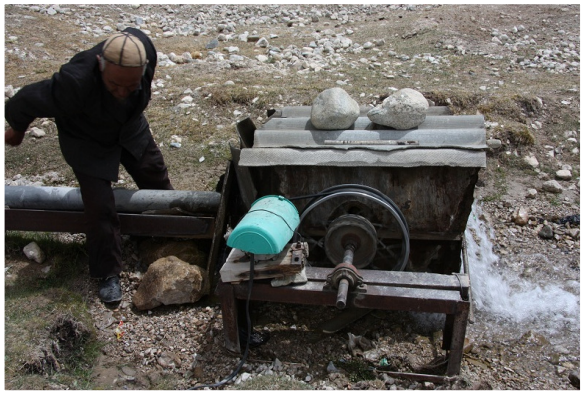
Report on hydro-electric potential in Shaymak, Tajikistan

Shaymak is a village of approximately ninety houses on the Aksu (or its tributary) in the far South-East of Tajikistan (approx. 74° 50' East, 37°30' North) at an altitude of 3852m.

There is an existing micro-hydro plant in the village, providing electricity for one household, and there was a proposal to build a larger plant to provide for the whole village.

Existing micro-hydro plant



A local homeowner has developed a micro-hydro solution in the village. Water comes from a hot spring in the side of the mountain above the village and, as a result, the water does not freeze in the winter. The water is collected behind a small dam then fed down a 50m long pipe, with 12cm diameter, to a water-wheel turbine. The dam water level is 3m above the level of the turbine (this is the 'drop'). The generated electricity is used for a television and lighting.

Two factors need to be considered when calculating quantity to generate hydropower: a flow rate of water (Q), and a head (H). It is generally better to have more head than more flow, since this keeps the equipment smaller. The formula for the calculation of potential power generation is as follows:

Potential output = 7 x flow-rate (Q) x head (H)

Flow-rate (Q) = Area of pipe (πr^2) x speed of water.

Head (H) = Available vertical fall in water, from upstream level to downstream level.

Radius of the pipe is 0.06m. Speed of the water was measured at 1m/s. The Head was 3m.

Flow-rate = π x 0.06 x 0.06 x 1

= 0.011m^3/s

Potential output = 7 x 0.011 x 3

= 0.24 kW or **240 W**

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Possible Improvements to existing plant:

- Improve the efficiency of the water-wheel to achieve an actual output closer to the potential output calculated above. A smoother pipe, without leaks and softer angled joints would stop power being lost before the water reaches the water wheel.
- Increase the drop by a few metres as the dam is below the level of the spring.
- The owner could start charging other people's batteries so that more people can benefit from the electricity generated.
- It may be possible to drill into the mountainside to access more spring waters and use a similar micro-hydro plant to the existing one on each of the new springs. This would depend upon the mountainside being stable enough for drilling to be carried out safely.

Proposed hydro-electric station for the whole village

The villagers of Shaymak have proposed using the larger river next to the village also as a source of hydro-electric power. They have defined a requirement of 30kW from the proposed plant to satisfy the whole village.

(Note: this requirement seems low in relation to the size of the village. Nevertheless, this was their stated requirement.)

The river is between 2m and 3m wide and 30 to 50 cm deep and does not freeze (unlike the one at the other side of the valley), as it is also fed by warm springs. It runs along the eastern side of a flat valley bottom, which, at Shaymak, is about 4km wide. Toktamish, the next village, is 86km down the valley and only 40m lower in altitude, so the average slope of the valley floor is less than 1m in 1km.

The proposal from the villagers was to use a pipe that they had already sourced to create a flow in a similar way to the existing micro-hydro plant. The pipe is 92cm diameter (i.e. 0.46m radius). The speed of the water in the river was estimated to be between 0.3 and 0.5 m/s in the middle of the river. The speed at the sides and bottom was less. The drop is assumed to be the same as the average valley slope (i.e. 1m per km). Hence, if the pipe was 2km long, the drop would be approximately 2m.

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Using these assumptions:

Optimistic potential output	= 7 x π r^2	x speed of water	x drop
	= 7 x π x 0.46 x 0.46	x 0.5	x 2
	= 4.7 kW		

This output would be very low in relation to the cost of building a 2km pipeline and would also not meet the (under)stated requirement of the village.

The villagers then proposed an alternative, using a pipe that got gradually narrower. They believed that this would increase the speed of the water. However, the flow-rate of the water in a pipe in m^3/s is not increased by this approach.

Building a dam and using all of the water in the river was also suggested. However, it would be cost prohibitive to build a dam more than 1m high and such a dam would also flood a huge proportion of the valley, impacting grazing for the villagers' herds.

Potential output	= 7 x flow-rate of whole river	x speed of water	x drop
	= 7 x 2 x 0.5	x 0.5	x 1
	= 3.5 kW		

Recommendation

The options considered for hydro-generation from the main river are **not recommended** as they would all be cost prohibitive.

However, the villagers could investigate alternative renewable energy sources such as solar or wind for electricity for their needs. There is evidence (Toktamish) that wind is a potential source and should the pilot in Toktamish succeed then a wind farm in Shaymak should also be considered.