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PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Building of spring-fed gravity-flow water supply systems in remote mountain villages of Lao PDR

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Action Contre la Faim (ACF) has been working in the field of water supply in Lao PDR since 1991. Since then, ACF has built water supply systems including water boreholes, wells, and spring fed gravity flow systems in more than 300 villages in 3 provinces of Lao PDR. The majority of target villages being rural villages, some of them with difficult access (up to two days walk), technical solutions have been developed for the building of gravity-flow water supply systems fed by springs in remote areas. For instance, plastic underground reservoirs or gabion structures have been used to replace usual concrete structures of gravity-flow systems. This paper discusses about the methodology and the techniques used to build such systems.

Background

Projects implemented by Action Contre la Faim (ACF) in Lao PDR since 1991 have mainly tried to address high morbidity and mortality rates in some rural areas through prevention of malaria and water-borne diseases. An important part of this prevention relies on access to clean water, focused on providing to high/upland population with water supply system to insure basic needs, providing appropriate development alternatives in situ, which allows ethnic minorities to remain in their original location if they wish to.

Over the past ten years, ACF has therefore put significant efforts on building clean water supply systems in targeted villages.

Work has been implemented together with the Lao department of clean water for rural areas (Nam Saat) and through a high participation of target communities. As a result, clean water supply systems such as wells, boreholes and spring fed gravity-flow systems have been built in more than 300 villages.

Experience gained over the 10 past years has demonstrated that, where it is technically possible, the best option is the gravity-flow system fed by springs (which is fortunately often the case for mountain villages). For small communities (up to say 1000 inhabitants) this system has several strong advantages indeed over other classical water supply systems: -

- It delivers water of constant and very good quality,
- It requires a low and infrequent maintenance and is reliable. This is of outmost importance, given that the level of education of targeted communities is low and is not adapted to other technologies requiring high maintenance skills. Moreover, construction materials and spare parts are hardly available, at least in some areas.

The possibility of implementing this technical solution should therefore be investigated prior to other classical water supply means such as well equipped with hand pumps as the latter are less sustainable.

As far as river-fed gravity-flow systems are concerned, ACF does not implement them as it considers that the water delivered by such systems is not drinkable. Moreover those systems require more maintenance that is not adapted for targeted communities.

For these reasons, only spring fed gravity-flow systems will be presented in the following paragraphs.

About 50% of the population in Lao PDR is located in mountainous areas. Most ACF target villages are located in those areas with, sometimes, no car or boat access facilities (ACF target villages are located up to two days walk away from the nearest car or boat access).

To be able to implement the building of spring-flow water supply systems in remote areas, ACF has developed innovative technical solutions.

Methodology for building of spring-fed gravity-flow water supply system

Feasibility study

This first step is carried out during the dry season in collaboration with villagers. First, a group discussion is held with villagers to assess the real needs of the village (ranking of water-related problems in the problem tree, health situation, interest in the participation in the construction of a water system etc.). If villagers are interested in building a water supply, local resources should be discussed thoroughly with them (location of water sources, distance, and reliability in terms of flow). This discussion is followed by a field visit to the different springs. Dry season yields are measured. Based on WHO recommendations, ACF considers that the quantity of water delivered by selected springs should at least reach 45 liters /day/per capita. Extrapolation is made for 10 years (taking into account a natural increase of population of 3% per year).

Once springs have been selected, a topographical survey is then made up to the village. Before placing tapstands in the village, a new discussion must be held with villagers to know where the village would like its water points to be located. The number of tapstands will, however, depend on the village population (1 tap for 75 people on average) and the village lay out. Moreover, tapstands should always be placed at the edge of the village with natural drainage lines. This discussion may be time-consuming, as several meetings may have to be held with villagers. It should, however, not be neglected. The topographic survey is then made to check the technical feasibility for each tapstand.

The next important step consists of evaluating the village potential in terms of local labour for construction and construction materials. ACF makes the technical design, provides the materials (cement, pipes, fittings etc.) and the technical support during the whole duration of the construction (with 2 technicians being assigned permanently to the village to advise villagers). However, the participation of the community is more than significant, as villagers will provide the local labour for construction to transport materials, dig trenches and so on.

Therefore, the local labour for construction of target communities is often a limiting factor in the implementation of classical water supply systems, especially if the village is not accessible by car. In this case, one should therefore assess: -

- The number of manpower and their capacity to work on the water supply system buildings (time of the year and compatibility with the agricultural calendar, other constraints such as acute rice shortage etc.);
- The walking time from the village to the nearest point accessible by car or boat. Transportation of construction materials (pipes and fittings, cement, tools, etc.) will be taken in charge by the organization up to this point. Villagers will have to transport materials by their own means from this point up to the village;
- The presence near the village (up to 2 hours walk) of rivers in which sand and gravel of good quality may be collected in sufficient quantity by villagers.

This assessment will allow adapting the technical design to village constraints.

Design of the water system

A classical spring-fed Gravity-Flow System is a closed system in the way that it is protected against external pollutions. It is usually composed of the following key elements:

1. The intake: this drains the spring water into the water system and protects it against water run-off coming from the outside. Intakes can be concrete structures or made with gabions. Gabion intakes are made of gabion walls. A layer of clay is set up on the inside of the gabion as a waterproofing layer. The concrete option is however, preferable for maintenance of facilities.
2. The sedimentation tank (BMC) is a small water reservoir that acts as a sedimentation tank. It can be built with concrete or made of a plastic tank buried in the ground.
3. The 'break pressure tank' (BC) is a small water tank that may be set up to reduce the water pressure in the pipes (if required). It is similar to the sedimentation tank.
4. Pipes used are high-density polyethylene (HDPE). They are buried 80 cm deep in the ground. Their diameter (usually 32, 40 or 50 mm external diameter pipes) is chosen according to in-situ parameters. Galvanised iron and PVC pipes are used, mostly on water tanks and tap stands. Galvanized iron pipes are also used over rocky areas and small river crossings.
5. Air valves may be set up on some systems to bleed air that may accumulate on highest points on the network. (Alternatively, for systems delivering sufficient quantities of water, the flow entering the main reservoir can be set up on the dry season flow).
6. The water tank is the last element prior to the tapstands. Its volume depends on both the flow of the spring and the population of the village. It is determined by technical design (if the spring flow is sufficient, no water tank needs to be set up). Water tanks can be made with concrete but for remote villages with difficult access to

Photograph 1. Concrete intake and its overflow in Namhee Village (6 hrs walk from road access)

Photograph 2. Building of gabion intake with clay (left) and set up of plastic sedimentation tank (right)

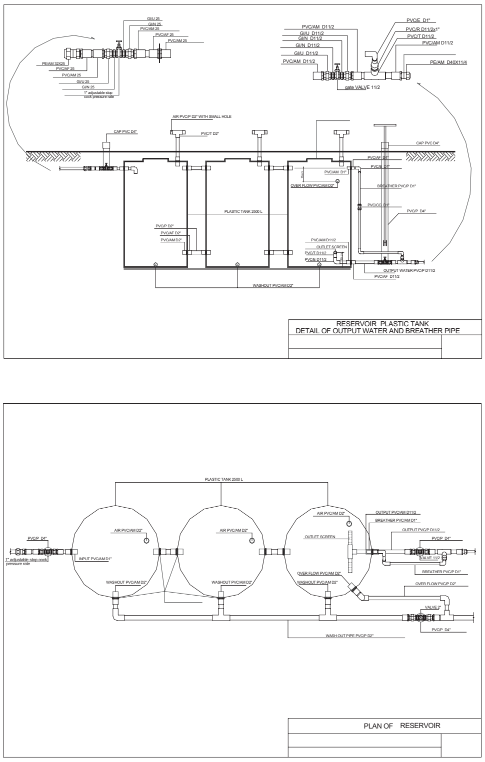

Figure 1. Design of underground storage reservoir from plastic tanks

Photograph 3. Underground storage water tanks made from plastic (before earth filling)

sand and gravel, plastic underground tanks represent an interesting alternative. Several units (unit size up to 2500 liters for transportation matters) can be assembled to reach the total required volume as shown in Photograph 3 and Figure 1.

7. Tapstands: are concrete and have an apron with drainage.
8. Taps: are self-closing.

Choice of technique according to available local labour resources

In villages where it is possible, one should build all the works i.e intake, reservoir and tap-stand with concrete as this material is obviously more resistant than gabion structures (intake or tapstand) or plastic (reservoirs).

However, for remote villages with difficult access to sand and gravel or for small communities, the above-mentioned alternative solutions are interesting as they allow to implement water supply building where it would not be otherwise possible.

From experience gained in the past ten years, the best compromise between quality and amount of work consists of building gravity-flow systems made of the following elements:

- Concrete intake,
- Underground plastic tanks for sedimentation tanks, break pressure tanks and reservoirs;
- Concrete tapstands.

When concrete water tanks are set up, they usually require greater amounts of sand, gravel, and cement and in turn greater labour for sand and gravel collection and transportation.

An order of magnitude of labour required for each works is summarized in the Table 1. This allows comparison between plastic underground and concrete water tanks:

For the example taken above, for a village of 40 families and

Table 1. Order of magnitude of labour required according to activity/works

Works	Activity	Number of labour days	
		Plastic	Concrete
Intake	Transport	-	200
	Building	-	42
Sedimentation /break pressure tank	Transport	10	170
	Building	50	80
Reservoir 4,4 m^3	Transport	45	440
	Building	60	315
Tapstand (2 taps)	Transport	-	181
	Building	-	54
Trench digging	5 m/cap/day	200	200
Pipe laying out	50 m/cap/day	20	20
Trench filling	10 m/cap/day	75	75
Total	**-**	**937**	**1777**

Note1: calculations are made for a 1000 m length gravity flow system 2 hours far away from road and sand/gravel collection point. For the calculation related to transportation, one assumes that 15 kg are transported per person per trip. Two trips are made per day (8 hours walk).

assuming that 1 member of each family works everyday:

- Option 1: The building of a system composed of one concrete intake, one plastic sedimentation tank, one set of plastic reservoirs of 4.4 m3 and one tapstand equipped with two taps would take 24 days,
- Option 2: The building of an equivalent system, but with a concrete sedimentation tank and a concrete reservoir, would take 45 days.

By experience, building of 'Option 1' systems usually takes about 3 weeks. Option 2 systems usually takes 6 to 8, weeks but is rarely implemented in remote mountain areas as limiting factors such as labour and sufficient quantities of sand and gravel in rivers are not often all met together (for instance if the village of the case study is made of 20 families instead of 40, the construction work would take at least 3 months, time that villagers can often not afford).

Cost comparison between the two different techniques

A comparison applied to the above example is made for the material costs for the two different options (concrete and plastic reservoirs).

In the example below, the total material cost for:

- Option1 is US $2,016
- Option 2 is US $1,863

The material cost is therefore slightly higher for Option 1 (8%). However, if the cost of village labour is taken into account (US $1 per man per day), Option 1 becomes 19% less expensive (US $2,953 for Option 1 against US $3,640 in total for Option 2).

If the cost of technical support had been also taken into account, the difference would be even greater, as building delays are shorter for Option 1 hence reducing the global cost when compared with Option 2 (all concrete made works).

Table 2. Material cost according to the type of works

Works	Type	Price ($)
Intake	Concrete	**$116**
Sedimentation / break pressure tank	Plastic 300L	**$147**
	Concrete 600L	**$192**
Reservoir	Plastic 2 *2200L	**$1,053**
	Concrete 4400L	**$855**
Tapstand (2 taps)	Concrete	**$220**
Pipe line HDPE 1000 m	Nominal pressure: 10 External diameter 32	**$480**

Conclusion

The use of underground plastic reservoirs allows building water supply systems of good quality in remote communities where it would not possible to do so otherwise because of excessive labour demand and poor accessibility.

Such water supply systems can even be made at a lower global cost which is

Based on a high community participation approach, the building of such systems has proven to be a success over the past 10 years addressing in an efficient and sustainable way the most basic need of rural communities.

When this water building activity is complemented with health education sessions (aiming at improving the awareness on water borne diseases and malaria prevention), qualitative surveys indicate that it has a real positive impact on morbidity reduction.

Photograph 4: Tapstand

References

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