

Report on

**Training Workshop on Hydrological Modelling using
JAMS/J2000**

25 Oct – 4 Nov 2018

New Delhi



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1. Background

Understanding the hydrological dynamics of a river system is crucial for water resources planning and management. Hydrological models have proven to be a useful tool to provide hydrological processes across the basin which otherwise would have been difficult with scarce hydro meteoroidal data based on installed stations. The high altitude areas of the Hindu Kush Himalaya (HKH) region are sources to 10 big rivers originating from the region. These 10 river basins have been inhabited by 1.3 billion people who depend on water resources for their livelihoods. The role of snow, glacier, precipitation, and groundwater in the water resources of the HKH region and the possible impact of climate change on this and overall water availability has become a matter of great concern. Besides, climate change is believed to contribute to extreme weather events and possibly to increase the frequency and magnitude of natural hazards and associated disasters, exacting high economic and social costs.

For better understanding, the hydrological dynamics of Panjshir catchment of Kabul sub river basin, the Training Workshop on Hydrological modelling using JAMS/J2000 took place from 25th October to 4th November in New Delhi, India. The training is a part of the Strengthening Water Resources Management in Afghanistan (SWaRMA) initiative.

The Strengthening Water Resources Management in Afghanistan (SWaRMA) is a two-year project supported by the Government of Afghanistan (Ministry of Energy and Water) and Government of Australia and implemented through International Centre for Integrated Mountain Development (ICIMOD) in collaboration with Commonwealth Scientific and Industrial Research Organization (CSIRO). SWaRMA aims at co-creating knowledge and providing co-learning opportunities to enhance the capacity of Afghanistan partners in water resources. This training program on the application of the J2000 model in Kabul sub river basin has been organized to relevant ministries in collaboration with the Ministry of Energy and Water (MEW), ICIMOD and Jena University.

J2000 is a standard hydrological model within the Jena Adaptable Modelling System (JAMS). The J2000 model has been adapted to represent the important hydrological processes of the Himalayan region. JAMS provides a flexible environmental modelling framework based on component-based modelling in which the major hydrological processes can be adapted based on the data availability of the interested catchment. Within this flexible modelling framework, other environmental processes simulations

such as erosion, nutrient and crop growth modelling can be carried out. The JAMS/J2000 has a flexible modelling framework, simple graphical user interface, data analysis tool, and online/offline based calibration, sensitivity and uncertainty analysis toolbox.

■ Objective of the training workshop

The objective of this training workshop is to co-create knowledge and constitute co-learning opportunities by strengthening the capacity of the Afghan partners on water availability assessment by applying the J2000 hydrological model in the Panjshir catchment of the Kabul sub river basin. The specific objectives are:

- To get familiar with the JAMS/J2000 modelling environment
- To understand the important hydrological processes of the J2000 model
- To set up the J2000 model in one of the sub-catchment in the Kabul river basin
- To carry out analysis such as water balance, melt runoff, etc. based on the output of the model

As a follow up of the training, at least 2 participants will be selected from this training and will be given on-the-job assignment based at ICIMOD office in Kathmandu to further develop the model in Kabul sub river basin.

■ Training date

25 Oct – 4 Nov 2018

■ Expected outcome of the training workshop

The training will enable participants to understand the mountain hydrological processes and the use of the J2000 hydrological model for water balance assessment. Furthermore, participants will set up the J2000 model in Panjshir catchment of the Kabul sub river basin and will carry out the water balance related assessment.

■ Resource persons:

1. Dr. Santosh Nepal, Climate and Hydrology Group Lead, ICIMOD
2. Mr. Saurav Pradhananga, Water and Climate Modeler, ICIMOD
3. Mr. Kabi Raj Khatiwada, Hydrological modeler, Consultant, ICIMOD

2. Agenda

The training workshop is divided into two weeks, during the first week of the training workshop, the theoretical description of hydrological processes with focus on JAMS/J2000 modelling system was provided to the participants. On the second week, the dedicated exercise was done for the Panjshir catchment.

Week 1: Getting familiar with modelling concept and J2000 hydrological model

Day 1		
9:00-9:30	Registration	Ayub Khan
Opening Session Session Chair: Eng. Fazulhaq Bakhtari, Director Water Resources, Ministry of Energy and Water, Afghanistan		
9:30-10:30	<ol style="list-style-type: none"> 1. Welcome remarks by Dr. Arun Bhakta Shrestha, Regional Programme Manager-River Basins and Cryosphere, ICIMOD 2. Introduction of SWaRMA and objective of the meeting by Dr. Neera Shrestha Pradhan, Programme Coordinator - SWaRMA 3. J2000 model in the context of Afghanistan by Dr. Santosh Nepal 4. Introduction of participants and expectations Remarks by the Representative, Australian High Commission, New Delhi (TBC) 5. Remarks by the Chair, Eng. Fazulhaq Bakhtari, Director WR, MEW 	Neera/Santosh
10:30-11:00	Group Photo and tea/coffee	Ayub
Day 1		
Morning	<ul style="list-style-type: none"> • Modelling concept • Hydrological modelling system • Understanding hydrograph and mountain hydrology • Model Calibration and validation 	
12:30-1:30 pm	Lunch break	

Afternoon (3:00 pm – Tea/Coffee)	<ul style="list-style-type: none"> • Getting familiar with J2000 hydrological model • Installation of the model • Getting familiar with the Dudh Koshi model • Running the model and understanding visualization of results • Understanding model input datasets and parameters 	
Day 2	•	
Morning (10:30 am – Tea/Coffee)	<ul style="list-style-type: none"> • Modules within the J2000 hydrological model • Evapotranspiration • Regionalization of input data • Precipitation correction 	
12:30-1:30 pm	Lunch break	
Afternoon (3:00 pm – Tea/Coffee)	<ul style="list-style-type: none"> • Understanding model input datasets and parameters • Connection between components and understanding model xml file • <u>Exercise:</u> Understand the influence of different meteorological variables in evapotranspiration • <u>Exercise:</u> Apply the precipitation correction factor 	
Day 3		
Morning (10:30 am – Tea/Coffee)	<ul style="list-style-type: none"> • Interception Module • Snow Module • Glacier Module • Presentation from Afghanistan: Previous hydrological modelling application • Presentation from Afghanistan: Challenges of modelling in Kabul river basin 	
12:30-1:30 pm	Lunch break	

Afternoon (3:00 pm – Tea/Coffee)	<ul style="list-style-type: none"> • <u>Exercise:</u> Understand the influence of different parameters in the hydrograph • <u>Exercise:</u> Change the parameter (eg. LAI, temp) to see the influence in hydrograph • <u>Exercise:</u> quantify the role of snow and glacier melt in streamflow 	
Day 4		
Morning (10:30 am – Tea/Coffee)	<ul style="list-style-type: none"> • Soil water Module • Ground water Module • Routing 	
12:30-1:30 pm	Lunch break	
Afternoon (3:00 pm – Tea/Coffee)	<ul style="list-style-type: none"> • <u>Exercise:</u> Understand the influence of different parameters in the hydrograph • <u>Exercise:</u> Role soil (by changing the soil parameter) in the hydrograph 	
Day 5		
Morning (10:30 am – Tea/Coffee)	<ul style="list-style-type: none"> • Calibration and validation and efficiency criteria • Introducing OPTAS: a sensitivity and uncertainty analysis tool 	
12:30-1:30 pm	Lunch break	
Afternoon (3:00 pm – Tea/Coffee)	<ul style="list-style-type: none"> • <u>Exercise:</u> Assess the sensitivity of parameters (RSA) • <u>Exercise:</u> Carry out uncertainty analysis (GLUE) 	

Week 2: Setting up the J2000 model in Panjshir catchment

Day 1		
10:30 am – Tea/Coffee 12:30-1:30 pm –Lunch break:3:00 pm – Tea/Coffee	<ul style="list-style-type: none"> • Description of the Panjshir catchment • Panjshir catchment: model input data (DEM, soil, land cover, and geology) • Creating Input dataset • How to derive parameter files (soil and land cover) 	

Day 2		
10:30 am – Tea/Coffee 12:30-1:30 pm – Lunch break 3:00 pm	<ul style="list-style-type: none"> • Introducing HRU concepts • Delineating HRUs • Interpreting HRUs and link with model parameters • Setting up the J2000 model in a new catchment 	
Day 3		
10:30 am – Tea/Coffee 12:30-1:30 pm –Lunch break 3:00 pm – Tea/Coffee	<ul style="list-style-type: none"> • Optimizing model parameters (example: only with few parameters) • <u>Exercise:</u> How the different parameter influence the different parts of the hydrograph • <u>Exercise:</u> Create spatial variability of precipitation, temperature and runoff components 	
Day 4		
10:30 am – Tea/Coffee 12:30-1:30 pm –Lunch break 3:00 pm – Tea/Coffee	<ul style="list-style-type: none"> • Using OPTAS tool for sensitivity and uncertainty analysis • <u>Exercise:</u> Identify most sensitive parameters • <u>Exercise:</u> Understand the parameter uncertainty 	
Day 5		
10:30 am – Tea/Coffee 12:30-1:30 pm – Lunch break 3:00 pm – Tea/Coffee	<ul style="list-style-type: none"> • Water balance assessment • <u>Exercise:</u> How the different parameter influence the different parts of the hydrograph • <u>Exercise:</u> Quantify the different runoff components, snow and glacier melt, Evapotranspiration • Closing, certificate distribution, and Evaluation 	

3. Inauguration activities

4. Opening session

The opening of the training workshop took place on 25th November. Following are the key remarks presented by the dignitaries.



Dr. Arun B Shrestha, Regional Programme Manager of River basins and cryosphere, ICIMOD shared that ICIMOD is dedicated to working in Afghanistan through SWARMA initiative and a better understanding of river basins and how they might change in the context of global climate change is very important information. He hoped that this training of hydrological modelling will provide the necessary knowledge and skills to participants in that direction.



Dr Neera Shrestha Pradhan, Programme Coordinator, of River Basins and Cryosphere, ICIMOD briefed about the SWARMA project, its objectives, thematic area, and working strategies. She highlighted the project, that aims in co-creating the knowledge and works together for the co-learning through the capacity building at the individual and institutional level.



Dr.Santosh Nepal, Group Lead, Climate and Hydrology, ICIMOD, shared about the spatial and temporal water availability and management challenges of the Himalayan region. He fronted that these type of training workshop is appropriate to address the key issue of the region and will facilitate to enhance the capacity of young hydrologist in understanding the Kabul river basin.He added that this type of training workshop enhances the understanding of the hydrological process for better water resource management and decision

making by the policymakers.



Mr. Fazullhaq Bakhtari, Director Water Resources Department, shared that understanding of water resources of Afghanistan's river basin is of high priority and such training would help to understand better about the river systems which can be very useful for water resources planning of the region.

Name of the participants

There were 15 participants from different organizations from Afghanistan for the training. The name and designation of the participants are as follow:

No	Name of Participants	Position	Organization	Department	Gender
1	Abdul Ahad Kohdamani	Head of Risk Assessment	ANDMA	Mitigation and DRR	Male
2	Ahmad Tamim Kabiry	Forestry Expert	NEPA	Head of IT Department	Male
3	Ali Madad Puyanda		MAIL	NRM	Male
4	Aziz Rahman Tahir		MAIL	NRM	Male
5	Farangis Rassouly	Hydrology engineer	MEW	Water Resources Department	Female
6	Fayezurahaman Azizi	Hydrology & Flood Specialist	MEW	Water Resources Department	Male
7	Fazlullah Durani	Hydrologist	MEW	Water Resources Department	Male
8	Khwaja Tamim Haqdad		MEW		Male

9	Milad Dildar	Hydrology engineer	MEW	Water Resources Department	Male
10	Mohammad Tayib Bromand	Water Resources and Climate Change Adaptation Specialist	MEW	Water Resources Department	Male
11	Najebullah Jamal	Hydrologist	MEW	Water Resources Department	Male
12	Rohullah Malikzooi	Lecturer/ Faculty Member	Kabul Polytechnic University	Faculty of Environmental & Water Resources	Male
13	Sadia Bariz	Hydrogeologist	MEW	Water Resources Department	Female
14	Sediqullah Reshteen	Asst. Professor	Kabul University	Geoscience Faculty	Male
15	Waheddullah Salehi	MAIL, Irrigation Dep	MAIL	Irrigation Dep	Male

Expectations from the participants

The expectations from the participants were as follow:

- To be familiar and learn J2000 hydrological model
- Expect that the model is better in capturing the hydrological dynamics of Afghanistan
- Hopeful that J2000 will be suitable for understanding water availability analysis in Afghanistan
- Hopeful that the training will be worthy for our capability building
- J2000 is good in snow melting and therefore hopeful that it will be helpful in Kabul River.
- Will help in transboundary issue and in Indus basin water management.

- Optimistic that this workshop will facilitate in developing integrated water resource management model for Panjshir and Kabul river
- Learning more and transforming knowledge to the students

5. Training program:

During the first week of the training workshop, the theoretical description of hydrological processes with a focus on JAMS/J2000 modelling system was provided to the participants while on the second week, the participants were able to set up the J2000 hydrological model in the Panjshir catchment and carry out hydrological assessments.

Week 1

During the first week of the training workshop, the theoretical description of hydrological processes with a focus on JAMS/J2000 modelling system was provided to the participants. On the first day, the participants were made familiar with the mountain hydrology, hydrographs, and modelling concepts. On the same day after the break, the trainers introduced the J2000 hydrological model, input datasets, parameters, and output variables, and visualization in the model was discussed. On this day, the participants learned to create the new plot with variables of their interest using this hydrological model.

The modules within the J2000 hydrological model were discussed during the second day. There were dedicated presentations and exercises to understand the different components and model files. The participants were able to understand the influence of different meteorological variables in evapotranspiration. Likewise, on the third day, the interception, snow and glacial module were discussed and the exercises related to this module was done. Similarly, on the fourth day the soil water, groundwater module and routing were discussed and the exercises were focused to understand the influence of different parameters in the hydrograph. Furthermore, on the fifth day, the calibration, validation and efficiency criteria were discussed.

The participants also became familiar with the OPTAS as a tool, for the sensitivity and uncertainty analysis. They were able to change the different parameters of the model and observe the difference in the visual graphs, efficiency, and monthly analysis plots. In overall during these first five days of the first week, the participants were able to get familiar with the JAMS/J2000 hydrological modelling system and perform different exercises to understand the hydrology of the Himalayan basin.

Week 2

The second week the participants were able to set up J2000 hydrological model and perform the exercises related to the Panjshir catchment of Kabul sub river basin. The initial assessment shows that the basin is largely dominated by the snowmelt processes.

To set up the model in the Panjshir catchment, initially, the participants prepared the input datasets. On the sixth day, participants were able to perceive how to derive the model input parameter files as (DEM, soil, land cover, and geology), also prepared hydrometeorological input datasets in the required format. On the seventh day, the concept of the HRU was introduced and the participants were able to delineate the HRU in the Panjshir catchment.

Once, the participants were able to set up the model in the Panjshir catchment using their own input data, the model was calibrated, firstly by hit and trial, by understanding the significance of different parameters on the eighth day. While on the ninth day the OPTAS tool was used for 2000 simulations and for the sensitivity and uncertainty analysis. The model was run for 2000 times in the server of JENA University. The participants were able to identify most sensitive parameters of their basin and understand the uncertainty in the Panjshir catchment. The model parameters were fixed by group discussion and the different water balance assessment was done on the tenth day.

During the last day, there was the closing ceremony, certificate distribution and evaluation/feedback from the different participants were also taken.

Initial findings/graphs from the training workshop

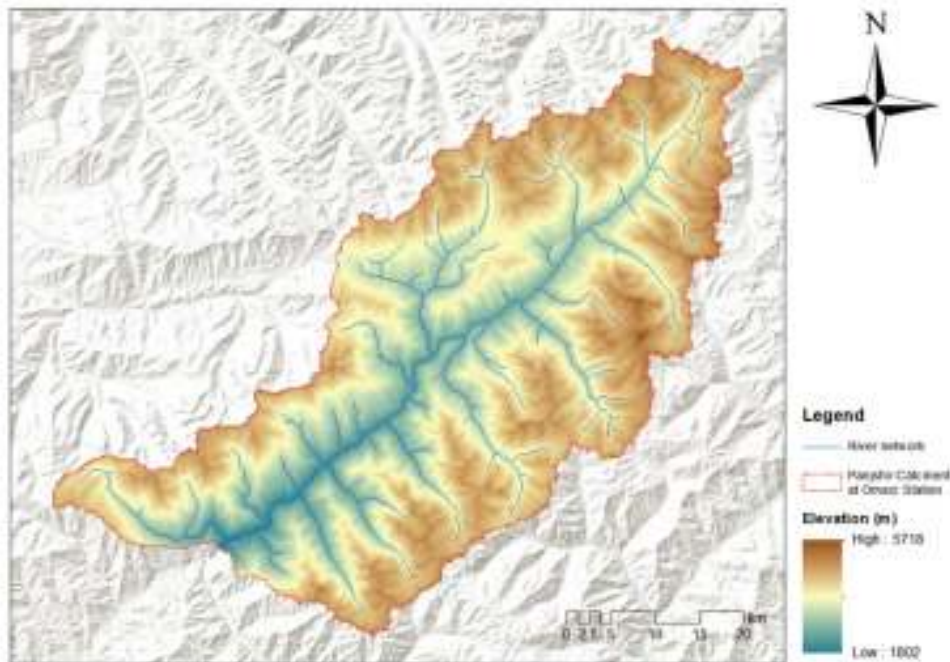


Figure 1: Study area, the Panjshir catchment of Kabul sub river basin

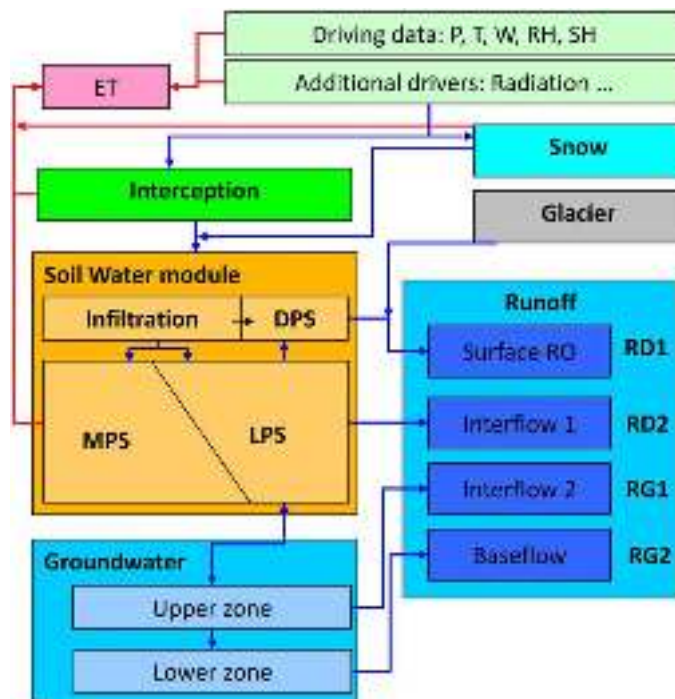


Figure 2: Principal layout of the J2000 model concept.

MPS: middle pore storage; LPS: large pore storage; DPS: depression storage; ET: Evapotranspiration. Source: adapted from (Krause, 2001)

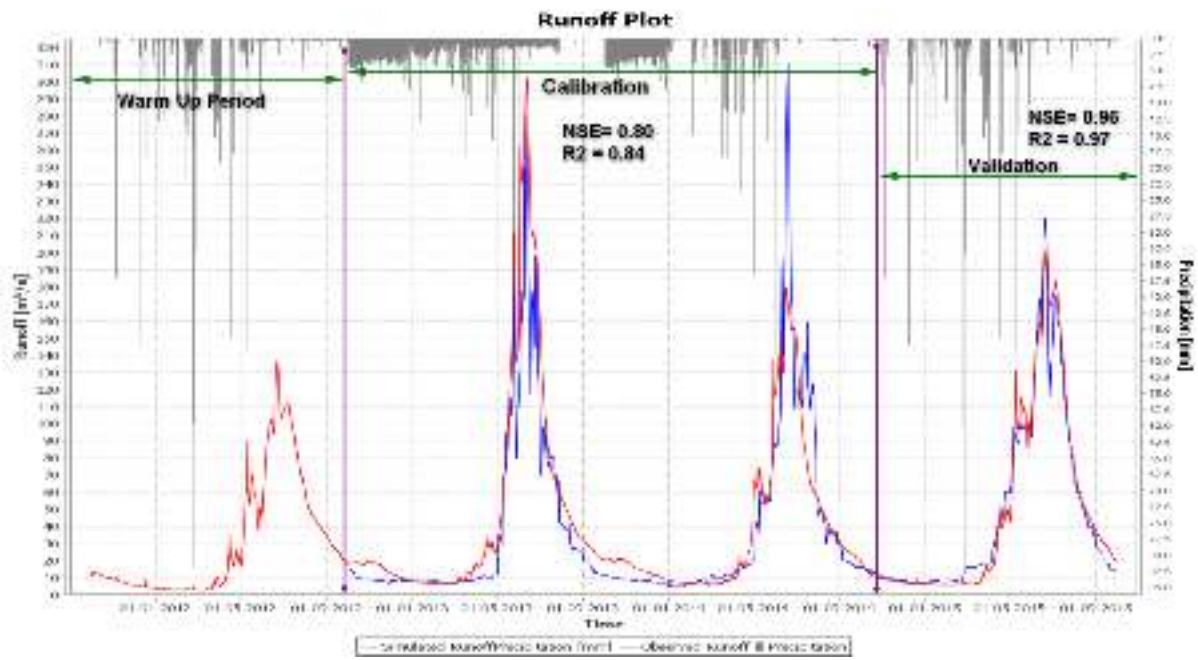


Figure 3: Calibration and validation of the model in the basin

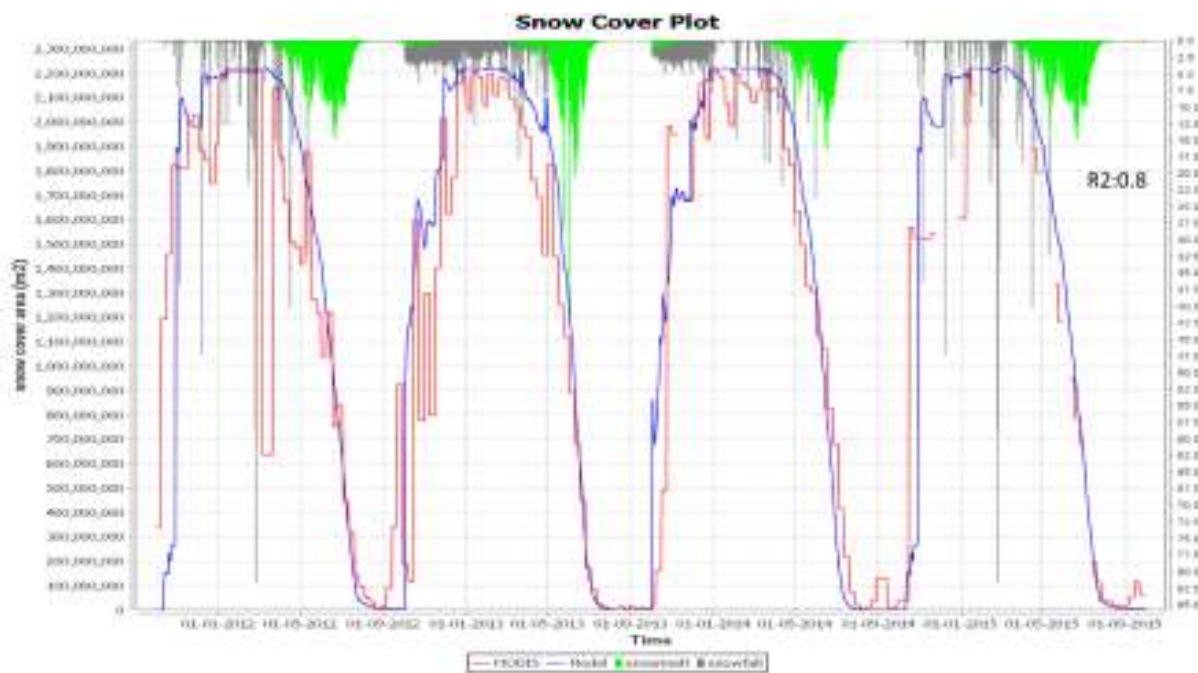


Figure 4: Validation of the MODIS snow cover area with the modelled data

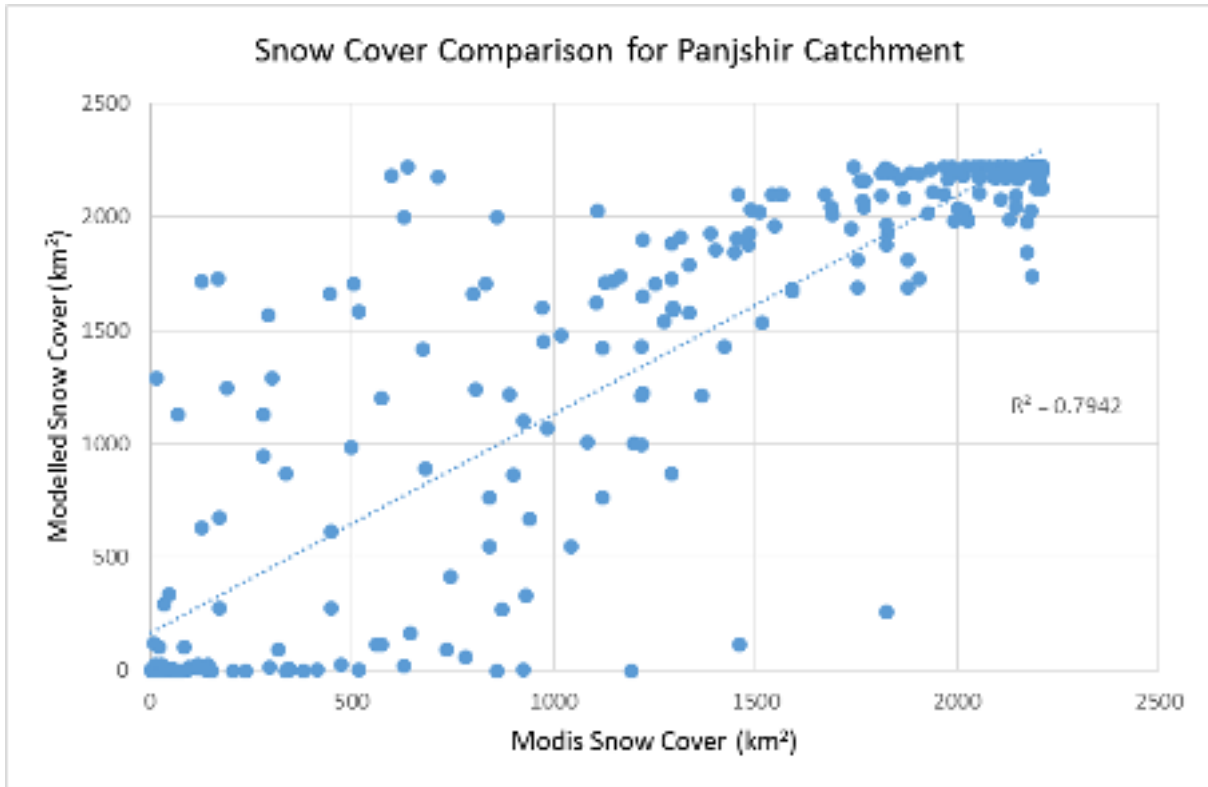


Figure 5: Snow cover comparison for the Panjshir catchment

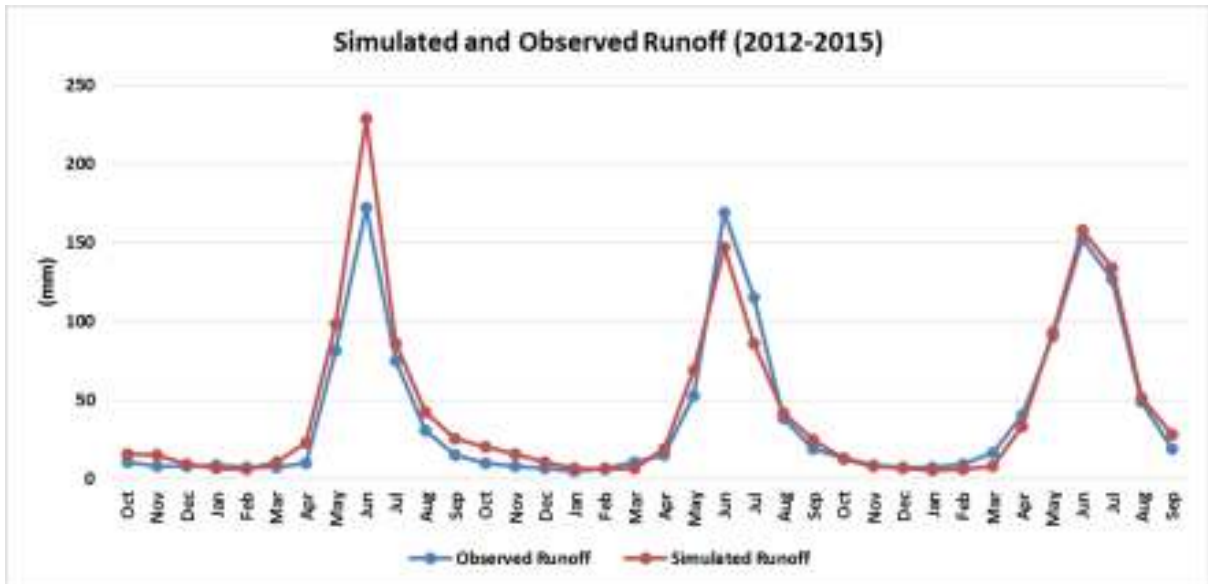


Figure 6: Observed and simulated runoff the Panjshir catchment

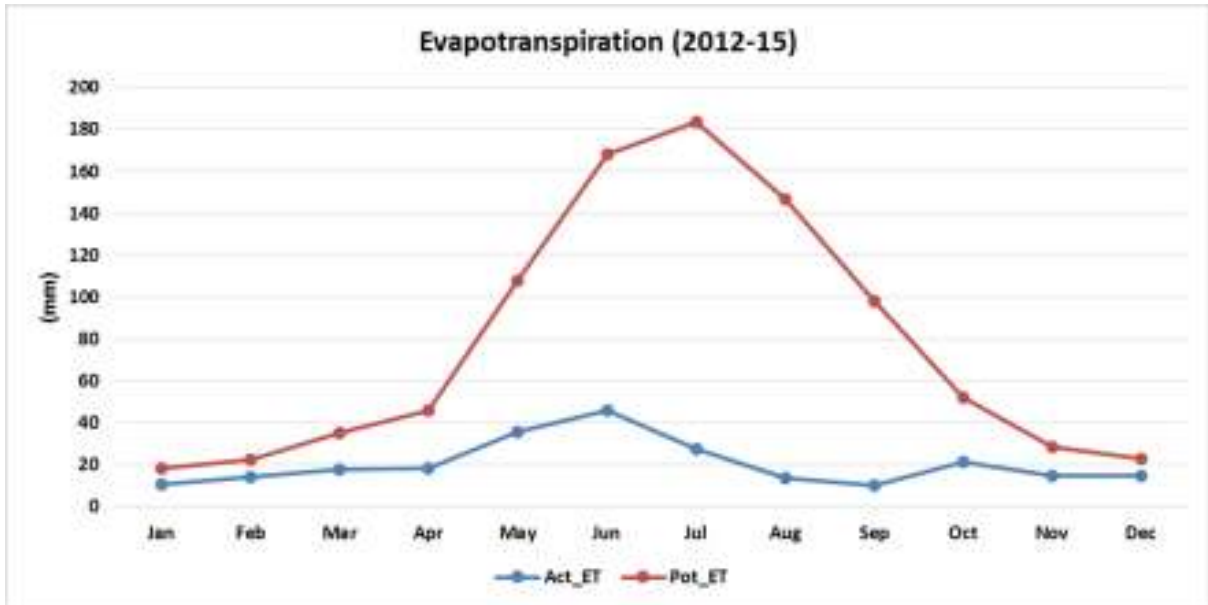


Figure 7: Evapotranspiration of the Panjshir catchment

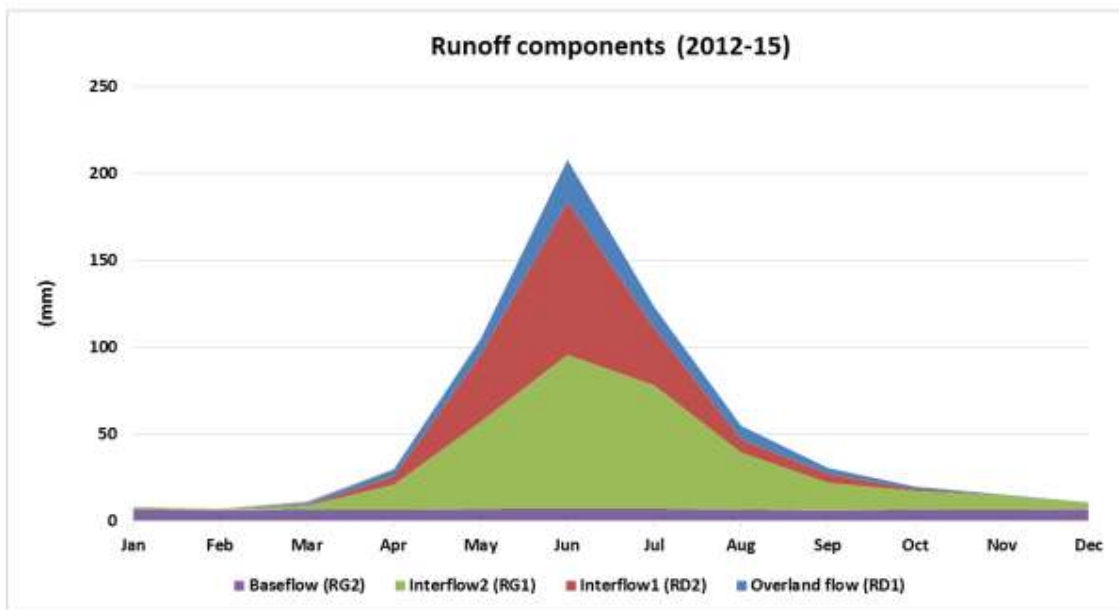


Figure 8: Runoff components in the Panjshir catchment

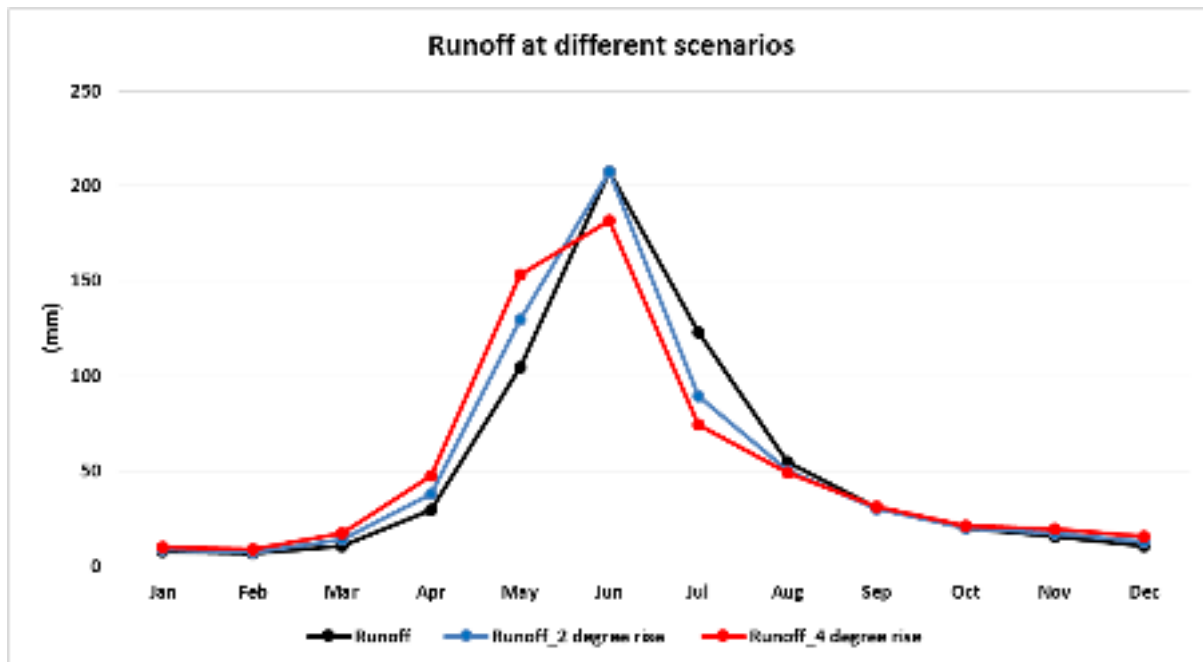


Figure 9: Runoff scenario at 2 and 4 degree rise of temperature in the Panjshir catchment

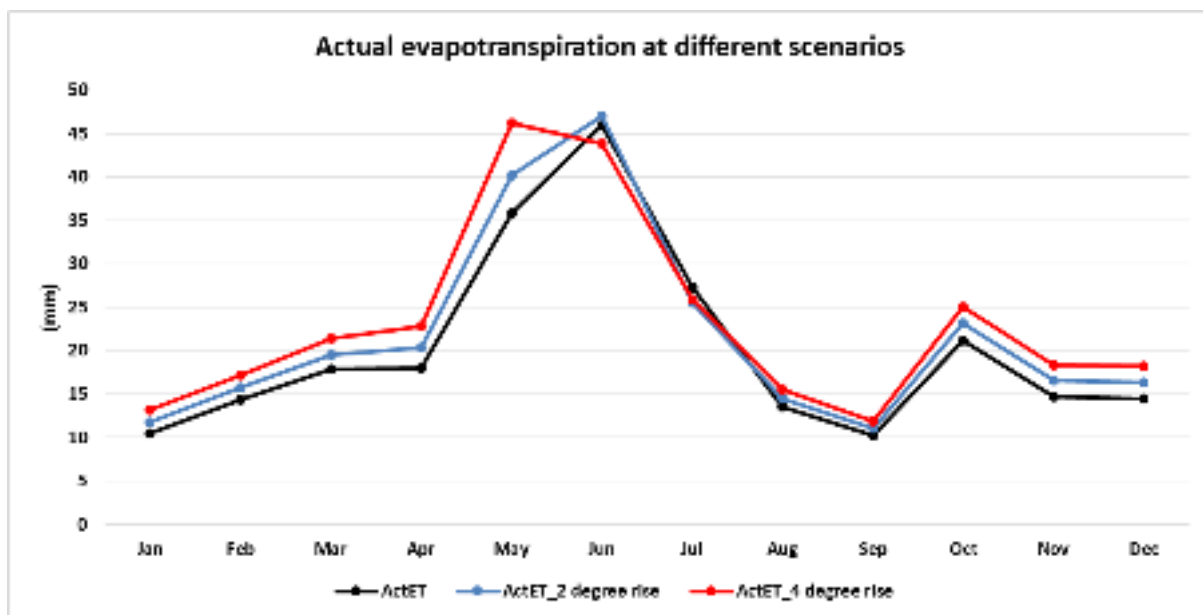


Figure 10: Actual evapotranspiration of Panjshir catchment after 2 and 4-degree rise of temperature scenario

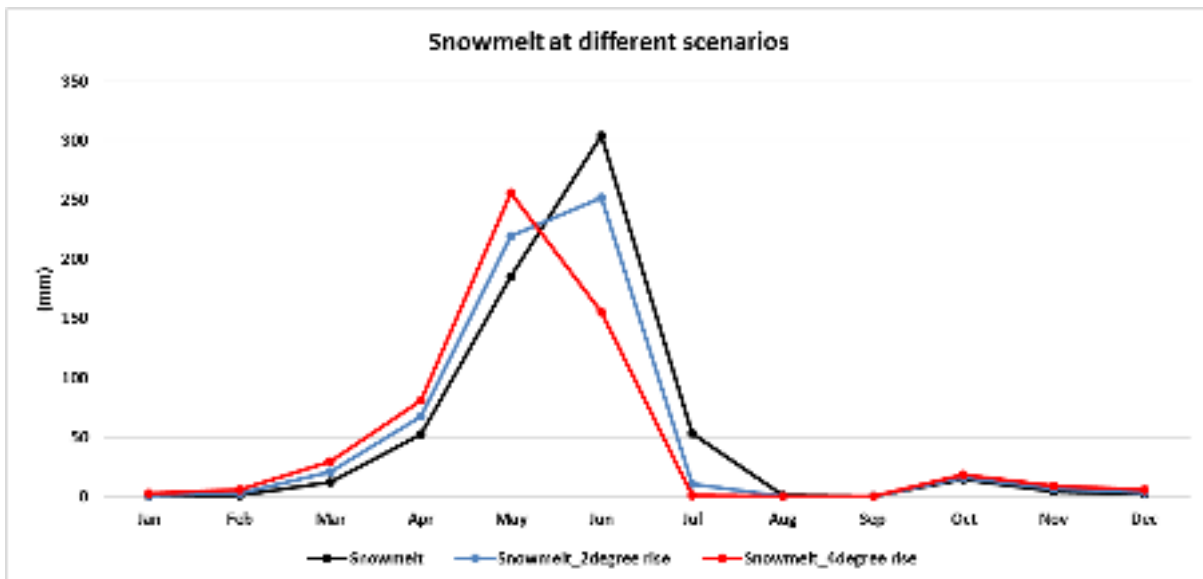


Figure 11: Snowmelt of Panjshir catchment with 2 and 4-degree rise in temperature scenario

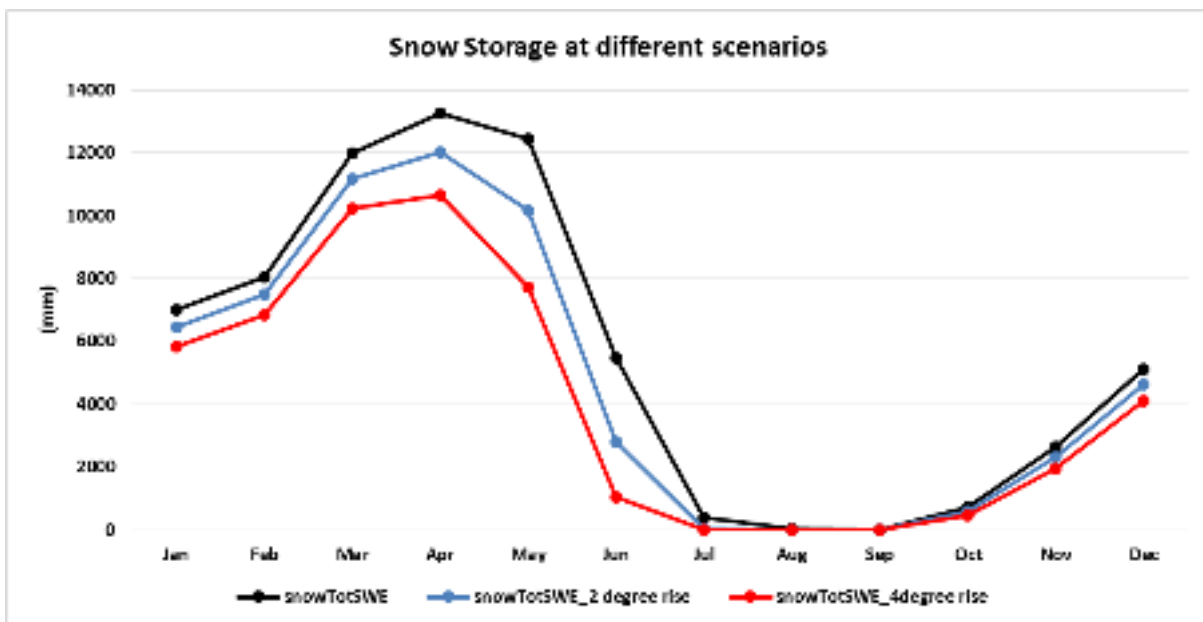


Figure 12: Snow storage in the Panjshir catchment with 2 and 4 degree rise in temperature scenario

6. Key remarks at the closing ceremony

The training workshop was appreciated by the participants. After the successful completion of the training workshop, during the closing ceremony, Mr. Tayib

Mahammad Bromand, from MEW shared his experience by appreciating this platform to learn on different aspects of hydrological modelling and setting up the model in the Panjshir catchment. Likewise, Mr. Ahmad Tamim Kabiry, one of the participants representing the NEPA said, “the trainers taught this complex topic in such an elegant way that it is understandable to the participants who were not from the hydrology background”. He thanked the entire team for the hard work. Mr. Rohullah Malikzooi from the Polytechnic University shared that this particular tool is very useful for students to learn hydrological aspects of Afghanistan’s river basin and he will try to share his knowledge and experiences of J2000 to students and faculty in his university.

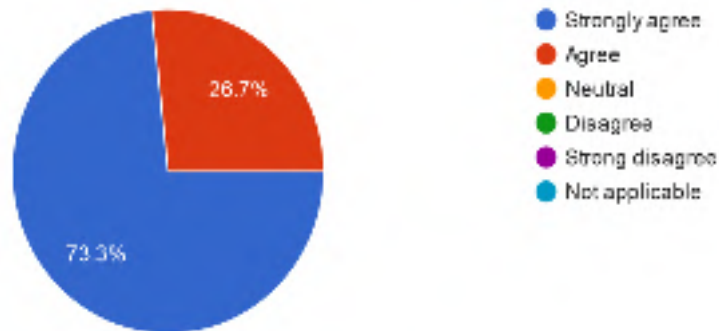
7. Evaluation of the workshop

The participants were provided an evaluation form after the training workshop and following is the result from the evaluation form



I will use the knowledge of this training to my future activities

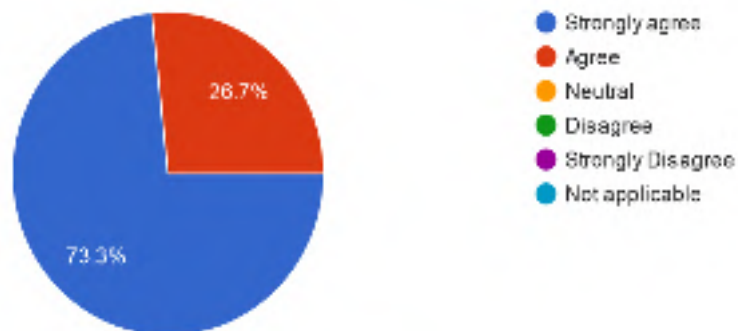
15 responses



About the training

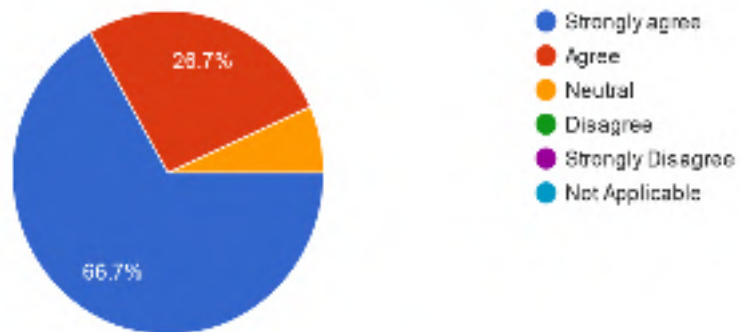
I found the trainers supportive and helpful in enhancing my skill in hydrological modelling

15 responses



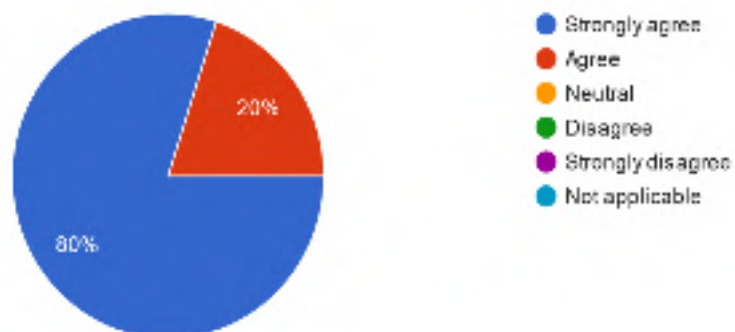
The trainers were competent for the technical supervision of the participants

15 responses



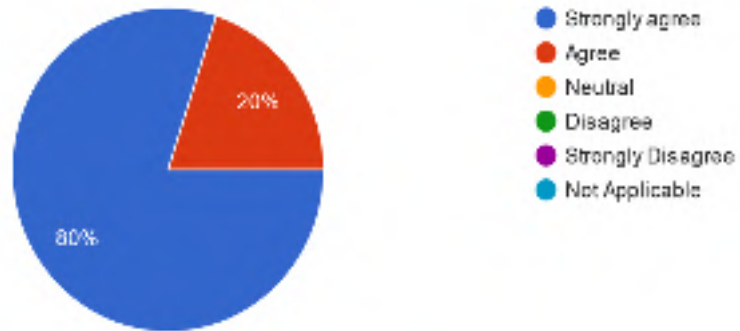
The trainers were enthusiast and keen to assist the participants

15 responses



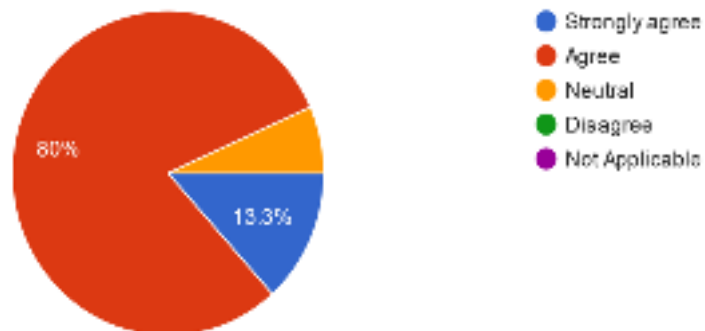
The theoretical explanations given by the trainers were easily understandable

15 responses



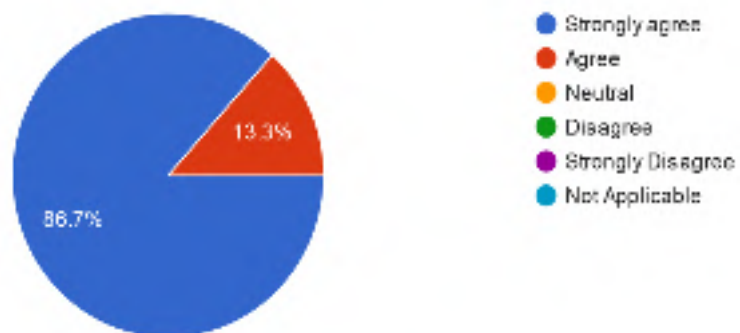
The pace of the training sessions were as per my expectations

15 responses



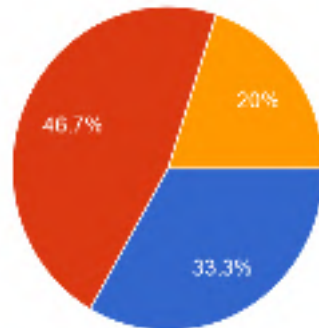
The trainers welcomed questions and responded to them appropriately

15 responses



Enough training materials were provided

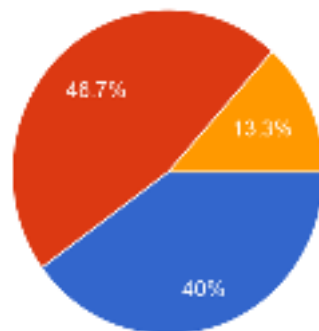
15 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not Applicable

I have found the training manual and exercises useful

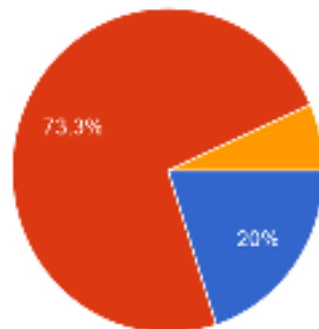
15 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not Applicable

I have read the training materials and it was understandable

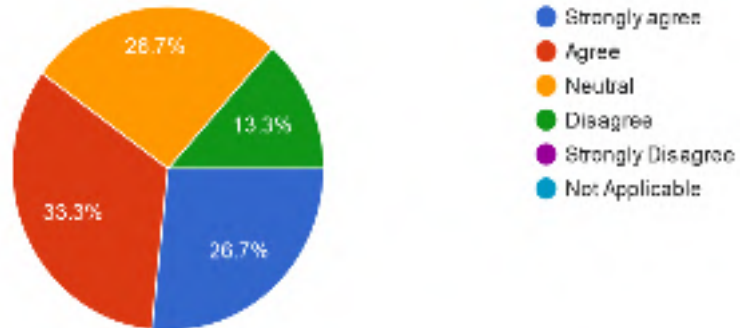
15 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not Applicable

There were enough time for training exercise and discussions

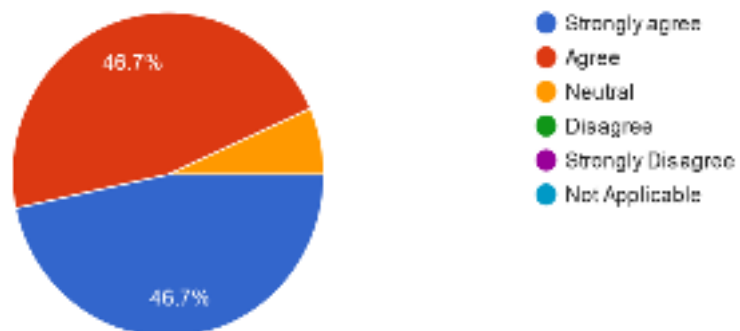
15 responses



About the training venue and logistics:

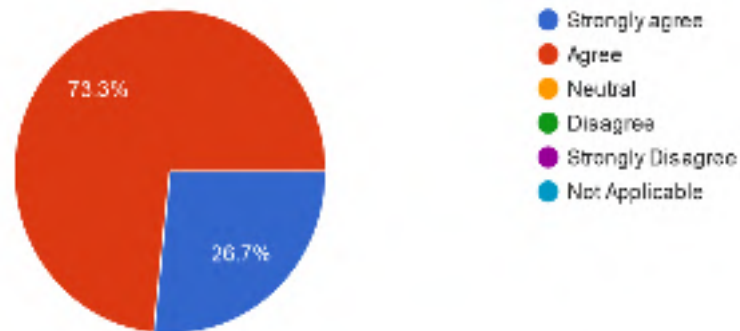
The training location was centrally located and easily accessible

15 responses



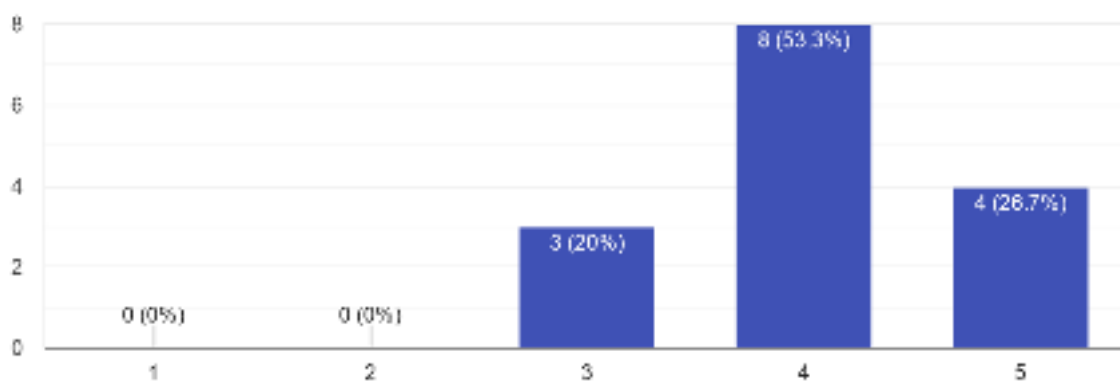
The food of the venue was fresh and healthy

15 responses



Overall Evaluation of the training workshop

15 responses



Overall remarks of the training workshop

What did you like most? (optional)

(14 responses)

- ❖ The presentation content and the theoretical parts were very well organized and delivered excellently.
- ❖ Exercise on hydrology modelling

- ❖ Actually the all part of the training was useful and the good thing we have learned the new model by very good trainer Dr. Santosh Nepal, I really appreciate his method of finding the best way for the solution
- ❖ J2000 modeling is a very good model for hydrology issue
- ❖ The detailed step by step practice on the model and group works.
- ❖ Assessment of the surface water availability and evaluation of the snow and glacier melting in the contribution of the river discharge was the most important and I have liked it most.
- ❖ The application was introduced very well and we got very good knowledge about the topic. As per my sense, the exercises were best but doing the same thing two or three times was a little bit boring but in overall it was very well.
- ❖ Besides J2000, I liked most is the use of web tool and web tutorials for further improvement and running the model. So, I found this training as one of my best training in recent years. I have learned some spacial plus use full analysis and get proper knowledge.
- ❖ This was a very useful workshop and I learned a lot about modelling.
- ❖ The trainer was very cooperative and they provided good enough material for the workshop.
- ❖ I liked most of the presentations because it improved my knowledge and practice in excel was very interesting for me.
- ❖ The concept / theoretical explanations by instructors.on hydrological dynamics based on modeling was motivating for me
- ❖ I would like to be part of another program related to this model.
- ❖ I like most presentations that improve my knowledge and exercise in excel was very interesting for me.

1. What can be improved and done differently? (optional)

(13 responses)

- ❖ The training was good but the training time wasn't enough
- ❖ The time for this model was okay, but to really understand all parts and parameters deeply its require more time.
- ❖ This kind of training for learning a model need more time because that is a very important model, especially for hydrologist and MEW.
- ❖ I want to recommend this training to have more time so that we can practice more and hope it will continue in the future.
- ❖ Dataset package

- ❖ The time of the training should be of more days with details description of the model.
- ❖ I think in the future the contribution of underground and flood inundation assessment is needed more.
- ❖ The exercises part is well, and to improve the contents and allocate sufficient time for each exercise, it is also good to have an evaluation from the participants, to maximize the training objectives.
- ❖ For the beginning of such hydrological model what we did was fine, but for further improvement, we or another group should run a model more extensively and face some more challenges during the course.
- ❖ I think it is better to share the material at least one week before any workshop so the student can get a fair idea about the relevant workshop.
- ❖ In the next workshops, I expect that the manuals and other training materials should be available for trainees before the starting of the workshops.
- ❖ Actually, the program was useful and hope the trainers and participants are in contact with each other for future questions, if any.

8. Photographs

Opening session



Photo: Participants of the training workshop on the hydrological modelling using JAMS/J2000



Photo: Dr. Neera Shrestha Pradhan sharing the information about the training workshop with the participants



Photo: Some of the participants during the training workshop



Photo: Dr. Arun Bhakta Shrestha sharing his remarks during the training workshop



Photo: Fazulhaq Bakhtari sharing his key remarks on the training workshop

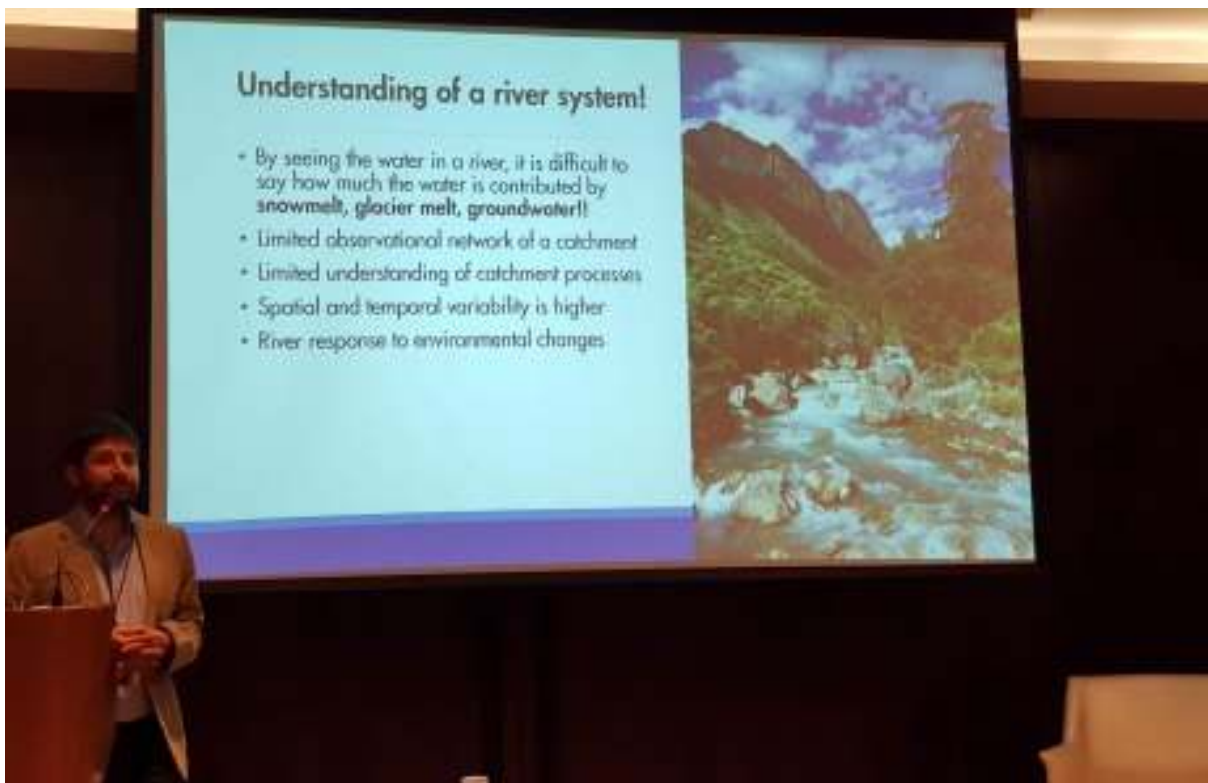


Photo: Dr. Santosh Nepal sharing his keynotes on training workshop



Photo: Listening to the feedback session after the completion of the training workshop



Photo: Group photo after the completion of the training workshop

Certificate distribution







Thank you ☺