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SCIENTIFIC AND TECHNICAL INPUTS TO SPRINGSHED MANAGEMENT IN PILOT LOCATIONS IN 5 DISTRICTS OF NAGALAND

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-Submitted to Department of Rural Development, Kohima, Nagaland

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BACKGROUND

Efforts to achieve various Development Goals for water access, during the last decade or so, millions of people around the world do not have access to safe drinking water. In the year 2012, for instance, some 800 million people did not have a safe source of drinking water; nearly 100 million of those people were said to be from India (UNDP, 2012). Large regions of the mountains in India are increasingly experiencing water scarcity due to various reasons. Springs and wells in the Northeastern Indian States that are overflowing during monsoons quickly run dry after winter, leaving communities few options but to rely on expensive tanker trucks and water rationing during the dry season. Even for those many parts of the region that record very high annual average rainfall, the geologic conditions do not provide sufficient storages of water. Most discussions have revolved around constructing small and large dams and water lifting schemes or increasing reliance on tanker trucks to provide the minimum amount for basic household needs. Sustainable alternatives are needed that have often ignored the mainstreaming of springwater management in practice and policy.

Natural springs occur in many parts of Nagaland. These springs form when sections of groundwater bearing aquifers discharge groundwater onto the surface in the form of springs and seeps. The disposition of aquifers, in the mountains of Nagaland is quite variable leading to variable geometry of the aquifer and the hill-sides. This variable geometry also produces different types of springs with unique sets of recharge zones, discharge rates and spring water quality.

There is large-scale reportage of depletion of springs. As much of the Northeastern Region of India is witnessing a fall in average annual rainfall (*pers. comm., ACWADAM – based on IMD datasets; India Water Portal),* it is expected that spring-discharge is likely to fall. Moreover, springs are also under threat from intensive land use in the springshed[1] (wood cutting, agriculture, anthropogenic fire, construction) and exploitation of ground water (pumping from bores, dug wells and lateral bores) are affecting springs, not to mention the effects of landslides and seismicity. Degradation of the springshed reduces groundwater recharge and consequently the storage in the aquifer. Over-pumping by wells reduces groundwater levels such that the water no longer reaches the springs. Therefore these traditional and sustainable sources of water are being lost almost everywhere that they occur, often being ignored and therefore trivialized at the expense of the more obvious river flows (that also include spring water!).

While there is significant research on the hydrological features of spring water across the HKH (Hindu-Kush Himalayan) Region, there are only a handful of examples that have used aquifer-based approaches to design and implement spring-water management projects in the region. All three partners on this project – ECS, PSI and ACWADAM - have worked on various components of spring-water management in this region, sometimes in partnership, bringing complementary strengths to the project. In fact, this project has build upon an earlier collaboration between ECS and ACWADAM supported by Tata Trusts in Tuensang and Mokokchung districts. The success of the earlier collaboration in terms of applying hydrogeology to spring-water management, institutionalizing the process of recharge and

[1] A 'springshed' denotes the system that affects various components of a spring and includes the watershed(s) in which the spring and its recharge zone lie and the underlying aquifer which stores and transmits water to the spring.

conservation alongside improved water and sanitation security has been the stimulus for the Government to approach ECS to develop a collaboration towards the current project.

Some of the key objectives of the programme are:

1) To provide spring based drinking water security to households in the region
2) To conduct surveys of springsheds and identify the recharge zones and any other specificities to each of the spring systems.
3) To build capacity of the community on spring hydrogeology, facilitate springs protection and management in the region
4) To create a pool of trained community members that is aware and knowledgeable about springs hydrogeology in the Western Ghats
5) To contribute significantly for understanding of social issues, critical to decentralised community based management of springs
6) To advocate for spring-specific policy at the District and State levels including development of policy recommendations and conducting outreach to decision-makers

The project included a short-term but systematic approach for piloting springshed management in 5 springsheds, one each in five districts of Nagaland. One pilot location per district was selected for this process, involving collaboration between the 3 organisations – ACWADAM, PSI and ECS (local partner and co-ordinator). The table below shows that the process will involve 8 steps (columns) and will be undertaken under the responsibility / lead of the 3 organisations that will partner this process. However, the this report includes the scope of work undertaken in the first three steps (highlighted in green) as a planning process for implementing the next 5 steps that will be undertaken by ECS with the help of each community.

District	Catchment survey	Survey Authentication	Report writing	Community mobilization	Training	Water testing	Discharge measurement	Catchment Treatment
Kohima	PSI	ACWADAM	ACWADAM	ECS	ECS	ECS	ECS	ECS

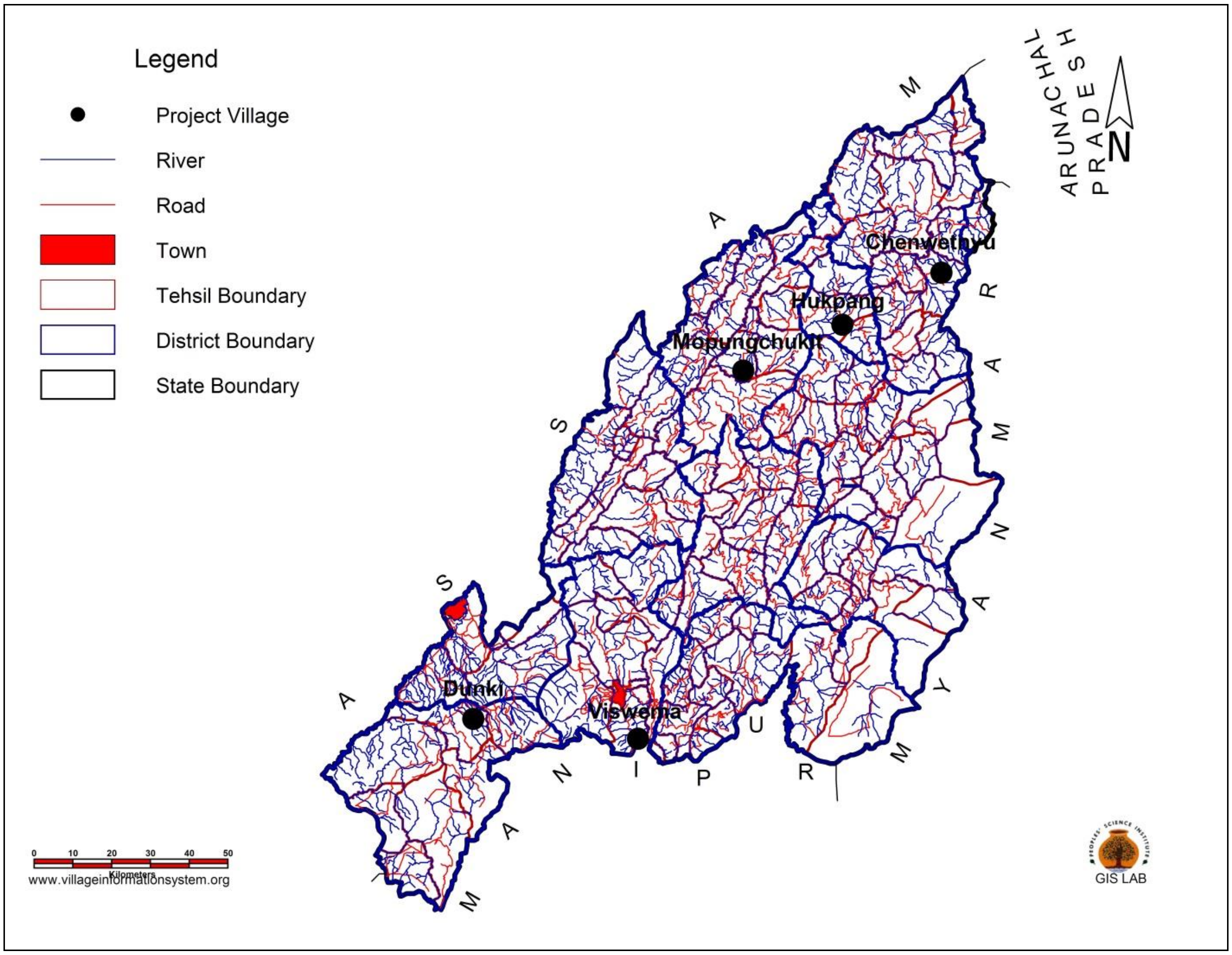
Peren	PSI	ACWADAM	ACWADAM	ECS	ECS	ECS	ECS	ECS
Mon	PSI	ACWADAM	ACWADAM	ECS	ECS	ECS	ECS	ECS
Longleng	PSI	ACWADAM	ACWADAM	ECS	ECS	ECS	ECS	ECS
Mokokchung	PSI	ACWADAM	ACWADAM	ECS	ECS	ECS	ECS	ECS
NOTE: ECS provided the local support including co-ordination and background information; ECS staff also accompanied PSI and ACWADAM teams to the field where they were exposed to survey techniques and processes								

Table 1: Project details – also indicating the step-wise approach for the project

LOCATION

Framed between the Assam plains to the west and Myanmar to the east, Nagaland state is located in the northern extension of the Arakan-Yoma ranges. The state is bound between the parallels of 25°15´ and 27°00´ N latitudes and 93°20´ and 95°15´ E longitudes. Almost the entire state is hilly, except along the foothills flanking the Assam plains. The general elevation increases towards the east. Barail and Japvo ranges and their extensions in Mokokchung and Tuensang mark a prominent water divide separating Brahmaputra and the Chindwin river systems.

As per 2015 records of State Forest Department, out of 16,579 sq. kms of total geographical land area, recorded forest area is about 9222 sq. kms out of which 86 sq. kms is under reserved forests, 508 sq. kms under protected forest and 8628 sq. kms under unclassed forest. The forests under government control are reported to be about 28.5% of the total forest area. The average rainfall is between 175 cm and 250 cm. Most of the heavy rainfall is during the 4months from June to September.



Pilot location map (Source: PSI, Dehradun

SELECTED VILLAGES		
District	Block	Village
Peren	Jalukie	*Dunki*
Kohima	Tsakha	*Viswema*
Mokokchung	Kabulong	*Mopungchuket*
Longleng	Longleng	*Hukpang*
Mon	Chen	*Chenwetnyu*

Pilot location details

The study was carried out in 5 pilot locations in each of 5 districts. Reconnaissance survey was carried out by PSI, Dehradun in these pilot locations to gather baseline data on the basis of which a summary report was produced. ACWADAM on the basis of this report undertook a comprehensive hydrogeological mapping exercise in four districts viz. Peren, Mokokchung, Longleng and Mon since there was a political unrest in the state during this visit and the Kohima visit has to be curtailed. Visit to Kohima will be planned later, after normalcy returns and conditions are favourable for conducting the field survey.

REGIONAL GEOLOGY

In the Naga Hills, four different geo-tectonic domains viz. Assam shelf, belt of schuppen, Paleogene inner belt and the ophiolite belt have been identified. Saramati formation of the ophiolite belt is the oldest formation along with Nimi formation, ophiolite suite, Salumi and Pokhpur formations which form the ophiolite complex. All litho-units are in tectonic contact with each other except Pokhpur formation which lies unconformably over Salumi sediments. The age of the complex is dated back to Mesozoic.

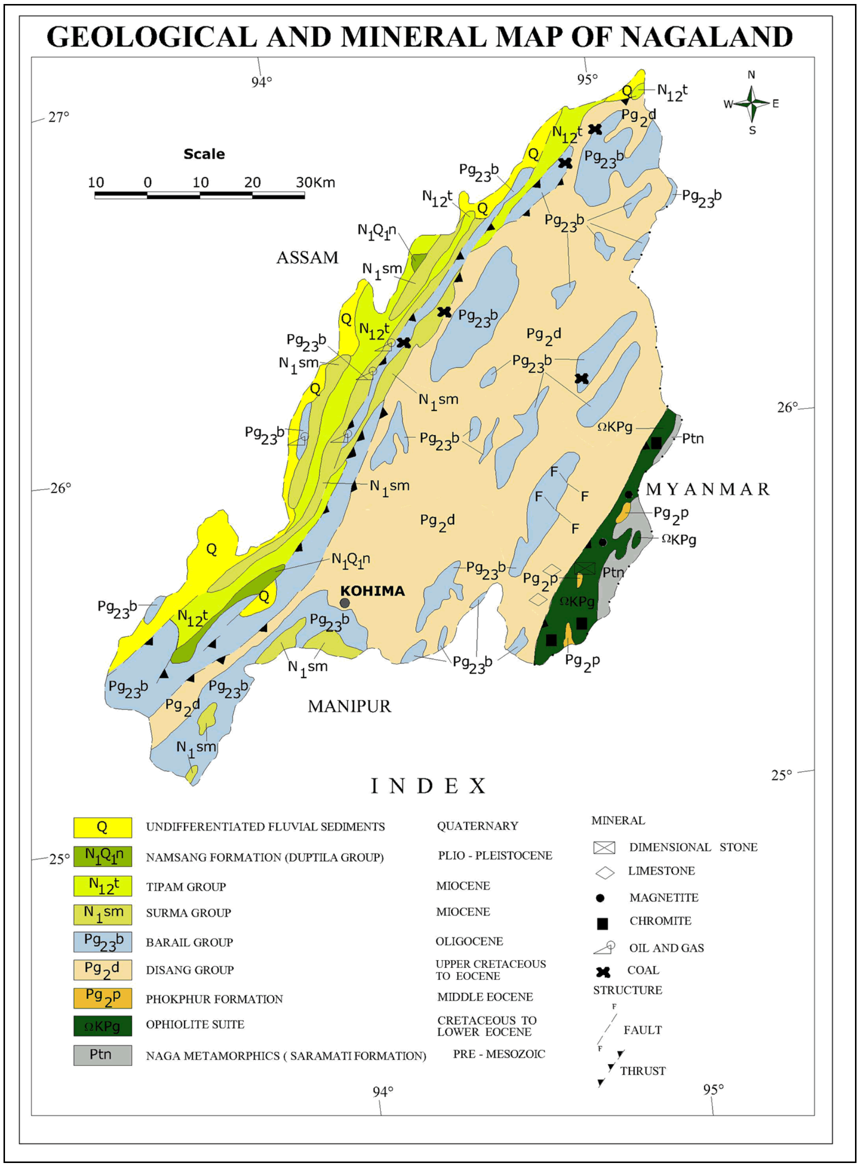


Fig 2: Regional geological map (Source: Geological Survey of India)

Disang overlies the ophiolite complex and forms the Palaeogene inner belt. Grey, khaki grey, black splintery shales with silty interbands forms the major lithology.

The Barail group of Oligocene is the next stratigraphic unit which comprises of Liasong, Jenam and Renji formation. Commonly, the formations comprises of alternating units of sandstone, shale and siltstone of various composition and character. Jenam formation is known for its carbonaceous deposits with coal seams in sandstone.

The Surma group of early to middle Miocene overlies the Barail Group. This group is characterized by basal conglomerate with alternating bands of sandstone and shale with subordinate siltstone.

Tipam Group is the uppermost stratigraphic unit deposited in Mioene and is overlain by alluvium and terrace deposits of Quaternary. The group is composed by Bhuban, Bokabil, Tipam Sandstone and Girijuan Clay Formation. As evident from the name itself, Tipam formation consist of thickly bedded, medium to coarse ferruginous sandstone while the Girijuan Clay dominantly made up of clay, mottled sandy clay with sandstone. At places, in the schuppen belt, Tipam group is unconformably overlain by Namsang and Dihing formation composed of grit, conglomerate, sandstone and clay beds.

Source: Tealam (Latitude: N 26.56262°, Longitude: E 95.13102°)
Chenvetnyu village, District: Mons

Demographic

The inhabitant of *Chenwetnyu* Village belong to Konyak tribe (ST), dominated by Christians in Mon district of Chen Block. Unlike other four districts, the village practice *Angh* System (hereditary). Everything the *Angh* and Chief words are law. He is responsible for the maintenance of harmony in the village, protection of their customary laws and procedures. Since the introduction of Panchayati Raj systems, they work harmoniously with the Village Council and other institutions that functions for the welfare of the community. There are about 250 HH in the village. *Chenwetnyu* populace is dependent on subsistence agriculture for generations (Jhum cultivation). They are adept artisans and skilled craftsmen and therefore generate their source of income through it. . Like all villages in Nagaland, the settlements are above the springs

Water Sources

There are 10 springs in the village viz., *Poaklay, Waaknee, Lingbong, Khoukhop, Waolu, Taemang, Lohchong, Owa Khat, Longkei* and *Lawthra*. Around 12 km from the village, there is second order stream Tealam which is the main water source. This village as well as a neighboring village is entirely dependent on it for their water supply. There is silting chamber/

storage tank near the stream from where a pipeline supplies water to the two villages which is a total of about 600 households. There is no other water distribution system.

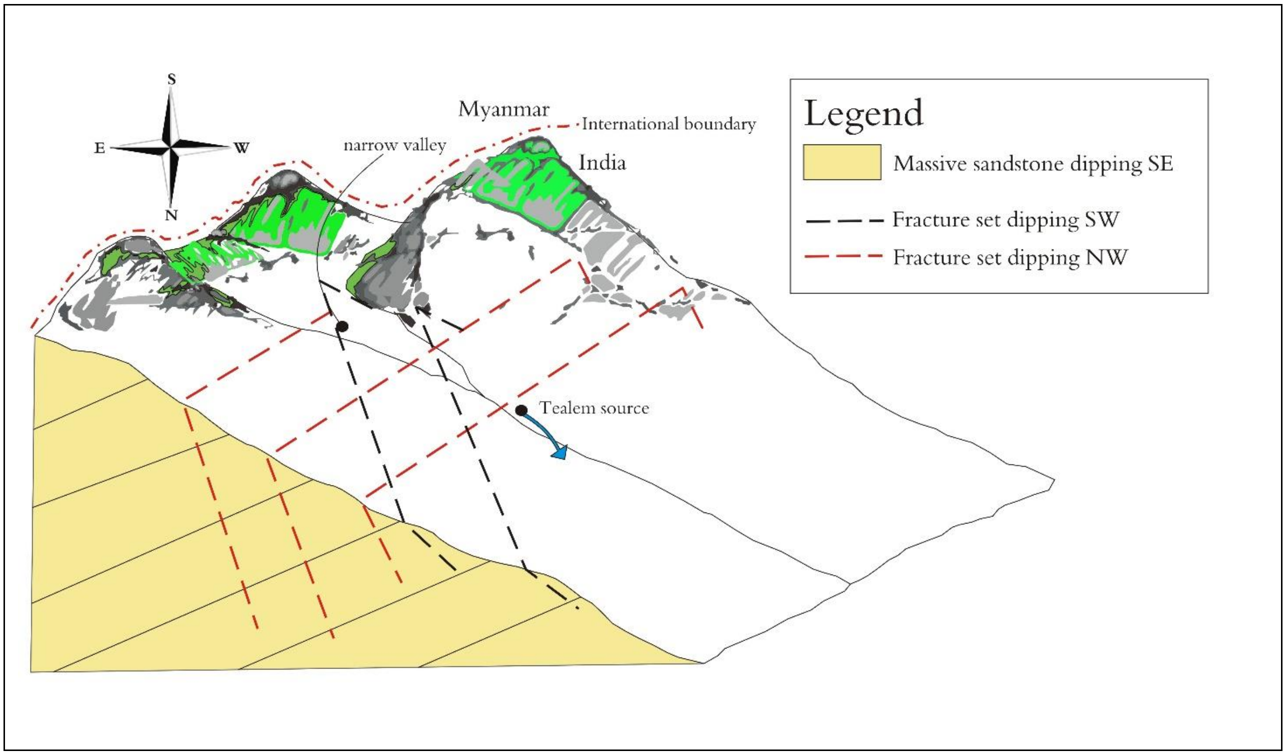
The Tealem stream is approximately 12 kms away from Chenventnyu village near the Myanmar border and currently supplies two villages i.e. Chenvetnyu and Chenmoho. It is a stream fed by many springs but during lean season discharge is highly reduced and it appears as a spring with low discharge. It is a fracture cum depression source. This spring fed stream being the primary source of water was selected for detailed hydrogeological studies to identify potential recharge area.

Hydrogeology of the area

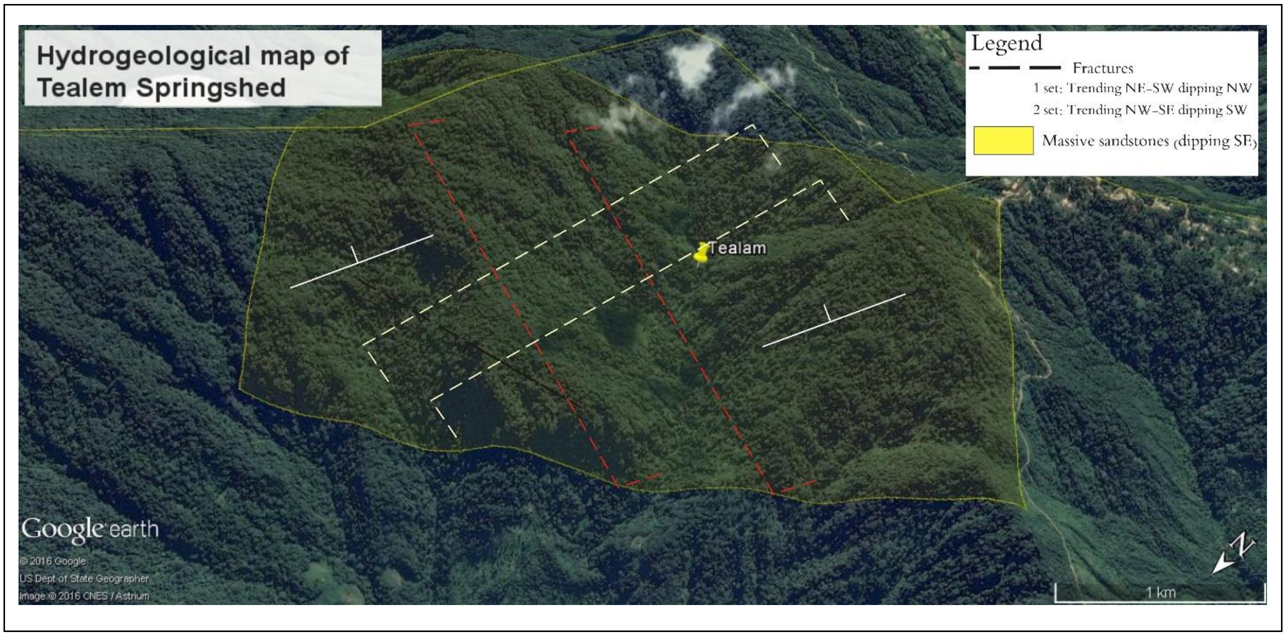
Dominant rock type in the area are alternate bands of very thin shale and thickly bedded massive sandstone. The dips of the rocks are in the SE thus the source is located on the escarpment slope. Sandstones are fractured, therefore providing secondary porosity allowing it to act as a potential aquifer feeding the source. One fracture set is found traversing NE-SW dipping in the NW while the other one traversing NW-SE dipping SW. Source is found emerging through this fracture network and thick soil cover in the area.

Massive bedded fractured Sandstone

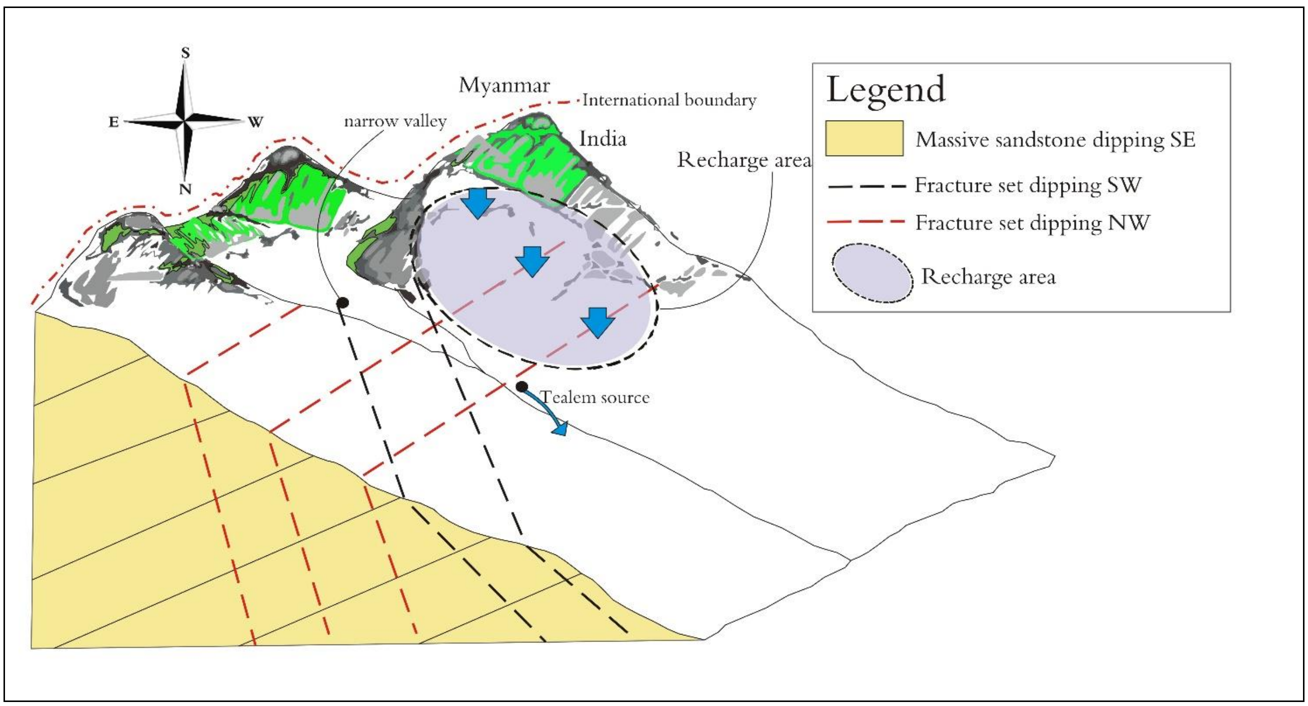
Silting/collection chamber at source



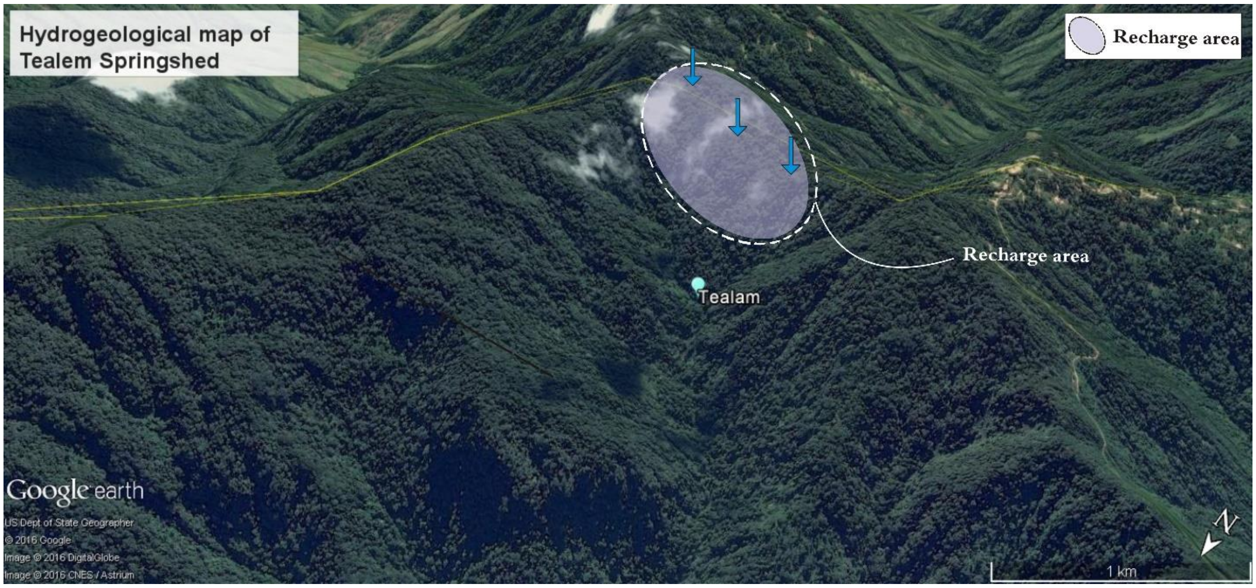
Hydrogeological conceptual layout for Tealem springshed



A Google image of Tealem springshed depicting geology



Hydrogeological conceptual layout for Tealem springshed depicting potential recharge area



A Google image of Tealem springshed depicting potential recharge area

Water Quality Parameters

Sl. No	**Parameters**	**Units**	**Result**
1	Discharge	lpm	1040
2	pH	mg/l	6.7
3	Fecal Coliform		Absent
4	TDS Reading	ppm	31
5	Temperature	Celsius	14.2

Recharge area recommendations

The potential recharge area for the source lies on the slope facing north towards the spring focusing on the fracture trends mapped in Sandstones (refer to conceptual layout). The approx. area of the recharge comes to around 20-25 ha. Complete area around the spring including recharge area is densely vegetated with thick soil cover. Thus, recommending any physical recharge activities might disturb the natural setting of the area. In fact protecting such areas would be very important to maintain the natural system. Although small activities like small dimension recharge pits can be planned in the recharge area depending on the feasibility which can capture some amount of surface runoff on the slopes. It must be ensured that *Jhum* cultivation should not take place in this area.

Sandstones dipping SE with fractures displaying seepage

Source: Nauyang (Latitude: N 26.44454°, Longitude: E 94.80856°)
Hukpang village, District: Longleng

Demographic

The indigenous Phom community of Hukpang village is populated by 3700 people and 450 Household (Village Council Record, 2015). It is inhabited by Schedule tribes and dominated by Christians. Hukpang village is located about 10 Km away from Longleng district. Village Council (apex body) functions along with different institutions like Village Development Board, Village Education Committee, Church, WATSAN Committee, Women Society and Students Union. They have access to 2 Primary School and 1 Middle school. There are 11 *Khels* viz., *Kauchong*, *Pheknyu*, *Yungchung*, *Hejan*, *Hetpu*, *Molim*, *Longkam*, *Angpupu*, *Nokshon*e, *Longkang* and *Phaihet*. The people here are depend on subsistence agriculture with majority practicing Jhum cultivation (rainfed agriculture). They cultivate mixed cropping and few household are engaged in commercial purposes. The main crops and vegetables include rice, maize, yam, garlic, ginger, brinjal, seasame, soyabean and mustard leaves etc.

Water Sources

There is no definite water distribution system in the village. Community has built a collection chamber near a stream around 5km away from the village. From there water supplied from a pipeline to the village. The pipeline is in a very bad condition and need repair. Most of the households in the village are dependent on this pipeline supply only.

No. of Springs in the Village	Other Source	Selected source	Spring type	Rock Typology	HH Dependency
4 Perennial springs	1 Stream	*Nauyang*	Fracture cum	Sandstone and Shales	450 (out of 450)

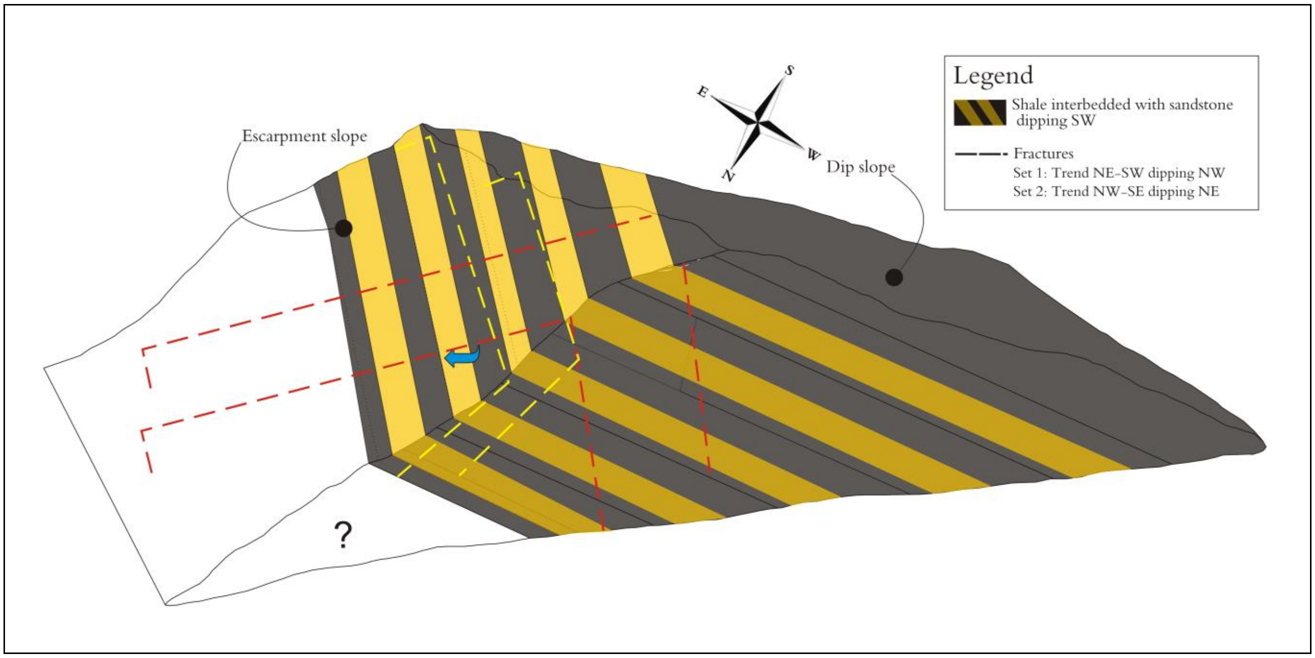
			depression		

The source selected for treatment was the one from where the village draws its main supply. It is a spring fed stream around 5 km away from the village. The discharge of the stream as measured on 12th November was 1500 lpm, the part of which might be the surface run-off post precipitation. According to the local people the stream discharge decreases down drastically during summer months. There is a silting chamber near the stream where the water is collected and then connected to the pipeline.

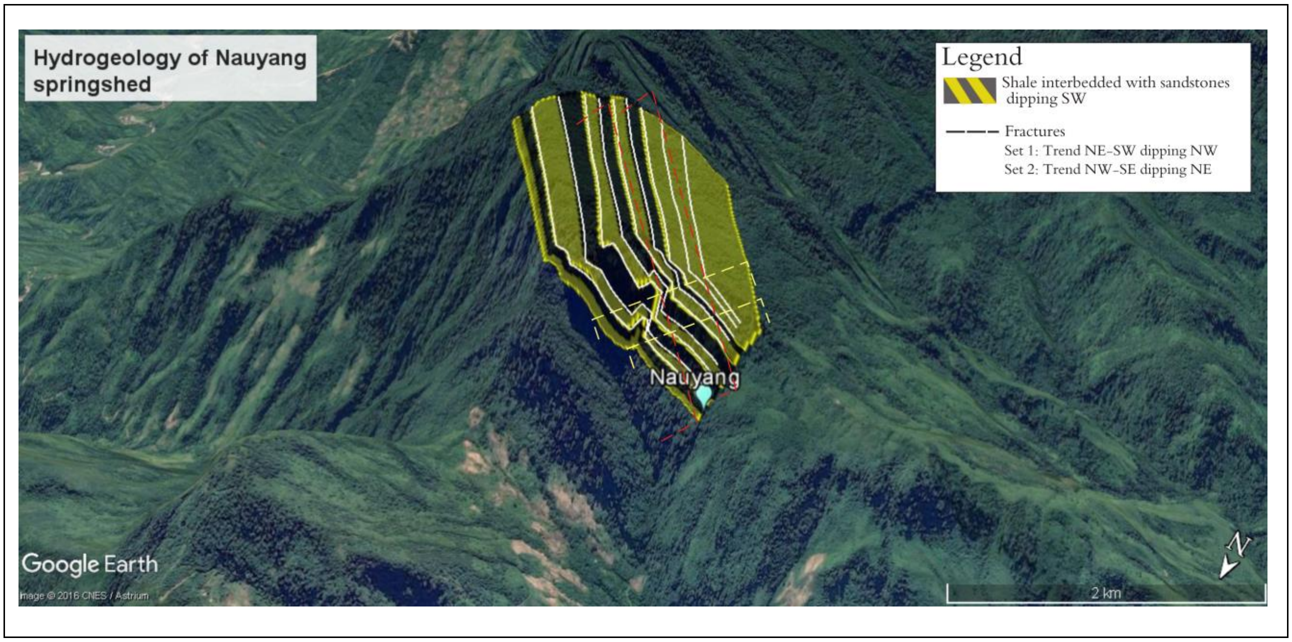
Hydrogeology of the area

The formation is an interbedded sequence of shale and sandstones. The shale is grey in colour with alternating thin bands of ferrugenious sandstones (depends on variations). Towards NE side with respect to spring there is a huge exposure of sandstone. It is massive hard and compact and fine grained in nature dipping towards SW direction. Both shale's and sandstones are highly fractured found trending NW-SE dipping in the SW direction. The primary aquifer being sandstone is hydraulically connected with shale's with fracture porosity and permeability. Inter granular porosity in sandstone might be present to some extent but fracture porosity dominates. One fracture set is found traversing NE-SW dipping in the NW while the other one traversing NW-SE dipping NE. The source seems to originate through the fracture network and lies on the escarpment slope. Thick soil cover with dense patch of vegetation is found on both escarpment as well as dip slopes.

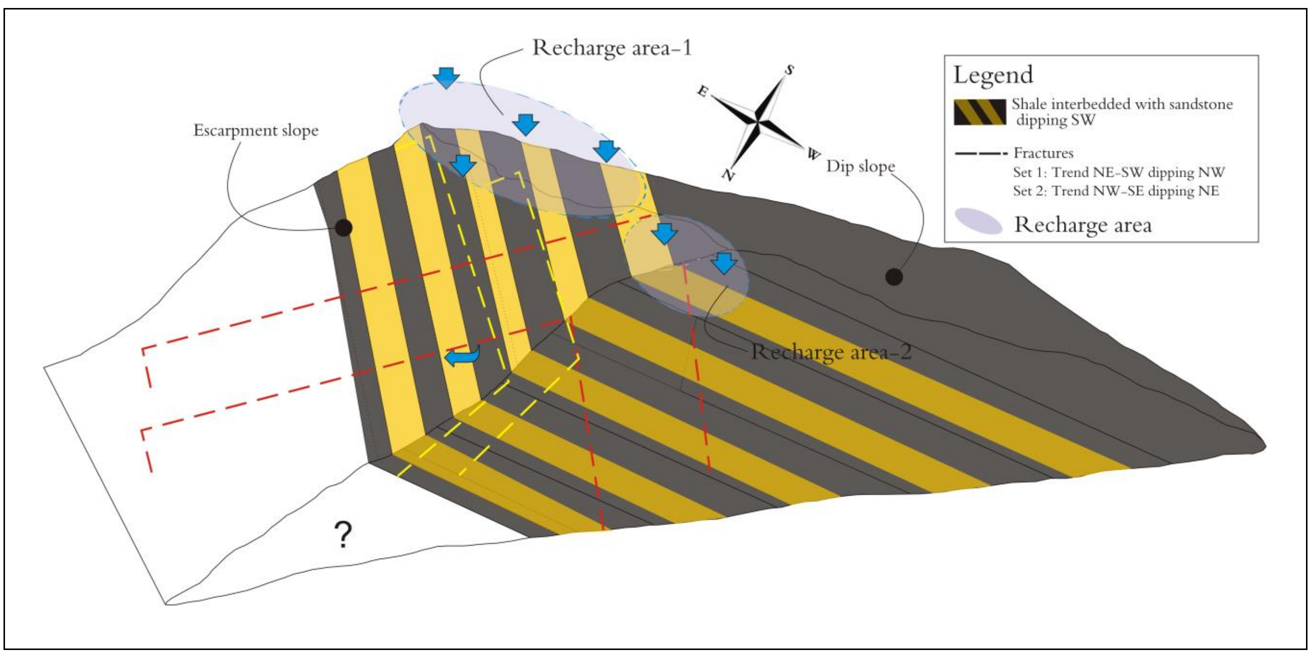
Shale-sandstone contact with Shales at the bottom and sandstones on the top



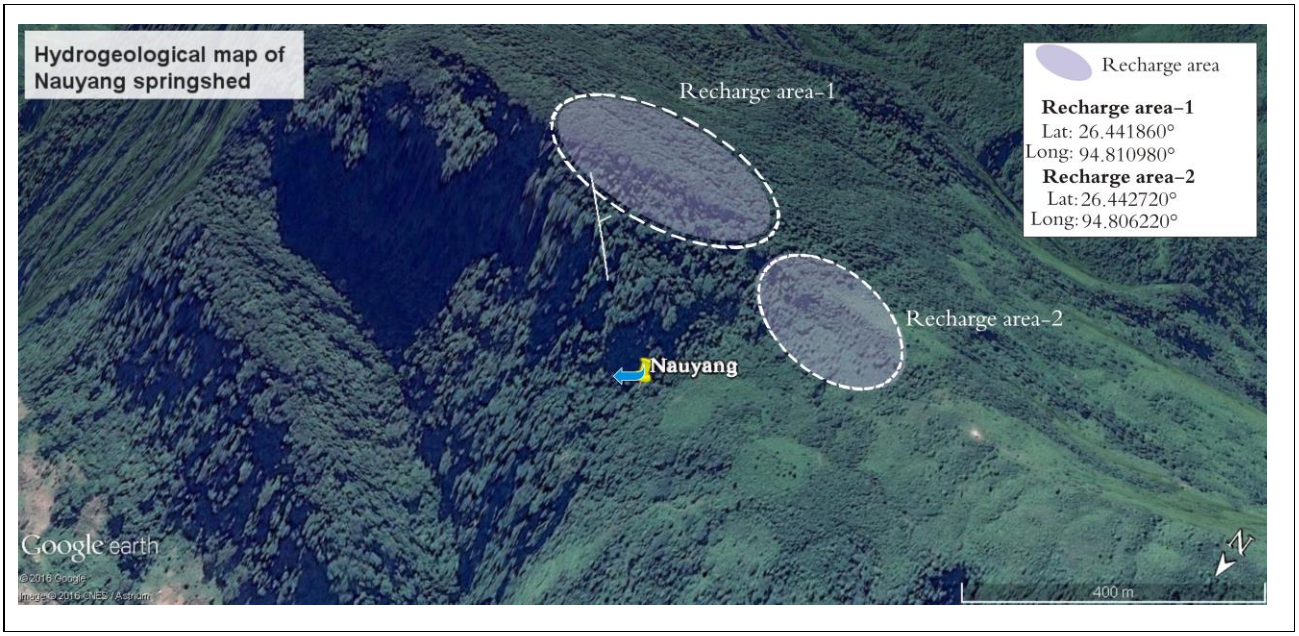
Hydrogeological conceptual layout for Nauyang springshed



A Google image of Nauyang springshed depicting geology



Hydrogeological conceptual layout for Nauyang springshed depicting potential recharge area



A Google image of Nauyang springshed depicting potential recharge area

Water Quality Parameters

Sl. No	**Parameters**	**Units**	**Result**
1	Discharge	lpm	400
2	pH	mg/l	7.8
3	Total Hardness	mg/l	32
4	Chlorides	mg/l	70.9
5	Nitrates	mg/l	0
6	Fluoride	mg/l	Less than 0.6
7	Iron	mg/l	Less than 0.3
8	Fecal Coliform		Absent
9	TDS Reading	ppm	53
10	Total Alkalinity	mg/l	40

Recharge area recommendations

The potential recharge area for the source lies in two locations on the slope facing S direction. *Recharge area-1* lies on the left with respect to spring location while the *Recharge area-2* lies on the right. Spring essentially lies on the escarpment slope and thus is controlled by fracture systems. The approx. area of the recharge comes to around total 30-40 ha. The area is quite densely forested with thick soil cover. Activities which will help arrest soil erosion can be planned so that water infiltration capacity to the aquifer system below remains intact. Trenching activity can be carried out in both the recharge areas. Recharge pond of smaller dimension over the ridge area in *Recharge area-2* is suggested to facilitate recharge. Moreover protection of the existing forest cover should be given prime importance which can then be followed by above activities.

Source: Ungersangpang (Latitude: N 26.39805°, Longitude: E 94.52631°) Mopungchuket village, District: Mokokchung

Demographic

Mopungchuket Village (Kabulong block) is one of the oldest Ao Villages in Mokokchung district comprising of 550 Households (Council Record, 2015). There are three *Khels* or Wards in the village viz., *Pongsen*, *Anungsa* and *Mongsen*. Village Council is the apex body and various institutions exists and functions for the welfare of the village. Some of them are: the Village Development Board, Village Education Committee, Church, WATSAN Committee, Women Society and Students Union. Anganwadi Centre, Primary and High School and Self Help Groups are also accessible. The main occupation is farming (*Jhum* or shifting cultivation) and few are engaged in skilled labour (masonry, carpentry, weaving etc.) and govt/private service.

Water Sources

In Mopugchuket village, springs are the main source of water. This village of 550 household population shares its major spring water with a neighboring village and hence cannot implement any treatment methods on that spring-shed without their consent. There is no central water distribution system. The villagers take water from the nearby springs.

No. of Springs in the Village	Other source	Selected Spring	Typology	Rock Typology	HH Dependency
10 Perennial springs	2 bore wells (Developed in 2011-2013)	*Ungersangpang*	Depression & contact	Sandstone	200 (out of 550)

Since the primary source could not be treated, the second most important source selected for treatment was *"Ungersangpang"* spring. The spring selected is perennial which nearly caters 200 households. Discharge starts reducing from the month of February. The village lies in the east over the ridge while there is a small habitation above the spring which was established two years back.

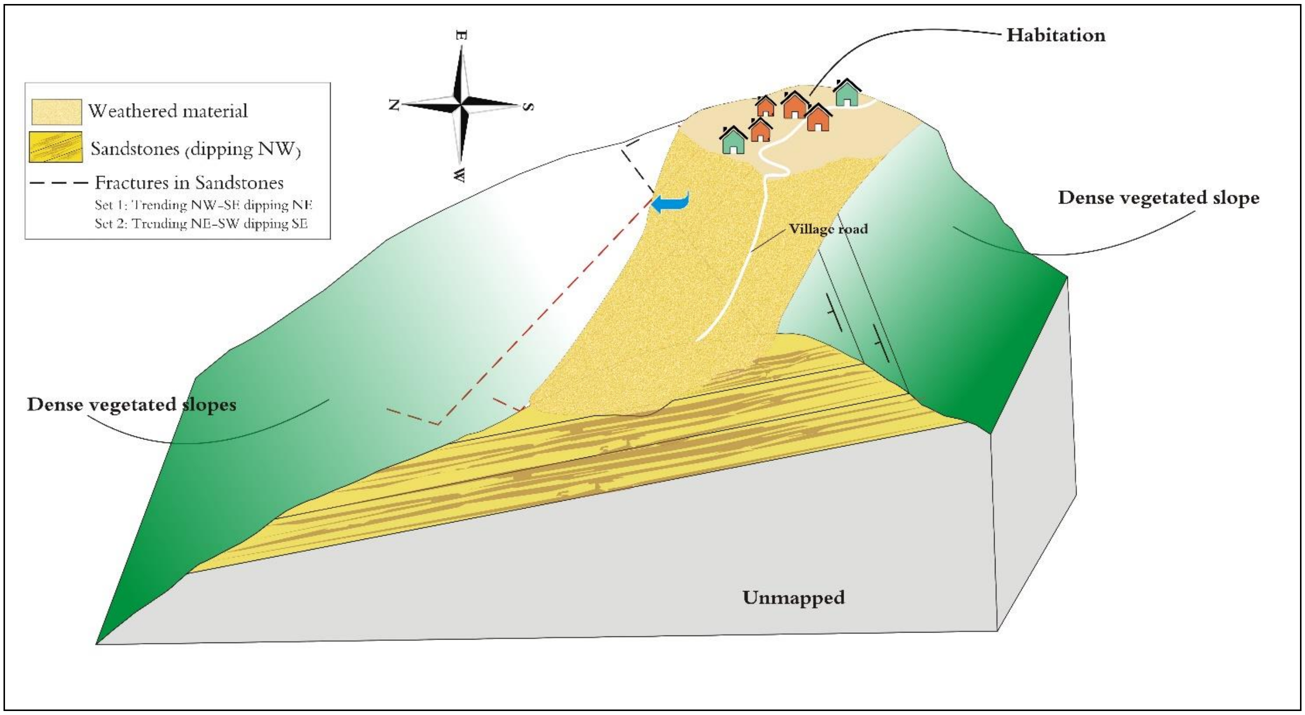
Hydrogeology of the area

The source is situated in the western direction of the village. The springshed is primarily consists of bedded sandstone which is medium to fine grained loosely bonded less hard in nature and is slightly intermixed with clay particles dipping in the NW. Weathering in this sandstone is observed along the ridge area out and hence bears the potential for groundwater movement and accumulation. The spring is found emerging out through this weathered material forming a depression spring.

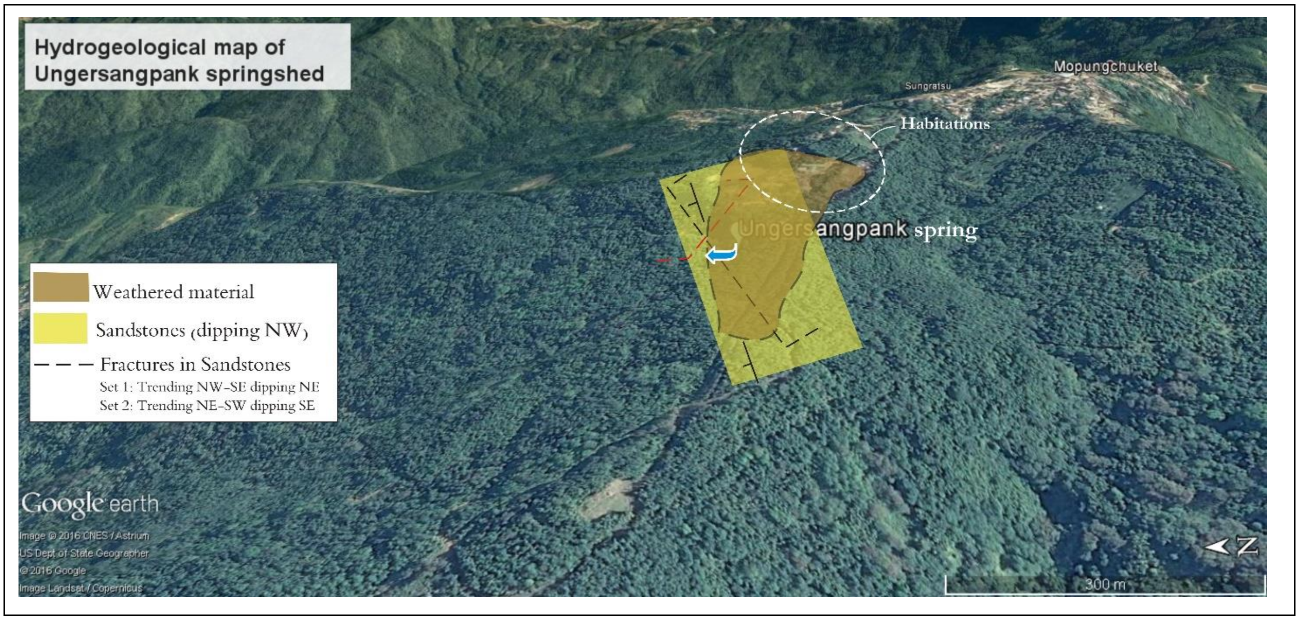
Sandstone outcrop in the springshed area

Ungersangpang spring

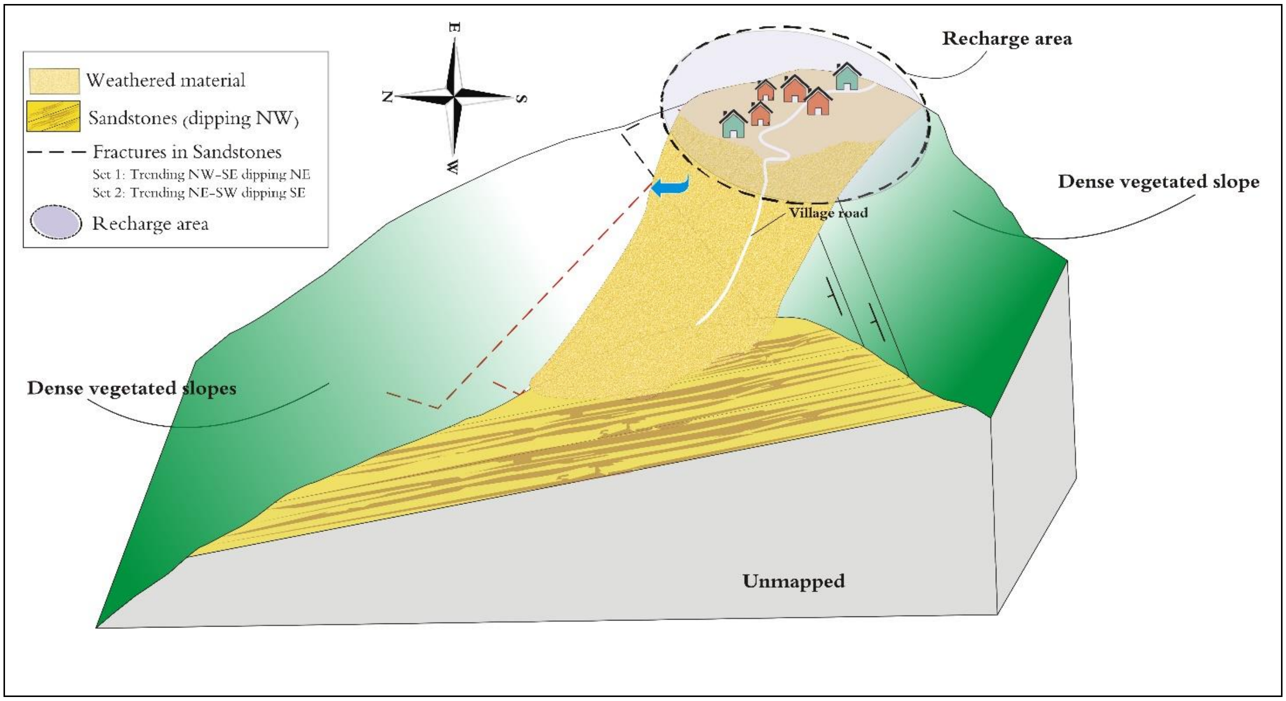
Sandstones being less hard in nature provides both primary and secondary porosity. Primary porosity is found in the form of inter granular pore space while the secondary porosity is gained by fractures and bedding. One fracture set is found traversing NW-SE dipping NE while the other set traversing NE-SW dipping SE. These fracture sets are nearly vertical with 85° dip amounts.



Hydrogeological conceptual layout for Ungersangpang springshed



A Google image of Ungersangpang springshed depicting geology



Hydrogeological conceptual layout for Ungersangpang springshed depicting potential recharge area

A Google image of Ungersangpang springshed depicting potential recharge area

Water Quality Parameters

Sl. No	**Parameters**	**Units**	**Result**
1	Discharge	LPM	113
2	pH	Mg/l	5.4
3	Total Hardness	Mg/l	400
4	Chlorides	Mg/l	319.5
5	Nitrates	Mg/l	10
6	Fluoride	Mg/l	0.6
7	Iron	Mg/l	Less than 0.3
8	Fecal Coliform		Absent
9	TDS Reading	Ppm	24
10	Temperature	Celsius	22 ℃

Recharge area recommendations

The potential recharge area for the spring lies in the east of the spring location which takes into account the rock dips, weathering and fractures. The approx. area of the recharge comes to around 15-20 ha. Most of the recharge area is sheltered by newly settled inhabitants (depicted in the layout) hence recharge through rainwater harvesting forms a feasible alternative. The water getting harvested over roofs has to be channelized through pipes and diverted to small but relatively deep recharge pits. These recharge pits should be well spaced from any sanitation facility nearby as it might lead to contamination of the resource "aquifer" feeding the spring.

Some portion of the area on the southern slopes (escarpment slope) can be treated with staggered contour trenching depending on the slope feasibility. If the slope is relatively gentler, a recharge pond can be structured. Along with these activity it also necessary to set up few protocols in terms of protecting the recharge area. As we understand that large chunk of the recharge area is occupied with settlements, it is important to avoid open defecation (if any) and to promote use of pucca latrines. This will ensure good quality of water in the spring.

Source: Beireucwak (Latitude: N 25.607694°, Longitude: E 93.764056°) Dungki village, District: Peren

Demographic

Migrated from neighbouring *Lumhai* Village, *Dunki* Village was established in 1964 and is located in Jalukie Block of Peren District, Nagaland. Peren district is predominantly inhabited by *Zeliang* and *Kuki* tribes (ST). The Village has a population of 240 HH (Village Council Record, 2015) and are reliant on subsistence agriculture. The village Council is the apex body and various institutions and groups function in the village viz., Village Development Board, Village Education Committee, *Gaonburas*, Church, WATSAN and Watershed Committee, Self Help Groups, Women Society and Students Union, Primary/Middle and High School etc. The village is divided into Block A, B and *Rehangki*.

Water sources

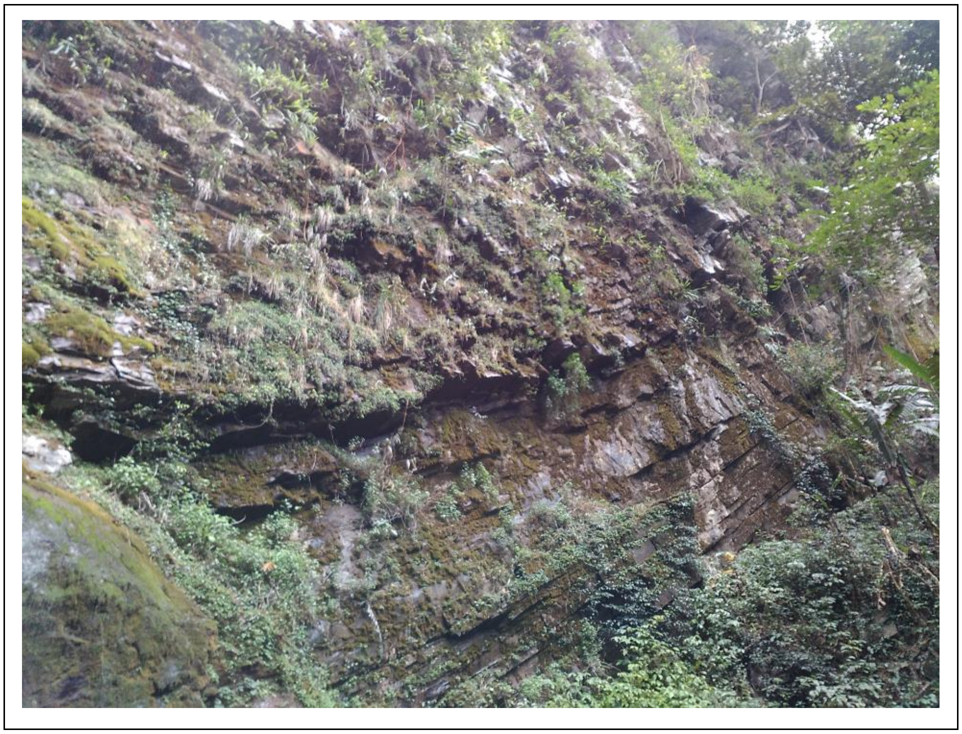
One source, the "*Beureicwak*", is a third order steam that provides water security for Dunki communities of 250 Households. It is used for drinking water and other domestic purposes. The terrain is rough and is about 12 Km away from the village habitation. It is characterised by a mixed forest and has a large catchment area (about 10 -12 ha). The slope on the left bank of the stream is about 50% or more and 20-25 % of the right bank of the stream respectively. They shared that the area is being reserved this year because of rampant hunting amongst others. There are two main reservoir tanks in the village.

No. of Springs in the Village	Other Sources	Selected Spring	Type	Rock Typology	HH Dependency
5 (1 Seasonal)	28 Ring wells and a stream	*Beurewcwak*	Third Order Stream	Sandstone	250 (out of 250)

This spring-fed source was selected for detailed hydrogeological assessment as it forms the primary source of water for the village. The water is collected in a silting chamber which is then supplied to the 2 main storage tank/reservoirs in the village of capacity 55000 lites each. Water connection is provided to each household in the village through these tanks.

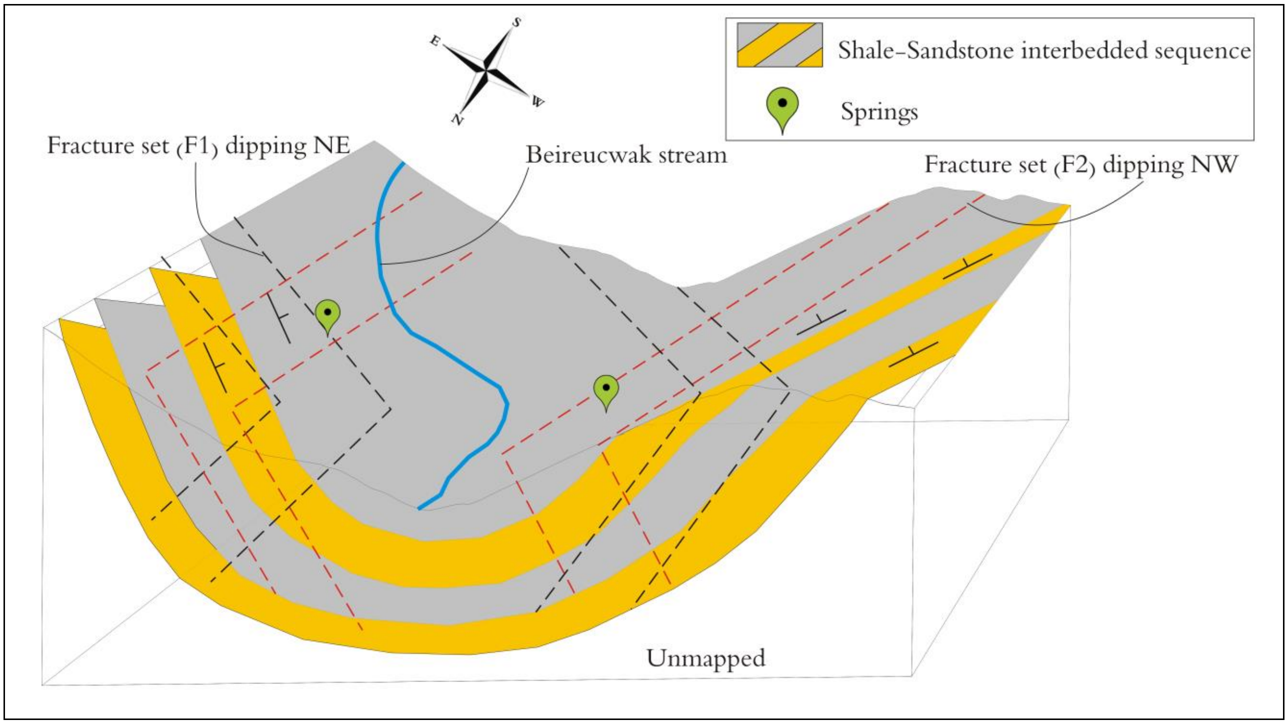
Hydrogeology of the area

The source is situated towards NE direction of the village. The springshed is mainly composed of two lithology's viz. sandstone and shale. Shales are red grey to grey colored interbedded with sandstones and are compact in nature and hardly possesses any primary porosity. The sprinshed is composed of plunging synclinal structure with the stream flowing through it (*depicted in the layout*). The beds dip towards each other bringing in all the water to the stream in the form of springs and overland flows. Fracturing is prominent giving it a scope for secondary porosity through which occurrence of groundwater accumulation and movement takes place. There are multiple springs in the springshed that feed the stream out of which two were mapped during the visit.

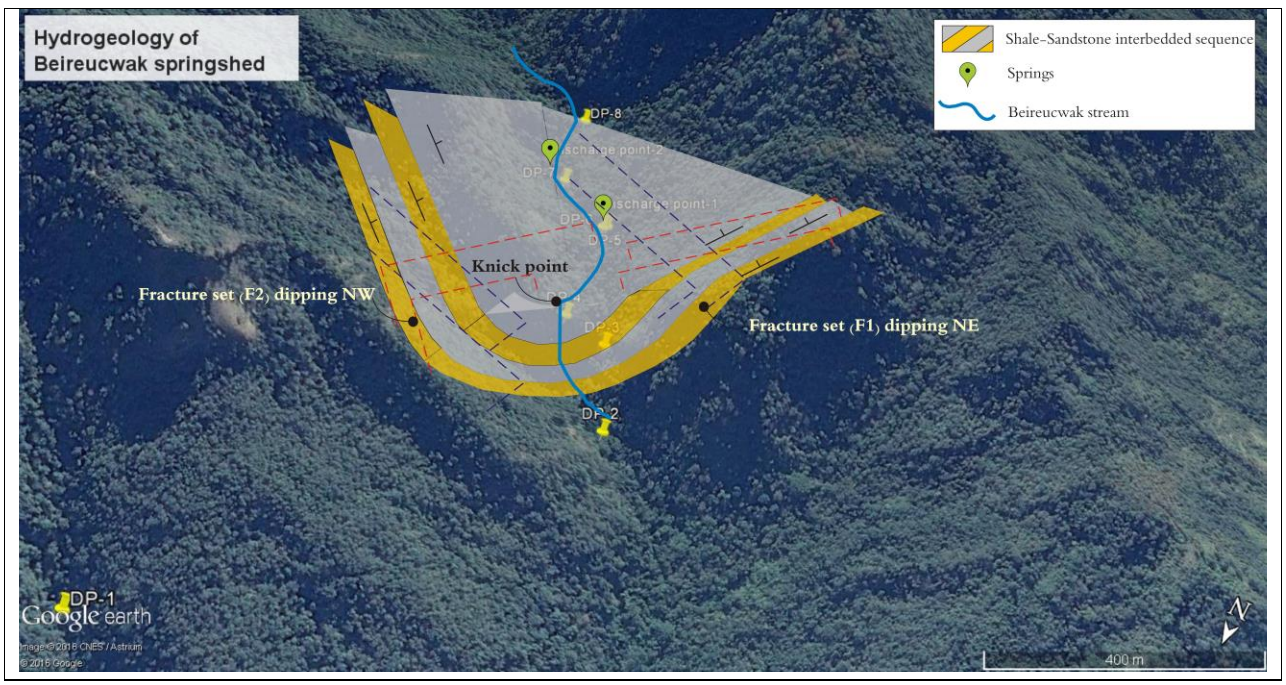


Interbedded Shale Sandstone with synclinal structure

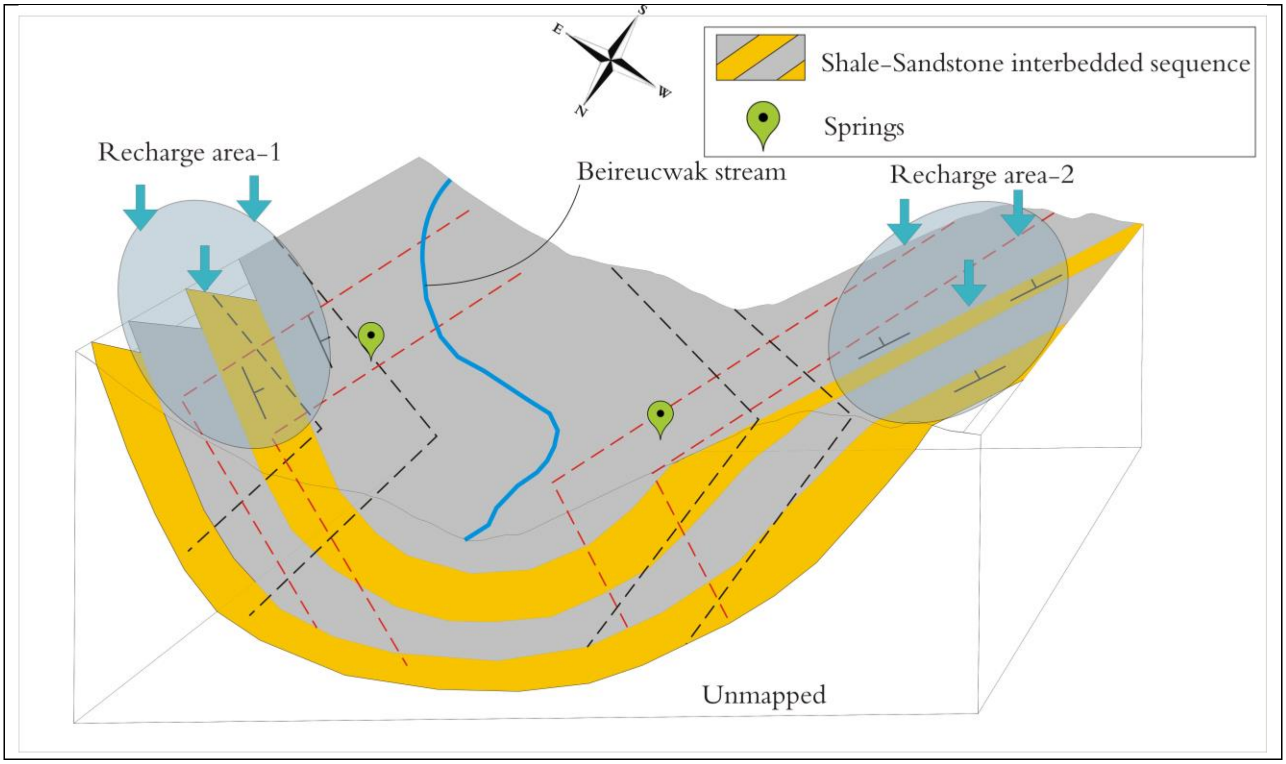
The contribution to the springs is through fractures and bedding planes. One fracture set is found trending NE-SW dipping NW while the other set trending NW-SE dipping NE. Both the springs are fractured controlled. The discharge in the stream as measured on 5th November was 1440 lpm. However, not all the discharge is spring flow. Part of it may simply be overland flow through direct runoff from precipitation. However, separation of the two was beyond the scope of this project.



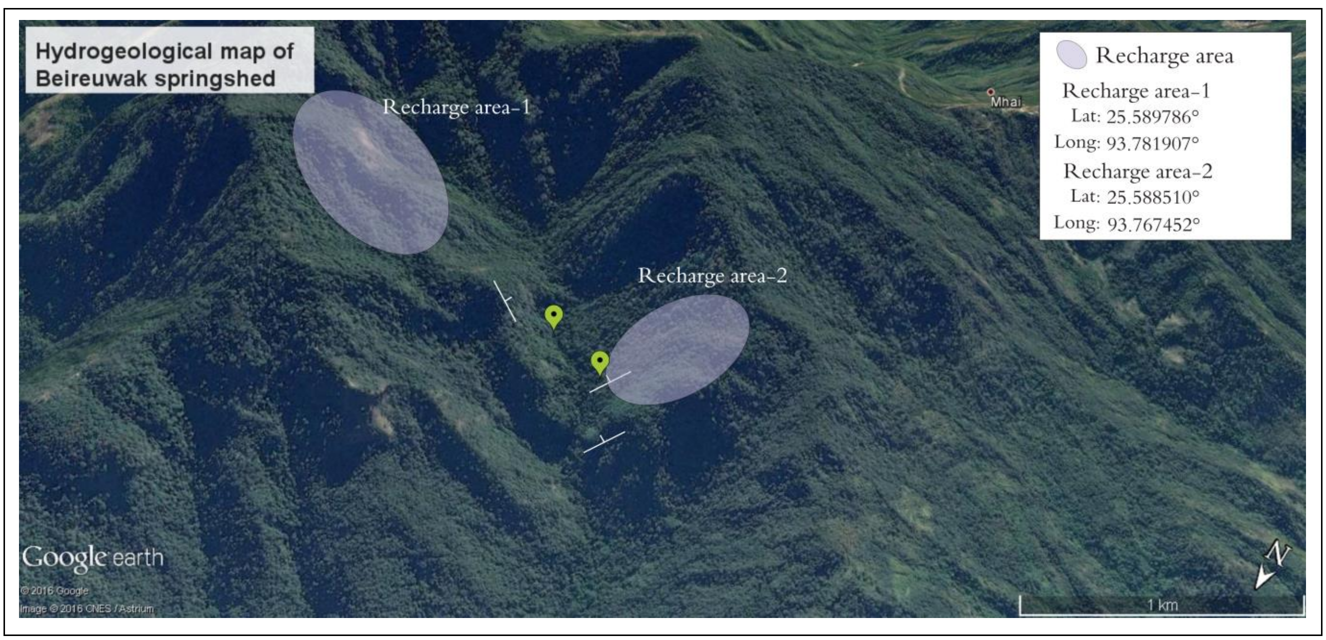
Hydrogeological conceptual layout for Beireucwak springshed



A Google image of Beireucwak springshed depicting geology



Hydrogeological conceptual layout for Beireucwak springshed depicting potential recharge area



A Google image of Beireucwak springshed depicting potential recharge area

Water Quality Parameters

Sl. No	**Parameters**	**Units**	**Result**
1	Discharge	lpm	1440

2	pH	mg/l	8
3	Total Hardness	mg/l	400
4	Chlorides	mg/l	21.3
5	Fluoride	mg/l	0.6
6	Iron	mg/l	Less than 0.3
7	Fecal Coli form		Absent
8	TDS Reading	ppm	85
9	Temperature	Celsius	23°C
10	Total Alkalinity	mg/l	200

Recharge area recommendations

The potential recharge areas were identified on the basis of hydrogeological conditions present in the springshed.

On the basis of observations and conditions prevalent in the springshed, two recharge areas were identified. One recharge area lies on the slope facing in the east direction (***Recharge area-2***) while other one lies on slope facing in the SW direction (***Recharge area-1*)**. Total recharge area comes to approx. 40-45 ha. Depending on the slope percentage and feasibility, staggered contour trenching can be structured in both the recharge areas. Since the soil cover is quite thick in the upper reaches, protection of the existing forest cover is crucial as it will ensure good infiltration to the aquifer system underneath. Trenching can also be accompanied with plantation activity. Jhum cultivation should not be practiced in the recharge area.

Source: Thaldzucha (Latitude: N 25.551250°, Longitude: E 94.132944° Viswema village, District: Kohima

Demographic

Populated by 2300 HH of indigenous *Angami* community, *Viswema* Village under *Tsakha* Block is located 12 Km away from the Capital Kohima district. The Village Council is the apex body and various institutions exists viz., Village Development Board, Village Education Committee, *Gaonbura* (11), Church, WATSAN and Watershed Committee, Self Help Groups , Women Society and Students Union. Anganwadi Centre (10), Primary (4) and High School (3), a Middle School, Higher Secondary (2) and Community Health Centre are also accessible. The main occupation is farming (*Jhum* or shifting cultivation) and few engaged in skilled labour (masonry, carpentry, weaving etc.), businesses and govt. /private service.

Water sources

Viswema is a very large village with 2300 households living in the four hamlets of the village. There four springs that supply water to the central reservoir of the village. Then there is one smaller reservoir in each hamlet in the village that receives water from the main reservoir. The capacity of the main reservoir is 361m^3. The smaller reservoirs' capacity was half of the main reservoir as quoted by the village council chairman. The 4 springs those supply water to the main reservoir are Chekrol dzu, Apul dzu, Kheyoke dzu and Thaldzucha.

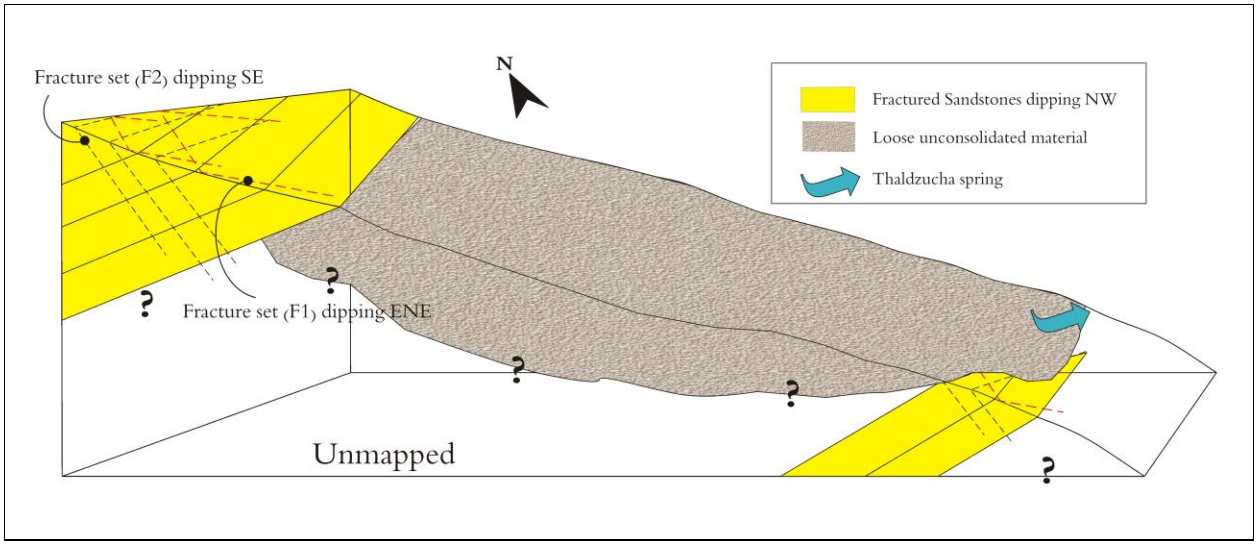
The major fraction of water in the main reservoir was contributed by Thaldzucha spring. This spring is also used to draw water independently by the villagers hence it was selected for further interventions. The discharge of the spring as measured on 7th November was 420 lpm. There is a silting chamber nearby to collect water from the spring which is connected to the storage tank of capacity 7000 litres. "Thaldzucha" spring (Perennial) is utilized by 600 HH in the village. The spring water has provided life (drinking and other domestic usage) since the inception of the village.

No. of Springs in the Village	No. of Reservoir	Selected Spring	Typology	Rock Typology	HH Dependency
22 (16 Perennial)	18	*Thaldzucha*	Depression	Sandstone	600 (out of 2300)

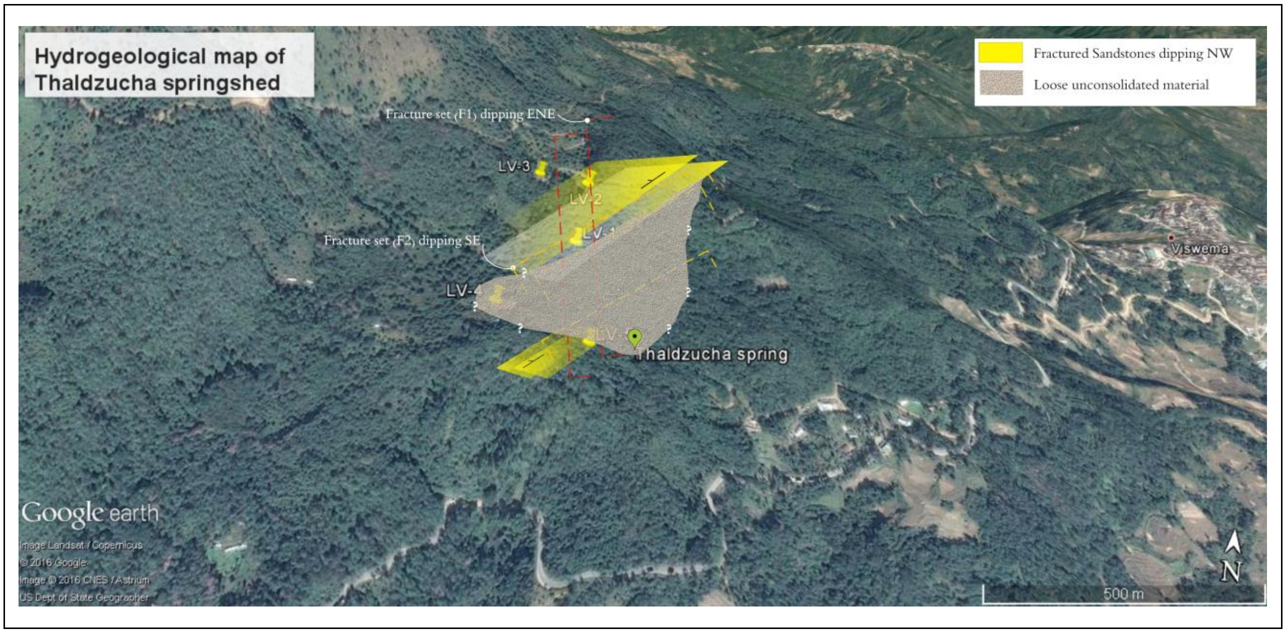
Hydrogeology of the area

The spring is situated towards SE direction of the village. The springshed is essentially comprised of hard ferruginous, very thickly bedded massive sandstone with alternate shale bands in between. The spring is found emerging out from a system of loose unconsolidated material which is underlained by thick massive sandstones. Sandstones have north westerly dips with amounts varying from 30-35°. Thaldzucha springshed is thus mainly comprised of loose unconsolidated material and massive sandstone as an aquifer system feeding the spring. Sandstones are fractured with two major sets of fractures, one trending NNW-SSE dipping ENE (F1) while the other one trending NE-SW dipping SE (F2). The major storage occurs in the loose unconsolidated deposit system while some storage takes places in the fractured sandstones.

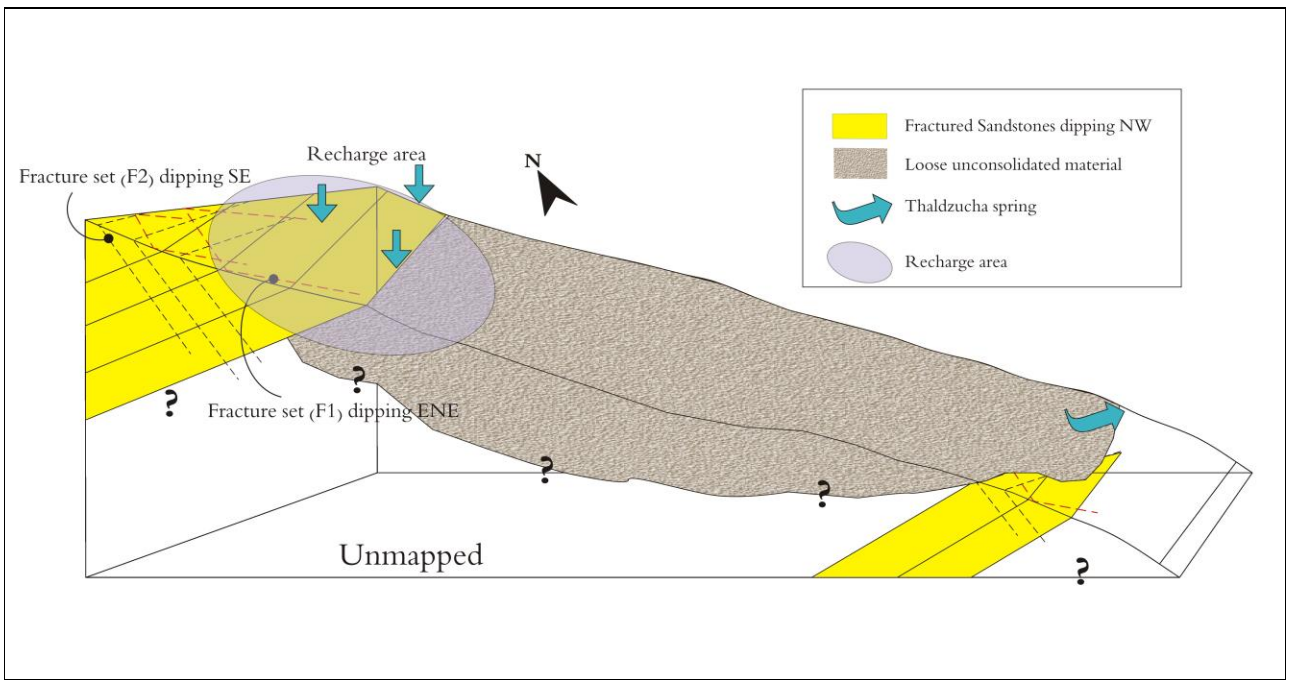
Massive bedded and fractured Sandstone



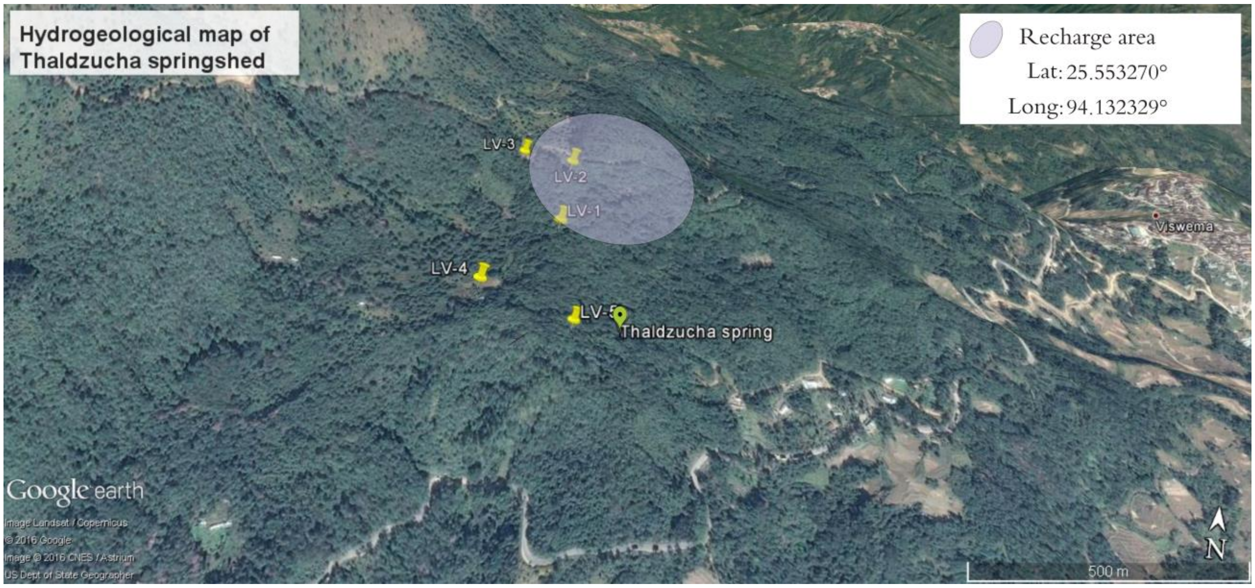
Hydrogeological conceptual layout for Thaldzucha springshed



A Google image of Thaldzucha springshed depicting geology



Hydrogeological conceptual layout for Thaldzucha springshed depicting potential recharge area



A Google image of Thaldzucha springshed depicting potential recharge area

Water Quality Parameters

Sl. No	**Parameters**	**Units**	**Result**
1	Discharge	lpm	420
2	pH	mg/l	6.8
3	Total Hardness	mg/l	400
4	Chlorides	mg/l	177.25
5	Nitrates	mg/l	Zero
6	Fluoride	mg/l	0.6
7	Iron	mg/l	Less than0.3
8	Fecal Coliform		Absent
9	TDS Reading	ppm	81
10	Temperature	Celsius	17 ℃
11	Total Alkalinity	mg/l	200

Recharge area recommendations

The potential recharge areas were identified on the basis of hydrogeological conditions present in the springshed.

On the basis of observations, potential recharge area was identified on the slope facing south and a bit on the left with respect to the spring location. Total recharge area comes to approx. 10-15 ha. Depending on the slope percentage and feasibility, staggered contour trenching can be structured. Since the soil cover is quite thick over the slopes, protection of the existing forest cover is important. Trenching should be accompanied with plantation activity. Jhum cultivation should not be practiced in the recharge area. Some development in terms of debri clearance using machines had taken place somewhere in the recharge area. This can pose harm to the system and affect natural recharge to the system and thus should be avoided.

Way Forward

Hydrogeological science forms the basis for any work related to watershed, springshed or any other intervention with connection to groundwater and aquifers. The science helps better understand springs scientifically and classify them into types based on the nature of their properties.

The complex geology, spring discharge locations and site specific recharge areas imparts a shift from the classical ridge to valley to valley to a valley approach in studies dealing with spring water.

This study involved a comprehensive hydrogeological assessment of the spring catchment to identify and demarcate potential recharge sites for four springs in four districts. Based on the recommendations, implementation measures will be carried out in the identified recharge area. This pilot study will help scale up the work further in all districts with substantial no. of springs.

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