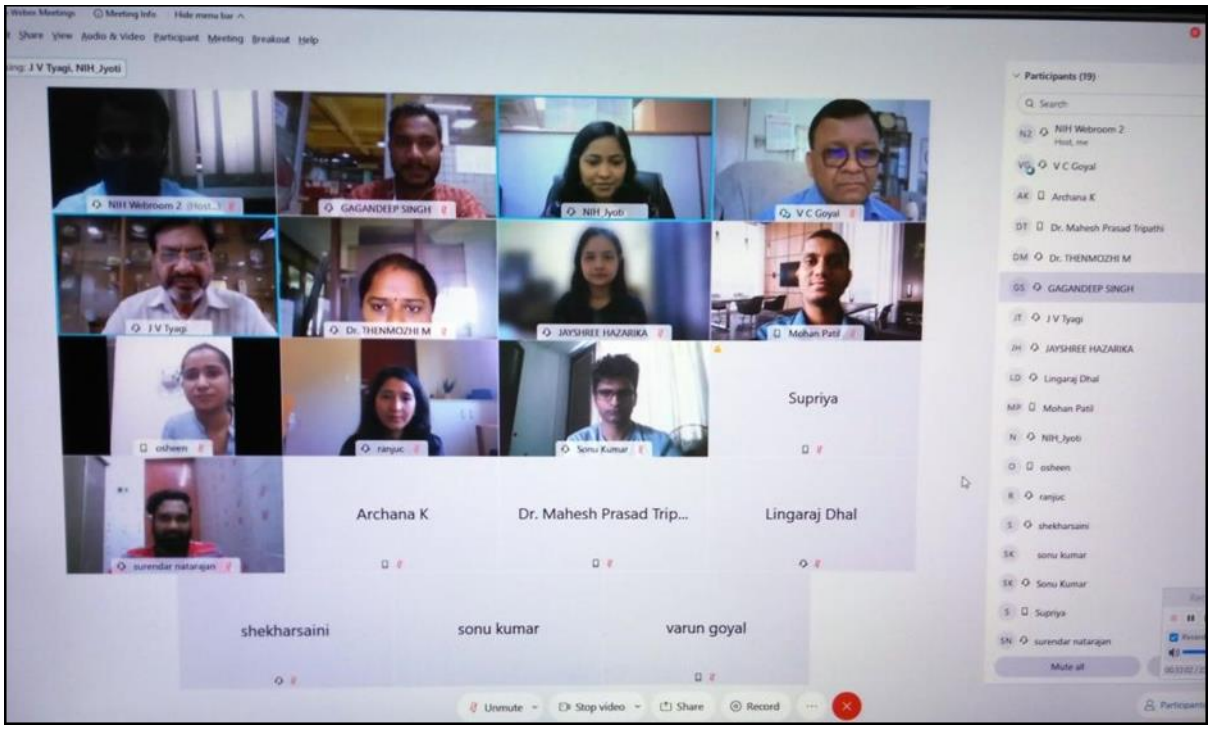
United Nations Educational, Scientific and Cultural Organization

Indian National Committee for Intergovernmental Hydrological Programme

National Institute of Hydrology

Report of the
05-day virtual training course on

# "Water security for resilience to deal with disasters and outbreaks"




**02-06 November, 2020**

***Organized by:***
**National Institute of Hydrology, Roorkee**

***Under the aegis of***
**Indian National Committee for**
**Intergovernmental Hydrological Programme (INC-IHP) of UNESCO**

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## Background

Water security is a complex multi-dimensional attribute. UN-Water defines water security as *"the capacity of a population to safeguard sustainable access to* ***adequate quantities*** *of* ***acceptable quality water*** *for sustaining* ***livelihoods***, ***human well-being***, *and* ***socio-economic development***, *for ensuring protection against* ***water-borne pollution*** *and* ***water-related disasters***, *and* ***for preserving ecosystems*** *in a climate of peace and political stability".*

Water is increasingly becoming a scarce natural resource in many parts of the world, and cannot be taken for granted. Multiple drivers like population growth, rural migration, urbanization, unregulated abstraction of water, indiscriminate pollution are already creating stress on existing water resources. However, since the last twenty years, the frequency of natural disaster events has increased at an alarming rate, which poses a serious threat to water resources. When disaster strikes, it usually manifests itself through the water. Floods, landslides, tsunamis, storms, heat waves, cold spells, droughts, and waterborne disease outbreaks are all becoming more frequent and more intense. Reducing risk to, and improving the resilience of, water and sanitation services will be key to maintaining access during a climatically uncertain future.

Water-related disasters pose both direct impacts (e.g. damage to buildings, crops and infrastructure, and loss of life and property) and indirect impacts (e.g. losses in productivity and livelihoods, increased investment risk, indebtedness, and human health impacts). An average of 25.3 million people is displaced each year by sudden-onset disasters. However, around 74% of all-natural disasters between 2001 and 2018 were water-related and during the past two decades, the total number of deaths caused only by floods and droughts exceeded 166,000, while floods and droughts affected over three billion people and caused total economic damage of almost US$700 billion.

Presently, we are witnessing a Coronavirus (COVID-19) outbreak, which has been declared a pandemic by the World Health Organization. Improving water, sanitation, and hygiene has the potential to prevent at least 9% of the global disease burden and 6% of all deaths. Recovery from the pandemic will require effective water management that reinforces the stability of disrupted food systems. In the post-pandemic world, we must use what we are learning about the dynamics of these interconnected systems to "build back better." Investments in water

should be used to build greater resilience to climate, health, and food system shocks, and more effective management of water-related risks.

## Objectives

Against this backdrop, the Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP) in cooperation with the National Institute of Hydrology (NIH), Roorkee (Uttarakhand) organized a 05-day training course from 02nd November, 2020 to 06th November, 2020 on a virtual platform. The course provided participants with comprehensive knowledge of the entire water security concepts and its resilience during these uncertain climatic conditions and outbreaks. The purpose of this training course was:

- To apprise the participants with water security and resilience concepts, and implications to deal with disasters/ outbreaks, and
- To train the participants with skills to perform water security assessment and chalk out resilience strategies at different scales.

## Topics covered during the training course

The training course was designed to focus mainly on water security concepts and its broader implications during the various natural disasters and outbreaks. Accordingly, the following topics were covered during the 05-day virtual training course:

| | |
|---|---|
| WHAT | Water security concepts and challenges |
| | Ecohydrology and ecological flow for water security |
| | Natural resources and their management strategies in post Corona period |
| WHY | Disaster risks reduction and contribution to SDG6 |
| | Climate variability and anthropogenic stress on hydrologic resilience |
| | Preparing communities for natural disasters |
| | Community health implications of 'water insecurity' |
| HOW | Wastewater treatment and management for water security |
| | Nature inspired thinking in ecologically sustainable water management and resilience |
| | Water security through resilient water bodies |
| ASSESSMENT TOOLS | Vulnerability assessment for water security |
| | Village level water security assessment |
| | DPSIR framework of water security assessment |

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

## Invited speakers of the training course

| S.N. | Name of speaker | Designation |
|---|---|---|
| 1. | Dr. V. C. Goyal | Scientist-'G', National Institute of Hydrology, Roorkee |
| 2. | Dr. Jagdish Krishnaswamy | Senior Fellow, ATREE, Bangalore |
| 3. | Dr. Anil K. Gupta | Professor, National Institute of Disaster Management (NIDM), New Delhi |
| 4. | Dr. Giriraj Amarnath | Research Group Leader, IWMI, Sri Lanka |
| 5. | Ms. Anupama Datta | Head, Policy Research and Advocacy, HelpAge India |
| 6. | Dr. Sudhindra Mohan Sharma | Ex- National Nodal Officer, Ministry of Drinking Water & Sanitation, Govt. of India |
| 7. | Dr. Rajesh Singh | Scientist-'D', National Institute of Hydrology, Roorkee |
| 8. | Dr. Jyoti P. Patil | Scientist- 'D', National Institute of Hydrology, Roorkee |
| 9. | Dr. Victor R. Shinde | Sector Coordinator, NIUA, New Delhi |
| 10. | Mr. Prashant Dhawan | Co-founder and Director, Biomimicry India, Bangalore |
| 11. | Dr. Ashutosh Sharma | Postdoctoral Fellow, The Pennsylvania State University, USA |

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

## Participants in the training course

The course was specially designed for youths and young professionals qualified in hydrology, water resources, or related fields, and associated with water resources assessment and management. For attending this training course, an online application was sought and in return, a huge response from across the globe was received. A total of 702 applicants had applied for the same, out of which 562 were Indian and 140 were foreign participants mainly from Nepal, Bhutan, Ethiopia, Bangladesh, Niger, Australia, Pakistan, Thailand, Myanmar, and Japan. But due to logistic limitations, we could not accommodate more than 37 participants. Seeing their keen interest, we also live-streamed our course on Facebook (except hands-on sessions and group exercises) so that all interested may benefit from the lectures.

| Indian (33) | Foreign (4) | Gender | Qualification/ profession | Age | States |
|---|---|---|---|---|---|
| National (32)<br>NIH (1) | Nepal<br>Australia<br>AIT, Bangkok | Male (24)<br>Female (13) | M. Tech. / M.E. / M.Sc.<br>Ph.D. Research Scholars<br>Assistant Professors<br>Engineers<br>Technical Officers | Between 19-25 (7)<br>Between 26-35 (29)<br>Above 36 (1) | Assam, Gujarat, New Delhi, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Maharashtra, Mizoram, Odisha, Punjab, Rajasthan, Jammu & Kashmir, Tamil Nadu, Uttar Pradesh, Uttarakhand |

The details of the selected participants are given at **Annexure-III**.

## Session details of the training course

### Day-1

In the opening session of the training course, the Deputy Coordinator of the INC-IHP Dr. Jyoti P. Patil welcomed Dr. J.V. Tyagi, Director, National Institute of Hydrology, Roorkee, and Chairman of the INC-IHP, Dr. V.C. Goyal, Member-Secretary of INC-IHP and all the participants of the course. Dr. Patil familiarized the participants with IHP and its activities in India. As the International Hydrological Programme had been started in 1975 and implemented on six-year programmatic time intervals or phases, she also briefed about its eighth phase (2014-2021) and outlined its various themes. As IHP's secretariat is housed in the National Institute of Hydrology (NIH), Roorkee, she also discussed the role and responsibilities of NIH in the successful execution of this phase. She also talked about various international programmes like- G-WADI, HELP, GRAPHIC, ISARM, JIIHP, UWMP, WHYMAP, *etc.* running under the umbrella of IHP. Lastly, she discussed Sustainable Development Goals (SDGs), which are to be achieved by 2030.

Further, Dr. V.C. Goyal, Member-Secretary of IHP introduces the participants to the training course. He gave a brief introduction to the training course and various other programmes that were organized on the theme of 'water security' by the National Institute of Hydrology in the

recent past. He also discussed the objectives, topics that were covered, selected participants, and the invited speakers of the course.

Dr. J.V. Tyagi, Director, and Chairman, INC-IHP also discussed the present challenges that water resources are facing. Due to extreme natural events like- landslides, cyclones, hurricanes, forest fires, *etc.*, water bodies are getting affected. Further, the Covid-19 pandemic has brought a new challenge for water practitioners as the water demand has been increased exponentially. The current challenge for the water sector is to strengthen water security to deal with disasters and outbreaks. In his view, we should focus mainly on three key areas:

1. We need to have proper supply and storage solutions, which is most needed to ensure adequate water supply in the context of climate change,
2. There is a need to maintain acceptable water quality in the water bodies, and
3. Efforts are required for strengthening the integrated water resources management both in quantity and quality.

In last, he wished the organizers for the successful conduction of this 05-day virtual training course.

The first lecture of this training course was delivered by Dr. V.C. Goyal on the topic "Water Security: Concepts and challenges". In the initial slides, he discussed the Sustainable Development Goals (SDGs) that are to be achieved by 2030 and the SDG-6, which is related to water. Further, Dr. Goyal discussed the various definitions of water security given by different organizations and why it is needed. He also talked about the water security index and its framework, which is based on five components for assessing water security in various Asia-Pacific countries. The per capita water availability is reducing day by day. It was 1820 $m^3$ in 2001, which was reduced to 1545 $m^3$ in 2011. It is estimated that it may reduce to 1341 $m^3$ in 2025 and 1140 $m^3$ in 2050. Further, he discussed the various components that are required for effective water security index assessment and the characteristics of an ideal water-secure model. In a slide, he talked about a new concept of dew harvesting. This plant has been set up at Kothara village in the Kutch region of Gujarat that can process an average of 500 liters of water daily. He also showed the case study of rejuvenation of village ponds using a natural treatment system, which has been carried by scientists of NIH.

In the end, he concluded that water security is the need of the hour. SDGs are in the latest monitoring agenda of the UN, and India fares poor in the water security index. IWRM is a means of achieving water security which concerns both water quantity and quality.

Subsequently, Dr. Jagdish Krishnaswamy delivered his presentation on the topic "India's Water security: Ecohydrology and ecological flow dimensions". Initially, he gave an overview of two dimensions of ecological security. The first one was the role that ecosystems play in the water cycle and the second was the ecological security that comes from maintaining water and sediment flow in our rivers. Further, he spoke about river dredging and channelization for waterways. In his opinion, inter-linking of rivers will adversely affect the aquatic ecosystem. Dredging of river bottoms can significantly alter sediment deposition and riverine habitats for endangered species, and damage fish breeding grounds. Dredging of sediment may also release pollutants into the river water, including Arsenic. He also showed a slide of the River-floodplain habitats of Vikramshila Gangetic Dolphin Sanctuary of Bhagalpur, Bihar.

In the end, he concluded that in India, the link between ecological security and water security is still not part of our policy and management discourse and there is a need for adaptive management of reservoirs and barrages to minimize negative impacts on endangered species. All climate change mitigation projects should be subjected to environmental scrutiny and defining ecological flows with clear normative goals in an inter-disciplinary manner for each stretch of the river and link across scales shall also be beneficial.

Ms. Anupama Datta delivered the first lecture of the post-lunch session on the topic "Community Health Implications of 'water insecurity': How to Make a Difference at Grass root Level". In the initial slides, she pointed out some alarming facts about water scarcity. Over 2 billion people live in countries experiencing high water stress and it is estimated that by 2040, one in four of the world's children under 18 – some 600 million in all – will be living in areas of extremely high water stress. 700 million people worldwide could be displaced by intense water scarcity by 2030. Due to urbanization and population growth, some of the metro cities like Chennai and Bengaluru are moving towards 'Day Zero'. Further, she discussed the various health implications of water scarcity. Drinking polluted water causes various diseases like gastrointestinal disease, different types of cancer, fluorosis, and stunted growth of children.

This also affects the mental and physical health of women as they are mostly responsible for collecting water in water-scarce regions.

In her concluding remarks, she emphasized that there is a requirement for innovative rainwater harvesting technologies. Action at the panchayat level is needed as in the case of Ahmednagar District in Maharashtra, where the 05-year plan was developed by the villagers to reverse water stress. Hiware Bazar is an outstanding example of community action. A multi-partner approach is also considered necessary to solve the issue and people being an important part of the plan. Use of technology to let people know the level of groundwater in their village or the water testing kits.

Subsequently, Mr. Sudhindra Mohan Sharma delivered an interesting lecture on the topic "Natural Resources and their Management Strategies in Post Corona Period: Global and National Challenges". Firstly, he discussed the prevailing Covid-19 pandemic and how it has been affecting us. We have changed our travel plans, business, and way of interaction. He also talked about the sector-wise contribution of the different sectors in the GDP of India. However, agriculture and allied sectors contributed only 17% in the year 2019; it employed the highest number of people in India (about 53% of the entire population). Further, he described SWOT analysis, which is the short form of Strength, Weakness, Opportunities, and Threats. By doing this, we can easily analyze how much and where we will be impacted by Covid-19. As this pandemic caused a huge loss to our economy, the key factors for the development and resurgence of India in the post-Corona period shall be mineral wealth, new and renewable energy, demographics and employment opportunities, and water resources. The post-Corona period will require a more robust water sector in our country simply because a big drive for geographical decentralization of manufacturing, livelihood, businesses, and employment opportunities shall be required to restructure ourselves.

He closed by showing a ray of hope that the post-Corona world would not be the same, yet it may have huge opportunities for us. It would be a blessing in disguise. World over the global business partnerships would change and may be realigned and the global value chains will be replaced by more local regional value chains.

The last lecture of Day-1 was given by Dr. Giriraj Amarnath on the topic "Preparing communities for natural disasters". He started his presentation by giving some figures about various natural disasters and the economic losses caused by it. River flooding affects 21 million people worldwide and affects $96 billion in GDP each year. Further, he explained how space technologies could be beneficial in disaster risk management solutions. This advanced knowledge can be applied across all phases of disasters (prevention, preparedness, response, and recovery). He also showed a slide of the rapid emergency response to the 2017 floods in Sri Lanka using this technology. International Water Management Institute (IWMI) has developed a framework on water risks and disasters that is very helpful in identifying and understanding the characteristics of flood hotspots, an inter-annual variation of regional flooding extent, *etc*. Further, he briefed about the bundling concept where seeds, insurance, and climate information are provided to the farmers.

Lastly, he concluded that there is a huge opportunity to utilize space technology in managing water risks and disaster applications. There is also a greater need for a solution-fit product across stakeholders in managing current and future climate risks and increasing demand to promote advanced capacity building including tools and models on IDRM towards the implementation of Sendai Framework for Disaster Risk Reduction and SDG targets.

## Day-2

The morning session of Day-2 was started with the presentation of Dr. Anil Kumar Gupta on the topic "Lessons for 2$^{nd}$ Generation Disaster Resilience for SDGs." In the initial slides, he briefed about the pre and post-Corona period. India is very prone to pandemics as safety measures yet to be a ground reality. However, Corona outbreak also opened a new sphere for businesses that would local or self-resilient. Further, Dr. Gupta discussed the environmental impacts of the Covid-19 pandemic. In a way, it enhanced air quality by slashing GHG emissions. Water quality has also improved, as there are reduced water transportation, industrial activities, *etc.* However, it increased the per capita waste generation as people stayed mostly indoors during the lockdown period. Huge quantities of biomedical waste have also become a major concern in recent times. He also explained some of the natural and anthropogenic disasters like- Amphan super-cyclone, Assam gas and oil plant explosion, VIZAG gas leak, that we have witnessed. We have also seen the locust attack in some parts of our country this year.

This is reported to be the worst attack in 27 years and farmers are now facing huge crop loss. The locusts have already destroyed nearly 50,000 hectares (1, 25,000 acres) of cropland.

In the end, he emphasized that we have to have a middle path that Lord Buddha showed us. It is very important that how we balance our materialistic growth with nature. We should make a balance between the built environment and the natural environment. Our integrated approach is sustainability and disaster resilience would not be effective. Water is a kind of a very critical component and a very important dimension for disaster resilience also.

Subsequently, Dr. Jyoti P. Patil delivered a very insightful lecture on "Vulnerability assessment for water security". She started her lecture by describing the concept of vulnerability. Vulnerability is the degree to which the system is likely to suffer damage as a result of exposure to a hazard. As per the IPCC (2018) definition, the degree to which a system is able or unable to cope with the adverse effects of climate change, including climate variability and extreme effects.VI-IPCC approach frames the major parameters into three contributing factors to vulnerability *viz.* exposure, sensitivity, and adaptive capacity. Data collection is an important part of this assessment, which includes both primary and secondary sources. She also explained the various steps involved in the vulnerability assessment exercise. Further, Dr. Patil showed the case study of the Bundelkhand region, where the vulnerability assessment was carried out in the selected watershed areas of four districts- Jhansi and Lalitpur of U.P. and Chhatarpur and Tikamgarh of M.P. The results of the Tikamgarh district revealed that Tikamgarh Tehsil was most vulnerable followed by Palera, Jatara, and Baldeogarh. Low-income diversification, low Income, and high expenditure, high migration, low crop productivity, scarcity of water resources, *etc*. might be the reason behind it.

Lastly, she concluded that this type of study will help to prioritize the area for interventions. The findings of the study will be linked to suggesting a water allocation plan. Efforts should also be made to enable government and local bodies to develop programmes and take initiatives to strengthen the most vulnerable villages.

The first lecture of the post-lunch session was delivered by Dr. Ashutosh Sharma on the topic "Resilience of terrestrial Ecosystems droughts". At the beginning of his presentation, he explained the basic concepts of Resilience. The resilience of a system is its ability to absorb a

disturbance and to recover to its equilibrium state after the disturbance. It may be of two types- engineering resilience (recovery) and ecological resilience (reorganization). Further, he explained the ecological resilience in brief and ecosystem water use efficiency (WUE), and the methodology used for resilience analysis. He also showed the case study of 22 river basins of India that were classified as per "Watershed Atlas of India" reported by IndiaWRIS (India-WRIS, 2014). The results showed that the north-eastern region of the country had higher WUE followed by northern, eastern, southern, and western regions, respectively. WUE for Brahmaputra basin (Basin Id. 2b, WUE=1.1 $gCm^{-2}mm^{-1}$) in the north-eastern region was significantly higher (p value<0.01) than other basins, whereas Mahi basin (Basin Id. 10) in the western region had the least WUE (=0.25 $gCm^{-2}mm^{-1}$).

In the last, he concluded that there is a large spatial variation in net primary productivity (NPP), evapotranspiration (ET), and WUE at the district scale in India. The forest dominated north-east and the Western Ghats had higher NPP, whereas the arid regions in the west had the least NPP. WUE was significantly higher for lower Himalayan regions. Among different biome types, districts dominated by forest cover had the highest WUE followed by cropland, grassland, and savanna, respectively.

Dr. Rajesh Singh talked on the topic "Wastewater Treatment & Management for Water Security", as the last lecture of Day-2. His presentation was entirely focused on wastewater treatment technologies. Firstly, he discussed the basic concepts and definitions of contaminants and pollutants and how the pollutant impacts water resources. He also talked about the water quality criteria for irrigation as given in the Indian Standard (IS: 11624-1986). Water pollutants may be classified into three main categories *viz.* elemental, organic, and biological. To satisfy the discharge norms, environmental awareness, and zero discharge, there is a compulsion of treating effluents. So, based on the type of pollutants, we can choose suitable treatment units. For example, to remove floating matter, we can use screen bars and for oil and grease, oil and grease trap can be adopted, and so on. Further, he discussed the biological treatment of wastewater and the mechanism involved in this. The main objective of this treatment method is to remove organic matter from wastewater in a natural way without using toxic chemicals. Sometimes the aim is to remove other than organic matter such as ammonia/ heavy metals/ toxic organic chemicals like cyanides, phenols, *etc.* The biological treatment methodology can

be further divided into aerobic and anaerobic processes. He explained all these processes in detail. He also showed the case study of rejuvenation of village pond in Ibrahimpur Masahi Village of Haridwar district using natural treatment systems.

In the last, he briefed about the wastewater treatment plant that is proposed for the residential colony of the National Institute of Hydrology (NIH), Roorkee. This will be a subsurface flow constructed wetland (SSFCW) type of treatment system that will treat the household wastewater.

## Day-3

The morning session of Day-3was started with the presentation of Mr. Sudhindra Mohan Sharma on the topic "Village level water security assessment". He started his presentation with a story and defined what drinking water security 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 the 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 the identification and nurturing of volunteers of gram-panchayat level may also be beneficial.

The lecture was followed by the exercise in which participants had to prepare a village water security plan. Mr. Sharma divided all the participants into two groups. The participants, whose names started with A to L were placed in group-A and they are given the case study of village Bheni Majra. On the other hand, participants having first names starting with M to Z were placed in group-B and they are given the case study of village Dungarli. Village Bheni Majra is located in the Kaithal district of Haryana; however, Dungarlii is situated in the Kota district of Rajasthan. All the participants enthusiastically participated in this session.

The first lecture of the post-lunch session was delivered by Dr. V.C. Goyal on the topic "Water security through resilient water bodies". He started his presentation by giving a background of the water security concept and water resilience. According to a recent study by IIT-Indore (2019), 20 out of 25 river basins, including Ganga, Narmada, and Tapi, are non-resilient, and they will not recover under extreme climatic conditions. 15 out of 25 river basins, such as Godavari, Mahi, and Krishna are prone to extreme deterioration. There are various factors including population pressure, GW withdrawal, urbanization, less water discharge, *etc*. that affect the sustainability of water sources. He also talked about the need for the protection and conservation of water bodies because our country is designated as water stresses by IPCC. Waterbodies are also encroached and polluted by the dumping of untreated sewage effluents. Further, he discussed the various schemes/projects run by the central government and different states to revive and rehabilitate the water bodies.

Lastly, Dr. Goyal concluded that to make water resources and food systems future proof from multiple disasters/hazards, build resilience and sustainability into these systems. Understanding the resilience of water bodies is important from the perspective of disaster and climate compatible development. Integrated Water Resource (IWRM) Management Plan can also be instrumental in achieving water security. The role of hydrology needs to be understood and adequately incorporated while planning for rejuvenation and conservation of water bodies.

The last lecture of Day-3 was delivered by Mr. Prashant Dhawan on the topic "Nature inspired thinking in ecologically sustainable water management and resilience". In initial slides, he briefed about geological time scale and how the life forms evolved in water bodies. In his opinion, water is both an operating condition as well as the necessary internal ingredient of life. Further, he discussed the term "Biomimicry", which is the examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems. Ethos, (re) connect, and emulate are three key elements of Biomimicry. He also gave various examples of Biomimicry from natural systems. Mangrove and fishes filter/desalinate water, while by the process of transpiration; plants regulate their temperature during hot conditions. If we talk about desert welwitschia, it uses water judiciously, whereas cactus and palm tree stores water.

In his concluding remarks, he emphasized that we should go for natural and places a specific solution for a certain problem. We must learn how does nature filter and clean water? How does nature optimize the utilization of water?

## Day-4

The entire morning session of Day-4 was taken by Dr. Victor R. Shinde, who delivered his presentation on the topic "Towards Water Resilient Cities: Measuring urban water security as a first step to achieving it". To make this session more interesting and live, he engaged all the participants in a water-related quiz at the beginning in which all have participated actively. Firstly, he set the background and context of his presentation. Our country is facing a massive water crisis. As per the study of TERI (2018), the water demand is 50,895 MLD but the supply is only 26,107 MLD. According to the NITI Aayog (2018), more than 750 urban local bodies (ULBs) in India are water-stressed and 21 cities are expected to run out of groundwater by 2020. Wastewater is also a major threat to water security as 63% of India's urban sewage is left untreated (CPCB, 2016). Further, he discusses the various problems that we are facing as of today and water security is among the top global issues. He also talked about the various definitions of water security from multiple perspectives. As per the definition of DECD (2013), water security is about learning to live with an acceptable level of water risk. It is central to all forms of security *viz.* human/community security, climate security, energy security, *etc.*

Later, Dr. Shinde discussed the DPSIR framework, which is an acronym for Drivers, Pressures, State, Impacts, and Responses. This is a framework that looks at the entire cycle of how the environment is affected by natural and anthropogenic factors and the societal response to these factors. Further, he explained all these factors in detail by giving the example of river health. Further, he showed a water security assessment framework that was developed by his team while carrying out a project on the same for Bangkok city. In this process, there were various dimensions like water supply and sanitation, water productivity, water-related disasters, water environment, water governance, *etc.* with its respective indicators.

In the last, he concluded that this framework has great potential to complement the Composite Water Management Index (2018) developed by the NITI Aayog. The CWMI looks at state-level

analysis, while this work focuses on city-scale analysis. The framework can be used as a template for several other assessment systems such as climate-smart assessment, river management, energy management, and biodiversity management

The post-lunch session of Day-4 was allocated for the group exercise. All the 37 participants were divided into 3 groups with each group having two group leaders. This session was of 3-hour duration and each group was provided with a separate room. Based on the learning of this training course, they chose the topics of the presentation on their own. All the participants actively participated in this exercise and interacted with each other very well.

## Day-5

On the concluding day of this virtual training course, all the 3 groups made their presentations exceptionally well. The topics of their presentation were as follows:

**Group-A: DPSIR & SWOT analysis: A case study of Dehradun**

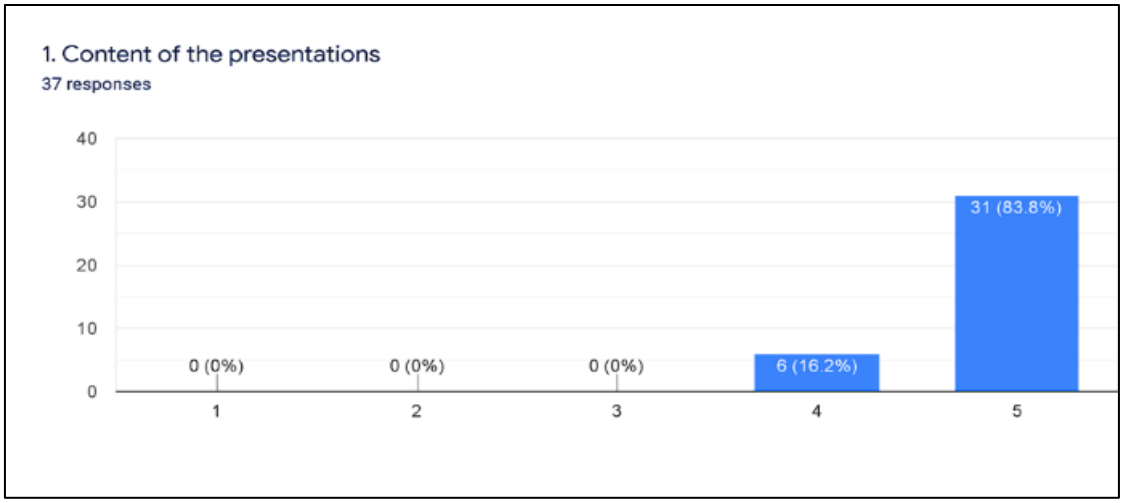
**Group-B: Water security challenges and management in agriculture sector: A case study of Mandla district, Madhya Pradesh**

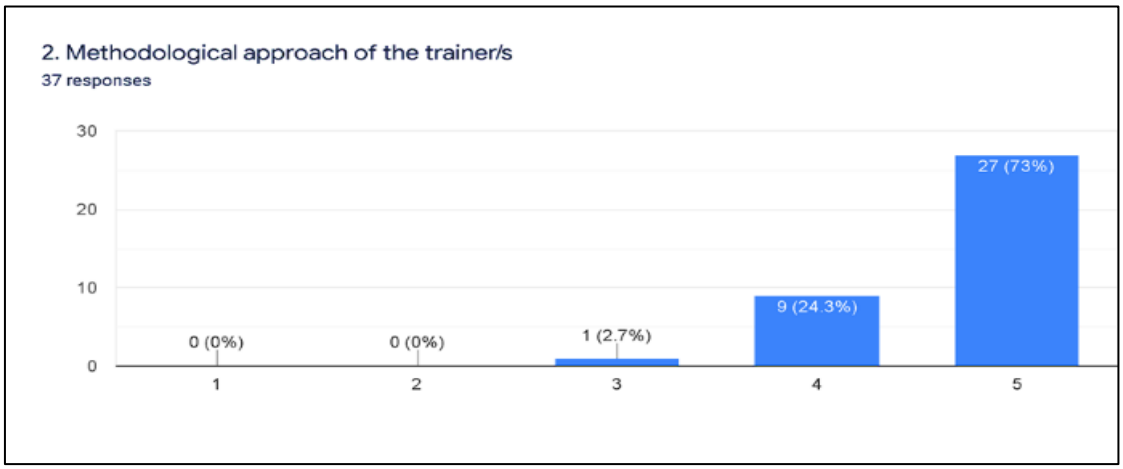
**Group-C: DPSIR framework for urban water security in Gurgaon city**

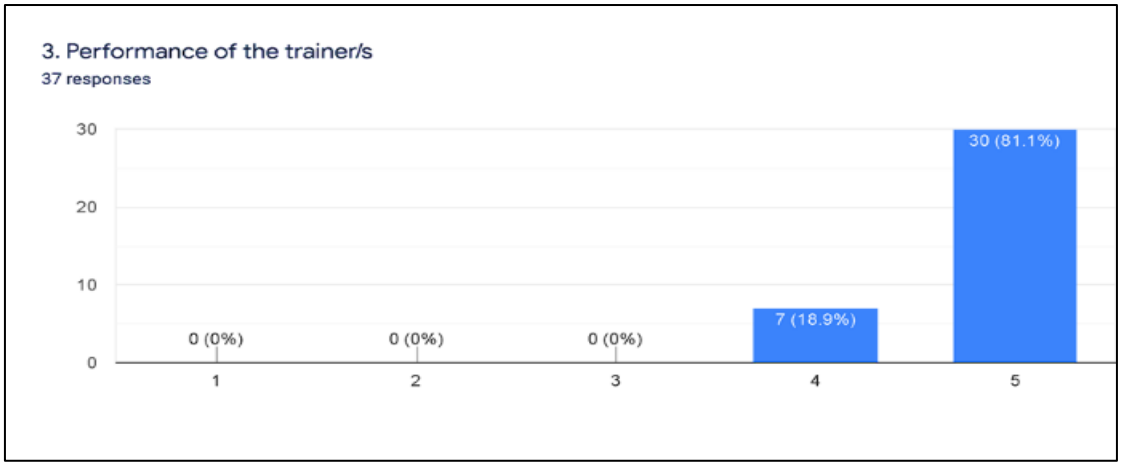
The presentations made by the three groups were appreciable in terms of understanding the various training modules and their applications in the selected study area. Though the time allotted for the groups was limited, they come up with excellent presentations.

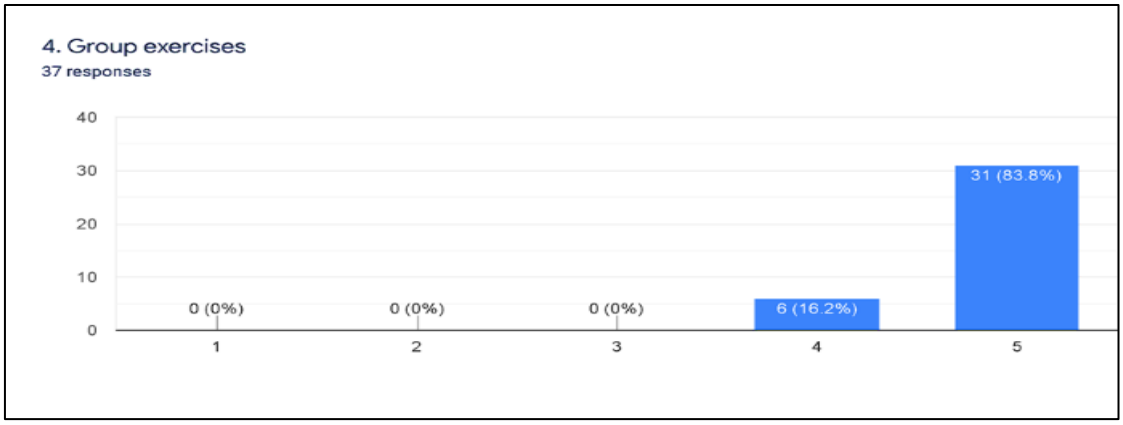
## Feedback of the training course

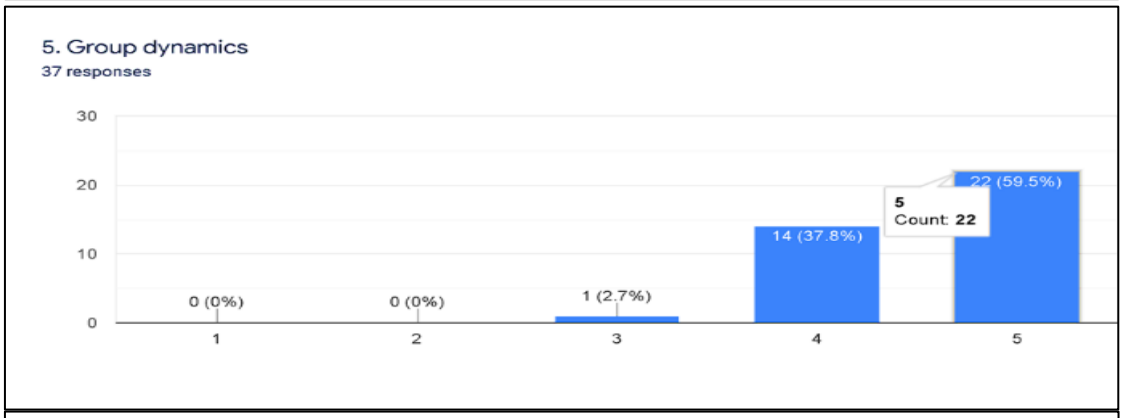
After the completion of the presentations, the feedback was invited from all the participants to make this type of training course more advantageous in the future. The format of the feedback form is placed at **Annexure-IV**. The feedback for the content of the presentations, the methodological approach of the trainers, the performance of the trainers, group exercises, group dynamics, expectations satisfaction, and duration of each topic were sought through the feedback form via google form link. The responses received from all participants are given in bar diagrams below. Almost are responses were in the range of very good (5) to good (4) rank.

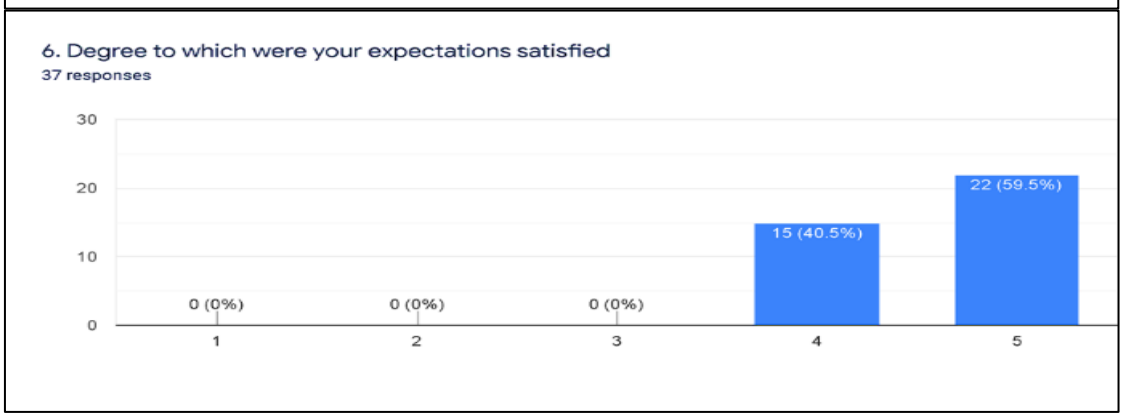

1. Content of the presentations
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
0 (0%)
6 (16.2%)
31 (83.8%)
1
2
3
4
5

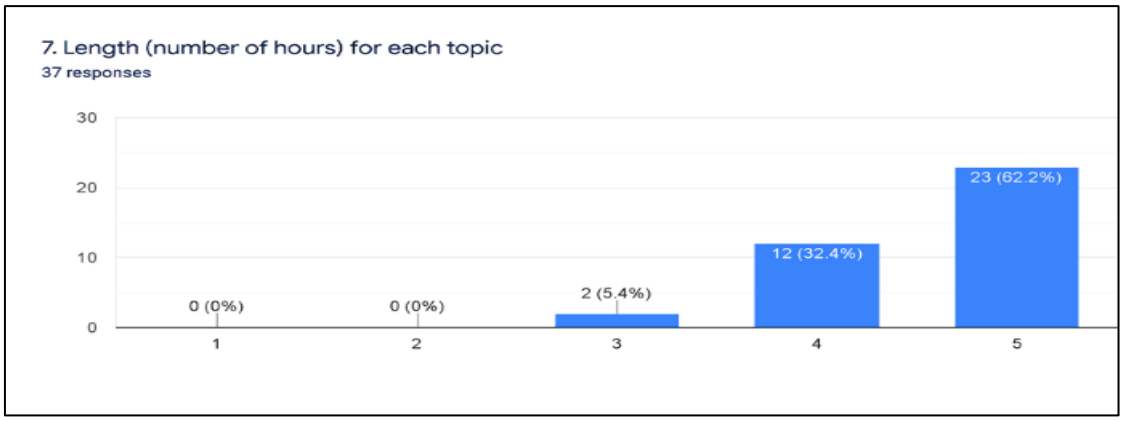

2. Methodological approach of the trainer/s
37 responses
30
20
10
0
0 (0%)
0 (0%)
1 (2.7%)
9 (24.3%)
27 (73%)
1
2
3
4
5


3. Performance of the trainer/s
37 responses
30
20
10
0
0 (0%)
0 (0%)
0 (0%)
7 (18.9%)
30 (81.1%)
1
2
3
4
5


4. Group exercises
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
0 (0%)
6 (16.2%)
31 (83.8%)
1
2
3
4
5


5. Group dynamics
37 responses
30
20
10
0
0 (0%)
0 (0%)
1 (2.7%)
14 (37.8%)
22 (59.5%)
5
Count: 22
1
2
3
4
5


6. Degree to which were your expectations satisfied
37 responses
30
20
10
0
0 (0%)
0 (0%)
0 (0%)
15 (40.5%)
22 (59.5%)
1
2
3
4
5


7. Length (number of hours) for each topic
37 responses
30
20
10
0
0 (0%)
0 (0%)
2 (5.4%)
12 (32.4%)
23 (62.2%)
1
2
3
4
5

Participants gave specific comments/suggestions on the training course. Some of them are mentioned below:

| S.N. | Name | Country | Specific comments/suggestions on the training |
|---|---|---|---|
| 1. | Sonu Kumar | Thailand | Overall training programme was really productive. One more day should have been provided for home work. |
| 2. | Salina Shrestha | Nepal | The training was very useful. In my view, it would be better if the human health and other social aspects related to water security are discussed in bit more detail way in such training. |
| 3. | Naba Raj Dhakal | Nepal | Thank you NIH to give this opportunity. Water resource and water security is most important for human being. This type of programme should be conducted in future. |
| 4. | Dr. Surendar N. | India | Modeling approach to be included. Technologies and tools related to DPSIR should be included. |
| 5. | Archana Kumar Yereseme | India | One session from policy makers could have been included, because we find a large gap between research recommended and policy making (in regard to water security). Under disasters, one session from IMD on how they predict disasters would help. Other topics of relevance are right to water in India. |

In the end, Dr. Jyoti P. Patil, deputy coordinator of INC-IHP gave a vote of thanks.

## Training Deliverables

1. All the PowerPoint presentations delivered by the invited speakers of this training course was shared with participants through the google drive link https://drive.google.com/drive/folders/16keQ0TBxBiSSvE-y5crmiYUUc7aBQcPr?usp=sharing.
2. The Certificate of Participation was issued to the participants (**Annexure-V**)

Annexure-I

## Training Schedule

| Time IST (UTC+05:30) | Day 1: November 02, 2020 (Monday) | Faculty/ coordinator |
|---|---|---|
| 1030 hrs-1100 hrs **Opening Session** | Welcome and About INC-IHP<br>Introduction to training programme<br>Address by Chair<br>Group Photo | JPP<br>VCG<br>Director, NIH<br>Webcam |
| 1100 hrs-1200 hrs | Water Security: Concepts and Challenges | VCG |
| 1200 hrs-1300 hrs | Linking ecological security with water security: Insights from India | JK |
| 1400 hrs-1500 hrs | Community Health Implications of 'water insecurity': How to Make a Difference at Grass root Level | AD |
| 1500 hrs-1600 hrs | Natural resources and their management strategies in post Corona period: Global and National Challenges | SMS |
| 1600 hrs-1700 hrs | Preparing communities for natural disasters | GA |
| **Day 2: November 03, 2020 (Tuesday)** | | |
| 1100 hrs-1200 hrs | Lessons for 2nd Generation Disaster Resilience for SDGs | AKG |
| 1200 hrs-1300 hrs | Vulnerability assessment for water security and its hands-on training | JP |
| 1500 hrs-1600 hrs | Resilience of Terrestrial Ecosystems to Droughts | AS |
| 1600 hrs-1700 hrs | Wastewater treatment & management for water security | RS |
| **Day 3: November 04, 2020 (Wednesday)** | | |
| 1100 hrs-1200 hrs | Village level water security assessment | SMS |
| 1200 hrs-1300 hrs | Village level water security assessment- hands on training | SMS |
| 1500 hrs-1600 hrs | Water security through resilient water bodies | VCG |
| 1600 hrs-1700 hrs | Nature inspired thinking in ecologically sustainable water management and resilience | PD |
| **Day 4: November 05, 2020 (Thursday)** | | |
| 1100 hrs-1200 hrs | Towards Water Resilient Cities: Measuring urban water security as a first step to achieving it. | VS |
| 1200 hrs-1300 hrs | Group Exercise- DPSIR framework | VS |
| 1500 hrs-1700 hrs | Group exercise (4 groups) | Organisers |
| **Day 5: November 06, 2020 (Friday)** | | |
| 1100 hrs-1300 hrs | Group presentations<br>Discussion/ Feedback | Organisers |

AD: Ms. Anupama Datta, Helpage India
AKG: Dr Anil K Gupta, NIDM
GA: Dr Giriraj Amarnath, IWMI
JK: Dr. Jagdish Krishnaswamy, ATREE
JP: Dr. Jyoti Patil, NIH
AS: Dr. Ashutosh Sharma, PSU, USA
PD: Mr. Prashant Dhawan, Biomimicry India
RS: Dr. Rajesh Singh, NIH
SMS: Dr. Sudhindhra Mohan Sharma, Indore
VCG: Dr. V.C. Goyal, NIH
VS: Dr. Victor R. Shinde, NIUA

## Annexure-II

## Brief Profile of invited speakers

**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 the Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP) of UNESCO. Dr. Goyal has more than 33 years of research experience in the field of hydrology. He is the editor of various journals and newsletters of NIH. He has over 150 publications in international/ national referred journals, book chapters, reports, and conference proceedings. Dr. Goyal is Principal Investigator of various sponsored projects of World Bank, DST, and Ministry of Jal Shakti, GoI at the institute. His skills include 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. Jagdish Krishnaswamy**

Dr. Jagdish Krishnaswamy has a B. Tech. in Civil Engineering from Indian Institute of Technology, Mumbai, India and an M.S. in Statistics and Decision Sciences and a Ph.D. in Environmental Studies, Duke University, North Carolina, USA. His research and teaching interests include ecohydrology, landscape ecology, conservation planning, ecosystem services, and applications of bayesian approaches in understanding complex changes in the environment over space and time.

He has coordinated the establishment of instrumented catchments in the Western Ghats and in the Himalayas to study the impacts of land-cover and climate variability on hydrological processes. Dr. Jagdish has recently become involved in defining and assessing ecological flow requirements of rivers in the Western Ghats and the Ganga basins with a special focus on endangered species such as the gharial and river dolphin. His work on climate science and climate change includes vegetation response to climate and land-cover change in India, Central America, and Africa. Over the years, his work has contributed to various policies and actions such as the declaration of the Western Ghats as a UNESCO World Heritage Site, the investment of the Critical Ecosystem Partnership Fund in the Western Ghats, and a special report on Himalayan Springs to the NITI Aayog. He has designed capacity building and field hydrology training courses for aquatic ecologists and grassroots NGOs. He is a Coordinating Lead Author of the Special IPCC Report on *climate change, desertification, degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*.

**Dr. Anil K. Gupta**

Dr. Gupta is the former Head/Director, Institute of Environment and Development Studies, Bundelkhand University, Jhansi since 2003, he joined NIDM in 2006. Disaster mitigation and crisis management professional, Ph.D. (1995), Post-doctorate (CSIR, NEERI 1996), he possesses interdisciplinary expertise, with institutional development– administration and management, coordinated several international/national projects, over 100 publications

including 10 books and 45 papers, guided Ph.D. research. His special contributions were in preparation of National DM Plan (including mitigation & response plan), National HR Plan for DRM, Perspective Plan for NIDM's strengthening, Strategy on Climate Change, NAP on Chemical Disasters, international cooperation with GIZ, UNEP, UNDP, ISET-US, UNU-EHS, UNESCO, CKDN, ICIMOD, NORAD, World Bank, etc. and coordination with States/UTs for DM capacity building/training matters. Areas include risk/vulnerability analysis, DMP, PDNA, CCA-DRR, housing safety & local emergency preparedness, DM planning, governance, etc. He also served NMDC, DMI, NEERI, and CICON in administrative/technical capacities. He is the coordinator of the Technical Advisory Committee of NIDM, a member of the Governing Council & Academic/Research Advisory of several institutions, and High level/Ministerial delegation abroad.

**Dr. Giriraj Amarnath**

Dr. Giriraj Amarnath is a remote sensing researcher specialized in the application of Remote Sensing and Geographic Information Systems in the study of risk assessment across a wide range of natural hazards and monitoring land and water resources in Asia and Africa. He has over 13 years' experience in research including 3 years in academics at the University of Bayreuth, Germany. He has researched the: (i) mapping flood inundation extent in south Asia and south-east Asia, (ii) global flood hotspots assessment for climate risk studies, (iii) piloting operational flood mapping and modeling in Eastern Sudan, (iv) snow cover mapping and monitoring in the Hindu-Kush Himalayas, (v) vegetation cover change and biodiversity assessment in the Western Ghats (India), Sagarmatha National Park (Nepal), (vi) species niche modeling for endangered plants species in the Western Ghats (India), (vii) environmental impact assessment using RS/GIS and (viii) relationship between upstream-downstream linkages in Indo-Gangetic plain and the possible causes of climate change impacts in this region. In recent years he has become interested in studying the relationship between land cover/use changes, hydrology, the impact of flooding on food security and livelihood. He is applying his expertise in geospatial technology in a recent project that assesses south Asia exposure and vulnerability towards climate hazards. Giriraj's academic and professional work has given him substantial experience including time living and working in India, Nepal, Germany, South Asia, Southeast Asia, and Eastern Africa.

**Ms. Anupama Datta**

Ms. Datta is working with HelpAge India for the last 17 years and heading the Policy Research and Development Department for the last 12 years. The department deals with policy research and advocacy for the Rights of Older Persons in the Country.

The main research projects undertaken were on elder abuse, pensions, enabling environment, laws for the protection of older persons, and the impact of natural disasters on older persons. Advocacy initiatives include organizing seminars and discussions on various topics concerning aging and aged in India. She is Editor of HelpAge India Research and Development Journal and author of 16 published articles on aging issues.

**Dr. Sudhindra Mohan Sharma**

Mr. Sudhindra M. Sharma is a Geologist, specializing in Groundwater and Drinking Water. His passions include water, the environment, rural development, community service, and working for youth development. He has been awarded by Govt. of M.P. for his work on Biodiversity

Conservation. He is a member of the Working Group of the National Institute of Hydrology, Roorkee, India. He is also the trustee of Jal evam Talaab Sanrakshan Samiti Trust, Indore. He has participated in various Interviews and talk shows on Radio (AIR, Gyaanvani, IGNOU, and Radio Philippines) and T.V. (DD, Star News, Zee News, India TV, CNBC, and News Nation, *etc.*) on water conservation, water pollution studies, and water management. He was the Team Leader of the International Youth Exchange Team of Rotary International to Malaysia. He is the faculty of Rotary Leadership Institute – South Asia.

**Dr. Rajesh Singh**

Dr. Rajesh Singh is a Scientist (Environment) at the National Institute of Hydrology, Roorkee and he is an awardee of the prestigious Water Advanced Research and Innovation Fellow by Indo-US Science & Technology Forum and Govt. of India. Dr. Singh received his M.Sc. and Ph.D. in Chemistry from V.N. South Gujarat University, Surat. He is actively involved in research, training, and consultancy activities related to water quality and pollution abatement at the National Institute of Hydrology, Roorkee since 2011. Before joining NIH, he was a Technical Manager at Ion Exchange (India) Limited, Mumbai, where he was involved in designing water and wastewater treatment systems based on IX, RO, FMR, MBR, UASBR, AOX, *etc.* His current research focuses on water quality monitoring, GHGs emissions, pollution abatement, nutrient remediation, and microbial induced contaminant mobilization. He has published more than 20 papers in peer-reviewed journals/conferences and 1 patent. He has made more than 30 presentations at various national/international conferences/workshops. He has successfully handled more than 10 sponsored and consultancy projects. Currently, he is involved in 8 major research projects fundedby DST, MoWR, RD & GR, World Bank, and other funding agencies. He is also holding the position of Joint Secretary, Indian Association of Hydrologists, Roorkee.

**Dr. Jyoti P. Patil**

Dr. Jyoti P. Patil is a Scientist at the National Institute of Hydrology, Roorkee. She completed her Ph.D. 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 modeling, 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 the Indian National Committee for Intergovernmental Hydrological Programme (INC-IHP) at NIH. At her institute, she is involved in wastewater treatment projects, IWRM formulation, and rejuvenation of village ponds studies.

**Dr. Victor R. Shinde**

Dr. 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 the interdisciplinary sector (required for this technical assistance), and also in relation to climate change.

**Mr. Prashant Dhawan**

Mr. Dhawan is the co-founder and Director of Biomimicry India, Bangalore. Mr. Dhawan has actively involved in spreading the knowledge of biomimicry and has conducted biomimicry talks and workshops at various colleges, corporate offices, conferences as well as talks and workshops across India. He prefers to see himself as an amateur.

**Dr. Ashutosh Sharma**

Dr. Ashutosh is a Postdoctoral Scholar in the Department of Civil and Environmental Engineering of The Pennsylvania State University, USA. He has a B. Tech. degree in Civil Engineering from NIT, Hamirpur, and an M. Tech. degree in Water Resources Engineering and Management from IIT, Guwahati. During his Ph.D. at IIT Guwahati, he worked on a resilience-based approach to examine the response of terrestrial ecosystems to droughts. He has also worked at the University of Nebraska-Lincoln (UNL), USA and McGill University, Canada under Water Advanced Research and Innovation (WARI) and Shastri Indo-Canadian Institute (SICI) fellowships, respectively. He is interested in interdisciplinary research to understand the hydro climatological processes and their connections to the natural-human world.

## Annexure-III

## List of Participants

| S.N. | Name of the participants | Designation | Name of Department/ Organization |
|---|---|---|---|
| 1. | Mohan Patil | PG Engg. Trainee | Tata consulting Engineers Ltd. |
| 2. | Parag Dilip Mahajan | Project Assistant | CSIR-NEERI |
| 3. | Gagandeep Singh | Technical Officer | Punjab Biodiversity Board |
| 4. | Nishant Kumar Mohapatra | Research Scholar | Sambalpur University, Odisha |
| 5. | Osheen | Research Scholar | WRDM, IIT, Roorkee |
| 6. | Lingaraj Dhal | Research Scholar | WRDM, IIT, Roorkee |
| 7. | Sachchidanand Singh | Research Scholar | Indian Institute of Technology, Roorkee |
| 8. | Jayshree Hazarika | Assistant Professor | Civil Engineering Department, Assam Engineering College |
| 9. | Sudhanshu Dixit | Assistant Professor | Civil Engineering Department, L.D. College of Engineering, Ahmedabad |
| 10. | Dr. Nirban Laskar | Assistant Professor | Department of Civil Engineering, Mizoram University |
| 11. | Kumar Mayank Singh | Research Scholar | Water Resources Engineering Dept., MNNIT, Allahabad |
| 12. | Vithlani Nipa Sunilbhai | Ph.D. Research Scholar | Soil and Water Engineering, Junagadh Agricultural University, Gujarat |
| 13. | Dr. Thenmozhi M. | Scientist | Training Education and Extension Division, Centre for WRD&M, Kozhikode |
| 14. | Abinaya Balu | Research Scholar | CCCDM, Anna University, Tamil Nadu |
| 15. | Dr. Mahesh Prasad Tripathi | Assistant Professor (Agriculture Engineering) | Eternal University, H.P. |
| 16. | Dr. Sandeep Kumar Pandey | Assistant Professor | Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, U.P. |
| 17. | Dr. Sushindra Kumar Gupta | Assistant Professor | Poornima University, Jaipur |
| 18. | Santhosh Kumar S. | Assistant Professor | Civil Engineering Dept., JEPPIAAR SRR Engineering College, Chennai |
| 19. | Dr. Surendar N. | Research Scholar | Civil Engineering Dept., NIT, Trichy |
| 20. | Vaibhav Deoli | Assistant Professor | Department of Civil Engineering, DBGI, Dehradun |
| 21. | Tabasum Rasool | Research Scholar | NIT, Srinagar |
| 22. | Archana Kumar Yereseme | Assistant Professor | BMS Institute of Technology and Management, Bangalore |

| | | | |
|---|---|---|---|
| 23. | Supriya Nath | Research Assistant | Central Water and Power Research Station, Pune |
| 24. | Anita | Ph.D. Research Scholar | G.B. Pant University of Agriculture & Technology, Pantnagar |
| 25. | Shekhar Saini | Senior Research Assistant | NIH, Roorkee |
| 26. | Anup Kumar Dey | Research Scholar | Delhi School of Economics, University of Delhi |
| 27. | Rohit Sambare | Scientist-'B' | National Institute of Hydrology, Roorkee |
| 28. | Abinash Dalai | Research Scholar | SVCAET & RS, Indira Gandhi Krishi Vishwavidyalaya, Raipur |
| 29. | Pallavi Kulkarni | Research Scholar | Department of Geography, Savitribai Phule Pune University, Pune |
| 30. | Shilpa Singh | Research Scholar | WRDM, IIT, Roorkee |
| 31. | Sashikant Sahoo | Research Scholar | Centre for Excellence in Disaster Mitigation and Management, IIT, Roorkee |
| 32. | Bhaskar Pratap Singh | Research Scholar | Department of Farm Engineering, Institute of Agricultural Sciences, BHU, Varanasi |
| 33. | R. Balakrushna Reddy | Research Scholar | IIT (ISM), Dhanbad |
| 34. | Ranju Chapagain* | Ph.D. Research Scholar | University of Tasmania, Australia |
| 35. | Sonu Kumar* | Student | Asian Institute of Technology, Thailand |
| 34. | Naba Raj Dhakal* | Hydrologist | Recham Consult Pvt. Ltd., Kathmandu, Nepal |
| 35. | Salina Shrestha* | Research and Program Co-ordinator | Center of Research for Environment, Energy and Water, Ekkacheen, Lalitpur, Nepal |

*Foreign participants

**Annexure-IV**

**Feedback form**

# The questionnaire used for participants' evaluation of the training course

Dear participant! We would like to kindly ask you to complete this evaluation form. Your feedback will help us to improve future training workshops. Please rate each category from 1 to 5 (1= very bad, 2= bad, 3= medium, 4= good, and 5= very good).

*Required

Name (As required in participation certificate)*

_____

E-mail ID (to which you will get your certificate)*

_____

| | 1 Very bad | 2 Bad | 3 Medium | 4 Good | 5 Very good |
|---|---|---|---|---|---|
| Content of the presentations* | | | | | |
| Methodological approach of the trainer/s* | | | | | |
| Performance of the trainer/s* | | | | | |
| Group exercises* | | | | | |
| Group dynamics* | | | | | |
| Degree to which were your expectations satisfied* | | | | | |
| Length (number of hours) for each topic* | | | | | |

Please indicate specific comments or suggestions on the training*

_____

_____

In your view, are there any aspects that should be further discussed?*

_____

_____

Many thanks indeed for your feedback!

## Annexure V

## Certificate of Participation

United Nations Educational, Scientific and Cultural Organization

Indian National Committee for Intergovernmental Hydrological Programme

# CERTIFICATE

of Participation

THIS CERTIFICATE IS PROUDLY PRESENTED TO

*Archana Kumar Yereseme*

He/She has successfully attended the 05-day virtual training course on "Water security for resilience to deal with disasters and outbreaks" organized by National Institute of Hydrology, Roorkee under the aegis of Indian National Committee (INC) for Intergovernmental Hydrological Programme (IHP) of UNESCO, during 02-06 November, 2020.

(Dr. Jyoti P. Patil)
Scientist- D, NIH
Course Co-Coordinator

(Dr. V. C. Goyal)
Member-Secretary, INC-IHP
Course Coordinator

(Dr. J.V. Tyagi)
Director, NIH