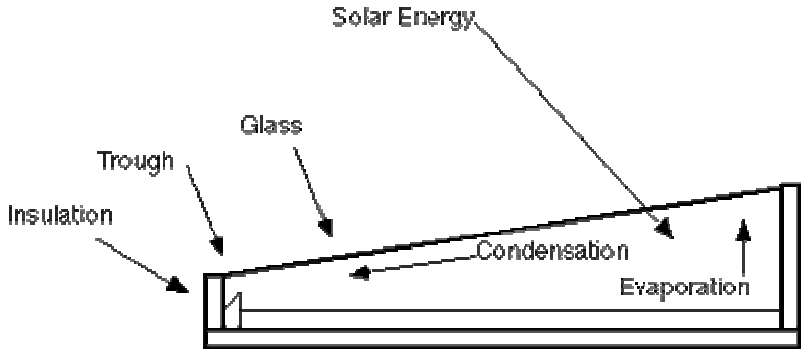
A Demonstration of Solar Stills to Desalinate Seawater

Phase 2



Project Proposal
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"The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses"
General Comment No. 15 (2002): The Right to Water.

- UN Declares 2005-2015 "Water for Life" as the International Decade for Action and set's the world agenda on a greater focus on water- related issues.

"We shall not finally defeat AIDS, tuberculosis, malaria, or any of the other infectious diseases that plague the developing world until we have also won the battle for safe drinking water, sanitation and basic health care."
Kofi Annan, United Nations Secretary-General

Eight Millennium Development Goals were agreed by the Member States of the United Nations at the Millennium Summit in 2000. The targets state that the proportion of people worldwide not having access to an improved water source, and the proportion of people worldwide not having access to adequate sanitation facilities, should be halved between the baseline year of 1990 and 2015.

Summary

Vanuatu is fortunate in that much of the country has plentiful springs, streams, and rivers that provide drinking water for the rural population. However, there are many small islands, and portions of larger islands, that are entirely dependant on rainwater collection for their drinking water (approximately 15% of the population). This is problematic when the dry season is longer than usual, the rainy season is shorter than usual, there are unexpected dry spells, or there are other problems due to the erratic nature of weather.

We found in our Demonstration of Solar Stills to Desalinate Seawater Project that we could readily change seawater into drinking water and we could do so in a solar-powered process that has no moving parts and uses no fuel. Solar stills can be site-built using inexpensive materials and they can be operated by unskilled labor. This is a dramatic departure from most methods of desalting seawater which are both energy intensive and expensive. These characteristics are also very much in line with the needs and limited resources of small, coastal communities in Vanuatu.

This second phase of the Solar Still Project is based on the successes and lessons learned during the demonstration phase of the project which took place on Rah Island during 2004 and 2005. In this phase of the Solar Still Project, Vanuatu Renewable Energy and Power Association will design and working with the community, construct a site-built, village-scale "distillation plant" on Rah Island. Rah has been chosen for this phase of the project due to the strong community buy-in shown during the demonstration project.

Project Ideologies

PRINCIPLES: Solar distillation purifies water where there is already an adequate supply, albeit a supply that is not fit for human consumption. This technology is best suited to improving relatively small amounts of water in isolated areas. As such, the solar distillation of seawater is an ideal solution for small, remote, island communities.

The basic principles involved in solar distillation are quite simple. Solar distillation is a thoroughly researched direct use of the sun's energy. The physical laws governing solar distillation are simple and universal. They involve four sequential steps. These are:

a. The production of vapor from a body of water using the sun's energy for the heat of vaporization.
b. The transportation of the warm vapor upward to a region where it is cooled.
c. The condensation of the vapor and its accumulation into water droplets.
d. The descent and collection of the condensed water due to gravity.

On a global scale, these four steps are the basis of the water cycle, which produces rain. The following diagram (Figure 1) is a graphical depiction of the water cycle:

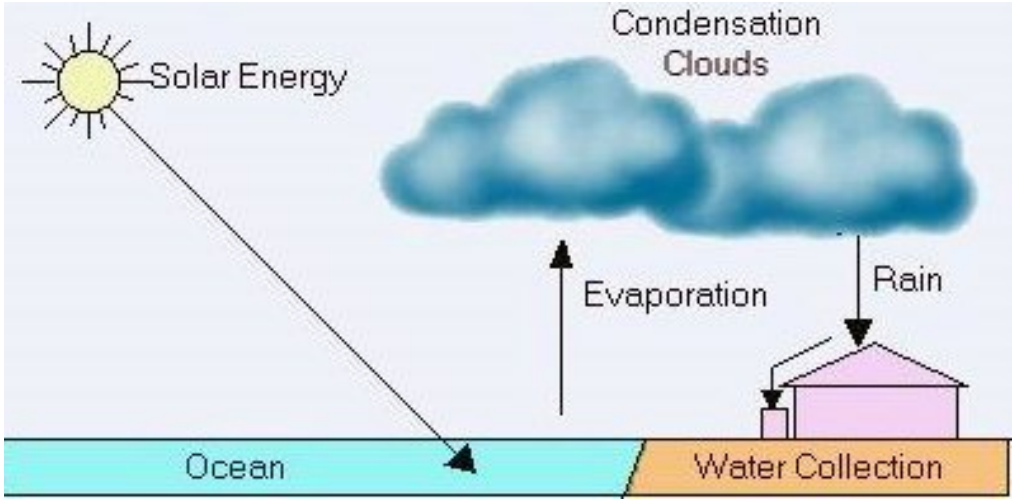

Figure 1: To make rain, solar energy heats water and evaporates it. Leaving behind salts and contaminants. The water condenses in clouds, and returns to earth as rainwater. (Diagram from El Paso Solar Energy Association)

The same steps occur within the solar still. Essentially, a solar still makes "rain in a box." The following diagram (Figure 2) illustrates how this happens:

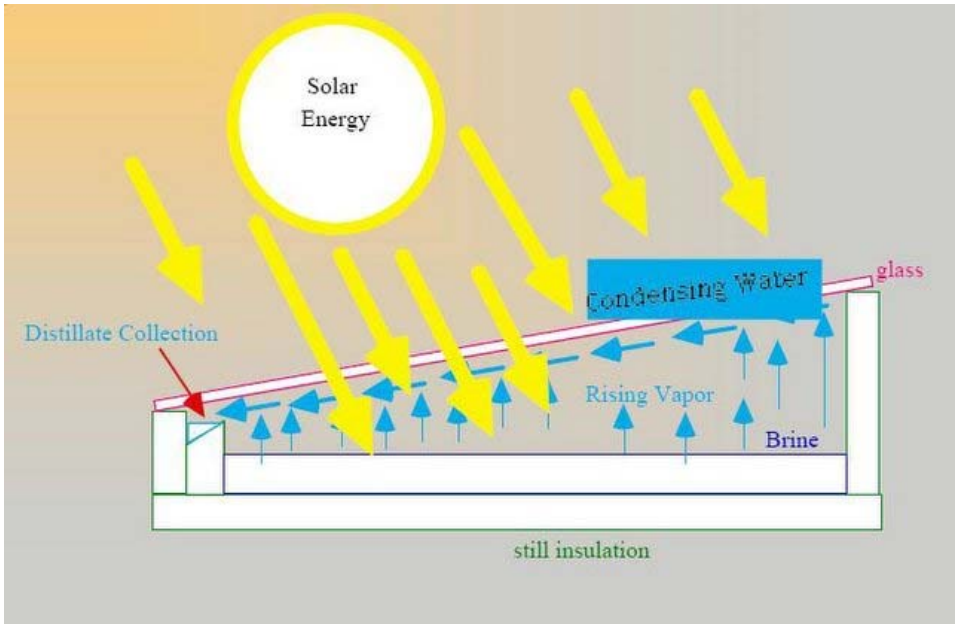

Figure 2: Solar distillation is a way of making "rain in a box." (Diagram from El Paso Solar Energy Association)

DEMONSTRATION PROJECT: Excellent results were achieved during the demonstration phase of this project. Not only did the stills perform well technically, they produced as much or more water than expected, and the community buy-in and ownership of the project was very strong.

Figure 3: The solar distillation "plant" on Rah Island.

There is a hand-dug well some distance from the community on Rah. The quality of the well water is poor (brackish, dirty.) However, during very dry times it was a place where villagers could go to get water. Since the solar distillation project has been operational on Rah, no one has gone to the well for water and the path to the well is overgrown and nearly impassable. The villagers are very proud of this "proof" that their solar distillation project is a solution to their drinking water problems.

SYSTEM DESIGN: Each still will be constructed of a poured concrete slab with concrete walls that are poured-in-place. Both the slab and the walls will be blackened to aid in heat absorption. The clear cover will be fabricated from corrugated polycarbonate, a very strong plastic.

Seawater will be pumped from the sea to holding tanks near the stills using solar pumps. This will eliminate the time consuming task of hand carrying seawater from the ocean to the project sites, adding efficiency to the system. If for some reason the pumps fail, water can be carried by hand while the pump is being repaired. After checking the water output from the previous day, the stills will be refilled from the tanks each morning. The water in the still will evaporate throughout the day. It is important to note that only the water evaporates, the salt and any other impurities remain in the still. As the ambient air temperature cools in the evening, the water vapor in the still will begin to condense on the inclined surface of the cover. This condensate will trickle down the cover to a collection trough which will drain into a collection container. In the morning, the distilled water is measured and put into tanks, the stills are flushed and refilled, and the process is repeated.

As part of a comprehensive water management scheme, the project will construct a rain catchment shelter and ferro-cement water storage tank at the project site. In this way, the system should provide adequate drinking water regardless of weather conditions.

PROJECT MANAGEMENT: The aim of this project is not to replace rainwater harvesting with the solar distillation of seawater as a primary source of drinking water. Rather, it is the integration of the two technologies so that the erratic nature of rain and weather in general does not impact the drinking water supply of remote, coastal communities. The integration of the solar distillation of seawater and rainwater harvesting could supply remote coastal communities with adequate dinking water supplies, regardless of the weather. However, projects frequently succeed or fail not because of the strengths of the technologies involved, but because of the strength of the management of the project and the degree of ownership the communities take in the projects.

As the community will ultimately manage its own water supply, training in the management of a community water supply is a key component of the project. There will be a participatory management trainer, who will facilitate dialogue that will enable the community to take ownership of the project and help maintain an active willingness of medium- and long-term participation. This is central to the delivery of a sustainable project.

The community will also be encouraged to use this water project to generate income to cover system maintenance costs. In order to encourage sustainability, the community will be asked to develop its own plans for income generation. Some income generating ideas that the community may like to consider include:

- The making of salt from the waste brine. This would be a fairly simple process. Villagers could at the least use the salt for personal consumption, thereby eliminating the need to buy table salt from local stores, and quite possibly sell the locally made salt to tourists in some of the "touristy" areas of Vanuatu.
- Seawater will be pumped from the sea to the stills by solar powered pumps. As a relatively small volume of water will be pumped a short distance, there will be excess capacity in the solar system. This excess capacity could be used to charge lanterns. Rechargeable lanterns typically give off a much higher quality light than kerosene lamps and they are less expensive to operate than kerosene lamps. Villagers could pay a small fee to recharge their lights. The fee would be less than what people already pay for kerosene. This could generate a fair amount of income for the project, give the project "higher standing," and transform the water utility into a water and light utility.
- This surplus power could also be used in battery charging stations where villagers could rent fully charged rechargeable batteries. When the batteries are flat, they would be returned to the station for charging and recharged batteries would be rented. This would save a great deal of money for the end-users, generate income for the community/utility, and reverse environmental degradation caused by haphazard battery disposal. (Note: VANREPA has already successfully tested this model in Vanuatu.)
- The communities that have these seawater distillation projects could be contracted by donors or government agencies to build them in nearby communities.
- System users could be requested to pay a fee to cover the cost of the water.

The Vanuatu Renewable Energy and Power Association (VANREPA) will also work with Torba provincial authorities to establish a province-wide water utility (which may be a government or non-government entity.) This utility will provide support to the community, especially with regards to management and sustainability of

the project. The utility will help the community to use its water project to generate income (see above.) This will help ensure that the initial project is sustainable and that the project can be replicated at other sites in the province without the need for further donor involvement. It is expected that the Torba Rural Economic Development Initiative (REDI) will assist with the development of the utility.

Project Activities

Vanuatu Renewable Energy and Power Association (VANREPA) will design and working with the community, construct a site-built, village-scale "distillation plant." The plant will consist of four stills that will be constructed of poured concrete slabs and poured in place concrete walls. Both the slab and the walls will be blackened to aid in heat absorption. The clear cover will be fabricated from corrugated polycarbonate, a very strong plastic. The plant will also consist of a rain catchment shelter and ferro-cement water storage tank at the project site. In this way, the system should provide adequate drinking water regardless of weather conditions.

The stills will have a design capacity of approximately 50 liters drinking water output/day. There will be four stills constructed on Rah Island for a design capacity of approximately 200 liters/day. VANREPA will assist the community in the construction and commissioning of the stills. The community will be trained in the day-to-day operation of the stills and in the successful management of a water project (se previous section.) The community will manage the project. The community will form a water management committee (utility) which in turn will select individuals to perform the day-to-day tasks. Vanuatu Renewable Energy and Power Association will assist the community in developing strategies to sustainably manage this project. VANREPA will work to establish a provincial water utility which would also provide support to the project.

Vanuatu Renewable Energy and Power Association will produce a user's manual in English and Bislama. VANREPA will also conduct hands on training sessions for the operation of the systems with key project participants. VANREPA will design an appropriate maintenance regime and produce a maintenance manual in English and Bislama.

VANREPA will visit the project site six months and one year after construction. These visits will allow VANREPA to survey the users and adjust operation and maintenance procedures as appropriate.

Goals and Objectives

- To solve the serious water shortage problems on Rah Island in the Banks Group.
- To empower local communities to solve their own water problems.
- To train local people in the construction of solar stills.
- To compliment various global water agendas (UN initiatives, Millennium Development Goals, etc.)
- To design/prototype a village scale solar still and water management scheme.

Sustainability

Solar stills require no fuel to operate, only sunshine. Therefore there are no ongoing fuel costs. There are no moving parts in solar stills so maintenance costs are negligible. The stills are robust and should last many, many years.

Multiplier Effect

Not only is this project sustainable, it is very easy to replicate it in other coastal communities throughout Vanuatu. Therefore, it could have a major impact on a significant percentage of the population in a short period of time.

Beneficiaries

The entire country will benefit from this project through education and awareness raising. In addition, the community on Rah Island will directly benefit from an improved drinking water supply.

Benefits to Women

Providing her family with water for drinking and cooking is one of a woman's primary responsibilities in rural communities in Vanuatu. Therefore, providing a more reliable water supply will greatly improve the quality of women's lives.

Phase 2 Solar Still Project Budget

Construction Materials - Stills

Concrete formwork	16,000 vatu
Cement and reinforcing iron	130,400 vatu
Iron framework	109,300 vatu
Polycarbonate sheeting	256,600 vatu
Neoprene sealant	43,300 vatu
Guttering and silicon tubing	25,300 vatu
Insulation	38,000 vatu

Solar Pumping Materials

Solar panels	120,000 vatu
Solar controllers	18,650 vatu
Batteries	73,800 vatu
Wires, fuses, and fittings	11,700 vatu
Solar pumps	54,500 vatu
Hoses and fittings	39,250 vatu

Tanks and Containers 270,000 vatu

Technical Support and Assistance 1,360,000 vatu

Domestic Travel

Airfares: 6 x vila/mota lava/vila	231,240 vatu
Land transport	18,000 vatu
Per diems: 42 x 1,500 vatu	63,000 vatu

Freight 85,000 vatu

Administrative Support 300,000 vatu

TOTAL DONOR COSTS 3,264,040 vatu

Community Contribution

Land rights
Sand
Coral
Labor