Experiments Conducted in Cape Verde. Constraints on Fog Collection Development Projects

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ABSTRACT

Since 1962 the experiments on fog and cloud water have been conducted. The obtained results show that the fog and cloud water can be a valuable source of water. In spite of the encouraging results, most of the implemented project failed. Researchers, and communities face tremendous constraints to implement new projects. This paper reports conducted experiments and constrains in implementing new projects.

1. INTRODUCTION

Cape Verde is composed of ten islands and five islets, scattered over an area of roughly 57,600 km2, between 14º 30' and 17º 30' north latitude and 22º 30' and 25º 30' west longitude in the Atlantic Ocean, 455 km west of Dakar (Fig. 1).

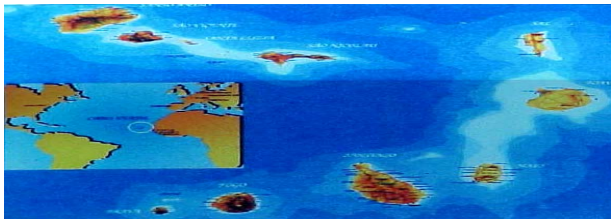


Figure 1. Map of Cape Verde

Although being an extension of Sahelian region, the evaporation rates are more oceanic in nature than found in continental sahelian countries. Table 1 indicates some climatic values of Cape Verde.

Table 1. Values of some climatic parameters in Cape Verde

Islands/stations	Average temper (°C)	Relat. humid (%)	Wind speed (km/d)	Sun-shine (h/d)	Solar radiati. (mm/d)	P.Evap. (mm/y)
Praia,64 m	25.3	65.8	499	7.8	824	2610*
Jorge,350 m	22	72	108	6.5	4.3	1559
LSant a,350m	21.9	75	189	5	3.9	1541
Corda, 950 m	18.3	60	221	7.9	4.4	1951
S.Vicent,10 m	23.5	68.5	725	8.4	817.8	2495*
Sal , 54 m	23.7	72	620	4.8	3.8	2629*

* Values of annual evaporation.
Source: Sabino (1999)

Figure 2-3 illustrates the correlation of mean annual rainfall with altitude and mean annual rainfall in arid zones of Cape Verde (Praia).

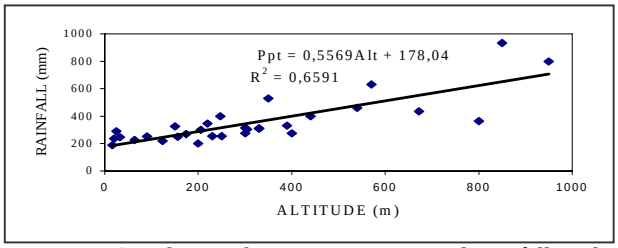


Figure 2. Correlations between mean annual rainfall and altitude in Cape Verde.

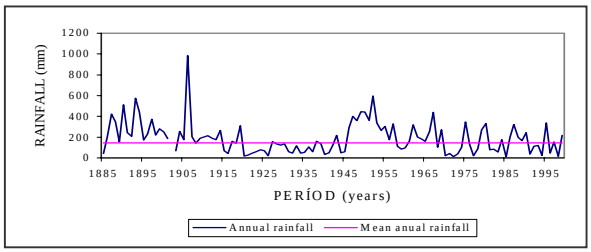
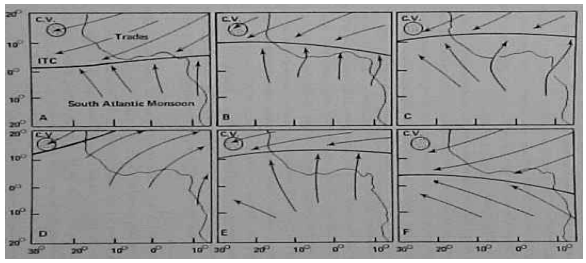


Figure 3. Precipitations in the arid zones of Cape Verde Islands, (Praia, 1985-2000).

Cape Verde's climatic conditions are characterised by low and erratic occurrence of rainfall determined by West African Inter-Tropical Convergence (ITC) resulting of the periodic movement of three air masses: (1) the Trade-winds from north-east which blow during most part of the year are fresh and humid but not rainy; (2) the Harmatan blows from the African continent is warm and dry and; (3) the Monsoon, responsible for the short rainy season, blows from July to October. Fig. 4 depicts the general seasonal migration pattern of the ITC.



A) January-February; B) April – May; C) May – June; D) July – August; E) September – October; F) November – December.

Figure 4. Migration of the West African Inter Tropical Convergence (ITC)
Source: Freeman et al (1978)

This paper documents the results of experiments carried out since 1961 as well as the main constrains encountered with the implementation of new fog water projects in Cape Verde.

2. EXPERIMENTS CONDUCTED

Since 1961 numerous researchers have been conducting experiments with various collectors to estimate the potential amount of fog water to be intercepted.

2.1. Results from 1961 -1966

From the end of 1961 to 1966, the Portuguese scientific community has been interested in fog water. Cunha (1961) installed various Hohenpeissenberg fog collectors in the existing meteorological stations of Cape Verde and the main results of experiments are illustrated in Figure 5 and Table 2.

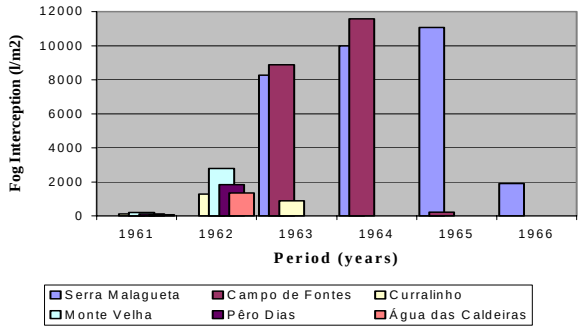


Figure 5. Fog water intercepted at Serra Malageta (750 m), Campo de Fontes (600 m), Curralinho (950 m), Monte Velha (1340 m), Pêro Dias (1110 m) and Água das Caldeiras (1430 m). Source: Cunha (1962) and Gonçalves (1975)

Table 2. Monthly rainfall and fog water (Curralinho, Monte Velha, Pêro Dias and Água Caldeiras,19621962)

Month/ Year	Curralinho(Santiago island)			Monte Velha (Fogo island)	
	Normal raingage	raingage with Hoenpeissenber collector	raingage under cupressus	Normal raingage	raingage with Hoenpeissenber collector
Oc-Dec (1961)	17,4	100,8	36,7	103,7	193,6
Jan-Dec (1962)	746,4	1292,4	818,8	1474,1	2450,7
Month/Year	Pêro Dias (Santo Antão island)				
	Normal raingage	Raingage with Hoenpeissenber collector	Raingage under cupressus	Raingage under eucaliptus	
Nov-Dec(1961)	112	292.3	116.9	114.7	
Jan-Dec (1962)	824,4	1839,0	910,8	848,7	
Month/Year	Água das Caldeiras(Santo Antão island)				
	Normal raingage	Raingage with Hoenpeissenber collector	Raingage under cupressus	Raingage under eucaliptus	
Nov – Dec (1961)	70.4	236.1	414.2	753.5	
Jan – Dec (1962)	645,1	1381,8	531,8	1788,9	

Source: Cunha (1962) and Gonçalves (1975)

2.2. Results from 1977 -1992

A Project of Bilateral Cooperation between Cape Verde and Netherlands was implemented In Santo Antão in 1977. Boers (1977) conducted the experiments at Corda (1000 m). Figure 6 shows the results of the experiments carried out from 1977 to 1978 in Santo Antão.

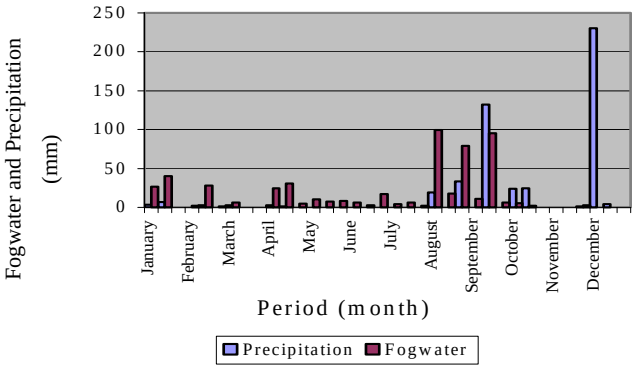


Fig. 6. Results of the experiments carried out (1977- 1978). Source: Sabino (1984)

2.3. Results from 1988 to 1992

Juvik (1988) propose a research project for fog water collection in Cape Verde Islands. Fog water interception measurements were undertaken during summer months of 1987 and the results indicate fog collection rates averaging about 10 liters/m^2/day at Serra Malagueta and 24 liters/m^2/day and Monte Verde. A vertical tower supporting a total of nine vertical layers of screens, each of them with 1m x 0.50m was used. An instrument shelter containing hygrometers (wet, dry-bulk temperatures), maximum and minimum thermometers, as well as anemometers and rain gage, in some cases, were installed to study of statistical correlation among the data series. Figure 7 shows relationship between fog water interception, screen types and height above the ground on the basis of the measurements carried out by Juvig (1987) and Carvalho (1991).

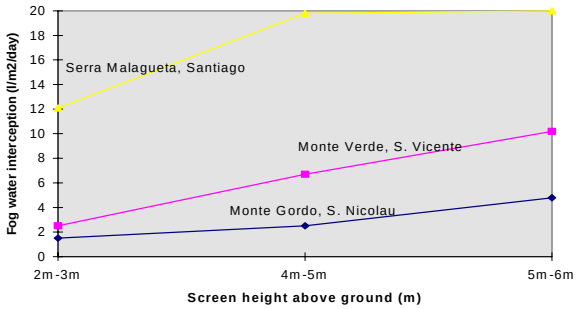


Figure 7. Relationship between fog water interception, screen types and height above the ground. (Data from Juvig, 1987; Carvalho, 1991).

3.4. Results from 1988 to 1992

The results of experiments show that fog water interception is related with the elevation, distance from the seacoast, wind speed and occurrence of rainfall precipitation or drought frequency.

Precipitation and fog water interception. The amounts of fog water collected on the mountainous areas exposed to trade winds are always higher than the rainfall precipitations. Data series of fog water measured with Hoenpeissenberg collector and precipitation measured with raingage (Brava, Campo das Fontes, 1965) show that there is a good correlation between monthly fog water collection and corresponding rainfall precipitation:

FWIBrava =0.046PptBrava – 19.66 (1)

Where FWIBrava = daily fog intercepted in mm and PptBrava = daily rainfall precipitation in mm.

Distance from the seacoast. There is a relationship between the amount of fog water collected and the distance from the seacoast. Six sites far from the seacoast about 2.5, 3,6,7,9 and 15km were selected for the purpose. Figure 8 shows the relationship between amount of fog water collected and the distance from the seacoast:

FWI Scoast = -0.24DISCoast + 4834.2 (2)

Where FWI Scoast = fog water intercepted 1/m2; and DISCoast= Distance from the seacoast.

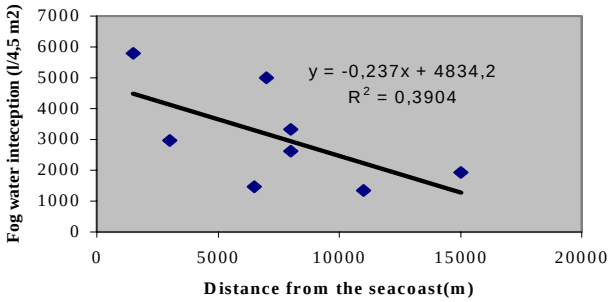


Figure 8. Relationship between amount of fog water collected and the distance from the seacoast.

Wind speed. Experiments conducted by Sabino (1990) show a relationship between wind speed and fog/cloud water intercepted for Monte Verde, São Vicente for the month of month of May, July and August:

FWIMay = 5.68WSMay – 112.69 (3)
FWIJune = 2.65WSJune + 15.64 (4)
FWIAug = 10.63WSAug - 121.66 (5)

Where FWIMay = daily fog water intercepted in 1/m2, and Wsmay = wind speed in km/hour.

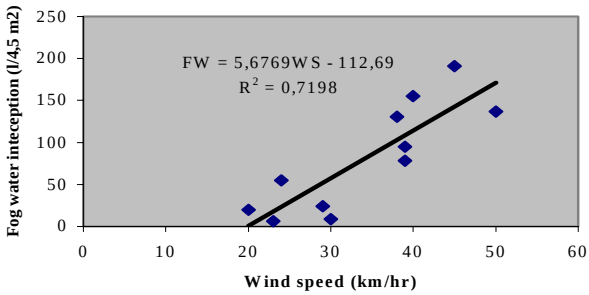


Figure 9 Relationship between amount of fog water interception and wind speed. May 1990. Monte Verde-San Vincent, Cape Verde

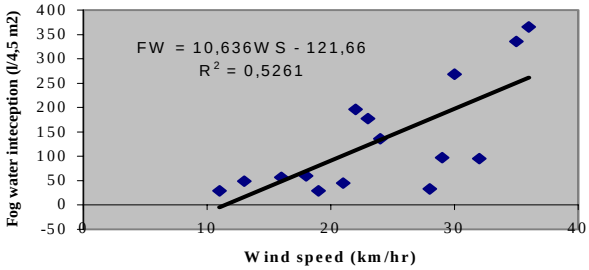


Figure 10. Relationship between amount of fog water interception and wind speed. August 1990. Monte Verde-San Vincent, Cape Verde

Estimation of potential fog water collection for the various ecological and the corresponding areas are illustrated in the Table 5.

Table 5. Estimation of the areas and potential water collection in some islands of Cape Verde

Islands	Island area	Foggy area	Potential fog water		Elect. cond.
	km^2	Ha	m^3/d	m^3/yr	dS/cm
Brava	67,4	54.00	2050	748250	
Santiago	991	300.00	3420	1248300	201[1]
SanVicent	476	19,10	500	182500	
St. Antao	779	330.00	3760	1372400	
S. Nicolau	388	105,00	720	262800	
Fogo	476	325,00	2960	1080400	
Total	3177,4	1133,1	2235	4894650	

[1]pH=7.9

3. CONSTRAINTS

The fog water development projects rely on funds from international cooperation and, very often, on expatriate expertise to find solutions to local problems. This position can be explained by: (1) country economic situation which does not consider funds for fog water projects in the governmental budget; (1) insufficient local professional skills; (2) not enough involvement of the communities in all stages of the projects implementation and; (3) lack of political will and awareness of the role played by fog water project in areas with water shortage.

Various project were purposed by several specialist working in Cape Verde since 1961 some of them were

implemented by the expected results failed due to a lack of maintenance and, even some of them were abandoned. We can cite some of them:

1. 1961-9166. Cunha (1964) proposes the following projects to be implemented as demonstration before a large scale implementation: (a) 5 screen collectors of $2m^2$ for Monte Verde São Vicente; (b) 20 screen collectors of 2 m^2 for São Nicolau island; (c) 15 screen collectors of 2 m^2 for Brava island; (d) 25 screen collectors of 2 m^2 for Fogo island and; (e) 10 screen collectors of 2 m^2 for Santiago Island;
2. 1987-1988. Juvic (1978) purpose a large scale permanent installation catchment system of 150,000 m2 capable of producing 1,500-2000 m3 of water per day during a substancial portion of the year);
3. 1988-1992. Sabino (1992), retook the works conducted by Cunha (1964) and Juvic (1988), and on the basis of the results of experiments conducted on 1991 at Monte Verde, purpose a project of 288 collectors of 144 m2 capable of producing 500 m^3 of water per day during the drought period. The proposed project were approved by the official authorities but were not implemented;
4. 1992-2004. As consultants we try to implement the following projects with the support of the Municipalities, Government and private sectors: (a) 1999. A project of fog water collection for the communities of Pêro Dias, Pico da Cruz and Cruz de João Dorode Santo Antão funded by the consultant and Municipality of Paul. The project operated quite well. However, due to the delay in sending the reservoirs for storage facilities, most of screen collectors were vandalized. It was the end of the project and; (b) 2003. A good project was implemented at Serra Malagueta. The Municipalities of Tarrafal and Santa Catarina supported this project. Due to the lack of maintenance the project is not operating. At the present, NIMWR decided to implement a small-scale project. We were invited to coordinate the activities. Because of the high bureaucracy and lack of funds the project are again in stand by.

4. CONCLUSION

There is a large potential for realizing the dream of large-scale fog water recovery at favourable sites in Cape Verde. Most of the implement projects failed to succeed in the past because of the insufficient support given by official services. The private sector seems to be in a better position to implement fog water projects but in order to achieve this goal there is a need of implementing the education programs to raise the education of the general public and awareness for fog water projects. In any case, the official services will always play a crucial role for implemented projects to succeed.

5. ACKNOWLEEGMENTS

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6. REFERENCES

Cunha, F.R., 1962: The problems related with the collection of fog water in Cape Verde Islands. *Mission of Studies Overseas*, 2-3, Lisbon.

Cunha, F.R., 1964: The collection of fog water in Cape Verde Islands. *Garcia da Horta (Lisboa)*, Vol n. 12, 719-756, Lisbon.

Gonçalves, M.N. and F.R. Cunha, 1991: Fog water catchment, and approach to water supply to the family in Cape Verde. *AGROS-ISA*, 33-42, Lisbon.

Juvic, J.O., 1978: Fog cloud water recovery systems for agricultural and domestic use in Cape Verde Islands. *University of Hawai at HILO*, USA.

Sabino, A. A., 1984. Water and soil conservation in Cape Verde.MDR/CILSS. Praia, Cape Verde.

Sabino, A.A. 1990. Fog/cloud collection in Monte Verde, S. Vicente islands. *National Institute of Agrarian Research (NIAR)*, 1-32, Cape Verde.