Short report on Rapid Hydrogeological observations of Springs and Lakes in parts of Sikkim State

Devdutt Upasani
Advanced Center for Water Resources Development and Management (ACWADAM), Pune

Introduction:

Water shortage has always been a problem for hamlets situated at a higher elevation, away from the main streams from many mountainous regions of India. It is glaringly true for the Himalayan region, where hamlets belonging to a village lie scattered throughout the area. During a drought period, when the upper springs dry up, these habitations experience serious water shortages. The pipelines to carry water are costly ventures in such areas. Thus, there is clearly a need for water conservation and water management programme that target various water needs of the hill people.

Similarly in Sikkim reducing discharge in the springs and drying up of hilltop lakes is a growing issue that needs immediate attention. Ongoing aquifer recharge and Dhara-Vikas programmes are implementing artificial recharge techniques for revival of lakes and springs. But unless knowledge of hydrogeology is incorporated in the recharge works the benefits from these programmes will be minimal and haphazard.

This report is about a 6 day visit to the eastern, western and southern districts of Sikkim where a few springs and hilltop lakes were observed. These 6 days also included about two days of classroom theory sessions and 2 days of field sessions where the Field Facilitators of State Institute of Rural Development (SIRD) Sikkim and other organisations were sensitised about the importance of hydrogeology in spring recharge work.

Some of the field observations on springs are given below.

Tareythang area: The general geology of the area comprises of high grade metamorphic rocks. The main rocks observed are mica-garnet schists, biotite gneisses and augen gneisses. The dip direction of the foliation in the rocks varies from 0° to 60°. The dip amount of the rocks is as high as 50° at places. The valley portions show the presence of loose unconsolidated sediments. The grain size of the sediments varies from boulder to clay size and the sediments are largely unsorted and angular in nature.

Kaphley Dhara: Mainly biotite schists seen near the spring and in the catchment areas. The dip of the foliation is 45°/60°. The major openings are also aligned along the dip direction of the schists. There is no other major control on the movement of water. Thus the spring is a *fracture* type of spring. The recharge area of the spring is towards the western direction towards the escarpment slope. The Water Quality measurements indicate a good rate of transmission through the rocks due to which the TDS and Ec values are low. The discharge of the spring is about 0.5 lpm.

Sansari Dhara: There is a series of 4 to 5 springs aligned in an east to west direction. The springs are also located in a linear valley which slopes towards the east direction. The rocks in the area are schistose in nature. The springs along this trend are all *fracture* springs controlled by a fracture trending in 90°-270°. The recharge areas for all these springs are concentrated along the fracture zone. Drainage line structures along this narrow valley will be beneficial in recharging all the springs along this line. The water quality values suggest significant transport and rock water interaction. This concludes that water coming to the spring is from a long distance.

Dharjee Dhara: Thin layer of sediments seen in the area indicates major storage in the sediment layer. The water is discharged on the ground at the contact between these sediments and the lower rock formation i.e. biotite schist. This spring is a *contact* type of spring. The discharge in the spring is quite low and the reduction in spring discharge can be due to some unnatural changes in the recharge area which is quite local and is concentrated in a small area upstream of the spring.

Dhimire dhara and Chautara dhara: These springs are located in sediments that are found in the main valley. A lot of terrace cultivation around the springs indicates presence of sediments in the region. The discharge in the spring remains constant at about 2.5 to 3 lpm for most part of the year. The discharge rises in monsoons for a short period of time indicating a direct influence of rainfall. These springs might be a combination of a *depression cum fracture* spring. The high discharge during rains is due to dewatering of the sediments in the region and the fracture contributes to the continuous discharge for the non-monsoon period. Comparative water quality measurements of the discharges during monsoon and during the non-monsoon times can give a clear idea about the two mechanisms of spring discharge viz. Depression and Fracture.

Sasbote Dhara: Mainly a *depression* spring as it is surrounded by sediments around it and the spring is formed at a change in the slope gradient of the ground. The discharge of water is about 2.5 lpm. The rock type below the sediments is augen gneiss. The discharge in the spring shows quick response to the rains, which indicates it to be a quick and local system and the water discharged from the spring has travelled a short distance in the ground before getting discharged.

Photo 1: Tracer being used for water quality testing at Sasbote dhara

Ghimredevi Dhara: This is a combination of a couple of springs, all falling on a linear zone, seen in the form of a narrow valley along 0°-180°. The rock is gneissic in nature and dips towards 320° with an amount of 22°. The springs are *fracture* controlled springs controlled by a fracture trending in N-S direction. The discharge of the spring remains constant at about 2 lpm throughout the year. This indicates that the fracture carries water from a long distance to the spring throughout the year at a continuous transmission rate. The recharge area of the spring is along the fracture zone and on the top flat portion of the mountain on which the spring is located.

Photo 2: Manahang dhara located along a fracture zone.

Dal Dhara and Manahang Dhara: These two springs are also *fracture* springs located along fractures trending in N-S direction. There are many more springs in this area, all located in zones trending along this N-S direction. These are all fracture springs located along parallel set of fractures trending in a direction of 0°-180°. The water quality measurements indicate water to be travelling from a considerable distance along these fractures but at fairly high transmission rates.

Shumbuk Area: This area shows relatively low grade metamorphic rocks like quartzites, phyllites and schists. The rocks in this area show a lot of structural disturbances. Folding and faulting is commonly observed in rocks in this area. The major fold axis is in E-W direction and so many axial fractures trending in this direction are observed. Sediments are also found commonly in the lower areas in the valley regions.

Devithan Dhara: The rocks in the area are mostly metamorphic in nature and phyllite is the dominant rock type. The phyllite layers dip towards the south with an amount of 37°. Two sets of fractures: one along E-W direction and another in N-S direction are observed in the area. The spring is a *fracture* spring and the water travels a considerable distance along the fracture before being discharged from the spring. The discharge of the spring is about 0.4 lpm, which is a very low discharge. The reduced discharge in the spring might be due to some land use changes in the recharge areas of the spring.

Malagiri Dhara: The rock in the area is phyllite, but no surface exposures of phyllite are seen in the area except in the higher parts of the mountain above the village and in some parts around the spring. The area is dominated by sediments that contain boulders of phyllite and other rock types. The size of the sediments varies up to clay size particles. There is also a small escarpment seen upstream of the spring. Thus the spring is of a *depression* type. The present discharge in the spring is about 6 lpm, but this increased discharge is due to the immediate effect of rains on the previous day. This is also indicated by the water quality of the spring water. The TDS in the water are very low indicating it to be water that has travelled a very short distance in the rocks and has had a small resident time in the rock. The entire surface catchment upstream of the spring is a good recharge area for the spring.

Poison Lake: The dried up lake in Kaluk area was studied to ascertain the contribution of groundwater to the lake. It was observed that the reduced inflows in the lake have led to a drying up of the lake. The masonry work done in the lake near the outlet has led to reduced groundwater flow to the lake as it has obstructed the main eastward flow of groundwater to the lake. Also, reduced discharges from a spring located towards the upstream part of the lake have contributed to the drying up of the lake. Recharge activities in the western direction of the lake on the escarpment slope and the top flat portion of the hill will prove significant in increasing spring discharge and baseflows to the lake. Puncturing of the masonry portion can also be considered as a possible intervention for the lake.

Photo 3: Dried bed of poison lake

Tamley lake: This hilltop lake in Mungram area has dried up drastically in the last two years after repair work and masonry work in the lake. The surface catchment does not prove sufficient for filling up of the lake and thus the lake has rendered dry. The (possible) groundwater inflows into the lake are blocked due to masonry lining of the lake. The percolation of water from the lake also is nil as the base of the lake is also plastered with cement concrete. There have also been reports of reduced discharges in the springs downstream after this intervention. Additional studies are required to ascertain the groundwater contribution to the lake and also the relationship between the lake and the springs in the downstream direction.

NOTE: All the observations in the report are drawn from limited field visits and basic principles from the science of hydrogeology. Detailed investigations are required in the areas for gaining more knowledge about recharge areas. Discharge data collected by SIRD staff and also long term water quality data will prove useful to ascertain the recharge areas of the springs. The current conceptualisation also draws upon ACWADAM's hydro geological interventions from within other locations in the Himalayan region.