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Exploring fog as a supplementary water source in Namibia

Shanyengana, E.S., Henschel, J.R. & Mtuleni, V.S.

Desert Research Foundation of Namibia,
Gobabeb Training and Research Centre,
P.O.Box 953, Walvis Bay, Namibia

Abstract: Namibia is an arid country, where fog has previously been identified as a feasible alternative source of water that could supplement existing traditional sources. The groundwater quantity and quality is impaired by the local hydro-climatic conditions- little and unpredictable rainfall and high a evapo-transpiration. Coastal fog occurs in western Namibia, during some 200 nights in a year and varies only by about 40% between years in comparison to a 133% coefficient of variation in rainfall. This makes fog a more reliable source of water than rainfall for many life forms. Potential sites for testing the application of fog water were identified, of which the primary test sites are located at villages of the indigenous Topnaar people and at the Gobabeb Training and Research Centre. Further tests are conducted along a 60 km transect extending from the coast. The gradually sloping and topographically featureless plain in the Namib fog zone differs substantially from its geographic counterpart in Chile and Peru, where the montane topography predictably enhances fog precipitation at most sites. In the Namib, fog precipitation is not enhanced at a particular site and fog occurs anywhere in the large expanse of land. Another limiting factor in the Namib, is the frequent occurrence of heavy windstorms (destructive sandstorms). Our current tests therefore concentrate on improving fog collectors in terms of yield and durability, and on investigation of alternative, more Namib conditions-suited, fog collectors while keeping costs low. Test variables include enhancing fog density through the collector and enhancing the condensation rate, depending on the material properties of the intercepting surfaces. We are also monitoring fog water quality over space and time in comparison to groundwater. Fog is a good source of supplementary water for rural and urban settlements in the Namib but further knowledge on its peculiar properties in this area needs to be gained in order to facilitate its incorporation into the local water supply schemes.

1 INTRODUCTION

The Namibian coastal region is part of a desert environment, the Namib desert, where freshwater availability is low. Fog occurs along the coast most of the year, exceeding rainfall even further inland. 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 long been investigated (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).

Namib fog has received increasing attention as a supplementary source of water for rural and urban settlements along the coast. This paper presents an overview of the Namibian fog collection programme. It discusses general aspects of the programme and future plans which includes, among others,

- investigation of fog collection potential at the coastal urban centres and inland, at rural settlements
- **adapting** fog collectors to the special Namib desert conditions- e.g., sandstorms
- investigation of alternative collectors: fog collectors suitable for the Namib conditions,
  prototype wind- and cooling system based harvesters

Fog is a potentially good source of potable water that can benefit settlements in the Namib and more so, if suitable harvesters are developed- i.e., ones that can withstand the special Namib-. Lastly, alternative fog harvesting techniques need serious consideration because they stand to benefit research efforts toward conception and design of efficient harvesters that can be used in bulk water supply schemes.

2 BACKGROUND

2.1 climatology

97 per cent 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, (Lancaster *et al.*, 1984 and Nagel, 1959). However, rainless stretches of about 10 years have also been recorded at Swakopmund (Sharon, 1984). The rainfall decreases in an east – west gradient through most of the country, and is most variable at the coast (west).

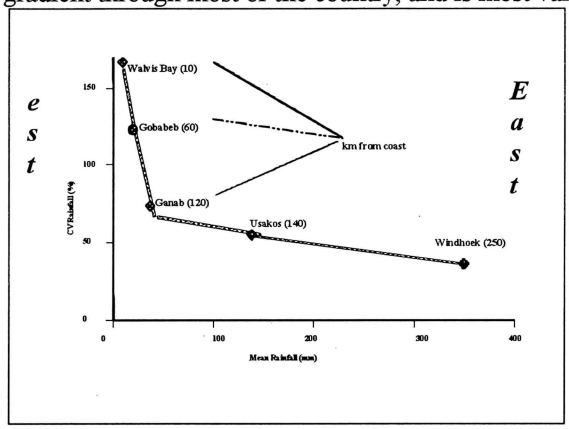

Figure 1: Coefficient of variability (CV) of Rainfall from central Namibia to the coast

Fog occurs regularly in the central Namib. Long-term records indicate that fog precipitation exceeds annual rainfall about seven times at the coast, in Swakopmund, and almost two times 60 kilometres inland, at Gobabeb (Nagel, 1959 and Lancaster et. al., 1984). It 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).

2.2 the water situation

In the Namib, water of good drinking quality is minimal and is only found in ephemeral river aquifers. Groundwater is minimal, and often is too saline for human use. This water situation restrains both domestic and industrial activities in the area.

Fog collection could contribute towards addressing this water situation. The fog water can be used alone or in mixed with the saline groundwater, as one solutions to the salinity problem. The latter is supported by studies that indicate that Namibian fog water is of low chemical content (e.g., Eckardt and Schemenauer 1998). Below, figure 2 shows the relation between period of high groundwater salinity and fog frequency at Gobabeb. In short, the graph indicates that groundwater dilution with fog water is suited, particularly inland, where the main fog season coincides with the period of high groundwater salinity.

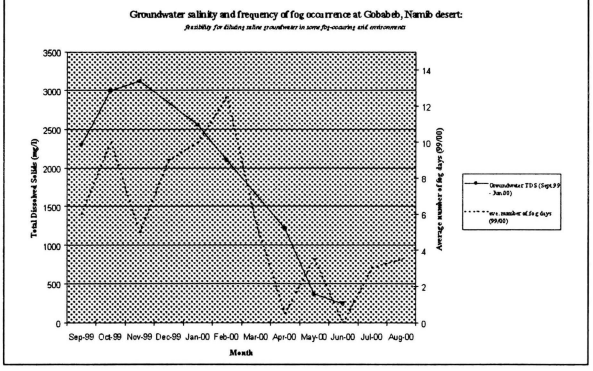

Figure 2: Monthly groundwater salinity and fog frequency at Gobabeb

2.3 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. It is recommended that such a system should be within 5 – 25 km of the fog source, and at an altitude of between 400 to 1000 m amsl where the highest liquid water content (LWC) and wind speed are often occur (Schemenauer and Cereceda, 1994). The situation in most of the central Namib is, however, unfavourable because of its gradually sloping and topographically featureless plain. It differs substantially from its geographic counterpart in Chile and Peru, where the montane topography predictably enhances fog precipitation at certain sites.

These and other limitations such as the frequent occurrence of destructive sandstorms with wind speeds of 24 – 32 $m.s^{-1}$, constitute the difficulty to successful implementation to fog collection systems in Namibia. Therefore, the programme is also investigating fog collection systems that would be best suited to conditions in the Namib.

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., Seely & Henschel, 2000 and Louw, 1993). There are three main methods of harvesting atmospheric moisture, including fog, that are found in endemic fauna and flora of the Namib namely,

- Collection of fog on the body e.g., *Onymacris unguicularis* (the 'fog-baking beetle');
- drinking fog water that has been collected on sabstratum, e.g., some scorpion species, and
- absorption of atmospheric moisture e.g., beetle larvae and fishmoths

Knowledge on 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 to fog harvesting at large- contributing to development of more efficient harvesters.

3.2 fog screens

Standard fog collectors were erected in the central Namib region, mainly alongside existing long-term weather stations and some of the designated sites for fog water collection systems for the Topnaar villages in order to assess the sites' potential for fog collection. Data was collected between October 1996 and September 1997.

The results indicate a strong seasonal variation in fog frequency and wetness, with most inland fog occurring between August and January, and the low period being period February – July. The annual daily average at the designated sites is 0.5 – 3 litres/m^2/day during fog events, and 0.1 – 1 litres/m^2/day all year-round, i.e., including non-fog days (Henschel et al, 1998).

No SFC records exist for the coastal area. However, a comparison between Swakopmund and gobabeb can be made with data from the 50's, 60s and the late 90s (Nagel, 1959 and Henschel et at., 1998). Earlier investigations at the coast indicate that fog occurs throughout the year and displays a winter maximum as opposed to a summer maximum that is seen in inland fog, (Henschel et al., 1998 and Nagel, 1959). Fog precipitation and thus, potential for harvesting is much higher than at the inland sites.

3.3 alternative collectors

The programme also works with other types of harvesters. These include both passive and active fog and general atmospheric moisture collectors. Thus far, experiments have been conducted with the following;

- A prototype developed by Mr. Krumsvik, of XXXX in Norway, that absorbs air moisture and fog on shredded paper, at night and then releases it into a collection chamber as pure water by evaporation when the sun rises.
- Cooling system and extractor fan -based prototypes, and
- Metallic fog collection meshes made of rust-proof material

Some initial results, particularly ones from the cooling system- and metallic harvesters show promising results. In both cases the fog yield was higher than that obtained with a polypropylene mesh of equal surface area. The systems indicate a yield of between 10 and 50% more than the normal mesh in the case of metallic mesh and about 10% in the cooling system-based harvester, dependent on the fog speed (wind speed).

4 Conclusion

Despite the poor quantity and quality of traditional sources of freshwater in the central Namib area, there appear to be promising opportunities for resolving the water scarcity. Fog is a viable source of water in these areas that can be used to supplement traditional sources in rural settlements of the central Namib 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 urban household applications such as gardening are but few of many. However, there is need for research on ways to better the efficiency of collectors in non-hilly areas, and development of more efficient harvesters. Indeed, this area of research deserves more attention than is currently afforded, particularly in fog-occurring low elevation areas as found in Namibia.

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