January 2016

HYDROGEOLOGICAL SURVEY OF CATCHMENTS IN CONOOR BASIN

- GUERENCY CATCHMENT
- GYMKHANA CATCHMENT
- AMBIKAPURAM VALLEY

ADVANCED CENTER FOR WATE R RESOURCES DEVELOPMENT AND MANANGEMENT (ACWADAM)

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Contents

Table of Contents

List of figures

Introduction

This report[1] is a step towards aquifer management in Nilgiris. Nilgiris has a unique hydrogeology of its own. Guerency catchment, Gymkhana catchment and Ambikapuram valley were studied from Hydrogeological point of view. Field visits to these catchment areas helped in understanding the aquifer systems in study area. Springs and other water sources were studied along with geology of the area.

Objectives of the study undertaken in above mentioned areas are

- Understand hydrogeology of the area
- Identify aquifers in the study area, and do hydrogeological mapping
- Understand relationship between aquifers, springs and other water sources in the region
- Identify recharge areas for springs and related aquifers
- Preparing guidelines and recommendations for developing a 'Groundwater Management Plan'

Groundwater has been the backbone of Nilgiri's domestic water supply since ancient times. Earlier the people were dependent on spring water for their daily necessities. Introduction of dugwells and borewells have increased the extraction of groundwater, but endangered the spring system too.This may not be the case throughout the Nilgiris, but undertaken study along with monitoring data will help unfold the exact relation between 'extraction through wells' and 'springs'. Relationship between water sources and aquifers is explained in the report. Recharge areas and areas to be protected (from hydrogeological point of view) are identified in the study area.

[1] The work has been carried out with financial support from Keystone Foundation, under a project of the Critical Ecosystem Partnership Fund (CEPF).

Geology of Guerency Catchment

The single type of rock is found in the catchment i.e. Garnet bearing Carnockite/Quartzite. Structurally rock varies from north to south. At some places foliations and trend of the rock is clearly seen i.e. approximately along E-W, while at some places granulose textured and massive outcrops are seen. Fractures and joints mostly occur in the areas where foliations are clearly seen in the rock. Also ESE-WNW trending fracture zones are seen at few places in the catchment.

Black and red coloured clayey soil is found in the catchment. Soil layer is around 10-15 cms in thickness. This soil layer is found above sediments which are of thickness 0.5-1 meter. The thickness of soil and sedimentary layer varies from place to place. The sedimentary layer lies above a layer of highly weathered in-situ material called 'saprolite'. Thickness of this layer is yet to be determined, but the thickness varies greatly from place to place based on structural geology of the rock. The fractures and joints helps the weathering process in the rocks.

Two sets of fractures are observed in the catchment, one set trending ESE-WNW and other set trending N-S. Fracture zones followed the trend of 1st set of fractures (ENE-WSW/ESE-WNW). The 2nd set of fractures were mostly seen near the valleys. Most of the fractures were vertical, but the fractures and joints in fracture zones were seen dipping towards north.

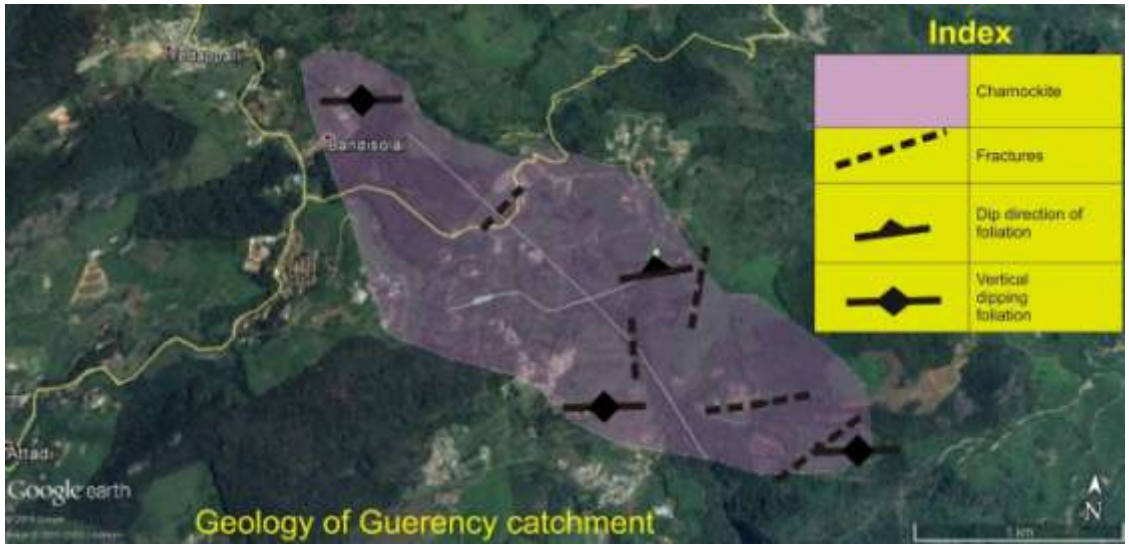

Figure 1-Geology of Guerency catchment

Geology of Gymkhana catchment

Garnet bearing Charnockite/quartzite are found in the Gymkhana catchment too (Fig.2). The foliation plains have similar trend as Guerency catchment i.e. east-west (approximately). A small secondary mafic intrusion was seen at an outcrop near Providence College for women. The trend of the intrusion was NE-SW. One set of fractures seem to have same trend as the intrusive body and other set of fracture has trend NW-SE. This structural geology changes as we go towards the western catchment. Near the western part of the catchment the rock has NNW-SSE trend and is dipping towards WSW with an amount of 70°. One more set of fractures are found here which trending north-south are and are vertically dipping.

The lithological sequence on Gymkhana catchment is similar as Guerency catchment. Along the slope of valley the thickness of the unconsolidated layer is greater than 2 meters (near the tea factory).

Figure 2- Geology of Gymkhana catchment

Geology of Ambikapuram valley

Rocks are mostly exposed near the Hubbathalai springs and as we go towards the outlet of the valley thick layer of sediments and weathered rock is observed. Whole valley has again single type of rock, which is Charnockite. North-South trending vertical fractures are seen near a quarry outside the valley. The foliation of the rock observed is same as observed in other two catchments. The thickness of sediments and weathered rock seems to be more than 9 meters (based on well depths)along the valley. The thickness of this layer gradually decreases as we go towards the hill tops. Sediments and weathered rock are mostly composed of clay.

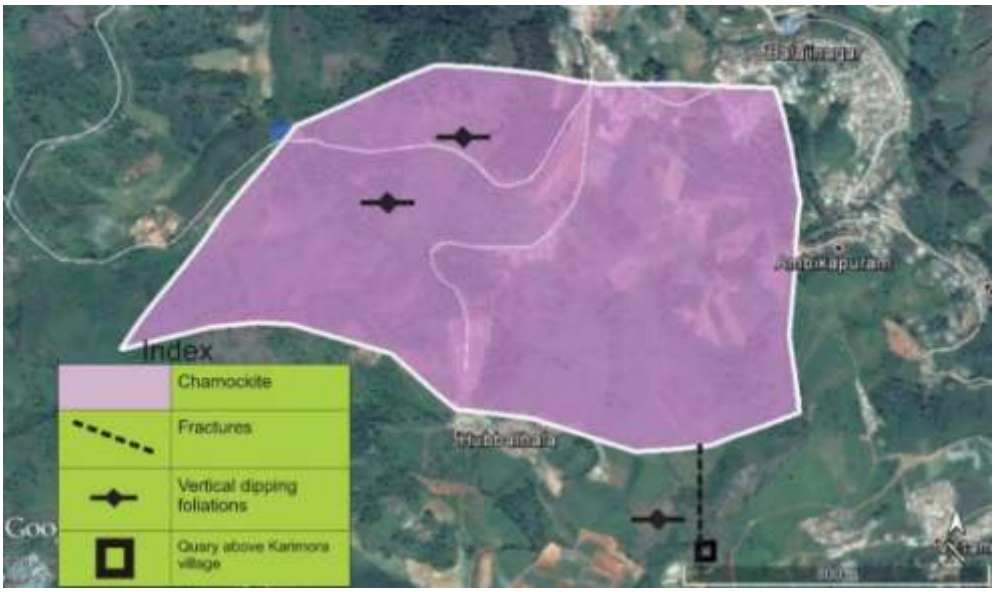

Figure 3- Geology of Ambikapuram valley

Hydrogeology of Guerency Catchment

Figure 4- Google earth image of Guerency catchment

The catchment lies to the north-east of Conoor city. It has a general slope towards south-east. Elevation and slope plays an important role in defining the aquifers of this catchment. Soil, sediments, weathered rock form the unconfined aquifer. This unconfined aquifer is found on the slopes of the catchment. The fractures beneath the weathered materials form the semiconfined aquifer which are very less in thickness.

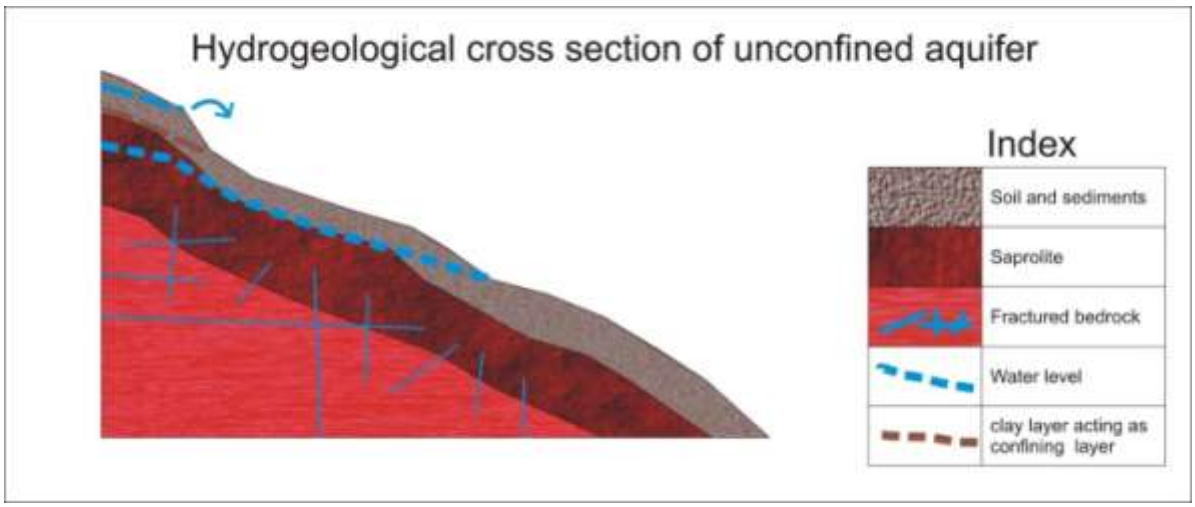

Figure 5- Hydrogeological cross section of unconfined aquifers

The unconfined aquifer in this catchment extends till the valley part, where it is deeply eroded by high velocity stream. This stream is result of high slope gradient in the catchment. Where ever the slope gradient is high, streams erode aquifer vertically near it causing seepages and springs to occur near the valley along the stream. Where the slope gradient is low, sedimentation and weathering is more. This increases the thickness of aquifer and thus the storage capacity (which is useful for wells).

The springs, seepages and wetlands (these mostly occur along the valley with gentle slope) forms the natural discharge points along the catchment. The groundwater is brought to the surface at these points and then flow as streams in form of surface water. In valleys with gentle slope and greater aquifer thickness, groundwater appears in form of wetlands and water table in wells.

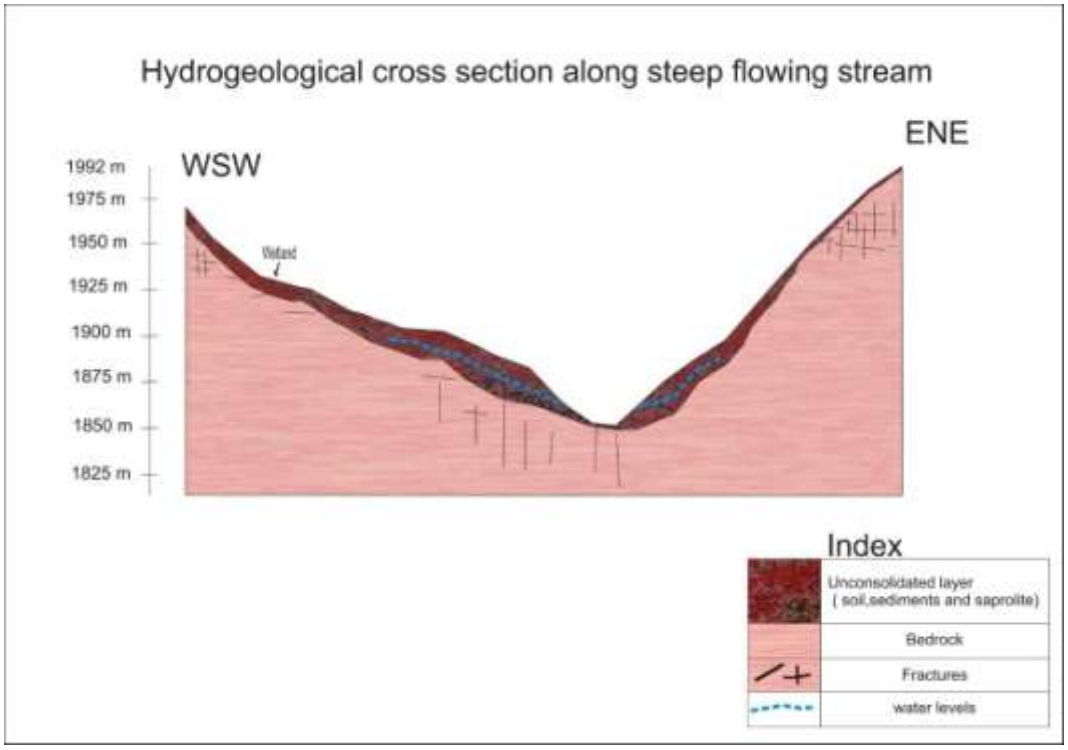

Figure 6-Cross section of Valley with high velocity streams

Nariyani spring

Figure 7- Google earth image showing location of Nariyani spring

This location is actually a cluster of 2 springs on west flank of the valley and wetland on east flank. The 2 springs are originating near a tea garden and can be classified as contact spring. The contact seems to be of hard rock below and sediments, weathered material above hard rock. Big rock exposures are seen near the spring area. Both the springs have a discharge of ¬ 90 lpm (liters per minute). The aquifer tapped by the springs in this area is the unconfined one.

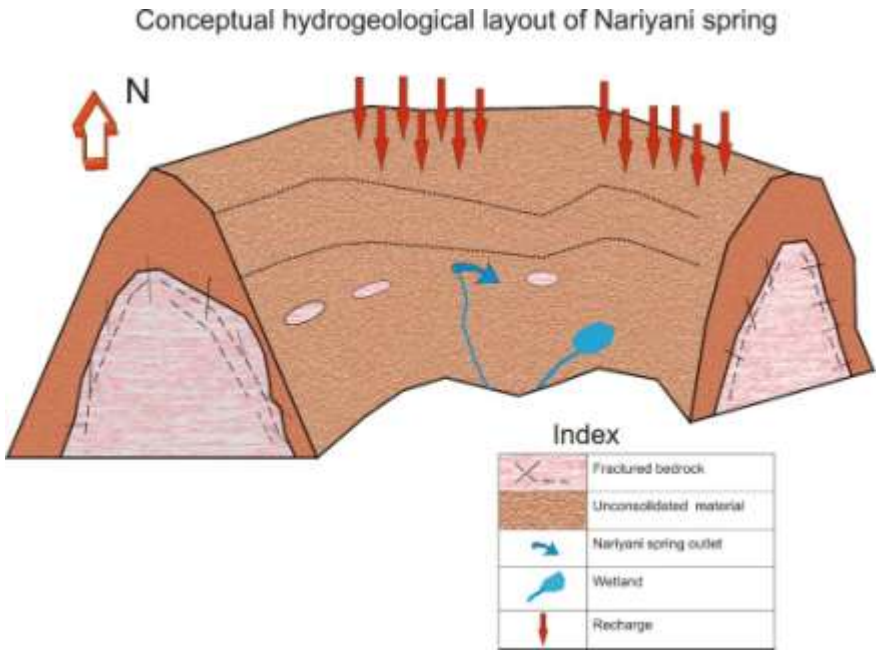

Figure 8- Conceptual hydrogeological diagram of Nariyani spring

Hydrogeology of Gymkhana catchment

The catchment lies to the west of Guerency catchment. It has a general slope towards south-east. In this catchment the unconfined aquifer is made up of soil, sediments and weathered material. The composition of aquifer systems in this catchment is quite similar to that of Guerency catchment.

The catchment is ideal example for denoting difference in behavior of unconfined aquifer in same catchment. The catchment is primarily made of 2 watersheds which are side by side. The watershed along Providence College has wider valley and gentler slope, Thus thickness of aquifer is greater along the valley.Most of the wetlands are found in this valleywhileit is the opposite in other watershed(which has a steep slope). Bharatinagar spring is found in this valley.

The streams in the catchment have water throughout the year. Most of the water coming in the streams is from springs originating upstream of the catchment. Nearly 4 main springs with high discharge provide water to the streams. The seepages along the valleys also provide water to streams.

The parts of aquifer providing the water to the springs, seepages are located in different parts but the composition of the unconfined aquifer remains the same. The behavior of aquifer changes due to the slope, elevation and sediments deposition and weathering factor.

Bhartinagar Spring

This spring is found near Wellingtontown on western flank of the catchment (Fig.9). The spring area has nearly 2 outlets from where the water comes to the surface. The area in valley above the spring is a dumping ground for local people and has thickness of weathered rock and sediments of 2-3 meters. The rocks upstream of the spring show a change is jointing pattern. The rocks in this area seem to be highly fractured. The fractures show one set of trend i.e. north- South and dips towards West. Highly weathered rock is found around the cantonment dugwell near the spring. All these observations point out that unconfined aquifer provide water to the spring, and the fractures seem to contribute water to the spring too. One outlet of the spring has a discharge of nearly 45 lpm (liters per minute).

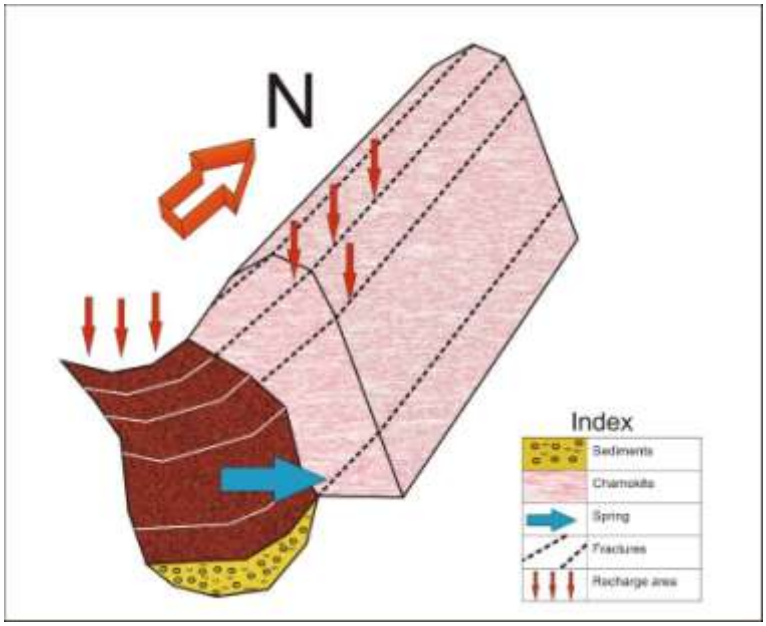

Figure 9- Conceptual hydrogeological diagram of Bharatinagar spring

Hydrogeology of Ambikapuram Valley

Ambikapiram is an east-west trending valley. Elevation in the valley ranges from 1988m-1877m. The valley has gentle slope and greater thickness of sediments and weathered material. This unconsolidated material forms the unconfined aquifer in this valley. The depths of wells indicate that, the thickness of aquifer is greater than 10 meters. Two springs (Hubbathalai springs) have been identified in the valley and these springs are the major source of water for the stream the valley. These two springs are depression type springs. These are very old springs and have a very high discharge. The rocky outcrops are hardly seen in the valley but quarry to the south of the valley has rock outcrops. The major vertical fractures are north-south trending.

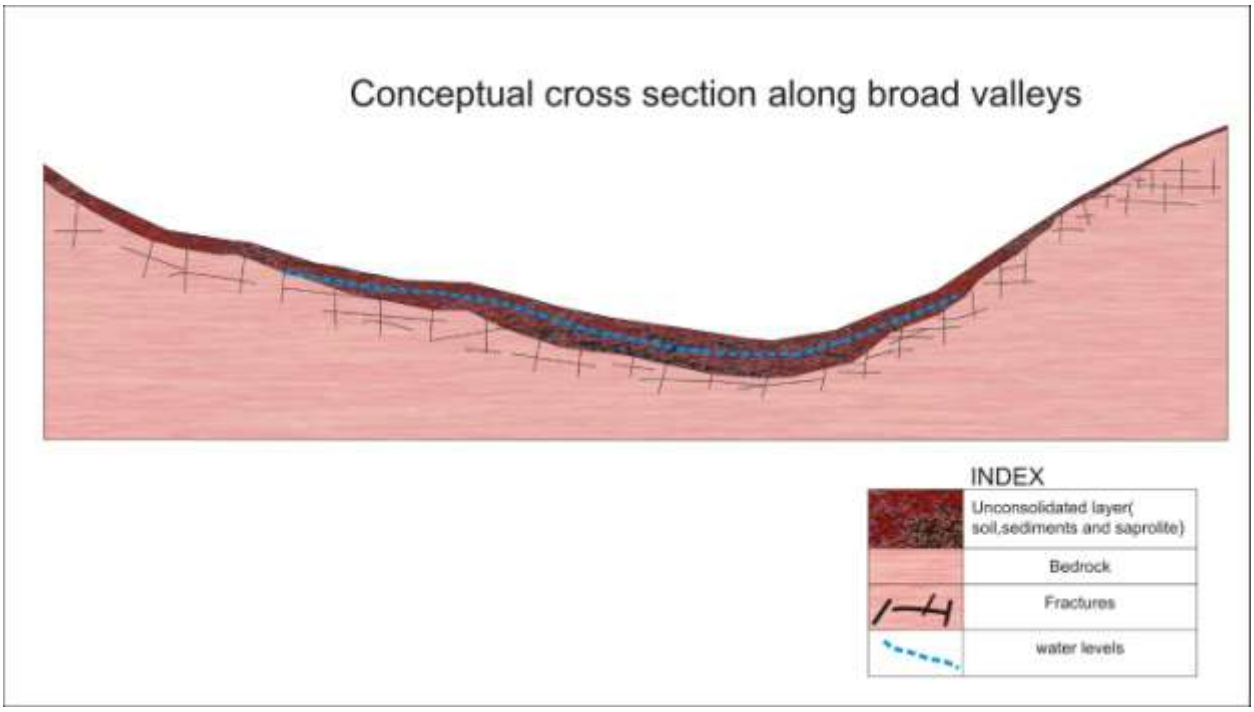

Figure 10- Cross section along the gentle slope gradient

Hubbathalai spring

The entire spring shed of the HU spring system comprises of soil, unconsolidated debris and weathered and hard-compact quartzite/Carnockite. The soil layer is relatively thin at higher elevations than in the valley. Underlying the soil is the unconsolidated debris which comprises of rolled and deposited rock material of varying sizes. Huge boulders of quartzite are also observed in between the valley. The debris deposit is thick in the central part of the valley and relatively thins out as we move up on the flanks. Massive Quartzite/Charnockite is present at the base. The rock is hard and compact and exposed on to the surface at the northern part of the ridge. The Quartzites/Charnockites are exposed only at 1-2 locations and hence is difficult to map out their spread of extent, vertically and laterally (Fig.11).

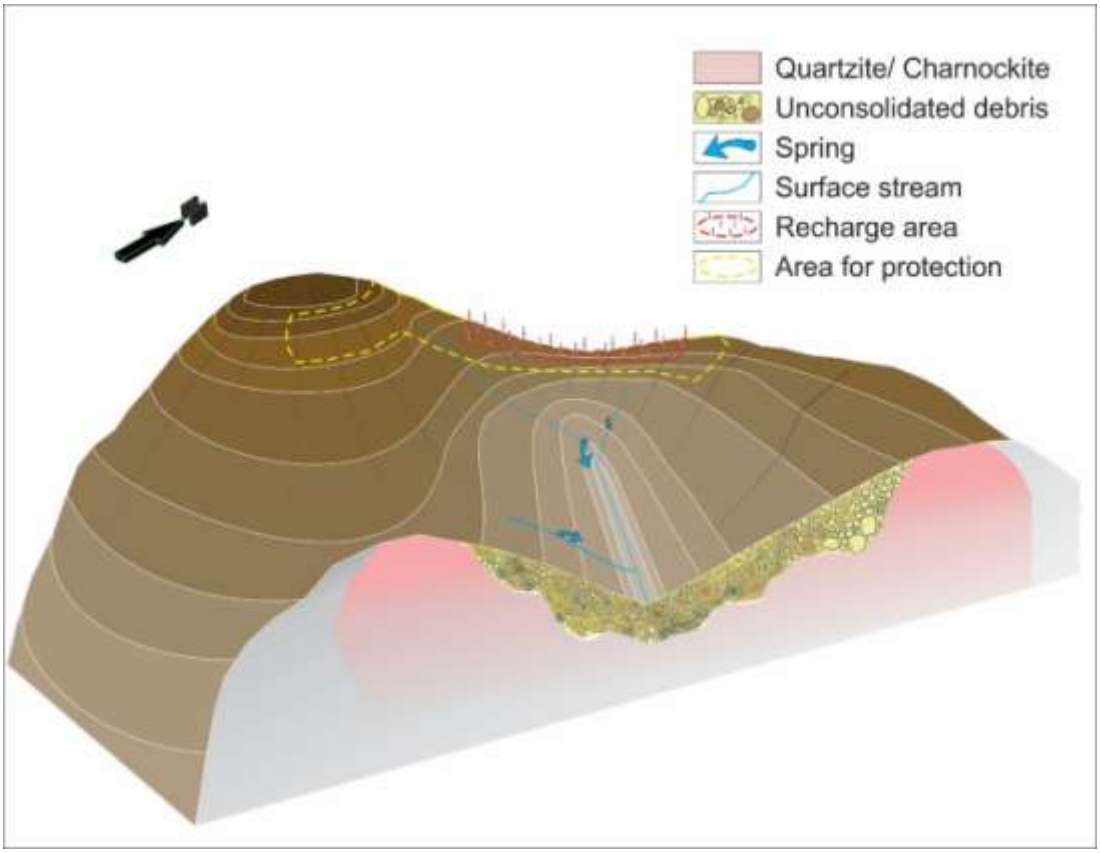

Figure 11-Conceptual hydrogeological diagram of Hubbathalai spring

Recharge areas

Guerency catchment

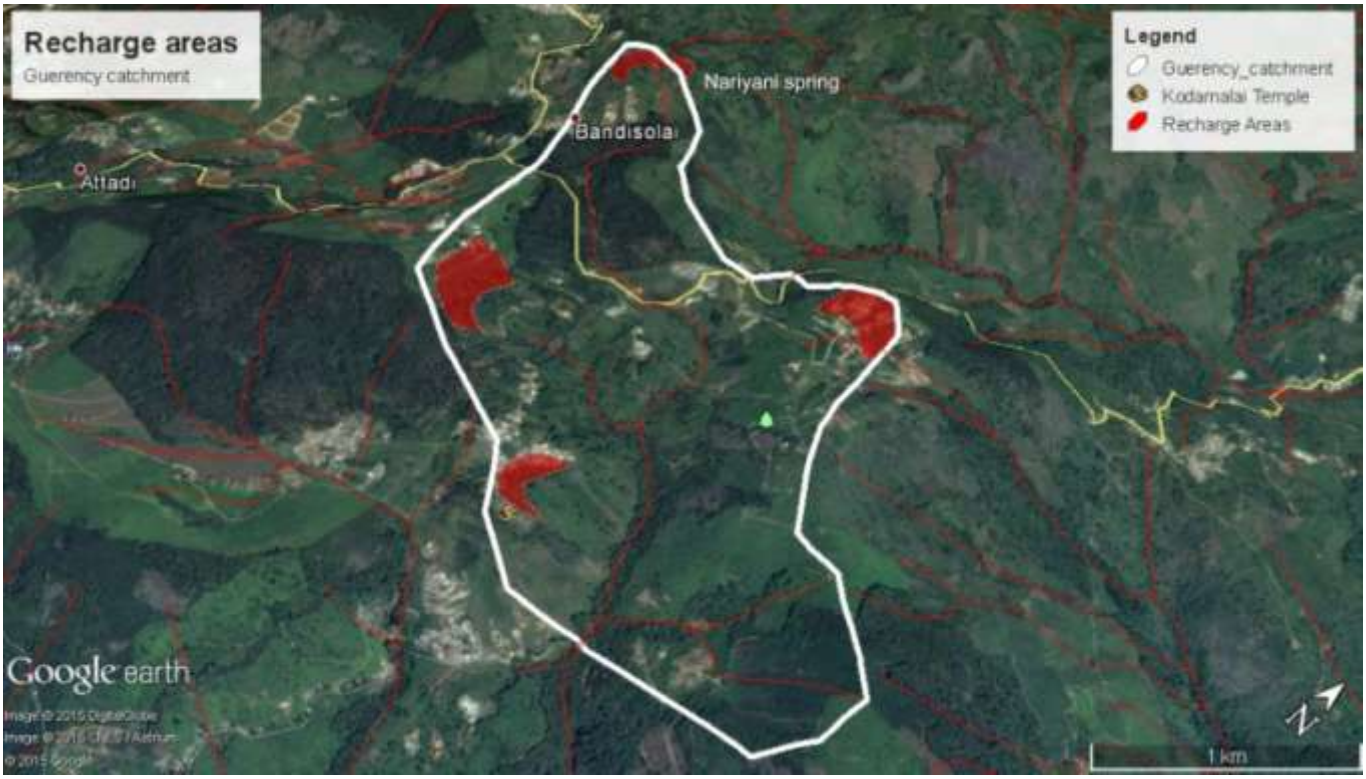

Figure 12- Recharge areas in Guerency catchments

Four recharge areas have been demarcated in Guerency catchment.

1. Recharge area of Nariyani spring
2. Recharge area of wells near Conoor tea estate
3. Recharge area of wetland near road to Kodamalai temple
4. Recharge area for springs below the Kodamalai temple

According to the layout of aquifers in the catchment, the hill tops in the catchment behave as recharge areas to the part of aquifer in the valley. Thus prioritizing major discharge zones (springs, wells, wetlands) in catchment, above recharge zones have been demarcated. Recharge zones demarcated above include human settlements and mostly tea plantations. Protection areas are mostly the recharge areas demarcated and the areas around the streams where the slope is steep and the stream cuts unconfined aquifer thus leading to occurrence of seepages and small springs near the stream.

Gymkhana catchment

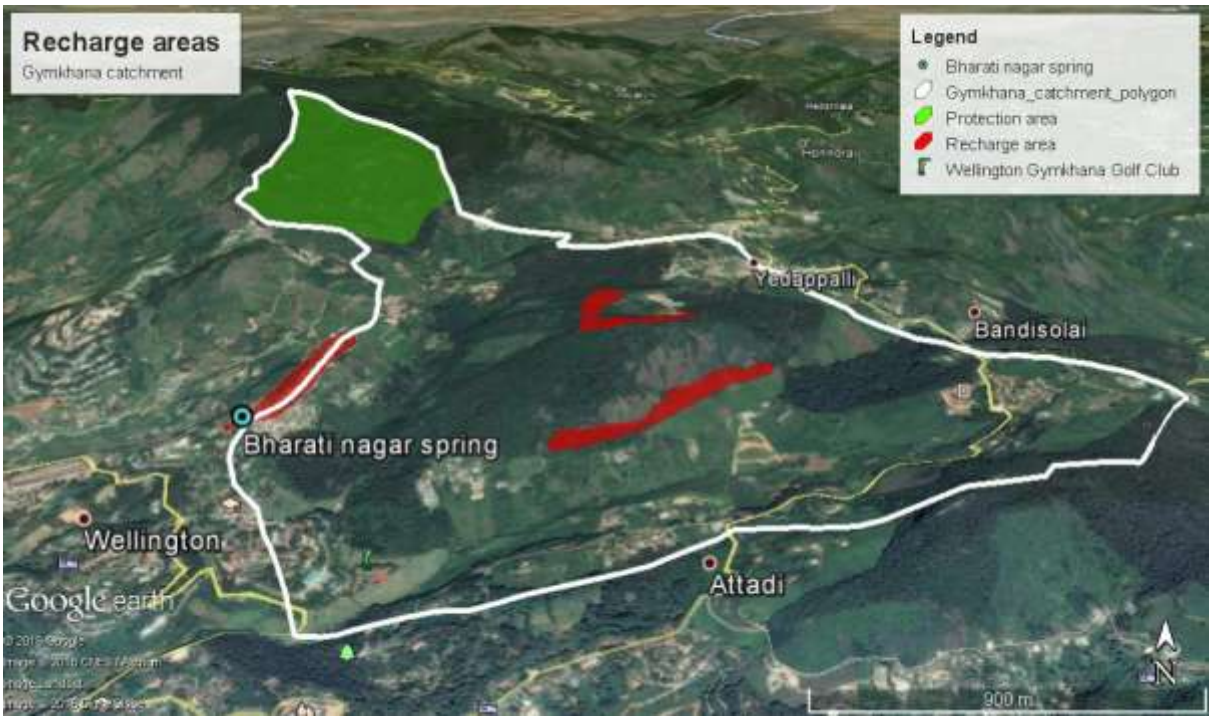

Figure 13-Recharge areas in Gymkhana catchment

Three recharge areas and one protection area are demarcated in the Gymkhana catchment.

1. Recharge area of Bharatinagar spring
2. Recharge area of Yedappallai spring (wetland)
3. Recharge area of aquifer in the providence college
4. Protection area for forest near Raliya dam.

The Bharatunagar and Yedappallai spring are major natural discharge points in the catchment. The stream coming from the forest area has a very high discharge. The origin of the stream couldn't be traced in the forest, but the high discharge throughout the year and perennial nature of stream denotes the presence of springs in the forest. Recharge area of Bharatinagar springs has a big human settlement. The recharge area of Yedappallai spring includes forest area and some area is covered with tea plantations. Recharge area near Providence College mostly comprises of tea plantations.

Ambikapuram valley

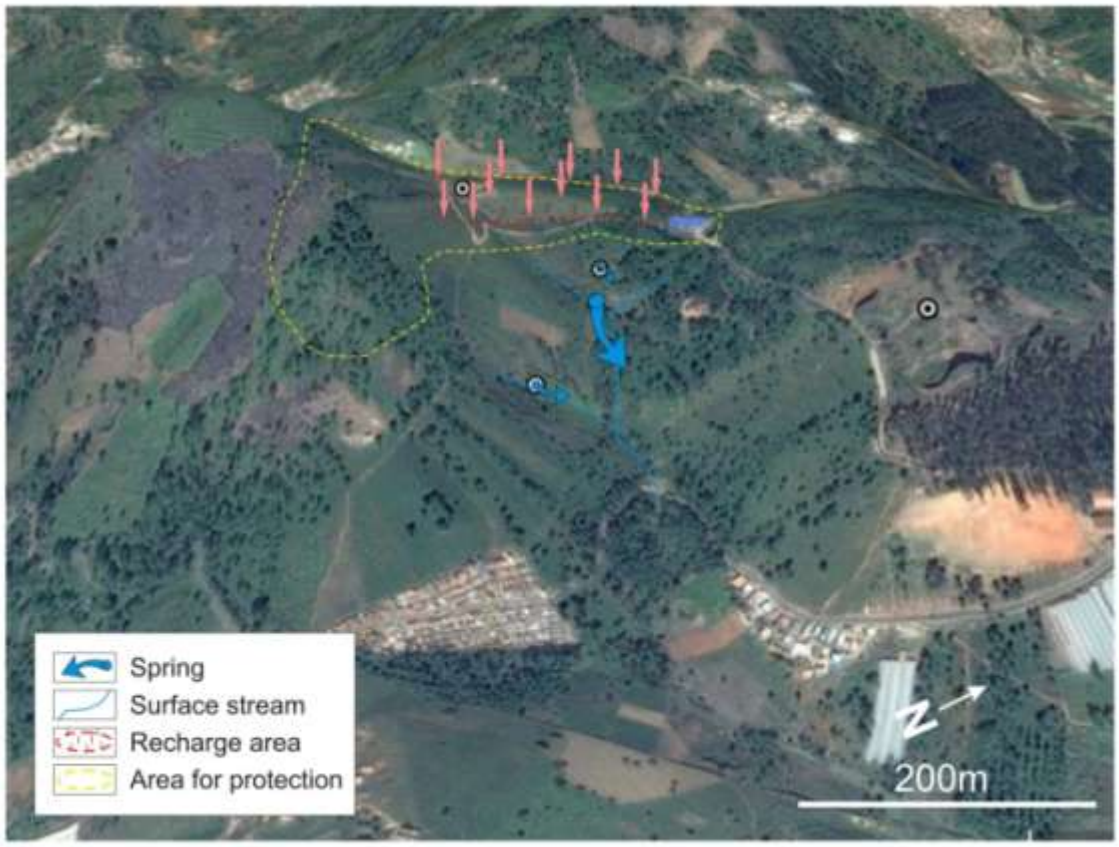

Figure 14- Recharge area in Ambikapuram valley

Hubbathalai springs are the main natural discharge points in Ambikapuram valley. Recharge and protection areas demarcated for these springs mostly comprise of private tea plantations. The hill tops all along the valley also form the recharge areas for the aquifer present in the valley.

Conclusions

- Geomorphology, slope and weathering profile of rocks are important factors in defining aquifers in Nilgiris
- Most of the catchments with thick weathered layer have hill tops and ridges as recharge areas
- Recharge areas are covered by plantations, forests and human habitats (dried wetland in Ambikapuram- heavy extraction of water)
- Water quality can be a problem in areas with recharge areas covered by plantations (fertilizers, pesticides) and human habitats (toilets and sewage). Open defecation needs to be stopped in the recharge areas and streams too
- Toilets and sewage lines in recharge area needs to be looked after so that they don't contaminate the groundwater and no new toilet constructions in the recharge areas.

- The behavior of aquifer changes due to the slope, elevation and sediments deposition and weathering factor.
- Areas around streams(steep slope) needs to be protected as it has seepages and springs near them
- Monitoring system will help in giving values to the groundwater equation (Amount of rainfall, infiltration, surface runoff, extraction, storage). Monitoring systems needs to be structured for data collection
- Amount of water coming in streams and finally in dams is affected by extraction of groundwater upstream of dams
- Quality of water depends upon human interventions in the catchments

Monitoring System

Spring discharge, well water levels and stream flow discharge are the important parameters that need to be monitored.

Spring discharge measurement can be done on 2 outlets of Nariyani spring and one outlet of Hubbathalai spring. Building spring box is possible on these outlets. Bi-monthly measurement of spring discharge can be done at each place.

Well level data will help to understand behavior of aquifers in broad valleys. It will help us to understand behavior of unconfined aquifer in the broad valleys with gentle slopes.

Stream discharge measurements, rainfall and spring discharge in particular areas will help us understand relationship between groundwater and surface runoff

During dry spells of rain, the major spring's discharge and stream discharge from a specific area can exactly tell us the amount of water that is being contributed to the streams by smaller springs and seepages along the streams.

Way Forward

- Recharge areas have been demarcated as shown in the figures, which denote the areas to be protected as first priority (as main discharge points draw water from these regions). Ridges all along the borders of the catchments needs to be protected. The layout of aquifers is such that the recharge areas are the areas of aquifers, at higher elevations (exception- Bharatinagar spring). Protecting ridge lines can become the second priority.
- Setting up monitoring system for knowing the behaviour of aquifer and setting a groundwater management plan
- Try to quantify supply and demand both, with respect to water.
- Collected data can help us know the endangered springs (quantity and quality wise) and take necessary action
- Groundwater related awareness in people can be developed

References

ACWADAM,-A Draft, Rapid Hydrogeological Survey of Guerency Catchment and Gymkhana Catchment, September 2015.