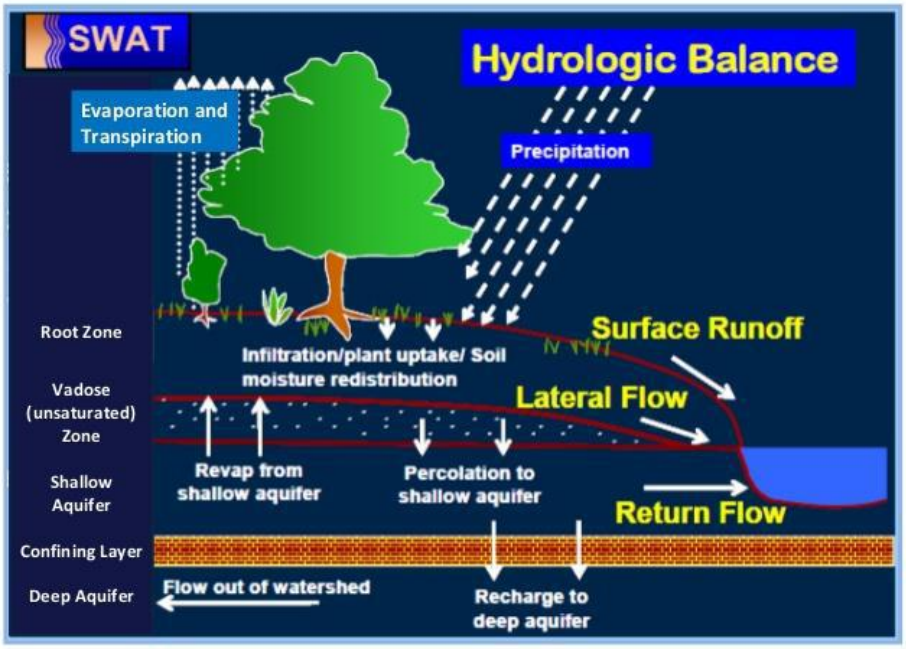
A BRIEF REPORT ON

NHP sponsored
Five-days online training course on

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

(August 16-20, 2021 at NIH, Roorkee)



Compiled by:

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

WATER RESOURCES SYSTEMS DIVISION
NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE- 247667 (UTTARAKHAND)
AUGUST-2021

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 Dr Vishal Singh, Scientist-C
Division	Water Resources Systems Division
Organisation	National Institute of Hydrology (NIH) Roorkee - 247667 (Uttarakhand)

TABLE OF CONTENTS

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 16-20, 2021, from NIH Roorkee. Dr JV Tyagi, Director, NIH, inaugurated the training course, in the gracious presence of Dr Sanjay K Jain, Sci-G, Head-WRS division & Nodal-Officer-NHP, and Dr Anil K Lohani, Sci-G, Head-SWH division & Training-Coordinator of NHP at 10:15 am on August 16, 2021. 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. Nodal-Officer NHP informed the various activities and purpose-driven studies under the NHP to the course participants. After that, the Training-Coordinator of NHP has mentioned the different training activities of NHP. The Director NIH briefed about the training and the SWAT modelling and various activities of NIH to the participants. Dr Vishal Singh, Sci-C, offered a vote of thanks to all the attendees of the session.

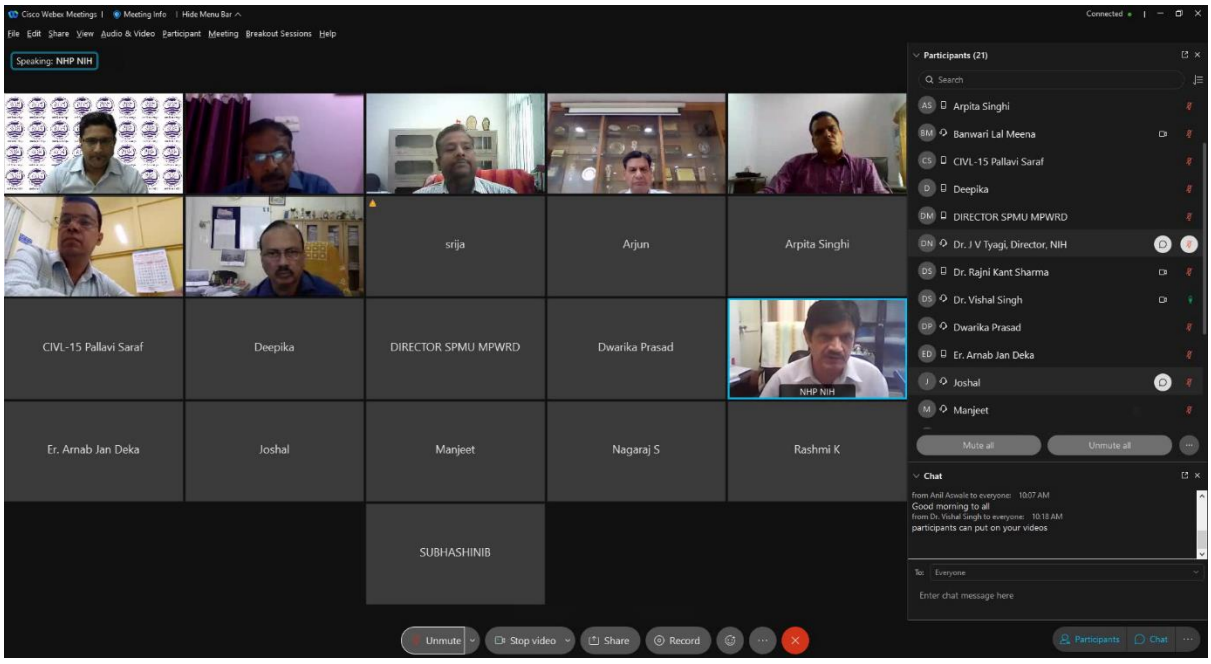


Fig. 1. The screen-shot during the Inauguration Session of the training

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 118 registrations were received through the online portal of NHP MIS. Many of the registrations from research and academic institutions were screen off. After scrutiny, 28 participants from the state government engineers from the water resources departments and other NHP implementing agencies have

been selected for the training. Finally, a total of 23 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 16, 2021 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 20, 2021 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 70% participants score 110 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.

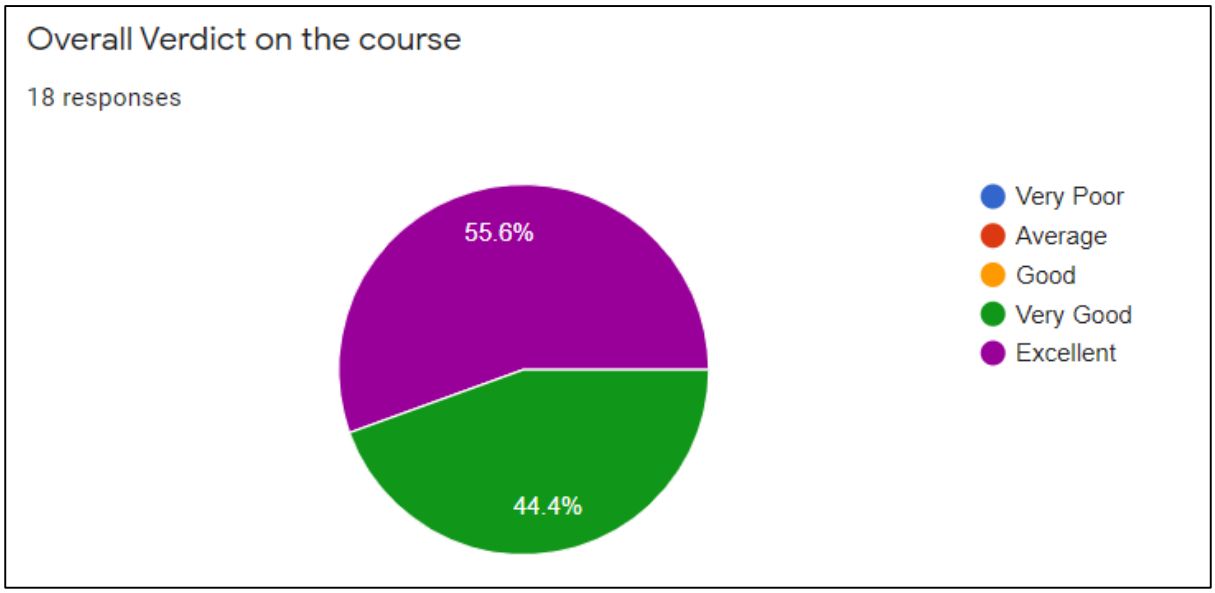


Fig. 2. The overall feedback of the training course

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 20, 2021, at 3:15 pm. National Training Coordinator of NHP Dr AK Lohani, Sci.-G, was the chief guest of the session, and the session was graced by NHP officials. 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	1000/-
2.	Honorarium for Faculty (As per Annexure-I)	21750/-
3.	Memento	5000/-
	Sub-Total	**27,750**/-

ANNEXURE-I: LIST OF PARTICIPANTS

SN	Name	Designation	Department	State	Gender	Mobile No	Email ID
1	Anil Aswale	Assistant Engineer	Chhattisgarh	Chhattisgarh	Male	9424242987	aswalea4@gmail.com
2	Ankita Somnath Musale	Assistant Engineer	Maharashtra SW	Maharashtra	Female	8422906090	ankitamusale7@gmail.com
3	Arjun Narwariya	Assistant Engineer	Water Resources Department	Madhya Pradesh	Male	9479347191	arjun12nov@gmail.com
4	Arnab Jan Deka	Assistant Engineer	RRA, AWRMI, WRD	Assam	Male	9954816628	janarnab@gmail.com
5	Arpita Singhi	Assistant Engineer	Water Resources Department	Madhya Pradesh	Female	8878899940	singhi.arpita10@gmail.com
6	Banwari Lal Meena	Scientist B	CWPRS	Maharashtra	Male	9422538257	meena.banwarilal@gmail.com
7	Budharapu Subhashini	Asst. Executive Engineer	WRD Surface Water	Andhra Pradesh	Female	9490080046	saisubhashinib@gmail.com
8	Chanchal Kumari	JRF	NIH	Madhya Pradesh	Female	7294820497	Chanchalsahu1801@gmail.com
9	Deepika S	Assistant Engineer	Karnataka SW	Karnataka	Female	8884879362	s.deepika06@gmail.com
10	Dwarika Prasad	Research Assistant	WRD Surface Water	Assam	Male	8126069951	dwarika2794@gmail.com
11	Joshal Bansal	JRF	NIH	Uttarakhand	Male	8558006883	joshalbansal22@gmail.com
12	K.Shalini	Asst .Executive Engineer	Telangana SW	Telangana	Female	9100790559	shalini13579@gmail.com
13	Manjeet Kaur	Deputy Director	Delhi	Delhi	Female	9810931967	neetubanga2002@gmail.com
14	Nagaraj S	Hydrologist	Water Resources Department	Tamil Nadu	Male	9944133599	nagaraj116011@gmail.com
15	Naneen Singhal	Superintending Engineer	Irrigation Department	Uttarakhand	Male	8279967748	serke-irri-uk@gov.in
16	Nikhilesh Sarkar	Assistant Engineer	RRA, AWRMI, WRD	Assam	Male	9435197268	nikhileshawrmi@gmail.com
17	Pallavi Saraf	Assistant Engineer	Maharashtra GW	Maharashtra	Female	7588687078	pallavi.saraf80@gmail.com
18	Rajni Kant Sharma	Scientist B (Chemist)	CGWB	Maharashtra	Male	8600992193	rasadurg@gmail.com
19	Rashmi K	Assistant Engineer	Karnataka SW	Karnataka	Female	9591975318	rashmik.krishnamurthy@gmail.com
20	Sanjay Agarwal	Assistant Director	Water Resources Department	Madhya Pradesh	Male	9760729557	sanjaya329@gmail.com
21	Srija Dangudubiyyam	JRF	NIH	Andhra Pradesh	Female	9014523728	srija.d138@gmail.com
22	Surendra Kumar Chandniha	Scientist	Chhattisgarh	Chhattisgarh	Male	8791310024	chandniha.surendra@gmail.com
23	Vikas Kumar Dubey	Assistant Engineer	Chhattisgarh	Chhattisgarh	Male	9893332761	vikas12dubey@gmail.com

ANNEXURE-II: TRAINING SCHEDULE

TIME	TOPIC	FACULTY
DAY 1: 16.08.2021: 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	JVT
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: 17.08.2021: TUESDAY		
1030 - 1130	Open Data Sources for Hydrological Modeling	VS
1145 - 1300	Demonstration of the SWAT Model	JVT
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 : 18.08.2021: 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 : 19.08.2021: 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 : 20.08.2021: 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:

JVT: Dr J V Tyagi, Director, NIH and Course Director
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

NIH/NHP/2021-22/T-6/01

NATIONAL HYDROLOGY PROJECT
NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE

CERTIFICATE

This is to certify that

Anil Aswale

has participated in the on-line training course on

"Hydrological Modelling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on"
August 16-20, 2021

Organised by

National Institute of Hydrology (NIH), Roorkee
under
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

निदेशक कार्यालय
Director's Office
आवक सं./Dy. No: 767
दिनांक/Date: 20/7/21

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

NIH/WRSD/SWAT-TRG/03
Date: 19/07/2021

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 16-20, 2021, 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 16-20, 2021, for participants from various states and central PMU NHP. Around 50 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 and the letter from training coordinator NHP are 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	1000/-
2.	Honorarium for Faculty (As per Annexure-I)	21750/-
3.	Memento	5000/-
	Sub-Total	**27,750/-**

A. Director is requested to kindly provide the administrative and financial approval of ₹ 27,750/- (Rupees Twenty-Seven Thousand Seven 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.1000/- may also be approved

(Vishal Singh)
Sci.-'C' & Course-Co-coordinator

(Manish K Nema) 19/07/21.
Sci.-'D' & Course-Coordinator

Training-Coordinator, NHP:

Nodal-Officer, NHP: 20/7/2021

326 Director: 'A' & 'B' above approved
20/7/21

NATIONAL INSTITUTE OF HYDROLOGY
(A Govt. of India Society under Ministry of Water Resources)
JAL VIGYAN BHAWAN, ROORKEE – 247 667, INDIA

Phone: +91 1332 249214 (Off)
Fax: +91 1332 272123, 8279915372 (M)
E-mail: aklnih@gmail.com; lohani.nihr@gov.in

Dr. A. K. Lohani
Scientist G & Training Coordinator NHP

No. NHP/T-/2020-NIH
Dated: July 01, 2020

All Nodal Officers / Training Coordinator,

Sub: Organization of Online Training course on "Hydrological Modelling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on" during August 16-20, 2021 by NIH, Roorkee.

Dear Sir,
I am happy to inform you that NIH, Roorkee is organizing **Online Training Workshop "Hydrological Modelling Using Soil and Water Assessment Tool (SWAT): Theory and Hands-on" during August 16-20, 2021**under National Hydrology Project as part of the NHP training activities. This training workshop is planned for the NHP Implementing Agencies. The course consists lectures and hands-on exercises on Soil and Water Assessment Tool.

There is no registration fee for the participants from the States/Central Agencies covered under NHP to attend the workshop. I request you to nominate participants for attending this One Week Online Training Workshop. It is requested to please register the participants in NIH-MIS using the following link: http://nhp.mowr.gov.in/HomeNew/SearchProfile.aspx

For further details about the training course, please contact the following:

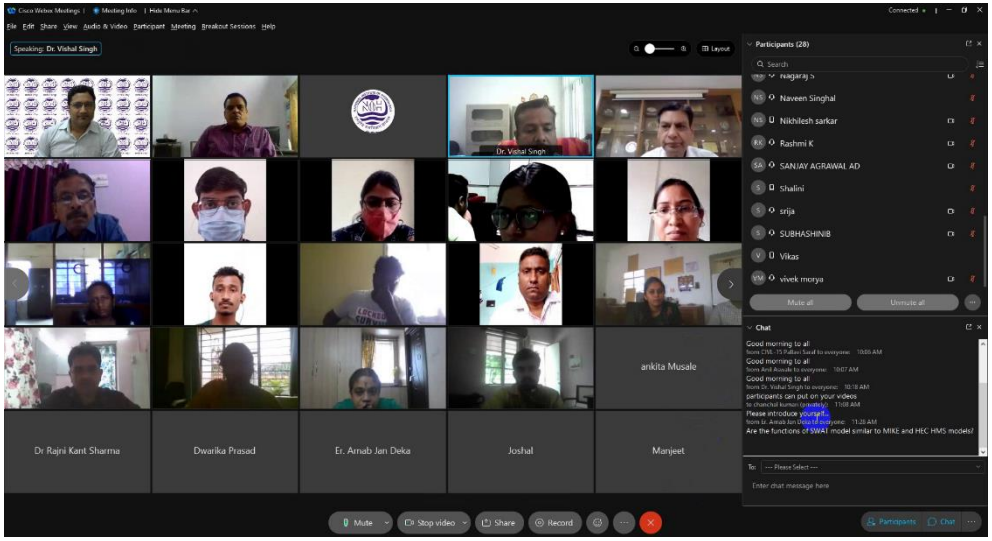
Dr Manish Kumar Nema, Scientist D; Email: mxnema@gmail.com
Dr Vishal Singh, Scientist C; Email: shalu.ashu50@gmail.com

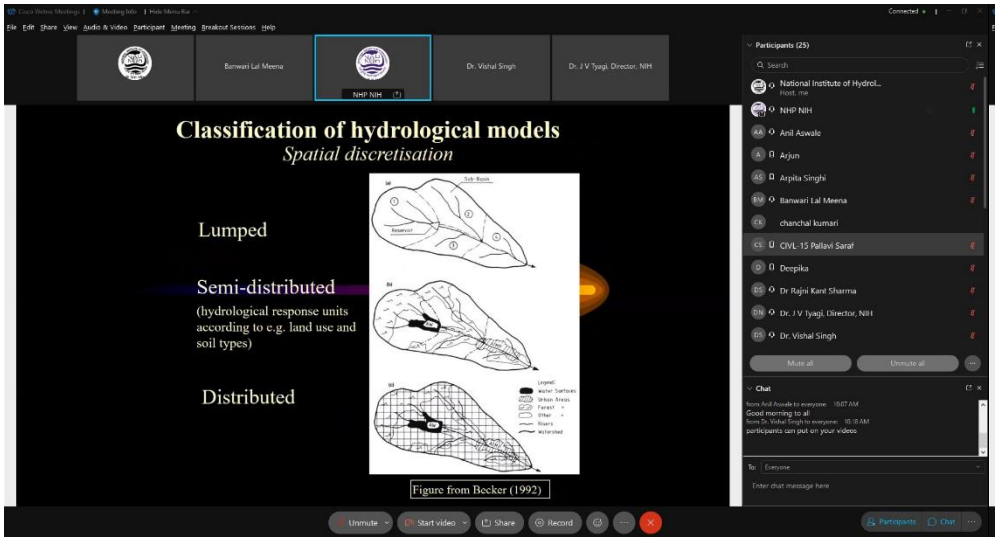
Thanking you,

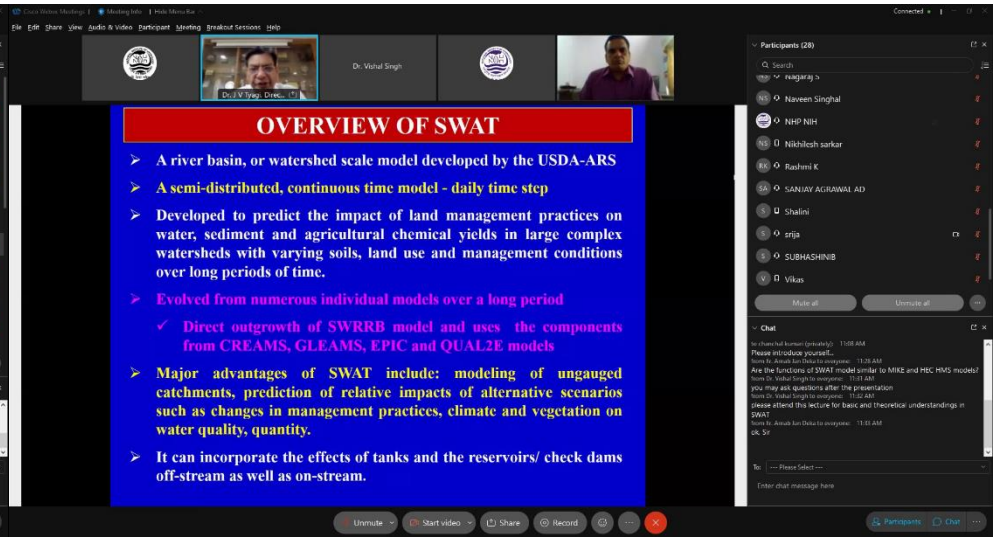
Yours sincerely,

(A.K. Lohani)

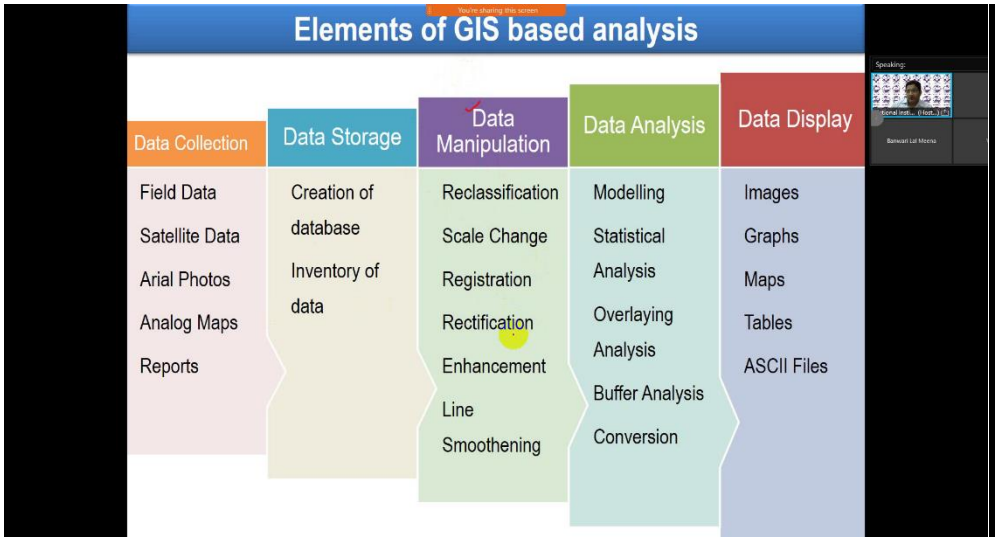
FEW GLIMPSES OF THE TRAINING COURSE

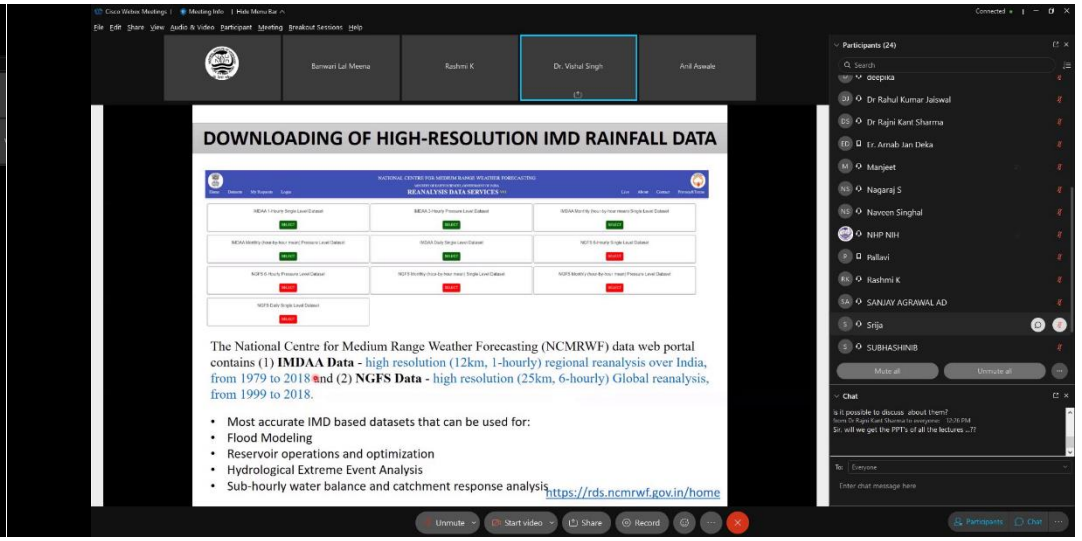


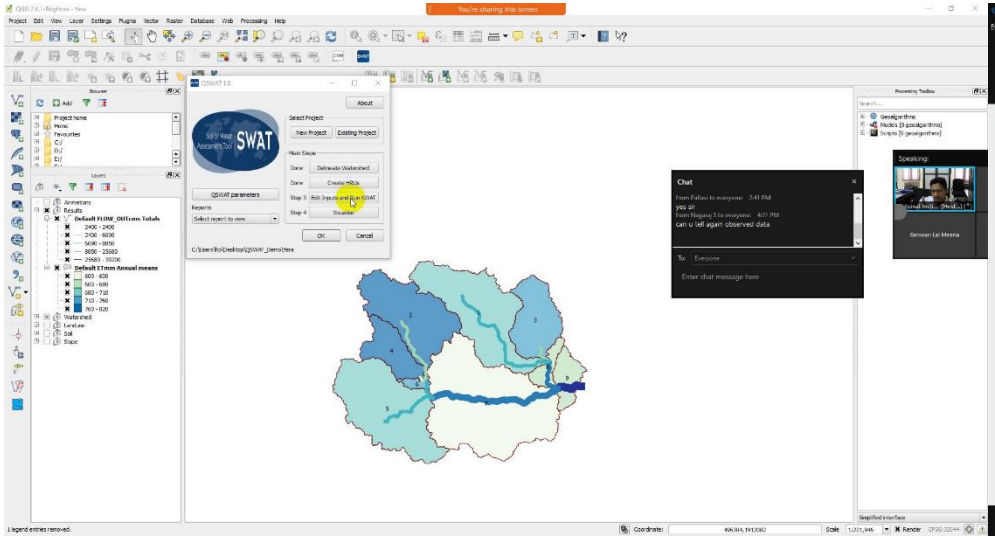


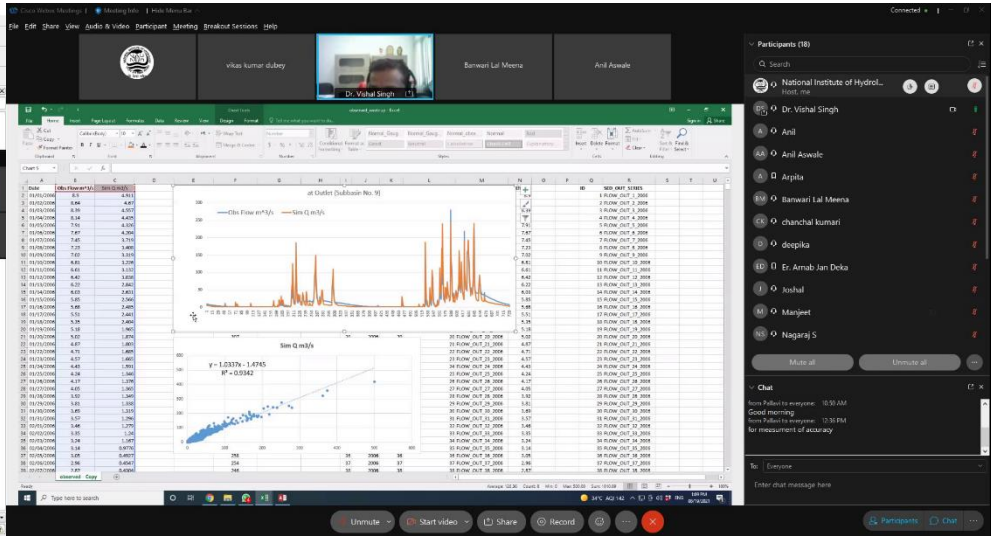


FEW GLIMPSES OF THE TRAINING COURSE









FEW GLIMPSES OF THE TRAINING COURSE