CASE STUDY

DRINKING WATER

Harvesting Water
from Fog in Limpopo

By Vaishali and Ajay Singh

Namib Beetle inspires new 'fog harvesting' technique.

Limpopo is the northernmost province of South Africa. South Africa is an arid country in which large sections of the population have inadequate water supply. It is one of 30 countries with the worst water scarcity in the world. The country's average annual rainfall of 450mm is nearly half of the global average of 860mm per year. Only 35 per cent of the country gets more than 400mm of annual rain, and with few unpolluted surface water sources, many contaminated ground water supplies and water tables that drop out of reach during drought.

The Problem - Lack of Water for School Children

Tshanowa Junior Primary School in Limpopo is frequently shrouded in dense mist and rain, but the nearest water sources are a non-perennial spring located 2km away, and a dam, 5km away. Since most water sources in the province are contaminated, the quality of the dam water is suspect. The 130 school children rely on what water they can carry with them to school each day and villagers were forced to rely on inadequate water sources including pools fed by springs, often shared with livestock. There were many incidences of waterborne diseases for the school's children.

Over a third of the more than 4,200 schools in Limpopo Province lack a reliable water source, affecting the health of some 54,000 children according to a University of Pretoria study which used Geographic Information Systems (GIS) data to find locations suitable for harvesting rainwater from fog.

Source of Inspiration: Namib Desert Beetle

The Namibian Beetle (Stenocaragracilipes) lives in one of the driest deserts in the world, the Namib on the southwest coast of Africa, but obtains all of the water it needs from ocean fog due to the unique surface of its back.

The Namib Desert is characterized by high temperatures, strong winds, and negligible rainfall, but it does experience nocturnal and early morning fogs that move in from the Atlantic Ocean. The fog droplets are unusually small, about 1-40 microns in diameter (human hair is about 50 microns in diameter) so could easily be carried off by the hot desert wind. To capture these droplets before they're gone, the darkling beetle faces into the wind and unabashedly sticks its rear end high in the air as if mooning all the beautiful creatures of the world, and starts to literally drink the fog as the droplets readily condense on its bumps and role down deliciously into its mouth. Observations suggest each beetle gains an average of about 12 percent of its body weight after fog-basking.

These clever darkling cover each 100-500 micron diameter bump with material that attracts water droplets (hydrophilic), while the area covering the 500-1,500 micron distance between each bump repels water (hydrophobic). As the tiny fog droplets cling to the top of each bump, they start to aggregate into bigger and bigger water droplets. At diameters of 4-5 mm, the weight of the droplet exceeds the forces attracting it in the first place, as well as the force of the desert wind, so it simply rolls off. Once in the trough between the forests of bumps, the droplet has no choice but to keep moving forward due the angle of the beetle's body and the waxy pavement. The highway system born of the configuration of bumps and troughs directs all traffic to the beetle's mouth.

Solution: Beetle-Inspired Water Harvester

South Africa is following the lead of a desert beetle in tackling the problem of water scarcity




in the country's drought-prone Limpopo province, where remote rural communities live far from reliable water sources - yet in areas that are often shrouded in mist.

Although unconventional, the technology behind fog collection is amazingly simple: Fog water collection uses large polypropylene mesh nets on ridges to capture water-loaded fog, which forms in humid months in mountainous regions or coastal areas. The meshes are erected perpendicular to the prevailing wind. The mesh captures small water droplets (1 to 40 µm), which trickle into a collection trough or gutter and drain into a series of tanks. Trees and grass intercept fog in a similar way. Intercepted fog is commonly of a good quality, but may be affected by air pollution, dirt on roofs or rust on metal sheets. If measures are taken to prevent the first polluted flush entering storage tanks, water can be fit for drinking and other domestic use with little or no treatment. ☞ **www.southafrica.info**

The Tshanowa Junior Primary School is located at the crest of one of the easternmost promontories of the Soutpansberg, at 1004m above sea level. Despite its relatively low elevation, this region is ideal for fog collection in that moist maritime air from the Indian Ocean moves over the escarpment and against the mountains during the night and early morning. This cloudiness sometimes persists throughout the day.

After several efforts, a fog water collection system was erected on vacant land adjacent to the school and local inhabitants were employed to assist.

Each fog collector consists of three 6m-high wooden poles, mounted 9m apart. Steel cables stretch horizontally between the poles, and from each pole to the ground. A double layer of 30 per cent shade cloth is draped over the cables, and fixed to the poles on each side. Water dripping from the net into the gutter runs through a sand filter and is then emptied into a tipping bucket. From there, it flows into a 10kl storage tank further down the slope. Two additional tanks were erected at the school to collect the overflow from the first. An automatic weather station was also installed to record rainfall, wind speed and wind direction. ☞ **www.scienceinafrica.co.za**

Conclusion

Within four days of completion, school children and members of the local community were drinking water collected by the fog screen. Although weather conditions have made accurate data collection difficult, daily yields of as much as 3800 l of rain and fog combined have been recorded. The average collection rate from March 1999 to April 2001 is over 2.5 L per square meter of fog screen. The giant fog screens at Tshanowa Junior Primary School in Limpopo province are providing pupils and members of the community an average of between 150L and 250L of water per day.

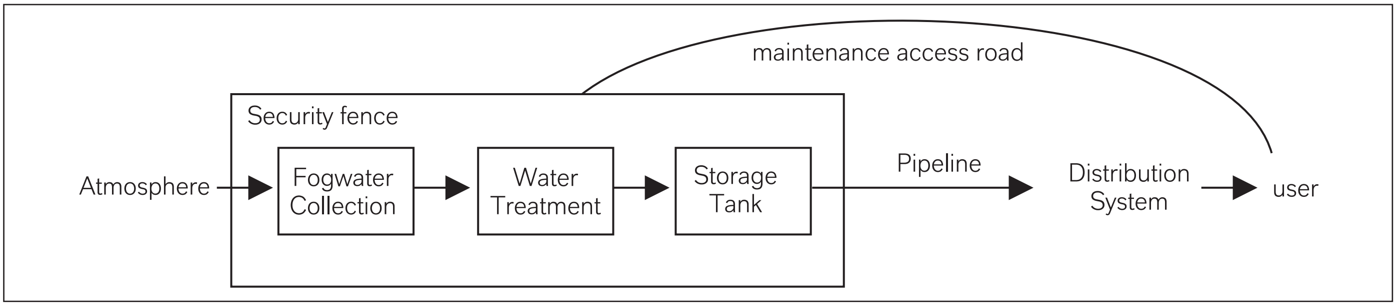
Water harvested from the fog is entirely pure, and is obtained from a source that needs no fuel and has no moving parts that can break down. The community is now being trained to look after the net and the government has pledged to support the initiative in other suitable sites. Villagers are already clamoring for help to install additional netting and trap more water.

It shows that in terms of quality and magnitude of yield, fog harvesting could go a long way to alleviating water shortage problems in the fog-prone mountainous regions of the country. "The costs are low, the technology is simple and the source is sustainable for hundreds, even thousands of years.

Suitable Conditions for Fog Harvesting

Fog collection is most suitable for locations with frequent fog periods. Upland areas where fog is produced by the advection of clouds over the terrain or where clouds are forced to rise over mountains are most suitable, in areas of prevailing winds between 3-12 m/s and with no obstructions to wind flow. Fog formed on the ocean surface, or nocturnal radiation fogs in low-lying areas normally lack sufficient liquid water content or sufficient wind speeds for substantial water collection. Examine meteorological records and consult local people about their observations.

A number of meteorological and geographic considerations are important in choosing a site: predominant wind direction (persistent winds from one

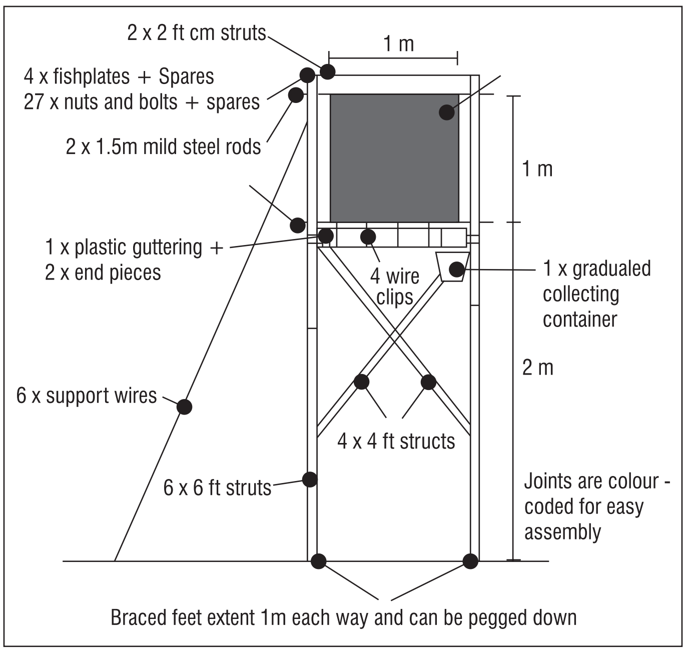


direction are ideal), clouds forming below the maximum terrain height, sufficient space for the fog collectors, and no major terrain obstacles. In the case of coastal cloud decks, the mountain range should be within 5 or 10 km of the coast.

If sufficient water is collected, vegetation or crops can also be planted and sustained. Once vegetation is established, it can sustain itself by catching the fog droplets directly.

Scope in India

Fog is a regular feature during winter season in north-east India, particularly on mountainous regions like Sikkim, Meghalaya, Mizoram, Manipur etc. Also, there is a major problem of water scarcity in these regions during winter when the rain ceases. Therefore, Fog harvesting should be looked at favorably while trying to ensure supply of clean water in this region. But such a method should be looked at favorably when trying ensuring the supply of clean water in those regions. Option, however, is not as simple as it appears. The North-East has a complex topography and harbors many micro climates.

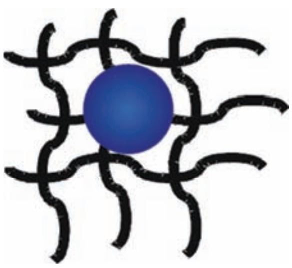


This necessitates that the areas, where such collectors may be installed, have to be identified carefully and after a long drawn study. The number of days a year when sufficient water can be collected and the amount of water that can be collected are crucial to make decision.

To move further, it is important to understand the important considerations for selecting fog weather collection. Since, the clouds are carried to the site by the wind, and the fog is then moved through the collectors by the wind, the interaction of the large- and small-scale topographical features with the wind determines the success of the site chosen. Thus, the important features include:

- A mountain range that raises high enough to intercept clouds of fog that are advanced into the region.
- Water content of fog.
- Absence of major obstacles to the wind.

Since the north-east has no experience of such a technology, it is important to proceed with care and caution.



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