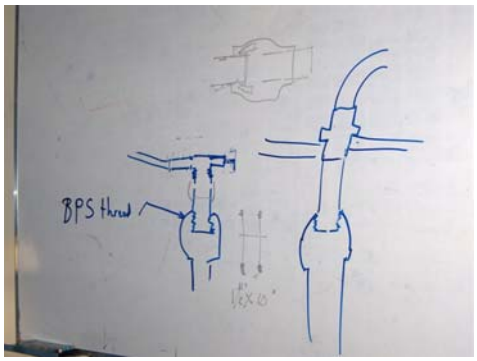
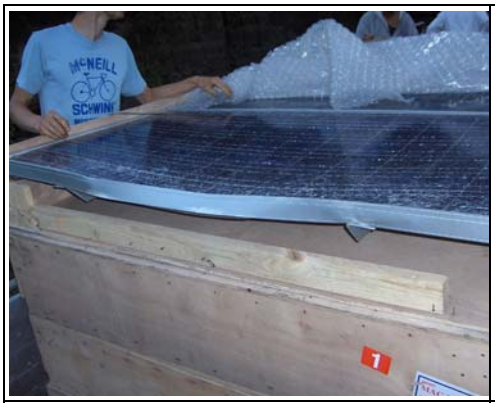
Green Empowerment
social justice - local leadership - sustainability

Installation of Solar Water Pumping System in Amgu-o (S. Cotabato, Mindanao, Philippines) August 2007

Step by step installation	**&**	**comments**
	**Aug 2: the Mono shipment arrived in Davao** **Aug 6,** in YAMOG's office in Davao, We review details of the project, drawing electric and hydraulic connection diagrams to make a list of existing and missing cables, fittings, T, pressure gauge, valves, sealant, tools and voltmeter, etc. We decide on final lay out of the 4 arrays next to the reservoir, so that Boy can go right away tomorrow and start the foundations. Bad surprise: the pump, made in Australia, requires a British standard thread. The Filipinos use the US standard. We will need a custom adaptor!	
		We also do a crash training/ refresher on PV design in general and on solar water pumping.. Bad surprise: Even though the import tax has already been paid, we can't get to the equipment for two days. We use the delay to prepare a Commissioning Report as well as User Documentation
		**Aug 8**: we finally are able to look inside the shipping container, but not to remove or move anything. Bad surprise: 2 out of 4 crates of PV arrays are visibly damaged. But we can't pull them out to look inside yet. As soon as we can load a truck, Joel will escort the equipment to the village.
		**Aug 10**: While Joel still waits for the shipment to be released, Nonoy, Michel & Marc go to the village by buses & motorcycle. Great surprise: the village has a welcome ceremony for us; 200 to 300 kids in the church watch the speeches and traditional dances in our honor.

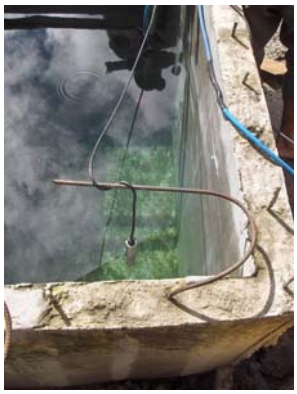
		After the ceremony, and while we wait for Joel, we tour the civil work in the village. The tank and distribution pipes to 8 tap stands are complete. Bad surprise: Somebody's cell phone gets a text message from Joel: one of the solar arrays is broken. We don't know the extent of the damage. The truck will arrive tomorrow.
		**Aug 11**. We go look at the foundation work started by Boy with carpenter and mason Moises and Bongbong. From the path down, the site looks hidden in the midst of thick vegetation. The 120m drop in altitude that villagers walk 2-3 times a day to fetch water takes us 20min. Going back up, we're drenched in sweat.
		Bad surprise: The truck broke down; the village leaders negotiate to rent another truck to go get the equipment, but it will take a while. To save time, we text Joel to bring at least the posts by jeep, so that the foundations can be completed. When he arrives, the bags of cement get loaded to horses to carry down to the site.
		The crew has been busy readying molds for foundations. Rebars are inserted in and around the posts The posts are lowered and positioned, and the concrete, using cement mixed with sand and stones from the stream, is poured.

		The foundations get completed, next to the holding reservoir built by the civil works crew.
		The reservoir will be fed by several springs, already captured in small boxes made by the civil works crew. For now, the springs still feed the traditional bathing and washing areas along the stream.
		The surrounding vegetation and mount Matutum loom over the site.
	Due to the rainy season's damage to the access road, the truck will have to use an alternate route and unload more than 1km away. There is some concern about how the heavy crates will be carried all the way to the site, down the slippery & eroded dirt road. The crates will have to be unloaded from the truck, but for security reasons, the crates can't be left on the side of the road through the night. A small crowd goes and waits for the truck to unload while there is sunlight. And wait… and wait… The truck arrives as night falls.	

		We have our first look at the damaged array. The end panel is warped, and its glass front shattered. We'll test its electrical characteristics by sunlight. The small parts are carried down by hand with flashlight. We worry while a large group of villagers promise they can carry the big crates down the slippery hill in the dark! They say they are used to it, and don't need us.
		**Aug 12** early morning Amazing! They did it without damage. A makeshift tent was set up for somebody to stand guard all night by the crates. We open the crates and test the electrical characteristics of each array. All meet specs, except the one with the broken panel.
		Villagers attach bamboos to the array frames to carry them down the steep foot path. They hacked a short cut by machete around the most tortuous part. The pastor's window drapes are used to protect the front of the panels.
		While we are dealing with the PV arrays, Joel has gone to Polomolok to get GI (galvanized iron) pipe, cut and threaded to the proper dimensions to connect the pump to the bore cap, the bore cap to the Tee, etc. He is also looking for PVC casing to hold the motor in place in the reservoir, and to support the bore cap.

		The arrays are stored temporarily next to the stream while the concrete foundations cure. The pump is carried to stay in the reservoir. Given the size and configuration of the reservoir, we decide to position the pump vertically as recommended, under Mono's bore cap, instead of horizontally as thought at some point.
		Back from shopping, Joel is improvising a resting nest for the motor, by poking holes in a plastic casing cap to let water circulate around the motor. Good surprise! The threading shop in Polomolok told him that British and US threads are the same! When we test the pipes he brought back, they fit! We will still try the HDPE Tee we have, though.
		
		After assembling a Tee for testing and connecting the pump to the delivery pipe, everybody is anxious to install the arrays, even though the concrete has only had 24 hours to sure. Boy, the civil engineer, agrees given the configuration vs. load. Villagers carry the first array and place it on top of the posts closest to the pump, with a temporary, approximate tilt angle.

		Time to install the controller, and do some electrical tests on the first array.
		The other arrays are brought and positioned.
		Even the broken array is installed, to get it out of the way and in case the pump can't operate without its partial power. Mono's CASS software, used in the village, has told us the pump should function with only 3 arrays, delivering less than the design daily water flow. We will check tomorrow, when there is enough sunlight.
		**Aug 13**, bright morning sun. First success: without counter pressure the pump operates normally. Now we can wire the water level probe and test its operation.

		We find the optimum level for the probe, and the technicians mark the spot on the reservoir cement to know where to position inside the reservoir it once the cover is complete.
		The arrays are fastened in the optimal angle of 10 degrees (facing South), and wiring is connected between the three good arrays.
		Moises & Bongbong cut and prepare the wood frame for covering the reservoir, leaving space for a man-hole and the casing for the pump. Protruding rebars are cut from the post foundations.
		We finally get the coupling needed to connect the pump to the delivery pipe. Noon: Everybody anxiously watches as Boy switches the arrays ON, and the controller ON…

The pump starts and works for a few minutes. The pressure rises as water makes it way up the pipe towards the village.

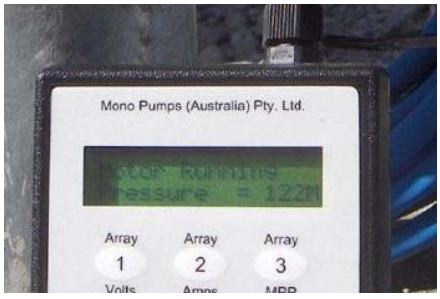
Darn! The slip-fit HDPE Tee coupling to the galvanized (GI) pipe doesn't stand the pressure and slips out!
We will need a set of GI fittings instead.
Boy is dispatched to Polomolok by motorcycle to find & buy those parts.

The rest of us has lunch and waits while the sun descends to the west

3:30pm - We are back with all the GI pieces needed. Finally, everything gets assembled securely, and we rush to switch the system ON before the sun gets too low.

We watch anxiously, as the pressure slowly increases, both on the pressure gauge dial and on the Mono Diagnostic Unit (SDU).

At 4pm, the pressure reaches about 100m and stops rising. The pump turns slowly, but apparently there is not enough sun to push the water all the way up the hill.
Eventually the pump stops, and the controller light shows "overpressure".
We take the SDU & leave the system on, anxious for morning to arrive.



Aug 14, 7am, bright sun.
When we arrive at the pump, the controller still says "overpressure", and the SDU shows more than 200m of pressure! We find out that somehow the "pump model" in the SDU is erased, showing "000". After reprogramming the system for pump model 042, the pressure reading matches the pressure gauge, and the pump re-starts.
8am: Success! The pressure stabilizes at 122m, the water is pouring in the tank in the village!

Both gauges match, everybody is elated.

Time for a group picture

		May the feast begins! A prayer takes place near one of the springs, chickens are slaughtered. Two ducks are slaughtered right over the pump, and some blood gets mixed into the water going to the village. Traditional forest rice cooking starts, in bamboo cut right next to the stream.
		While cooking takes place, we conduct the community training, showing details to the designated operators and anybody who wants to watch. Pastor Nonobert Malit translates from English into B'laan.
		Finally, the commissioning report, manually filled with the site-specific technical data, gets signed by Joel for YAMOG, Pastor Nono as community leader, and Michel. We review with Joel the finishing touches that are needed, including a permanent way to hold the delivery pipe above the stream.
		We can finally relax and partake with the villagers.
		As we start climbing back up to the village, we check the tree nursery that will allow the village to improve and preserve the watershed. There is now a small crowd admiring the water that reaches the tank. Moises has been using the first water to clean the concrete inside the tank.

Quantitative impact data
The complete water pumping and distribution system will serve a total of approximately 700 people in the village of Amgu-o, plus children from other villages attending school during the day. The water system might now attract more people and increase the village population as well as housing plot prices.

Technical specs
Location: 6.35 deg N, 125.13 deg East, on the island of Mindanao, The Philippines
Design goal: provide minimum 14 m³ of clean water as a daily average for the minimum average monthly insolation (on tilted fixed array) of 4.6 kWh/m^2/day.
Total static elevation from water level to the tank: 118 m.
Surface water from a spring, maxi available flow rate = 2 liters/sec (maybe 1.5 at the driest season)

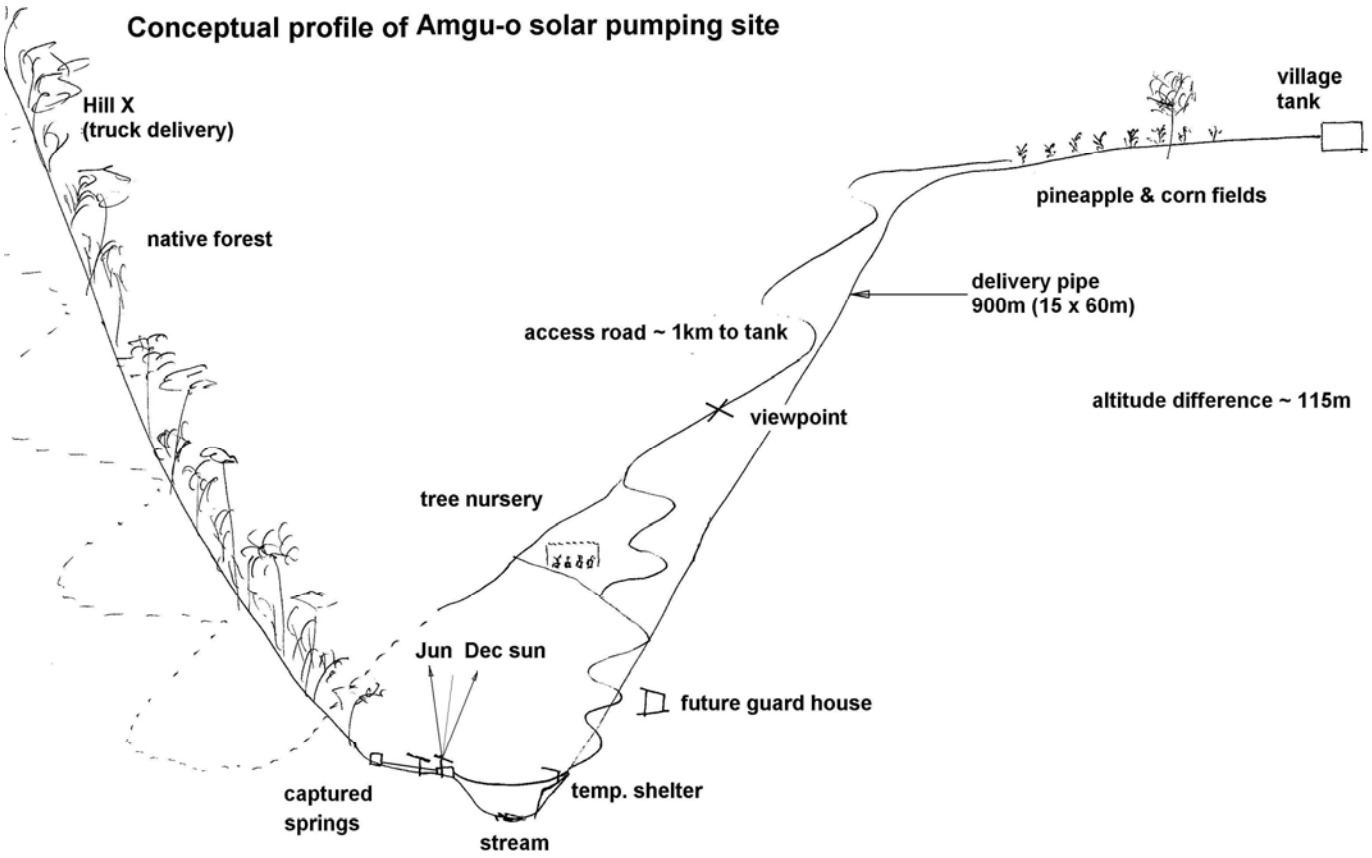
Delivery pipe to the tank: 15 rolls of 60m each 1 ½" HDPE, for a total length of 900m.
Tank size: 42 m³, equivalent to 3 days of storage

Pumping system: Mono Pump Sun-Sub SM042, with Series 3000 Solar Motor Controller,
2400Wp of PV panels, comprised of 16 BP Solar 3150S (150Wp) PV panels in 4 arrays of 600Wp each.
SUN S0346 pump protection water level probe.
Optional Mono handheld display unit (SDU)

Pump peak flow rate: 0.6 l/s (Mono had to select a pump for this system that is lower in flow than ideal because of the high operating pressure. A higher peak flow with a larger pump would require too high motor currents. Since the pump has a lower flow rate, the system is designed so that it reaches full speed before midday and runs at full speed for around 4 hours before starting to slow down.)

Work left to do by YAMOG starting August 14
- cover the reservoir and secure the pump and level probe in their final spot,
- anchor and tie permanently the delivery pipe above the stream,
- install a drain around the foundations to avoid erosion
- install the grounding rod which was forgotten in Davao

Other work the villagers plan to do
- Build a sturdy fence around the system
- build a guard house overseeing the system
- install a high fish net around the system to potential catch objects being thrown at the arrays



Due to rainy season damage to the access roads, truck delivery happened on the hill marked X (left of drawing), about 1km farther away than planned. Plus, there was a steep path to reach the site from the road.

Lessons Learned

Mono's "plug and play" kit makes the electrical set up easy and insures good quality connections
BUT pre-assembled arrays are too big and heavy and inappropriate for transportation to such remote places. Crates that look very sturdy can be destroyed by handling, probably during consolidation from one container to another in a hub harbor. In addition, such crates should be clearly marked "Fragile".
With the standard MC connectors built into the BP Solar panels, proper electrical connections are quite feasible in the field without needing pre-assembly.

The fact that the PV system was oversized in order to operate the pump at full speed for 4 hours, saved us when one of the 4 arrays was unusable; With 1800Wp instead of 2400Wp, the system was still operational, although at less than intended water delivery per day.

Time and energy was lost because of lack of clear communication:

- We received the information early on that the pump outlet used 1.5" BSP thread, but nobody checked whether that meant a special order. It wasn't clear that the Mono 'bore cap' also included a thread for the 'rise pipe'. (SunPumps 'well seals' are slip fit for the recommended 'drop pipe' size)
- We had foundations specs early on for each array post, but had not communicated clearly enough on the specific placement of the 4 posts with reference to the reservoir and E-W orientation.
- We did not have a conclusion on exactly what type (GI vs. HDPE) of fittings were needed for this pressure.
- Information provided in attachments sometimes cannot be read due to e-mail access limitations.

Recommendation for next project: keep a running list of technical questions and answers, and document a detailed 'bill of quantity' including all fittings.

Extra costs not correctly forecasted in the original budget, to include in future projects:

- Import tax and broker fees (this varies greatly by country); we thought we could get a waver for this type of project, and the exact amount was not known until it was time to write the check.
- Currency exchange rate fluctuation of 10% between proposal time and implementation time.
- One optional accessory (AC backup) was ordered and delivered, but cannot function with the Philippines AC characteristics of 220V /60Hz; YAMOG will attempt to return it to Mono for a refund, but has already incurred import taxes on it and shipment back will be costly.
- Penalty cost of re-scheduling consultant plane tickets due to late shipment + delays.