Squeezing water out of fog

Rural women walk passed fog harvesting nets located at Lutshaya near Lusikisiki, in the Eastern Cape.

Christine Nesbit-Africa Media Online

A current study by researchers of the University of Pretoria is investigating if fog harvesting is a valid supply of potable water for small communities, and if so, for how long. Article by Petro Kotzé.

"If you have no water to drink, even just a little is a lot," says apple farmer Jimmy Zondagh. Zondagh is owner of the farm, *Belle Vue*, in Avontuur in the Western Cape, an area which receives about 600 mm rain per year. The farm is situated on a mountain, and even though the headwaters of the Kouga and Gourits rivers are close by, the farm has almost no source of potable water. Zondagh has drilled 39 boreholes on his property, pointed out by geologists, water diviners and satellite technology, but not one has yielded water. He is thus dependent on a fountain, which sometimes has to be pumped as much as five times before he gets anything. Recently, Zondagh has started turning his eyes skywards for water again, but he is not looking for rain. He is looking for fog.

The idea of harnessing fog as a source of drinking water has been studied for decades, and it has been implemented with great success in some countries where conventional sources of fresh water, such as wells, lakes, rivers and pipelines are unavailable.

One of the world's first successful experiments took place in the remote Chilean fishing village of Chungungo located in the Atacama Desert, one of the planet's driest regions. In 1992, the village's inhabitants relied on water delivered from distant wells, but after the installation of 80 fog collectors, village residents were enjoying an average of 10 000 ℓ/day of fresh drinking water – an estimated 35 ℓ per individual. Consequently, the quality of life in Chungungo improved dramatically as the freshwater boom led the village to flourish.

In South Africa, the percentage of the population with access to clean drinking water is said to have increased from 62% in 1994 to 93% in 2011, however this still leaves millions of people without this basic human right. Furthermore, South Africa is a semi-arid country with only 35% of its surface areas receiving more than 500 mm rain per year. Fog harvesting is not an entirely new method of supplying potable water to remote villages in South Africa, but now some researchers, with the help of funding from the Water Research Commission (WRC), are fine-tuning the concept for local conditions and while they are at it, expanding our knowledge about this meteorological condition.

"One of the biggest advantages of such a system," says project leader Prof Jana Olivier, "is that the water is available as soon as the nets have been erected." Where other systems might need to be pumped to users, water from fog harvesting is transported with gravitation, uses no electricity and maintenance is minimal. Fog water harvesting is especially suitable for areas where fog occurs frequently and other sources of water are not available. There are a number of places in South Africa that might benefit from such systems.

FOG IN SOUTH AFRICA

In South Africa a number of places record over ninety days of fog per

annum, mostly along the West Coast and in mountainous regions. Along the West Coast, advection sea fog is common. This is formed when moist air from the South Atlantic Ocean passes over the cold Benguela Upwelling region and is cooled down. Along the mountains of the Eastern Escarpment and the Western Cape, the most frequent source of fog is orographic fog and stratus clouds. The first happens when low level onshore flow blows air up the escarpment, adiabatically cooling it as it rises, causing the moisture in it to condense.

Local fog harvesting projects are scattered across these two regions. Prof Olivier, a climatologist and professor extraordinaire at the University of Pretoria (UP), first got involved in the concept in the mid-1990s, when she made a call over an agricultural radio show for farmers to help researchers collect information on fog patterns in the West Coast. Forty farmers replied, she says, wanting to know how much water she thinks she can squeeze out of the fog. This led to a WRC-funded study which investigated the use of fog harvesting to augment domestic water supplies in South Africa. Pilot 1 m² fog collectors were erected in various parts of the country and the water collection rates monitored over a three-year period. Water yields were found to be a function of elevation, wind speed, moisture content of the air and site characteristics.

Along the West Coast yields ranged from 1 to 5 ℓ/m²/day while in the mountainous regions, they exceeded 10 ℓ/m²/day at elevations greater than 1 800 m. For example, says Prof Olivier, they could harvest on average about 12 ℓ/m²/day at Woodbush in the vicinity of Magoebaskloof. At the Groenland Mountains in Grabouw, she says, they harvested just over 10 ℓ/m²/day.

The successes of these projects led to the erection of larger systems, closely following the Chilean designs but adapted to suit South African conditions. These involved two

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A young boy quenches his thirst with water collected from fog in Limpopo.

sections of 9 m x 4 m shade cloth netting draped over a top cable and secured to the middle and lower cables and to the poles on either side. This forms a fog collection screen of around 70 m². A gutter is attached to the lower ends of the screen, filling Jojo tanks underground.

Seven of these large fog water collection systems were erected between 2001 and 2008 at two schools in the Soutpansberg Mountains in Limpopo, at five schools in the Eastern Cape and at a small West Coast village, Lepelfontein. These were selected because all the necessary elements were there, says Prof Olivier. Factors include accessibility, need and location (up a hill). Daily water collection rates ranged from zero on a sunny day to almost 4 000 ℓ during wet and foggy conditions and the water was found to be of an exceptionally high quality, "naturally distilled," says Prof Olivier.

The researchers then moved on to finding stronger and more stable designs and a more durable mesh to increase the longevity of the nets, especially as some nets were damaged during storms. Current systems consist of nine panels arranged in the shape of four equilateral triangles to form the basic nine panel system of 396 m². Additional nine panel systems can be linked to this, allowing the expansion of the system to the space available.

The individual mesh panels of the system are 11 m x 4 m, suspended

by three individual 6 mm galvanized cables anchored to ground via brackets. According to Prof Olivier, a compulsory element to all their fog harvesting projects is that a trough has to be supplied for animals to drink from. In some cases, she explains, animals have ripped the nets to get to the water, and in this way, not only are thirsty animals catered for, but it ensures the safety of the nets.

An experimental site was established on the Zondachsberg at Avontuur, just outside Uniondale. At this site more than 8 000 ℓ of water were collected from one 38 m^2 system during October and November 2009, coinciding with one of the most devastating droughts experienced in the region during the last 80 years. The water quality collected at Avontuur is excellent, far surpassing all international and local standards for potable water, notes Prof Olivier. She says that another experimental system will also be erected at Lambertsbaai this year, allowing researchers to compare West Coast and East Coast systems and factors influencing them.

The current four-year WRC research project will also entail a number of other elements. Among others the researchers will investigate the difference between so-called 'wet' and 'dry' fog, as described by West Coast locals. According to Prof Olivier, it is suspected that dry fog consists of droplets with a dust nucleus, while wet fog has salt as a nucleus, which typically causes bigger droplets to be formed. This means that the wet and dry fog may be associated with different synoptic systems.

The research project also entails an investigation of long-term climate data to ascertain if climate change will have an impact on the frequency of fog and thus on the volume of fog water that can be harvested in the long term.
Prof Hannes Rautenbach, Head of the Department of Geography, Geoinformatics and Meteorology at UP, says they are looking if the weather patterns that cause fog, and especially cold fronts that are important for the formation of fog, could be affected by a change in climate. This will also help establish where it will be most economically feasible to erect large fog harvesting systems.

The search for the perfect material is also still continuing. Five nets made from different materials have been erected; one, for example, with fine hairs, to see which would result in the most water harvested. Further outputs will also include innovative new fog harvesting designs that can harvest water during times of no wind.

Another result will be the compilation of a set of maps indicating optimal fog harvesting areas in South Africa. This will be combined with information on roads, accessibility and more, eventually indicating not only the areas where fog harvesting would be the most feasible, but also which specific sites would be suitable. "Thorough scientific support like this is essential before the fog harvesting structure is built in order to ensure that scarce resources are not wasted in areas where a project will not be feasible," says Prof Johan van Heerden of the Department of Geography, Geoinformatics and Meteorology at UP, who has been involved with the fog harvesting research since its early days. He adds that another element of integral importance to successful project is buy-in from the community, on who continued maintenance of the structure is dependent.

As with the case in Chile, says Prof Olivier, eventually they would like to incorporate a social responsibility element into their project. Once people have enough water to drink, they want to try and help community members to use the water for food gardening. After that has been supplied, they are exploring the possibilities of creating small-scale projects to generate income. "This is how water can affect communities," she says, "and empower them to create opportunities for themselves."

Zondagh himself, after his experience with the fog nets on his property, is keen to continue the exercise. Even though the start-up cost is a hurdle, he sees "a lot of potential" for their continued use, even though the yield is at times as little as two litres a day, and the distance to the nets from his house is quite far (in future, he would probably have to pipe it closer). Still, if you're thirsty, and you have no water, he says, even two litres of pure drinking water makes a difference. ❑

Lani van Vuuren

One of several fog-harvesting projects found along the West Coast.