Temporary Registration No. : TPN / 100119

सत्यमेव जयते
Ministry of Science & Technology
Government of India

Project Proposal On

"Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions"

Submitted to

Division : Water Technologies Cell

Programme or Scheme : DST Water Technology Call for Proposals 2023

Submitted by

Project Investigator:

Dr. Sumit Sen

INDIAN INSTITUTE OT TECHNOLOGY ROORKEE-Roorkee

Swami Rama Himalayan University
Director Research

Part 1 : General Information

General Information:

Name of the Institute/University/Organisation submitting the Project Proposal :

INDIAN INSTITUTE OT
TECHNOLOGY ROORKEE

State	Uttarakhand
Principal Investigrator Name:	Dr. Sumit Sen
Category:	General
Type of the Institue :	Academic Institutions(Government)
Project Title :	Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions
Division :	Water Technologies Cell
Programme Or Scheme :	DST Water Technology Call for Proposals 2023
Thematic Area :	Water Availability, Distribution, and Management
Stream :	Technology Development
Academic Area :	Earth and Atmospherical Science, Civil Engineering,
Application Area :	Security, Water,
Goverment National Initiative :	Swasth Bhart, Swachh Bhart, Nammami Gange,
Type of Proposal :	Proposal Against Call
Project Duration :	2 Years
Proposal Submit Date :	27/09/2023
Project Keywords :	Rainwater Harvesting, Water Quality, Implementation, Groundwater Recharge

Project Summary :

Objectives
•Development of innovative and sustainable field-scale direct injection system for recharging the depleted or dried-up aquifers with harvested rainwater collected through handpumps/borewells in hilly regions.
•Development of pilot scale prefabricated filtration system for treatment of rainwater.
•Comprehensive assessment on aquifer recharge, water quality and risks from direct injection technique.

Methodology
•Phase 1 Situational assessment
The initial phase involves assessing hydrological conditions, analyzing high-resolution hydro-meteorological data, examining physiographical characteristics, and conducting hydrological modelling for sustainable water resource management.
•Phase 2 Roof-Top Rainwater Harvesting Assessment
In this phase, a thorough assessment of rainwater harvesting potential will be conducted by using advanced GIS tools to measure rooftop areas within the study site. This data will be used to estimate the volume of rainwater available for groundwater recharge through a direct injection system integrated with selected wells.
•Phase 3 Geological Assessment During this phase, an extensive geological assessment will focus on the impact of rainwater recharge on groundwater dynamics. This includes examining the lithological and structural framework, including bedrock fractures and foliations, to gain insights into groundwater occurrence and movement.
•Phase 4 Water Quality Assessment
In this phase, a thorough water quality analysis will be performed on harvested rainwater intended for groundwater recharge. The goal is to identify contaminants and, if found, assess health risks specific to the study area.
•Phase 5 Development of Graded Filter Media
This phase will focus on developing an efficient purification and filtration system using graded filter media. Laboratory column infiltration tests will optimize filter media size and efficiency under vertical flow and fluctuating head conditions, providing insights into the impact of different depths of graded filter media on filtration rates and clogging tendencies.
•Phase 6 Measurement of Enhanced Groundwater
In the final phase, the Water Table Fluctuation WTF method will be used to measure increased groundwater levels in previously depleted aquifers. Additionally, the impact of direct injection on the discharge and water quality of downstream springs will be assessed by measuring spring discharge and water quality before and after injection.

Deliverables
Detailed designs and technical specifications for prefabricated direct injection of rainwater to the aquifers.
Reports and data on effect on discharge water quality of aquifer and springs located downstream of the injection site.
Development of a high efficiency filtration system which will supply treated water to handpump/borewell.
Preparation of reports on the operation, maintenance, and performance of the graded filter media and direct injection system and identifying and evaluation of systems drawbacks, if any.
Capacity building of the community for operation and maintenance of the direct injection system.

Part 2: Particulars of Investigators

Principal Investigator:

1. Name:	Dr. Sumit Sen
Gender:	Male
Date of Birth:	20/10/1978
Designation :	Associate Professor
Department:	Hydrology
Institute/University:	INDIAN INSTITUTE OT TECHNOLOGY ROORKEE
State:	Uttarakhand
District:	Haridwar
City/Place:	Roorkee

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Fax:	
Category:	General

Co-Investigator:

1. Name:	Er. Harsh Pati Uniyal
Gender:	Male
Date of Birth:	25/11/1952
Designation :	Honorary Advisor
Department:	WATSAN
Institute/University:	SWAMI RAMA HIMALAYAN UNIVERSITY
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City/Place:	Dehradun
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Category:	General
2. Name:	Er. Neelima Garg
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Date of Birth:	01/06/1965
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Institute/University:	UTTARAKHAND JAL SANSTHAN
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Mobile:	9411110575
Phone:	
Fax:	
Category:	General
3. Name:	Mr. Nitesh Kaushik
Gender:	Male
Date of Birth:	11/03/1974
Designation :	Deputy Director
Department:	SWAMI RAMA HIMALAYAN UNIVERSITY
Institute/University:	SWAMI RAMA HIMALAYAN UNIVERSITY
State:	Uttarakhand

District:	Dehradun
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Category:	General

4. Name: Dr. Srikrishnan Siva Subramanian

Gender:	Male
Date of Birth:	16/07/1990
Designation :	Assistant Professor
Department:	Centre of Excellence in Disaster Mitigation and Ma
Institute/University:	INDIAN INSTITUTE OF TECHNOLOGY, IIT ROORKEE
State:	Uttarakhand
District:	Haridwar
City/Place:	Roorkee
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Category:	General
5. Name:	Dr. Ashutosh Sharma
Gender:	Male
Date of Birth:	09/03/1993
Designation :	Assistant Professor
Department:	Department of Hydrology
Institute/University:	INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
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District:	Haridwar
City/Place:	Roorkee
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Pin:	247667
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Category:	General

Part 3: Suggested Refrees

Suggested Refrees:

1. Name:	Debashish Sen
Mobile:	
Designation :	Director
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Institute/University:	PEOPLE'S SCIENCE INSTITUTE
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Academic Area:	
Application Area:	
State:	Uttarakhand
District:	Dehradun
City:	
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2. Name:	Badrish Mehra
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Designation :	Executive Director
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Academic Area:	
Application Area:	
State:	Uttarakhand
District:	Nainital
City:	Nainital
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Pin Code:	263158

3. Name:	V C Goyal
Mobile:	
Designation :	Retired Scientist
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Institute/University:	NATIONAL INSTITUTE OF HYDROLOGY ROORKEE
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Academic Area:	
Application Area:	
State:	Uttarakhand
District:	Haridwar
City:	Roorkee
Address:	National Institute of Hydrology Roorkee-247667 (Uttarakhand)
Pin Code:	247667

Part 4: Financial Details

Financial Details:

A. Non - Recurring

Equipment

S.	Equipments	Qty.	Justification	1 Year	Total
1 .	Altimeter for site level measurement 4 Nos.	4		7000	7000
2 .	Automatic Weather Station 1No	1		250000	250000
3 .	Bruton Compass 4 Nos.	4		4400	4400
4 .	Digital Depth Sensors 15 Nos	15		7500	7500
5 .	Digital Flow Meter for spring discharge 15 Nos.	15		277500	277500
6 .	Digital Rain Gauge 4 Nos	4		54000	54000
7 .	GPS for study area coordinates 3 Nos.	3		73500	73500
8 .	Graded Filter Media	2		100000	100000
9 .	Hammer with soft Chisel 4 Nos.	4		4800	4800
10 .	Physical Parameter testing probe 2 Nos	2		29000	29000
11 .	V-Notch 12 Nos.	12		780000	780000
			Total	**1587700**	**1587700**

B. Recurring

Project Staff

S.	Project Staff	No.	Justification	1 Year	2 Year	Total
1.	Others	2	16740/m each field worker for SRHU. Manpower is needed for various field survey data collection and sample collection and to run field scale experiments and support to installation on site.	401760	401760	803520
2.	Research Associate-I	1	58000+10% HRA per month for IITR. A scientific study is needed for successful of this project. RA can use their skills along with research expertise for successful completion of this project.	765600	765600	1531200
3.	Research Associate-II	1	61000 + 10% HRA per month for SRHU. Research Associate with specialization in the particular field is needed for lab scale experiments	805200	805200	1610400
4.	Senior Research Fellow (SRF)	1	42000 + 10% HRA per month for SRHU. SRF is needed for field scale study and will support research.	554400	554400	1108800
			Total	**2526960**	**2526960**	**5053920**

Consumables

S.	Items	Qty.	Justification	1 Year	2 Year	Total
1.	Consumables for IITR	1	For IITR:Chemicals use in lab scale (Cost at least 1,00,000) for testing water quality parameters. Office stationary including files, document register papers, pen, pencils etc and maintenance of office equipment(40,000 for 2 years)	200000	200000	400000
2.	Consumables for SRHU	1	For SRHU:It includes material (Pabbles, sand and charcoal and other materials) which will be used in field demonstration @Rs.10,000/site field demonstration at least 10 site cost 1,00,000. Office stationary required for printing photocopy and other stationary item @2500/month for two years 60,000. lab scale and pilot scale testing required consumables e.g material use in optimize the efficiency of graded filter media and other lab test minimum of 3,00,000	230000	230000	460000
			Total	**430000**	**430000**	**860000**

Contingency

S.	Description	Justification	1 Year	2 Year	Total
1.	Contingency for IITR	The amount proposed for this purpose will be utilized in registration fees in national and international conferences 30,000/year for national conferences and 70,000/year international confrences. The approximate amount of 50,000 will also use to report printing and publicity of the designed product .	150000	150000	300000
2.	Contingency for SRHU	Time to time maintenance of product and supply main will be required quarterly approximate cost 5000/site/quater (2,00,000 for 2 years, 5 sites) and, 20,000 for national conferences and 50,000 international conferences and 1,00,000 for accussation of services of gov/non gov department like UJS, Payjal Nigam etc, IMD etc.	185000	185000	370000
		Total	**335000**	**335000**	**670000**

Travel

S.	Description	Justification	1 Year	2 Year	Total
1.	Travel for IITR	Grant has been proposed to carry out characterization at study area or site and other institutes or universities including travel, boarding, and lodging (bimonthly basis), to travel, boarding, and lodging for national and international conferences and workshops by flight or train. The travel will be undertaken by the manpower and the investigators involved in the project (bimonthly basis).	200000	200000	400000

2 .	Travel for SRHU	Grant has been proposed to carry out characterization at study area or site and other institutes or universities including travel, boarding, and lodging (bimonthly basis, approximately 35,000/month), to national and international conferences and workshops (2,00,000/year) by flight or train. The travel will be undertaken by the manpower and the investigators involved in the project (bimonthly basis).	600000	600000	1200000
		Total	**800000**	**800000**	**1600000**

Overhead

S.	Description	Justification	1 Year	2 Year	Total
1 .	Overhead	IITR	146560	146560	293120
2 .	Overhead	SRHU	439521	439521	879042
		Total	**586081**	**586081**	**1172162**

Any Other Recurring

S.	Description	Justification	1 Year	2 Year	Total
1 .	Other Cost for SRHU	Installation of product including labour and transportation is required for study at least 5 sites will select and cost approx. 2,45,000/site, 5 sites which include supply and lying PVC pipe at a depth of 3' below the surface which will cost 350/cum. considering at least 150m excavation on each site, in dist. Tehri and Pauri as mentioned. Small civil work also required for construction of intake chamber which cost approx 5,000 at each site.	825000	825000	1650000
2 .	Other Cost for IITR	Soil and water quality parameter testing	150000	150000	300000
		Total	**975000**	**975000**	**1950000**

Budget Head Summary in (INR)

Budget Head	Year-1	Year-2	Total
1- Non-Recurring			
Equipment	1587700	0	**1587700**
Subtotal (Capital)	1587700	0	**1587700**
2- Recurring			
Project Staff	2526960	2526960	**5053920**
Consumables	430000	430000	**860000**
Contingency	335000	335000	**670000**
Travel	800000	800000	**1600000**
Overhead	586081	586081	**1172162**
Any Other Recurring	975000	975000	**1950000**
Subtotal (General)	5653041	5653041	**11306082**
Total Project Cost (Capital + General)	**7240741**	**5653041**	**12893782**

Part 5: PFMS Details

PFMS Unique Code Available: Yes

PFMS Unique Code : iitru

Part 6: Current Ongoing Project

Current Ongoing Project: NA

List of Uploaded Documents:-

1. Complete Project proposal
2. Biodata
3. Certificate from PI
4. Conflict of interest
5. Endorsement from head of Institute
6. Quotation for Equipments

विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY

Water Technology Cell (WTC)
DEPARTMENT OF SCIENCE & TECHNOLOGY (DST)
विज्ञान एवं प्रौद्योगिकी विभाग (डीएसटी)
MINISTRY OF SCIENCE AND TECHNOLOGY
विज्ञान और प्रौद्योगिकी मंत्रालय
GOVERNMENT OF INDIA,
भारत सरकार
AUGUST 2023

COMPONENT/ STREAM APPLIED FOR:

Serial No.	Thematic Area	Stream *(Tick the most appropriate one)*	
A	Water Availability, Distribution, and Management	Applied Research	
		Technology Development	✓
		Technology Assessment	
		Convergent Solution	
B	Water Quality, Monitoring and Treatment	Applied Research	
		Technology Development	
		Technology Assessment	
		Convergent Solution	
C	Waste Water Recycling and Management for Industrial, Domestic and Community based Solution	Applied Research	
		Technology Development	
		Technology Assessment	
		Convergent Solution	

Note: Project Investigator may apply in any one of the above-listed thematic areas and choose the appropriate stream accordingly.

I. Proposal Summary

S. No.	File No.	*DST/WTC/2K23/* **(TO BE FILLED BY DST)**			
I	Title	**Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions**			
II	Project cost	123.87 Lakh			
III	Duration	*24 Months*			
III	PI Details	Name	Gender	Date of Birth	Category (General/SC/ST/Others etc)
		Dr. Sumit Sen	Male	20.10.1978	General
IV(a)	Advisor Details	Name	Gender	Date of Birth	Category (General/SC/ST/Others etc)
		Er. H.P. Uniyal	Male	25.11.1952	General
IV(b)	Co-PI Details	Name	Gender	Date of Birth	Category (General/SC/ST/Others etc)
		Ms. Neelima Garg	Female	24.07.1965	General
		Dr. Ashutosh Sharma	Male	09.03.1993	General
		Dr. S. Srikrishnan	Male	16.07.1990	General
		Sh. Nitesh Kaushik	Male	11.03.1974	General
V	Lead Organization	Indian Institute of Technology Roorkee, Uttarakhand			
VI	Lead Organization Status	Government autonomous institute			
VII	Partner/Collaborator Organization (CO)	Swami Rama Himalayan University (SRHU has signed MOU with IIT Roorkee for Research, MOU Attached)			
VIII	Partner/CO Status	State Private University			
IX	Objectives	• Development of innovative and sustainable field-scale direct injection system for recharging the depleted or dried-up aquifers with harvested rainwater collected through handpumps/borewells in hilly regions. • Development of pilot scale prefabricated filtration system for			

		treatment of rainwater. • Comprehensive assessment on aquifer recharge, water quality and risks from direct injection technique.
X	Methodology	• **Phase 1: Situational assessment:** The initial phase involves assessing hydrological conditions, analyzing high-resolution hydro-meteorological data, examining physiographical characteristics, and conducting hydrological modelling for sustainable water resource management. • **Phase 2: Roof-Top Rainwater Harvesting Assessment:** In this phase, a thorough assessment of rainwater harvesting potential will be conducted by using advanced GIS tools to measure rooftop areas within the study site. This data will be used to estimate the volume of rainwater available for groundwater recharge through a direct injection system integrated with selected wells. • **Phase 3: Geological Assessment:** During this phase, an extensive geological assessment will focus on the impact of rainwater recharge on groundwater dynamics. This includes examining the lithological and structural framework, including bedrock fractures and foliations, to gain insights into groundwater occurrence and movement. • **Phase 4: Water Quality Assessment:** In this phase, a thorough water quality analysis will be performed on harvested rainwater intended for groundwater recharge. The goal is to identify contaminants and, if found, assess health risks specific to the study area. • **Phase 5: Development of Graded Filter Media:** This phase will focus on developing an efficient purification and filtration system using graded filter media. Laboratory column infiltration tests will optimize filter media size and efficiency under vertical flow and fluctuating head conditions, providing insights into the impact of different depths of graded filter media on filtration rates and clogging tendencies. • **Phase 6: Measurement of Enhanced Groundwater:** In the final phase, the Water Table Fluctuation (WTF) method will be used to measure increased groundwater levels in previously depleted aquifers. Additionally, the impact of direct injection on the discharge and water quality of downstream springs will be assessed by measuring spring discharge and water quality before and after injection.
XI	Deliverables	*New/ Upgraded System;* ✓ Detailed designs and technical specifications for prefabricated direct injection of rainwater to the aquifers. ✓ Reports and data on effect on discharge & water quality of aquifer and springs located downstream of the injection site. ✓ Development of a high efficiency filtration system which will supply treated water to handpump/borewell.

		✓ Preparation of reports on the operation, maintenance, and performance of the graded filter media and direct injection system and identifying and evaluation of systems drawbacks, if any. ✓ Capacity building of the community for operation and maintenance of the direct injection system.

Note: Restrict the above information to a single A4 page size

File No.	*DST/WTC/2K23/* (TO BE FILLED BY DST)

II. Financial requirements: for SRHU

(Break-up of cost)

Sl no.	ITEM	Description		Individual sub-head cost	Total Amount (All figures in lakhs)
1	**MANPOWER**	1. Research Associate - II for 2 years 2. SRF for 2 years 3. Field Worker for 24 Months – 2 no.		16,10,400 1108800 8,03,520	3522720
2	**PERMANENT EQUIPMENT LIST**	Indigenous	1. Graded Filter Media 2. Altimeter for site level measurement 4 Nos. 3. GPS for study area coordinates 3 Nos. 4. Digital Flow Meter for spring discharge 15 Nos. 5. Digital Rain Gauge 4 Nos. 6. Digital Depth Sensors 15 Nos. 7. Physical Parameter testing probe 2 Nos. 8. Bruton Compass 4 Nos. 9. V-Notch 12 Nos. 10. Hammer with soft Chisel 4 Nos. 11. Automatic Weather Station 1No	1. 1,00,000 2. 7,000 3. 73,500 4. 2,77,500 5. 54,000 6. 7,500 7. 29,000 8. 4,400 9. 7,80,000 10. 4,800 11. 2,50,000	15,87,700
		Foreign			
3	**OTHER COST**				16,50,000
4	**CONSUMABLES**				4,60,000
5	**TRAVEL**				12,00,000
6	**CONTINGENCIES**				3,70,000
7	**OVERHEADS CHARGES**				8,79,042
	GRAND TOTAL				**96,69,462**

Grand Total : 96,69,462

DST Share: 96,69,462

Collaborator share (if any) (Mention the Item & its amount):

Note: Kindly restrict the information to a single A4 page size

III. Financial requirements: for IITR

(Break-up of cost)

Sl no.	ITEM	Description		Individual sub-head cost	Total Amount (All figures in lakhs)
1	**MANPOWER**	Research Associate-I (PDF) for 2 years		15,31,200	15,31,200
2	**PERMANENT EQUIPMENT LIST**	Indigenous			
		Foreign			
3	**OTHER COST**				3,00,000
4	**CONSUMABLES**				4,00,000
5	**TRAVEL**				4,00,000
6	**CONTINGENCIES**				3,00,000
7	**OVERHEADS CHARGES**				2,93,120
	GRAND TOTAL				**32,24,320**

Grand Total : 32,24,320

DST Share: 32,24,320

Collaborator share (if any) (Mention the Item & its amount):

Note: Kindly restrict the information to a single A4 page size

IV. CORE PROPOSAL FORMAT

(Applied Research/ Technology Development/ Technology Assessment/Convergent Solution Stream)

Project Title Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

1. **Principal Investigator (PI)**
   Name: Prof Sumit Sen
   Designation: Head, Centre of Excellence in Disaster Mitigation and Management, Associate Professor
   Complete Address *(with city pin code)*: Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee – 247667, Uttarakhand, India
   Telephone & Mobile No. :91-1332-284754
   E-mail: Sumit.sen@hy.iitr.ac.in

2. **Co-Principal Investigator (Co-PI)**
   Name: Ms. Neelima Garg (Uttarakhand Jal Sansthan will lead in field implementation and scale up technology)
   Designation: Chief General Manager & HOD Uttarakhand Jal Sansthan
   Complete Address (with city pin code): Jal Bhawan, Nehru colony, Dehradun (248001)
   Telephone & Mobile No. :

3. **Co-Principal Investigator (Co-PI)**
   Name: Mr. Nitesh Kaushik
   Designation: Deputy Director, SRHU
   Swami Rama Himalayan University, Swami Ram Nagar
   Jollygrant, Dehradun, 248140
   Telephone & Mobile No. :+91-9837021771
   E-mail: niteshkaushikhiht@gmail.com

4. **Name: Dr. Ashutosh Sharma**
   Designation: Assistant Professor
   Complete address *(with city pin code)*: Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee – 247667, Uttarakhand, India
   Telephone & mobile No. : +91-7896880487
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5. **Name: Dr. S. Srikrishnan**
   Designation: Assistant Professor
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   Telephone & mobile No. : +91-8220923734
   Email: srikrishnan@dm.iitr.ac.in

6. **Collaborating Agencies/Industries**: **Swami Rama Himalayan University**

7. **Target Beneficiaries**
   Communities in mountainous regions relying on subsurface and groundwater sources, including springs and hand pumps, for their drinking water needs. The study will be conducted at 10 sites in the Tehri and Pauri districts of Uttarakhand. According to the State Government's information, a total of

3,517 hand pumps (6.93%) in Uttarakhand alone have been reported as non-operational due to the depletion or drying up of underground aquifers connected to these hand pumps. These hand pumps can be made operational immediately after installing this system.

8. Objectives of the Proposal

- Development of innovative and sustainable field-scale direct injection system for recharging the depleted or dried-up aquifers with harvested rainwater collected through handpumps/borewells in hilly regions.
- Development of pilot scale prefabricated filtration system for treatment of rainwater.
- Comprehensive assessment on aquifer recharge, water quality and risks from direct injection technique.

9. Critical Review of Status Identifying Gaps (*include references)*

Water, a fundamental component for sustaining life on Earth, is a critical resource. Freshwater, comprising merely 2.5% of the total water volume, is distributed unevenly (Gleick, 1993). Approximately 69% of freshwater exists as snow and ice in polar and mountainous regions, while around 31% constitutes groundwater (Gleick, 1993). The portion of freshwater available for terrestrial ecosystems, including human consumption, is less than 1% of the total freshwater and a mere 0.01% of Earth's overall water volume (Shiklomanov, 1999).

Groundwater, characterized by its superior quality, limited seasonal fluctuations, and consistent availability, has become a paramount natural resource in many regions worldwide. It is notably the sole source of domestic water supply in countries such as Denmark, Malta, and Saudi Arabia (UNESCO, 2004). Furthermore, groundwater constitutes over 70% of total water consumption in numerous European countries and holds primary significance for irrigation purposes in arid and semi-arid regions.

According to World Bank, India is the world's largest consumer of groundwater, utilizes approximately 320 km3/year, satisfying 85% of its drinking water needs and 60% of irrigation demands. However, around 30% of groundwater reserves are experiencing acute stress, particularly in highly productive areas. The combined effects of climate change and population growth are anticipated to intensify pressure on groundwater resources, posing significant challenges to sustainable development.

Natural springs, originating from aquifers, constitute the primary source of drinking, domestic, and agricultural water for mountain communities (Pandit et al., 2009; Valdiya & Bartarya, 1989; Jha et al., 2007). These springs represent discharge points where the saturated aquifer intersects with the surface, allowing water to emerge through rock pores, fissures, fractures, or depressions (Ford & Williams, 2007; White, 1988).

Aquifer and springs are highly regarded for their consistently superior water quality, year-round availability, and cost-effectiveness (Jha et al., 2007). Within the Indian Himalayan Region, aquifers

and springs serve as the predominant sources of domestic water supply (Niti Ayog, 2018; Valdiya & Bartarya, 1989; Chinnasamy & Prathapar, 2016; NDF, 2014; Adhikari et al., 2021). Their superior water quality renders them suitable for utilization in remote villages lacking the necessary infrastructure for water treatment. Despite the presence of snow-fed rivers in the Himalayas, upstream communities reap limited benefits due to the absence of distribution infrastructure along drainage routes. Consequently, surface water resources hold limited significance in these regions. Notably, over 60% of the rural population in the Himalayan area, along with 64% of total irrigated land, relies entirely on aquifers or spring water, according to estimates by NITI Ayog (2018).

Climate change and increasing human populations are exerting considerable stress on freshwater resources, both in terms of quality and quantity (Abdelzaher and Shehata, 2022). A decrease in the spring discharge in response to climate change has been observed all around the world such as in the Colorado Plateau (Weissinger et al., 2016); Picentini Mountains, Italy (Leone et al., 2021); Gafsa basin, Tunisia (Mokadem et al., 2018); Shanxi Province, China (Fan et al., 2013); and Himalayas (Poudel & Duex, 2017). Several studies suggest that a warming climate in the Himalayas is expected to worsen water scarcity (ICIMOD 2009; IPCC 2014; Vaidya et al. 2014). There is mounting evidence of accelerated depletion of Himalayan springs attributable to factors like altered precipitation patterns (Macchi et al., 2014), reduced winter rainfall (Tambe et al., 2012), rising temperatures (Pandey et al., 2018), deforestation (Valdiya & Bartarya, 1989), land use changes (Joshi et al., 2014), forest degradation (Rautela, 2015), including shifts in forest types (Ghimire et al., 2012; Naudiyal & Schmerbeck, 2015). Instances of declining spring discharge have been documented in Uttarakhand (Agarwal et al., 2012; Kumar & Sen, 2018). Studies by Mahamuni and Kulkarni (2012) and Tambe et al. (2011) have identified acute water shortages resulting from spring drying, particularly during dry seasons. Research by Chapagain et al. (2019) reveals that spring discharge has declined by over 30% over three decades in the mid-hill region of Nepal. Nearly half of perennial springs in the Indian Himalayas have either dried up or become seasonal (Rana & Gupta, 2009). Furthermore, seasonal springs in the Himalayan region experience more rapid recession than perennial ones (Rai et al., 1998).

The problem is exacerbated by the fact that Himalayan communities are solely dependent on springs for their water needs, and fluctuations in spring discharge can profoundly impact their domestic and drinking water supplies (NITI Ayog, 2018; Kulkarni et al., 2021). In the Himalayan region, natural springs provide 90% of drinking water in Uttarakhand (NITI Aayog, 2018), 43% of the total population in Nepal are spring dependent (Chapagain et al., 2019) in the Central Himalayan region, and 80% of rural households in Sikkim (Tambe et al., 2009) in the Eastern Himalayan region rely on springs. Although springs are essential in sustaining the livelihood and ecosystem of mountain communities (Kresic & Stevanovic, 2010), they are on the verge of drying up. The problem of spring water quantity and quality depletion has gained significant importance for a couple of decades due to the efforts of various organizations and independent researchers. Over the years, various watershed interventions have been executed in the Himalayan region to enhance the spring discharge in the susceptible areas (Singh et al., 2014). In the Himalayan region, the development of conceptual models has improved knowledge of spring sources and guided the conservation and restoration efforts in recent years (Government of Sikkim, 2014). Kulkarni (2008) used conceptual models to study the impact of hydrogeology on the groundwater resources in the Nainital district of Uttarakhand. Valdiya and Bartarya (1989) found that changes in vegetation and land-use patterns caused a 40% reduction in spring discharge from 1951 to 1986 in the Kumaon Himalayas, with 70%

of the springs completely dried up. Climate change and unsuitable watershed management are the cause of depleting discharge in Himalayan springs (Adhikari et al., 2021; Agarwal et al., 2012). According to ICIMOD (2015), the drying up of springs was caused by a combination of biophysical and socio-economic factors like land use, climate change, and spring maintenance. Vashisht (2008) concluded that the water shortage can be prevented if springs and small canals are properly managed. Jeelani (2008) used the area velocity method to monitor the discharge of 40 springs for 23 years (1982–2005) and found a decrease in spring discharge. The spring discharge was found to be impacted more by snowmelt than precipitation. The Himalayan springs, vital for sustaining mountain communities, face increasing stress due to various environmental and anthropogenic factors. Understanding and managing these aquifer and springs are critical for securing water resources and supporting the fragile Himalayan ecosystems, especially in the face of changing climatic conditions and growing population pressures.

With this background about the depleting groundwater, aquifer water levels, and springs discharge, this proposal is focused on the revival of the aquifers and increasing the discharge the springs located downstream of the aquifers through direct injection of rainwater in hilly regions.

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10. Outline of the Project (with schematics, where possible) (*Define the problems and give technical details)*

Water, an invaluable natural asset, necessitates prudent management and judicious utilization. Precipitation in the form of rain constitutes the exclusive primary source for replenishing this vital resource, yet the overall volume of rainfall remains constant. However, the increase in population and economic prosperity has created a huge demand for water, thereby exerting substantial strain on its availability. Agriculture continues to remain the largest consumer of water, and industrial demand is also growing at a rapid pace. The availability of water in hilly terrains perennially presents a daunting challenge.

India receives an annual precipitation (as snow and rainfall) of around 4,000 billion cubic meters. Of this the surface runoff (which means accessible water) is 1,869 billion cubic meters. Regrettably, a mere 690 billion cubic meters are effectively harnessed, while the remainder is lost as it drains into the sea due to the absence of comprehensive storage strategies. Compounding this issue, a substantial proportion of precipitation occurs during approximately 100 days of monsoon, despite the continuous requirement for water throughout the entire year. Consequently, the imperative necessity of formulating effective storage plans becomes evident, an arena in which India has encountered significant inadequacies. The per-capita water storage in India stands at a meager 190 cubic meters, in stark contrast to the figures of 5,961 in the United States, 4,717 in Australia, and 2,486 in China.

Paradoxically, in mountainous regions, heavy discharges occur in rivers and rivulets during rainfall, leading to flash floods and landslides. This phenomenon can be attributed to various factors such as the expansion of barren land, Pine (Cheer wood) forests, uncultivated agricultural land (approximately 9% increase), paved areas, and more. These factors contribute to increased surface runoff and reduced

infiltration and percolation, subsequently diminishing the recharge of groundwater. Natural waterways, valleys, and village ponds (chal/khal) are subject to encroachment, disrupting the smooth flow of rainwater. Incorporating rainwater harvesting techniques into the planning of rural and urban development projects will not only mitigate flooding but also enhance groundwater recharge, thus bolstering the sustainability of surface water sources. Continuous access to a reliable water source stands as a fundamental prerequisite for implementing any artificial recharge system.

The depletion of spring sources and flooding during the monsoon serve as indicators highlighting the imperative need for meticulous preservation of catchment regions and natural watercourses. At the individual household level, it has become paramount to eliminate wastage of water, necessitating active citizen involvement in the quest for solutions to address water scarcity while simultaneously aiding in the prevention of flooding incidents.

The process through which surface water is intentionally directed into an aquifer is termed as artificial recharge. Various strategies can be employed in runoff zones, recharge zones, and discharge zones to facilitate this process. The structures commonly used are chal/khal, contour channel, gully plugs, nalah bunds, check dams and percolation ponds bench terracing etc.

All the aforementioned engineering structure are based on the principle of infiltration and percolation. The selection of an appropriate site for the purpose of recharging underground water resources necessitates a comprehensive geo-hydrological examination. Upon the initial contact of rainfall with the ground, a sequence of events unfolds before the water can percolate into the soil: evaporation from the surface or pond, retention of moisture in the soil, and moisture allocation for vegetative cover. Consequently, only a fraction, typically ranging from 10% to 20%, of the total received rainfall has the potential to infiltrate into the underground aquifer. It is important to acknowledge the possibility that, even after the construction of the aforementioned structures designed for aquifer recharge, the intended recharge may not occur as expected. Such occurrences have been observed in numerous locations.

Presently, there exists a network of 10,162 hand pumps distributed across nine hilly districts in Uttarakhand, along with an additional 40,575 hand pumps deployed in three districts within the plains of Uttarakhand. Regrettably, a total of 3,517 hand pumps, comprising 2,000 in hilly regions and 1,517 in plains, have been reported as non-functional or inoperative due to a variety of factors. The principal cause of their malfunction is the depletion or drying up of the underground aquifers linked to these hand pumps.

A novel technique has been developed to repurpose these defunct or unused handpumps, enabling them to directly recharge the aquifers connected to them by harnessing approximately 80-90% of the rainwater collected from rooftops or surface runoff.

Details of Innovative Technology

1. Within the Himalayan region, the installation of hand pumps for potable water supply is contingent upon the confirmation of subsurface water sources or aquifers during their construction. These hand pumps are strategically placed at depths ranging from 50 to 80 meters in mountainous terrains and 30 to 60 meters in plains, thereby establishing a direct connection with these subterranean water reservoirs.

2. The dwindling aquifer levels have resulted in the dysfunctionality of these hand pumps. To restore their functionality, it is imperative to replenish the aquifers situated at depths of 50 to 80 meters. Additionally, recharging these subterranean aquifers will have a positive cascading effect on downstream water sources such as Dhara, Naula, Gad, and Gadhera, augmenting their discharge rates and long-term sustainability.

3. The implementation of this recharge method is poised to augment the moisture content in downstream lands, potentially revitalizing arid fields and fostering the growth of indigenous vegetation.

4. This innovative technology is designed to harvest rainwater from elevated rooftops and efficiently transport it to non-functional hand pumps via an interconnected network of pipelines, as illustrated in Figures 1 and 2. To safeguard against potential impurities or contaminants infiltrating the subterranean water source, the rooftop-collected rainwater undergoes filtration through a graded sand filter prior to entering the hand pump.

5. An additional pivotal objective of this innovative technique is to expedite the effective delivery of a minimum of 80% of the rainfall to the subterranean water source, thus mitigating losses through evaporation and other channels.

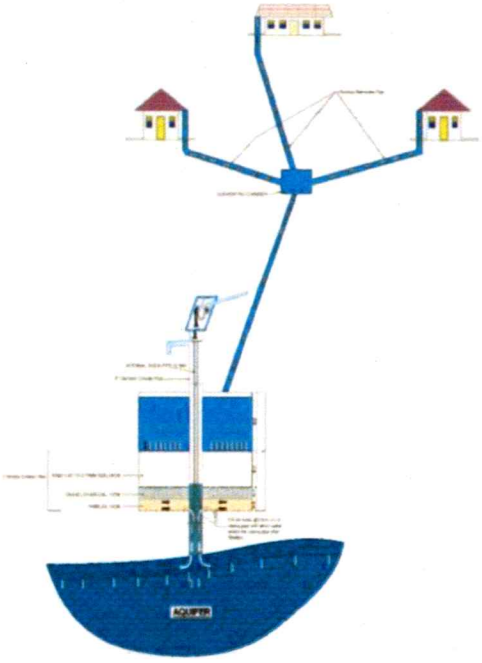


Fig 1 Schematic layout of the system

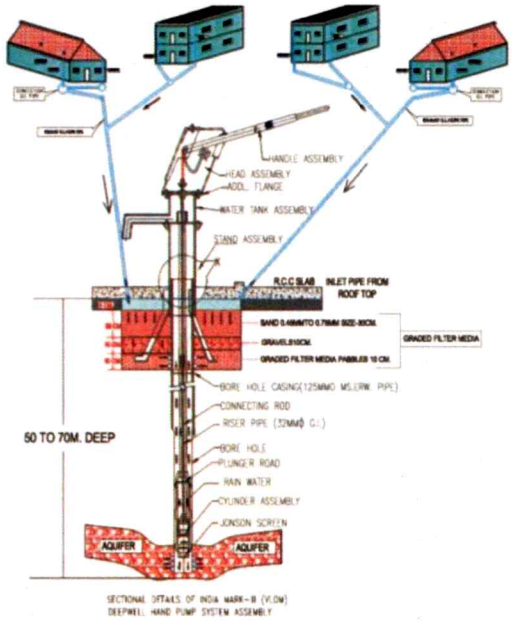


Fig 2 details of hand pump with surrounding filter assembly

11. Deliverables of the project (brief description)

i) New/ Upgraded System

- Detailed designs and technical specifications for prefabricated filtration system and direct injection of rainwater to the aquifers.
- A solution technology using graded filter media for removal of organic and inorganic pollutants from rainwater.
- Pilot scale prefabricated sustainable and cost-effective system implementing the developed graded filter media for filtering the harvested rainwater water and scale-up analysis and performance report.
- Reports on field scale performance of the graded filter media in the prefabricated system and treatment of the harvested rainwater.
- Extensive reports and data on the assessment of the influence of direct injection intervention

on the discharge of the springs located downstream of the injection site.

- Extensive reports on the recharging capacity or rate of recharge through direct injection.
- Detailed report assessing the suitability of the direct injection system for broader implementation.
- A detailed document outlining informed recommendations for policymakers regarding adoption of direct injection and filteration system.
- Analysis of technical, economic viability, and scalability potential

12. Methodology

The proposed study aims to develop an innovative and sustainable aquifer rejuvenation through direct injection of rainwater in the Indian Himalayan Region (IHR). The methodology of the proposed project as follows:

Phase 1: Situational assessment

The initial phase involves a thorough situational assessment to comprehensively evaluate the prevailing hydrological conditions within the study area. High-resolution hydro-meteorological data, encompassing precipitation and temperature, will be meticulously analyzed either in gridded or station-based formats. Concurrently, the physiographical characteristics of the study area, including soil type, land use/land cover (LULC), and topography, will be examined using recently acquired high-resolution datasets from diverse sources. Additionally, a hydrological modeling exercise will be conducted to estimate the surface runoff patterns, offering valuable insights into the hydrological dynamics of the region, thereby facilitating informed and sustainable water resource management

Phase 2: Roof-Top Rainwater Harvesting Assessment

During this phase, a comprehensive assessment of rainwater harvesting potential will be executed, focusing on the determination of rooftop areas within the study site. Advanced Geographic Information System (GIS) tools will be employed to accurately measure and quantify the total rooftop area within the study area. Subsequently, this measured rooftop area will serve as the basis for collecting and estimating the total volume of rainwater available for groundwater recharge through a direct injection system integrated with selected wells.

Phase 3: Geological Assessment

This phase will center on conducting an extensive geological assessment to investigate the influence of harvested rainwater recharge on groundwater dynamics. This will involve an in-depth examination of the lithological and structural framework of the study area, including the dominant orientations of bedrock fractures and foliations present within the geological formations. The geological assessment will provide crucial insights into the hydrological capabilities and structural attributes that impact groundwater occurrence and movement.

Phase 4: Water Quality Assessment

In this phase, a comprehensive analysis of water quality will be conducted on the harvested rainwater designated for groundwater recharge. The primary objective is to ascertain the presence of contaminants and, if detected, perform a health risk assessment specific to the study area. An appropriate collection site will be chosen to facilitate convenient rainwater sampling, followed by laboratory-scale testing aimed at detecting heavy metals and analyzing key parameters, including pH, conductivity, turbidity, major ions (e.g., nitrate, sulfate, chloride), heavy metals, and microbial indicators.

Phase 5: Development of Graded Filter Media

The development of an effective purification and filtration system, particularly employing graded filter media, will be undertaken in this phase. Graded filter media is widely employed in diverse filtration systems to manage pollutants and eliminate physical impurities. Addressing the issue of filter clogging, which often diminishes filtration efficiency, will be a primary focus. Optimization of filter media size and efficiency will be achieved through laboratory column infiltration tests, considering vertical flow conditions and fluctuating head conditions. This phase aims to provide a comprehensive understanding of the impact of varying depths of graded filter media on filtration rates and clogging tendencies.

Phase 6: Measurement of Enhanced Groundwater

The final phase involves the measurement of enhanced groundwater within previously depleted or dried-up aquifers, employing the Water Table Fluctuation (WTF) method, following established scientific protocols. Baseline data regarding the initial water table elevation in selected

handpumps/borewells will be collected before initiating recharge through direct injection systems. Subsequently, continuous monitoring over an extended timeframe will record water table fluctuations following recharge activities. This phase will culminate in the quantification of average water table rise in downstream areas, including previously depleted aquifers. Furthermore, the effect of the direct injection on the discharge and water quality of springs located downstream of the system will also be quantified by measuring the discharge and the water quality of the spring before and after direct injection.

Design and fabrication of field scale direct injection system:

Operating the direct injection system in the field and evaluating its performance: *A total number of 5 sites being selected for the study. These sites are located in district Tehri Garhwal & Pauri Garhwal of Uttarakhand the present situation and location with coordinates of few identified sites are as below:-*

District: Tehri Garhwal & Pauri Garhwal

S.No.	Gram Panchayat	Revenue village	Installation year	period of defunct	Downstream source & Distance	Present Status	Latitude	Longitude
1	Saud	Saud	2011	4-5 yrs	Source of Saud & Kakwadi village (500m)	no water availability	30.409857	78.345536
2	Kanatal	Kanatal	2011	4-5 yrs	Source of Sangaon(700m)	No water availability	30.415832	78.322276
3	Batwaldhar	Kalaban Tegna	2011	4-5 yrs	Source of Batwaldhar(500 m)	No water availability	30.415451	78.262432
4	Chureddhar	Chopdiyal gaon	2011	3-4 yrs	Chorgadna (500m)	Bed odour and red water	30.381615	78.366776
5	Kaddukhal (Market)	Kalaban Tegna	2011	less use	Source of Tegan(800m)	Bed odour water and less discharge	30.407798	78.287043

6.	Khandyusain-2	Ojali, Chawath			Ojali		30.156573	78.734812
7.	Kholachauri	Aryanagar			Kthuli Ghadera		30.15718	78.677076
8.	Lower Chopra (Shri Nagar Road)	Lower Chopra			Chopra Ghadera			
9.	Petrol Pump Shrinagar	Dandal Gaon			Lower Dhara Dandal gaon	30.138713	.78.791795	
10	Gunogi	Gunogi	2011	less use		Bed odour and red water	30.376205	78.368772
11	Kaddukhal	Kalaban Tegna	2011	5 yrs		Bed odour water and less discharge	30.406323	78.290297

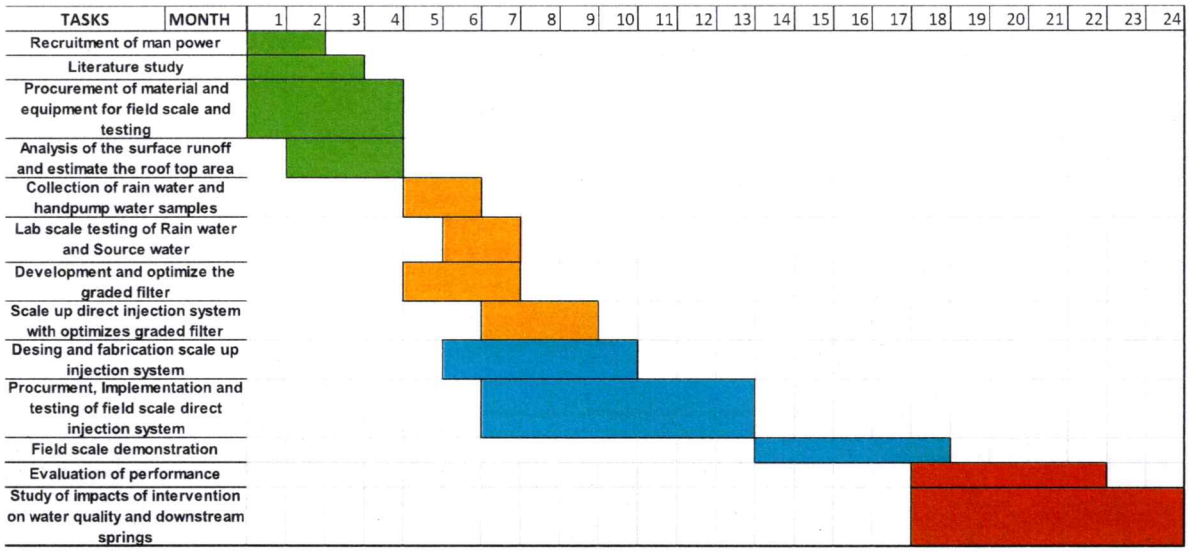
13. Milestones with Months, Work Elements & Responsible Organisation for each Work Element

S. No.	Milestone	Target Month	Work Elements	Responsible Organisation
1	Project Planning and study	1-4	1. Recruitment of man power 2. Literature study 3. Procurement of material and equipment for field scale and testing 4. Analysis of the surface runoff and estimation of the rooftop area available in the study site	SRHU/IITR
2	Lab scale development of graded filter for treatment physical and bacteriological contamination	5-9	1. Collection of rain water and handpump water samples 2. Lab scale testing of rain water and source water 3. Development and optimize the graded filter 4. Scale up direct injection system with optimize graded filter	SRHU/IITR

3	Scale up studies and field scale direct injection system	5-18	1. Desing and fabrication scale up injection system 2. Procurement, Implementation and testing of field scale direct injection system 3. Field scale demonstration	SRHU/IITR
4	Evaluation of performance	18-24	1. Evaluation of performance 2. Study of impacts of intervention on water quality and downstream springs	SRHU/IITR

14. Work Plan

(Attach bar chart giving project activities and milestones. Highlight Milestones)



15. Names of 5 Experts/Agencies/Institutions working in the similar area

(Please give complete Name, Designation, Address with pin code, telephone numbers & e-mail addresses)

Central Himalayan Rural Action Group
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P.O. Box : 3226, Ktm, Kathmandu, Nepal
Phone : 00977-5003222

Arghyam
599, Rohini, 12th Main road, 7th cros, Hall
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Phone Num : +91-8041698941

16. **Water challenges in the Identified site** *(for Convergent Solution Streams Only)*

N/A

17. **Role of the Solution designer and Solution provider in the deployment of Convergent Solution** *for Solution Streams Only)*

N/A

18. **Role of User/Utility Partner/Other Stakeholders in the consortia (***for Solution Streams Only)*

N/A

19. **Details of Beneficiaries** *(for Convergent Solution Streams Only)*
(in terms of Category (General/SC/ST/OBC/Others etc) *or benefit for Specific Geographical Region)*

N/A

20. **Any other information relevant to the Project proposal/ execution of the project**

V. Bio-Data of Principal Investigator (PI)

1. **Name** : Sumit Sen
2. **Gender** : Male
3. **E-mail ID** : sumit.sen@hy.iitr.ac.in
4. **Qualifications** :

S.No.	Degree	Institution	Year	Division/Class
1	PhD Civil Engineering., (Concentration: Biosystems engineering)	Auburn University (AU), USA	2009	
2	MS Biological and Agricultural Engineering	University of Arkansas, USA	2004	
3	BS Agricultural Engineering	Allahabad Agricultural Institute DU, India	2001	

4. **Employment Experience**

S.No.	Position & Organisation	Period
1	Head, Centre of Excellence in Disaster Mitigation and Management.	2021 - present
2	Associate Professor, Dept., of Hydrology, IIT Roorkee.	2018 - present
3	Assistant Professor, Dept., of Hydrology, IIT Roorkee.	2012 – 2018
4	Fellow, Ashoka Trust for Research in Ecology and The Environment, India.	2011 – 2012
5	Post-doctoral Fellow, Biosystems Engineering Department, AU.	2009 – 2011
6	Graduate Research Assistant, Biosystems Engineering Department, AU.	2005 – 2009
7	Graduate Research Assistant, Biological and Agricultural Engr., University of Arkansas.	2002 – 2004

5. **List of Publications** *(For last 5 years only)*

5.1 Journal Publications

- van de Giesen, N., Peña Haro, S., **Sen, S.** WMO HydroHub Innovation Snapshot: Introduction to non-contact technologies for hydrometry. **WMO HydroHub**, Issue 1, **2023**.
- Dass, B., Daniel, D., Saxena, N., Sharma, A., Sen, D., **Sen, S***. Informing watershed management in data-scarce Indian Himalayas. ***Water Security Journal*** 19, 100138, **2023**.
- Yadav, A., Boothroyd, R. J., Sambrook Smith, G. H., **Sen, S**. Morphological adjustments of the Yamuna River in the Himalayan foothills in response to natural and anthropogenic stresses. ***Hydrological Processes***, 37:e14934, https://doi.org/10.1002/hyp.14934, **2023**.
- Mukherjee, S., **Sen, S.**, Kumar, K. Multifactor prediction of the central Himalayan spring high-flows using machine learning classifiers. ***Environmental Earth Sciences***, 82: 85, **2023**
- Yasmin, T., Khamis, K., Ross, A., Sen, S., Sharma, A., Sen, D., **Sen, S**., Buytaert, W., Hannah, D. Brief Communication: Inclusiveness in designing early warning system for flood resilience. EGUSphere, ***NHESS,*** 23 (2), 667-674 **2023**.
- Subramanian, S. S., Srivastava, P., Yunus, A. P., Martha, T. R., **Sen, S**. Numerical model derived intensity-duration thresholds for early warning of rainfall-induced debris flows in the Himalayas.

NHESSD, doi.org/10.5194/nhess-2022-297, **2023**

- Meena, R.K., **Sen, S.***, Nanda, A., Dass, B., Mishra, A. A contribution to rainfall simulator design–a concept of moving storm automation. ***Hydrology and Earth System Sciences*** 26 (16), 4379-4390. **2022.**
- Orr, A., Ahmad, B., Alam, U., ….. **Sen, S.**, et. al. Knowledge priorities on climate change and water in the Upper Indus Basin: A horizon scanning exercise to identify the top 100 research questions in social and natural sciences. ***Earth's Future*** 10 (4), e2021EF002619. **2022.**
- Jameel, M., **Sen, S.,** Perumal, M. Evaluation of Sediment Management Techniques of Dokan Dam Accomplished with Climate Change Scenarios Using ResCon 2.2 Beta Model. ***Journal of Water Resources and Geosciences*** 1 (1), 117-124. **2022**.
- Yadav, A., **Sen, S.**, Mao, L., Schwanghart, W. Evaluation of flow resistance equations for high gradient rivers using geometric standard deviation of bed material. ***Journal of Hydrology*** 605, 127292. **2022**.
- Anandhi, A., Srivastava, P., Mohtar, R.H., Lawford, R.G., **Sen, S.**, Lamba, J. Methodologies and Principles for Developing Nexus Definitins and Conceptualizations: Lessons from FEW Nexus Studies. ***Journal of the ASABE.*** **2022.**
- Kumar, M*., Hodnebrog, Ø., Daloz, A. S., **Sen, S**., Badiger, S., & Krishnaswamy, J. Measuring precipitation in Eastern Himalaya: Ground validation of eleven satellite, model and gauge interpolated gridded products. ***Journal of Hydrology***, 599, 126252.2021. **2021**.
- Dass, B., **Sen, S***., Bamola, V., Sharma, A., & Sen, D. Assessment of spring flows in Indian Himalayan micro-watersheds–A hydro-geological approach. ***Journal of Hydrology***, 598, 126354.2021. **2021**.
- Kumar, V*., **Sen, S**., & Chauhan, P. Geo-morphometric prioritization of Aglar micro watershed in Lesser Himalaya using GIS approach. ***Modeling Earth Systems and Environment***, 7(2), 1269-1279. **2021.**
- Dass, B., **Sen, S***., Sharma, A., Hussain, S., Rana, N., & Sen, D. Hydrological process monitoring for springshed management in the Indian Himalayan region: field observatory and reference database. ***Current Science*** (00113891), 120(5). **2021.**
- Daniel, D., Anandhi, A., & **Sen, S***. Conceptual Model for the Vulnerability Assessment of Springs in the Indian Himalayas. ***Climate*** 9(8), 121. **2021.** https://doi.org/10.3390/cli9080121
- Musie, M., Momblanch, A., **Sen, S***. Exploring future global change-induced water imbalances in the Central Rift Valley Basin, Ethiopia. ***Climatic Change***, 164:47, doi.org/10.1007/s10584-021-03035-x. **2021**.
- Musie, M., **Sen, S***., Srivastava, P. Application of CORDEX-AFRICA and NEX-GDDP datasets for hydrologic projections under climate change in Lake Ziway sub-basin, Ethiopia. ***Journal of Hydrology: Regional Studies***, 31, 100721. **2020.**
- Nanda, A., **Sen, S***., Sharma, A. N., & Sudheer, K. P. Soil Temperature Dynamics at Hillslope Scale—Field Observation and Machine Learning-Based Approach. ***Water***, 12(3), 713, **2020**. **(Invited)**
- Kumar, V., **Sen, S***. Assessment of spring potential for sustainable agriculture: A case study in lesser Himalayas. ***Applied Engineering in Agriculture***, 36(1), 11-24, **2020**.
- Musie, M.; **Sen, S***. Chaubey, I. Hydrologic Responses to Climate Variability and Human Activities in Lake Ziway Basin, Ethiopia. ***Water***, 12, 164, **2020**.
- Musie, M., **Sen, S***., Srivastava, P. Comparison and Evaluation of Open Source Precipitation Datasets for Streamflow Simulation in Data Scarce Watersheds of Ethiopia. ***Journal of Hydrology***, 579, 124168. **2019**. https://doi.org/10.1016/j.jhydrol.2019.124168
- Nanda, A., **Sen, S***, McNamara, J.P. How spatiotemporal variation of soil moisture can explain hydrological connectivity of infiltration-excess dominated hillslope: Observations from Lesser Himalayan Landscape, ***Journal of Hydrology,*** 579, 124146, **2019**.
- Sonkar, I., Kotnoor, H. P., **Sen, S**. Estimation of Root Water Uptake and Soil Hydraulic Parameters

from Root Zone Soil Moisture and Deep Percolation. ***Agricultural Water Management***, 222:38-47, **2019.**

- Bhattaraia N., Mallick, K., Stuarta, J., Vishwakarma, B. D., Niraula, R., **Sen, S.**, Jain, M. An automated multi-model evapotranspiration mapping framework using remotely sensed and reanalysis data. ***Remote Sensing of Environment***, 229: 69-92. **2019**.
- Nanda, A., **Sen, S***., Jirwan, V., Sharma, A., Kumar, V. Understanding Plot-Scale Hydrology of Lesser Himalayan Watershed- A Field Study and HYDRUS-2D Modeling Approach. ***Hydrological Processes***, 32(9): 1254-1266, **2018**.

5.2 Invited Talks in Conferences

- **S. Sen.** Expert lecture on "Spring Instrumentation Hydrology – Experiences from Research Studies at the Ministry of Jal Shakti, New Delhi, 31 Jan, **2023**
- **S. Sen.** Keynote lecture on "Advances in the monitoring of forest hydrological processes" at the Forest Research Institute, Dehradun on 18th Feb. **2022**
- S. Sen. Delivered a lecture on "Ground Water Perspectives- Information and Knowledge from the Hidden Underground Flows". University of Kashmir, March 2022 (World Water Day).
- S. Sen. Delivered a lecture on "Operationalizing LIDAR-based non-contact water level monitoring in the Indian Himalayas". Innovation Workshop WMO HydroHub Phase II Innovation Roadmap. Feb. 2022.
- Public Talk on 7th July 2021 at Aligarh Muslim University by Prof. Sumit Sen on "Prioritization of Land Parcels for Capturing Rainwater: Two Case Studies of Contrasting Biogeographic Regions."

6. **S. Sen.** Invited lectures on "Fundamentals of Springshed Management: Water security through science-based participatory approach" online training program on Long-term sustainability, security, recharge, and management of drinking water sources, 5th October & 15th December **2021**

- **S. Sen**. Invited talk on "Terrestrial Water Budget: The Himalayan Region" during a workshop on Himalayan Biosphere-Atmosphere-Hydrosphere Interactions: Status, Challenges, and Way Forward under National Mission o Himalayan Studies (NMHS), MoEFCC, GoI Date: December 14, **2021.**

6.2 Conference Presentations

- Nanda, A., **Sen, S.** Interactions between Hillslope-Scale Hydrological Fluxes: A Case Study from Lesser Himalayan Landscapes. *AGU Fall Meeting*, San Francisco, California, USA, Dec., 9-13, **2019**
- Kumar, V., **Sen, S**. Optimal crop planning under the constraint of area and water demand using multi-objective programming. Global Water Security for Agriculture and Natural Resources. Hyderabad, Oct., 3-6, **2018**
- Sen, D., **Sen, S**. Hydro-geology based Revival of Drying Springs through Community Participation: A case Study from the Indian Himalayan Region. *Asian Ministerial Conference on Disaster Risk Reduction 2018 (AMCDRR)*, Mongolia, July, 3-6, **2018**.

7. *Patents filed/Granted with details*

-

8. **Books Published /Chapters contributed**

9. Kumar V., **Sen S.** Analysis of Spring Discharge in the Lesser Himalayas: A Case Study of Mathamali Spring, Aglar Watershed, Uttarakhand. *In: Singh V., Yadav S.,* Yadava R. (eds) Water Resources Management. Water Science and Technology Library, vol 78. Springer, Singapore, 2018.
10. Panda, S.S., Mason, E., **Sen, S.**, Kim, H.W., Amatya, D.M. Forest Hydrology Management Decision Support with Geospatial Technology. *Chapter in Forest Hydrology*. CAB International, Nosworthy Way, Wallingford OX10 8DE, United Kingdom, **2016**.

11. Sponsored Research Projects

S. No	Title	Sponsoring Agency and Officer Concerned	Period	Amount	Achievements
1	Probabilistic floods and sediment transport forescasrting in the Himalayas during the extreame events	DST, Indo-Italy Bilateral Project	2022-2025	$42000	
2	Lidar based non-contact hydrometry for mountainous terrain	World Meteorological Organization WMO	2020-	$67500	
3	Climate proofing of springshed development program through science & technology interventions in drought probe areas of Sikkim.	United Nations Development Program, UNDP	2019-	$60000	
4	Pine-Oak Ecosystem: Interactions with Water-Climate-Chemistry	Min. of Water Resources, Govn. of India	2019-2022	$75000	
5	Hydro-geological Assessment and Socio-Economic Implications of Depleting Water Resources in Nainital	Min. of Water Resources, Govn. of India	2019-2022	$85400	
6	Water Security through Community Based Springshed Development in the IHR	National Mission on Himalayan Studies, MoEF&CC	2018-2021	$30000	
7	Development of Field Demonstration Site for Revisiting Rainfall Measurement: An Undercatch Issue	Ministry of Water Resources, River Development and Ganga Rejuvenation, CWC, DRIP	2017-2020	$48500	
8	Citizens Science Approach for the revival of dying spring	Uttarakhand Government, Water for Welfare Initiative, IIT Roorkee)	2017-2018	$5000	
9	Understanding Hydrogeological Processes and Their Impacts on Water Security in the Tehri-Garhwal Region of Uttarakhand	Seed Grant IIT Roorkee	2013-2017	$11500	
10	Understanding Relationship between Infiltration Tradeoff Hypothesis and Surface Runoff Generation Mechanisms	SERB, DST	2014-2017	$23200	

12. Consultancy Projects

S. No	Title	Sponsoring Agency	Period	Amount
1	Spring Rejuvenation for Water Security in Mizoram	IWRD, Mizoram Govt.	2021-2023	₹14.99 Lakhs

2	An Early Warning System to Improve Adaptive Capabilities and Resilience of Vulnerable Himalayan Communities to Extreme Rainfall and Flooding	NERC, UK	2021-2023	₹39.53 Lakhs
3	WMO Myanmar Hydrology Training Programme	UKCEH	2020-2022	₹59.54 Lakhs
4	Climate proofing of springshed development program through S&T interventions in drought probe areas of Sikkim	UNDP	2019-2021	₹16.52 Lakhs

13. Sponsored Research/Consultancy Projects submitted for approval

S.No.	Title	Agency to whom submitted	Duration	Amount

VI. Bio-Data of the Advisor

1. **Name : H.P. Uniyal**
2. **Gender : Male**
3. **E-mail ID :** hpuniyal@gmail.com
4. **Qualifications : B.Tech (Civil Engineering)**

S.No.	Degree	Institution	Year	Division/Class
1.	B.Tech	M.I.W.E	1976	1st

5. Employment Experience

S.No.	Position & Organisation	Period
1.	Honorary Advisor, Himalayan Institute Hospital Trust/ Swami Rama Himalayan University, Swami Ram Nagar, Jolly Grant, Dehradun	Apr 1997 – Nov 2000
2.	Advisor, State Planning Commission, Govt. of Uttarakhand	Dec 2012-Dec 2019
3.	Director, State Planning Commission, Govt. of Uttarakhand	Oct 2009-Nov 2012
4.	Chief General Manager and Head of Department.	Nov 2002-oct 2009

6. **List of Publications** *(For last 5 years only)*

a. Journal Publications

-

b. Conference Presentations

7. *Patents filed/Granted with details*

- Patent application number 202311053398, Roof top Rain Water Harvesting published in Patent journal no. 35/2023, dated 01/09/2023.
- Patent application number 202311008945, System for Injecting Treated Rain Water Directly to the Aquifers, dated 10/02/2023.

8. **Books Published /Chapters contributed**

- Uttarakhand Manual for Rain Water Harvesting & Recharge-Published by Planning Dept. Government of Uttarakhand
- Published a book documenting the innovations by Drinking Water Supply Department, Government of Uttarakhand.
- Drinking Water Production in India- "Bank filtration as an Alternative" Published in Water Digest New Delhi July-August, 2006
- Drinking Water- Source, Treatment & Distribution.
- Harvest Rainwater -Secure Tomorrow.
- Uttaranchal Koop an innovation for mountainous water supply.
- Uttarakhand Manual for Rain Water Harvesting & Recharge-Published by Planning Dept. Government of Uttarakhand

9. Sponsored Research Projects

S. No	Title	Sponsoring Agency and Officer Concerned	Period	Amount	Achievements

10. Consultancy Projects

S. No	Title	Sponsoring Agency	Period	Amount

11. Sponsored Research/Consultancy Projects submitted for approval

S.No.	Title	Agency to whom submitted	Duration	Amount

VII. Bio-Data of Co-Principal Investigator (Co-PI)

a. **Name : Neelima Garg**
b. **Gender : Female**
c. **E-mail ID : neelima-garg@hotmail.com**
d. **Qualifications : B.Tech (Civil Engineering)**

S.No.	Degree	Institution	Year	Division/Class
1.	B.Tech	IIT Roorkee	1987	1st

12. Employment Experience

S.No.	Position & Organisation	Period
1.	Chief General Manager at Uttarakhand Jal Sansthan	1992- Till Now
2.	Design Engineer at THDC	1987-1992

13. **List of Publications** *(For last 5 years only)*

a. Journal Publications
-

b. Conference Presentations

14. Patents filed/Granted with details
-

15. Books Published /Chapters contributed

16. Sponsored Research Projects

S. No	Title	Sponsoring Agency and Officer Concerned	Period	Amount	Achievements

17. Consultancy Projects

S. No	Title	Sponsoring Agency	Period	Amount

18. **Sponsored Research/Consultancy Projects submitted for approval**

S.No.	Title	Agency to whom submitted	Duration	Amount

VIII. Bio-Data of Principal Investigator (Co-PI)

a. Name: S. Srikrishnan
b. Gender: Male
c. E-mail ID: srikrishnan@dm.iitr.ac.in
d. Qualifications: Dr. Eng.

S. No.	Degree	Institution	Year	Division/Class
1	M.Sc. (Five Years Integrated)	Bharathidasan University, India	2012	First with Distinction
2	Dr. Eng	Hokkaido University, Japan	2017	First with Distinction

19. Employment Experience

S. No.	Position & Organisation	Period
1	Project Assistant - 1, CSIR - Central Institute of Mining and Fuel Research, Nagpur, India	18 Months Jan 2013 – Sep 2014
2	Post-Doctoral Researcher, Hokkaido University, Japan	6 Months Oct 2017 – March 2018
3	Post-Doctoral Researcher, State Key Laboratory of Geohazard Prevention and Geoenvironment Protection (SKLGP), Chengdu University of Technology, China	30 months Sep 2018 – Feb 2021
4	Post-Doctoral Fellow, Indian Institute of Technology Gandhinagar	6 months April 2021 – Oct 2021
5	Assistant Professor, Indian Institute of Technology Roorkee (IITR), Roorkee, Uttarakhand, India	October 2021 – Present

20. List of Publications *(For last 5 years only)*

a. Journal Publications

- **Siva Subramanian, S.,** Srivastava, P., Yunus, A. P., Martha, T. R., & Sen, S. (2023). Numerical model derived intensity-duration thresholds for early warning of rainfall-induced debris flows in the Himalayas. ***Natural Hazards and Earth System Sciences Discussions***, 1-18. https://doi.org/10.5194/nhess-2022-297
- Fan, X., Yunus, A. P., Yang, Y. H., **Siva Subramanian S.**, Zou, C., Dai, L., ... & Huang, R. (2022). Imminent threat of rock-ice avalanches in High Mountain Asia. ***Science of The Total Environment***, 155380. https://doi.org/10.1016/j.scitotenv.2022.155380
- Y Zhu, T Ishikawa, **Siva Subramanian S**, BT Nguyen (2022) A FEM-MPM hybrid coupled framework based on local shear strength method for simulating rainfall/runoff-induced landslide runout. ***Landslides***. 1-12. https://doi.org/10.1007/s10346-022-01849-z
- BT Nguyen, T Ishikawa, Y Zhu, **Siva Subramanian S**, TT Nguyen (2022) New simplified transient method for determining the coefficient of permeability of unsaturated soil. ***Engineering Geology***. 106564 doi: https://doi.org/10.1016/j.enggeo.2022.106564
- Marino P, **Siva Subramanian S**, Fan X and Greco R (2022) Changes in debris-flow susceptibility after the Wenchuan earthquake revealed by meteorological and hydro-meteorological thresholds. ***CATENA*** 210: 105929. doi: https://doi.org/10.1016/j.catena.2021.105929
- Dave, R., **Siva Subramanian, S.**, & Bhatia, U. (2021). Extreme precipitation induced concurrent events trigger prolonged disruptions in regional road networks. ***Environmental Research Letters***, 16(10), 104050. https://doi.org/10.1088/1748-9326/ac2d67

- Zhu, Y., Ishikawa, T., Yamada, T.J. and **Siva Subramanian, S,** 2021. Probability Assessment of Slope Instability in Seasonally Cold Regions under Climate Change. ***Journal of Infrastructure Preservation and Resilience***. 2, 20. https://doi.org/10.1186/s43065-021-00034-1
- Yang, F., Fan, X., **Siva Subramanian, S**., et al. 2021. *Catastrophic debris flows triggered by the 20 August 2019 rainfall, a decade since the Wenchuan earthquake, China*. ***Landslides.*** https://doi.org/10.1007/s10346-021-01713-6
- Fan X, Dufresne A, Whiteley, J, Yunus, AP, **Siva Subramanian S,** et al. 2021. *Recent technological and methodological advances for the investigation of landslide dams*. ***Earth-Science Reviews.*** *218: 103646.* https://doi.org/10.1016/j.earscirev.2021.103646
- Zhu, Y., Ishikawa, T., **Siva Subramanian, S**. & Luo, B. 2021. *Early warning system for rainfall- and snowmelt-induced slope failure in seasonally cold regions*. ***Soils and Foundations***, 61, 198-217, doi: https://doi.org/10.1016/j.sandf.2020.11.009.
- Jiang, Z., Fan, X., **Siva Subramanian, S.,** Yang, F., Tang, R., Xu, Q. & Huang, R. 2021. *Probabilistic rainfall thresholds for debris flows occurred after the Wenchuan earthquake using a Bayesian technique*. ***Engineering Geology***, 280, 105965, doi: https://doi.org/10.1016/j.enggeo.2020.105965
- Fan, X., Yunus, A. P., Scaringi, G., Catani, F., **Siva Subramanian, S.,** Xu, Q., & Huang, R. 2021. *Rapidly evolving controls of landslides after a strong earthquake and implications for hazard assessments*. ***Geophysical Research Letters****, 48 e2020GL090509*. https://doi.org/10.1029/2020GL090509
- Yunus, A.P., Fan, X., **Siva Subramanian, S.,** Jie, D. & Xu, Q. 2021. Unraveling the drivers of intensified landslide regimes in Western Ghats, India. ***Science of the Total Environment***, 145357. https://doi.org/10.1016/j.scitotenv.2021.145357
- **Siva Subramanian, S.,** Fan, X., Yunus, A.P., van Asch, T., Scaringi, G., et al., 2020. *A sequentially-coupled catchment-scale numerical model for snowmelt-induced soil slope instabilities.* ***Journal of Geophysical Research: Earth Surface*** 125, e2019JF005468. https://doi.org/10.1029/2019JF005468
- Zhu Y, Ishikawa T, **Siva Subramanian S**.,Luo, B. 2020. *Simultaneous analysis of slope instabilities on a small catchment-scale using coupled surface and subsurface flows.* ***Engineering Geology.*** https://doi.org/10.1016/j.enggeo.2020.105750
- Liu, J., Xu, Q., Wang, S., **Siva Subramanian, S.,** Wang, L. and Qi, X., 2020. *Formation and chemo-mechanical characteristics of weak clay interlayers between alternative mudstone and sandstone sequence of gently inclined landslides in Nanjiang, SW China.* ***Bulletin of Engineering Geology and the Environment.*** https://doi.org/10.1007/s10064-020-01859-y
- Fan X, Dufresne A, **Siva Subramanian S**, Strom A, Hermanns R, Tacconi Stefanelli C, et al. 2020. *The formation and impact of landslide dams – State of the art*. ***Earth-Science Reviews*** . 203: 103116. https://doi.org/10.1016/j.earscirev.2020.103116
- Fan, X., Yang, F., **Siva Subramanian, S**., Xu, Q., Feng, Z., Mavrouli, O., et al., 2019. *Prediction of a multi-hazard chain by an integrated numerical simulation approach: the Baige landslide, Jinsha River, China*. ***Landslides.*** https://doi.org/10.1007/s10346-019-01313-5
- Fan, X., Xu, Q., Liu, J., **Siva Subramanian, S.,** He, C., et al., 2019. *Successful early warning and emergency response of a disastrous rockslide in Guizhou province, China*. ***Landslides***. https://doi.org/10.1007/s10346-019-01269-6
- Wang, F., Fan, X., Yunus, A. P., **Siva Subramanian, S.,** Alonso-Rodriguez, A., Dai, L., et al. 2019. *Coseismic landslides triggered by the 2018 Hokkaido, Japan (M_w 6.6), earthquake: spatial distribution, controlling factors, and possible failure mechanism*. ***Landslides***, 16(8), 1551-1566. https://doi.org/10.1007/s10346-019-01187-7
- Fan, X., Xu, Q., Alonso-Rodriguez, A., **Siva Subramanian, S.,** Li, W., Zheng, G., et al. 2019. *Successive landsliding and damming of the Jinsha River in eastern Tibet, China: prime investigation, early warning, and emergency response*. ***Landslides***. https://doi.org/10.1007/s10346-019-01159-x
- **Siva Subramanian, S.,** Ishikawa, T., Tokoro, T. 2018. *An early warning criterion for the prediction of snowmelt induced soil slope failures in seasonal cold regions*. ***Soils and Foundations***. 58(3), 582-601. https://doi.org/10.1016/j.sandf.2018.02.021

b. Conference Presentations

- **Siva Subramanian, S**., Srivastava, P., Sen, S., & Yunus, A. P. (2023, May). Physically-based model derived thresholds of sediment disasters for impact-based rainfall forecasts. In EGU General Assembly Conference Abstracts (pp. EGU-8674). https://doi.org/10.5194/egusphere-egu23-8674

- **Siva Subramanian, S.**, Sen, S., & Yunus, A. P. (2023, May). Applicability of complex rainfall thresholds for Territorial Landslide Early Warning Systems (Te-LEWS) in the Himalayas. In EGU General Assembly Conference Abstracts (pp. EGU-16763). https://doi.org/10.5194/egusphere-egu23-16763
- Vashistha, A., **Siva Subramanian, S.,** & Das, J. (2023, May). Co-seismic landslide damming in the Indian Himalayas. In EGU General Assembly Conference Abstracts (pp. EGU-11125). https://doi.org/10.5194/egusphere-egu23-11125
- Dewrari, M., & Subramanian, S. S. (2023). Correlating grain-size distributions, transport mechanism, and runout distance of debris flow deposits in the Himalayas (No. EGU23-13031). Copernicus Meetings. https://doi.org/10.5194/egusphere-egu23-13031
- Dewrari, M., Zhu, Y., & **Siva Subramanian, S.** (2022, December). *Numerical Model Based Correlation of Rainfall Intensity-Duration Thresholds of Landslides with Velocities from Seismological Monitoring*. ***In Fall Meeting 2022. AGU.***
- **Siva Subramanian, S**., Srivastava, P., & Sen, S. (2022). *Numerical weather prediction model outputs define intensity-duration thresholds of extreme-precipitation-induced sediment disasters* (No. EGU22-7804). Copernicus Meetings. ***EGU General Assembly 2022*** https://doi.org/10.5194/egusphere-egu22-7804
- **Siva Subramanian, S.,** Dave, R., & Bhatia, U. (2021) An Integrated Approach to Analyze Concurrent Debris Flow-Induced Transport Network Failures. ***AGU Fall Meeting 2021***. https://doi.org/10.1002/essoar.10509608.1
- **Siva Subramanian, S.,** Fan, X., Yunus, Ali. P., van Asch, T., Xu, Q., and Huang, R.*: Envisaging post-earthquake snowmelt-induced shallow landslides under climate change,* ***EGU General Assembly 2020,*** Online, 4–8 May 2020, EGU2020-12199, https://doi.org/10.5194/egusphereegu2020-12199

21. *Patents filed/Granted with details*

Nil

22. Books Published /Chapters contributed

- Geotechnics for Transportation Infrastructure Year: 2019, ISBN: 978-981-13-6700-7 Tatsuya Ishikawa, Siva Subramanian, S.,, Tetsuya Tokoro | Springer Contribution: Ishikawa T, Siva Subramanian S, Tokoro T 2019 Applicability Evaluation of Slope Disaster Risk Assessment Method in Snowy Cold Regions In Sundaram R, Shahu J, Havanagi V (eds) Geotechnics for Transportation Infrastructure Lecture Notes in Civil Engineering , Pages: 467-498 , Volumes: 28

23. Sponsored Research Projects

S. No	Title	Sponsoring Agency and Officer Concerned	Period	Amount	Achievements
1.	Development of a prototype territorial early warning system for precipitation-induced sediment disasters (i.e., landslides and debris flows) in India	Indian Institute of Remote Sensing (IIRS), Indian Space Research Organisation (ISRO)	2022 - 2025	37,30,790 INR	Established a Territorial Landslide Early Warning System for Landslides in Uttarakhand
2.	Experimental and process-based multi-scale understanding of the onset, instability, and runout mechanisms of extreme-precipitation induced mass movements	Indian Institute of Technology Roorkee	2022-2024	20,00,000 INR	Established a Sediment Disasters Research (Se-DiRe) Laboratory
3.	Implementation of Japanese early-warning criteria Soil Water Index (SWI) into TELWs in India for landslide disaster mitigation	Department of Science and Technology (DST)	2022-2024	13,00,000 INR	Developing SWI based thresholds for landslide early warning in Uttarkhand

IX. Bio-Data of Co-Principal Investigator (Co-PI)

a. **Name : Nitesh Kaushik**
b. **Gender : Male**
c. **E-mail ID :** nitshey@gmail.com
d. **Qualifications : M.Tech**

S.No.	Degree	Institution	Year	Division/Class
1.	M.Tech (Atmospheric Science)	University of Pune (Dissertation at IIT – Delhi)	1997	1st (Gold Medalist)
2.	M.Sc (Physic)	IIT, Roorkee	1995	2nd
3.	Master in Ecology & Environment	Indian Institute of Ecology & Environment	2000	1st
4.	B.Sc	University of Meerut	1993	1st

24. Employment Experience

S.No.	Position & Organisation	Nature of Job	Period
1.	Environmental Specialist and Portfolio Manager at Project Management Unit, The Swajal Project, Dept. of Rural Development, Govt. of Uttar Pradesh	Management of World Bank funded Water & Sanitation project. Activities include Water Resource management, water & sanitation services, water quality	Apr 1997 – Nov 2000
2.	Environmental Specialist at Project Management Unit, The Swajal Project, Dept. of Drinking Water & Sanitation, Govt. of Uttarakhand Uttarakhand	-do-	Nov 2000 – Jan 2004
5.	Dy. Director, WATSAN & Environmental Specialist at Swami Rama Himalayan University / Himalayan Institute Hospital Trust, Dehradun	Management and technical expertise on various consultancy water & sanitation projects, Nodal officer for National Jal Jeevan Mission, GoI	Feb 2004 - Present

25. **List of Publications** *(For last 5 years only)*

a. Journal Publications

b. Conference Presentations

- "Water Bank: Rooftop Rainwater Harvesting in Mountainous Village of Himalayas" in 6th India Water Week, Sept. 2019 by Ministry of Jal Shakti, Govt. of India
- "Action Research on Solar Pumping Water Scheme & Geohydrology based Springshed Management in Himalayas" in 6th India Water Week, Sept. 2019 by Ministry of Jal Shakti, Govt. of India
- "Experience of Himmothan Project in the Himalayas through a community management approach" in 37th International Conference of Water, Engineering and Development Centre (WEDC), Loughborough University, UK
- "Action Research on Solar Pumping Water Scheme by Mountain Community through Learning Alliance Approach" in 37th International Conference of Water, Engineering and Development Centre (WEDC), Loughborough University, UK

- "Water Management Systems & Approaches: Ancient Time to Present and Role of Community in Water Management in Indian Himalayas" in World Mountain Forum (WMF) - 2014 at Cusco, Peru during May-2014

26. *Patents filed/Granted with details*

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27. Books Published /Chapters contributed

28. Sponsored Research Projects

S. No	Title	Sponsoring Agency and Officer Concerned	Period	Amount	Achievements

29. Consultancy Projects

S.No.	Title	Sponsoring Agency	Duration	Amount
1.	Swajal (UP Rural Water Supply as Environmental Sanitation Project)	World Bank	1998-2002	4,55,87,000
2.	Sector Reform Project	Ministry of Rural Development, Deptt. of Drinking Water and Sanitation.	2002-2005	74,09,000
3.	Total Sanitation Campaign	Ministry of Rural Development, Deptt. of Drinking Water and Sanitation.	2005-2006	16,00,000
4.	Himmothan Pariyojana Phase I	Sir Ratan Tata Trust, Mumbai	2002-2005	3,72,67,559
5.	Himmothan Pariyojana Phase II	Sir Ratan Tata Trust, Mumbai	2006-2009	6,65,75,332
6.	Watermill Initiative	UREDA & Asian Development Bank	2006-2007	10,35,448
7.	Sector Wise Approach Program (SWAp) Project Management Unit Swajal Project, Dehradun/Tehri	World Bank	2006-2009	2,60,00,000
8.			2010 to 2014	2,40,00,000
9.	Uttarakhand Urban Center Development Institute	Asian Development Bank	2011- 2013	56,42,000
10.	Himmothan Pariyojana Phase III	Tata Trusts	2011- 2014	4,21,66,845

S.No.	Title	Sponsoring Agency	Duration	Amount
11.	National Rural Drinking Water Program	Ministry of Drinking Water & Sanitation, GoI	2014-2016	25,00,000
12.	Zila Yojana Phase I	State Govt.	2015-2016	1,17,213
13.	Himmothan Pariyojana WASH Plus	Tata Trusts & Titan Co. Ltd	2015 – 2017	3,27,56,600
14.	Zila Yojana Phase II	State Govt.	2017-2018	2,00,000
15.	School WASH Rudrapryag	Himalayan Institute Hospital Trust	2018-2019	12,00,000
16.	Solid and Liquid Waste Management phase I (SLWM)	Swachh Bharat Mission (G), GoI	July-Sept 2018	50,000
17.	Hans Jaldhara	The Hans Foundation	2016 – 2018	3.00 Cr.
18.	Preparation of DPR 8 village Pauri and 1 village Haridwar District	The Hans Foundation	Sept.-Oct. 2018	1,98,000
19.	Need Assessment survey of water and Electricity	The Hans Foundation	Jan -June 2019	2,35,224
20.	Key Resource Center - ODF verification Study UP	Deptt. of Panchayati Raj Gov. of UP	2017 to 2018	13,20,000
21.	Namami Gange	State Programme Management Group GoUK.	2017-2017	1,50,000
.22.	Solid and Liquid Waste Management phase II (SLWM)	Swachh Bharat Mission (Gramin), GoI	2019-2022	2,76,000
23.	National Key Resource Center (NKRC)	Ministry of Drinking Water & Sanitation, GoI with State Govt.	2018 – 2020	40 Lac
24.	THF-Implementation of Water, Springshed and Sanitation Schemes	The Hans Foundation	2018 – 2020	5,61,00,000
25.	Implementation Support Agency (ISA) Jal Jeevan Mission, GOI	Govt. of India, Govt. of Uttarakhand	2020 to cont.	23,00,000
26.	Sector Partner	Ministry of Jal Shakti, Govt. of India.	2021 to cont.	27,72,000

S.No.	Title	Sponsoring Agency	Duration	Amount
27.	Key Resource Centre (KRC)	Ministry of Jal Shakti, Govt. of India.	2021 to cont.	2,51,18,426

30. Sponsored Research/Consultancy Projects submitted for approval

S.No.	Title	Agency to whom submitted	Duration	Amount

X. BUDGET ESTIMATES

1. Break-up of Total Budget For IITR

(All Amount in Lakhs)

S.No	Item		1st Year	2nd Year	Total
			DST	DST	DST
1.	Manpower		7,65,600	7,65,600	15,31,200
2.	Permanent Equipment	Indigenous			
		Foreign			
3.	Other Costs (Outsourcing, Fabrication, Testing and patents etc)		3,00,000		3,00,000
4.	Consumables		2,00,000	2,00,000	4,00,000
5.	Domestic Travel		2,00,000	2,00,000	4,00,000
6	Contingencies		2,00,000	1,00,000	3,00,000
7	Overhead Charges		1,61,560	1,31,560	2,93,120
	Total		**18,27,160**	**13,97,160**	**32,24,320**

Grand Total (DST + Collaborator) 27,18,320

* Give financial contributions of Each Collaborator Separately, if any.
Note: Kindly prepare the budget outlay for each partnering Organisation/Institution wise also

2. Break-up of Total Budget For SRHU

(All Amount in Lakhs)

S.No	Item		1st Year	2nd Year	Total
			DST	DST	DST
1.	Manpower		17,61,360	17,61,360	35,22,720
2.	Permanent Equipment	Indigenous	15,87,700		15,87,700
		Foreign			

3.	Other Costs (Outsourcing, Fabrication, Testing and patents etc)	15,20,000	1,30,000	16,50,000
4.	Consumables	4,00,000	60,000	4,60,000
5.	Domestic Travel	6,00,000	6,00,000	12,00,000
6	Contingencies	2,50,000	1,20,000	3,70,000
7	Overhead Charges	6,11,906	2,67,136	8,79,042
	Total	**67,30,966**	**29,38,496**	**96,69,462**

Grand Total (DST + Collaborator) 96,69,462

* Give financial contributions of Each Collaborator Separately, if any.
Note: Kindly prepare the budget outlay for each partnering Organisation/Institution wise also

3. Itemised Budget

(Please provide justification)

3.1. Manpower

Budget for Salaries (For IITR)

Designation	Qualification	Salary per month	No. of Persons	Amount Rupees in Lakh	Justification
Research Associate-I (PDF) for 2 years	(PDF)	58000+10% HRA	1	15,31,200	A scientific study is needed for successful of this project. RA can use their skills along with research expertise for successful completion of this project.

Budget for Salaries (For SRHU)

Designation	Qualification	Salary per month	No. of Persons	Amount Rupees in Lakh	Justification
Research Associate - II for 2 years	Ph.D	61000 + 10% HRA	1	1610400	Research Associate with specialization in the particular field is needed for lab scale experiments
SRF For 2 years	M.Tech with research experience	42000 + 10% HRA	1	1108800	SRF is needed for field scale study and will support research.
Field Worker for 24 Months	1 Diploma holder & 1 intermediate with skill	16740/m each field worker	2	803520	Manpower is needed for various field survey data collection and sample collection and to run field scale experiments and support to installation on site

2.2 Equipment*

Budget for Permanent Equipment (To be borne by DST) **For IITR**

Description of Equipment	Foreign/Indigenous	Unit Landed Price (CIF + Custom Duty + others)	Nos. of Equipment	Total Rupees	Justification in relation to project requirement

Budget for Permanent Equipment (For SRHU)

Description of Equipment	Foreign/Indigenous	Unit Landed Price (CIF + Custom Duty + others)	Nos. of Equipment	Total Rupees	Justification in relation to project requirement
Graded Filter Media	**Indigenous**	50,000	2	100000	Development of an optimized graded filter media
Digital Altimeter 6 in 1	**Indigenous**	1750	4	7,000	For measuring spring and rivulets elevation and find the total head b/w source and habitation
GPS	**Indigenous**	24500	3	73,500	For measuring the coordinates of the spring/rivulets and study area
Digital Flow Meter	**Indigenous**	18500	15	2,77,500	For field scale measurements of spring discharge
Digital Rain Gauge	**Indigenous**	13500	4	54,000	For determination of amount of rainfall in catchment or springsshed
Digital Depth Sensors	**Indigenous**	500	15	7,500	to determine the depth of water flowing through V-Notch
Physical Parameter testing probe	**Indigenous**	14500	2	29,000	in situ water quality testing
Brunton compass	**Indigenous**	1100	4	4,400	to understand dip, strike and pattern of rock
Hammer with soft chisel	**Indigenous**	1200	4	4,800	Will use in Geographical Investigation
V-Notch	**Indigenous**	65000	12	7,80,000	For masuring spring flow in various seasons
Automatic Weather Station	**Indigenous**	250000	1	2,50,000	Variation of discharge w.r.t weather conditions (will use in Tehri and Pauri dist. of Uttarakhand)

** A List of equipment and facilities available to the investigators and relevant to the project may also be provided, separately*

2.3. Other Costs (Outsourcing, Fabrication, Testing and Patenting etc.)

Budget for Other Costs (IITR)

Item	1st Year	2nd Year	Total	Justification including basis of cost estimates/quotations
Outsourcing				
Fabrication				
Testing	2,00,000		2,00,000	Soil and water quality parameter testing
Patenting				
Others				

Budget for Other costs (For SRHU)

Item	1st Year	2nd Year	Total	Justification including basis of cost estimates/quotations
Outsourcing	70,000	30,000	1,00,000	Uttarakhand Jal sansthan will lead in field implementation and will help to identify the appropriate location and provide support to work on already installed handpumps and other water supply structures as the supply line and other civil structures are govern by UJS. This would also include boarding lodging of other line department.
Fabrication	2,00,000		2,00,000	Fabrication of filtration unit and fabrication for direct injection system will also require where needed.
Testing				
Patenting		1,00,000	1,00,000	Noval innovative technologies needs to be patent.
Others	12,50,000		12,50,000	installation of product including labour and transportation is required for study at least 5 sites will select and cost approx. 2,45,000/site, 5 sites which include supply and lying PVC pipe at a depth of 3' below the surface which will cost 350/cum. considering at least 150m excavation on each site, in dist. Tehri and Pauri as mentioned. Small civil work also required for construction of intake chamber which cost approx 5,000 at each site. The proposed amount will also use to connect rooftop of the houses to the injection system through PVC pipes (@Rs.250/m up to 150m length pipe will be used considering minimum

				5 houses at higher elevation for each injection system)

2.4 Consumables

Budget for Consumable Materials (For IITR)

1st Year	2nd Year	Total	Justification including basis of cost estimates/ quotations
1,20,000	20,000	1,40,000	Chemicals use in lab scale (Cost at least 1,00,000) for testing water quality parameters. Office stationary including files, document register papers, pen, pencils etc and maintenance of office equipment(40,000 for 2 years)

Budget for Consumable Materials (For SRHU)

1st Year	2nd Year	Total	Justification including basis of cost estimates/quotations
4,00,000	60,000	4,60,000	It includes material (Pabbles, sand and charcoal and other materials) which will be used in field demonstration @Rs.10,000/site field demonstration at least 10 site cost 1,00,000. Office stationary required for printing photocopy and other stationary item @2500/month for two years 60,000. lab scale and pilot scale testing required consumables e.g material use in optimize the efficiency of graded filter media and other lab test minimum of 3,00,000

2.5. Domestic Travel*

Budget for Domestic Travel (To be borne by DST) **For IITR**

1st Year	2nd Year	Total Rupees	Justification; indicating (journeys, mode and class of transport
2,00,000	2,00,000	4,00,000	Grant has been proposed to carry out characterization at study area or site and other institutes or universities including travel, boarding, and lodging (bimonthly basis), to travel, boarding, and lodging for national and international conferences and workshops by flight or train. The travel will be undertaken by the manpower and the investigators involved in the project (bimonthly basis).

Budget for Domestic Travel (To be borne Collaborator (s), if any) **For SRHU**

1st Year	2nd Year	Total Rupees	Justification; indicating journeys, mode and class of transport.
6,00,000	6,00,000	12,00,000	Grant has been proposed to carry out characterization at study area or site and other institutes or universities including travel, boarding, and lodging (bimonthly basis, approximately 35,000/month), to national and international conferences and workshops (2,00,000/year) by flight or train. The travel will be undertaken by the manpower and the investigators involved in the project (bimonthly basis).

(*) No foreign travel is generally not permitted under DST grants. Class and mode of transportation should be as per the entitlement of the concerned staff in the institute. The travel component of PRC visits would be added by DST separately to the project cost).

2.6 Contingencies

Budget for Contingencies (To be borne by DST) **For IITR**

1st Year	2nd Year	Total	Justification including basis of cost estimates/quotations
2,00,000	1,00,000	3,00,000	The amount proposed for this purpose will be utilized in registration fees in national and international conferences 30,000/year for national conferences and 70,000/year international confrences. The approximate amount of 50,000 will also use to report printing and publicity of the designed product

Budget for Contingencies (To be borne by Collaborator (s), if any) **For SRHU**

1st Year	2nd Year	Total	Justification including basis of cost estimates/quotations
2,50,000	1,20,000	3,70,000	Time to time maintenance of product and supply main will be required quarterly approximate cost 5000/site/quater (2,00,000 for 2 years, 5 sites) and, 20,000 for national conferences and 50,000 international conferences and 1,00,000 for accussation of services of gov/non gov department like UJS, Payjal Nigam etc, IMD etc.

2.7 Designation of the officer in the organization who is vested with financial power: **AR SRIC** (IIT Roorkee)

i. Organisation Name as per Bank records: **Indian Institute of Technology, Roorkee**
ii. Bank Account No.: **33012172097**
iii. IFSC Code: **SBIN0001069**
iv. MICR Code: **247002094**
v. Bank Name: **State Bank of India**
vi. Bank Branch Address: **IIT Roorkee, Roorkee – 247667, Uttarakhand, India**

2.8 Designation of the officer in the organization who is vested with financial power: **Mr. Nitesh Kaushik** (Deputy Director & Incharge WATSAN, SRHU)

Proposal if approved, Payment shall be made in favour of SRHU SCIENTIFIC AND INDUSTRIAL RESEARCH

i. Bank Account No: 37200223663
ii. Bank name: **State Bank of India**
iii. IFSC Code. SBIN0010580
iv. MICR Code. 248002201
v. Bank Branch Address: HIHT, Jollygrant, Dehradun, Uttarakhand, 248140

(This will facilitate in the fast electronic transfer of funds)

2.9 Mention HRA % applicable to the Research fellow in your institute and the classification category of your city/town: 10% with class Z city

*(Please ensure to fill in all the above details otherwise it shall be considered as **NIL**)*

Annexure-I

UNDERTAKING FROM THE INVESTIGATOR

Project Title: Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

1. I have carefully read the terms and conditions of the **Water Technologies Cell** Programme and I/We agree to abide by them.
2. I have not submitted this or a similar Project proposal elsewhere for financial support.
3. I have explored and ensured that the equipment and the basic facilities described in the Research Proposal, will actually be available as and when required for the purpose of the Project. I/We shall not request financial support under this project, for procurement of these items.
4. I undertake that spare or idle capacity of the permanent equipment procured under the Project will be made available to other legitimate users from parent and other organisations.
5. I have enclosed the following:

   a. Endorsement from the Head of the Institution (on letterhead) -- **Attached.**
   b. Undertaking from the Collaborator(s) – **N/A**

Name and signature of the Investigators

Date

Place

Annexure-I

UNDERTAKING FROM THE ADVISOR (Scan copy attached)

Project Title: Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

6. I/We have carefully read the terms and conditions of the **Water Technologies Cell** Programme and I/We agree to abide by them.
7. I/We have not submitted this or a similar Project proposal elsewhere for financial support.
8. I/We have explored and ensured that the equipment and the basic facilities described in the Research Proposal, will actually be available as and when required for the purpose of the Project. I/We shall not request financial support under this project, for procurement of these items.
9. I/We undertake that spare or idle capacity of the permanent equipment procured under the Project will be made available to other legitimate users from parent and other organisations.
10. I/We have enclosed the following:

    c. Endorsement from the Head of the Institution (on letterhead)

    d. Undertaking from the Collaborator(s)

Name and signature of the Investigators

Date

Place

Annexure-I

UNDERTAKING FROM THE CO-INVESTIGATOR (Scan copy attached)

Project Title: Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

11. I/We have carefully read the terms and conditions of the **Water Technologies Cell** Programme and I/We agree to abide by them.

12. I/We have not submitted this or a similar Project proposal elsewhere for financial support.

13. I/We have explored and ensured that the equipment and the basic facilities described in the Research Proposal, will actually be available as and when required for the purpose of the Project. I/We shall not request financial support under this project, for procurement of these items.

14. I/We undertake that spare or idle capacity of the permanent equipment procured under the Project will be made available to other legitimate users from parent and other organisations.

15. I/We have enclosed the following:

e. Endorsement from the Head of the Institution (on letterhead)

f. Undertaking from the Collaborator(s)

Name and signature of the Investigators

Date

Place

Annexure-I

UNDERTAKING FROM THE CO-INVESTIGATOR (Scan copy attached)

Project Title: Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

16. I/We have carefully read the terms and conditions of the **Water Technologies Cell** Programme and I/We agree to abide by them.
17. I/We have not submitted this or a similar Project proposal elsewhere for financial support.
18. I/We have explored and ensured that the equipment and the basic facilities described in the Research Proposal, will actually be available as and when required for the purpose of the Project. I/We shall not request financial support under this project, for procurement of these items.
19. I/We undertake that spare or idle capacity of the permanent equipment procured under the Project will be made available to other legitimate users from parent and other organisations.
20. I/We have enclosed the following:

    g. Endorsement from the Head of the Institution (on letterhead)

    h. Undertaking from the Collaborator(s)

Name and signature of the Investigators

Date

Annexure-II

ENDORSEMENT FROM THE HEAD OF THE LEAD ORGANISATION (IITR)

(*To be typed on the letter-head of the organization*)

Project Title Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

1. Certified that the organization welcomes the participation of Dr. Sumit Sen as the PI and Dr. Ashutosh Sharma as the Co-PI for the project and that in the unforeseen and legitimate event of discontinuation by the PI, the Co-PI will assume full responsibility for completion of the project. Information to this effect, endorsed by me, will be promptly sent to the DST
2. Certified that the equipment, other basic facilities and other administrative facilities as per the terms and conditions of the award of the Project, will be extended to the investigator(s) throughout the duration of the project
3. The Organization shall ensure that financial and purchase procedures are followed as per the prevailing norms of the organization, within the allocated budget.
4. The Organisation shall provide timely the Statement of Expenditure and the Utilisation Certificate of the grant as required by the DST in the prescribed format.
5. The grant for the proposal, if approved may be made in favour of, Payment shall be made in favour of.....
    i. Organisation Name as per Bank records:
    ii. Bank Account No.:
    ii. IFSC Code:
    iii. MICR Code:
    iv. Bank Name: **Union Bank of India**
    v. Bank Branch Address

(Head of the Institute)

Seal/Stam

Date

Place

Annexure-II

ENDORSEMENT FROM THE HEAD OF THE PARTNER ORGANISATION (SRHU)

(*To be typed on the letter-head of the organization*) **(Scan copy attached)**

Project Title Innovative and Sustainable Aquifer Rejuvenation through Direct Injection of Rainwater in the Hilly Regions

1. Certified that the organization welcomes the participation of Dr. Sumit Sen as the PI and Dr. Ashutosh Sharma as the Co-PI for the project and that in the unforeseen and legitimate event of discontinuation by the PI, the Co-PI will assume full responsibility for completion of the project. Information to this effect, endorsed by me, will be promptly sent to the DST
2. Certified that the equipment, other basic facilities and other administrative facilities as per the terms and conditions of the award of the Project, will be extended to the investigator(s) throughout the duration of the project
3. The Organization shall ensure that financial and purchase procedures are followed as per the prevailing norms of the organization, within the allocated budget.
4. The Organisation shall provide timely the Statement of Expenditure and the Utilisation Certificate of the grant as required by the DST in the prescribed format.
5. The grant for the proposal, if approved may be made in favour of, Payment shall be made in favour of.....
    i. Organisation Name as per Bank records:
    ii. Bank Account No.:
    vi. IFSC Code:
    vii. MICR Code:
    viii. Bank Name: **Union Bank of India**
    ix. Bank Branch Address

(Head of the Institute)

Seal/Stam

Date

Place

Annexure-III

Endorsement from Stakeholders/User/Collaborating Industry/ Non-Academic Partners/Voluntary Organizations etc (*if any*) *(On the official letterhead)*

I have gone through the Project proposal entitled.....submitted by.....*(Name of PI)*.....of.....*(Name of the Institute)* for DST funding and noted the obligations and responsibilities indicated in our name which are as below : (Tick, as applicable)

1. Total Contribution in financial terms *(mention the amount in Rs.)*
2. Contribution in Cash (Rs.):
3. Contribution in Kind *(list activities)*:

3.a Pre-implementation of the project:

- 3.a.1 Land approvals and acquisition
- 3.a.2 Commitment towards technical/human resources.
- 3.a.3 Legal clearances
- 3.a.4 Sharing of data – technical designs & drawings.
- 3.a.5 Undertaking to maintain the assets.
- 3.a.6 Providing data as required
- 3.a.7 Sharing preliminary work done so far on similar activities.
- 3.a.8 Any other, please specify.

3.b During the implementation of the project:

- 3.b.1 Coordination and partnership with the consortium.
- 3.b.2 Depute a dedicated manpower team for the project.
- 3.b.3 Community mobilization and engagement, group-creation, capacity building, training, orientation and awareness etc.
- 3.b.4 Any other, please specify.

3.c Post project:

- 3.c.1 Undertaking for taking over of the project & ensuring the sustainability of the intervention.
- 3.c.2 Generation and analysis of data from the intervention.
- 3.c.3 Any other, please specify.

I hereby affirm that my organization/industry is committed to participate in the Project to the full extent as indicated including financial liabilities accruing therefrom as detailed above. A brief profile of my organization is summarized below:

Name of Organisation
Line of Business/ Service
No. of employees
Annual Turn over (if industry)
The Annual Report for the last 3 financial years is enclosed (if industry)

(Head of the Organisation)
Seal/Stamp

Date

Place

Annexure-IV

Terms & Conditions of the Grant

1. Approval of the Research Proposal and the grant released for it is for the specific Project sanctioned and the released grant should be exclusively spent on the Project within the stipulated period. The Institution may use funds obtained from any other Organisation with the concurrence of DST, for the Project. **Any unspent balance out of the amount sanctioned must be surrendered to the Government of India through a crossed Cheque/ Demand Draft drawn in favour of Drawing & Disbursing Officer, DST.**

2. For permanent, semi-permanent assets acquired solely or mainly out of the project grant, an audited record in the form of a register shall be maintained by the Institute. The term "Assets" include (a) the immovable property acquired out of the grant, and (b) movable property of capital nature where the value exceeds Rs 1000/-. The Institute is required to send to the Department of Science & Technology a list of Assets acquired from the grant. The grant shall not be utilised for the construction of any building unless a specific provision is made for that purpose. Full infrastructural facilities by way of accommodation, water, electricity, communication, etc. for smooth implementation of the project shall be provided by the Institute.

3. All the Assets acquired from the grant will be the property of the Government of India and should not be disposed of or encumbered or utilised for purposes other than those for which the grant had been sanctioned, without the prior sanction of the DST.

4. At the conclusion/ termination of the project, the Government of India will be free to sell or otherwise dispose off the Assets which are the property of the Government. The Institute shall render to the Government necessary facilities for arranging the sale of these assets. The Government of India has the discretion to gift the Assets to the Institutions or transfer them to any other Institution if it is considered appropriate.

5. The Institution/ PI will furnish Six Monthly Progress Report (Annexure- V) (5 copies) of the work on the Project on a half-yearly basis (i.e. if the date of start of a project is 12.09.07 the first Six Monthly Technical Progress report shall be for the period 12.09.07 to 31.03.08, the next will be from 01.04.08 to 30.09.08 and so on). In addition, the DST may designate a Scientist/ Specialist or an Expert Panel to visit the Institution periodically to review the progress of the work being carried out and to suggest suitable measures to ensure the realisation of the objectives of the Project. During the implementation of the Project, the Institution will provide all facilities to the visiting scientist/ specialist or the Expert Panel by way of accommodation, etc. at the time of their visit. In case of exceptional circumstances, a request for an extension for time period must be submitted to DST six months prior to the approved date of completion of the project (Annexure-VII). On completion of the project, submit the final statement of Expenditure (Annexure-II) along with utilization certificate (Annexure-III) and ten copies of the self-contained Project Completion Report (Annexure-VI) as per DST format.

6. At the time of seeking further instalment of the grant, The Institution/ PI has to furnish the following documents:

   a) Statement of Expenditure (SE) (Annexure-II) and Utilisation Certificate (UC)

(Annexure-III) for the financial year up to 31st March (in original or copy if sent earlier)

b) An authenticated up-to-date Statement of Expenditure (annexure-II) including Committed Expenditure for the Project on the date of seeking further instalment.

7. Request for specific approval of the Department to **carry forward** the unutilised grant to the next financial year for utilisation for the same Project should be sent along with SE & UC, after completion of the financial year.

8. The Comptroller & Auditor General of India, at his discretion, shall have the right of access to the books and accounts of the Institution maintained in respect of the grant received from the Government of India.

9. The Institution will maintain separate audited accounts for the Project. If it is found expedient to keep a part or whole of the grant in a bank account earning interest, the interest thus earned should be reported to the DST and should be reflected in the Statement of Expenditure. The interest thus earned will be treated as a credit to the Institution to be adjusted towards the further instalment of the grant.

10. The Institution will not entrust the implementation of the work (except the out-sourced part as approved) for which the grant is being sanctioned to any other institution nor will it divert the grant receipts to other institutions as assistance. In case the Institution is not in a position to implement or complete the Project, it should, forthwith, refund to the DST the entire grant received by it or the balancing grant with it in favour of DDO, DST.

11. All the personnel including Research personnel appointed under the project, for the full/ part duration of the project, are to be treated as temporary employees and will be governed by the Administrative rules/ service conditions (for leave, TA/DA etc) of the implementing Institute. They are not to be treated as employees of the Government of India and the DST will have no liability, whatsoever, for the project staff after the completion of the Project duration.

12. For the expeditious implementation of the research Project, the PI will take the assistance of the Institution in the process of selection and appointment of staff and payment to them. Scale and emoluments for the posts not covered under DST's OM are governed by the norms prevalent in the implementing Institution or as agreed upon in consultation with the DST.

13. The DST reserves the right to terminate the project at any stage if it is convinced that the grant has not been properly utilised or satisfactory progress is not being made.

14. **The Project becomes operative with effect from the date on which the Draft/ Cheque is received by the implementing institution.** This date should be intimated by the Institution authorities/ Principal Investigator to the DST. *It will, in no case be later than one month after the receipt of the draft/ cheque by the Institution.*

15. If the Principal Investigator (PI) to whom a grant for a project has been sanctioned wishes to leave the institution where the project is based, the PI/Institution will inform the DST of the same and in consultation with the DST, evolve steps to ensure successful completion of the Project, before the PI is relieved.

16. The data pertaining to the project should be systematically collected, scientifically documented and submitted to DST which later would be placed in the public domain. This

clause would not be applicable for the projects where legal protection of the know-how generated is felt necessary.

17. Investigators wishing to publish technical/ scientific papers based on the research work done under the project should acknowledge the assistance received from the DST, indicating the scheme. Investigators are expected to publish some of the research papers emerging out of the Project work in leading Indian Journals.

18. If the results of the research are to be legally protected, the results should not be published without securing legal protection for the research results. For projects identified to have a distinct potential for generating know-how, in the form of product/ process, that could be protected through patenting, copyrights etc., the PI should carefully follow the "**Guidelines/ Instructions for Technology Transfer and Intellectual Property Rights"** provided in the **Guidelines for Implementing Research Projects** booklet issued by the DST. [http://www.tifac.org.in] For further information/ clarification on this subject- The Director, Technology Information, Forecasting and Assessment Centre (TIFAC), Patent Facilitating Cell, Vishwakarma Bhawan, Shaheed Jeet Singh Marg, New Mehrauli Road, New Delhi-110016, E-mail:tifac@nda.vsnl.net.in, may be contacted.

Annexure – V

Information about DST funding: maximum budget and what costs can be reimbursed

(a) Maximum budget from DST: The projected budget by the Indian PI will be reviewed by Indian members of the advisory committee and will undergo financial due diligence as per DST processes, which will take into account the cost needed for the projected activities, matching efforts and conformity to DST guidelines.

(b) Heads wise break up of cost *(Break- up of cost)*

A. Non–recurring cost: *Permanent Equipment as per quotations and GeM module will be permitted to procure.*

B. Recurring costs

1 **MANPOWER:**

S.No.	Manpower Position	Monthly Emoluments	Essential qualifications & age limit, Selection Process & Service Conditions for Scientific/Technical Manpower
1	Research Associate – I	Rs. 58,000/- + HRA	As per **DST OM. No. DST/PCPM/Z06/2022 dated** 26th June 2023.
	Research Associate – II	Rs. 61,000/- + HRA	
	Research Associate – III	Rs. 63,000/- + HRA	
	Junior Research Fellow (JRF)	Rs. 37,000/- + HRA	
	Senior Research Fellow (SRF)	Rs. 42,000/- + HRA	
2	Scientific Administrative Assistant/Fieldworker, Project Associate-I, Project Associate-II, Senior Project Associate, Principal Project Associate, Project Scientist-I, Project Scientist-II, Project Scientist-III, Project Scientist B, Project Scientist C, Project Scientist D, Project Coordinator-II, Project Coordinator-III, Project Manager	As per DST OM. No. SR/S9/Z-05/2019 dated 21.08.2019	As per **DST OM. No. SR/S9/Z- 05/2019 dated 21st August 2019**

2	**OVERHEADS CHARGES** ***DST OM: SR/S9/Z11/2013 dated 24 February 2015***	*As per DST norms and conditions:* *Towards meeting the cost of academic expenses including infrastructural facilities, an amount of:* a) *For project costing up to Rs.1 crore, 10% of the total cost for educational institutions and NGOs and 8% for laboratories and institutions under Central Government Departments/Agencies;* b) *for projects costing more than Rs.1.0 crore and up to Rs.5.0 crore, overheads of Rs.15.0 lakh or 10% of total cost whichever is less;* c) *for projects costing more than 5.0 crore and up to Rs.20.0 crore, Rs.20.0 lakh will be provided as overheads; and* (d) *for projects costing more than Rs. 20 crore, the quantum will be decided on a case to case basis.*
3	**CONSUMABLES** ***DST OM: SR/S9/Z11/2013 dated 24 February 2015***	*Amount as per project requirement (justification through DST processes)*
4	**CONTINGENCIES** ***DST OM: SR/S9/Z11/2013 dated 24 February 2015***	*Contingency can be utilised for stationery, accessories, software, printer cartridges, the printing of reports and publicity materials etc. The contingency amount may also be used for paying Registration Fees for attending international conferences etc.*
5	**TRAVEL** ***DST OM: SR/S9/Z11/2013 dated 24 February 2015***	*The budget allocated for travelling can be used for attending review meetings, conferences, workshops and training programmes. Travelling expenses for collection of data, survey and visits to other centres in the multi-partners study can be budgeted.* *Amount as per project requirement (justification through DST processes), to be provided where the research work involves fieldwork or/and project has many investigators/institutions and large manpower.* *Travel will include both national and international travel between the two collaborating countries. International travel of PI/Co-PIs and coordinators will be admissible only based on reciprocity. One way travel is not encouraged. The maximum period of stay of faculty will be 3 months and for students, it will not exceed 12 months. Travel costs should not exceed 20% of the total budget (excluding overheads)*

6	**OTHER COST**	*May include knowledge sharing and research uptake activities such as costs towards Subcontract work like fabrication, testing/standardization, renovation and small civil work and other works like the publishing of joint (only) research outputs, filing of patents, technology transfer, stakeholders meet or awareness camps etc.*
GRAND TOTAL		*Approx.* ***Rs.*** *per project (The amount will be the maximum cost admissible under the call. The actual amount may vary depending on the level of activities proposed in the programme.)*

Annexure – VI

DEPARTMENT OF SCIENCE AND TECHNOLOGY

POLICY ON CONFLICT OF INTEREST FOR APPLICANT (IITR)

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics are objective measures that are intended to protect the integrity of the decision-making processes and minimize biases. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in the award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, before, during and after the currency of the programme to be entered into with a view to enabling the public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision-makers will commit to preventing corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision-making process adopted by DST.

Definition of Conflict of Interest:

Conflict of Interest means "any interest which could significantly prejudice an individual's objectivity in the decision-making process, thereby creating an unfair competitive advantage for the individual or to the organization which he/she represents". The Conflict of Interest also encompasses situations where an individual, in contravention to the accepted norms and ethics, could exploit his/her obligatory duties for personal benefits.

1. **Coverage of the Policy:**

a) The provisions of the policy shall be followed by persons applying for and receiving funding from DST, Reviewers of the proposal and Members of Expert Committees and Programme Advisory Committees. The provisions of the policy will also be applicable to all individuals including Officers of DST connected directly or indirectly or through intermediaries and Committees involved in the evaluation of proposals and subsequent decision-making process.

b) This policy aims to minimize aspects that may constitute actual Conflict of Interest, apparent Conflict of Interests and potential Conflict of Interests in the funding mechanisms that are presently being operated by DST. The policy also aims to cover, although not limited to, Conflict of interests that are Financial (gains from the outcomes of the proposal or award), Personal (association of relative / Family members) and Institutional (Colleagues, Collaborators, Employer, persons associated in a professional career of an individual such as PhD supervisor etc.)

2. **Specifications as to what constitutes Conflict of Interest:**

Any of the following specifications (non-exhaustive list) imply Conflict of Interest if,

(i) Due to any reason by which the Reviewer/Committee Member cannot deliver a fair and objective assessment of the proposal.

(ii) The applicant is a direct relative or family member (including but not limited to a spouse, child, sibling, parent) or personal friend of the individual involved in the decision-making process or alternatively if any relative of an Officer directly involved in any decision-making process / has influenced interest/ stake in the applicant's form etc.

(iii) The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/award has had an employer-employee relationship in the past three years with that individual.

(iv) The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(v) The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(vi) The Reviewer /Committee Member is or was, associated with the professional career of the applicant (such as PhD supervisor, Mentor, present Collaborator etc.)

(vii) The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(viii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(ix) The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(x) The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

The Term "Relative" for this purpose would be referred to in section 6 of Companies Act,1956.

3. Regulation:

The DST shall strive to avoid conflict of interest in its funding mechanisms to the maximum extent possible. A self-regulatory model is however recommended for stakeholders involved in scientific research and research management, on issues pertaining to Conflict of Interest and scientific ethics. Any disclosure pertaining to the same must be made voluntarily by the applicant/Reviewer/Committee Member.

4. Confidentiality:

The Reviewers and the Members of the Committee shall safeguard the confidentiality of all discussions and decisions taken during the process and shall refrain from discussing the same with any applicant or a third party unless the Committee recommends otherwise and records for doing so.

5. Code of Conduct

(a) The applicant must refrain from suggesting referees with potential Conflicts of Interest that may arise due to the factors mentioned in the specifications described above in Point No. 2.

(b) The applicant may mention the names of individuals to whom the submitted proposal should not be sent for refereeing, clearly indicating the reasons for the same.

6. **Final Appellate authority**:

Secretary, DST shall be the appellate authority in issues pertaining to conflict of interest and issues concerning the decision-making process. The decision of Secretary, DST in these issues shall be final and binding.

7. **Declaration**

I have read the above "Policy on Conflict of Interest" of the DST applicable to Applicant and agree to abide by provisions thereof.

I hereby declare that I have no conflict of interest of any form pertaining to the proposed grant * I hereby declare that I have a conflict of interest of any form pertaining to the proposed grant *

* & # (Tick whichever is applicable)

(Name /Signature with date)

Annexure – VI

DEPARTMENT OF SCIENCE AND TECHNOLOGY

POLICY ON CONFLICT OF INTEREST FOR APPLICANT (SRHU, Scan copy attached)

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics are objective measures that are intended to protect the integrity of the decision-making processes and minimize biases. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in the award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, before, during and after the currency of the programme to be entered into with a view to enabling the public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision-makers will commit to preventing corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision-making process adopted by DST.

Definition of Conflict of Interest:

Conflict of Interest means "any interest which could significantly prejudice an individual's objectivity in the decision-making process, thereby creating an unfair competitive advantage for the individual or to the organization which he/she represents". The Conflict of Interest also encompasses situations where an individual, in contravention to the accepted norms and ethics, could exploit his/her obligatory duties for personal benefits.

8. **Coverage of the Policy**:

a) The provisions of the policy shall be followed by persons applying for and receiving funding from DST, Reviewers of the proposal and Members of Expert Committees and Programme Advisory Committees. The provisions of the policy will also be applicable to all individuals including Officers of DST connected directly or indirectly or through intermediaries and Committees involved in the evaluation of proposals and subsequent decision-making process.

b) This policy aims to minimize aspects that may constitute actual Conflict of Interest, apparent Conflict of Interests and potential Conflict of Interests in the funding mechanisms that are presently being operated by DST. The policy also aims to cover, although not limited to, Conflict of interests that are Financial (gains from the outcomes of the proposal or award), Personal (association of relative / Family members) and Institutional (Colleagues, Collaborators, Employer, persons associated in a professional career of an individual such as PhD supervisor etc.)

9. **Specifications as to what constitutes Conflict of Interest:**

Any of the following specifications (non-exhaustive list) imply Conflict of Interest if,

(xi) Due to any reason by which the Reviewer/Committee Member cannot deliver a fair and

objective assessment of the proposal.

(xii) The applicant is a direct relative or family member (including but not limited to a spouse, child, sibling, parent) or personal friend of the individual involved in the decision-making process or alternatively if any relative of an Officer directly involved in any decision-making process / has influenced interest/ stake in the applicant's form etc.

(xiii) The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/award has had an employer-employee relationship in the past three years with that individual.

(xiv) The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(xv) The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(xvi) The Reviewer /Committee Member is or was, associated with the professional career of the applicant (such as PhD supervisor, Mentor, present Collaborator etc.)

(xvii) The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(xviii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(xix) The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(xx) The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

The Term "Relative" for this purpose would be referred to in section 6 of Companies Act,1956.

10. Regulation:

The DST shall strive to avoid conflict of interest in its funding mechanisms to the maximum extent possible. A self-regulatory model is however recommended for stakeholders involved in scientific research and research management, on issues pertaining to Conflict of Interest and scientific ethics. Any disclosure pertaining to the same must be made voluntarily by the applicant/Reviewer/Committee Member.

11. Confidentiality:

The Reviewers and the Members of the Committee shall safeguard the confidentiality of all discussions and decisions taken during the process and shall refrain from discussing the same with any applicant or a third party unless the Committee recommends otherwise and records for doing so.

12. Code of Conduct

(c) The applicant must refrain from suggesting referees with potential Conflicts of Interest that may arise due to the factors mentioned in the specifications described above in Point No. 2.

(d) The applicant may mention the names of individuals to whom the submitted proposal should not be sent for refereeing, clearly indicating the reasons for the same.

13. **Final Appellate authority**:

Secretary, DST shall be the appellate authority in issues pertaining to conflict of interest and issues concerning the decision-making process. The decision of Secretary, DST in these issues shall be final and binding.

14. **Declaration**

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* & # (Tick whichever is applicable)

(Name /Signature with date)

Annexure – VI

DEPARTMENT OF SCIENCE AND TECHNOLOGY

POLICY ON CONFLICT OF INTEREST FOR APPLICANT (UJS Scan copy attached)

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics are objective measures that are intended to protect the integrity of the decision-making processes and minimize biases. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in the award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, before, during and after the currency of the programme to be entered into with a view to enabling the public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision-makers will commit to preventing corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision-making process adopted by DST.

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(xxiii) The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/award has had an employer-employee relationship in the past three years with that individual.

(xxiv) The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(xxv) The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(xxvi) The Reviewer /Committee Member is or was, associated with the professional career of the applicant (such as PhD supervisor, Mentor, present Collaborator etc.)

(xxvii)The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(xxviii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(xxix) The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(xxx) The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

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I hereby declare that I have no conflict of interest of any form pertaining to the proposed grant * I hereby declare that I have a conflict of interest of any form pertaining to the proposed grant *

* & # (Tick whichever is applicable)

(Name /Signature with date)

Bio-Data of Principal Investigator (PI)

1. **Name :** Sumit Sen
2. **Gender :** Male
3. **E-mail ID :** sumit.sen@hy.iitr.ac.in
4. **Qualifications :**

S.No.	Degree	Institution	Year	Division/Class
1	PhD Civil Engineering., (Concentration: Biosystems engineering)	Auburn University (AU), USA	2009	
2	MS Biological and Agricultural Engineering	University of Arkansas, USA	2004	
3	BS Agricultural Engineering	Allahabad Agricultural Institute DU, India	2001	

4. Employment Experience

S.No.	Position & Organisation	Period
1	Head, Centre of Excellence in Disaster Mitigation and Management.	2021 - present
2	Associate Professor, Dept., of Hydrology, IIT Roorkee.	2018 - present
3	Assistant Professor, Dept., of Hydrology, IIT Roorkee.	2012 – 2018
4	Fellow, Ashoka Trust for Research in Ecology and The Environment, India.	2011 – 2012
5	Post-doctoral Fellow, Biosystems Engineering Department, AU.	2009 – 2011
6	Graduate Research Assistant, Biosystems Engineering Department, AU.	2005 – 2009
7	Graduate Research Assistant, Biological and Agricultural Engr., University of Arkansas.	2002 – 2004

5. List of Publications *(For last 5 years only)*

5.1 Journal Publications

- van de Giesen, N., Peña Haro, S., **Sen, S.** WMO HydroHub Innovation Snapshot: Introduction to non-contact technologies for hydrometry. **WMO HydroHub**, Issue 1, **2023**.
- Dass, B., Daniel, D., Saxena, N., Sharma, A., Sen, D., **Sen, S***. Informing watershed management in data-scarce Indian Himalayas. ***Water Security Journal*** 19, 100138, **2023**.
- Yadav, A., Boothroyd, R. J., Sambrook Smith, G. H., **Sen, S**. Morphological adjustments of the Yamuna River in the Himalayan foothills in response to natural and anthropogenic stresses. ***Hydrological Processes***, 37:e14934, https://doi.org/10.1002/hyp.14934, **2023**.
- Mukherjee, S., **Sen, S.**, Kumar, K. Multifactor prediction of the central Himalayan spring high-flows using machine learning classifiers. ***Environmental Earth Sciences***, 82: 85, **2023**
- Yasmin, T., Khamis, K., Ross, A., Sen, S., Sharma, A., Sen, D., **Sen, S**., Buytaert, W., Hannah, D. Brief Communication: Inclusiveness in designing early warning system for flood resilience. EGUSphere, ***NHESS,*** 23 (2), 667-674 **2023**.
- Subramanian, S. S., Srivastava, P., Yunus, A. P., Martha, T. R., **Sen, S**. Numerical model derived intensity-duration thresholds for early warning of rainfall-induced