This report, by ACWADAM, is a culmination of the first part of the VWSP development for TENDONG HILL Region, in partnership with RMDD and GIZ

HYDROGEOLOGY OF SPRINGS IN TENDONG HILLS, SOUTH SIKKIM DISTRICT, SIKKIM

As part of ACWADAM-RMDD-GIZ Project on Village Water Security Plans

ACWADAM

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HYDROGEOLOGICAL ASSESSMENT OF TENDONG HILLS REGION WITH SPECIAL REGARD TO THE DEVELOPMENT OF VWSP

Introduction

The complex interplay of rock types and rock structure in the Himalaya not only give rise to diverse hydrogeological environments, but such environments lie in close proximity to each other. The hydrogeological setting in mountain areas is a result of variation in the rock type and structure of the aquifers. Overlap and inter-fingering of different litho-units or rock strata lead to the development of composite aquifers (aquifers formed by a grouping of different rock types). Such overlaps are facilitated by structural deformation such as folding, faulting and development of fracture zones. Loss of aquifer continuity at mountain slopes or along faults and fractures, leads to the formation of springs. Spring discharges vary considerably depending on various factors, the foremost being the variations in pore-space and hydraulic conductivity of the aquifers (rock type and rock openings). Moreover, change in the quantity of precipitation on account of altitudinal differences is responsible for varying degrees of temporal variation in the discharge of springs.

Aquifers in Himalaya, due to the discontinuity of the rock formations by conditions imposed by the terrain and the structural setting, are often only of local extent. Even within a small area, many separate aquifers may be encountered; these aquifers may be composed of a single lithology or may be composite in nature. Despite such an intricate and complex geological setup, a vast majority of the watershed development programmes and spring development strategies implemented in Himalayan villages give no regard to the geology of the *catchment*. Even in geologically less complex areas, the success of watershed development programmes depends highly upon a sound geologic input. In the Himalayan mountain belts; therefore, many projects with watershed or spring development agenda run the risk of limited scope, sometimes leading to the failure of achieving the full objective of the project. These projects are important because of various risks posed to springs, whether through fluxes imposed by a changing climate or by anthropogenic factors ranging from deforestation to hydropower infrastructure, much of these fluxes weighing hydrologically or structurally on the aquifers and watersheds hosting important spring systems.

ACWADAM, in partnership with other organizations, is attempting the development and implementation of scientifically motivated, hydrogeologically driven spring development programmes in the Indian Himalayan Region. The hydrogeological input provided by ACWADAM is intended to identify and "treat" the recharge area of the aquifer / spring. This is important because the diverse hydrogeological setting in the Himalaya means the size and location of a recharge area of a spring can be highly variable.

ACWADAM is also attempting to help partner organisations monitor spring discharge and spring water quality in a bid to understand spring behaviour and to help capacity building of partner organizations and the community through a knowledge and information driven process.

The *Dhara Vikas* project the State of Sikkim is a Government of Sikkim initiative, involving partners such as Rural Management and Development Department (RMDD henceforth) and State Institute of Rural Development (SIRD henceforth) and various other partners. The *Dhara Vikas* was constituted with the hope to arrest the disappearance of springs and develop strategies for the conservation of springs through an approach appropriately labeled 'Springshed' development. The technical input for these strategies was provided various entities, with ACWADAM undertaking detailed hydrogeological investigation of the spring catchments and study of factors like spring discharge and spring water quality.

ACWADAM's involvement in the project at the beginning of 2010 commenced with selection of springs for collection of data and group exercises for improving the understanding of hydrogeological principles among the participants. Field facilitation was coupled with capacity building exercises and providing back-stopping support to organizations involved in the project, a process in keeping with ACWADAM's modus operandi. In order to develop a first-cut understanding of the science of hydrogeology, 15 members from partner organizations were invited to participate in the July, 2010 training session in Pune. The comprehensive training session was followed by field exercises in the spring-shed area (aimed at the identification of spring recharge area and planning of recharge measures for different springs on the basis of hydrogeological investigations conducted). Refresher workshops, to revisit the skills and knowledge acquired during intensive training sessions and for the development of future strategies in the treatment of individual springs, have been planned from time to time. Subsequent to these, RMDD has been deputing some of its staff for the 15-day foundation training on hydrogeology and groundwater management conducted by ACWADAM in Pune.

Subsequently, ACWADAM undertook a rapid participatory hydrogeological study of 30 springs and 3 hill top lakes in Sikkim under a project funded by GIZ (formerly GTZ). The project outputs were used in springshed development around these 30 springs, many of which were mapped through the efforts of *field facilitators* of RMDD. The actual implementation of measures was undertaken by RMDD through MGNREGS funds.

Background to current study

The Tendong Hill, located in South district of Sikkim rises to a highest elevation of around 2640 m (8545 feet) above mean sea level. The hill is devoid of human settlements on top and is a popular trekking destination for tourists. The Tendong hill is an abode to several natural springs that support almost all the settlements surrounding it, mainly on its flanks and in the adjoining valley portions. A popular tourist destination, Tendong Hills is also a part of a high rainfall zone. South District, of which Namche is the headquarters and is located quite close to the Tendong Hills, receives an average annual rainfall of more than 1600 mm. CGWB, in its groundwater district profile of South Sikkim (http://sikkimsprings.org/dv/Educational%20research/South_sikkim.pdf) pegs the annual rainfall for the region as close to 3500 mm, a more realistic range for Tendong Hills.

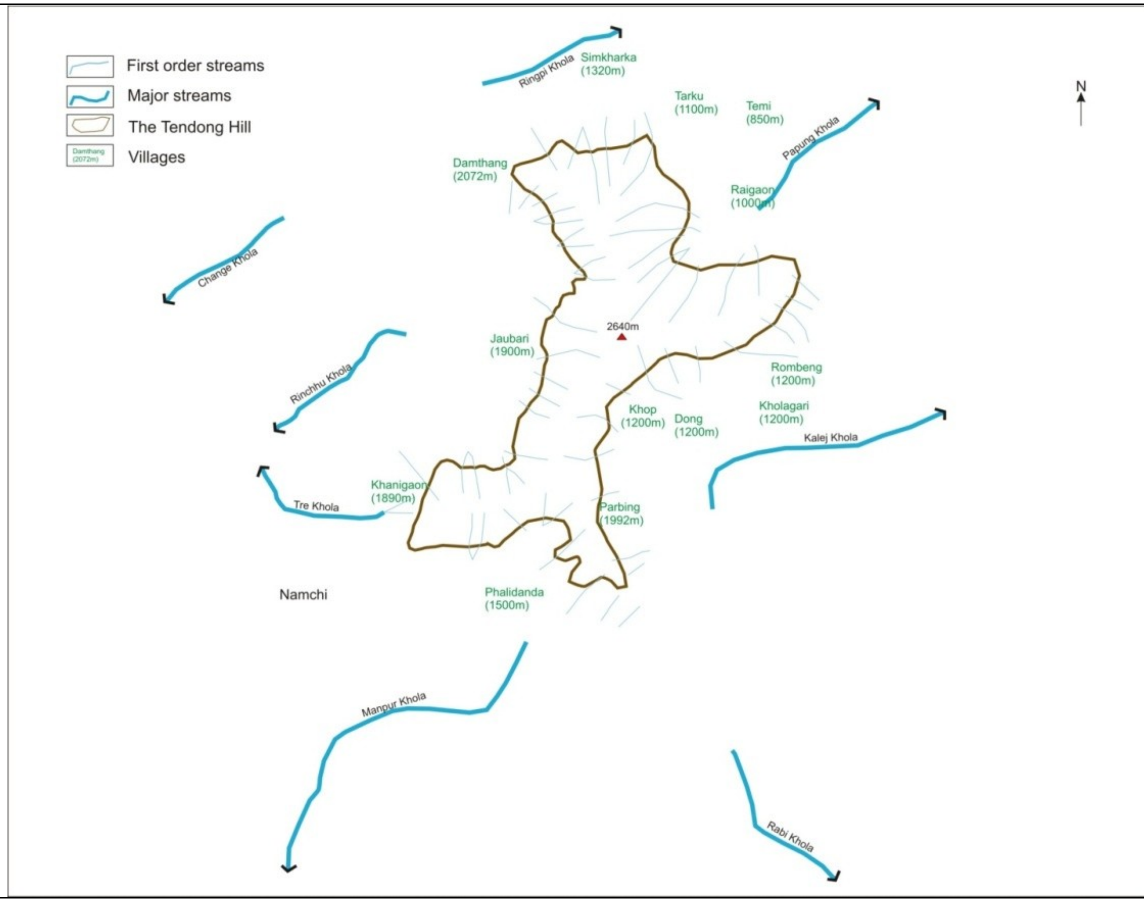


Figure 1: Tendong Hill region with various streams emerging from the region; Namchi lies to its southwest

Understanding the Tendong Hill water resource system – *topography and drainage*

Tendong hill region occupies a trans-river region that is part of the divide between Rangit and Teesta River Basins (Figure 1). The contour map of the region shows how the hill slopes more gently towards the northeast, i.e. towards Teesta as compared to the west and southwest, i.e. towards the Rangit. The slopes are generally indicative of the underlying structure and formed the first-cut in exploring the underlying geology. However, before doing so, it was felt necessary to understand the imprint of the drainage network given the slope configuration of the region.

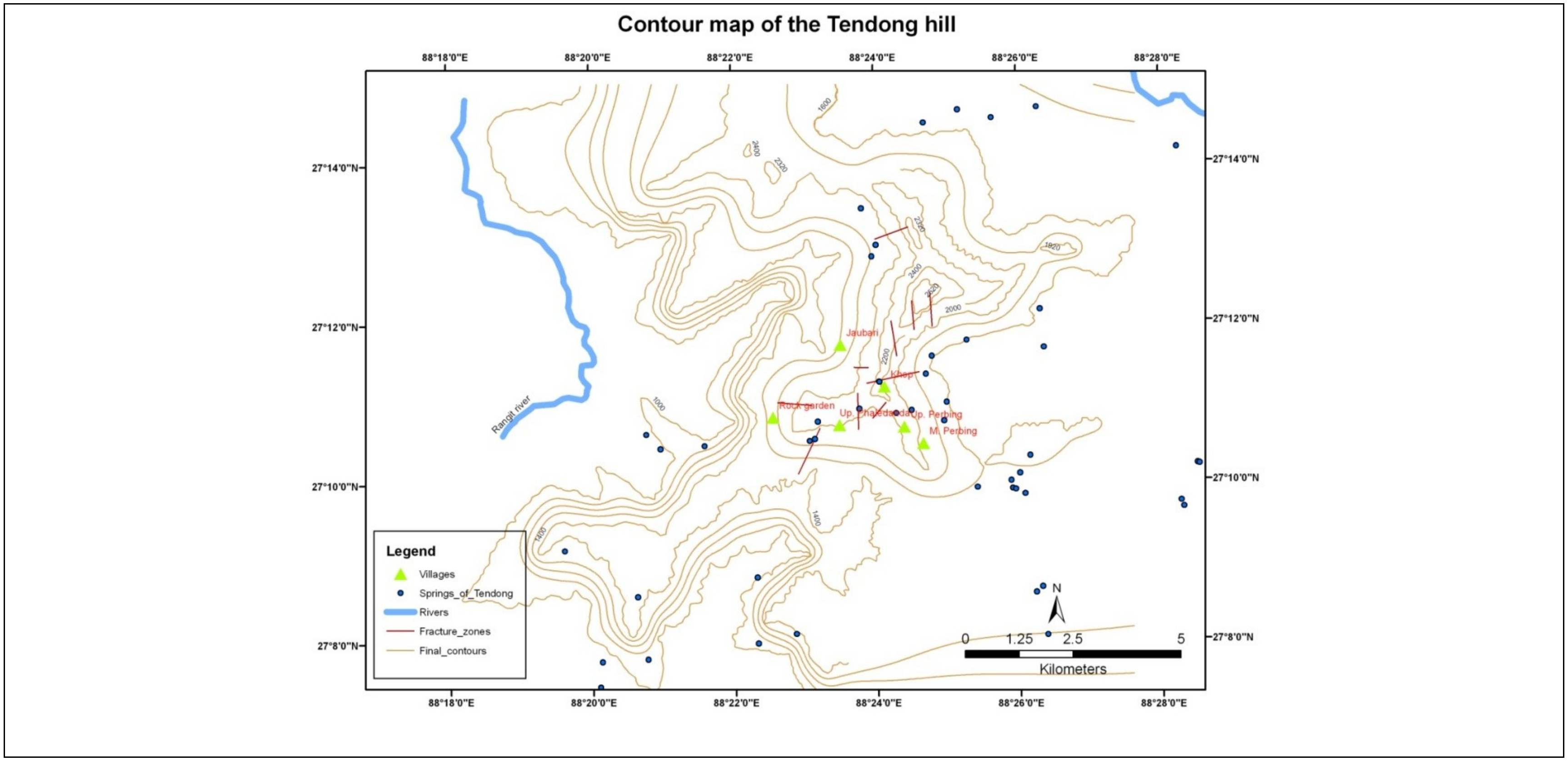


Figure 2: Tendong Hills – Contour map, with villages, springs and position with regard to the two major rivers of Sikkim – *Rangeet in the west and Teesta in the northeast*

It becomes important to understand the drainage in the region, given that the vegetation cover, particularly forest, is quite dense and it is difficult to visualize the drainage, even on Google Images. Survey of India toposheets – on the scale of 1: 50000 - for the region, provided by RMDD, were used to digitize drainage in order to understand drainage patterns and relate it, if possible to other aspects such as slope and the underlying geology. The drainage in Tendong Hill region is part of the two major river basins of Sikkim. The drainage map (Figure 3) clearly shows that despite the slopes, the only drainage that shows a sub-dentritic pattern is in the southwest (green polygon). All the other drainage is dominated by parallel to sub-parallel drainage patterns, except in the western part where some of the drainage shows a trellis pattern (red polygon). The drainage types in the area are indicative of the following factors:

Drainage type	**Tendong Hills region – as indicated on map**	**Indicative geo-morphological features**
Dendritic	Green polygon – in the southwest portion of Tendong Hills	Drainage pattern is represented by a large number of branching streams that do not necessarily follow any set pattern. Such drainage is representative of impermeable surfaces, often crystalline rocks; the impermeable nature of rocks is also reflected in steep slopes along which such 'branching' of streams is apparent.
Trellis	Red polygon – one major watershed in the western part of Tendong Hills	Tributaries are aligned perpendicular to the main stream. Such drainage is usually developed in sedimentary rocks that are dipping and fractured.
Parallel	Most other drainage is of this type in Tendong Hills region	Tributaries are parallel to each other and often to their main streams, indicating flow along linear (often water bearing features) such as faults and fractures.

Tendong Hills drain into the Teesta through four major watersheds, all flowing along the eastern and northeastern portions of the Hills. Another four major watersheds, along with at least 4 smaller ones drain the western portions of the hills into Rangit river. Incidentally, the major villages that were first identified as part of the larger set for VWSPs, are situated close to the divide between watersheds draining into Teesta and Rangit. This could be one of the reasons that these villages face an acute water scarcity during certain periods. However, this is a question that needs further exploration as we move forward into adding another layer to contours and drainage – the layer of information on the geology, which determines the nature and extent of aquifers and the amounts of groundwater that an aquifer discharges to springs located in its groundwater discharge zones.

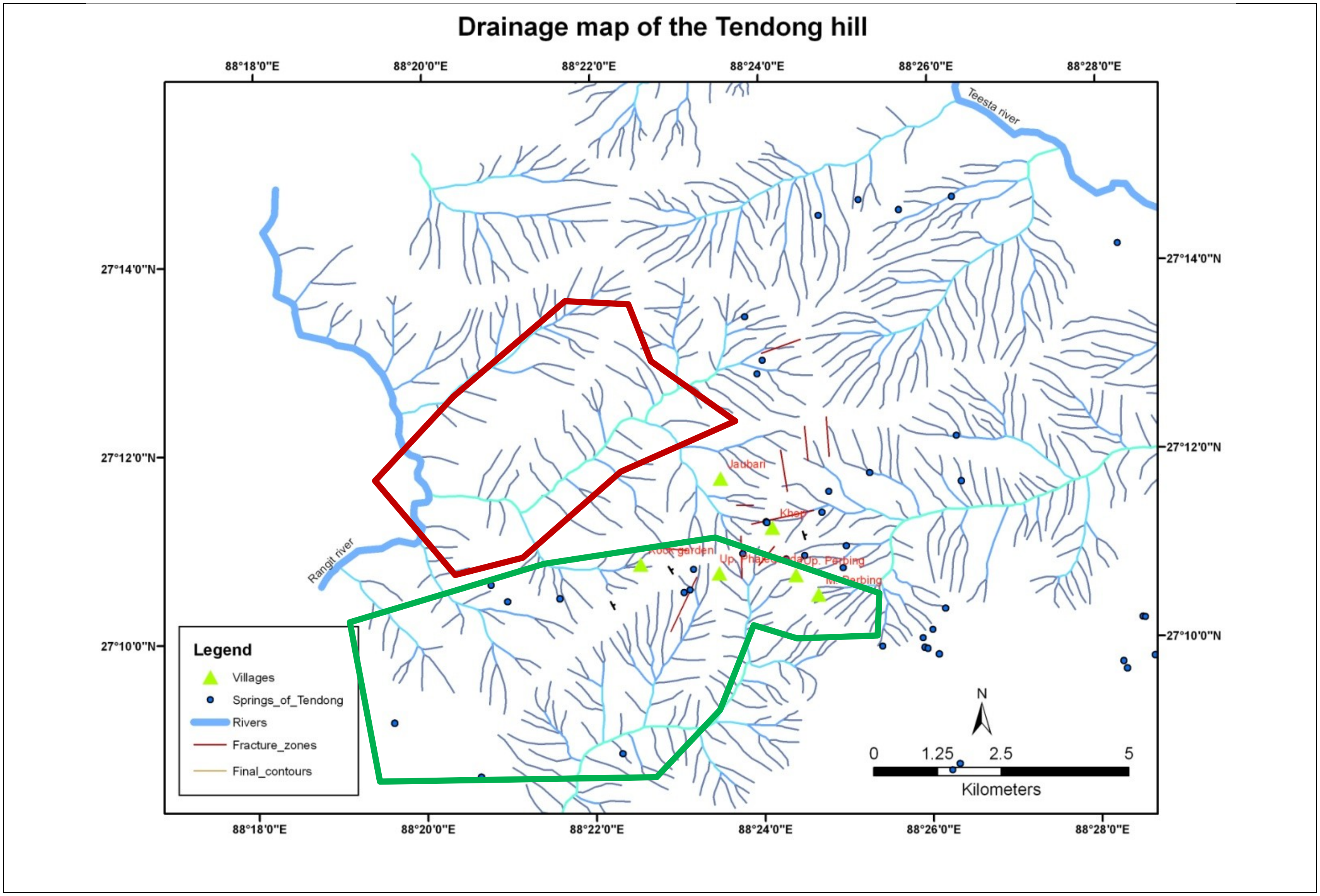


Figure 3: Tendong Hills – detailed drainage map with a few villages and springs

Understanding groundwater – *hydrogeology of Tendong Hill Region*

Extensive hydrogeological mapping was carried out in the Tendong area with an aim of developing a regional implementation plan for the area was first conducted. This was, in fact, the first part of the exercise that ACWADAM carried out. Critical factors such as geology, location of springs, structure of rocks and fractures were considered for demarcation of recharge areas for the implementation plan. Geology was thought to be particularly important because available geological maps indicate a large part of this region to be under *unclassified rocks* (map made available by RMDD labeled after CISMHE). However, other literature indicates rocks belonging to the Daling Group (phyllites, quartzites and slates) and Gondwana Group (shales and sandstones along with coal-bearing horizons and a few quartzites) to be dominating in the regions around Tendong Hills.

The geological study by ACWADAM indicated that the lithological setting of Tendong hill is largely constituted of three different suites of rocks (Figure 4). The lowermost in the sequence is a shale-sandstone sequence of rocks, exposed from the base of the Tendong Hill to an approximate elevation of 1700 m on the southern flank. Some parts of the shales are coal-bearing, clearly indicating that these rocks belong to the Gondwana Group. This sequence of rocks is comparatively softer than those found further upslope or even those at the top of the hill. These rocks are also quite weathered as compared to the sequence of rocks further upslope. At elevations higher than 1700 m, the sequence changes to alternate layers of quartzite and phyllites. Phyllite layers are thicker than the quartzite layers and show some degree of folding. Quartzites dominate this sequence with rise in elevation and are more fractured than weathered. Local exposures of gneisses are observed on top of the hill at an elevation of around 2500m, where a small plateau represents the top portions of the hill.

The shale-sandstone sequence and the phyllite-quartzite rocks, both dip towards northeast by an amount 30-40 degrees. This implies that the western and south western slopes from the *escarpment* slopes of Tendong Hill, while the northeastern and eastern slopes form the *dip* slopes. All the three rock suites are traversed by regional fracture zones, with two fracture trends being persistently observed across the hill. One of the fracture trends is NNE-SSW and the other is ENE-WSW, with a majority of fractures in both trends being vertical to sub-vertical. Much of the major drainage – the second and third order streams of the larger watersheds mentioned earlier – is closely aligned closely to these two fracture trends.

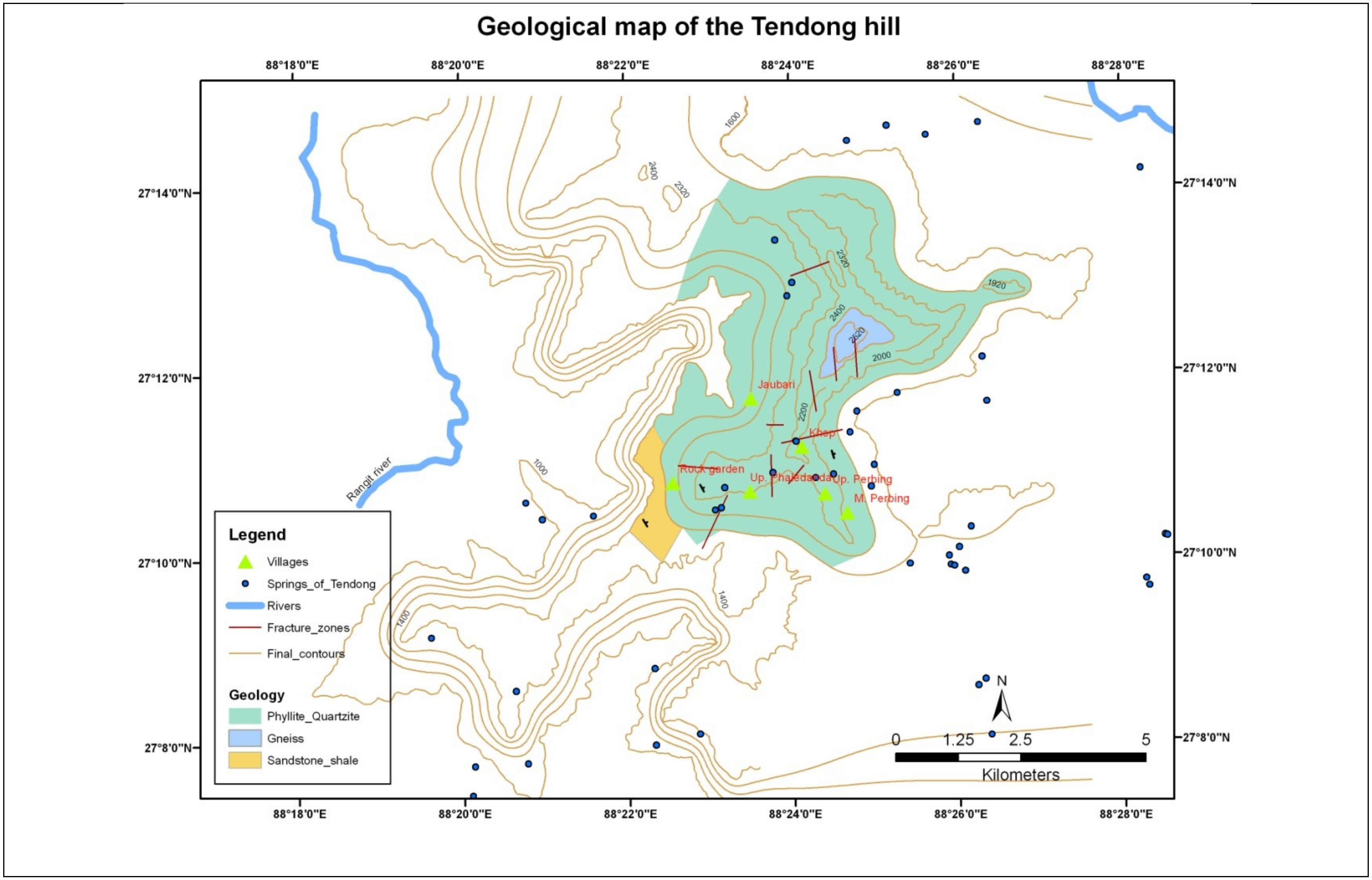


Figure 4: Tendong Hills – geology of core region where villages are located

The genesis of most of the springs emerging in the Tendong hills is related to these two fracture trends, although the storage of groundwater discharged to these springs is either on account of the porosity attributed to the aquifer by the weathering and fracturing of the sandstone-shale and the phyllite-quartzite sequence. Most springs are controlled by fractures in these two suites of rocks, with weathering of shales and phyllites accounting for groundwater storages close to the southwestern or western slopes, i.e. the dip slopes. Although a few depression springs are observed as a result of local isolated unconsolidated deposits – mostly gravity-moved debris – most of the other springs are largely controlled by the two sets of fracture systems that traverse the Tendong Hill Region.

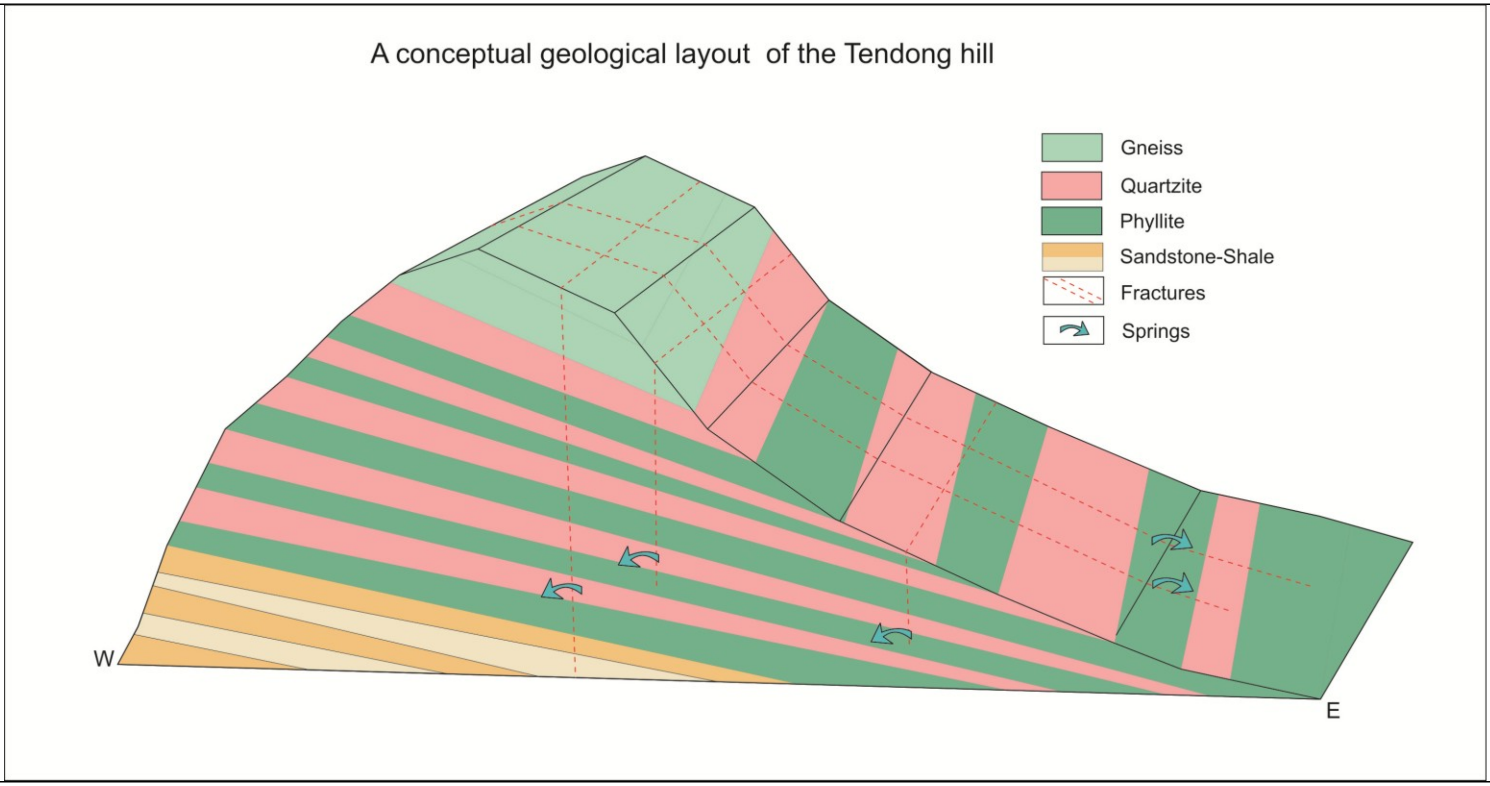


Figure 5: Conceptual geological layout of Tendong Hills – also indicating the discharge locations for the major spring systems in the region

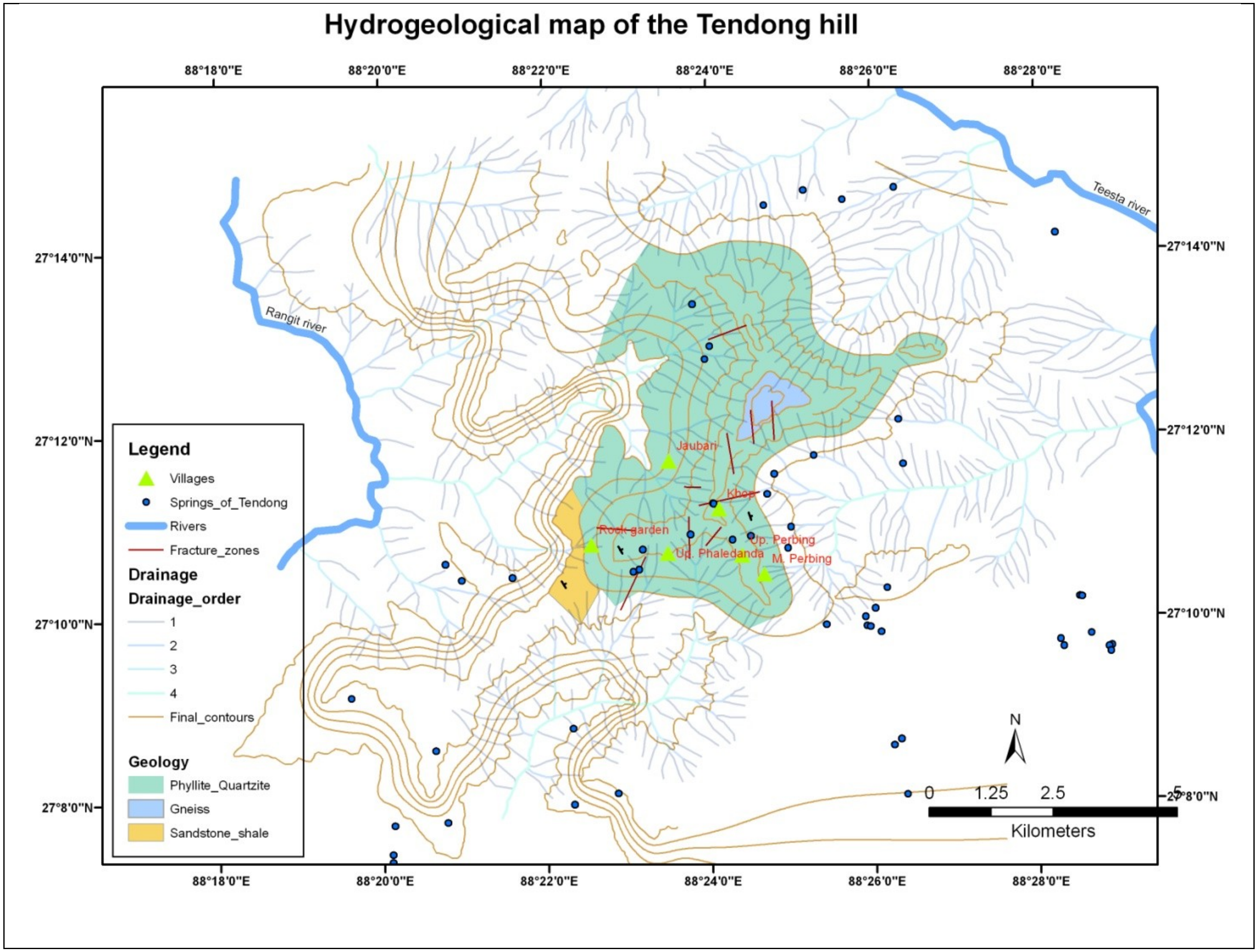


Figure 6: Tendong Hills – Hydrogeology – ***geology, contours, drainage, springs and villages***

A regional implementation plan for the Tendong Hills

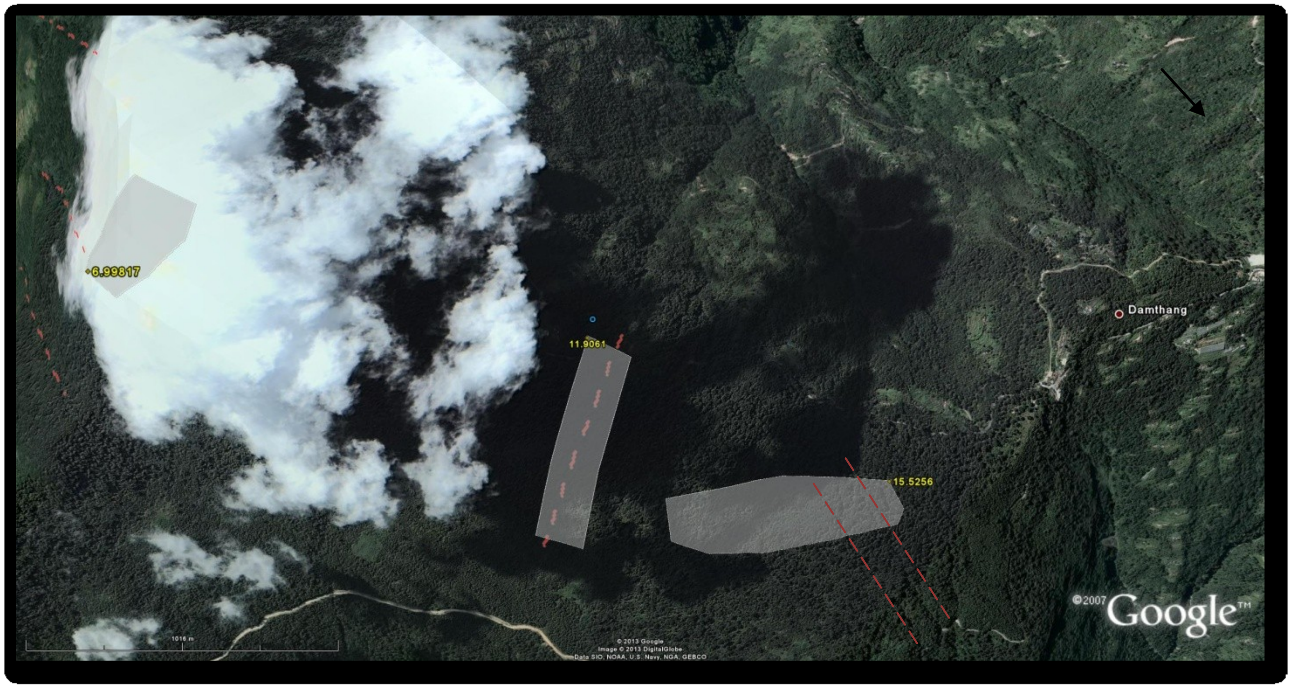
Rural Management and Development Department (RMDD) requested hydrogeological inputs for preparing a regional springshed implementation plan for the Tendong Hills, which was based largely on field visit carried out in Jan'13. This visit was expected to pave the way for taking the water security pilot for the Tendong Hill area further and form a platform for a more focused field visit to the selected project village and focused capacity building in conjunction with the localized field visit. This input was also based on certain hydrogeological information analysed through the mapping and GIS layers generated – as described in the foregoing sections.

Clearly, the approach emerging from the hydrogeological study of Tendong Hill region is related to the following key aspects:

1. The escarpment slopes of Tendong Hill – western and southwestern slopes of the hill – form the major recharge zones for springs on the dip slopes towards the northeast and east.
2. The two major fracture zones also contribute to recharge depending upon their relationship with the dipping strata.
3. The discharge points – springs – are either aligned at along the major fractures if they are not on the main dip slope or they emerge at the fractured contacts of phyllites and quartzites on the dip slope.
4. Most of the springs in the immediate vicinity of the Tendong Hill are restricted to the phyllitic-quartzitic sections of the local geology.
5. Most of these springs are a mix of contact and fracture types, although fracture springs dominate.
6. Given this situation, the regional implementation of recharge through MGNREGS is likely to have an overall significant impact on the discharge of many springs in this region.

Based on the structure (dips) of rocks, their weathering and fracturing patterns and the regional trends of the two major fracture zones, the recharge areas for the spring systems have been identified. The recharge areas fall in three parts of the Tendong hill, one in the north and the others towards southwest and south. They are depicted in the sections below, with overlays on Google Images.

<u>Catchment area 1 – for Damthang, Temi and Tarku villages</u>

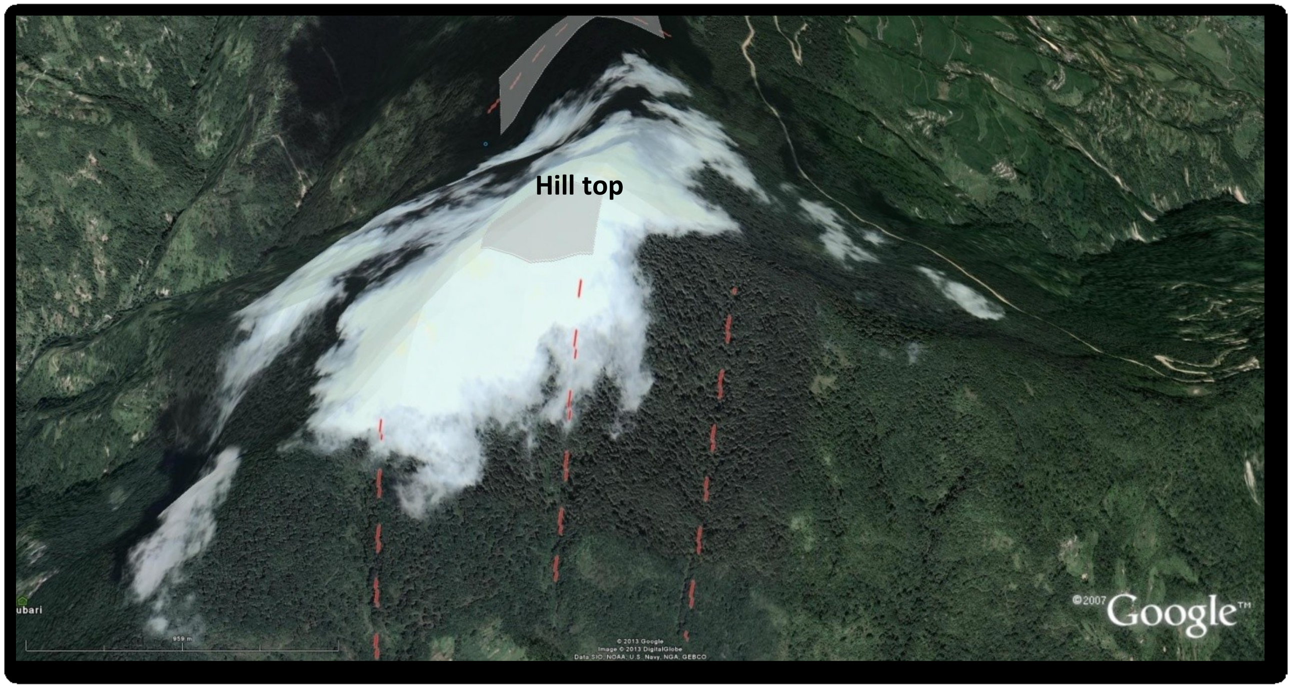


Recharge areas towards the north of the Tendong hill

Springs emerging in the areas of Damthang, Temi and Tarku villages have their recharge areas to the north (as marked in the map above). The total area for recharge is about 27.42 hectares. A part of the recharge area is along the ENE-WSW trending fracture while the one northernmost is on the escarpment slope as the rocks dip north east.

Thick forest is observed on the dip slopes of Temi region in the northeastern part of the Tendong hill. This zone should act as the area for protection where any deforestation activities should be banned. In the recent developments it has been observed that a four lane wide tar road is being constructed under some tourism activity which has resulted in clearing off a lot of forest ground.

Catchment area 2 – Plateau of Tendong Hilltop



The top of the Tendong hill is a relatively small and flat area. A *Gompa* at the very top has a simple rainwater harvesting system which fills up a small tank nearby. During the rains, the overflow from this tank could be used to carry out point recharge by constructing small but fairly deep recharge pits. The area on top, for recharge is about 7 hectares, a considerable area given that the slopes here have a relatively gentler gradient as compared to other parts of the hill.

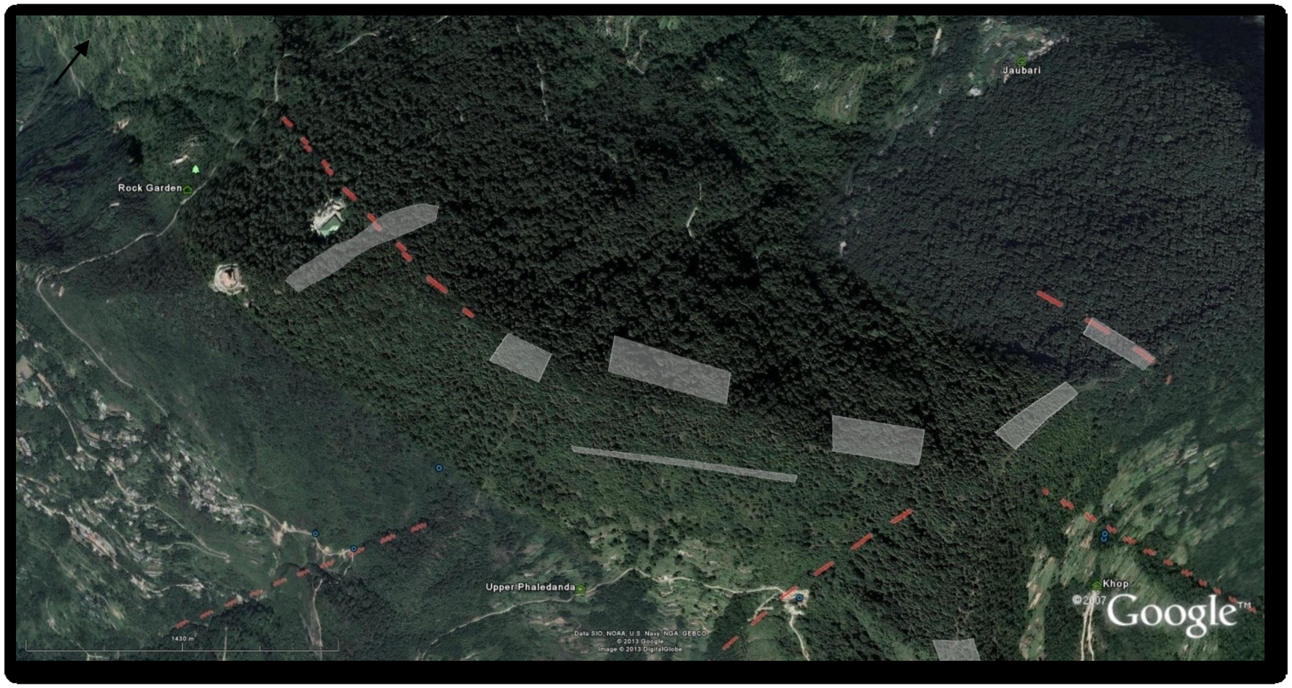
The top of the Tendog hill, a relatively flat area hosts a few gompas. Point recharge through roof top rainwater harvesting should be carried out around this area, where the rooftop rainwater harvesting can be connected to recharge pits at various location on the plateau.

Catchment area 3 – Khop and Parbing villages

The NW-SE trending ridge towards the south of the Tendong hill is a critical recharge area for springs emerging towards Parbing and Khop villages. The ridge has a flat top and is dominantly made-up of phyllites dipping northeast. The recharge areas fall on the escarpment side of the ridge i.e. towards the southwest. The phyllites on top are quite intensely weathered, forming thick clay zones at some places. Such areas should be avoided as they act as impermeable zones restricting water to percolate downwards. The total area for recharge is about 4-5 hectares.

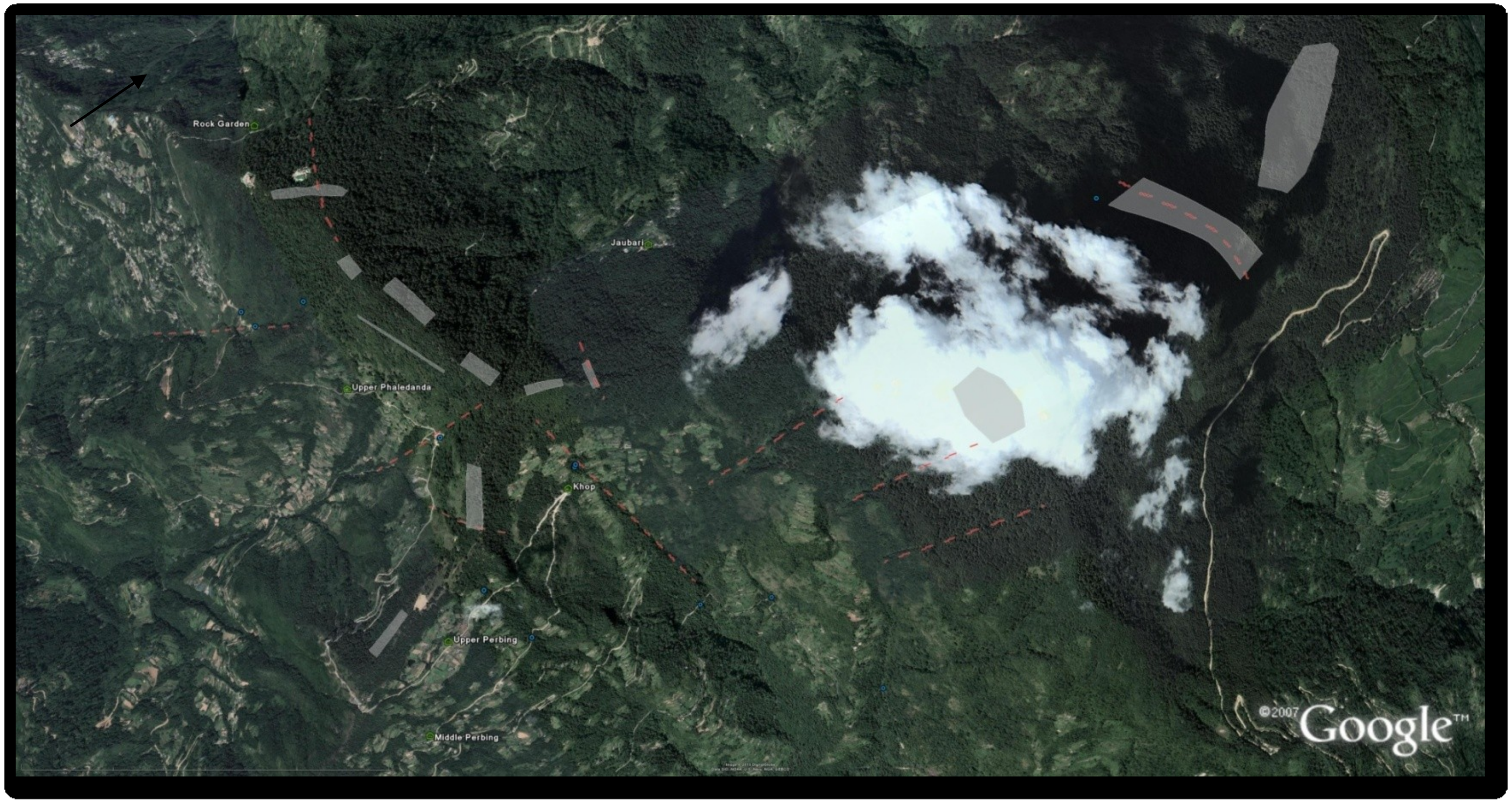
Clay layer observed in the area close to the football ground west of Parbing

Catchment area 4 – Phalidanda village



The NE-SW trending ridge towards the south of the Tendong hill hosts a critical recharge area for springs emerging towards Phalidanda village. Treatment measures are to be carried out on the escarpment as well as the dip slope as depicted in the google image above. The spring systems around this village are local and are a combination of fracture and depression type. The total area for recharge accounts to be around 9-10 hectares.

Areas suitable for treatment just NE of Samdruptse; the break in slope leading to a relatively flatter area is suitable for recharge to springs in Phalidanda village area.



A regional implementation plan for the Tendong hills. The total catchment area for the regional implementation plan accounts to be around 50 hectares.

(Springs as blue dots, Fractures as red dashed lines, Recharge areas as grey polygons and villages in green symbols)

Village Water Security Plan (VWSP)

Tendong Hill is an area where isolated approaches involving 'a single village, its small hydrological catchment and treatment measures such as the ones undertaken in watersheds' will turn out to be quite restrictive. This was one of the reasons why ACWADAM approached the regional plan as a pre-condition to going into the specifics of village-wise water security planning. The regional plan, based on detailed understanding of slopes, drainage and geology, evolved also through two field mapping visits where field-workers from the villages and from the forest department indicated certain key aspects of the regional setting of Tendong Hills. Moreover, ACWADAM's field mapping is always participatory in nature and certain elements of hydrogeological fieldwork were explained to accompanying member of the community and local staff. These elements including identification of local hydrogeological features, rock types and rock structure, certain measurements, including spring discharge, in-situ springwater quality monitoring etc.

Developing an effective VWSP entails a set of protocols for ensuring safe, sustainable and equitable distribution of drinking water to the village. During the field visits for developing a regional catchment treatment plan, a few of the villages and springs were surveyed surrounding the Tendong hill. Secondary data related to a few of these villages which SIRD had gathered earlier was used to select the village(s) towards developing a VWSP.

A snapshot of the secondary data available for villages around the Tendong:

Village	GPU	Wards (if any)	Popn.	Occupation	Water users (HHs, schools, gompa, temples)	Water sources (springs, streams etc)	Source details (gathered through interaction with community)	Overall water distribution in the village (public standposts/ private taps etc)	Overall water use (Drinking, agriculture domestic use)	Water related problems if any (Quantity-quality)
Phalidanda			788	Farmers - 95%, Govt. servant -5%		Springs & Streams	Talkharka, Sallapani, ChangrAKhola, Rang-rang khola, Gurungkhola, SingrangkholaKuwapaniSLong khola, SadukholaManpurkhola, Dharakhola	School-1nos, Gumpa- 1nos, ICDS- 2nos, Model Floriculture Centre- 1nos	Drinking, agriculture & domestic purpose	Quantity- scarcity Dec- April
Khainigaon			257	Farmers	51HH	Streams	Shim Gairi source, Bhalukhop source	Households, Schools &Gumpa	Drinking, agriculture & domestic purpose	Quantity- scarcity Dec- April
Jaubari			378	Farmers	75HH	Springs and streams	Pool khola A&B, Gobre source, Peepli source, Ambake source, Dare source, Labdange source	School, Tribal house, Tourism hall, church, Gomps, -1	Drinking, agriculture & domestic purpose	scarcity during winter season
Damthang			320	Farmers	67	Springs & Streams	Dhara Source, Gaddikhola source, 10mile source, Limboo source	Public :2 nos, Private: 67 nos	Drinking, agriculture & domestic purpose	Quantity- scarcity

Simkharka	Simkharka under Ben-Namphrick GPU	Diu-Simkharka	350	Predominantly vegetable and Flower grower Farmers	60 Households, 1 school, 1 gompa	Ringpi/RingkhimKhola, Changeykhola, Kopcheykholcha, lower Diu source etc.	The sources are perennial, though the discharge of the water is significantly low in dry season, yet it is sufficient to quench the thirst of the village. Ringpi/Ringkhimkhola is a significantly a big stream which caters the need of almost 500 more households of Temi Bazaar.	Almost cent percent	Morethan 80% for drinking and domestic purposes	No significant problem has been recorded so far.
Temi	Temi	6 wards	3337	Tea Plantation works, floriculture, cardamom, Vegetable cultivation	702 Households, 7 schools, 2 temple,	Devithaney, ChaiteyDhara, Dewalpani, AsineKhola	The sources are perennial, the discharge of the water is significantly low in dry season, and is insufficient to quench the thirst of the village. However, a large pipeline is Ringpi/Ringkhimkhola is a significantly a big stream which caters the need of almost 500 more households of Temi Bazaar.	More than 90 percent	More than 90% is for drinking and domestic use, insignificant amount is used for irrigation purposes.	Not sufficient for irrigation and even drinking purposes during dry season
Tarku	Tarku	6 wards	2600	Agriculture and Horticulture, Livestock	520 households, 9 schools, 3 temples	Jamireydhara, Tewaridhara, Takmarey, Chanautey, Jukeydhara	The sources are perennial and are almost sufficient to quench the thirst of the villagers. During rainy season, it supports irrigation to undertake paddy cultivation, however, it is not sufficient to irrigate fields in winter.	80%	More than 80% is used for drinking and domestic purposes	Quantity is significantly low in dry winter season for irrigation.

Raigaon	Raigaon under Namphing GPU	Pabong ward	50 (village), 539 (Ward)	Cardamom and agriculture	10 household in the village and 170 in the ward including a School	Pabongkhola in the village and Devithan I&II, Tsheringkhola, Rinki source in the other part of the panchayat ward	Pabongkhola is comparatively a significant stream with good discharge and is perennial. Originates in higher altitude and is tapped for distribution in various villages under Namphing and BermiokTokal GPU.	Almost 70%, there are several small springs and ponds which are being tapped by the villagers.	Equal proportion for each activity	No significant problem.
Rambeing-Nizrameing GPU	Dong		160 (Household-40)	90% Farmers (10% Business, Priest, Govt. Services)	Households-40, Schools-1, Temples-1, ICDS-2	)Dong: Siring khola, Bherikhola, Jharringaray Khola		Public standpost as well as private taps	Drinking, Agriculture, Domestic use	Quantity – Drying up, decreasing water discharge every year, Quality – Yet not tested, but bacteriological contamination
Parbing and khop	Perbing		670	90% Farmers (10% Business, Priest, Govt. Services)	Households-239, Schools-4, Gompa-2, Temples-1, ICDS-3	Khop – AkhlayKhola, Dong, PaaKhola, Bethgharidhara, b) Perbing – Virkhuneykhola,Kheraulay, SimanaKhola, Dhong, Devithan,Indradhara, Beganbarikhola		Public standpost as well as private taps	Drinking, Agriculture, Domestic use	Quantity – Drying up, decreasing water discharge every year, Quality – Yet not tested, but bacteriological contamination

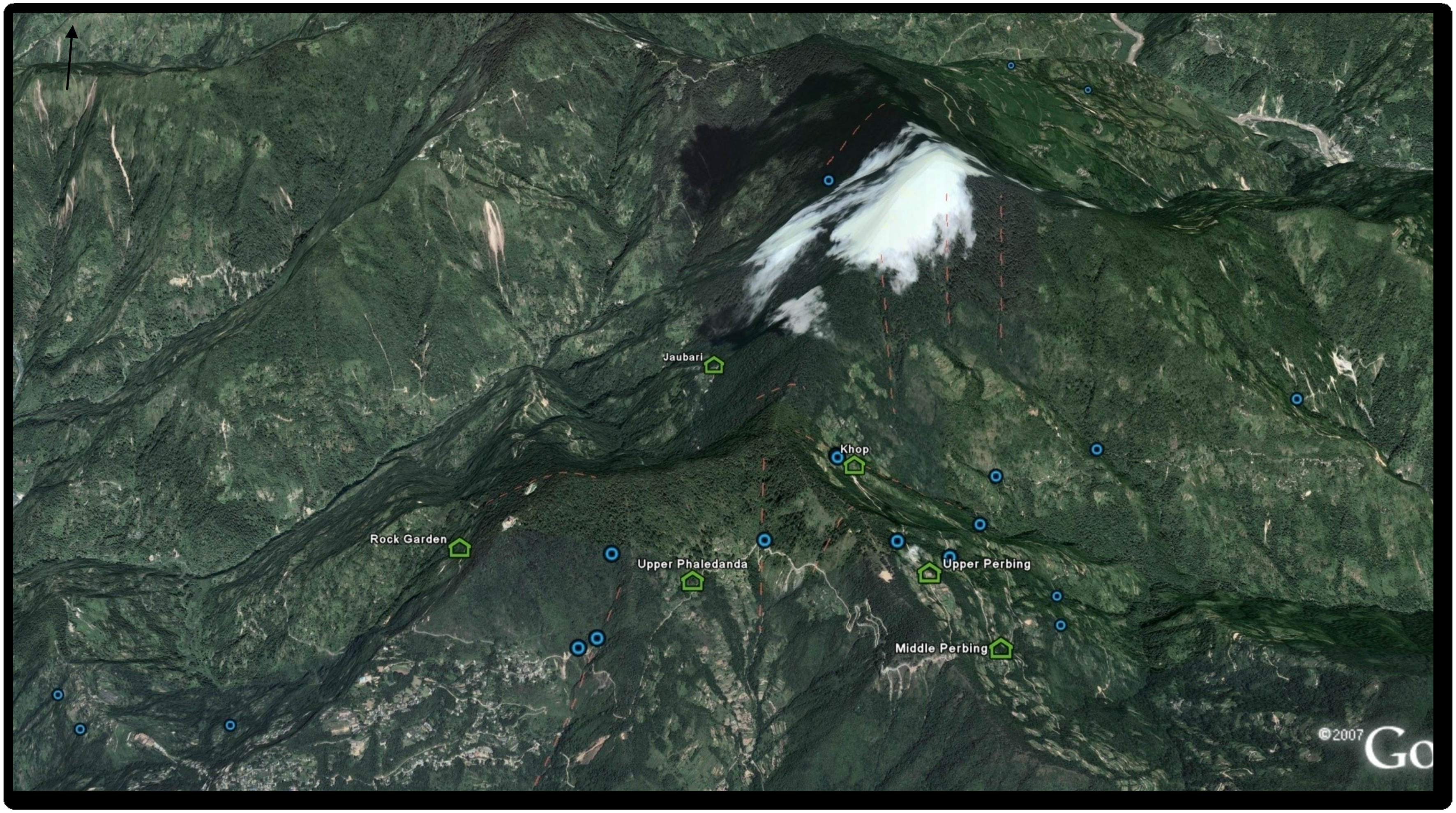
The eastern/northeastern flank of the Tendong hills is water rich as compared to the southern and western flank, not surprising given that the dip of rocks is towards the northeast and the aquifers discharge a major part of their groundwater storages as discharges to springs on the northern and eastern slopes. Being dip slopes, these slopes are also gentler than the south and west facing slopes. Southern and western slopes, therefore are drier. Drying up of springs leading to water scarcity from December to April in villages towards south has been commonly interpreted from the secondary data as well as observed in the field, bearing testimony to this observation. Village Phalidanda and/or Parbing have been selected towards developing VWSP, given that they are located on the drier portions of the Tendong Hill and are challenging, both sociologically and hydrogeologically. Although the regional plan for larger scale recharge – implemented by RMDD through MGNREGS type interventions – is likely to play some role in improving water security in these villages, a more focused effort is necessary, the plan for which is proposed as an annexure to this report.

TENDONG HILLS -Background information on discharge of 15 springs - prior to MGNREGS works - collected during the participatory field visits in Tendong Hill Region - November 2012 and February 2013 (ACWADAM)

Spring	Discharge in litres per minute	Latitude	Longitude	Date
T14	5	27°10'30.69"N	88°23'3.71"E	11-02-2012
T15	High discharge spring	27°10'32.24"N	88°23'7.96"E	11-02-2012
T16 Kuapani	5	27°10'54.83"N	88°23'45.69"E	11-02-2012
T19	Tapped	27°10'22.09"N	88°22'9.76"E	11-02-2012
T24	Tapped	27°10'29.80"N	88°24'11.73"E	11-02-2012
T25 Ferking	15	27°10'51.22"N	88°24'16.68"E	11-02-2012
T26 Khopi dhara	Tapped	27°11'15.10"N	88°24'2.62"E	11-02-2012
T27 Parbing dhara	20	27°10'53.36"N	88°24'29.86"E	11-02-2012
T29	High discharge spring	27°11'20.68"N	88°24'42.22"E	11-02-2012
T30	High discharge spring	27°11'34.00"N	88°24'47.37"E	11-02-2012
T32	High discharge spring	27°12'08.79"N	88°26'18.68"E	11-02-2012
Pl 15	Tapped	27°12'57.89"N	88°24'1.00"E	11-02-2012
Khop Dhara	0.75	27°11'14.94"N	88°24'2.76"E	14/2/2012
Aakhaley Dhara	2.2	27°11'40.20"N	88°24'17.16"E	14/2/2012
Khani Khola	>200	27°10'59.28"N	88°24'59.46"E	14/2/2012
Kailabajey Dhara	7	27°10'45.30"N	88°24'57.12"E	14/2/2012

High discharge spring = more than 50 lpm

Tapped = tapped for water supply and therefore not possible to measure in-situ discharge



A google earth view of the villages and springs surrounding the Tendong hill

ANNEXURE TO REPORT: SUMMARY OF ACTION, STATUS AND TIME-FRAME, BASED ON SUGGESTIONS BY DR. INDRANI PHUKAN, GIZ, FOR THE PERIOD JUNE TO SEPTEMBER 2013

1. ACWADAM's specific inputs for VWSPs

Points of action	Status	Time frame
Methodology and plan of action	Some steps already completed – regional maps with crucial (hydrogeology) GIS layers ready; finer scale mapping and details of way forward submitted as a separate document along with this summary	• Plan for implementing VWSPs, including fieldwork will be submitted by 30th September 2013 • Discussions with community with the help of RMDD and GIZ will follow, for which ACWADAM will facilitate – September to December 2013
Development of VWSPs through a participatory approach	VWSP villages selected in consultation with RMDD and on the basis of degree of water scarcity; a couple of field visits and interaction at different levels will be required to finalise VWSPs for the two villages	• As mentioned above, plan for implementation can be ready by 30th September on the back of at least one field visit to the villages by a joint team of ACWADAM (Dr. Himanshu Kulkarni, Mr. Amit Upmanyu and Mr. Kaustubh Mahamuni) + RMDD (Mr. Nima Tashi Bhutia) and GIZ (Mr. Ghaneshyam Kharel) + others as may be deemed appropriate • The actual roll-out of the plan will be undertaken by RMDD (Mr. Nima Tashi Bhutia) in close consultation with GIZ (Mr. Ghaneshyam Kharel) and other experts; ACWADAM could facilitate in whatever form required, possibly through one visit where a workshop can be conducted between September and December 2013
Technical inputs by ACWADAM	1. Regional mapping is already in place in addition to the identification of zones of regional recharge 2. Finer-scale mapping to be conducted with specific knowledge and technical inputs on the augmentation of recharge and protection measures 3. Final report will be undertaken in close co-ordination with RMDD	• Final technical report by September 2013 for the two villages in order to develop VWSPs – the report will lay emphasis on *water source protection, climate proofing of water resource management and protocols on water and hygiene* • Part of the inputs, including some work on the ground may spill-over post September 2013

2. Submissions by ACWADAM – for capacity building

Points of action	Status	Time frame
Capacity development plan	1. Five people deputed by RMDD/GIZ have attended ACWADAM's basic training on groundwater management; Capacities specific to monitoring have been imparted to some of the field staff during ACWADAM's two visits to the field. 2. A structured capacity building module (submitted separately with this summary) is being provided with the intention of running this module with appropriate staff involved in this VWSP as well as potential staff from RM&DD and SIRD who can outscale this model in respective locations	• One capacity building module of 4-5 days will be conducted after consultation with RMDD, SIRD and GIZ in July/August as felt appropriate, possibly in conjunction with or separate from the field visit for finer scale mapping • One shorter training-cum-workshop between September and December 2013 to decide on the process for larger outscaling and longer-term efforts, again to be decided as appropriate in close co-ordination with RMDD and GIZ
Training modules	1. One capacity building module to be run before September 2013, the venue for which will be decided by RMDD & GIZ – *module time table provided here* as separate document; Presentations for each lecture and practical will also be provided to the participants after the training; soft-copy of training material will be provided, including all the presentation and tool-kit for practical sessions (hard copies, if felt necessary, will need to be printed at extra costs since these are not budgeted under ACWADAM's current ToR 2. Training-cum-workshop, possibly in Gangtok after the preparation of VWSPs with regard to the scaling out strategy	• August/September, at a mutually convenient date to be decided in close co-ordination with RMDD & GIZ • Between October and December, to be decided in agreement between ACWADAM, RMDD and GIZ

3. RMDD and GIZ as core team to be supported by ACWADAM – Co-ordination and communication

Points of action	Status	Logistics and communication
Co-ordination and communication	RMDD and GIZ will form the core team and derive inputs water source protection and recharge, climate proofing and water – hygiene; ACWADAM will help in the implementation work but will not undertake any implementation of the actual physical work in this regard	Dr. Himanshu Kulkarni will co-ordinate from ACWADAM's side with a direct line of communication with GIZ – Dr. Phukan (cc to Helga Fink), who will then facilitate further lines of communication with the field staff and with RMDD/GIZ-Sikkim

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