



Report of the
International Training Programme on
**IWRM, WATER SECURITY AND CLIMATE CHANGE
FOR DEVELOPING ECONOMIES**

(Participating countries: Bangladesh, Bhutan, India, Nepal, Maldives, Sri Lanka)



15-16 November 2018

**National Institute of Hydrology (NIH)
Roorkee, India**



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Background

Water is widely regarded as the world's most essential natural resource yet freshwater systems are directly threatened by human activities and stand to be further impacted by the climate change. During the last few decades, the combined effect of climate change and over exploitation of water sources is violating the water cycle, degrading aquifers and depleting ground water resources. Although, climate change could lead to gains in yields and cultivated area for some crops and in some regions, the overall impacts on agricultural production are projected to be highly negative, with increasing food prices intensifying the risk of hunger.

Unlike in East and Southeast Asia, economic growth has not been matched by significant improvements in social indicators in South Asia. The region faces some of the greatest population pressure on the land in the world. Risk and uncertainty are increasing in the region due to climate change, greater frequency of extreme events, warmer temperatures, and increased incidence of temperature-influenced diseases.

Climate change impacts that South Asia will probably face are:

- More erratic and variable rainfall- arriving earlier or later and lasting for shorter, more intense periods of time,
- Longer drought periods under a changing climate,
- Increasing temperatures will hasten the rate of melt of the Himalayan glaciers, upon which major rivers of the region depend, and
- Changes in precipitation patterns shift growing seasons and increase the likelihood of crop failure in the short run and production declines in the long run.

Thus, nowhere are sound land and water resources management needed more urgently than in South Asia. The region requires a new and integrated framework to deal with climate change impacts on water security issues. It is the high time to prepare an appropriate agenda, which is abide by whole of the region in mitigating the impacts of changing climate.

Objectives

Against this backdrop, Indian National Committee for International Hydrological Programme (INC-IHP) in cooperation with National Institute of Hydrology, Roorkee (India) and UNESCO New Delhi cluster office planned to organize a 02-day training course in November, 2018 at New Delhi, India. The course provided policy-makers and professionals with comprehensive background knowledge relevant to the increasingly important policy challenge of 'water security and climate change'. The purpose of this training was:



- To imbibe the state-of-the-art knowledge among the participants on climate change impacts on water security related issues,
- To train the participants to develop a framework for water security assessment at different scales,
- To train the participants with ‘out-of-the box’ thinking about tackling water security, and
- To identify means of effective dissemination of knowledge on water security.

Sessions of the training programme

The training programme was designed to focus IWRM, Climate change and water security in broader manner, accordingly following six sessions were covered during 2-days training programme:

1. SDGs, Water Security and Climate Change
2. Water Security Essentials
3. IWRM for Water Security
4. Water Security Index Assessment
5. Education and Skill Building
6. Socio-cultural-economic Aspects

The detailed schedule of the training programme is given at **Annexure-I**.

Invited speakers of the training programme

S.N.	Name of speaker	Designation
1.	Dr. Neha Midha	National Professional Officer, Natural Sciences, UNESCO New Delhi Cluster Office
2.	Dr. A.K. Sikka	International Water Management Institute Representative-India
3.	Dr. Anik Bhaduri	Executive Director, Sustainable Water Future Programme, Australia
4.	Dr. T.P. Sabin	Scientist- D, Indian Institute of Tropical Meteorology, Pune
5.	Dr. Devesh Sharma	Assistant Professor, Central University of Rajasthan
6.	Dr. J. Adinarayana	Professor & Head, Centre of Studies in Resources Engineering, IIT Bombay
7.	Dr. Sudhindra Mohan Sharma	Ex- National Nodal Officer, Ministry of Drinking Water & Sanitation, Govt of India
8.	Dr. S.K. Bartarya	Ex- Scientist- G, Wadia Institute of Himalayan Geology, Dehradun



9.	Dr. M. Dinesh Kumar	Executive Director, Institute for Resource Analysis and Policy, Hyderabad
10.	Dr. V. C. Goyal	Scientist G, National Institute of Hydrology (NIH), Roorkee
11.	Dr. Jyoti P. Patil	Scientist- C, NIH, Roorkee
12.	Mr. Subrato Paul	Technical Adviser, UNDP State Project Management Unit, Uttarakhand
13.	Dr. A.B. Gupta	Professor, Dept. of Civil Engineering, Malviya National Institute of Technology, Jaipur
14.	Dr. Victor Shinde	Sector Coordinator- Water and Environment, National Institute of Urban Affairs, New Delhi
15.	Dr. Sharad Kumar Jain	Director, National Institute of Hydrology, Roorkee
16.	Dr. Fawzia Tarannum	Assistant Professor, TERI School of Advanced Studies, New Delhi
17.	Dr. Shibu K. Mani	Associate Professor, Dept. of Civil Engineering, Christ University, Bengaluru
18.	Dr. Indranil De	Associate Professor, Institute of Rural Management, Anand

The brief profiles of the invited speakers is given at **Annexure-II**.

Participants of the training programme

The participants of this course were entry and mid-level water and development practitioners, policy makers and professionals in government, NGO and implementing agencies and consultants as well as researchers from South Asian countries working in the water and environment sector. The details of selected participants from Bangladesh (5), Bhutan (3), India (13), Nepal (2), Maldives (2) and SriLanka (4) is given at **Annexure-III**.

Session details of the training programme

The 2-days training course had six different sessions, which covered almost all the aspects of Hydrology. After formal inauguration of the course, Dr. Neha Midha, National Programme Officer, UNESCO New Delhi office briefed about Sustainable Development Goals (SDGs) set by UNESCO in connection with Water Security. She also familiarised the participants about International Hydrological Programme. It is the only intergovernmental programme of the



United Nation system devoted to water research, water resources management, and education and capacity building. Founded in 1975 and implemented in six-year programmatic time intervals or phases, it entered into its eighth phase during the period 2014-2021 and having six themes with different focal areas.

The next talk was delivered by Dr. Sharad Kumar Jain on the topic “Water and Food Security”. In the beginning, he explained water and food security giving various definitions. There are four pillars of food security, which include- availability, access, stability, and utilization. Water plays a significant role in achieving food security because it is essential for viability of all ecosystems of the world including agriculture. However, adverse impacts of climate change will impose new constraints and problems. Further, he discussed the major causes of water scarcity like- population rise, higher food and energy requirements leading to higher water requirements and economic development (changing habits/diets), which attributes almost 80%.

Lastly, he concluded that feeding the ever-growing population and reducing hunger would only be possible, if the agricultural yields increased significantly- and sustainably. It is high time to make the shift from increasing agricultural productivity per unit of land to per unit of water.

Session 1: SDGs, Water Security and Climate Change

The first lecture of this session was delivered by Dr. A.K. Sikka on the topic “Integrated Water Management Solutions for Adaptation to Climate Change, Addressing Water Security and SDGs”. In the first slide, he showed a list of top 5 global risks in terms of their impacts and water crisis is one amongst them. He also discussed that how climate change is affecting the overall agricultural production with special reference to South Asia. Due to multiple stresses and low adaptive capacity, this region is more vulnerable to extreme climatic phenomena like drought, flood, hails, cyclones and related water and food shortages. Further, he emphasized that by way of land management, improved plantation methods and making check dams/bandharas, farm ponds and de-siltation of traditional water bodies, the impact of these events can be minimized. The use of



ICT-based technologies integrating weather, water and crop related information may be very fruitful to the farmers.

Finally, Dr. Sikka closed by discussing the role of Integrated Water Management (IWM) in addressing the water security and achieving the SDGs. There must be a convergence of programmes and policies across water, energy and food sectors. Retrofitting of canals with pressurized irrigation systems and participatory integrated watershed management for adaptation is also the need of time.

Dr. Sabin T.P. delivered the topic “Indian monsoon precipitation variability in a changing climate”. He started his lecture by introducing South Asian summer monsoon and various methods like CMIP5 projections and LMDZ approach for predicting its uncertainties. The use of high-resolution simulations has enabled us, to draw new insights about the key regional feedbacks, associated with the 20th century and likely future monsoonal changes. The findings obtained above from models highlight the collaborative influences of regional land-use change, anthropogenic-aerosol forcing and accelerated IOSST warming, which conspired to weaken the South Asian Monsoon (SAM).

In the end, he summarized his presentation by drawing some inferences like- The projected monsoonal rains tend to recover in the latter part of the 21st century, although drier conditions prevail over the subcontinent. This possibility, however, is still not clear especially in the light of the persistent IO-SST warming in the future projections and The new IITM model will be contributing towards the IPCC –AR6 assessment and the 27 km AGCM simulation will be available for climate assessment over the country.

The last lecture of this session was delivered by Dr. Devesh Sharma on the topic “Climate Change and Water Security”. First, he gave an overview about climate change with few recent catastrophic events. Afterward, he talked briefly about water security and water security assessment (WSA) with various definitions. There are also some data related issues, lack of holistic and multidisciplinary approach and proper understanding of outcomes and further



application in management while going for WSA. Dr. Sharma also showed the WSA study in the Banas river basin, is located in East-central Rajasthan, which fulfills the daily water need of Jaipur, Tonk and Ajmer. He also made aware the participants about SWAT model, which is a long-term, continuous watershed simulation model.

Lastly, he concluded that about 50% times, there are occurrences of drought in the Banas river basin (6 out of total 11 years) with more severity in the year 2009 and 2013. However, water health index of this river basin is satisfactory as dissolve oxygen level is close to permissible limit. Based on the questionnaire, both institutional and adaptation factors have crossed the condition of partial implemented. It is a good indicator as response against water insecurity.

Session 2: Water Security Essentials

Dr. J. Adinarayana delivered the first lecture of this session on the topic Disruptive Technologies for Agriculture Water Security. In the beginning, he briefly explained the basics of disruptive technologies and its use in the agriculture water security (AgWS). AgWS is a perspective of saving and conserving water for agricultural use. However, the overall problem of water security roots much deeper. To visualize AgWS in a new perspective, we need to understand the factors that constitute it. Further, he described about SenseTube, which is an IoT platform for smart agriculture and can be used in weather monitoring, precision crop water /nutrient management and precision crop pest/ disease management. It is an integrated telemetry of temperature, humidity, wind speed, wind direction, soil temperature and soil moisture over a range of 2-5 km.

In his concluding remark, he emphasized that data-driven techniques help in boosting agricultural productivity by increasing yields, reducing losses and cutting down input costs. However, these techniques have seen sparse adoption owing to high costs of manual data collection and limited connectivity solutions.



Mr. Sudhindra Mohan Sharma gave the second presentation of this session on the topic “Drinking Water Security in Groundwater Based Rural Water Supply”. He started his presentation with a story and defined what drinking water security actually is? The key elements of drinking water security are adequacy, equity, accessibility, quality, sustainability and usage. He focused mainly on rural areas and Gram-Panchayat (Village Governments) or aquifers may be the unit area for drinking water security planning and upscaling. For preparation of a water security plan, there must be coordination between different government departments. This plan needs a lot of data like administrative details, demographics, land details, drinking water supply infrastructure such as no. of sources, depth, pipelines, ESR, sump etc.

Lastly, he recommended that successful preparation and execution of sustainable drinking water security plans would require certain administrative and policy initiatives on the part of the state and central government. It also needs continuous training and capacity building of government officers on soft skills and behavioral change. Special schemes and incentives for identification and nurturing of volunteers of gram-panchayat level may also be beneficial.

Dr. S.K. Bartarya delivered on the topic “Spring Flow Management for Water Security in the Himalayan Region”. Firstly, he introduced the participants to basics of spring and its importance in achieving water security. Springs are the main source of water for people in the Himalayan region. Both rural and urban communities depend on springs for meeting their drinking, domestic and agricultural water needs. Therefore, it has slowly become a nationally pertinent problem for water security for the Himalayan population than groundwater. Further, he talked about various geological structures that gave rise to springs. However, in recent times, it is also affected by climate change or anthropogenic activities. It is reported that, half of the perennial springs have already been dried up or have become seasonal resulting into acute water shortage for drinking and other domestic purposes across hundreds of Himalayan villages.

He closed by suggesting various measures that can be taken to conserve this natural water body. It may involve spring vulnerability assessment, efficient management, and mitigation



strategies. Proper identification of the recharge areas is critical for the protection and implementation of springshed development strategies. The springshed development program can involve multiple stakeholders from different sectors, including scientists, policymakers and real beneficiaries.

Mr. Subrato Paul delivered “Integrated Climate Resilient Practices for Springshed restoration in Kalsi Block, Uttarakhand”. In the beginning, he discussed about impacts of water crisis with special reference to the Himalayan region. There is a continuous decrease in river base flow. Women and girl of this area have to walk kilometers for potable water as springs across the Himalayas reportedly facing reduction in water availability. Further, he showed a case study of Jendo, Latao, Dabra and Bado villages which falls under two watersheds namely- Seligad and Dobragad. Apart from springs, the inhabitants are also dependent on external water supply through a pipeline which taps the springs located up to 5 km southwest in watershed 2. During the lean season, discharge from the pipeline also reduces drastically and the residents rely on supplies through mules and even tankers, for fulfilling domestic needs.

Lastly, he concluded that water sector in Uttarakhand is highly vulnerable. To combat, there is a need of community capacity building. State Climate Change Centre is also playing a key role in integrating climate actions in the planning process.

Session 3: IWRM for Water Security

This session was held on the second day of the training course *i.e.* - 16.11.2018. Dr. M. Dinesh Kumar made the first presentation on the topic “Managing Water Systems in the Face of Floods and Droughts in India: Institutional Alternatives under IWRM”. At the outset, he discussed the institutional and policy regimes that govern water development and use. He also talked about how stakeholders work at cross-purposes in a basin? There is an increase in green water use by rainfed farmers in basins, which reduces the blue water flows; but this doesn’t get counted in water accounts. While irrigation benefits increase due to large storage, benefits of nutrient transport and fish production of wetlands reduces. Further, he introduced the participants



to various government departments and stakeholders involved in water resources development and water management.

Lastly, he showed a case study of Kundi sub-basin of Narmada River that how watershed interventions affect the stream flows and run-off? He concluded that Blue water use in crop production generates much higher value in economic terms than green water and there is a need of stringent water law, which defines and enforces private property rights/ 'entitlements' in surface water and groundwater, in water scarce regions.

Dr V C Goyal and Dr Jyoti P Patil delivered the lecture on topic 'IWRM Plan at watershed scale'. In the discussion, IWRM concepts and framework were presented. A case study of Ur River watershed, Tikangarh District, Bundelkhand region, India was shown to the participants. It included water balance analysis, livelihood vulnerability assessment using LVI-IPCC approach and formulation of IWRM plan. The IWRM framework in three sections viz., Water management, Crop Management and Livelihood management were presented. The pamphlet of the study was distributed among the participants.

Dr. A.B. Gupta delivered the third and last presentation of this session on the topic "Water quality aspects of IWRM leading to water security". He started with introducing water and how important it is? About 75% of Asian countries are water insecure and agriculture sector uses about 79% of this single finite resource. Further, he talked about the health issues arise due to use of contaminated drinking water. Ozone, Ultraviolet Radiations, Chlorine, Chloramines, and Chlorine Dioxide are some common disinfectants, which are frequently used. He emphasized that there is a need of recycling of sewage for reducing water demand because developing countries like India are facing severe water scarcity. The demand of growing urban communities for both food and water requires the agriculture sector not only to increase food production but also to sustain its water demand.



In the end, he concluded that pollution of drinking water can have large scale ramifications on human health and recent findings of multi drug resistance among pathogens calls for a detailed study to understand the impact of sewage irrigation on drinking water quality.

Session 4: Water Security Index Assessment

Dr. Victor Shinde gave the first presentation of this session on the topic “Framework for Water Security Assessment at City Scale”. At the start, he discussed various water-related disasters that humanity faced in recent times. Afterward, he defined what water security actually is? In his opinion, there is a need for city-scale assessments because 54% of the world’s population lives in cities. This figure is likely to increase to 66% by 2050. Cities are the smallest unit at which water security enhancement interventions takes place. Further, he showed a water security assessment framework that was developed by his team while carrying out a project on the same. In this process, there are various dimensions like water supply and sanitation, water productivity, water-related disasters, water environment, water governance etc. with its respective indicators.

Lastly, he familiarises the participants to the whole process of water security assessment, giving the example of Bangkok city in Thailand.

Subsequently, Dr. Anik Bhaduri, assisted by Dr. Jyoti P. Patil, discussed about the topic ‘Navigating the Water Challenges of the 21st century, India’ through Skype. He started his lecture with comparing visible and less visible actions in achieving water security. Some actions are much “less visible”—and far more challenging and complex. Yet, they underpin the more obvious elements of water management. In his presentation, he showed concern about the deteriorating water quality. Due to increased sewerage connections, the wastewater production shall be doubled by 2050. The problem is intensified due to excess use of fertilizers and pesticides in the crop fields. He also talked about various linkages and missing links in achieving improved human health, food security and energy access and supply.



Lastly, he emphasized on various technology driven solution to this menace. We are having more data (because of Earth Observation System) for integrated modelling than before. There is also a global commitment like SDGs, which shall go beyond water and sanitation. Increased capability in forecasting future threats is also an add-on as methodologies already exist in undertaking such synthesis.

Session 5: Education and Skill Building

Dr. Fawzia Tarannum delivered the only lecture of this session on the topic “Water Security- Role of Education”. She started with describing the importance of education. As per Agenda 21, Chapter 36 of the United Nations Conference on Environment and Development that was held in Rio de Janeiro in 1992, education, including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their fullest potential. Target 4.7 of Sustainable Development Goal (SDG) of the United Nations calls for "by 2030 all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture’s contribution to sustainable development". In her words, the water crisis is synonymous with women’s crisis or education crisis.

Lastly, she concluded that a person only be called “sustainability literate”, who understand the need for change to a sustainable way of doing things, individually and collectively and have sufficient knowledge and skills to decide and act in a way that favours sustainable development.

Session 6: Socio-cultural-economic Aspects

The first presentation of this session was delivered by Dr. Shibu K. Mani on the topic “Water Security & Socio, Cultural, behavioural correlates: What can we do?”. He began with how have water, food, energy and health security been conceptualized in the UN and in the



scientific and in the political realm and in societies (ethnic groups/nations)? In his words, water is a coordinating agent for interactions between earth system and the human system while climate change is a major concern. Water borne diseases like Diarrhea, Dysentery, Cholera, Typhoid, Hepatitis A etc. have been increasing at an alarming rate. However, we can treat contaminated water at the household level by chlorination, flocculation/disinfection, filtration, solar disinfection, and boiling. Solar photo-oxidative disinfection may prove advantageous for Indian sub-continent as it is practiced in many parts of Africa, South America, and Asia.

Lastly, he concluded that the conventional method of storing potable water in a brass/copper vessel, especially in rural households of India, has scientific evidence and is very economical. He also emphasized that the Millennium Development Goals (MDGs) or the Sustainable Development Goals (SDGs) are totally based on 4Cs concept, i.e. - coordination, communication, consultation and cooperation.

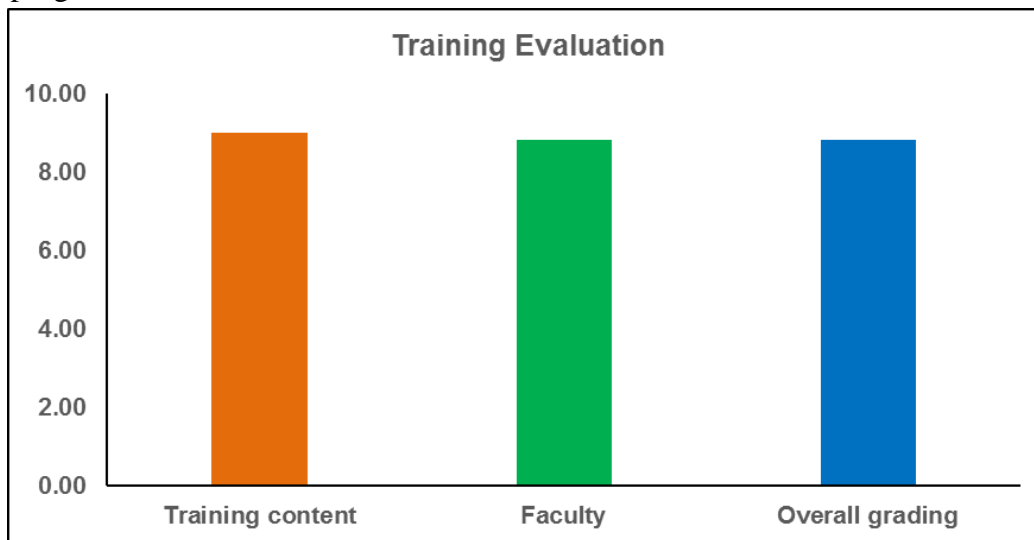
Dr. Indranil De delivered last lecture of this session as well as training course, on the topic “Why Poor Receives Poor Water Supply Services? A Political Economy Perspective”. At the outset, he gave a background that how poor people are deprived of basic services. In his opinion, access and availability of water supply are better in economically better-off wards than in wards consisting of the slum. This is mainly due to “political clientelism” and lack of credibility of politicians to provide broad public goods, as opposed to private transfers and subsidies.

Lastly, he concluded that the lower is the level of local government from which service is managed and high is the measurability of service standards; the greater is the service susceptible to clientelism. Political competition results in the lesser provision of services, which are deemed important and resource intensive.

Training evaluation and feedback from participants

The participants of the training were asked to evaluate the content of the training as well as concepts explained by the invited speakers/ faculties. The proforma used for evaluation and feedback is placed at **Annexure-IV**.

The training content was highly appreciated by the participants by giving average score of 9 out of 10, followed by faculty (8.8 out of 10) of the training programme. The overall grading of the training programme was 8.9 out of 10.



Some of the appreciated topics by the participants and useful information to take away home from training course are given in the table below (one from each country):

S. No.	Country	Name	Appreciated Topic	Useful information in current or future roles
1.	Bangladesh	Ms. Bushra Monowar Duti	Disruptive technologies for agricultural water security	Yes
2.	Bhutan	Mr. Dumber Kumar Ghemiray	Spring flow management for water security Climate change and water security linking with SDG.	Definitely – especially integrated climate change resilient practices for spring shed restoration.
3.	India	Mr. Archisman Mitra	IWRM for water security Socio-economic aspects of water security	Yes, especially the water security index frame work would be very useful.
4.	Sri Lanka	Mr. N.M. Akila Senadinatha	All lectures are most relevant.	Yes
5.	Nepal	Mr. Suresh Maskey	Spring water management, IWRM for water security.	Yes
6.	Maldives	Ali Mishal	IWRM for water security.	Yes



Training Deliverables

1. The complete course material in form of powerpoint presentations and some reference literature on the topic of water security was provided to the participants in a pen drive
2. The Certificate of Participation were issued to the participants (**Annexure-V**)



Annexure-I Training Schedule

Day 1: November 15, 2018 (Thursday)	
0900 hrs- 0930 hrs	Registration
0930 hrs-1000 hrs	Inauguration
1000 hrs-1030 hrs	SDG, Water Security & IHP-VIII, by Dr Neha Midha, UNESCO, New Delhi
1030 hrs-1115 hrs	Hydrology for water and food security, By Dr Sharad K Jain, NIH
<i>1115 hrs-1145 hrs</i>	<i>Tea & Snacks</i>
Session 1: SDGs, Water Security and Climate Change	
1145 hrs-1230 hrs	Climate change and water security: linking with SDGs, by Dr. A.K. Sikka, IWMI, New Delhi
1230 hrs-1315 hrs	Indian monsoon precipitation variability in a changing climate, by Dr. T.P. Sabin, IITM, Pune
<i>1315 hrs-1415 hrs</i>	<i>Lunch</i>
1415 hrs-1500 hrs	Climate change and water security, by Dr. Devesh Sharma, CU-Rajasthan
Session 2: Water Security Essentials	
1500 hrs-1545 hrs	Disruptive technologies for agricultural water security by Dr. J. Adinarayana, IIT, Bombay
<i>1545 hrs-1600 hrs</i>	<i>Tea & Snacks</i>
1600 hrs-1645 hrs	Drinking water security in groundwater based rural water supply, by Mr. Sudhindra M. Sharma, Indore
1645 hrs- 1745 hrs	i. Spring flow management for water security, by Dr. S. K. Bartarya ii. Springshed restoration- a case study in Uttarakhand, by Subrato Paul and Tripti Jayal, UK-CCC Dehradun



Day 2: November 16, 2018 (Friday)	
Session 3: IWRM for Water Security	
0930 hrs-1015 hrs	IWRM for water security, by Dr. M. Dinesh Kumar, IRAP, Hyderabad
1015 hrs-1100 hrs	IWRM Plan at watershed scale, by Dr V C Goyal and Dr Jyoti Patil, NIH
<i>1100 hrs-1115 hrs</i>	<i>Tea & Snacks</i>
1115 hrs-1200 hrs	Water quality aspects of IWRM leading to water security by Dr. A.B. Gupta, MNIT-Jaipur
Session 4: Water Security Index Assessment	
1200 hrs-1300 hrs	Water security index assessment by Dr. Victor Shinde, NIUA, New Delhi
1300 hrs-1345 hrs	Navigating the Water Challenges of the 21st century, India by Dr. Anik Bhaduri, SWFP and Dr. Jyoti P. Patil, NIH
<i>1345-1430</i>	<i>Lunch</i>
Session 5: Education and Skill Building	
1430 hrs-1515 hrs	Water security through education by Dr. Fawzia, TERI-SAS, New Delhi
Session 6: Socio-cultural-economic Aspects	
1515 hrs-1600 hrs	Socio-cultural aspects of water security by Dr Shibu K Mani, Christ University, Bengaluru
<i>1600 hrs-1615 hrs</i>	<i>Tea & Snacks</i>
1615 hrs-1700 hrs	Socio-economic aspects of water security by Dr. Indranil De, IRMA, Anand
1700 hrs	Feedback Session and Valedictory Function



Annexure-II Brief Profile of Trainers

Dr. Neha Midha



Dr. Neha Midha is currently working as National Professional Officer at UNESCO New Delhi Cluster Office. She has about ten years of experience in Natural Resource Management, Biodiversity Conservation, Landscape Conservation Planning, Smart Green Infrastructure, Spatial Analysis, Sustainable Development, Wildlife Corridor Conservation and Management for strategic program management and research. She worked as Sr. Coordinator for WWF-India at New Delhi for seven years; managed international and CSR funded conservation projects; coordinated with multifaceted field teams. She was the key member of the team, which was successfully granted three USFWS projects in the field of Wildlife Conservation in row for three years. She also worked at Wildlife Institute of India (WII), Dehradun for MoEFF&CC-NNRMS-WII project that utilized Spatial GIS technologies to develop comprehensive spatial database as a decision making tool for management of protected areas planning and conservation.

Dr. Sharad K Jain



Dr. Sharad K Jain is an experienced Scientist with a demonstrated history of working in R&D in water sector. He is skilled in Mathematical Modeling, Systems Analysis, Water and Environment, Numerical Simulation, and Water Governance. Dr Jain is strong research professional with a Doctor of Philosophy (PhD) focused in Water Resources Development from IIT Roorkee. He has published more than 225 technical papers, edited five books, wrote about 30 chapters, and developed a web-based course for NPTEL. Notably, he has co-authored five books published by reputed international publishers. Dr Jain is the Chairman of Expert Appraisal Committee (River Valley and Hydro projects), Ministry of Environment and Forests, and member of many technical committees. Currently, Dr Jain is the Director of Roorkee based National Institute of Hydrology.

Dr. A.K. Sikka



Dr. Alok K. Sikka is with the International Water Management Institute, Delhi Office as IWMI Representative-India since April, 2016. Prior to joining IWMI, he served as Deputy Director General (Natural Resource Management), Indian Council of Agricultural Research (ICAR) and Technical Expert (Watershed Development), National Rainfed Area Authority (NRAA), Planning Commission, Government of India, New Delhi. He was Director of ICAR Research Complex for Eastern Region, Patna and Basin Coordinator for Indo-Gangetic Basin under the CGIAR Challenge Program on Water and Food from 2002-2007. He has more than 250 publications and is recipient of many national awards including Fellow of National Academy of Agricultural Sciences.



Dr. T.P. Sabin



Dr. T. P. Sabin is currently working as Scientist D at Centre for Climate Change Research, Indian Institute of Tropical Meteorology, Pune, India. His skills and expertise includes climate dynamics, monsoon variations and Global Climate model. He is actively involved in research of Indian Institute of Tropical Meteorology Earth System Models (IITM ESM) that has been developed, for investigating long-term climate variability and change with focus on the South Asian monsoon. The IITM-ESMv2 was first climate model from India to contribute to the Coupled Model Inter-comparison Project Sixth Phase (CMIP6) for the IPCC sixth assessment report (Ar6). Dr. Sabin has published several research papers in peer reviewed international journals.

Dr. Devesh Sharma



Devesh Sharma is currently working as faculty in the Department of Environmental Science at Central University of Rajasthan, India. He has over 15 years of experience and specializes in Integrated Water Resources Management and Climate Change. He has wide experience of various sponsored research projects at national and international level including IGES (Japan); AIT (Thailand); SMHI (Sweden); APN (Japan); Thuyloi University (Vietnam); UNU (Japan). He has over 30 publications in international refereed journals, book chapters and conference proceedings. His research areas are Climate Change and Water Resources, Watershed Management, Integrated Water Resources Management, Modeling of Water Resources Systems, Geospatial Applications, water-energy-food nexus.

Dr. J. Adhinarayana



Dr. J. Adhinarayana is Professor of Centre of Studies in Resources Engineering (CSRE), Indian Institute of Technology, Bombay (IITB). Dr. J. Adhinarayana has completed his Ph.D. from Banaras Hindu University, Varanasi, India. His area of research is Agro-informatics and Rural Development. His expertise includes Geo-Spatial Technology in Rural Extension Activities; Rural-Informatics in decision-making; Remote Sensing and Geographical Information Systems in the study of soils, rural land-use planning and watershed / conservation management. Dr.

Adhinarayana is Board Member, Asian Federation for Information Technology in Agriculture, Japan (<http://www.jsai.or.jp/afita/>); and Executive Member, Indian Society of Agricultural Information Technology (<http://www.insait.org>). He has carried out several research projects on Agro-Informatics/Rural-Informatics and published research papers in international refereed journals.

Mr. Sudhindra M. Sharma



Mr. Sudhindra M. Sharma is a Geologist, specializing in Groundwater and Drinking Water and A Rotarian, A Nature Lover. He has worked with various government organizations i.e. Works as Advisor- Water Resource Management and Nodal Officer for National Drinking Water Security Pilot Projects at Ministry Of Drinking



Water and Sanitation, Govt of India, New Delhi. He was Former Assistant Governor at Rotary International and Former Nodal Officer for National Drinking Water Security Pilot Projects at Ministry of Drinking Water and Sanitation. Mr Sharma also worked as Consultant of Water Resources Management and Hydrology at Ministry of Rural Development, Govt. of India, New Delhi.

Dr. S. K. Bartarya



Dr S.K Bartarya is mountain hydrogeologists and an Ex senior scientist from Wadia Institute of Himalayan Geology Dehradun known for his contributions in the field of mountain springs and environmental geology. He has over 30 years of experience and specializes in Hydrogeological investigations of Himalayan region. A BOYSCAST Fellow (1992-93) of DST at LGGE, France, Dr Bartarya has written over 70 research papers in the field of hydrogeology, water chemistry and landslides and in international and national journals and books, prepared a hydrogeological map and edited one special volume on Doon Valley, besides more than 50 technical / consultancy reports. In a pioneering and benchmark study on hydrogeology of springs and reporting of declining of discharges of Himalayan springs in 1988 and 1991, he developed the concept of “spring sanctuary” for augmenting the spring discharges. The similar studies have been followed in subsequent years in many areas of the Himalaya. Recently, he has developed and demonstrated, utilization of geothermal energy from hot springs for space heating in Chumathang area of Ladakh region in collaboration with NGI Norway.

Mr. Subrato Paul



Mr. Subrato Paul has overall 14 years of experience, including six years in development advisory and ten years’ experience in project management and implementation of environmental, natural resources management, forestry, livelihood development, and RS/GIS application projects. He worked as Assistant Director for Social and Economic Development Group of US based engineering firm for last six years; managing entire project lifecycle of ODA funded projects; managing consulting team of 10 to 25 national and international consultants. Mr. Paul has significant experience in strategic planning, client engagement, due diligence & research across ODA market, tailored bid responses to EOI/RFP/RFPs, budgeting and implementation of JICA, DFID, USAID, World Bank and ADB funded projects. He is proficient in project development and management, planning, budgeting, managing complete execution, resource planning, risk assessment, monitoring and reporting.

Dr. M. Dinesh Kumar



Dr. Dinesh Kumar is the Executive Director of Institute for Resource Analysis and Policy (IRAP), Hyderabad. He has 26 years of working experience on technical, economic, institutional & policy issues in water management in India and other south Asian countries such as Nepal, Pakistan and Bangladesh. Dr Kumar is the author of several books on water, energy, agriculture, food security



and has published extensively in international peer-reviewed journals on hydrology, water resources, energy, and food security. Dr Kumar has 160 research papers to his credit including several journal articles, book chapters, international conference papers and monographs.

Dr V C Goyal



Dr V C Goyal is Scientist G and Head, Research Management & Outreach Division at National Institute of Hydrology, Roorkee. He is Member Secretary of Indian National Committee for International Hydrological Programme (INC-IHP) of UNESCO. Dr Goyal has more than 33 years of research experience in the field of hydrology. He is editor of various journals and newsletter of NIH. He has over 150 publications in international/ national refereed journals, book chapters, reports and conference proceedings. Dr Goyal is Principal Investigator of various sponsored projects of World Bank, DST and MoWR, RD&GR, GoI at the institute. His skills includes hydrologic instrumentation, watershed management and watershed hydrology, wastewater treatment & rejuvenation of village water bodies, rural development & management, technology development, application & commercialization, project management & IPR, and outreach activities.

Dr Jyoti P Patil



Dr Jyoti P Patil is Scientist at National Institute of Hydrology, Roorkee. She completed her PhD in Soil and Water Conservation Engineering from Indian Agricultural Research Institute, New Delhi. She has about 9 years of research experience in the field of hydrological modelling, drought assessment and watershed management. She has published several research papers in peer reviewed international/ national journals and conference proceedings. Dr Patil is deputy coordinator of Indian National Committee for International Hydrological Programme (INC-IHP) at NIH. At her institute, she is involved in Neeranchal National Watershed project, IWRM formulation and rejuvenation of village ponds studies.

Dr A B Gupta



Dr. A.B. Gupta is working on various aspects of water and air pollution and their impact on human health- evolved pathophysiologies for fluoride, nitrate and aluminium toxicities and linkages between air pollution and human respiratory health; and developed low cost technologies for removal of fluorides and nitrates from drinking water/wastewater. Advance bio processes for waste treatment, characterization of PM fractions in air, developing field kits for biological analysis are his current areas of research. His research interests are Environmental Engg., Environment & Health, Biological Waste Treatment, Env. Modeling, Bioprocess Engineering, Wastewater Treatment. At present, Dr A B Gupta is Professor at Malaviya National Institute of Technology Jaipur, Rajasthan.



Dr. Victor R. Shinde



Victor has more than 13 years of work experience—both professional and academic—in the environmental sector in six countries, in Asia and Africa, of which the last seven years have been in the water sector. He is currently based in New Delhi working at the National Institute of Urban Affairs (NIUA), which is the think tank of the Ministry of Housing and Urban Affairs. He manages NIUA’s work related to water and the environment. Concurrently, he is also a senior research specialist in Water Engineering and Management at AIT. He specializes in ‘urban water’ issues, particularly in relation to supply-side and demand-side engineering and management of water, and has worked on prestigious projects funded by APN, CGIAR, CTCN, and UNEP. He also works on interdisciplinary studies, e.g. water-energy nexus, river health-human health linkages, and cross-sectoral climate change adaptation. He has published 17 articles in books, journals and conferences. He has carried out extensive work in interdisciplinary sector (required for this technical assistance), and also in relation to climate change.

Dr. Anik Bhaduri



Dr. Anik Bhaduri is Executive Director, Sustainable Water Future Program (SWFP), Future Earth and Associate Professor, Griffith University, Brisbane, Australia. Previously, he was a Senior Researcher at the Center for Development Research (ZEF), University of Bonn. With a background in environment and natural resource economics, he has specialized in water resource management. He has worked on several topics and projects in water resource management, ranging from trans-boundary water sharing to adaptive water management under climate change. Dr. Bhaduri obtained his PhD degree in December 2005 from the University of Wyoming. After his PhD, he worked as a post-doctoral research fellow in resource economics for the International Water Management Institute (IWMI). He was involved there in doing the economic analysis of India’s National River linking Project. His current research areas include sustainable land and water management, climate change impacts and adaptive water management through incentive based approaches, and role of scarcity in virtual water flow. He has published several research papers in peer reviewed international journals.

Dr Fawzia T



Dr. Fawzia Tarannum, an Assistant Professor in the Department of Regional Water Studies at TERI School of Advanced Studies (TERI SAS), is an inter disciplinary water professional with 20+ years of experience in project management, teaching and training. She is an Electrical Engineer with Diploma in Management and her PhD dissertation is on ‘Analysis of public perception of water quality and role of Information Communication Technology (ICT) in supporting participative management’. In 2013, she was awarded the University of Nairobi- IDRC Doctoral Research Grant for her PhD study. She was also awarded the Fulbright Hubert H. Humphrey Fellowship



by the US State Department in 2017 and has spent a year in Cornell University to enhance her skills in interdisciplinary approach to water management.

Dr Shibu K Mani



Dr Shibu K Mani is Associate Professor in Department of civil Engineering, Christ University, Bangalore. He obtained his PhD degree from University of Northumbria, New Castle and M Tech from University of Roorkee (Indian Institute of Technology, Roorkee). His skills and expertise includes probabilistic risk analysis, risk management/ communication, disaster planning & management and drinking water quality. He has participated in different seminars & conferences and published his research work in various peer reviewed national and international

journals.

Dr. Indranil De



Dr. Indranil De is an Associate Professor in the area of Social Sciences and Economics at Institute of Rural Management, Anand (IRMA), Anand, Gujarat. His areas of interest are institutional economics, political economy, transaction cost economics, labour, economics, slum improvement and applied econometrics. Dr. De is also the Editor of International Journal of Rural Management which is published by Sage. He holds a Ph.D degree from Jawaharlal Nehru University, New Delhi. He worked on Fiscal Decentralisation and Access to Basic Services in

Rural India with Reference to Water Supply and Sanitation in West Bengal. He has also completed M.Phil and MA in Economics from the same university. Dr. De has also worked for more than four years with renowned research institutions and important projects. He has worked with National Council of Applied Economic Research and Indian Council for Research in International Economic Relations. His research work has mainly addressed the socio-economic developmental issues and related government policies.



Annexure-III List of Participants

S.N.	Name of participant	Designation	Country
1.	Ms. Bushra Monowar Duti	Junior Specialist, Institute of Water Modelling, Dhaka	Bangladesh
2.	Mr. Mohd. Jamal Haider	Scientific Officer, Water Resources Planning Organisation (WAPRO), Dhaka	Bangladesh
3.	Mr. Md. Monowar-ul Haq	Junior Specialist, Center for Environmental and Geographic Information Services, Dhaka	Bangladesh
4.	Mr. Kazi Kamrull Hassan	Senior Specialist, Center for Environmental and Geographic Information Services, Dhaka	Bangladesh
5.	Mr. Md. Shahadat Hossain	Junior Specialist, Institute of Water Modelling, Dhaka	Bangladesh
6.	Ms. Deki Dema	Senior Communications Officer, Royal Society for Protection of Nature (RSPN)	Bhutan
7.	Mr. Tsheten Dorji	Deputy Chief Project Officer, Royal Society for Protection of Nature (RSPN)	Bhutan
8.	Mr. Damber Kumar Ghemiray	Researcher, Ugyen Wangchuck Institute for Conservation and Environmental Research	Bhutan
9.	Mr. Ali Mishal	Engineer, Environmental Protection Agency (EPA) in Water and Sewerage section	Maldives
10.	Ms. Rifa Fathmath	Project Officer, Water and Sanitation Department	Maldives
11.	Mr. Prem Kumar Srivastava	Senior Divisional Engineer, Water and Energy Commission Secretariat	Nepal
12.	Mr. Suresh Maskey	Senior Divisional Hydrologist, Water and Energy Commission Secretariat	Nepal
13.	Ms. Pramila Kumari Mahanama Dissanayake	Design Engineer, National Water Supply & Drainage Board	Sri Lanka
14.	Ms. Nalika Lakmali Engiliyage	Research engineer, Lanka Hydraulic Institute (LHI)	Sri Lanka
15.	Mr. Akila Senadhinatha	Construction Engineer, Uva province in	Sri Lanka



	Nawaratna Mudiyansele	National Water Supply and Drainage Board	
16.	Mr. Jahapu Appuhamilage Salika Iroshan Thilakarathne	Graduate Research Assistant, Department of Civil Engineering, University of Moratuwa	Sri Lanka
17.	Mr. N. Kumara Vel	Scientist-D/Dy. Adviser, NITI Aayog	India
18.	Mrs. Shobhika Singh	Assistant Director, CWC, New Delhi	India
19.	Dr. Sumit Rai	Scientist-C, GBPNIHESD, Almora	India
20.	Dr. Rakesh Singh	Scientist-B, CGWB, Faridabad	India
21.	Ms. Monalisha Singh	Scientist-B, CGWB, Dehradun	India
22.	Ms. Madhumanti Roy	Scientist-B, CGWB, Faridabad	India
23.	Mr. Ramesh Rai	Scientific Assistant, CWC, New Delhi	India
24.	Mr. Ashwani Kumar	Associate Professor, CEPT Univ., Ahmedabad	India
25.	Mr. Archisman Mitra	Assistant Research Associate, International Maize and Wheat Improvement Center (CIMMYT)	India
26.	Mr. Neeraj Singh	Researcher, State climate Change Centre, Uttarakhand	India
27.	Dr. Swapnali Barman	Scientist-C, NIH, Roorkee	India
28.	Dr. Sunil Gurrapu	Scientist-C, NIH, Roorkee	India
29.	Ms. Meeta Gupta	Junior Research Fellow, NIH, Roorkee	India



Annexure-IV Feedback form

Name: Country:

1. Training Content	Excellent 5	Good 4	Satisfactory 3	Fair 2	Poor 1
Coverage of theme of training programme					
Exposure to new methodologies and techniques					
Distribution of time among various components of the course					
2. Faculty	Excellent 5	Good 4	Satisfactory 3	Fair 2	Poor 1
The concepts were clearly explained					
My questions were answered adequately					

3. Most relevant/ appreciated lecture/topic (mention the faculty):

4. Will you able to use the information and/ or skills in your current or future roles?
.....

5. Your overall grading of the course on a scale of 10 (1-Min and 10-Max):

6. Various arrangements (lodging/ boarding/food/travel) on a scale of 10 (1-Min and 10-Max):

7. Please provide any additional recommendations or suggestions:
.....

THANK YOU FOR COMPLETING THIS EVALUATION



Annexure V- Certificate of Participation

United Nations Educational, Scientific and Cultural Organization
Indian National Committee on International Hydrological Programme

NATIONAL INSTITUTE OF HYDROLOGY
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Certificate of Participation

Dr. Sunil Gurrapu from **India** has successfully attended UNESCO sponsored training programme on **“IWRM, Water Security and Climate Change for Developing Economies”**, jointly organised by National Institute of Hydrology, Roorkee and UNESCO, New Delhi Office, during 15-16 November 2018. The course was attended by participants from *Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka.*

(Dr Neha Midha)
National Programme Officer,
Natural Sciences, UNESCO

(Dr V C Goyal)
Course Coordinator
INC-IHP, NIH

(Dr Sharad Jain)
Director, NIH



Glimpse of the training programme



