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World Water Day

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The "ENVIS Centre on Himalayan Ecology" is housed at G.B. Pant National Institute of Himalayan Environment (GBP-NIHE), Kosi-Katarmal, Almora, Uttarakhand, which is an autonomous Institute of Ministry of Environment, Forest & Climate Change (MoEF&CC), Government of India, New Delhi.

The **"ENVIS Centre on Himalayan Ecology"** collects, collates, compiles and builds quantitative and qualitative database of information in the fields related to the Himalayan Ecology. The information is disseminated regularly via online as well as hardcopies to several valuable stakeholders and various users such as DICs, Universities, Institutions along with other ENVIS Centres across India to support overall Environmental Information System in India.

Editor's Note

Dear Readers, the crucial role of mountains as the providers of large volumes of freshwater and as the natural storage site of this vital ecosystem service attracted the special attention of world leaders after the United Nations Conference on Environment and Development in 1992. Himalaya holds a significant position among the world mountains and also popularly known as "*Water Tower of Asia*". The Himalayan river basins are home to about 1.3 billion people, and supply water, food, and energy to more than 3 billion people. The Himalayan region stores more snow and ice than anywhere else in the world outside the two poles and thus popularly also known as "the third pole." Ten major rivers emerge from the Himalayan region, making it an important ecosystem for management of the water resources among others. However, in spite of abundance of water resources in the Himalaya its uneven distribution both in space and time comes in the way of development needs of the people. Governed by monsoon pattern of rainfall, this region which has enough water during the rainy season faces scarcity of varying magnitudes during rest of the year. The region is therefore confronted with "a too-much and too-little water syndrome". As the concern over water demand and supply is increasing in this region, understanding of the intricate relationship between ecological, hydrological and geomorphic factors, which governs the hydrological response of spring and river catchments is important in water resource management. The public awareness plays a crucial role in ensuring water sustainability. To raise awareness among the people about conservation and sustainable use of water the World Water Day is globally celebrated each year. The people are involved in various events to promote appropriate actions to tackle the global water crisis and achieving Sustainable Development Goal 6: Water and Sanitation for all by 2030. The theme of World Water Day 2021 was "Valuing Water". Beyond the issues of pricing, this topic includes the environmental, social and cultural value people place on water. This Newsletter published by the ENVIS Centre on Himalayan Ecology of the GBPNIHE covers the events/activities organized by the Institute on this occasion to educate the College and University students of the region about the importance of water. This Newsletter also contains articles on various issues of water resources in the Himalayan region. I hope readers will like this issue and send their valuable inputs / suggestions to improve this publication.

Kireet Kumar
Guest Editor
Director In Charge

Co-Guest Editors

Water is an important natural resource for all facets of the mountain environment, and plays a major role in shaping the environment and socio-economic development of people. The natural springs act as a primary source of water for villages and towns in mountain regions. For many people springs are only source of water. In the recent decades drying up of mountain springs in several middle mountain belt has come up as a major issue of environment and human development. This issue has posed new challenges for rural communities and women in particular in the region. Therefore, revival of drying springs needs prompt action by local communities, Panchayati Raj Institutions (PRIs), other Community Based Organizations (CBOs) and as well as R&D Institutions to find pragmatic solutions for water resources augmentation for the local inhabitants and reviving the drying springs. There is a need now to distinguish between 'Springshed' and 'Watershed' for a more targeted intervention and hence, implementation can be done to maximize the benefits. Ensuring the longevity of springs requires a coordinated approach and also understanding of external factors that impact the flow in the springs and the overall well–being of dependent population. Parallel, need is also felt to develop a curriculum on developing a training programme for young professionals to deal with the declining water availability across mountain region and also promote research on impact of anthropogenic factors such as deforestation, changes in land use and land cover, population pressure, infrastructure development, overexploitation of ground water, ecological degradation and climate change. With the above scenario in mind, a Training–cum-Consultation meeting on "*Participatory Springshed Management*" was jointly organised by GB Pant National Institute of Himalayan Environment (GBPNIHE), Garhwal Regional Centre, Srinagar (Garhwal) and Deptt. of Geography, School of Earth Sciences, HNB Garhwal University (A Central University), Srinagar (Garhwal) at Academic Activity Centre Chauras Campus, HNB Garhwal University, Srinagar (Garhwal) on 19th & 20th February 2021. On first day lectures by leading experts such as Prof. A.K. Sharaf, IIT Roorkee, Prof. M.S. Panwar, Prof.M.S.Negi, Prof.H.C.Naiwal, Dr. A.Darmora, HNB Garhwal University, Dr.V.Thapliyal, Dr.Sunesh Sharma, Sh. Asha Ram Mamgain and Sh. S. Tarafdar, GBPIHED imparted to the selected 65 trainees from various IHR Universities, R&D organizations, NGO etc. and on the second day a site visit to Saur, Gajeli, Kafoli and Pallygaon spring site was organized for participatory Springshed Training. During this two days event, sharing of experiences and lessons on Participatory Springshed Management was made and the experts emphasized that our main focus should be on hydro-geological mapping of aquifers and springs, classification of springs, artificial recharge and identification of spring recharge area, village water security plan promotion through participatory conservation and management of springs and linking it with livelihood and income generation and creating cadre of water professionals (para-hydrologists). All experts also emphasized that such forward focused thinking is needed to ensure that the necessary knowledge and skills for reviving springs are imparted to the next generation who are living in mountain areas. The rural communities especially women participants recognized their own contribution in springshed management, who are direct users of springs. It was encouraging to note that through such programs some participants showed their commitments to strengthen springshed management in their respective areas.

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Training–cum-consultation meeting on participatory springshed management

Geoinformatics in spring studies

A watershed is an area of land that drains all the streams and rainfall to a common outlet, whereas spring shed is simply an area of land that contributes groundwater to a spring. It is easier to delineate and manage a watershed rather a spring shed. Changes in springs discharge, location, quality of water etc. occur due to landuse / land cover changes, earthquakes, landslides, human interventions, climate change etc. In recent years such major changes have been observed in drying up of springs in the IHR particularly in Garhwal Himalaya. Springs are the major source of potable water in the IHR Therefore, there is an urgent need to preserve these springs for the sustaining life. It is important to note that though delineation techniques for watershed and spring shed are different but their management techniques are quite similar. Therefore, better management of watersheds should bring positive results towards spring management. In recent years, some efforts have been made towards management of watersheds in the Himalaya, which have brought positive impacts. Since springs bring groundwater on surface due to topographic setup, and hence in order to improve springs, well established groundwater recharge techniques of hard rock terrain may be adopted. Rainfall data analysis of past about 120 years has revealed that total annual precipitation over India has not changed significantly. Further, it is also well known that more about 98% of our rainfall water ends up in the form of surface runoff. Further, it is important to note that in last 120 years our requirements of water has increased many folds due to rapid increase in the population and industrialization, however, at the same time our efforts towards groundwater recharge have not increased proportionally. Recent studies have shown that groundwater recharge measures can brings significant improvements in groundwater conditions in hard rock terrains than within 2-3 years' time. Techniques of groundwater recharge are well known and have been in practice since ages and therefore instead of making efforts towards spring shed delineation etc., emphasis should be towards better management of overall watershed and extensive groundwater recharge. Geoinformatics techniques which includes remote sensing, GIS and global navigation satellite systems (GNSS) may be employed to investigate better locations of groundwater recharge sites and overall management of watersheds. Remote sensing techniques can be employed to assess current landuse / landcover as well as changes occurred in last few decades, whereas GIS along with GNSS will provide a digital platform to manage, analyse and model spatial data related with overall watershed management and groundwater recharge in the Himalayan mountains.It is reported that half of the perennial springs have already dried up or have become seasonal resulting into acute water shortage for drinking and other domestic purposes across hundreds of Himalayan villages. Continued crisis will consequently affect lives of millions of people in the mountains. The dependency of majority of the population on spring water implies that with changing climatic conditions and rainfall pattern, a large number of villages, hamlets and settlements will face potential drinking water shortage. Of late, efforts to preserve and save springs from drying up and recharging them are gaining momentum across various Institutions, Government and NGOs which include; hydrogeological mapping of spring sheds, catchment area restoration/protection for augmentation of recharge; monitoring and management of springs, dissemination, outreach and sharing of knowledge.

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Participatory springshed management is the key for water security and resilience of mountain villages of Uttarakhand

Mountain springs are the primary source of water for over 60% rural households in the Himalayan region for fulfilling their domestic and livelihood needs such as drinking water, sanitation and irrigation. Despite the key role they play, springs have not received their due attention and facing the threat of drying up. There is increasing evidence that springs are drying up or their discharge is reducing throughout the Himalayas. Spring discharge is reported to be declining due to increased water demand, changing land use patterns, and ecological degradation. The Himalayan ecosystem is quite fragile and susceptible to several changes caused due to both natural dynamism and anthropogenic interventions. The erratic rainfall pattern with marked decline in winter rain, seismic activity and ecological degradation associated with land use change for infrastructural development is posing huge pressures on mountain aquifer systems. The problem of dying springs is being increasingly felt across the IHR. It is reported that half of the perennial springs have already dried up or have become seasonal resulting into acute water shortage for drinking and other domestic purposes across hundreds of Himalayan villages. Continued crisis will consequently affect lives of millions of people in the mountains. The dependency of majority of the population on spring water implies that with changing climatic conditions and rainfall pattern, a large number of villages, hamlets and settlements will face potential drinking water shortage. Of late, efforts to preserve and save springs from drying up and recharging them are gaining momentum across various Institutions, Government and NGOs which include; hydro geological mapping of spring sheds, catchment area restoration/ protection for augmentation of recharge; monitoring and management of springs, dissemination, outreach and sharing of knowledge. However, in addition to these efforts, there is also a need to address demand side challenges to ensure the current water requirement in times of limited resource availability, by augmenting the efficiency of water use. Hence, social, economic and ecological sciences must compliment hydrology and hydrogeology in the management of the precious spring water resource in the mountains. This entire process would gain further value and utility when institutions like village water and sanitation committees (VWSCs) that have specific water and sanitation focus, or more formal systems like the Gram Sabah's of Gram Panchayats or Village Councils participates in it activity. Therefore, multiple actions need to be taken right from use of technology for spring recharge to social and policy level participation for sustaining the water discharge of the drying springs of Himalayan mountains.

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Participatory approaches for springshed management

Participatory springshed management in the mountains

Uttarakhand is vital for the ecological security and integrity of the country as it provides perennial water sources, fertile soil and forest cover. The ecosystem of the region is highly vulnerable and susceptible to anthropogenic and natural impacts. An economic and technological intervention in the name of development is responsible for overexploitation and overuse of nature. The forest logging for construction of roads and buildings and hydropower projects has depleted forests in this fragile and sensitive area. Further, unplanned tourism activities have also add to the vulnerability of the water resources. Forests play important role in harvesting rain by regulating the water yield and flow. An area with thick forest cover and slopes percolates down the high-quality water in the whole watershed area which provides regular water supply to the local community. The watershed area not only regenerates water but also replenishes water streams, ponds, rivulets and the downstream rivers. Thus it has become imperative to declare the life supporting natural resources as sacred so that these can be protected and conserved. Various legends and myths are associated with most of our area to protect environment. The wisdom of our ancestors was good enough to create fear and guilt amongst community by declaring many areas as sacred landscapes and sacred groves where no human intervention is allowed. Our wetlands especially in high altitude area are considered to be sacred and are associated with certain beliefs, so as the rivers. Traditionally Dhara, Naula, Gadhera are used for daily water needs. However, most of the aquifers in the area are on the verge of depletion. The maintenance of these natural water resources is being also ignored because of door-to-door water supply. Need of the hour is to map all the water resources and to identify the related issues such as their present status, recharge, biodiversity, livelihood of communities, etc. The regeneration of the springs can be done by preserving the catchment of the spring and by declaring Water Protected Area (WPA). All anthropogenic activity should be banned. Seeds of indigenous herbs, shrubs, climbers and trees can be sprayed in the recharge zone during monsoon so as to assist the natural regeneration. Minor check dams can be erected on landslips. These should be done by bioengineering and conserving forests. The water policy should be focused on keeping in mind the protection/conservation of water aquifers; emphasis on gravity tapping of water and legal teeth to all catchment of the natural water resources. It must be ensured that large catchment areas around water bodies are developed so that natural water recharge takes place. Just like the Seog water catchment area in Shimla, Himachal Pradesh which is a wild life sanctuary since 1999 and where no construction is allowed. This can be cited as a success story for regeneration of water sources. This water catchment area in Shimla is the watershed management work initiated by the Britishers by making a reservoir at Seog, Shimla in 1901 and declared as water catchment area. The catchment has an area of 1020.32 ha and receives average 1600 mm rainfall. The water supply based on gravity and is the source of supply of water to Shimla town. At the same time, it is an important wildlife sanctuary having a great conservation value. A long history of conservation has been associated with catchment area; it has been conserved for more than past 100 years. The area is being managed by the Himachal Pradesh Forest Department. The catchment area is rich in biodiversity, home to many species of plants, animals, birds and insects and has 9 perennial streams. Shimla city which had the water supply from Seog has supplemented the same through lift irrigation schemes from major water sources— Gumma, Giri and Churat.

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Water security through participatory springshed managment in Uttarakhand

Himalayan region is facing challenges pertaining to water insecurity due to changing climatic and anthropogenic factors. On the basis of people's perceptions and data collected from the region it is noticed that spring discharges are declining on regular basis and leading to water scarcity in the area. Many villages are facing acute water shortage especially in the summer season. Drying up of the water sources have adversely affected the rural water security of people; especially women have to travel greater distances for water collection. Rural communities of Uttarakhand are using traditional water sources such as Naula, Dhara etc. for daily water requirement. These water resources are mostly owned, used and maintained by the local communities and treated as common pool resources. Climate change and change in land use pattern is a serious threat for the water resources (springs) in this region (Uttarakhand) and affecting adversely on spring discharges. The rural water supply systems in Uttarakhand are spring-fed and most of the water sources (springs) originate partially and fully from reserve forest area or in some cases the springs catchment protection area falls under reserve forest. Besides springs catchment, small artificial ponds, pits, trenches and plantation, constructed on the slopes of mountains, these structures were not only the traditional methods of rainwater harvesting which helped in maintaining the groundwater level but also provided water to domestic and wild animals in forests. Such traditional water resource management systems are now dying due to lack of forest and tree cover, irregular and unpredicted rainfall pattern, loss of traditional knowledge, modernization and uncontrolled development. Among the important reasons behind the negligence of these important water resources is modernization, which has caused a loss of traditional knowledge systems among rural communities along with a lack of maintenance due to out-migration of villagers to nearby towns and cities for better job opportunities. United Nations' Sustainable Development Goals (SDGs) that have been targeted towards the year 2030 and mountains play a key part in achieving the SDGs for water (SDG 6). Springs are the main source of drinking water for the local communities and called as lifeline of mountain people. Springs are an essential resource and plays key role in context of mountain region to provide water for drinking, domestic and livelihoods to rural communities. Spring water flowing through gravity is appropriate in such terrains which often emanate from localized unconfined aquifers also known as perched aquifers. Therefore, a local geological system beneath the ground, holding and disseminating water is important and understanding of geology will be useful for planning and implementation. The varied geological set-up coupled with complex structures, controls the hydro geological scenario of the mountain region and in addition, the morphology plays an important role on the occurrence and movement of ground water over the area. As per NITI Ayog report (2018), it is reported those more than three million perennial springs in IHR. States have already dried up or become seasonal, resulting in acute water shortages across thousands of Himalayan villages. Reflections of climate change are also challenging in Himalayan region. Science, Governance and community participation are the main pillars of water conservation programmer. Since the beginning of the 21st century, Uttarakhand is facing an increasingly acute water crisis. Less than 50% of the people receive adequate quantities of safe drinking water. The availa¬bility of potable water during the dry season in rural areas can drop to 25-30 liters per capita per day (LPCD). In 2019, it was estimated that over 50% of springs located in the state of Uttarakhand have dried up or become season¬al. It is widely accepted that climate change, land use change, unplanned development activities, and lack of resource manage¬ment due to outmigration from rural to urban areas and moun¬tains to lowlands are responsible for diminishing spring flows. Though entire region faces the problem of water scarcity specifically during long dry spells, but it is more pronounced in mid and upper hilly regions due to limited number of springs characterized with smaller recharge zones, thus having finite discharge.

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Participatory approaches for springshed management

Water resource sustainability in middle Himalaya

The hydrogeology as well as topography largely controls the availability of groundwater flowing as springs or seeps for the rural and urban population in the IHR . The most vulnerable rural water supply network has it source in groundwater springs spread all across the mountain-scapes. However, over a period of last 4–5 decades reports of diminishing supply of water from the springs and streams are emerging from the middle mountains of Himalayan region. The complex underlying reasons for such a wide spread observation is a result of both changes in the biophysical as well as socio-economic factors.

Rural-to-urban migration of people from the hill district of Uttarakhand has led to series of changes in terms of rapid landuse change marked by agriculture land abandonment and regeneration of trees such as pine which has significantly higher water demand. Recurrent forest fire in pine-dominated forests has further led to hardening of soil causing more run-on than infiltration. One of the most important drivers threatening the water resource sustainability in recent times is the alteration in the characteristics of rainfall, series of drought years and delay in monsoon. Anthropogenic drivers such as road expansion and apathy of people towards government funded initiatives are major issues which need science-based understanding and result-based financial funding for forest and water improvement schemes. All the state implementing agencies related to water and forest sector are engaged in soil and water conservation with cluster of villages as an administrative unit, but without effectively demonstrating the efficacy of the treatment for spring recharge at a catchment scale. The success of any intervention will largely depend on the understanding of the "black box", which in this case is the catchment subsurface characteristics governing storage, flow pathways and residence time. Environmental stable isotope, due to the its conservative nature and natural abundance in water is used as a tracer to estimate the contribution of direct runoff and baseflow to the total hydrograph, estimation of average elevation of recharge for springs and low-order streams and finding out the mean residence time. $\delta 18O$ and $\delta 2H$ environmental stable isotope by its measurement in water (rain, surface runoff, soil and groundwater) is extensively used for understanding the rainfall-runoff relationship for small catchments, thus giving insight into the hydrological processes. Two microwatershesds located in Ir-gad watershed which is part of Paschimi Nayar River basin was investigated using stable isotopes over the past decade. The local meteoric water line was developed for the region which indicates that rainfall, especially the monsoon recharge is the primary source of recharge for springs and streams and the approximate elevation of groundwater recharge lies within the immediate watershed divide. Some of the key knowledge gap is effectively managing the rising evapotranspirative demand due increasing expansion of fast growing pine and understanding of its impact on water availability. Future water sustainability for mountainous basins need focused interdisciplinary water research divulging the link between terrain characteristics; geology, landuse, climate change and soil and water conservation activities with supporting pre-and post implementation data for better management of freshwater. Stakeholder of Himalayan headwaters should be made aware of the complex water related issues and training and exposure of the future water aspirants should take precedence.

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जल स्रोतों का प्रबन्धन एवं संरक्षण

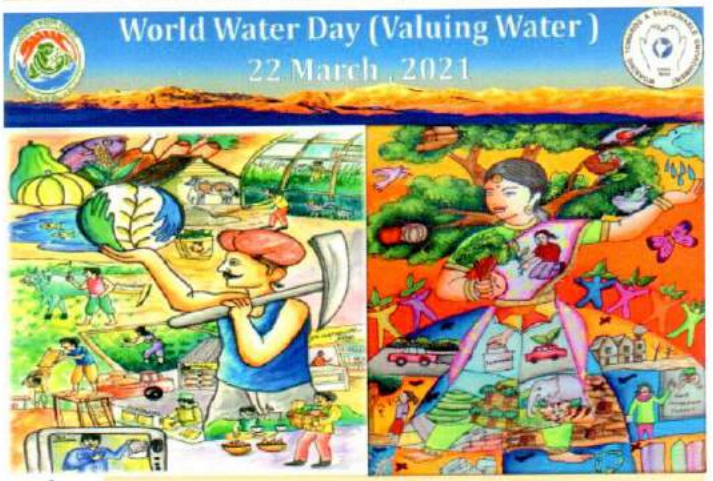
जल स्रोतों का वर्तमान समय में प्रबंधन एवं जरूरतें

उत्तराखण्ड के भौगोलिक परिपेक्ष्य को देखा जाय तो पिछले 50 वर्ष पूर्व 80 प्रतिशत आबादी मध्य हिमालय के पहाड़ी ग्रामीण क्षेत्रों के गांवों की बसावट थी, उसके पीछे मुख्य कारण पानी एवं कृषि, तथा चारे को लेकर हर गांव बसता था। गांव उसी को माना जाता था जहा पर मनुष्यों का रहना एवं खेती करना तथा मनुष्यों एवं पशुओं तथा खेती की सिंचाई के लिए पानी उपलब्ध हो क्योंकि जलस्रोतों के अलावा जीवनयापन का और कोइ विकल्प नही था। गॉव के 2 किलोमीटर के दायरे में जितने भी जल स्रोत एवं कुऐं व गाड़–गधेरें होते थे उस पर सम्पूर्ण स्वामित्व ग्रामीणों का होता था जिससे उनका सम्पूर्ण प्रबंधन की जिम्मेदारी वहा स्वयं की समझते थे जिसे वह अपने लिए पीने के पानी, पशुओं के लिए पेयजल, कृषि के लिए सिंचाई की व्यवस्था अपने तरीकें से करते थे। जलस्रोतों के एक किलोमीटर के क्षेत्र में पशु चुगान पर प्रतिबंध और वन अग्नि से बचाव, शौच पर प्रतिबन्ध, पेड़ों के कटान पर रोक आदि कई पारम्परिक तरीकों से प्रबन्धन करते थे ताकि आगे आने वाली पीढ़ीयों को जल संकट से न गुजरना पड़ें और गॉव का अस्तित्व भी बचा रहें। लेकिन आधुनिक विकास की दौड़ में जल स्रोतों का पानी को पाइप लाइनों द्व ारा टेप करके रोड़ साइड के कस्बों को दिया गया। कच्ची गूलों की जगह पक्की गूलें बनवाई गई, जिससे ग्रामीणों ने समझा कि इन जलस्रोतों से हमारा अधिकार छीन लिया गया है, फिर वह पूर्ण रूप से लाप्रवाह हो गये और धीरे–धीरे जल स्रोतों पर संकट मंडराने लगा। पिछले दशक से जलवायु परिवर्तन और बारिश के समय का अनियत्रित होने का प्रभाव सीधा जल स्रोतों पर पडा। आज से 25–30 वर्ष पूर्व शीतकाल में 1 से 2 सप्ताह की लगातार हल्की बारीश होती थी जिससे जल स्रोतो पर ग्रीष्मकाल में मई–जून में फर्क नही पडता था लेकिन आज वर्तमान में शीतकाल की बारिश बिल्कुल विलुप्त हो चुकी है जिससे जल स्रोतो पर गहरा संकट छा गया है। इसके कारण बारीश का पानी जमीन के अन्दर जाने के बजाय सीधा बह जाता है जिससे भूमि में नमी का संरक्षण नही हो पाता है। पहले खेती में हल लगने से पानी जमीन में खेतों के मध्य में रूक कर समा जाता था और वही कहीं न कहीं हमारे जल स्रोतों को जीवन प्रदान करता था लेकिन अब ऐसा नही है। ग्रामीणों द्वारा प्रत्येक वर्ष सामूहिक तरीके से जल स्रोतों को पूजने की परम्परा थी और सभी गॉव वाले मिल करके स्रोत को सफाई एवं अगल–बगल की झाड़ियां साफ करते थे। स्रोत के एक किलोमीटर क्षेत्र को वन अग्नि से बचाया जाता था। नई बहू द्वारा धारा पूजन का कार्य किया जाता था। गांव में किसी की मृत्यु होने पर सभी संस्कार पितृ कार्य जल स्रोतों के नजदीक किया जाता था। जल स्रोतों को कुल देवता के अनुसार पूजा जाता था, लेकिन यह सभी प्रथाऐं धीरे–धीरे समाप्त हो गई है। अतः जल स्रोतों के संरक्षण के उपायों में सरकारों द्वारा ग्रामीणों को जल स्रोतों के हक–हकूक को वापस दिलवाना, खेती के प्रति सोच बदलना, फ्लायन की रोक, बड़ी जल विद्युत परियोजनाओं पर रोक, पानी के स्रोतों के कम से कम पॉच किलो मीटर के दायरे में कोई निर्माण कार्य पर रोक, जल स्रोतों के महत्व के प्रति ग्रामीणों को जागरूक करना, ग्राम पंचायतों में जल स्रोतों के रखरखाव के प्रति प्रस्ताव बनाकर शासन–प्रशासन को अवगत करवाना, चौड़ी पत्ती के पौधों का रोपण करवाना और चीड़ को समाप्त करने के लिए सरकारों एवं विभागों पर दबाव बनाना, खाल–खन्तियों व रिचार्ज पिटों, आदि का निर्माण पंचायत द्वारा मनरेगा के अन्तर्गत सरकारी एवं गैर–सरकारी संगठनों द्वारा किया जा सकता है।

आशा राम मंमगाई
डालियों का दग्ड़िया, श्रीनगर गढ़वाल

ENVIS activities on World Water Day

The ENVIS Centre of the Institute also participated in the World Water Day celebration organized by the Centre for Land and Water Resource Management, (GBPNIHE), Kosi - Katarmal, Almora. On this occasion ENVIS Newsletter entitled "*Understanding the dynamics of Himalayan Glaciers*" Vol. 12(1), 2015 was distributed among the participants to raise awareness about water resources and also participated in the cleanliness drive arround river Kosi. Also, on the theme of the World Water Day 2021- *Valuing Water,* on-line poster competition was also organized in which 54 students of class 6 - 9th across the country participated and the winners were given certificates.



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Mahesha Nand, ENVIS Centre,
GBPNIHE, Kosi-Katarmal, Almora,
Uttarakhand

Activities during world water day

Namami Gange: A water conservation mission

Water is Life. Most of the human activities require water for day-to-day activities. All over the world water crisis has been an evolving and daunting phenomenon, which needs high attention and efforts for sustainable water management. With regard to this the S.S.J. University, Almora in collaboration with State Management Group Namami Gange, Uttarakhand developed an action plan for Information and Education activities among the students, teachers and public in general with an objective of creating awareness regarding cleaning and maintaining water resources (Table 1). Namami Gange Programme', is an Integrated Conservation Mission, approved as 'Flagship Programme' by the Government of India in June 2014 to accomplish the twin objectives of effective abatement of pollution, conservation and rejuvenation of National River Ganga. It includes sewerage treatment infrastructure, river-surface cleaning, afforestation, industrial effluent monitoring, river-front development, bio-diversity conservation, public awareness and development of Ganga Gram. S.S.J. University, Almora stepped forward in this direction with the special efforts and keen interest of Hon'ble Vice Chancellor of the University various activities were conducted under this programme in Almora. The Programme was inaugurated on 15th March 2021 by Hon'ble Vice Chancellor and Chief Development Officer, Almora by beginning a three days' "National Workshop-cum-Painting Competition" whereby the student participants of the University made beautiful and stimulating paintings on the theme of Namami Gange.

"Rivers are a source of cultural and spiritual value in India from cradle till death. Many civilizations had established near the banks of water bodies and rivers. It's the duty of every citizen to make efforts for conservation of water bodies. Our University has been trying to connect with all the students and general public in this mission by conducting awareness activities."
Prof. N.S. Bhandari,
Vice Chancellor, Soban Singh Jeena University, Almora

The second activity in the sequence was "One Day Training-cum-Awareness Programme on Rejuvenation of Rivers and Water Resources", inaugurated by Chief Guest, Dr. R. S. Rawal, Director GBPNIHE, Kosi-Katarmal, Almora. Guest of Honour Prof. J. S. Rawat, National Geophysical Chair, SSJ Campus Almora, Resource Person Dr. G.C.S. Negi, Scientist G, GBPNIHE, Prof. Neeraj Tiwari, Director, SSJ Campus and Dr. Mamta Aswal, University Co-ordinator Namami Gange were present on the occasion. The participants were Research Scholars, National Service Scheme volunteers and Teachers of the University.

The resource persons presented their talks on mountain springs, which are natural sources of groundwater and perched aquifers are the primary sources of water in Himalayan regions such as Naula, Dhara and Gadhera (Bhatt, 2017). Various problems of water crisis in the hills due to developmental activities, deforestation and climate change were discussed in details. Such as people are forced to reduce water consumption, consume unhygienic water, prone to water borne diseases and face conflicts over water issues (Negi, 2017). Major recharge zones in the Kosi river basin area were discussed and modus operandi to recharge the dying river Kosi, which serves as the main sources of water in the city, were suggested. How to conserved rain water through chal-khals, check dams, infiltration holes and tree plantation and indigenous knowledge about was provided to the participants in detail. Dr. Rawat emphasized that drying rivers can be rejuvenated by recharging the origin of these rivers leading to increase in underground water storage which will revive the small springs (Gadhera) and consequently the big rivers will survive (Rawat, 2011). On the World Water Day (22 March 2021) a cleaning drive on the banks of Kosi river was conducted along with a visit to the Rural Technology Complex and arboretum of GBPNIHE, Kosi-Almora where the participants came to know a variety of sustainable practices being carried out at using Chir Pine needles (Pirul), which is otherwise a big menace for forest fire in this region. Participants gained a lot of information and knowledge about conservation of water resources. They pledged to remain active in dealing with the concerns of water scarcity and also performed a "Nukkar Natak" to generate awareness among the street people during this programme.

Table 1: A brief programme schedule of the activities conducted under the Swachhta Pakhwada

Dates	Events
15 March	Inaugural of Ganga Swachhta Pakhwada
15 - 17 March	Painting Competition
19 March	One day Training cum Awareness programme on Rejuvenation of Rivers and Water Resources
21 March	Nukkad Natak
22 March	Cleaning Drive on Kosi Rver Banks/ Pledge/ Visit to GBPNIHE
22 March	Exhibition of Paintings
26 March	Cleaning Rally Signature campagain

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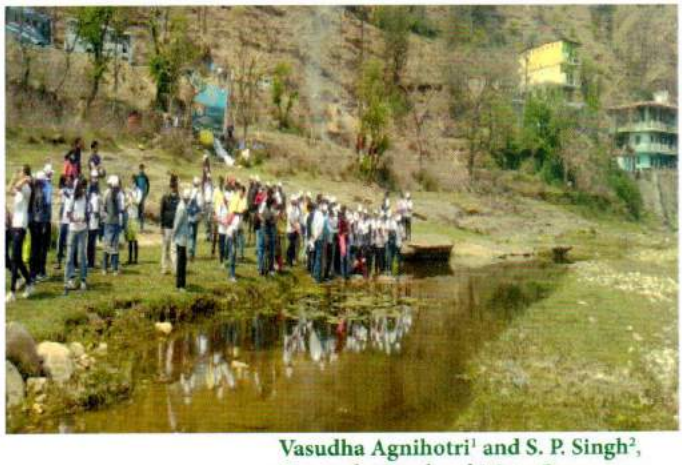
Kosi river cleanliness campaign

Centre for land and water resource management activities during World Water Day

The Kosi river originates from its north at Pinath (NW of Kausani, Distt. Almora), which flows down towards the discharge point at Kosi barrage (Rāmnagar, Nainital). Geographically, the Kosi catchment has its spatial extension between 290 22' 41.60" to 29052' 20.81" N lat. and 79002' 38.21" to 79051' 15.08" E long., which covers about 1868.64 km² area. The absolute relief of the catchment ranges between 349 m to 2758 m from the mean sea level. The Kosi river basin water is used for various purposes such as drinking, irrigation, fishing, cremation, etc. Over the years, the flow of water in the river has been decreasing drastically due to climate change, anthropogenic activities, infrastructural changes etc. In view of this, various initiatives and campaigns for the rejuvenation of Kosi river have been started by the district administration Almora and other organizations such as Uttarakhand Forest Department, Eco-taskforce of the Army, G.B. Pant National Institute of Himalayan Environment (GBPNIHE) etc. Under these initiatives, National Mission on Himalayan Studies-State Government Project scheme funded project entitled, "Rejuvenation of the Kosi river of Kumaun Himalaya through field interventions and people participation" has been started. On the occasion of "World Water Day' on 22nd of March 2021, the GBPNIHE, Almora in association with District administration Almora and Government Inter College, Hawalbagh, a Kosi cleanliness campaign was organized by Dr. V. Agnihotri, Scientist, GBPNIHE near Kosi barrage and Kosi bazar, Almora in association with research team of the NMHS-SGP project coordinator and other staff of GBPNIHE. Both banks in the upstream reaches of Kosi barrage were cleaned with the active participation of students & teachers (Dr. K. Nayal, Mr. M.P. Sahoo, Ms. S. Bora and Ms. H. Tamta) from GIC, Hawalbag and Mr. P. Kandpal,

Block Development Officer (BDO), Hawalbagh, Almora. During the program, an appeal was made to local residents, shopkeepers, restaurant owners and tourists, not to pollute the flood plain of Kosi River, as the river water is further pumped to Almora city for drinking and various other household purposes. During the mass awareness program, along with elaborating the theme of "Aazadi ka Amrit Smaranotsava" a vision of making Indian Himalayan Region (IHR) an epicenter of eco-diversity, with availability of surplus freshwater was introduced among all the participants. Students and all participants were motivated by experts and teachers by sharing the importance of water conservation and river rejuvenation during the event at the Kosi river bank. Dr. V. Agnihotri demonstrated onsite water quality analysis to the students, using handheld pH, electrical conductivity, and TDS measuring devices, to which they responded with great enthusiasm. A pledge on protection of Kosi river was also taken by all the participants (Box 1). All collected garbage during this programme was disposed-off to the prescribed dumping site.



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Water quality assessment in the river Satluj basin, north-western Himalaya, India

Centre for environmental assessment & climate change contribution for World Water Day

The availability of freshwater on land is scarce and it is used for a variety of uses such as drinking, irrigation, water mills, hydropower generation, recreation etc. Aquatic ecosystem is such that connects with other ecosystems, carries water and transports dissolved minerals and make available nutrients for the end-users for various consumptive and non-consumptive demands. The Indian Himalayan Region (HR) is rich in water resources but is threatened due to anthropogenic stress, over-exploitation, and lack of management techniques. As a result, freshwater resource is continuously depleting. While rivers draining the land, recharge the groundwater by percolating into deeper aquifers. But this is affected greatly by the existing climatic conditions. Along with this, maintaining water quality is a challenging task. This is affected by the interaction of dissolved oxygen with organic material; thus, a variety of chemical transformations may take place. So, there is a need to analyze water quality of limited fresh river water system which will help in the management of water resources. In this article we are presenting the water quality of river Sutlej that originates from Mansarowar Lake in Tibet (4572 m asl) and is a major tributary of the River Indus. This River plays a key role in the economy of the northern India. The total length of the river is 1,448 km. The Sutlej leaves Himachal Pradesh when it enters into the plains of Punjab at Bhakra-India's highest gravity dam. Seven monitoring sites from Luhri (878 m) to Khab (2996 m) from the Upper Satluj basin were selected for making an assessment of the selected parameters like physical, chemical and biological parameters of water quality. In this regard, basic water quality parameters physical and chemical parameters were tested with the Manual on water and waste water analysis (APHA, 2015). For the calculation of water quality index, 7 parameters were chosen using the standards of drinking water quality recommended by the World Health Organization (1995), Bureau of Indian Standards and Indian Council for Medical Research. An early water quality index was proposed by Horton (1965), and then developed by Brown et al. (1970) was considered. The weighted arithmetic index method was used for the calculation of WQI of the water body.

The computed values of WQI for the River Sutlej water during post-monsoon, winter and pre-monsoon season in the selected sites were 39.90, 46.12 and 54.78, respectively. These were taken into account in relation to the overall parameters which were categorized as good, good and poor water quality status, respectively. In a comparative way, three of these, pre-monsoon season is rated as 'C' and had high WQI values. Also, water in pre-monsoon season is not fit for drinking and other purposes. The WQI during the post-monsoon season is rated as good. This shows that water is fit for human drinking purposes. The average mean values of different parameters were within their acceptable limits except for hardness (210±21.72 mg l-1) and dissolved oxygen (DO) i.e., 6.76±0.62 mg l-1. The WQI during winter season was found 'good' and found fit for drinking and other human uses. The average mean values of different parameters were within their acceptable limits except for total alkalinity (200±20 mg l-1), total hardness (280±44.59 mg l-1) and dissolved oxygen (13±2.11 mg l-1). Alkalinity is influenced by carbonate and bicarbonate and other ions. The alkalinity is directly linked to the abundance of phytoplankton which dissociates bicarbonate into carbonates and carbon dioxide. DO is one of the most important parameters. Its correlation with the water body gives direct and indirect information, e.g., bacterial activity, photosynthesis, availability of nutrients, stratification, etc. The WQI during pre-monsoon season was found under 'poor' category and was not found fit for drinking. The average mean values of different parameters were within their acceptable limits except pH (8.95±0.20) and dissolved oxygen (6.76±0.42mg l-1). The pH value above 8.7 indicates presence of carbonates. Pearson's correlation coefficient shows EC with strong correlation r = 0.989, 1.000, 0.913 with TDS during pre-, winter and post-monsoon seasons, respectively. While pH shows r = 0.812 with alkalinity during post-monsoon. In pre-monsoon, alkalinity shows r = 0.811 with hardness and DO gives r = 0.872 with BOD. During winter, EC shows r = 0.811, 0.803 with Ca+, Cl-, while TDS shows r = 0.809, 0.808 with Ca+, Cl- respectively. Also, Cl- shows r = 0.883 with Ca+. The results showed that EC is dependent on TDS, while alkalinity on hardness. The interrelationship indicates that the hardness of the water is permanent in nature. The positive and negative correlation among the parameters represent as major sources of seasonal changes in water quality. TDS is a direct measure of all the dissolved particles, both organic and inorganic in water. High TDS influences also the other quality parameters. But EC is the most affecting parameters among others. It is made clear from the linear equation that there is a relationship between two variables, i.e., TDS vs. EC and alkalinity vs. hardness. A known value of EC gives the contribution of each ion that can be obtained by substituting an average ionic value for the entire study area and similarly in case of other parameters.

The analysis reveals that the surface water of the area needs some degree of treatment before consumption or use, and this scarce water also needs to be protected from contamination. However, a comprehensive program of monitoring water quality for a longer period may further improve the understanding of a river water system. WQI may be used as an important indicator to know the health of river water. Hence, there is a need for regular monitoring of water quality in view of detecting changes in physico-chemical parameters, its remedial measures and creating awareness among the people.

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Framework of inclusive local governance for safe guarding Himalayan blue heritage springs sources

Centre for land and water resource management contribution during World Water Day

The present water crisis is not about the scarcity of the water alone but its more as a governance crisis. That's why good water governance is a prerequisite for improved water management all over the world. Here, one such local level water governance model framework is considered, modified and elaborated suitably for springs water sources conservation and management. 'Springs' are ecosystems where groundwater is ex¬posed at, and typically flows from the Earth's surface. Indian Himalayan Region (IHR) endowed with three million of springs sources according to a rough estimate. These springs are fondly called as Himalayan Blue Heritage. Springs are the main source of fresh water for millions of people across the IHR for their drinking, domestic and agricultural water needs. Most the rivers of Himalayan region are spring-fed rivers and most of the water supply schemes in the region are also springs dependent. However, approximately 50% of the mountain springs in the IHR are drying up or becoming seasonal, causing untold misery to both rural and urban inhabitants of the IHR (NITI Aayog, 2018). Therefore, there is an urgent need for implementing spring rejuvenation programmes, based on sound scientific studies across the Himalaya. Subsequently, many programs were undertaken by different agencies to revive or rejuvenate these drying springs using different approaches. Of late, most spring protection efforts have a similar scientific approach that offers engineering solutions to enhance spring recharge. What lacking is the social and institutional engineering. At a local scale, this implies the involvement of the community, understanding of traditional practices and culture around springs, educating various stakeholders and developing framework for safeguarding the springs using other management tools. Therefore, inclusive local governance initiative in the mountain villages is the best options to safeguard the springs sources. Jal Chaupal, Village Water Security Committees, Jal Doot, Jal Sevak are few such initiatives which involves village representatives those can be integrated under multi-level water governance reform. Therefore, effective inclusive governance of these natural resources starting from local level is essential for their protection and future sustenance. However, it has been observed that neither the multi-level water governance of the springs is documented or studied, nor has there been a systematic effort for developing local governance framework for safeguarding Himalayan springs resulting in lacking of inclusive system for protection of springs sources. With strong belief that real development starts at a local level, a three-layer model for good water governance based on and modified after Havekes et al., (2013) and Hofstra (2018) is advocated here for management of spring sources at local level (Fig.1). For conservation and management of any spring sources in addition to the knowledge of the spring water systems and the nature and extent of the problems, a good qualitative information and the experience and skills needed to solve the problems are highly crucial. However, apart from this content information, spring source conservation and management needs an adequate organizational framework which have sufficient legal mechanisms. Further to carry out actual ground work a good financing structure/arrangement and cooperation between different stakeholders and their participation is central to any spring water resources conservation and management. This inclusive local governance framework will share common concerns around accountability, transparency, trade-offs and participation in spring conservation and management. Adapting this three-level governance model will offer opportunities, benefits and lessons for wider governance; and at the same time will give the opportunity to the relevant stakeholders to participate in decision-making and experience at the local level, and secure or maintain social, cultural and economic benefits without disturbing the sanity of this Himalayan Blue Heritage.

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Fig. 1. Three-layer local level governance model for spring water sources (based on and modified after Havekes *et al.*, 2013 and Hofstra, 2018)

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Community participated naula Himalayan Wetlands and springs Biodiversity conservation program, district Almora, Uttarakhand

Role of Naula Foundation for Springshed Rejuvenation

The hydrological system of the Indian Himalayan Region (IHR), upon which some 1.5 billion people depend, is under enormous stress as about one-third of the springs of Himalaya are drying up. Complex and diverse climatic, geographical, cultural, and socio-economic factors influence water security. The projected changes in the Himalayan climate are going to threaten the availability of natural resources, including water, NTFPs and food. Water stress is going to affect many other sectors in the region among which agricultural systems are the most important, which is the primary livelihood source in the region. The water stress will further increase the conflict in the region with the growing demand for water due to increasing population and rapidly growing urbanization. Developmental processes such as the construction of hydropower dams are further going to amplify the problem of water stress. Good water governance is the need of the hour. Ensuring local and regional water security requires proactive IHR-wide teamwork, unambiguously in open data sharing among governments and scientists; conflict management via regional platforms; and investment of public- and private-sector funds for generating and exchanging knowledge, stimulating action, and enhancing public awareness. Trade-offs between upstream and downstream water use; between urban and rural areas; and among industrial, energy, irrigation, and other sectors must be carefully managed to enhance water security. Participatory and cooperative decision making, transparent programme implementation, evidence-based policies, transboundary and regional cooperation, and accountability at all levels are essential to ensuring water security in the region. The contribution of springs to overall water budgets within the region is poorly understood. The groundwater, from the springs in the mid-hills of the IHR, is a significant contributor to river base flow. Better scientific knowledge of groundwater in the IHR is urgently needed, primarily because millions of mountain people rely directly on springs. Water is the primary life-giving resource. Its availability is an essential component in socioeconomic development and poverty reduction (UNESCO-WWAP 2006). Himalaya which are the youngest mountains of the earth and constitutes about 12% of the country's landmass. It is not only home to rich biodiversity supporting approximately 30.16% of nation's fauna and flora but also the source of major rivers of the nation. These rivers are made from several streams and tributaries, which again have some smaller origin sources such as aquifers. Though the Himalayan range is a source of countless perennial rivers, paradoxically the mountain people depend primarily on spring water for their sustenance. The mountain springs, locally known as Dharas and Naula (aquifers), are the natural discharges of groundwater from various aquifers, in most cases unconfined. Mountain springs emanating naturally from unconfined aquifers are the primary source of water for rural households in the Himalayan region. About 90% of Uttarakhand population is dependent on natural springs for drinking water. If humans are to have a sustainable future there, they will need to understand better the region's geological vulnerability, ecological fragility, and sociocultural sensitivity. We are facing many environmental issues in the Himalayan region, and a more in-depth analysis of these will indicate anthropogenic activities as well as indiscriminate developmental priorities. Such actions have ultimately resulted in habitat loss and natural resource declination due to land-use change, illegal wildlife trade, forest fires, eventually causing environmental degradation and loss of ecosystem services. Similarly, the traditional indigenous knowledge and practices are related to the management of the natural resources are also getting lost, some of which was very critical to the survival of early Himalayan society. Today, the Himalaya is threatened by recurrent natural disasters and is at risk of catastrophic loss of life. Due to the impacts of climate change on precipitation patterns such as rise in rainfall intensity, reduction in its temporal spread, and a marked decline in the winter rain, coupled with other anthropogenic causes, the problem of dying springs is increasingly felt across the Indian Himalayan Region. Due to man-induced climate change impact in the State, the process of transformation of non-glacial fed rivers into seasonal rivers has also been started in Kumaun as the mighty Kosi and Gagas rivers which are lifelines of the Almora and Ranikhet towns have been converted into seasonal rivers first time in their life history in the year 2003 and 2005, respectively. If no river regenerative measures are taken immediately, all the non-glacial fed rivers of the Uttarakhand State might be converted into seasonal rivers within the next two/three decades; and the summer discharges of all the non-glacial fed rivers may dwindle alarmingly. A community based non profit organisation Naula Foundation, founded in June 2018 by group of common civil society people in leadership of social reformer Bishan Singh based in Uttrakhand aimed springs biodiversity restoration via adopting traditional methodology to ensure water security in Himalayan region. Access to clean drinking water for all is one of the crucial goals of global sustainable goals. Providing water to the burgeoning population in the Himalayan region has become a challenge. Traditional adaptations and coping strategies need to be revived. As multiple factors affect water availability in a region, including spring biodiversity, maintenance of recharge zones, awareness, and local climatic conditions, all need to be monitored regularly. To counter the arduous and immediate threats to human drivers' water security and climate change, productive, equitable, and sustainable water use should be encouraged through regionalized decision making, improved infrastructure planning, effective management of urban pollution, and enhanced regional cooperation. Access to clean drinking water for all is one of the crucial goals of global sustainable goals. Providing water to the burgeoning population in the Himalayan region has become a challenge. Traditional adaptations and coping strategies need to be revived. As multiple factors affect water availability in a region, including spring biodiversity, maintenance of recharge zones, awareness, and local climatic conditions, all need to be monitored regularly. To counter the arduous and immediate threats to human drivers' water security and climate change, productive, equitable, and sustainable water use should be encouraged through regionalized decision making, improved infrastructure planning, effective management of urban pollution, and enhanced regional cooperation. Today, the Naula Foundation, a community based non profit based in Uttrakhand has been working closely with the stakeholders, along with scientists from various National and International Institutes. Till date, the foundation has been focussing mainly in Uttarakhand. As a result of their efforts, many spring sheds and Naula-Dhara systems have been rejuvenated and restored in Kumaon region of Uttarakhand. We have conducted more than 180 community participated programmes, and many of these programmes such as Pahar Pani Parampara, Jaago Uttrakhand, Blue Himalaya, Water calling, Un-plastic India, Pani Panchayat, Jal Hai To Kal Hai etc. had a great success story. Till date the direct indirect strong force of 8000 plus volunteer based Naula foundation firmly believes that revive mountain springs holds promise for the Himalayan region. Naula Foundation takes various measures to bring about real water savings, including recharging and revival of groundwater level or rehabilitation of the main old water tributaries that delivering water to Main River, land levelling, canal lining, improved drainage, tree plantation, biodiversity conservation along with the education among the citizens through workshops, seminars and mass awareness programmes. In order to revive

The age-old civilization of sustainable use and management of water resources, the Naula foundation has developed a Himalayan Declaration of Springshed Rejuvenation (HDSR 2030) (http://naulafoundation.org/hdrs/) as per the context of UNSDGs. With the empanelment of National Mission for Clean Ganga, Ministry of Jal Shakti, Govt. of India & National Water Mission, Ministry of Jal Shakti, Govt. of India for various community participated Springs Biodiversity Conservation Awareness program for last 1 year. As springs have been providing water to the hill communities for time immortal and are still the major source of water in most of the remote villages of Uttarakhand. But unfortunately, these springs are now drying and facing threat due to several reasons such as variation in climatic conditions, anthropogenic pressure, lack of policy and conservation measures. We plan to revive and manage the springs and tributaries of major rivers in the Kumaon region of Uttarakhand so that the major rivers do not become seasonal and they remain perineal. the natural source of water and considered as the natural discharge point of the aquifer that provides access of water to people in their natural, often pristine state. Traditionally spring water is considered clean and pure due to the natural filtering that occurs during infiltration and its movements through shallow and deep acquirers as the case may be. It is estimated that springs and underwater seepage provide about 90% of the hilly states domestic water needs beside used for irrigation, livestock and cultural purposes (NITI AYOG). Any depletion in spring flow or spring discharge will surely impact the flow of rivers. Springs are also the primary source of water for the rural households in the hilly region. Springs are the point of natural groundwater discharge and decreasing spring discharge is an indication of reducing recharge to the mountain aquifer system that feeds the spring. A It can move through the aquifer and resurface through springs and well. Locally these springs are called Naula (aquifer) and Dhara (spring). The profound dependence of hill communities on springs their conservation, rejuvenation, sustainable spring shed management and recharge is required special attention immediately. If no river or spring regenerative measures are taken immediately, all the non-glacial fed rivers of the Uttarakhand state might be converted into seasonal rivers within the next decades. According to the local people, water was enough for their use even in the summers and they can irrigate their fields easily in the months of April. There was enough water throughout the year and generally, people used to bathe in the river during summer. Due to the well-developed spring civilization the rivers of the region were being recharged and presently declining water flow of the spring converting the perennial Kheergana into the seasonal river. . It is observed that the water discharge from the springs of the region is reducing day by day even some of them are almost dried up this leads to the water scarcity in the region resulting migration of the local residents. General Geologic setting- The area forms a part of Lesser Himalaya in Kumaun. The topography and drainage of the region are structurally controlled and tectonics plays an important role in landform development. Structurally the Almora Thrust (AT) which is a major tectonic unit of the region. Basically, the AT is an asymmetrical synformal thrust sheet, the northern and southern flanks of this thrust sheets commonly known as the North Almora Thrust (NAT) and South Almora Thrust (SAT) respectively. The NAT traverses through the region and the town is situated just south of the tectonically active NAT zone in Dwarahat Range. The Famous Dunagiri Mountain range lies just north of the area. Geologically the rocks of the region belong to the Almora Crystalline mainly comprises of low to medium grade metamorphics, associated with course to medium grain granite (Valdya et al 1980). Identification and management of recharge zones through field-based hydrogeology and community knowledge, mapping and modelling of spring catchment discharge, and smart construction can help revive the dying springs in IHR. The Naula and Dhara are two important traditional water spring sources throughout the Himalaya. The channelization of the water of these springs up to the rivers can help in reviving the drying rivers in the region, including the holy Ganges. With this background concept, the Naula-Ganga Channelization programme is being initiated by Naula Foundation with the aim to revive the springs in the region and proper channelization of spring water to rivers so that both the springs and the rivers are revived, and water security is ensured in the Himalayan region. This is a call for action for the revival of all the springs, wetlands and rivers of Himalaya. We strongly believe, together we can, and we will make a change.

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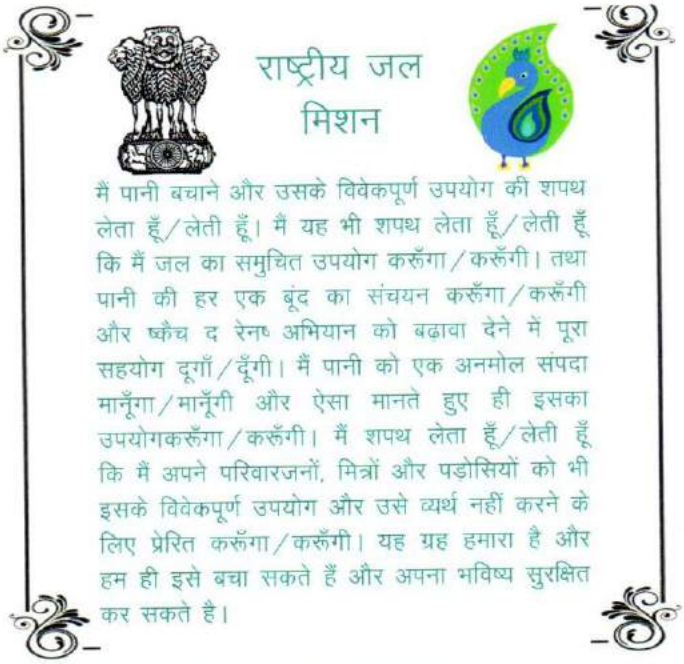

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