Fog Harvesting in Namibia

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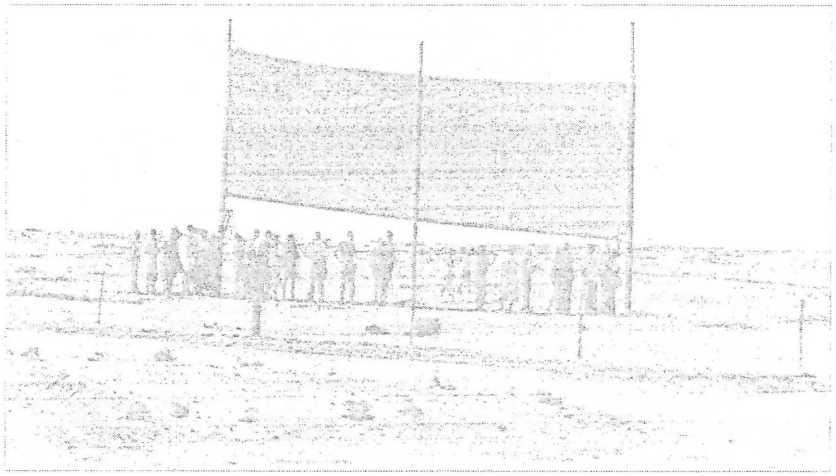

Abstract: Namibia is an arid country, where fog has previously been identified as a feasible alternative source of water. Fog occurs in western Namibia during some 200 nights in a year and varies only by some 41% between years in comparison to a 133% variation in rainfall. This makes fog a more reliable and key source of water for many life forms in the Namib. Fog harvesting in plants and animals of the Namib has been studied by the Desert Research Foundation of Namibia (DRFN) over the last thirty years (e.g., Louw, 1993; Seely & Henschel, 2000; Henschel et al. in press). The knowledge gained from this work and from exchange with researchers from South America gave rise to the Namibian application of fog collection systems project (Namfog). Namfog is a joint project of the DRFN and the Namib-based Topnaar community and aims to evaluate the potential of collecting fog water for domestic use, following a model case in Chile. This evaluation involves studies of the climatology of Namib fog, investigation of current and new fog harvesting equipment and lastly, determination of the water needs and ensuring the participation and awareness by the potential consumers. Preliminary results of studies indicate that the quantity and quality of the fog suffice for a water supply scheme. Experiments with standard fog collectors at a potential fog collection site indicate an average fog yield of 3.3 litres/m2/day during fog events and an annual average of about 1 litre/m2/day. Storm winds and variations in fog and in the water consumption affect the design of a water supply scheme. The costs of a fog-water supply scheme are similar to that of installing a wind pump for groundwater abstraction, but it is a more sustainable and environmentally friendly water source. Following the current fog water evaluation, more information transfer is taking place and a partnership is being formed with the rural community for the joint development of fog harvesting schemes. Fog water as a resource needs to go hand in hand with an integrated awareness of all natural resources and the need to manage them in a sustainable manner.

Keywords: *Namib Desert, Fog harvesting, standard fog collector, water supply, rural communities*

Introduction

The Namibian coastal region is part of a desert environment where sources of freshwater other than fog are scarce. Fog occurs along the coast and for some distance inland during most of the year. Its precipitation exceeds rainfall and as such, it presents a reliable supplementary source of water for communities in these areas.

The ecological implications and uses of fog by fauna and flora in the Namib Desert have been investigated for a long time (Hamilton & Seely, 1976 and Seely et al., 1998). However, investigations of fog collection for water supply to human settlements in the area only began in 1995 (Henschel et al., 1998; Seely & Henschel, 2000). While it appears that the quantity and quality of fog water make this a potentially good source of potable water, suitable collectors with a durability of several years in the particularly aggressive weathering conditions of the Namib still need to be developed. These collectors can be adaptations of existing technology, or alternative fog collecting techniques. Concerted research efforts towards the conception and design of efficient collectors would stand to benefit many desert-dwelling people either through small-scale rural or bulk urban water supply schemes.

This paper presents an overview of the Namibian fog collection programme. It discusses general aspects of the programme and future plans which includes:

- investigation of fog collection potential at the coastal urban centres and inland, at rural settlements;
- adapting fog collectors to the special conditions of the Namib Desert, e.g., frequent sandstorms;
- investigation of other types of collectors that would be suitable for the Namib conditions, e.g., prototype wind- and cooling-system based harvesters

1 CLIMATE

Ninety-seven percent of Namibia is arid to semi arid. The central Namib is the most arid part of the country and rainfall is low and highly variable in time and space. Average annual rainfall is 18 mm at the coast at Swakopmund, and 21 mm 60 km inland at Gobabeb (Nagel, 1959; Lancaster *et al.*, 1984).

Fog occurs regularly in the Central Namib. Long-term records indicate that fog deposition exceeds annual rainfall about seven times at Swakopmund, and almost two times at Gobabeb (Nagel, 1959 and Lancaster et. al., 1984). Fog precipitation is more predictable than rainfall and indicates a coefficient of variation (CV) of only 41% between years, compared to a 133% CV for rainfall (Seely & Henschel, 2000).

2 WATER SITUATION

In the Namib, groundwater is often too saline for human use. This water situation restrains both domestic and industrial activities in the area. Fog collection could contribute towards alleviating this water shortage. The fog water can be used alone or mixed with the saline groundwater, to reduce its salinity. The latter is supported by studies that indicate that Namibian fog water is of low chemical content, expressed as TDS, (e.g., Eckardt & Schemenauer 1998 and Seely et al., 1977). In inland areas, the fog season coincides with the period of high groundwater salinity (Fig. 1), suiting groundwater dilution with fog water.

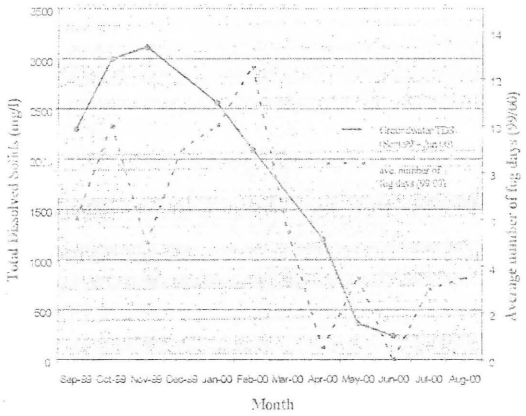

Figure 1 Groundwater salinity and frequency of fog occurrence at Gobabeb (Shanyengana ES, in preparation)

3 FOG COLLECTION

3.1 fog collection in endemic plants and animals

Fog is a key source of water for plants and animals in the Namib Desert (e.g., Louw, 1993; Seely & Henschel, 2000; Henschel et al. in press). There are three main methods of harvesting atmospheric moisture, including fog, that are found in endemic fauna and flora of the Namib, namely,

- collecting fog on the body, e.g., fog-basking beetle *Onymacris unguicularis*, fog-absorbing leaves of the succulent shrub *Trianthema hereroensis*;
- enhancing fog water deposition on the substratum and drinking this, e.g., the beetle *Lepidochora kahani* which builds fog-water deposition ridges in sand, and dune grass *Stipagrostis sabulicola* dropping condensed fog water onto shallow roots;
- absorption of atmospheric moisture, e.g., beetle larvae and fishmoths.

Knowledge of some of the techniques and interactions of fog water and the natural collector surfaces would contribute to the understanding of fog droplet behaviour and surface interactions. This could be of major benefit for fog harvesting in general, contributing to development of more efficient harvesters.

3.2 standard fog collectors (SFC)

Since October 1996, SFCs have been used to monitor fog deposition at long-term weather stations and some of the designated sites for fog water collection systems at Topnaar villages and the Gobabeb Training and Research Centre.

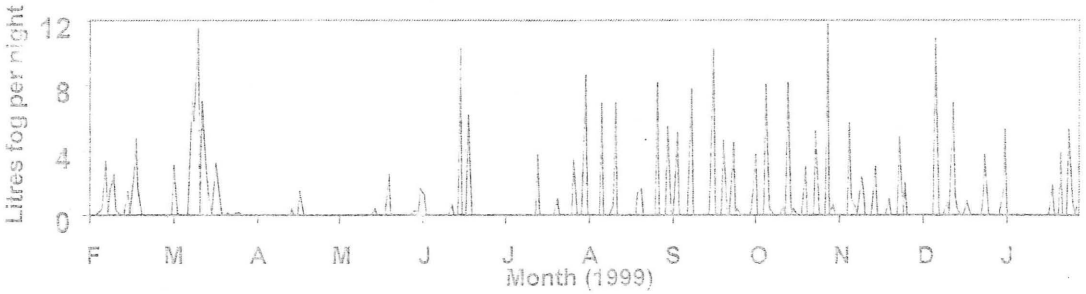

Figure 2 Daily fog collection with an SFC at Vogelfederberg, located 60-km inland from the coast

The results indicate a strong seasonal variation in fog frequency and wetness, with most inland fog occurring from August to January, and the low period being February - July, as reflected at one of the sites in Figure 2. The annual daily average at the designated sites is 0.5 - 3 litres/m2/day during fog events, and 0.1 - 1 litres/m2/day all year, i.e., including non-fog days (Henschel et al, 1998). No long-term SFC records exist for the coastal area, but measurements with other methods indicate that coastal fog also occurs throughout the year. It displays a winter maximum as opposed to the summer maximum seen with inland fog (Nagel, 1959; Henschel et at., 1998). Fog deposition and thus, potential for harvesting, appears to be highest at around 20-30 km from the Namib coast (Hachfeld, in press).

3.3 constrains and limitations

Topography and nearness to the source of fog are some of the factors considered when selecting a site for a fog collection system. In Chile, such systems are within 5 - 25 km of the fog source, and at an altitude of between 400 to 1000 m a.m.s.l where the highest liquid water content (LWC) and wind speed often occur (Schemenauer and Cereceda, 1982, 1994). The situation in the Central Namib differs substantially from its geographic counterpart in Chile because the gradually sloping and topographically featureless plain of the Namib does not enhance fog deposition.

These and other limitations such as the frequent occurrence of destructive sandstorms with peak wind speeds in the range of 24 - 32 m.s-1, represent some of the constraining factors to successful implementation of fog collection systems in Namibia.

3.4 alternative collectors

Other types of fog harvesters with increased yield and durability are also being tested in the Namib. These include both passive and active fog and general atmospheric moisture collectors. The following experiments have been conducted:

- a prototype developed by Mr. Krumsvik, of Stryn in Norway, uses shredded-paper bricks to absorb air moisture and fog at night and then releases it by evaporation into a condensation chamber when the sun heats the bricks by day;
- different kinds of polypropylene netting tested by Messrs. Coetzee and Mulder of Swakopmund, Namibia;
- cooling system and extractor fan-based prototypes to enhance condensation are being tested by Mr. Shanyengana of DRFN;
- metallic meshes made of oxidation-resistant and wind-durable material tested by DRFN.

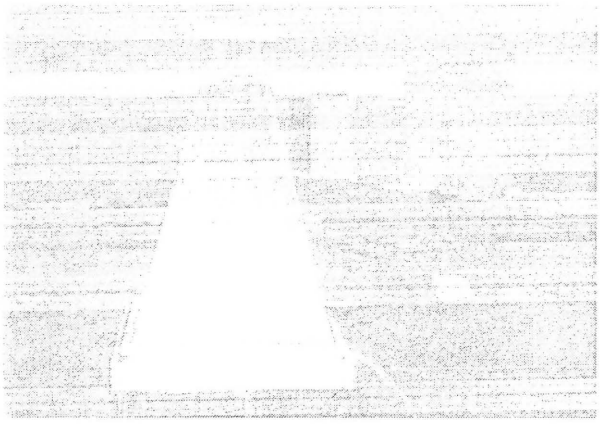

Figure 3 The cooling system-based fog harvester and metal-coated fog screens

Initial results are promising. The cooling-system and metal-coated mesh tests yield more fog-water than that obtained with a polypropylene mesh (Rashel) of equal surface area.

4 CONCLUSION

Despite the poor quantity and quality of traditional sources of freshwater in the Central Namib Desert, there appear to be promising opportunities for resolving the water scarcity. Fog is a viable source of water that can be used to supplement traditional sources in rural settlements in this region.

The possibility and implications for water supply to the coastal urban centres are equally great. Dilution of saline groundwater or desalinated water with fog-water, and its use in rural and urban household applications such as gardening are but few of many. However, there is need for research on ways to improve the efficiency of existing fog collectors and to develop more efficient harvesters. Indeed, fog harvesting and particularly, the development of more efficient harvesters present a challenge to students and researchers in the field of alternative water resources.

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