SPRINGS: A COMMON SOURCE OF A COMMON RESOURCE

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ABSTRACT

Spring water is the main source of water providing life to people in the mountain region especially in the Himalaya. Spring is a natural source of groundwater. Unlike wells, which may be owned and controlled privately; springs are generally community-owned and community-managed. Thus, they give a sense of a “common” resource i.e. groundwater shared through a common mechanism, i.e. the spring. Decreasing spring discharge has become a matter of concern throughout the Himalayan region. Springs are points of ‘natural groundwater discharge’. The decrease in spring-discharge implies either or both of two scenarios – firstly, the recharge to the system which feeds the springs (mountain aquifers) has reduced; secondly, the storages of these mountain aquifers are tapped by artificial means such as wells. The recharge areas of these springs are site specific, depending on the rock type and rock structure. Current trends indicate emphasis on spring recharge. Despite the complexity of spring hydrogeology, geomorphology remains the prime factor on which conventional watershed approaches for spring recharge are being promoted in the Himalayan region. A systematic process of identifying the type of springs and characterizing them on the basis of their type, discharge quantities, seasonal factors and water quality is the way forward towards improved spring-water management in the Himalayan region. In the same vein, the socio-economic and administrative units are extremely crucial in the management of springs as ‘commons’. A recharge site, for instance, may be located within forest land, private land, common land, revenue land etc. The strategies adopted for the purpose of spring recharge will vary depending on these locations, the type of spring, dependent population etc., and calls for a scientific approach that includes all the above considerations.

Keywords: Spring, Himalaya, hydrogeology, common resource, socio-economic and administrative contexts

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INTRODUCTION

Springs are points on the surface of the earth through which groundwater emerges and flows. This water is then used as a main source of drinking and domestic purposes in many areas. It also forms a main source of irrigation water in many parts of the country.

Springs are also studied by scientists in great detail using high-tech and eye-catchy tools like remote sensing, geophysical investigation and isotope techniques, but mainly from an academic point of view. The utility of such research for the welfare of the community and managing this resource itself is completely ignored. Traditionally springs were and at a few places still are considered sacred and they form a major cultural pivot on which the entire community livelihood is based upon.

In spite of all of this springs still lack its much deserved recognition as a 'common' property resource. Land use changes, construction works in the guise of modernisation and pollution have led to the rampant abuse of this 'common' resource which is severely affecting it in both a quantitative and a qualitative manner. The abode of this important resource i.e. the underlying rocks or aquifers also are a 'common' unit; which is an ignored fact all over India. The science of groundwater known as hydrogeology can lead us to a better understanding of this 'common' resource, thus providing ways and means for its proper sustainable management.

Photo 1: A low discharge spring in Palampur, Himachal Pradesh

Photo 2: A man filling water from a low discharge spring in Leh, Jammu & Kashmir

The importance of springs in the Himalayan region is much more significant as compared to the other parts of the country. Springs are the only source of groundwater for the '*pahadi'* people. In addition of it being the only freshwater source, the rugged topography of the Himalayas also makes it difficult to access it.

The most important concept in understanding groundwater and its behaviour is to understand 'aquifers'. It is these aquifers where groundwater is stored, replenished and is then made available for use under differing geological conditions. Without the proper understanding of aquifers, the study of groundwater remains incomplete and thus springs can be understood only superficially and not in their entirety. 'Aquifers' are defined as a saturated geological formation which can yield sufficient quantities of water to wells and springs. In simple words aquifer are rock layers which allow storage and movement of groundwater within them. They are units for understanding groundwater. As is clear from the definition of aquifers, groundwater is stored and transmitted through openings in rocks. These openings may be in form of pore spaces or fractures. Thus the study of rocks forms the basis for study of groundwater. Similar to the rest of the country, mountain aquifers are not yet recognised as a unit for study on springs.

Along with the study of rocks (geology), temporal variation in spring discharge and quality also compliments better understanding and classification of springs. The capacity of the aquifer to store and transmit groundwater directly reflects in the nature of spring discharge.

Photo 3: A girl filling spring water from a collection chamber and then carrying it on her back in Shumbuk, Sikkim

Photo 4: Fractured and dipping rock(quartzite)

Hydrogeological mapping of the springs often reveals that the recharge and protection areas of the springs are very site specific. The extent and location of these areas can be indirectly correlated to the spring type and nature of discharge. The extent and location of these areas are governed by the local geology and structure present and not by the administrative boundaries or type of land viz., private, common, agricultural, forest etc.

SPRINGSHED DEVELOPMENT: A hydrogeological approach

The utilization and tapping of springwater is an ancient art. Historically, to have easy access to water, cities were often situated near large springs, while those cities without a reliable water supply were destroyed or abandoned because they could not survive the sieges. (Kresic .N and Stevanovic .Z, 2010)

Groundwater has being used by man from ancient times. Evidences of the same are seen across the world, be it the excavated wells from the Harappan civilization found in Dholavira, Gujarat or citations in various ancient literatures. In early times the use of groundwater was less as the dependent population also was less. Later on with increase in the number of dependants the use of groundwater also increased. Earlier groundwater or springwater use was restricted to drinking purpose, but due to urbanisation and an increased demand, flour mills, saw mills, fountains and then electricity was generated from springwater. The adverse effects on the supply of this resource was felt when groundwater was tremendously exploited by the industry and for irrigation. This led to the formulation of a number of conventional watershed practices in order to augment the supply of this resource. However, these practices followed in order to augment groundwater recharge were completely based upon geomorphic (surface) features not at all considering the sub surface geology. The same concept has been used in the plains to increase the water level in wells as well as in the hills to increase spring discharge.

Groundwater is stored and transmitted through aquifers. Thus, an aquifer should be considered as the very basic unit for any study on groundwater or any watershed development or a recharge augmentation programme. In the mountain areas like the Himalayas, high relief and the complex geological structure play a vital role in formation of ‘mountain aquifers’. These mountain aquifers store groundwater which discharges out on to the surface in form of springs. Every spring is different from the other in terms of its type, catchment area, recharge and discharge. This is governed by the local slope and the geological structure present beneath. Based on these factors springs are classified in various types, viz; contact, depression, karst, fracture or a fault spring. Depending on the type every spring has its unique characteristic recharge area, the margins of which are irrespective of the land type, ownership and administrative boundaries.

A springshed development approach should comprise of the following steps:

- Hydrogeological mapping of springshed

  This involves detailed study of rocks, streams and springs in the springshed. Different types of rocks in the area, their attitude, openings present and the different structural features are the components that govern the accumulation and movement of groundwater. In case of the Himalayas the complexity of these components makes their study all the more important. The dip and strike of different types of rocks forms the basis of geological mapping. Outcrops are studied to gather information about the various rock types and trends of openings which may be in form of bedding planes, foliation planes, fractures, faults etc. Hydrogeological mapping requires a base map of the area to be studied and simple instruments like a geological hammer and a clinometer compass. GPS instruments also prove handy during this exercise.

- Delineation of the mountain aquifer

  Aquifers are rock layers which store and transmit groundwater. In case of mountainous terrains these aquifers usually are comprised of hard dipping and fractured rocks. Point of emergence of the spring helps in the classification of the spring and also gives an idea of the geologic formation which acts as the aquifer storing and transmitting groundwater to it. In most of the cases in the Himalayan region more than one rock layer contributes to form an ‘aquifer system’. One out of these rock layers may be capable of storing groundwater and the other transmitting it out onto the surface in form of a spring. The impermeable rock layers surrounding the aquifers or aquifer systems of a spring are incapable of storing and transmitting groundwater forming an impermeable base. Thus mapping of these layers and measuring different trends helps in delineating the aquifer boundaries.

- Classification of the spring

  Springs are classified into different types based on their hydrogeology and the rock structure which leads to the formation of the spring. The different types of springs are depression, contact, fracture, karst and fault springs. Spring discharge data and water quality data also support the classification of springs in the different types. Such a classification is critical in the study of springs as the recharge areas and the discharge mechanism are highly dependent on the type of the spring.

- Secondary data collection and interpretation

  Though secondary data like spring locations, discharges and water quality are not available, some sort of secondary data can still be handy in beginning the study of springs. Base maps like SOI toposheets at various scales, GSI

District resource maps, Satellite imageries, Google Earth images and weather data are useful for hydrogeological studies of springs. Land use data, forest cover maps, slope maps, geomorphological maps can also be used indirectly at different stages of the study.

- Identification of recharge area based on local geology and structure

  Using the secondary data, field observations and measurements the recharge areas of springs can be identified. Regional geology combined with local hydrogeological understanding leads to systematic understanding of different zones within the springshed like recharge protection zones, direct recharge zones, zones for soil-water conservation etc. These recharge zones can then be mapped on the available base maps or good springshed photographs which can then be used by the implementing agencies.

- Setting up a monitoring system for periodic spring discharge and water quality data collection

  Along with hydrogeological mapping and recharge area demarcation, primary data collection at the spring site is also critical. Spring discharge data can be collected at the point of spring emergence in a simple manner using a container of known volume and a stop watch. Regular and timely data collection (weekly, monthly or seasonal) can help in understanding the different hydrogeological characteristics of the aquifer viz. Transmissivity and Storativity. This data also can support the classification of the springs into different types. Regular monitoring pre and post implementation of recharge measures also can be used to show the impact of these activities. Water quality data collected seasonally also can show the variance in the quality of groundwater. This indirectly points to various aspects of groundwater like rock-water interactions, travel and resident time of water within the aquifer, interrelation between rainfall, recharge and the spring discharge. Local implementing field workers and the community involved needs to be made aware of the importance of such data collection as it is these members of the society which are critical in such data collection and also the beneficiaries in the end.

- Planning of treatment measures in the recharge area with the help of community participation

  The above studies will lead to identification of recharge areas. But the main challenge of implementation of recharge measures arrives at this point. Recharge areas are not dependant on administrative or socio-economic boundaries. Common lands, community lands, forest areas, agricultural areas, waste lands etc. demand a different strategy for implementation of recharge measures. Social mobilisation in case of community and private lands and interaction with different departments in case of common lands or forest areas is a main part of spring recharge activity. Community mobilisation for understanding the intricacies of hydrogeological concepts and importance of site specific recharge measures, contradicting the usual ridge to valley approach of different programmes is also a necessary step.

- Conceptual layout of spring

  Laying out the springshed alongwith the underground makeup of the area in the form of conceptual diagrams conveys the understanding of the spring mechanisms to one and all. Aquifers, geology, structure, spring location, recharge areas etc. can be easily displayed on such conceptual models. Two dimensional or three dimensional conceptual models along with some animation facilitates the better understanding of the geohydrology of the springshed.

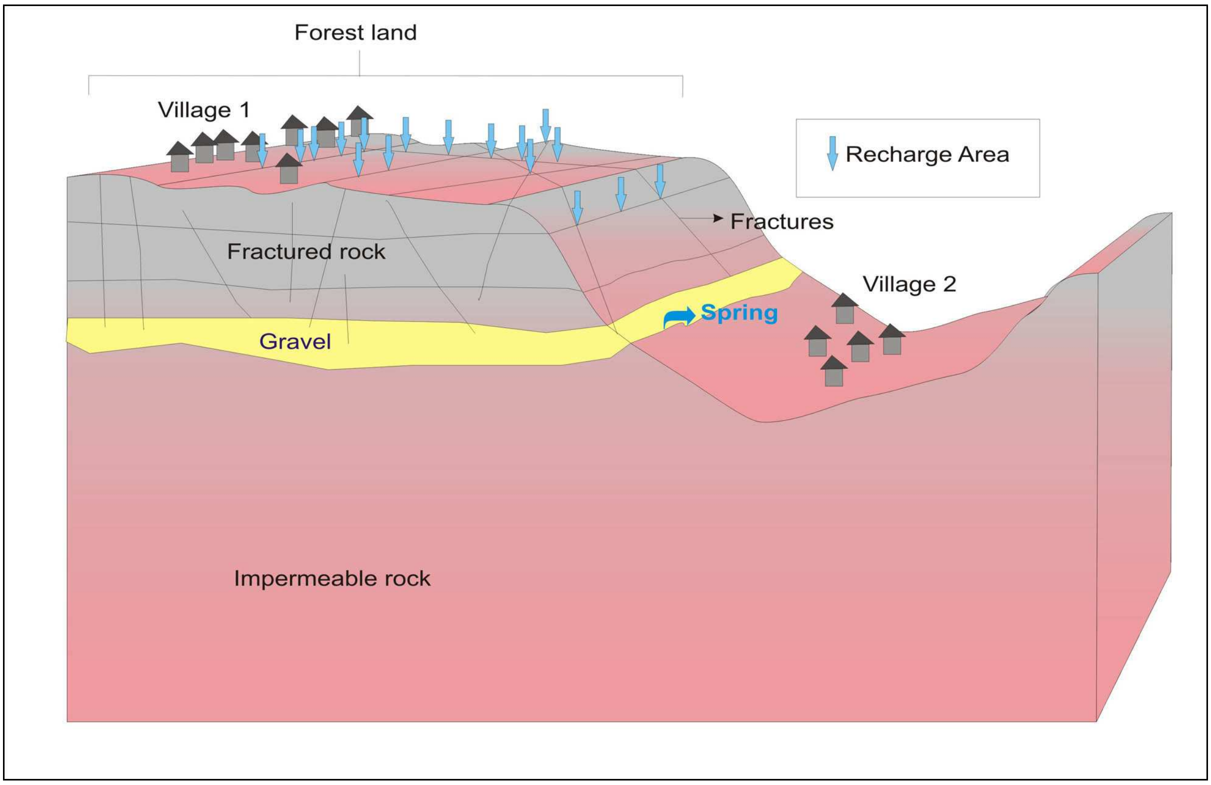

Figure 1: A 3-d conceptual model of a springshed depicting information related to hydrogeology, rock structure, land type etc.

SPRINGSHED DEVELOPMENT: challenges, conflicts and community participation

Himalayas pose many challenges in the study of springs. First of all, the rugged topography of the Himalayas makes travelling and fieldwork a very hectic task. The high relief in many areas make many places inaccessible without proper climbing equipment. That combined with thick vegetation makes walking through them a difficult task, let alone studying the hydrogeology of the area. The complex geology of the Himalayas caused by the various repeated structural disturbances is difficult to study and map. Thick forest cover also leaves us with limited insitu exposures of rocks for study of rock types and structure. Natural disasters like floods and landslides add up to the chaos equally.

Another problem in study of springs in the Himalaya or for the matter of fact throughout India is the lack of any kind of data on springs. Barring a few government and non-government organisations in a few areas, there is no database on the location, type and discharge or water quality data of springs. The lack of awareness of utility of such data is one of the main causes of unavailability of such data. Inspite of the large number of springs and also the huge population dependency, such data collection has never been seen as a priority in India. Unaware community is also a reason for such data gaps.

It is also a fact that geological or aquifer boundaries rarely coincide with administrative or socio-economic boundaries. According to the geohydrology of the area it may so happen that the recharge area of a spring might fall in a forest area, within the administrative boundaries of the beneficiary community or even outside it in another village boundary. Also the type of land comprising the recharge zone may be of different land uses such as agricultural, private forests, reserved forests, waste lands, community or private lands etc. The strategy for implementing the recharge measures cannot be uniform in all the cases mentioned and thus poses a challenge for the implementing agencies. In case of agricultural and private lands social mobilisation and incentivisation in the form of land treatment, horticultural or fodder crop plantations and some engineering structure like trenching, contouring, terracing can be applied. Due sensitisation of the private owners about the community benefit from such an action should also be emphasized. Common lands do-not pose that difficulty and hence are easier to deal with implementing issues. Community mobilisation for understanding the intricacies of hydrogeological concepts and importance of site specific recharge measures, contradicting the usual ridge to valley approach of different programmes is also a necessary step.

Forest areas are controlled by the forest departments and hence there are restrictions on any type of interventions being carried out within. Therefore involving the forest departments in springshed planning, development and management also form an integral part. Ease of implementation of recharge measures also depends on the implementing agency. For example, implementation by civil society organisations in common, private or agricultural lands is easier due to their social mobilization skills and constant interaction with the community. Whereas for government agencies implementation in forest lands is easier due to mutual co-operation between the different government departments.

Following are a few of our experiences at ACWADAM working on springshed development and management in different areas of the country depicting the above mentioned conflicts and challenges.

Case 1: Tehri district, Uttarakhand

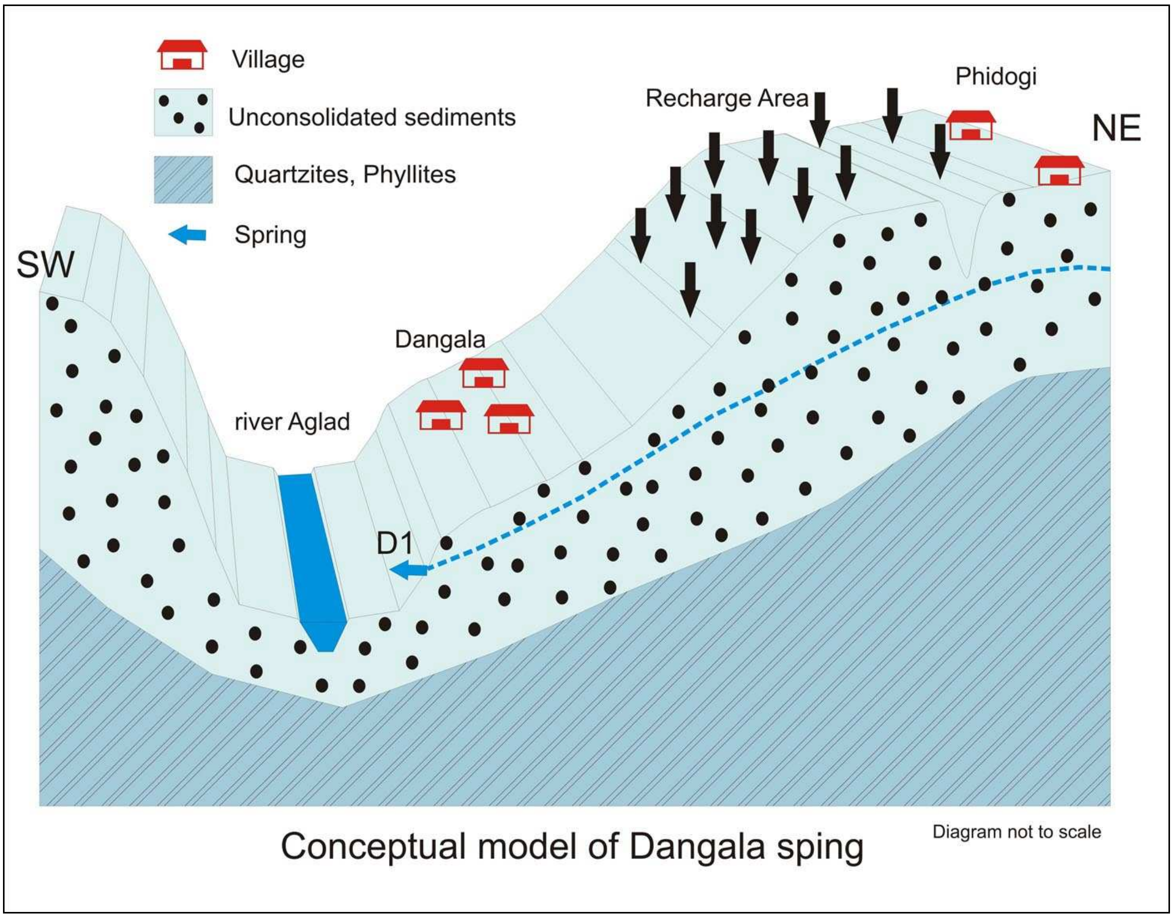

Figure 2: Conceptual layout of Dangala spring

The Dangala spring (D1) emerges at the base of a ridge trending NE-SW located near Dangala village. The entire ridge is made up of loose unconsolidated sediments. These loose sediments are made up of sub-rounded pebbles of different rocks like quartzites, phyllites and slates held together by a fine grained material. These pebbles also show a preferred alignment in a particular direction. These loose sediments underlain by phyllites are permeable enough making them favourable store and transmit fairly large quantities of groundwater. Groundwater thus flows through the intergranular opening in these loose sediments under the influence of gravity. This water suddenly experiences a change in slope at the base of the ridge. The depression formed in the area due to the stream channel causes the groundwater to emerge on to the surface in the form of a spring - classified as a

‘Depression Spring’. The unconsolidated sediments form the aquifer to the spring. Based on hydrogeology of the springshed the recharge area of the spring D1 is located uphill near village Phidogi while the spring emerges in village Dangala. This poses a conflict that any recharge measures to be carried out have to done on the land possessed by the Phidogi community while the direct beneficiary from the spring is the Dangala community.

Case 2: Tehri district, Uttarakhand

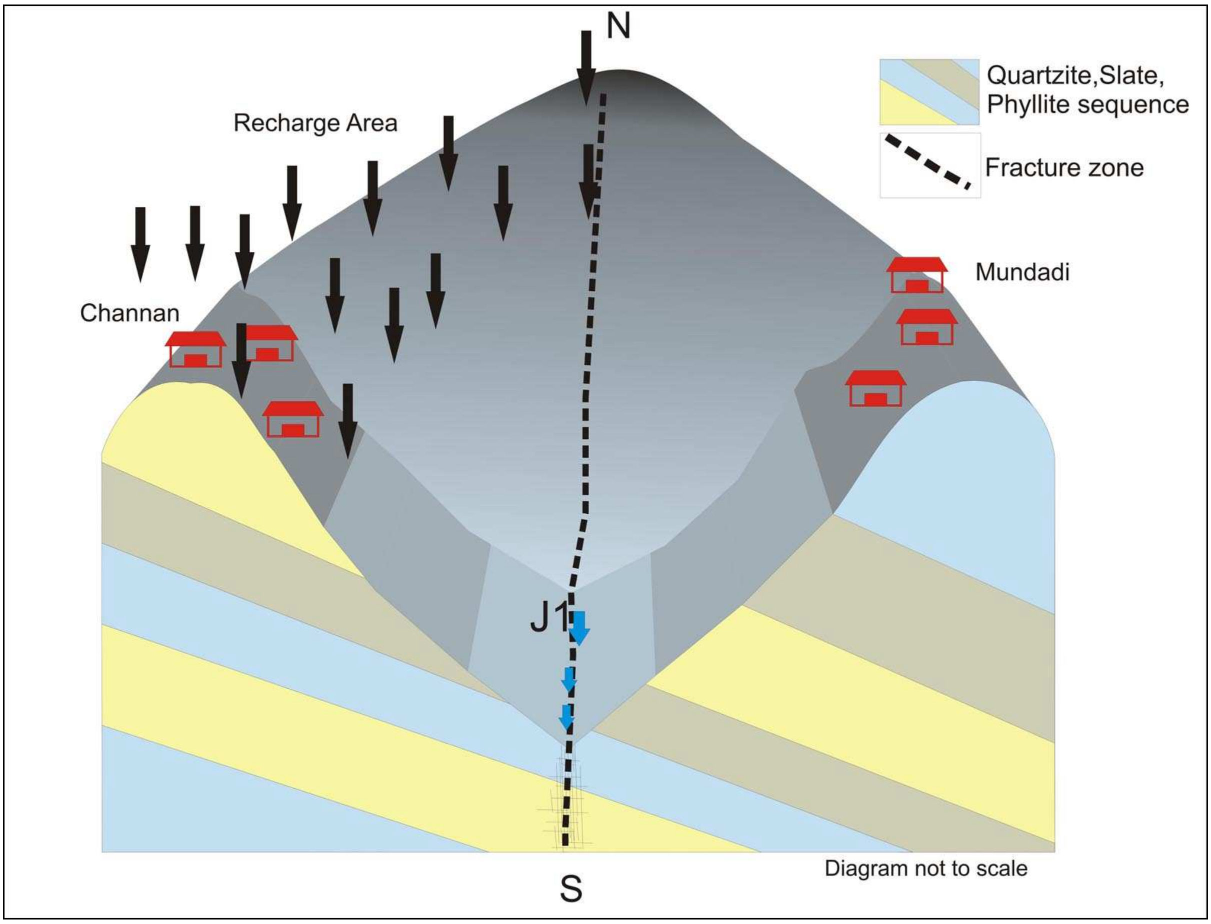

Figure 3: Conceptual layout of Mundani spring

Two villages Channan and Mundadi are located on the opposite sides of a valley running in the N-S direction. Both the ridges on which the villages are located are entirely made up of a dipping sequence of quartzites, slates and phyllites. The entire rock sequence dips 40° towards north east.A fractur e zone trending N-S cuts across the rock sequence leading to emergence of springs along it. Spring J1 is thus classified as a fracture spring. Based on the hydrogeology of the springshed the recharge area of spring J1 is located near village Channan and to some extent uphill along the fracture zone. The conflict that emerges here is that community from Chanan and Mundadi both use J1 spring water but the recharge measure to be carried out have to be done on the land owned by the Chanan community. Also, the recharge area present uphill along the fracture zone is a forest area.

Case 3: Satara, Maharashtra

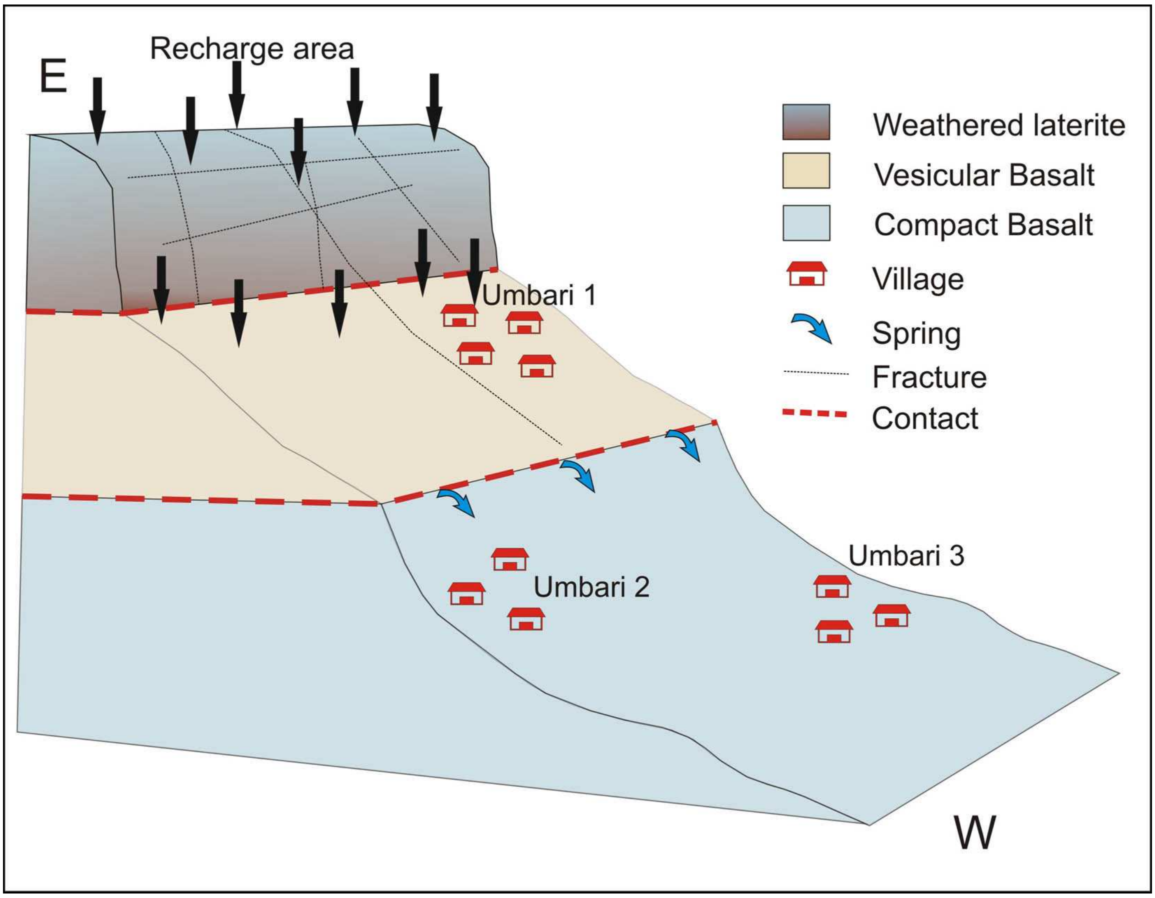

Figure 4: Conceptual layout of Umbari springs

The geological setup of the area around Umbari villages is made up of horizontal layers of Basalt with weathered laterite at the top. The laterite is highly fractured with vertical, horizontal and inclined fractures. Below the laterite vesicular basalt is present which has undergone a low degree of lateratization and weathering. Below this is present the unweathered compact basalt.

The central vesicular basalt capable of storing and transmitting groundwater acts as the regional aquifer to the springs that emerge at the contact of the vesicular and the compact basalt. Thus these springs are classified as contact springs. Considering the hydrogeology of the area the recharge area for the contact springs is the weathered laterite on top along with the fractures present in the upper portions of the vesicular basalt. The conflict that emerges here is, all the intervention for recharge are to be made in the topmost laterite which falls in the forest area and some portion of land held by the village Umbari 1 community. The direct beneficiary of the effect of recharge on springs is the community of Umbari 2 and Umbari 3 villages.

Case 4: Nainital, Uttarakhand

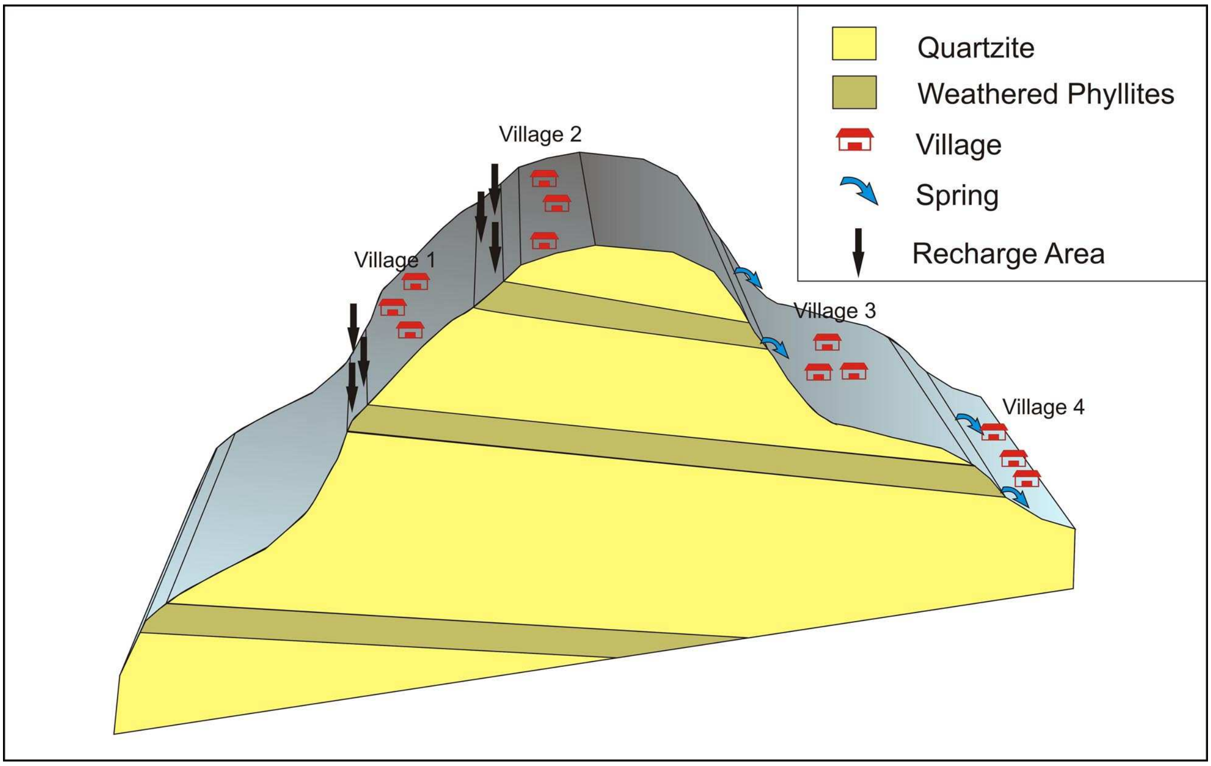

Figure 5: Conceptual layout of Myora spring

The geological framework of the Myora spring area is madeup of alternate layers of quartzites and phyllites dipping towards northeast. The phyllite layers have undergone a high degree of weathering while the quartzite layers are hard and unweathered. The phyllite layers being weathered are capable of storing and transmitting groundwater. These phyllites act as aquifers which feed the springs emerging at the contact of phyllites and quartzites. Thus the springs are classified as contact springs. Villages 1 and 2 are situated on the escarpment slope of the ridge while villages 3 and 4 are located on the dip slope.

Considering the hydrogeology of the springshed the recharge areas to the springs are located where the phyllites are exposed on the escarpment slope. The conflict that arises is that all the recharge measures are to be made on the land owned by the community of village 1 and 2 on the escarpment slope while the springs emerge on the other side of the ridge i.e. the dip slope. Hence, the direct beneficiary from the recharge to the springs are the communities of village 3 and 4.

SUMMARY

Our firm belief at ACWADAM is that hydrogeological science should form the base for any work related to watershed, springshed or for the matter of fact anything related to groundwater. The ignorance of the concept of aquifers as the basic unit groundwater development and management has resulted into failure or incomplete success of programmes on groundwater.

In various groundwater projects, watershed projects or soil-water conservation projects surface geomorphology and engineering stability are the main factors considered for planning and implementation. Whereas the correct scientific approach involves study of local hydrogeology and rock structure.

Concept of scale needs to be considered in the entire planning, implementation and development process of any project. Planning of these programmes is usually carried out at a watershed scale, implementation occurs at a cadastral scale, whereas as explained earlier the appropriate scale for planning of programmes should be a combination of an aquifer and watershed scale.

The location an extent of recharge areas are purely governed by the local hydrogeology and not by administrative or socio-economic boundaries.

Although a spring point source may emerge in a private land, its ownership should be community managed considering the entire hydrogeological system and the recharge areas of it.

In a developing and highly groundwater dependent country like India, considering groundwater resources as ‘commons’ still remains an ambiguous goal. In the last 10 years ACWADAM has attempted to give groundwater it’s much deserved importance as ‘commons’.

Springs offer a good opportunity towards recognising and developing groundwater as commons, if at all they themselves are considered as commons.

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