commercial GIS. Given its robustness and wide use in academic and professional environments, the present training course was conducted using QSWAT, a QGIS interface for the SWAT model.

2.0 OBJECTIVES

The training course was designed to introduce participants to QGIS, SWAT model and SWAT-CUP, mandatory and optional inputs to the model, database preparation, and SWAT setting up using the QSWAT interface. The course covered many advanced topics, including sensitivity analysis, model calibration, validation and uncertainty analysis using SWAT-CUP.

The course contents were designed for five days' duration devoted to SWAT set up, including spatial and non-spatial data preparation, data input, model execution, and visualization and interpretation of results using QGIS interface and model calibration and validation using SWAT-CUP. By the end of the course, the participants were capable of using the model on their own.

3.0 ABOUT NIH AND NHP

National Institute of Hydrology (NIH):

NIH is a premier Research and Development organization under the Dept. of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti, Government of India. It was established as an autonomous society in 1978 with its headquarters at Roorkee. The main objectives of NIH are to undertake, aid, promote and coordinate systematic and scientific work in all aspects of hydrology. The Institute was declared as an S&T organization in 1987.

The Institute is an ISO 9001:2008 Certificated organization. Over the years, the Institute has grown as a centre of excellence for pursuing research activities in hydrology and water resources with emphasis on technology transfer and demand-driven, user-defined, strategic research. The research in the Institute have been carried out under six scientific divisions at the headquarters at Roorkee, four Regional Centres located at Belgaum, Jammu, Kakinada and Bhopal and two Centres for Flood Management Studies at Guwahati and Patna.

National Hydrology Project (NHP)

The Ministry of Jal Shakti / Department of Water Resources, River Development and Ganga Rejuvenation has proposed to undertake National Hydrology Project (NHP) with the World Bank Assistance. The project proposal has already been approved by the EFC held on 16-10-2015. National Hydrology Project with overall cost of Rs3679.7674 crore as a Central Sector Scheme is to be taken up in two stages.

There are a total of 49 Implementing Agencies (IAs) including eight central agencies, 39 state-level agencies and two River Basin Organizations (RBO) in National Hydrology Project. Central Water Commission is one of the implementing agency under National Hydrology Project and it has to play a crucial role of central technical coordination agency in NHP. Central water Commission has been allocated approx. Rs275 crore in National Hydrology Project for carrying out the various activities. Member, River Management, CWC is the coordinator officer & Chief Engineer, Planning & Development is the nodal officer for NHP on behalf of CWC.

Under HP I and HP II projects, a large part of country is still not covered for example Ganga Basin States, Himalayan Region, North Eastern States and Indus Basin. There is a need to

develop infrastructural and technological gaps, commissioning of standardize tools and systems and bringing uniformity among all the States including operation & maintenance of infrastructure created under HP I and II projects. With the new National Water Policy is in place, the approach for National Hydrology Project (NHP) is to align water resources development in line with the policy especially Integrated Water Resource Management (IWRM).

4.0 INAUGURATION

The five-day online training course was organized from August 22-26, 2022, from NIH Roorkee. Dr JV Tyagi, Director, NIH, was expected to inaugurate the training course, but due to some other urgent engaugments he could not attended. The course was formally inaugurated by Dr Anil K Lohani, Sci-G, Head-SWH division & Training-Coordinator of NHP at 10:15 am on August 22, 2022 in the gracious presence all the participants and tratining coordinators. The function was presided over by Dr Manish K Nema, Sci.-D & Course Coordinator, WRS Division, formally welcomed all the participants and briefly informed them about the training course and its objectives. After that, the Training-Coordinator of NHP has mentioned the different training activities of NHP and informed the various activities and purpose-driven studies under the NHP to the course participants. Dr Vishal Singh briefed about the training contents and schedule of next five days and various activities of NIH to the participants. Dr Vishal Singh, Sci-C, also offered a vote of thanks to all the attendees of the session.

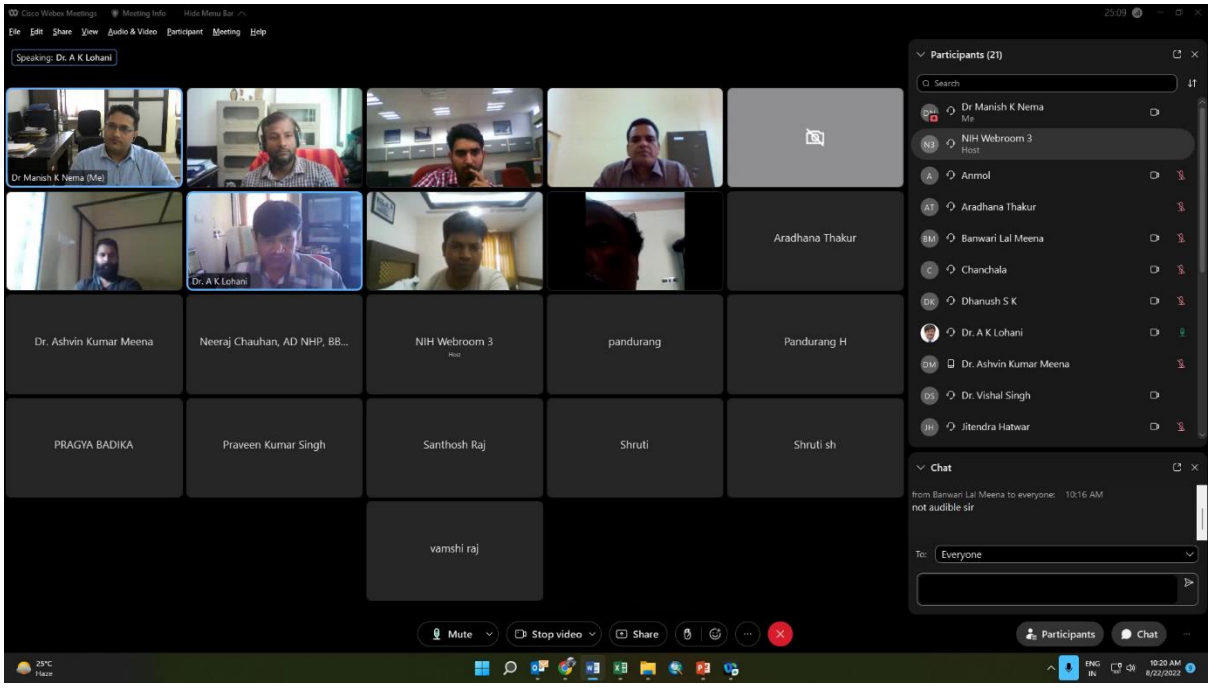


Fig. 1. The screen-shot during the Inauguration Session of the training

5.0 PARTICIPATION

This training course was sponsored by the National Hydrology Project (NHP) for the participants from various states and central PMU of NHP. A total of 28 registrations were received through the online portal of NHP MIS from the different state government engineers

from the water resources departments and other NHP implementing agencies. Finally, a total of 18 Nos. of participants from 10 states and 03 central PMU have successfully completed the course. A list with various detail of all the participants who have completed the course is provided in **Annexure-I**

6.0 COURSE CONTENT AND FACULTY

The course consists of online lectures supported by hands-on sessions on computers to cover both theory and practice in the right proportion. The training lectures were provided by the subject experts of the National Institute of Hydrology, Roorkee. The course was conducted as a two-way interaction with the participants so that the problems and experiences of participants from academia as well as field organisations are shared. The theoretical and pratical sessions were degined in 70:30 ratio for better understanding of the modeling approach to te participants. Broadly, the following topics were covered in the course:

- Basics of Hydrological modelling
- Calibration and Validation
- Introduction to GIS, Hydrological Application of GIS and overview of QGIS;
- Various input data requirements of SWAT model;
- Hands-on sessions for preparing spatial datasets for SWAT using RS and QGIS
- SWAT model theory and applications;
- Preparation of spatial and non-spatial datasets
- Introduction to QSWAT interface; model set up;
- Sensitivity, calibration/validation and uncertainty analysis using SWAT-CUP-SUFI2;
- Visualization and interpretation of SWAT model outputs.
- A Case Study of Snowmelt Runoff Modeling using SWAT

7.0 SCHEDULE

The duration of the training course was five days. The course was started on August 22, 2022 at 10:15am with inaugural sessiona and then fllowed by the technical sessions. The training courses included 08 lectures, 09 online tutorials and hands-on sessions, and one Multiple Choice Question (MCQ) based Online Test quiz session. The course was concluded on August 26, 2022 at 4:00pm. The detailed schedule of the training course is given in **Annexure-II**.

8.0 FEEDBACK FROM PARTICIPANTS

The participants highly appreciated the smooth organization and sound management of the training course. During the valedictory session few of the participants had expressed their verbal feedback about the course and suggested few points fr further improvement. Online feedback was collected via filling Google-Form survey by the participants. Participants were agreed that the course content supported and delivered the training objectives, and the course provided opportunities to them for practising and reinforcing what was taught. The feedback suggests that the participants were happy that the course information provided was appropriate to understand the learning objectives. More than 80% participants score 120 or more marks out

of a total 170, which indicates the understanding of participants towards the SWAT hydrological Model have enhance during the training course. The overall verdict on the training course for the satishfaction level was also asked in google feedback form, based on the feedback provided by the participants is shown in the Figure below.

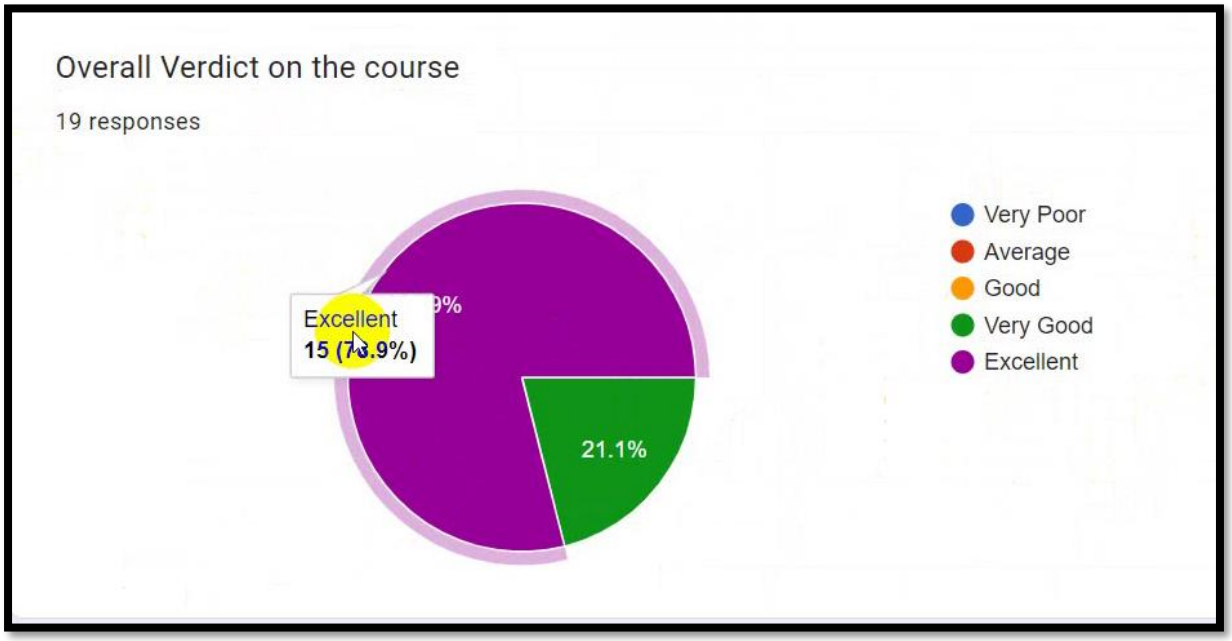


Fig. 2. The overall feedback of the training course

In their views, the instructors were knowledgeable about the course content and were responsive to questions and other needs. However, some of the participants expressed the need for more practical sessions, longer course duration, and to include more modelling content, etc.

9.0 VALEDICTORY FUNCTION & CERTIFICATE DISTRIBUTION

The valedictory function of the training course was held on August 26, 2022, at 3:15 pm. The Course Coordinator, Dr Manish K Nema, Sci.-D, WRSD, presented a brief report of the five days training course. During the valedictory function, a few participants have also shared their learning experiences during the training programme. In general, the training got excellent responses from the participants, and they suggested enhancing the training time for such specialized models. With the veldictory remarks, Dr AK Lohani announced the formal closure of the course. In the last, Dr Vishal Singh, Sci-C, offered a vote of thanks to all the dignitaries and all the participants for their since participation. The training certificates to the participants have been sent by email. A sample of the training certificate, which was distributed to the participants, is enclosed in **Annexure-III**.

10.0 FINANCIAL ASPECTS

The total budgetary provision of Rs. 27750/- (Rs. Twenty-Seven Thousand Seven Hundred Fifty only) had been approved by the competent authority for the training course and same has

been utilized (Approvals at **Annexure-IV**). A brief break-up of the expenditure is presented in the following Table 1:

Table 1. Total Budget of Training

Sl. No.	**Items**	**Estimated expenditure (₹)**
1.	Session Tea	2500/-
2.	Honorarium for Faculty (As per Annexure-I)	21750/-
3.	Memento	5000/-
	Sub-Total	**29,750**/-

ANNEXURE-I: LIST OF PARTICIPANTS

SN	Name	Designation	Department	State	Gender	Mobile No.	Email ID
1	Ankitkumar R Patel	Assistant Engineer	WRD	Gujrat	Male	9909429747	arpatel972@gmail.com
2	Aradhana	Research Assistant	NIH, Roorkee	Uttarakhand	Female	8090596945	aradhana.thakur@bhu.ac.in
3	Banwari Lal Meena	Research Officer	CWPRS, Pune	Maharashtra	Male	9422538257	meena.banwarilal@gmail.com
4	Chanchala	Research Officer	CWC	Odisa	Female	8144779792	chanchaladas@rocketmail.com
5	Dhanush SK	Asst. Research Officer	WRD	Karnataka	Male	7204649914	dhanushstarer@gmail.com
6	Jitendra Hatwar	Consultant	WRD	Maharashtra	Male	9665930804	enquiry.aees@gmail.com
7	Jyoti Kushawaha	Hydrogeologist	I & FCD	NCT Delhi	Female	8800569927	jyoti.vaishnavi@gmail.com
8	M Abdul Rahman	Assistant Engineer	WRD	Tamilnadu	Male	9585688734	abrahwrd@gmail.com
9	Navyashree M L	Research Assistant	WRD	Karnataka	Female	9686410862	shreenavya444@gmail.com
10	Pandurang	Research Assistant	WRD	Karnataka	Male	9535811936	hpanducv037@gmail.com
11	Pranab Baruah	Assistant Engineer	WRD	Assam	Male	9952017929	pranabbaruah010@gmail.com
12	Pragya Badika	Research Assistant	NIH, Roorkee	Uttarakhand	Female	7470891243	pragya.badika@gmail.com
13	Sabiha Begum	Deputy Engineer	I & CAD	Telangana	Female	9989334869	begumsabhia@gmail.com
14	Salana Gnaneswara Rao	Junior Engineer	CWC	Telangana	Male	9603930490	vinaykumarsalana@gmail.com
15	Shruthi Sri	Asst. Research Officer	WRD	Karnataka	Female	7829089377	shruthi1369@gmail.com
16	Shruti Halli	Research Assistant	WRD	Karnataka	Female	6363209161	shruthi.shivaganga@gmail.com
17	Sumit Kant	Asst. Research Officer	NIH, Belagavi	Karnataka	Male	9889999992	sumit.kant57@gmail.com
18	Vimal Chandra Sharma	Data Entry Operator	CWC	Telangana	Male	9533326967	vcsharma.iith@gmail.com

ANNEXURE-II: TRAINING SCHEDULE

TIME	TOPIC	FACULTY
DAY 1: 22.08.2022: MONDAY		
1000 - 1030	Inauguration of Course and Brief about the Training Course	
1030 - 1130	Hydrological Modeling	AKL
1130 - 1300	Introduction of SWAT Modeling and Data Requirements	VS
1300 - 1430	Break	
1430 - 1530	Calibration and Validation in Hydrological Modeling	AKL
1530 - 1630	Introduction of GIS, Its Applications and QGIS Brief	MKN
DAY 2: 23.08.20221: TUESDAY		
1030 - 1130	Open Data Sources for Hydrological Modeling	VS
1145 - 1300	Demonstration of the SWAT Model	VS/MKN
1300 - 1430	Break	
1430 - 1530	Tutorial and Hands-on Practice – SWAT Setup and Watershed Properties	VS/MKN
1530 - 1700	Tutorial and Hands-on Practice – SWAT HRU analysis, Weather Generator & Run	MKN/ VS
DAY 3 : 24.08.2022: WEDNESDAY		
1030 - 1130	Snowmelt Runoff Modeling using SWAT	VS
1145 - 1300	Tutorial – SWAT Snow Hydrology Module	VS/ MKN
1300 - 1430	Break	
1430 - 1530	Tutorial and Hands-on Practice – SWAT Run, SWAT Check & Visualization of Results	MKN/VS
1530 - 1700	Tutorial and Hands-on Practice – SWAT Data Editing and Re-run	MKN/VS
DAY 4 : 25.08.2022: THURSDAY		
1030 - 1130	Introduction of SWAT CUP, Model Parameterisation and Sensitivity Analysis using SUFI2	MKN

1145 - 1300	Tutorial and Hands-on Practice – SWAT CUP Database Preparation	VS/MKN
1300 - 1430	Break	
1430 - 1530	Tutorial and Hands-on Practice – SWAT CUP Calibration and Uncertainty Analysis– SUFI2-I	VS/MKN
1530 - 1700	Tutorial and Hands-on Practice – SWAT CUP Calibration and Uncertainty Analysis – SUFI2-II	VS/MKN
DAY 5 : 26.08.2022: FRIDAY		
1030 - 1130	Tutorial and Hands-on Practice – SWAT CUP Calibration and Uncertainty Analysis – SUFI2-III	MKN/VS
1145 - 1300	Tutorial and Hands-on Practice – SWAT CUP Calibration and Uncertainty Analysis – SUFI2-IV	MKN/VS
1300 - 1430	Break	
1430 - 1515	Multiple Choice Question-based Online Test for the Participants	MKN
1515 - 1545	Valedictory Function	

FACULTY:

AKL: Dr Anil K. Lohani, Sci.-'G', NIH and NHP-Training Coordinator;
MKN: Dr Manish K Nema, Sci-'D', NIH and Course Coordinator
VS: Dr Vishal Singh, Sci.-'C', NIH and Course Co-coordinator

ANNEXURE-III: FORMAT OF CERTIFICATE

CERTIFICATE NUMBER
NIH/NHP/2022-23/T-4/01

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE

Department of Water Resources, RD & GR
Ministry of Jal Shakti, Govt. of India

CERTIFICATE

This is to certify that

Ankitkumar R Patel

has participated in the on-line training course on

"Hydrological Modelling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on"

held from August 22-26, 2022

Organised by

National Institute of Hydrology (NIH), Roorkee

Sponsored by

National Hydrology Project (NHP)

A.K. Lohani
Scientist G & Training Coordinator
National Institute of Hydrology, Roorkee

Sanjay Kumar Jain
Scientist G & Nodal Officer
National Institute of Hydrology, Roorkee

J.V. Tyagi
Director
National Institute of Hydrology, Roorkee

ANNEXURE-IV: APPROVALS

जल संसाधन तंत्र प्रभाग / **WATER RESOURCES SYSTEMS DIVISION**
राष्ट्रीय जलविज्ञान संस्थान / **NATIONAL INSTITUTE OF HYDROLOGY**

NIH/WRSD/SWAT-TRG/04
Date: 26/07/2022

Subject: Organization of a 5-days online training course on "Hydrological Modeling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on" from August 22-26, 2022, under the National Hydrology Project (NHP).

A five-day online training course on "Hydrological Modeling Using SWAT" is proposed to be organized under the National Hydrology Project (NHP) from August 22-26, 2022, for participants from various states and central PMU NHP. Around 40 participants are expected to participate in this program. It is planned to provide them with lectures, tutorials and demonstrations on SWAT modeling and calibration-uncertainty analysis through SWAT-CUP. The tentative training schedule is attached herewith for reference. The following estimated expenditure is expected to be incurred in the organization of the Course.

Sl. No.	Items	Estimated expenditure (₹)
1.	Session Tea and others miscellaneous.	2500/-
2.	Honorarium for Faculty (As per Annexure-I)	21750/-
3.	Memento	5000/-
	Sub-Total	**29,250/-**

A. Director is requested to kindly provide the administrative and financial approval of ₹ 29,250/- (Rupees Twenty-Nine Thousand Two Hundred Fifty only) regarding Items Nos. 1 to 3 for the organization of the training course.
B. For meeting the expenditure in cash, an advance of Rs.2500/- may also be approved and credited o the undersigned.

'A'

(Manish K Nema) 26/07/22.
Sci.-'D' & Course-Coordinator

Training-Coordinator, NHP: On Tour

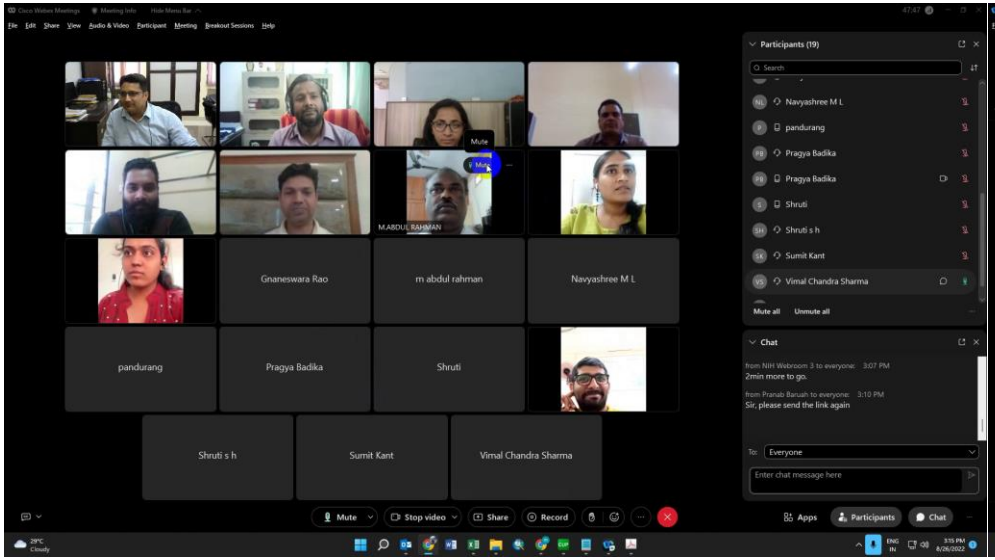
Nodal-Officer, NHP: Sd/- 26/07/2022

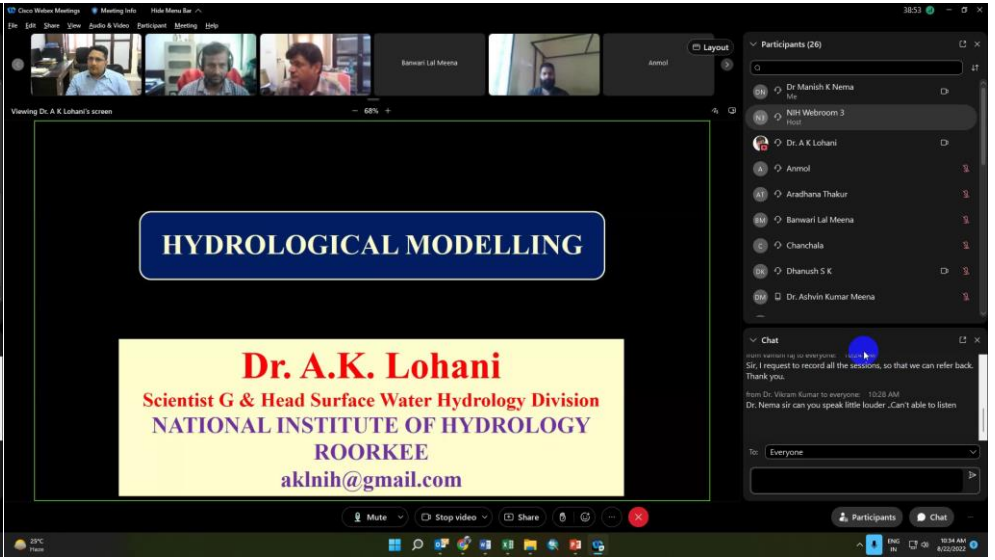
Director: 'A' approved. There are other programmes also during this week. I may not be available in the programme due to other pressing engagements.
26/7/22

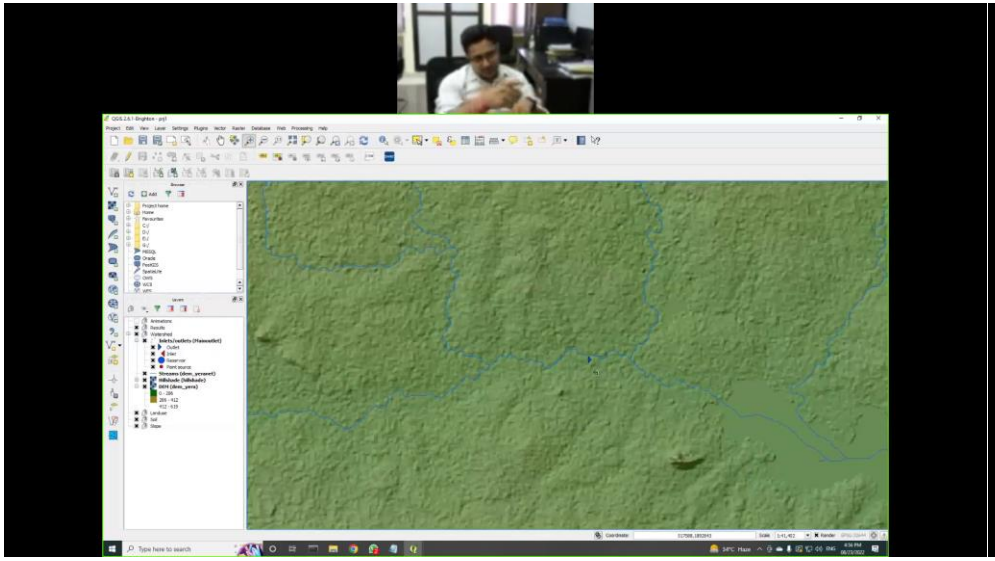
2104
निदेशक कार्यालय
Director's Office
डायरी सं/ Dy. No. 1108
दिनांक/Date: 26/7/22

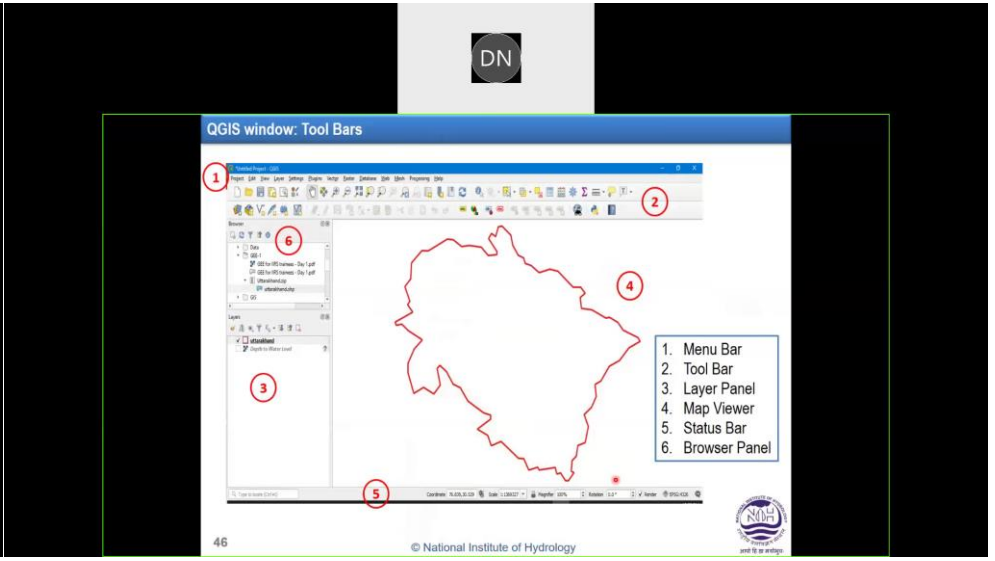
DDO: Please issue & credit an advance of Rs. 2500/- to my account as per the director's approval.
27/07/22

FEW GLIMPSES OF THE TRAINING COURSE









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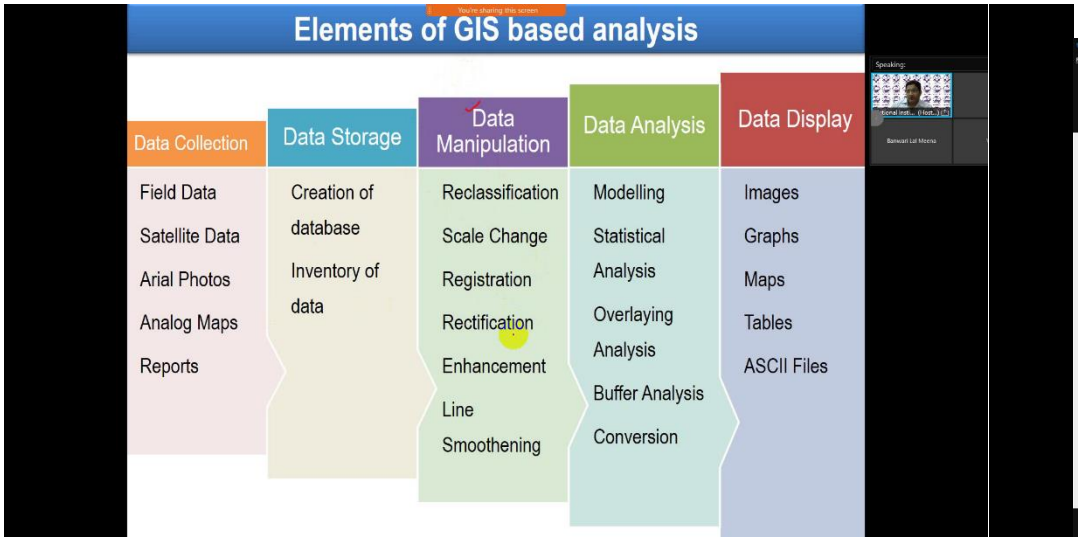

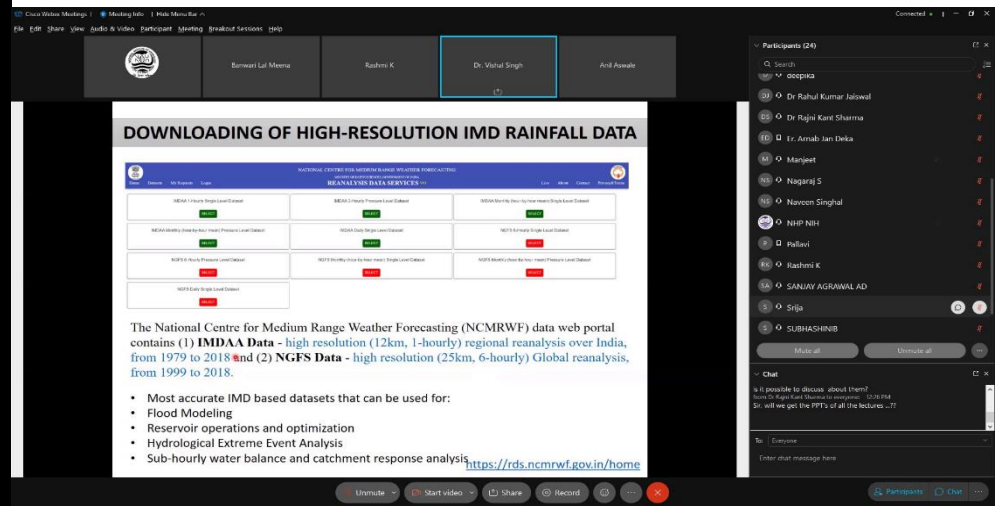

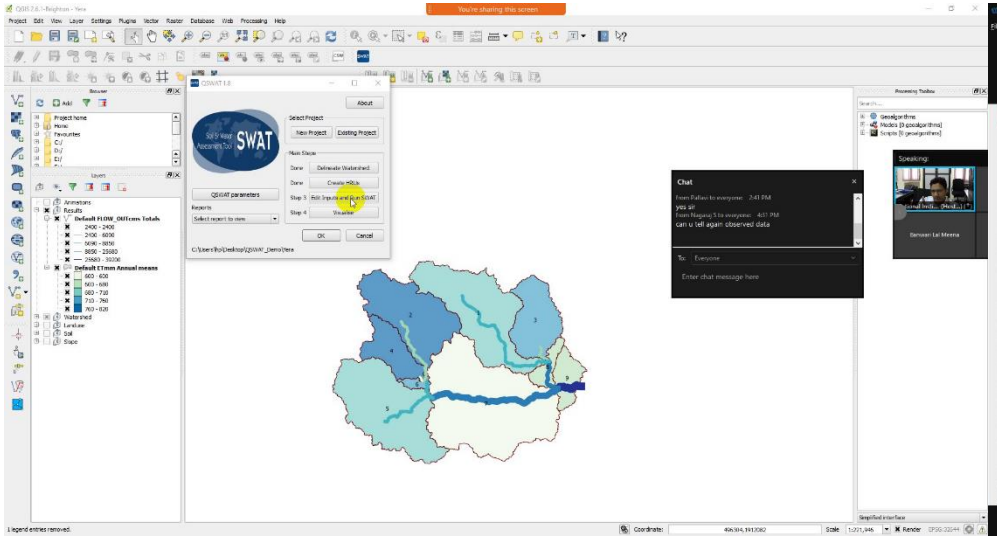

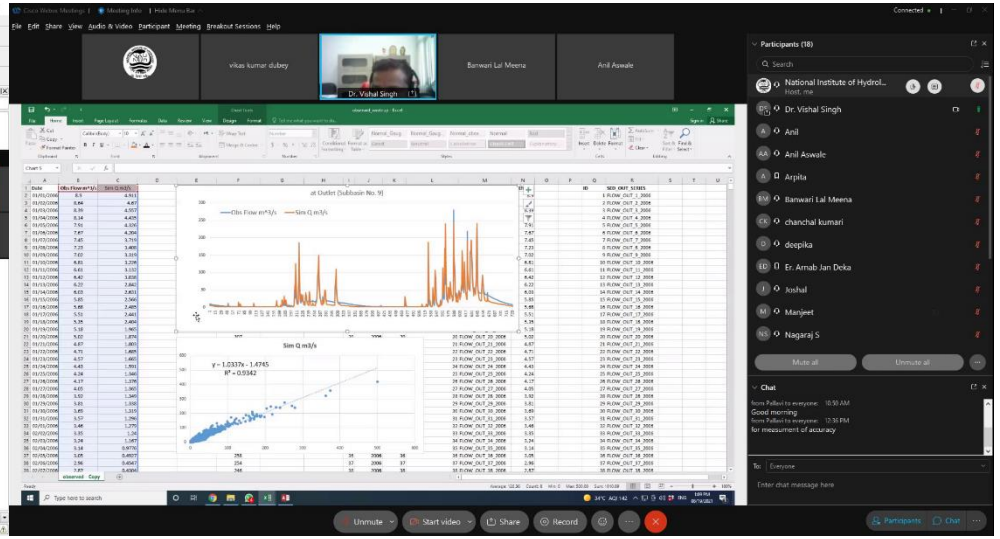

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