

Feasibility Study:
Water System for
Nga Gyur Shed Dup Cho Ling School

Study Performed by:
Living Earth Institute
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Introduction

The school, Nga Gyur Shed Dup Cho Ling, lies in the village of Anzi located at an altitude of 4300m above the sea level. The village consists of the school, 31 houses and a monastery. It is located in a rural part between China and Tibet. Yak herding is the primary occupation of the people of this village. In the village, there are approximately 150 people in summer with a peak of 250 people during religious ceremonies in the monastery. However, in winter time, the population approximately reached to 250 with a peak of 300-500 during ceremonies. There is no electricity in the area so the villagers rely on solar panels for basic lighting purposes. Separated by a small creek, the school lies on one side and the village on the other side. There is a tap-stand besides the creek on the path to the school from the village. There are two tap heads at this tap-stand.

In this feasibility study, we examined the existing water sources and also searched for other alternatives around the area to fulfill the water demand of Anzi village. The major challenge that the villagers are facing is that during winter, there are no creeks that contributes to the only existing tap stand. Due to extremely low temperature, all the creeks freeze and therefore the tap water dries.

The study indicated that it is feasible to design a water system capable of accomplishing the water need of the villagers. Based on the measurement of discharges of the spring sources active during the wet season, it is possible to store the water necessary for the dry season during the wet season. With an engineered system of insulated reservoirs, pipes running at least 3ft deep and properly covered with soil would prevent the water from freezing. As concerns of the freezing of the water, through accurate calculations on the basis of precise data, if we can confirm that water in the reservoir tank freezes only to a certain depth, there is enough water to store for the school and perhaps for the village as well. Moreover, collection of water in the wet season can be made effective by improving the existing system, adding additional sources to the reservoir, harvesting the rain water, etc.

Current Water System

Design

The government of China built the current water system. It consists of one tap stand, a reservoir tank with the dimensions 2.6m x 3.9m x 3m (i.e. 30.42 m³) and multiple small pressure break tanks. There are two spring water sources that have been tapped for this water system. For the tap, the discharge was 32 liters per minute with a reasonably high pressure. However, the quality of water was not as clean as it contained some suspended particles (water sample C₂). The water sample analysis has shown that except for the suspended particles, the quality of water is suitable for drinking purposes.

For the existing water system, a number of 2-inch diameter pipes are laid at the sources and pressure tanks installed in different locations. These pipes were exposed to the atmosphere for the most part except for few locations (close to the source) where it is covered by about 2ft of soil and they follow the flowing creek in some sections. Under such condition, it is likely that, water in the pipes will also freeze into ice when the water in the creek is frozen during winter times.

Spring Water Discharge

Water discharge measured as of 3rd of August 2011 of the lower spring source (S_1) and the upper spring source (S_2) suggest that the source has enough water for the school and the village for the entire year if we are capable of storing it during the wet season (figure 2, 3). The lower spring source has a discharge of 17 liters per minute. In case of the upper spring source (S_2) water is collected in an intake tank which is located about 8 meters down from the spring itself. Water is collected in this tank through 4 different pipelines. At the time of field visit, one of the pipes for upper source was running dry. In spite of this, the total spring water that was being collected in the upper intake tank was 63.9 liters per minute. Therefore the total discharge of water collected at that time was 80.9 liters per minute.

Challenge

According to the villagers, there is no water flow in the tap in winter because water at the spring sources itself freezes. However, there is no information as to whether water in the reservoir tank also freezes during winter. It is unlikely that all the water that is collected in the reservoir tank freezes when the temperature decreases in winter. Theoretically, only an upper layer of water would freeze into ice, and the rest underneath would remain in liquid state.

Freezing of the spring source also needs to be properly verified. We were reported that discharge from the spring water source (S_1 and S_2) stops during winter because water is frozen into ice at the source itself. The spring source is the groundwater seepage as the part of the watershed area. It is important to verify with careful observation whether at the source, seepage would continue to freeze under low temperature. This is because groundwater seepage would continue to flow regardless of the temperature. It is only after it comes to the surface that water generally gets frozen. This point could be established from the fact that the villagers use a water seepage source that occurs below the school during winter that does not freeze (figure 4).

According to Lama Che Che, at the time of construction, three outlet pipes were fitted together for the water supply from the reservoir tank. However, two of those pipes have now been disconnected and therefore does not supply water anywhere. According to the lama, the reason for the dysfunctional pipes was the insufficient water in the reservoir. Given the tremendous pressure with which the existing pipe carries water, this given reason seems inadequate to explain the existing situation. This pressure is demonstrated by the pressurized water leakage from the pipeline upstream to the tap stand. It is possible that the available water is capable of supplying water to more than just the existing one tap-stand.

Alternatives

Water Storage

Given the spring water sources that are abundant during the wet season (3-4 months), it is possible for us to store the water during the wet season for the entire dry season. Assuming that the reservoir tanks do not freeze entirely, we can use the water that is in liquid state underneath the icy surface. This can be further engineered with better insulation, pipes in varying depths, water gauges, etc.

Also, if we can confirm whether or not the sources freeze in the winter, we can design a water storage system which will provide a continuous flow system thus requiring less storage area.

- I. **Additional Spring Source (S₃):** During the field observation, we observed small swampy area in the middle of the valley, the water from which had not been tapped (figure 5). There were numerous groundwater seepage areas within this swampy area. Water from all these seepages in the swamp eventually contributed to the creek that runs by the school. Among those seepages, we could locate one spring, at the crown (head) of the swampy area, which has the potential of yielding better quality water at sizable discharge volume. This new water spring, which is located at the crown of the swampy area, has a discharge of at least 31.2 liters per minute (we could not channelize all the water into the outlet which we used for discharge measurement as it flowed over large surface area). This spring could be considered as one additional source of water that could be used for supplying water to the school and the village if we combine this source with the existing piped water system. This spring source is located approximately about 510m above the existing tap stand (Please refer to the water quality report C₂).
- II. **Stream Source:** We also explored for the water sources outside the watershed valley where the school and the village is located. Lama Che Che suggested a stream water source, at its confluence with the Sya Tha Chhu river, at an elevation of 4,200m. This location lies in the east of the school, in a different river valley, and is very far from the school. We also looked at the source of this Sya Tha Chhu river, but found that it is very far from the school and hence will involve lots of investment. This might be an alternative that requires water pumps, bigger reservoirs, etc. which is hardly an option for us given the absence of electricity.
- III. **Water from Different Watershed:** Although in the absence of electricity, we can still rely on gravity flow system from another watershed area, the cost of doing this would be significantly high. There is a small spring water source (figure 6), in the adjacent valley in the west that could be a possibility but Lama Shoba indicated that the inhabitants there might object regarding the authority over the water source. According to the lama, cooperating with them would not be easy.

- IV. Rainwater Harvesting:** We were told that throughout the year, it either rains or snows, suggesting a wet environment. However, to determine if it rains enough to harvest we need to have more precise data about the quantity of rain.

Majority of the houses in the villages as well as the school consisted of flat roof with mud with an exception of the monastery and few buildings in the school that had corrugated roofs. In the school, boy's classroom, girl's classroom and the girl's hostel consisted of corrugated roofs. It seemed like other buildings were yet to be added with the roofs.

The school premise has six buildings- aligned in a rectangular compound. The plinth/roof area of each building is as below:

$$\text{Boys' hostel} = 60 \text{ m} \times 3.8 \text{ m} = 228 \text{ m}^2$$

$$\text{Boys' classroom} = 17 \text{ m} \times 7 \text{ m} = 119 \text{ m}^2$$

$$\text{Girls' hostel} = 12.5 \text{ m} \times 7 \text{ m} = 87.5 \text{ m}^2$$

$$\text{Girls' classroom} = 9.2 \text{ m} \times 7 \text{ m} = 64.4 \text{ m}^2$$

$$\text{Kitchen} = 10 \text{ m} \times 6 \text{ m} = 60 \text{ m}^2$$

$$\text{Teachers' house} = 12 \text{ m} \times 3.8 \text{ m} = 45.6 \text{ m}^2$$

$$\text{Total roof area} = 100.75 \text{ m}^2$$

Water Need

Design population in the School = 120

Daily water requirement @ 45 liters per day (lpd) per capita = $120 * 45 \text{ lpd} = 5,400 \text{ lpd}$

Design population in the Village = 31 houses x 8 member per house = 248

Daily water requirement @ 45 lpd per capita = $248 * 45 \text{ lpd} = 11,160 \text{ lpd}$

Therefore, total daily water requirement for village and school = (5,400 + 11,160) lpd = 16,560 liters

Assuming that all the spring sources gets frozen during winter season, and the scheme is to design storage of summer time discharges into a reservoir, then the **water storage required for one month** period supply is = $16,500 * 30 \text{ days} = 496,800 \text{ liters} = 496.8 \text{ cubic meters}$ (This should be size of the reservoir tank).

Conclusion

From the study, it can be deduced that it is feasible for the school to design a water system that would supply water enough for the whole year. As the area is devoid of electricity, our options are limited to the gravity flow systems. Therefore, given a more precise data of the climate and the temperature of the area for a whole year, an engineered reservoir system can be designed to store water for the dry season and then distributed according to the need.

Appendix
Figures
Water Quality Analysis

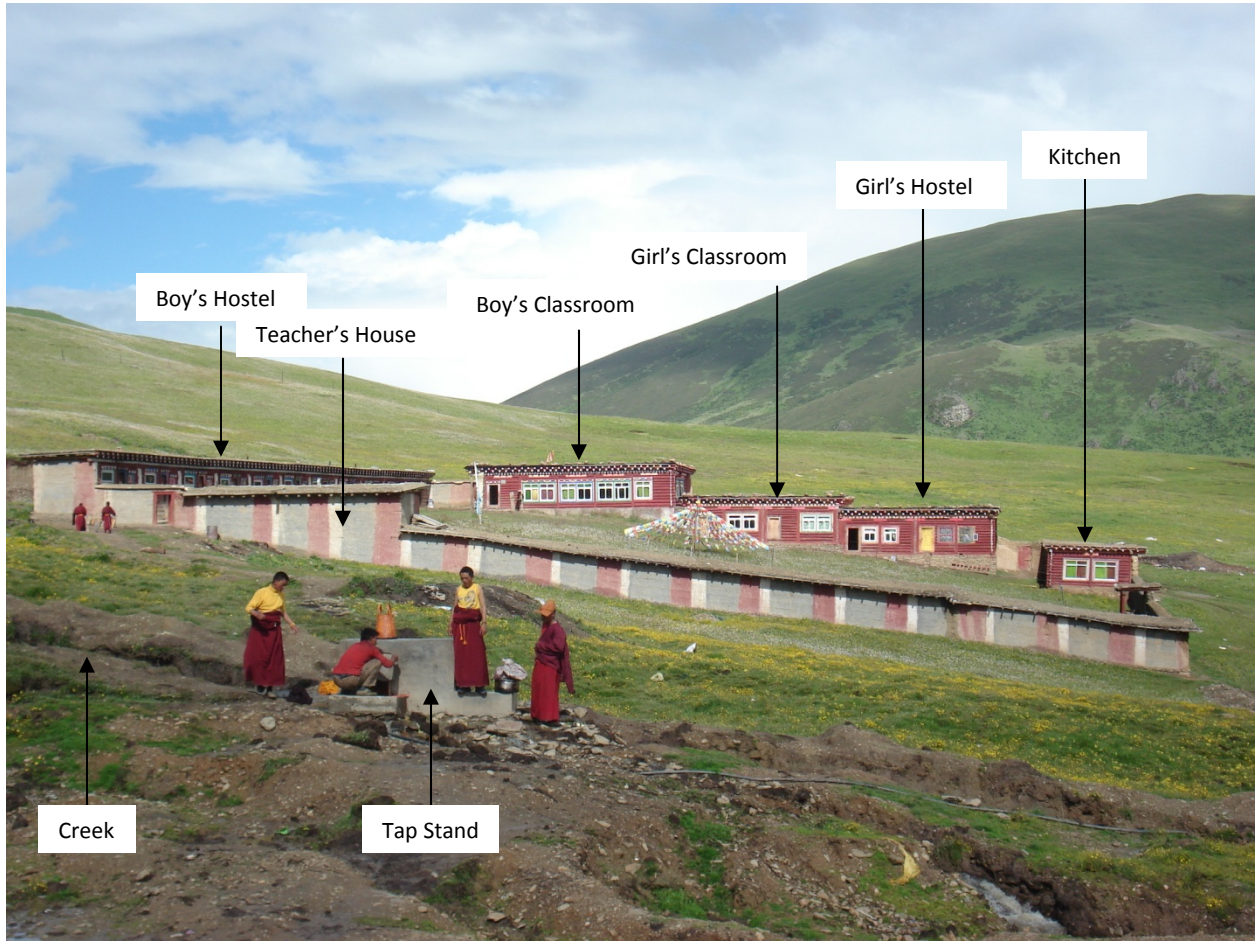


Figure 1: The relative location of the school from the tap stand.



Figure 2: Lower spring source (S_1) has a discharge of 17 liters per minute.



Figure 3: Upper spring source (S_2) has 4 different intake pipes with a total discharge of 63.9 liters per minute.



Figure 4: Winter spring source, groundwater seepage that villagers claim not to freeze during winter.

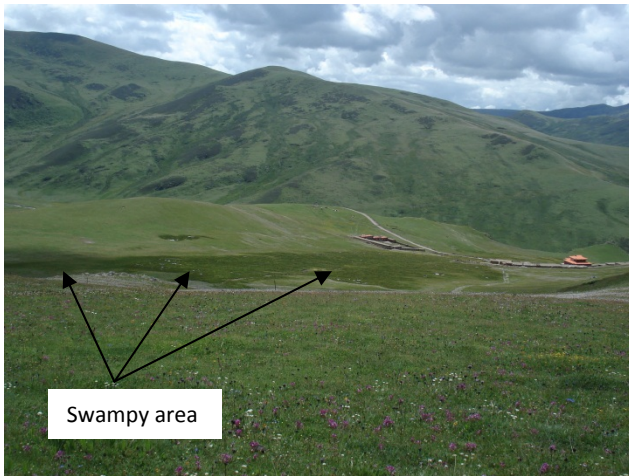


Figure 5: Swampy area (S_3) located approximately 510m above the existing tap stand. With a discharge of more than 31.2 liters per minute, this is a potential additional source to tap for water storage.



Figure 6: Spring water source in a different watershed by a different village.