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NAMIBIAN APPLICATION OF FOG-COLLECTING SYSTEMS (NAMFOG) PHASE I: FOG-WATER EVALUATION

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Abstract

Fog transports water into the hyperarid Namib Desert. The DRFN, working with the neighbouring local community, evaluated the potential of this water being collected for domestic purposes following a model case in Chile. The evaluation entailed gaining an understanding of climatological, temporal and spatial parameters of Namib fog, determining the water needs and ensuring participation and awareness by potential consumers of fog water. Our ECEP-funded project endeavours to recommend whether, how and where fog water can be collected to help alleviate the water shortage along the lower Kuiseb valley in the Namib Desert.

The twelve objectives concern the quantity and quality of fog water, the collecting equipment, the water needs, information transfer, the identification of socioeconomic and environmental consequences, the design of a fog water supply scheme, the production of a report and publications, dissemination of information and plans of phases 2 & 3. It was found that the quantity and quality of the fog suffice for a water supply scheme. Strong winds and variations in fog and in the water consumption affect the design. Following the fog water evaluation, more information transfer is taking place and a partnership is being formed with the 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 sustainably.

WATERSHED AND WETLAND

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Summary
Fog transports water into the hyperarid Namib Desert. The DRFN, working with the neighbouring local community, evaluated the potential of this water being collected for domestic purposes following a model case in Chile. The evaluation entailed gaining an understanding of climatological, temporal and spatial parameters of Namib fog, determining the water needs and ensuring participation and awareness by potential consumers of fog water. This initial report recommends whether, how and where fog water can be collected to help alleviate the water shortage along the lower Kuiseb valley in the Namib Desert.

The twelve objectives of phase 1 of the project concern the quantity and quality of fog water, the collecting equipment, the water needs, information transfer, the identification of socioeconomic and environmental consequences, the design of a fog water supply scheme, the production of a report and publications, dissemination of information and plans of phases 2 & 3. It was found that the quantity and quality of the fog suffice for a water supply scheme. Strong winds and variations in fog and in the water consumption affect the design. Following the fog water evaluation, more information transfer is taking place and a partnership is being formed with the 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 sustainably.

Acknowledgements
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Introduction

The Central Namib Desert is a hyperarid area without perennial rivers, receiving <20mm of rain per year. Fog occurs in the area on 60-200 days per year, making it a potentially reliable source of water for animals, plants, and humans equipped to collect its water. Some 150 000 people live in the region, distributed in the cities of Swakopmund and Walvis Bay, coastal towns and villages. The latter include small communities of indigenous people, the Topnaar, and the research and training centre at Gobabeb, situated in the desert interior. Potable water is obtained from groundwater via manually maintained wells, boreholes, and the Central Namib Water Scheme based on aquifers in the ephemeral rivers, Kuiseb and Omaruru. Groundwater reserves depend on input from rainfalls in the >300km distant interior of Namibia's highlands. In recent years, water output has exceeded input and the depletion of the groundwater is taking place. Alternative water supplies will be required for rural as well as urban consumers. Fog water has the potential to supplement small-scale users, as a model case developed in Chile has demonstrated. Fog could thus contribute to alleviating the water deficiency along the Namibian coast.

Phase I of the NAMFOG project (Namibian Application of Fog-Collecting Systems) entails evaluating the potential for the DRFN and the local Topnaar community to collect and use potable fog water. The occurrence, water content and climatological parameters of fog were investigated. From this information, the yield of fog water was determined as a fundamental premise to further objectives. Water needs and the social, environmental and economic considerations were taken into account in the preliminary design of a fog-water supply system for a Topnaar village to serve as a model for others. The experience gained with such systems in the proposed Phase II project, will facilitate the further application of this technology in Namibia. The current report presents a summary of the initial results of Phase I. These are being analysed for a full report due for completion by 20 April.

Objectives of Phase I

1. Quantify fog water yield with Standard Fog Collectors for one year in areas that can supply potential future users of potable water in the Central Namib Desert
2. Analyse water quality
3. Test suitability and durability of fog-collecting equipment, identify problems and test solutions
4. Assess local water needs
5. Inform, train and educate potential users and managers of potable fog water supply plants
6. Identify major social and environmental aspects involved in collecting, supplying and using potable fog water
7. Make preliminary designs of fog-water collection and supply systems
8. Produce a report that evaluates the potential of using fog water
9. Publish analyses of climatological data of Namib fog and results of the project
10. Disseminate the information appropriately
11. Plan phase II: pilot plant to supply indigenous village along the Kuiseb River
12. Suggest phase III: further studies to expand the application of this technology in Namibia

PROGRESS REPORT

<u>Objective 1</u>: Quantify fog water yield with Standard Fog Collectors for one year in areas that can supply potential future users of potable water in the Central Namib Desert

Activity: Standard Fog Collectors (SFC = Standard Fog Collector: 1m² screen of double-layered Rashel mesh positioned at 2m above the ground, suitable to collect fog in moderately windy conditions (Schemenauer & Cereceda 1994) were placed at six sites along the lower Kuiseb River and were monitored manually or with data loggers between October 1996 and December 1997. The sites were:

Place	distance from sea (km)	number of SFCs	altitude (m)	reason for monitoring
Rooibank	18	1	219	closest river site to sea
Ituseb	27	1		inform children at school
Swartbank	37	5	332	evaluate fog water supply
Klipneus	46	2	340	evaluate fog water supply
Soutrivier	53	1	387	evaluate fog water supply
Gobabeb	54	4	406	compare & test equipment

The populations fluctuate. Residents are occasionally joined by job commuters to town and school children, who spend 10-25% of their time at the villages. People use only a small proportion of the total water consumption, and most goes to domestic animals. The water supply and climate is not conducive to keeping gardens. The daily water consumption (litres) was found to be as follows:

		Swartbank		**Klipneus**		**Soutrivier**	
Consumer	Indiv. Needs	Population	Consume	Population	Consume	Population	Consume
People	22-30	15-42	330-1260	6-13	132-390	14-37	308-1110
Goats	2-4	96	192-384	50	100-200	53	106-212
Donkeys	16-18	44	704-792	20	320-360	16	256-288
Cattle	40-50	26	1040-1300	16	640-800	0	0
Dogs	2-3	6	12-18	7	14-21	10	20-30
Chickens	0.1	34	3	30	3	20	2
TOTAL			**2281-3757**		**1209-1774**		**692-1642**

People used only 11-68% of the total water consumed. The total fluctuated strongly, least at Klipneus (47%), and most strongly at Soutrivier (137%). The total water consumption at Klipneus was about half that at Swartbank.

Conclusions: The water needs are most predictable at Klipneus and least predictable at Soutrivier where the volume of fog was lowest. The total volume of water consumption is highest at Swartbank, where the need for a scheme to supplement the hand-dug wells is highest. The water requirements could be halved by excluding cattle.

Objective 5: Inform, train and educate potential users and managers of potable fog water supply plants

Activities: Demonstrate the possibilities of the new technology to the Topnaars at the villages and school as well as to other household owners (e.g. in the coastal towns); demonstrate possibilities to staff and visitors of the DRFN. Provide hands-on training and experience for the rural population and DRFN staff to prepare them for operating and using fog-collecting schemes. Discuss attitudes towards fog as a water source with residents of the area. Hold workshops and follow this up with further interactions to explore fully the potential of fog as a water source. Work with Topnaar leaders towards a fully participatory relationship addressing fog harvesting as a component of sustainable resource management.

Results: Implementing this most important part of the project was subject to our findings in objective 1 concerning the quantity of fog water. The project was discussed with residents of Soutrivier, Klipneus and Swartbank. The possibilities of forming water committees for each village, as is also promoted by the Department of Water Affairs, were discussed and these are in an early planning stage. Those residents who assisted actively in the project (e.g. family !Narib of Klipneus) helped to explain explain the process to other villagers. The technology is by now familiar to many Topnaars. The fog project featured prominently in two workshops of the DRFN and over 50 Topnaars held in March 1997 and November 1997. A workshop on the fog-harvesting project is planned for the 26th April 1998.

Conclusions: More information transfer is necessary to familiarise people, from local users to the Department of Water Affairs personnel, with fog as a potential water source. This is possible now that the aspects concerning the supply of fog water have been studied (objective 1) and compared to the identified need (objective 4).

Objective 6: Identify major social and environmental aspects involved in collecting, supplying and using potable fog water

Activities: Establish by interviews and discussions with residents how important a new water supply, derived from fog, would be to the people and how it would influence their lives and household economics. Assess what possible environmental consequences could be.

Results: People living along the lower Kuiseb River are in need of alternative water sources. However, following years of Government dependency, they seem to have accepted their daily struggle with the existing system as a way of life: they walk long distances to hand-dug wells that require much maintenance, while they wait patiently for a Government technician to arrive to fix a pump. On the other hand, they have expressed interest in a reliable system that they can maintain themselves with

Results: The data obtained from those sites where the physical characteristics would allow the construction of potential water-supply screens in future are:

Place	record days	number of fogs	water per fog (l/m^2/fog)	daily average (l/m^2/day)	seasonal range (l/m^2/day)
Swartbank	321	108	2.384	0.802	0.423-2.720
Klipneus	356	111	3.345	1.043	0.984-1.894
Soutrivier	273	60	0.437	0.096	0.084-0.704

Conclusions: Swartbank and Klipneus are candidate targets for potential fog water supply systems. Klipneus has the best water supply and the fog-collecting site is situated close to the village. Considerable seasonal variation in the quantity of fog needs to be taken into account for the design of fog-water collecting schemes.

Objective 2: Analyse water quality

Activity: Collect water samples collected from SFCs at Gobabeb and send them to the Department of Water Affairs for Analyses. Compare these with fog water collected with sterile, clean screens (Eckardt 1996).

Results: Fog water is quite pure and of neutral pH. However, the screens accumulate dust and wind-blown salts that get washed off by fog water. The initial rinse off the screen after a non-foggy period yielded turbid, brackish water that was only marginally fit for human consumption, but could be used for livestock. The water quality (by taste) was improved considerably by allowing the first water to drain away before collecting the rest.

Conclusions: Collected fog needs to be processed in such a way as to divert the first water collected from a fog (ca. 0.1 l/m^2) so as to improve the quality of the water to be stored. A filter should remove dust particles.

Objective 3: Test suitability and durability of fog-collecting equipment, identify problems and test solutions

Activity: Observe SFCs during strong winds during the winter of 1997. Analyse damage and modify the supporting structures accordingly. Plan to build a large fog collector in April 1998 for testing in the 1998 winter.

Results: On 12 occasions during winter, the average hourly wind speed exceeded 12 m/s (43 km/hr) with a maximum of 16 m/s (60 km/hr). Gusts could be double this speed. Several SFCs were damaged during winter storms and were rebuilt differently. Some of the plastic logger equipment did not withstand this weather, resulting in data loss.

Conclusions: Structures should be designed to withstand winds of 120 km/hr coming from the east (at right-angles or from the opposite direction to that of the fog). The design of the planned large collector is being adapted accordingly.

Objective 4: Assess local water needs

Activity: Observe and question household heads and other people at Swartbank, Klipneus and Soutrivier concerning the water sources and requirements as well as the population size of people, domestic animals and gardens (see appended questionnaire). This was done during winter (July), when only permanent residents were present, and was repeated during the summer school holidays (December). Volumes were estimated from the containers used to fetch or store it at the homes.

Results: The current water sources were from traditional, hand-dug wells in the river bed that extended to depths of 5-15 m. In addition, there was a wind pump at Klipneus and a diesel-operated pump at Soutrivier, both of them being installed and irregularly maintained by the government. The pumps are unreliable after a few years. Swartbank fetches a considerable proportion of its water with donkey carts from the Ituseb school, 20 km away. The school gets its water from the municipal supply of Walvis Bay.

ECEP Form R-5

Interim Financial Report
ECEP
Date: 13 March, 1998
Name of Researcher: Vilho Mtuleni, Joh Henschel, Elias Shanyengana, Mary Seely
Research Title: Namibian application of fog-collecting systems (NAMFOG).
Phase I: fog-water evaluation

Category of Expenditure (as in approved ECEP propsal budget)	Approved Amount (N$)	Actual Expenditure (N$)			Difference (A-B)
		Mid-Term	Final	Total (B+C)	
	A	B	C	D	E
1. Travel					
Domestic	16 792.56	3 272.50			13 520.06
2. Living Expenses					
Bench Fees	7 350.48	6 000.00			1 350.48
3. Dissemination & Communication					
Communication	5 976.00	293.81			5 682.19
Publications	11 952.00	0.00			11 952.00
4. Research Assistance					
Cloete (Soutrivier)	1 374.48	1 760.00			(385.52)
Narib (Klipneus)	1 374.48	2 100.00			(725.52)
Totals	44 820.00	13 426.31			31 393.69

Amount received from ECEP was N$34 906.72 (=78% of total)

little effort. However, they currently have limited funding and do not intend to invest this towards a new water scheme, a service always provided by Government in the past. The means to afford to run the fog harvesting technology would need to be developed through a lengthy participatory process parallel to and integrated with that of the Department of Water Affairs which is focused on fostering self-responsibility for the management of this resource.

Most people indicated that given more water, they may keep more goats. This could increase the impact that these animals would have on the environment. However, changes would probably be limited due to the need for careful management of the collected fog water (see objective 7). Integrated water and range management is also an objective of the Department of Water Affairs.

Given a better reliable source of water, the Topnaars could diversify their activities, for instance to include gardens. A fog water supply system could become a touristic attraction and could facilitate the plans of the Topnaar Community in developing tourism in this area. Diversification should improve the living standards of the Topnaars.

Conclusions: 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 sustainably.

Objective 7: Make a preliminary design of a fog-water collection and supply system
Activities: Take the above points into consideration in designing a pilot fog-collecting plant at a suitable site. Design the storage and supply system so as to enable effective management and monitoring.

Results: It is suggested that the first experimental fog water supply scheme be constructed at Klipneus (see objective 1 & 4). This suggestion has been discussed by the Topnaar community, although a final decisions is awaited. The lessons from this scheme would facilitate planning for the more complex situation at Swartbank. In the meantime, we have made a preliminary design for the Klipneus conditions. This design assumes that fog water will become the only water source, but a hybrid system may be more realistic.

The following factors need to be taken into account: 1) seasonal variation in fog water availability; 2) the effect of the storage capacity on water availability; 3) the consumption rate that can be sustained without running the storage tank dry; 4) the ability to vary the consumption rate.

Calculations were made to find the optimum magnitude of each factor. Most importantly, due to the intervals between fog, the reservoir can frequently run empty unless the consumption is regulated. Ideally the water will be rationed, i.e. an adequate quantity be made available each day, which cannot be exceeded if a tap is inadvertently left open. The resulting design comprises the following elements:

- 25 fog collecting units (FCUs) of 48 m^2 each (following a modified construction plans of Cereceda et al 1996) to collect an average of 1.2 m^3 fog water per day
- pipes to allow the passage of 1.2 litres per second
- intermediate tanks for pressure control and initial cleaning of the water
- a preliminary tank to hold the first brackish rinse water
- a filter system to clean the remaining water
- a reservoir of 25 m^3 that would sustain the consumers for 21 days without fog
- a side tank of 600 litres to contain the daily ration of water for cattle at times when the main reservoir is over half full; cattle require alternative water when this side tank is empty (i.e. when the main reservoir is less than half full)
- a side tank of 600 litres to contain the daily ration of water for households as well as domestic animals other than cattle.

Conclusions: According to our calculations, the above system should provide fog water to Klipneus on a sustainable basis. This has been discussed with the Topnaar community but a formal agreement between the DRFN and the Topnaars still awaits finalisation.

Objective 8: Produce a report that evaluates the potential of using fog water
Activities: A report with details on the activities and fully analysed results is being prepared for publication as an Occasional Report of the DRFN. This should be ready to be presented to the Namibian Government towards the end of April 1998.

Results: In preparation.

Objective 9: Publish analyses of climatological data of Namib fog and results of the project
Activities: Once the report is finished, part of it will be redrafted for scientific publication.

Results: A literature review is currently in preparation.

Objective 10: Disseminate the information appropriately
Activities: Prepare brochures, news releases, film documentaries and radio shows based on the results of the current study.

Results: To follow the completion of the full report in collaboration with the Topnaar community.

Objective 11: Plan phase II: pilot plant to supply indigenous village along the Kuiseb River
Activities: Besides the design of a preliminary water scheme (objective 7), the phase II project needs to incorporate the consumers, operators, water committee and plans for the continued monitoring and analyses of a pilot water supply scheme.

Results: Plans to be incorporated into the report. The fog screens at Gobabeb have made the technology familiar to potential donors and the development of the technology at the villages has featured in two film documentaries.

Objective 12: Suggest phase III: further studies to expand the application of this technology in Namibia
Activities: The feasibility of other applications of fog water in Namibia should to be investigated at the very small scale (e.g. urban house owner) as well as the very large scale (e.g. municipal water supply, supplementing aquifers).

Results: Suggestions to be incorporated into the report.

Literature
Cereceda, P., Cruzat, A., Ossandon, J. & Schemenauer, R. 1996: Prospection, evaluation and construction of fog water collection systems: a new technology of simple application and large economic and social impact. IDRC/CIID-GAFCS, 80 pp.

Eckardt, F., 1996. The distribution and origin of gypsum in the Central Namib Desert, Namibia. PhD Thesis, University of Oxford, 320 pp.

Schemenauer, R.S. & Cereceda, P., 1994. A proposed standard fog collector for use in high-elevation regions. Journal of Applied Meteorology. 33, 1313-1322.