MANAGING THE UMBARI SPRINGS:

A Hydrogeological approach

ACWADAM

Advanced Center for Water Resources Development And Management, Pune

acwadam@vsnl.net

www.acwadam.org

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Introduction

The regional setting for the project site of Chorage Umbari and Jadhav Umbari villages is made up of Deccan basalts comprising horizontal lava flows stacked over one other. The regional geomorphology of the area is mountainous with flat tops (plateaux). The area shows prevalence of *lateratization*, with small 'minable' iron ore deposits at a few places. Such quarries dote the landscape and are evidence of laterite quarrying in the region for significant periods. Laterite quarrying also reflects on the fact that many of these are *in-situ*, a fact that has significant bearing on groundwater accumulation and movement in the region. The overall geology of the region shows lateratization of the underlying basalts belonging to the deccan volcanic province. The region shows evidence of 'laterite sections' developed at two main elevations resulting into two distinct plateaux (at 1000 and 1170 m above msl), has meant that springs and groundwater discharges are quite common between elevations of 980 m above msl and 1170 m above msl, the latter being a close approximation to the higher altitudes in this region). This phenomenon has meant groundwater contribution to stream hydrology, especially in the upper reaches of larger catchments, so much so that springs are reported near the base of *kaas talav* located at about 1080 m above msl.

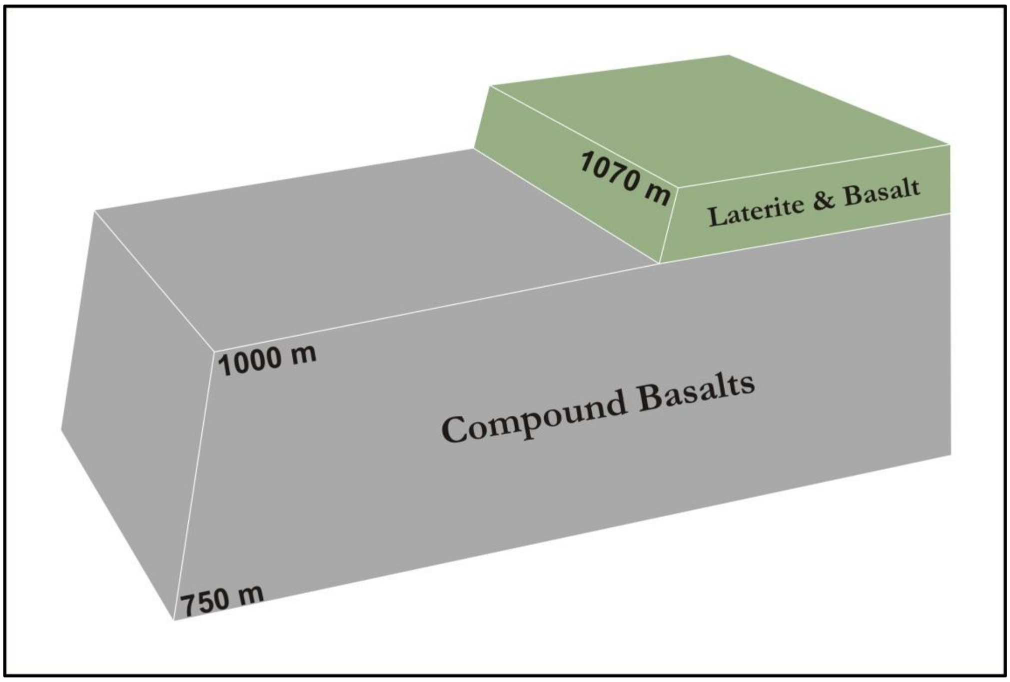

Fig 1: Regional geological makeup of the study area

The springs in Chorage and Jadhav Umbari emerge along approximately the same elevation, i.e. At about 1140 meters.These springs form the only reliable freshwater source for Chorge Umbari and Jadhav Umbari villages, considering the fact that these two villages are located along steep slopes that are likely to carry large volumes of runoff as a consequence for high, seasonal precipitation (usually intense rainfall between the months of July and September every year). The springs are perennial and spring water is brought down under gravity through pipes into a collection chamber and then supplied to the villages through public stand posts.

Photo 1: Collection chamber at chorge Umbari

Photo 2: A public stand post

With the changing rainfall pattern and decreasing spring discharge coping up with the ever increasing population and demand for water has become a matter of concern in the recent times, a fact that has prompted AWARD, an ngo from satara, which is working on natural resources management and human needs, in these two villages.

Methodology

The methodology included three major components, namely fieldwork, analysis and technical reporting. A reconnaissance visit was carried out in Nov'10 to the study area followed by three more visits in Feb and April'11. Each visit was carried out under specific objectives such as hydrogeological mapping, water sampling, conducting pumping tests etc. A conceptual hydrogeological layout of the springs was prepared based on the mapping exercise. Springs and their aquifers/aquifer systems were defined based on geological, water quality and pumping test data collected. This report contains salient observations, conclusions and specific recommendations leading towards a collective and strategic approach for spring water management of the Umbari springs.

Photo 3: Intake chamber of JU spring

Hydrogeology

Springs are natural sources of groundwater. The most important concept in understanding groundwater and its behavior is to understand 'aquifers[1]'. It is these aquifers where groundwater is stored, replenished and is made available for use, under differing geological conditions through springs or wells. The concept holds true even for the villages of Chorage and Jadhav Umbari.

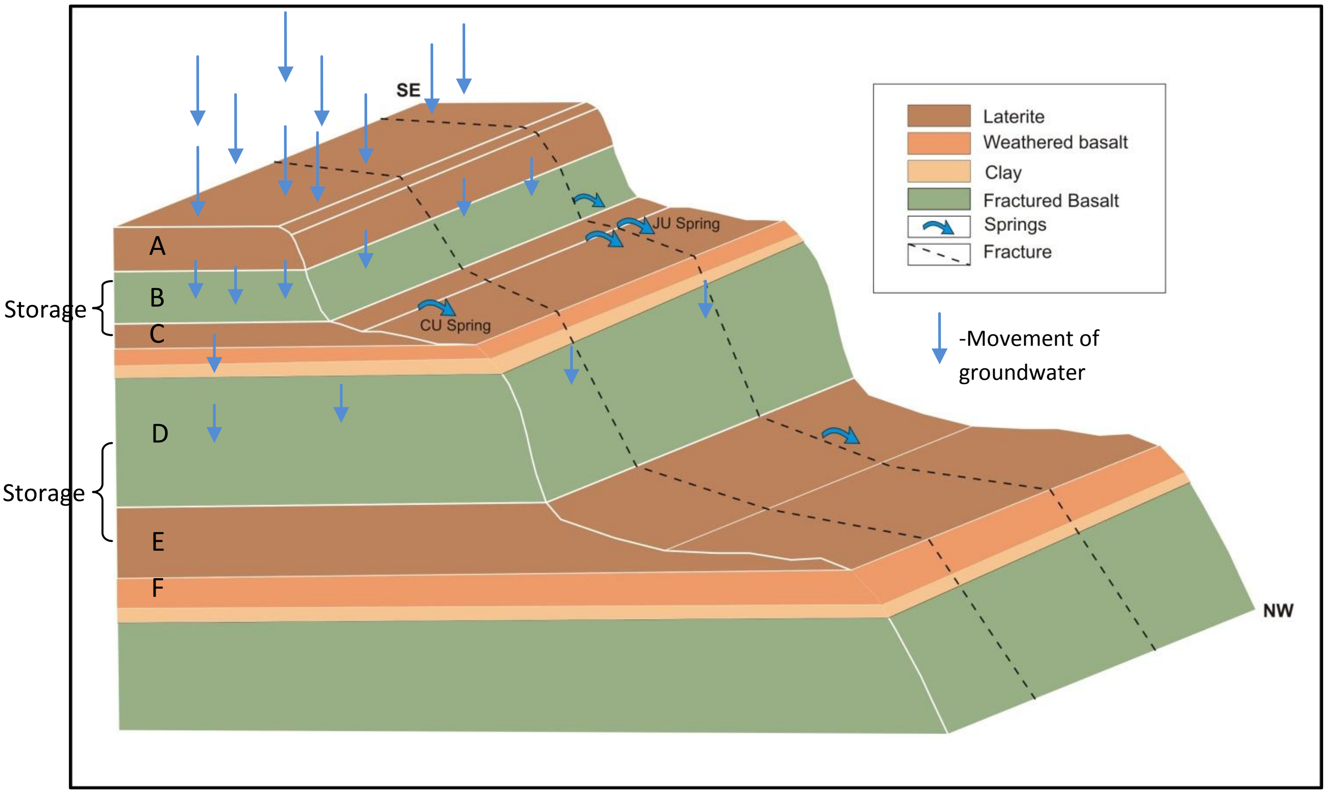

Fig 2: Hydrogeological layout of the Umbari springs

The study area (adjoining the villages of Chorage and Jadhav Umbari as well as the springs upslope that supply water to these villages) comprises horizontal basaltic (lava) flows. Each flow is separated from the other by a red layer, representing the contact between two lava flows. Three basalt flows outcrop from the ridge top to just down slope of the two villages. The upper portion of each of these lava flows is lateratised and fractured, followed by weathered basalt, then a clay layer and then the underlying fractured basalt. Three sets of springs are seen to emerge from this system, all of which are classified as contact springs *because water discharges at or very near to the contact between the laterite (above) and the weathered basalt (below) (fig 2)*. One set of springs is observed to emerge from the fractured basalt (B). This spring is in the form of a slow seep leading to a puddle formed as a depression in the fractured basalt. The water from this does not flow out but remains stocked up in the puddle throughout the year; this is a *fracture spring* within the laterite portion. Water quality tests indicate this water to be of a good quality.

[1]Aquifers are defined as saturated geological formations which can yield sufficient quantities of water to wells and springs.

The second set of springs emerges from the thin lateritic layer (C) present between the fractured basalt (B) and the weathered basalt – nearly at the contact with the weathered basalt below. These are contact springs. The laterite (C) exposed on the surface is overlain by thick lateritic soil which is rich in *iron* at a few places. The recharge to these springs (JU & CU) takes place through the topmost fractured laterite, whereas the fractured basalt (B) acts as the main aquifer that discharges at these springs. The fractured basalt and the iron rich soil are in hydraulic connection. Thus the water (springs) that emerge from the fractured basalt get contaminated with iron only after entering the iron rich soil – i.e. after discharging at the surface. *In-situ* and *laboratory* tests performed on water samples taken from the soil indicated high iron content in the water, while those performed on water samples from the overlying fractured basalt indicated relatively uncontaminated groundwater.

Photo 4: Laterite exposed on top

Photo 5: JU springs and intake chamber

Photo 6: A well/naula tapping the lowermost aquifer

The third set of springs (base flows) is observed in the laterite (E) present below the villages, although the mechanism of water discharge is similar to the second set of springs (described in the above paragraph). Water from these sources is used by the villagers during the summer season, when the upper spring discharge drops significantly. The fractured basalt (D) and the laterite (E) form the aquifer system for these springs. A pumping test performed on a well located in this laterite yielded the following values:

Transmissivity (t): 13.8 m^2/day   Storativity (s): 0.11

The storativity value indicated is on a higher side and may not be representative enough as the test was neither long-duration nor with observation well data. Detailed analysis through pumping test requires a series of such tests to be conducted along with good data, which remained a limitation given the timeframe available for the study. The base flow discharges observed in the month of November 2010 and April 2011 indicates a fairly good storage in this laterite, nevertheless.

The average discharge value of the Umbari springs is about 8 liters per minute (data collected during Nov 10 and April 11 visits). This value is indicative of the operating discharge on which water supply in these villages should be designed and maintained. This estimate implies:

8 lpm = 8 x 1440 = 11520 liters per day

11520 x 365 = 4202800 liters/ year = 4204.8 cubic meters/ year

This estimate implies that the aquifers in the area are not high-storage aquifers; nor do they have exceptionally high permeability. This means that large-scale groundwater development for irrigation and agriculture will surely not be possible from aquifers that support drinking water supply for these two villages and pumping from many wells in the region.

Photo 7: The plateau on which the Umbari villages are located

Laterite: A laterite is a weathered product of the parent rock. It is formed under high rainfall and high temperature conditions and is rich in iron and aluminum. The infiltrating water chemically reacts and dissolves minerals present in the rock creating small cavities. These cavities later grow in size and get interconnected thus giving a high permeability to the rock which then allows groundwater to flow rapidly through it.

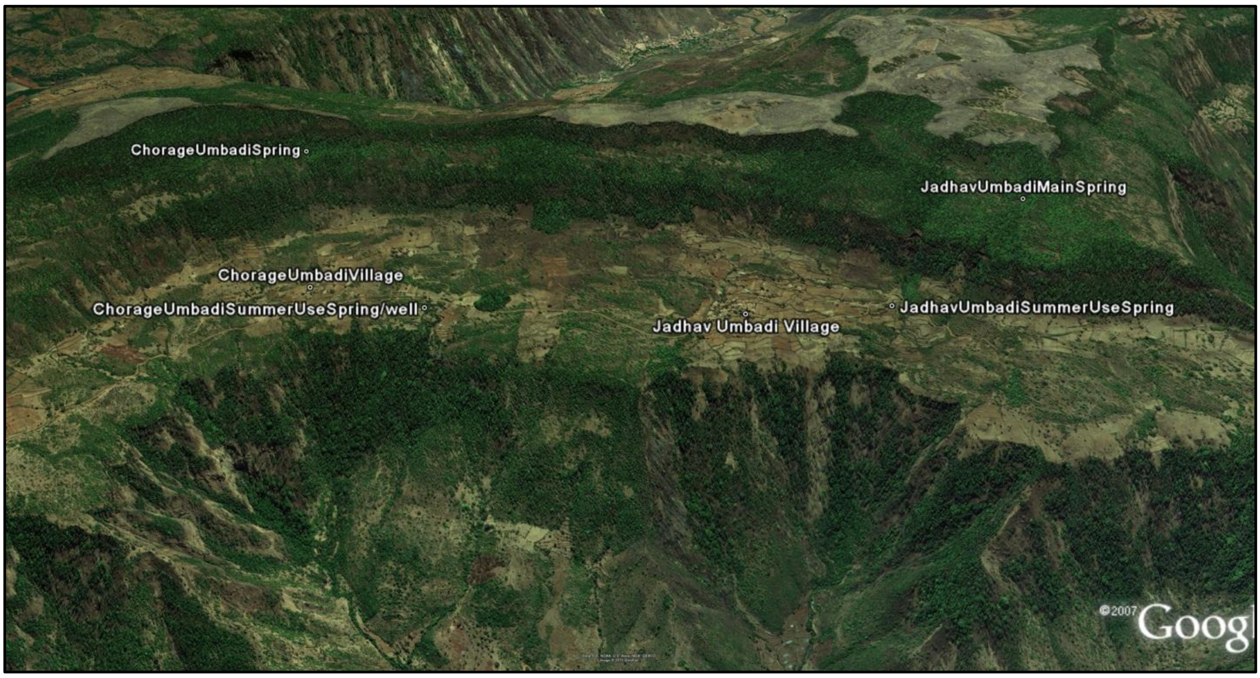

Photo 8: A Google perspective of the Umbari springs

The three sets of springs from the area and the overall *quick geohydrological appraisal* helped to arrive at the following important conclusions:

1. The springs in the area are fed by shallow-unconfined (phreatic) basalt aquifers.
2. Laterites and laterite material above the basalt aquifers act as the main recharge mechanism to these aquifers; fracture zones that trend EW help in infiltration, mainly into the laterite below.
3. Once the basalt aquifer is recharged to its full capacity, spring discharge begins and continues as water from upslope moves slowly into the system. Monsoonal discharges are likely to be high because these will represent fluxes from upslope that may not have much to do with the aquifer contribution from the basalt.
4. The relatively modest transmissivity (capacity of the rock to transmit groundwater from one point to the other) of the aquifer implies that summer spring discharges will operate at optimal rates (not more than 5-10 lpm), despite any conservation or recharge augmentation effort.
5. Some degree of hydraulic continuity (interconnectedness) exists between the three sets of springs – mainly due to the continuous set of EW fractures present in the area.

Recommendations and a way forward

- Chorage Umbari and Jadhav Umbari springs emerge uphill of the Umbari villages at the contact of fractured basalt and the underlying laterite. Given the day-to-day importance of the Umbari springs for the villages, the increasing demand and the changing climate, a scientific, community based approach is necessary for a sustainable and equitable management of the spring system in these two villages.

- The recharge area for Umbari springs is located on the uppermost plateau (at elevations above 1150 m above msl) made up of laterite (A). Good amount of natural recharge takes place through this weathered and fractured laterite. It is not necessary to carry out any recharge measures in laterite, considering its high permeability. The slope where fractured basalt (B) is exposed is steep and thickly vegetated thus ruling out the possibility of carrying out major recharge measures at this location. Soil conservation measures may be carried out on this slope mainly to maintain the soil, which is vulnerable to erosion from the large quantities and rapid surface runoff.

- The spring water distribution system i.e. the supply pipes and the collection chamber should be repaired to reduce leakage because of the limited summer discharges possible from all the three sets of springs.

- Protection of the natural forest in the recharge should be a priority because it is directly related to upstream infiltration that results into recharge below. Most of the recharge to the lowermost aquifer takes place from the top due to the hydraulic connection (fractures) between the two aquifer systems.

- Spring water harvesting (only excess runoff during high spring discharge) and roof top rainwater harvesting in artificially created tanks or recharge to the lower aquifer system is a possibility (where the villages are located).

- In the overall spring water management strategy or even for understanding springs, spring discharge data plays a vital role. Spring discharge data and periodic groundwater quality data should be maintained by the village, with the help of AWARD, for long-term strategic planning and decision making.

- Source development work should be done at both the springs in order to ensure proper collection of spring water into collection tank and also an aid to measure spring discharges. Regulations regarding protection of spring discharge areas should be developed through the panchayat system of both villages.

- Proper care should be taken to prevent iron rich water (emerging from the soil layer) from entering the collection chamber at Jadhav Umbari spring.

- A set of regulations can be framed at the Panchayat level in order to facilitate equitable and sustainable groundwater distribution. It may not be total ban on borewells but, restrictions on pumping during specific seasons. Community borewells should be encouraged rather than individual ones. These regulations are to be formulated based on the future water requirements at the household level as well as agricultural practices. For this monitoring of baseflows/springs (summer water sources) and water level in wells from the lowermost aquifers is utmost important. Any excessive pumping in future from the lowermost aquifer will adversely affect the springs/wells, this should be considered while forming the regulations.

- Also the plateau where villages are located should be protected from any activities which will directly contaminate the aquifer below.