

FOG COLLECTORS IN TROPICAL AREAS

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Introduction

Studies on fog precipitations in the tropics have followed three different approaches: *i*) to measure precipitations with *ad hoc* apparatus; *ii*) to harvest fog in nets to catch this water resource in arid areas; *iii*) to study natural collectors, such as trees, and cloud forest ecology.

Definitions and thesis

Fog can be a nuisance because pollution in tropical regions is strongly linked to slash and burn cultivation system (Fontan, 1993). Elsewhere in developed countries Eliás et al. (1992) studied fog relationships with acid rains and phytopathology in the Moravian Mountains forests. Road traffic and aircraft circulation are disturbed by intense fog (Guedalia and Bergot, 1992). We know very little on these fog problems and nuisances.

On the other hand, fog is a neglected water resource which could be very useful in arid countries (Cereceda et al., 1992a). New papers review the fog water collection process and list arid and humid locations worldwide where collection of fog water has been documented (Schemenauer and Cereceda, 1991; Gioda et al., 1992, Schemenauer and Cereceda, 1992a). Traditional forest improvement techniques have used this resource which is now rediscovered by scientists (Aumeeruddy and Pinglo, 1989; Carlson and Añazco, 1990). Indeed, the aim of our research is to consider trees and elfin cloud forests as the best way to exploit and preserve fog water resources,

such as the cypress example above Antofagasta in the Chilean desert (Gischler, 1991), and fountain trees in the Canary Islands (Gioda et al., 1993a; 1993b).

Fog-Catchers on Raingauge

Aside UCN (*Universidad Católica del Norte* of Antofagasta, Chile) experiments, the apparatus are gauze cylinders, i.e., fog-catchers on raingauges (South Africa, Germany, Cape Verde Is., Canary Is.) (Figure 1).

Since Marloth's pioneer works on Table Mountain (South Africa) in 1904 and 1907, it has become the practice to measure fog precipitation by means of two raingauges with a fog-catcher attached to one of them. Grunow in the fifties found that in the absence of fog the raingauge with the fog-catcher collected about the same total amount of rainfall as the standard raingauge over a period of one year, though single comparisons show appreciable differences. It appears that continuous observation is necessary to ensure whether fog is present or not. Therefore, in Tenerife (Canary Is.), fog-catchers are located close to forestry offices in mountain areas. On La Gomera Is. in the eighties, Santana Pérez (1990) developed a special fog-catcher under tree heath (*Erica scoparia*). It is a 50 cm large square collector and its depth is 2.5 cm (Gioda et al., 1993b).

Nets to Harvest Fog for Drinking Water

Pacific coast ridges are frequently covered in fog, which is produced as low decks of marine stratocumulus are blown

onshore (Espejo Guasp, 1992a). In Lachay, a Peruvian National Reserve located 100 km North to Lima, fog has been recorded 186 days . yr⁻¹.

In the fifties, the Department of Physics of the new UCN founded in 1956/57 at Antofagasta in Chile, began to work with nets (Acosta Baladón and Gioda, 1991; Gischler, 1991; Acosta Baladón, 1992). The Chilean CONAF work on mesh is perhaps the best one because Chilean scientists have an impressive background (Lopez M. et al., 1989). A nylon material, the RASCHEL[®] mesh is chosen. It is a triangular weave of a flat fiber about 1 mm wide into a mesh with a pore size of about 1 cm (Figure 2). The best material covers approximately 47 percent of the cross-sectional area of the mesh. The nets are characterized by two layers of mesh rubbing together to capture droplets. The fog collectors are rectangular (12 m x 4 m) (Figure 3). On the ridge of El Tofo in Chile, fifty 48 m² collectors have been installed. They are the bulk of the Chungungo village (350 inhabitants) water supply. Project leaders in Chile are CONAF (*Corporación Nacional Forestal*) and Environment Canada. The cost of this fog water is US\$ 2 per m³.

In Peru, Senamhi (*Servicio Nacional de Meteorología e Hidrología*) and Estratus s.r.l. Company cooperate. Senamhi is working since the sixties in the following *lomas*, i.e., coastal hills facing the Pacific Ocean: Lachay, Pasamayo, Cerro Campana, Atiquipa, Cerro Orara (Ventinilla-Ancón), Cerro Colorado (Villa María de Triunfo), Parque Recreacional de Cahuide (Ate-Vitarte). In Southern Ecuador, CISA (*Centro de Investigaciones Sociales Alternativas*) is beginning to work following Chilean examples in the National Park of Machalilla on Cerro La Gotera (Mejía, 1993).

The quality of water for agriculture and domestic use with the fog water supply system is better than those with cistern system and local spring water in Northern Chile (Cereceda et al., 1992a; Schemenauer and Cereceda, 1992b). Fog water is mineralized counter to the rainfall.

Trees and Cloud Forests

On Cape Verde Is., in Oman, and on Canary Is., farmers and breeders traditionally put cisterns under agaves or trees of different species (olive tree, laurel, juniper tree) to collect water dropping off the leaves in periods of fog (Figures 4 and 5). Note that UCN scientists tried to imitate the trees with an ecological fog water collector made of bamboo (Figure 6).

Cloud forests include variations and local names such as elfin and mossy forests, *bosques de ceja*, *lomas*, *laurisilvas*, *selvas nubladas* (in Spanish), *Gebirgsnebelwalden* (in German), *forêts néphélophiles*, *nébuleuses* (in French) and others, where persistent winds drive cloud or fog yields. The tropical mountain cloud forests are vanishing ecosystems (Doumenge et al., 1993) but reforestation will be possible, for instance even on very arid areas such as Cape Verde Is., according to P. A. Lindskog information, because the fog water resource is persistent. Other very dry regions are however characterized by elfin forests on low mountains not far away from the coast: Sudan, Ethiopia, Djibouti (Blot, 1991), Northern Colombia in the Guajira peninsula, Far West of Venezuela (Cavelier and Goldstein, 1989), etc.

Nowadays the best prospect for applied projects is perhaps to exploit fog resource in the National Reserve of Paposo (25°S; 70° 30'W), in the coastal ridge between La Serena and Antofagasta in Chile where scientists and technicians agreed to promote Paposo area (Estades Marfán, 1991a, 1991b; Cereceda et al., 1992b; Espejo Guasp, 1992 b; Soto, 1992).

In the Old World, an example of fog applied researches has been granted in 1993 on the Canary archipelago. A famous fountain tree, a centenary juniper (*Juniperus phoenicea*), was destroyed by a bush fire in 1990 at Cruz de los Reyes (Hiero Is.). The project aims to transplant a new tree to the existing location and make use of existing fog water concrete collector and tank buildings (Gioda, 1993).

Conclusions

We tried to promote fog research in the tropics with the help of this recent bibliographic review showing a new interest about this water resource. Fog has been a neglected water resource which could be very useful in arid countries. It is an alternative and renewable resource produced by the wind energy to be included in a sustainable development framework.

In-humid and arid tropics, mountain cloud forests and especially elfin forests are endangered communities which have a high biodiversity. Rather than a generic objective, such as the tropical cloud forest conservation, we choose a simple communication vector, i. e., the fountain tree which represents a good pedagogic impact.

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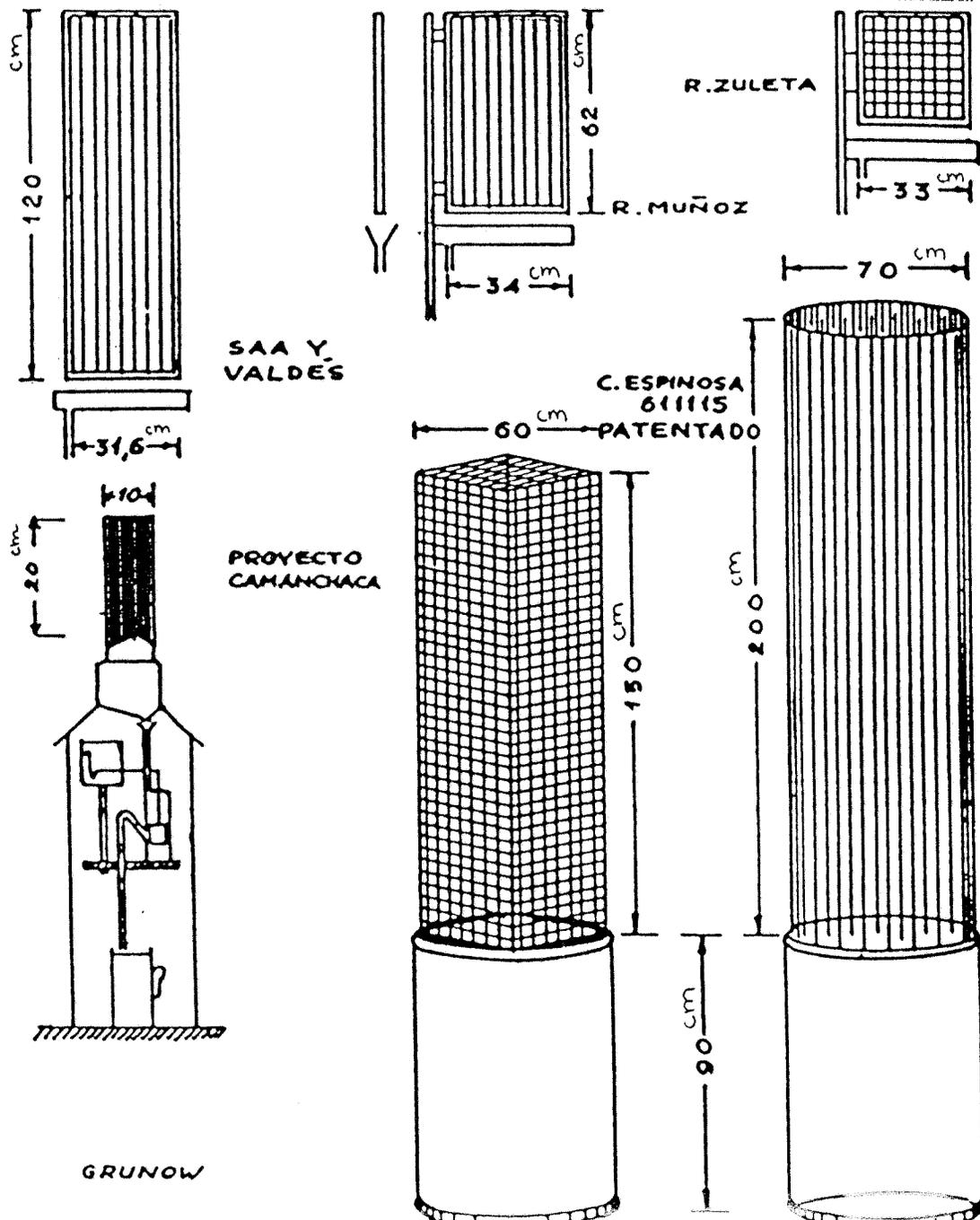
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Figure 2. Two layers of mesh rubbing together of the RASCHEL® mesh of 35 %, i.e., which covers 35 % of the cross-sectional area of the mesh (Lopez M. et al., 1989).



Figure 1. Examples of fog-catchers to measure precipitation used in Chile from the fifties (Nagel, *Quart. J. Roy. Meteor. Soc.*, 1956, 82: 452-460; Tapia and Zuleta, *Viente años de camanchaca y dos de proyecto Mellijones*. UCN, 1980; Soto, 1992).



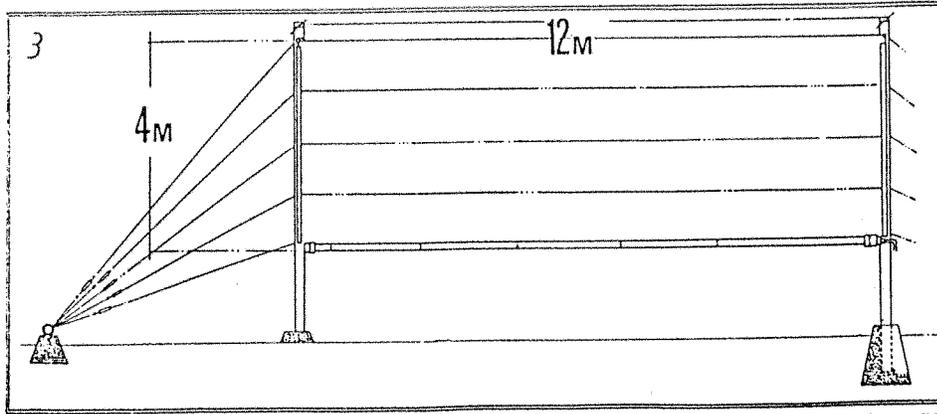
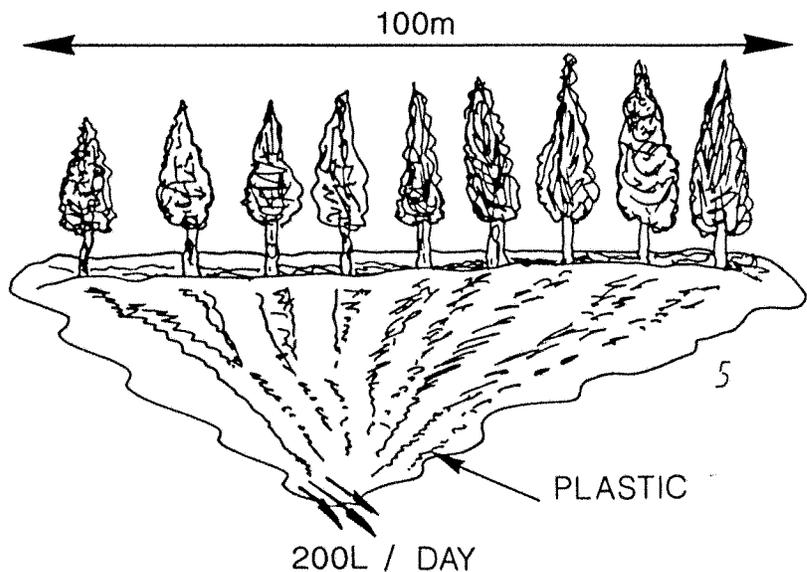
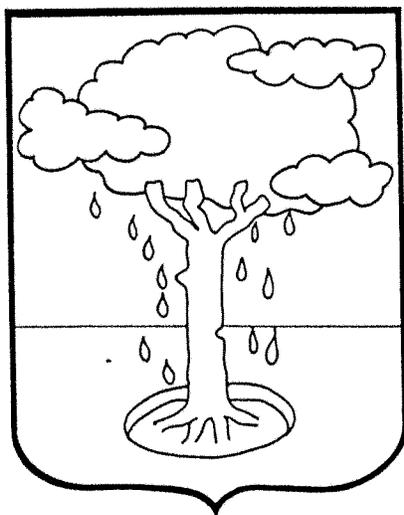
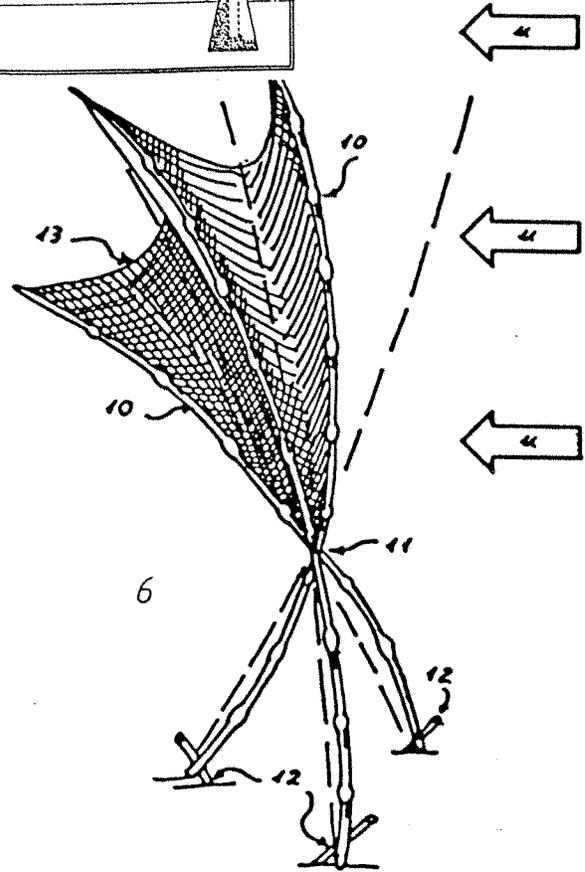


Figure 3. The 48 m² fog water collector used in Northern Chile. It is the biggest net to collect water for small villages (Lopez M., 1989; Soto, 1992).

Figure 4. The fountain tree of Hierro (Canary Is.) on the simplified arms of the island. It was a laurel (*Ocotea foetens*) uprooted by a hurricane in 1610 (Alaya Zamora, *El agua, variante de una trágica leyenda*, *El Día*, 1931; Gioda et al., 1992).

Figure 5. Trees used such as fog water collectors for drinking water on Cape Verde Islands (Colombani, ORSTOM).

Figure 6. The ecological fog water collector made of bamboo (Tapia et Zuleta, *Viente años de camanchaca y dos de proyecto Mellijones*. UCN, 1980; Soto, 1992).



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