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Dew, fog and rain water collectors in a village of S-Morocco (Idouassksou)

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ABSTRACT

The coastal region of south Morocco presents a chronically shortage of drinkable and fresh water. In 2007, only 49 mm of rain were recorded. However, measurements in the same year showed that the dew yield was on order of 40% of rain fall. In order to recover dew water in addition to rain water, a small village (Idouassksou), 8 km from Mirleft and the Atlantic Ocean, was equipped with three pilot condensers of 136 m^2 total surface area. A local organization (IMIRJANE) collaborated to ensure a good integration of the project by the village inhabitants. All materials were from local shops. Only the special radiative and hydrophilic coating was coming from non local resources (www.opur.fr). Dew water production during six months, from 15 Dec. 2008 to 31 Jul. 2009 (137 dew events, 47% of days) was more than 3,800 L (28 mm, 0.2 mm/dew day). The devices not only condense dew water, they also harvest rain and fog, thus providing to the population a valuable water resource (during fall 2009, the collectors were the only source of water of the village).

Keywords: Alternative water resources; Atmospheric water; Dew water; Rain water; Fog water; Radiative cooling

1. Introduction

Nowadays, the development of the water resources of the arid areas is centered on projects of great irrigation. These projects, however, offer few direct advantages for the small farmers or the nomads who must survive in the constraints of their environment without benefiting from new technologies that are not adapted to their needs. Fortunately, the collection of water is one of the methods of improvement of the

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Fig. 1. Site in its initial state. (a) General view and (b) (1) condenser on terrace; (2) double-slope roof condenser and (3) dull condenser on ground.

conditions of existence of these populations. After the measurements of rain, dew and fog yield in Mirleft, south Morocco (43 m asl, 29° 35′ N, 10° 02′ W), it was found that the dew contribution, amounting to about 40% of rain precipitation, could not be ignored any more [1].

In a small nearby village (Idouasskssou, 8 km SE of Mirleft, about 300 m asl) some data of dew, fog and rain was collected by OPUR-type 2 m^2 dew collectors and a fog net collector on the roof of a small school by the teacher with the help of a local organization for local development IMIRJANE. They showed indeed that a significant amount of dew water could be collected. With the help of the above organization IMIRJANE and the local population it was then decided[1] to set up a demonstration site at Idouasskssou. The goal was to show to the local population the interest of recovering dew (and fog) water in addition to rain water. The implication of the local population and local organization is always fundamental in this type of project. Three dew condensers (135.7 m^2 total surface area), easily accessible from the ground, have been constructed in a month: a roof terrace (40.64 m^2), a slope roof (21.2 m^2), a ground condenser (73.8 m^2), together with a fog collector (F) (40 m^2).

2. Collection device

2.1. Site

A site favourable to the installation with two water storage tanks has been found on a slope of approximately 17° with the horizontal (Fig. 1). The cistern (1) exhibits a planar surface area of $10.6 \times 5.3\,m^2$ on its top and is used as emergency tank when the water distribution is down. The second, $4.7 \times 3.0 \times 1.60\,m^3$, not covered, was abandoned by the inhabitants. The site is downwards the village on a slope that is not used by the inhabitants. The installation of condensers will thus not disturb the practices of the inhabitants.

A terrace condenser (40.64 m^2) was installed on the covered cistern in (1). The second cistern (2) was rehabilitated to collect water from all the condensers. It was also used to set up a two slopes roof condenser (21.2 m^2). In (3), above (2), on the slope, a ground condenser was installed (see Figs. 1 and 2).

2.2. Terrace condenser

The top of the cistern was firstly surmounted by a parapet in order to find a configuration of traditional terrace. The characteristic of this standard "roof" being it is easily accessible. The condensing materials is made with of 0.75 mm galvanized iron sheets painted with a special painting (OPUR) that enhances infrared cooling in the atmospheric window and keeps hydrophilic thanks to continuous photocatalytic reaction with the sun UV. Thermal insulation below the sheets is insured by 2 cm thickness Styrofoam plates (see Figs. 3 and 4).

2.3. Double-roof condenser

The open cistern (2) was firstly raised by three lines of cement blocks then of a gable intended to receive the ridgepole. The condenser was then installed with the same elements as the terrace condenser.

[1]The construction was financed by an award (université de Corse/CNRS/Corsica Ferries company) granted to one of us (OC) for the Calvi "Festival du vent".

Fig. 2. General view. CoT, 40.64 m^2; CoR, 21.2 m^2; CoG, 73.8 m^2; F, 40 m^2.

2.4. Condenser on ground

The condenser on ground required a preparation (chaining and stabilization of the ground). The design was selected to profit from the slope of the ground (17°) to collect dew water. The principal surfaces of condensation are tilted by 30° in order to increase the dew yield [2]. The surface is made with a UV treated white polyethylene foil that is commercially available in Morocco and presents a high resistance to mechanical stress.

2.5. Fog collector

A 40 m^2 F made with two layers of aluminum shading net (50% transmission, ribbon width 1.7 mm), similar to that by Schemenauer et al. [3] has been installed nearby the condensers, near a crest (Figs. 2 and 5). No data have been collected so far.

Fig. 3. Two slopes CoR and CoT.

3. Measurements

The data were collected during 229 days, between 15/12/2008 and 31/07/2009. 137 events of dew were counted, that is, 46.9% of the period of collection with a cumulated volume of 3791.5 L (corresponding to 28 mm). It corresponds to an output of 16.6 L/day over the complete period and 27.7 L/dew event. Unfortunately, the method to measure volume (graduated bucket) saturates at 22 L. On Fig. 6, it is clear that many dew events should have given more water. This saturation also prevented to measure rain water. However, one can refer to the data collected in 2007 during the same period in the nearby village of Mirleft [1]. Here 17 mm of rain water was measured, to be compared to the 28 mm collected from dew water.

Fig. 4. Condensor on ground (CoG).

Fig. 5. Fog collector (F).

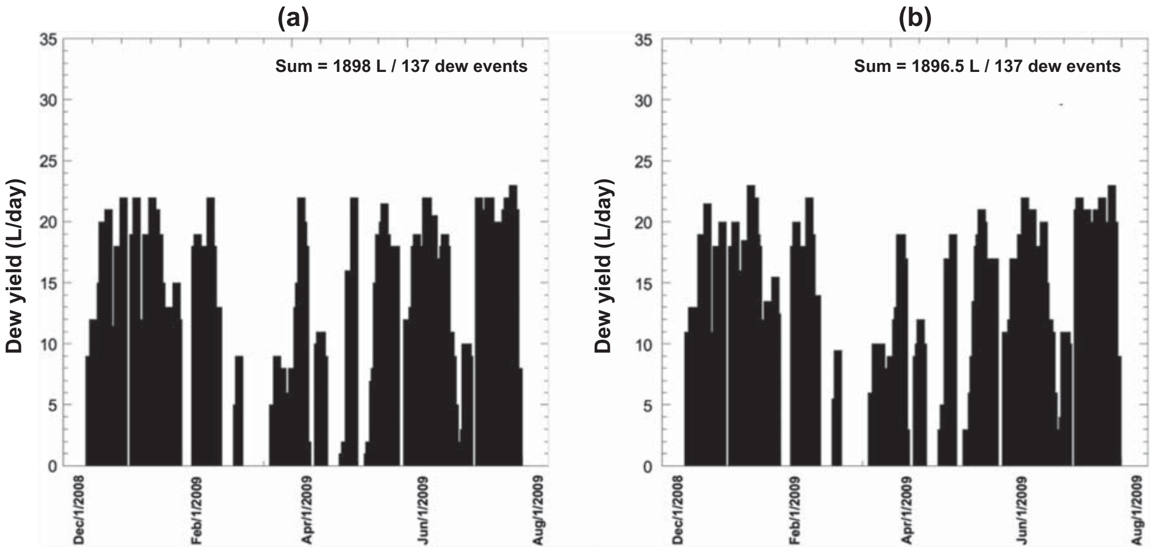

Fig. 6. Dew yield (L) for 229 measurement days. (a) CoT (40.64 m^2) plus CoR (21.2 m^2) and (b) CoG (73.8 m^2).

According to the figures above, the condenser on terrace (CoT) plus double slope condenser on roof (CoR) (total: 61.8 m^2) collect almost the same quantity of water than the condenser on ground (CoG) (73.8 m^2). This can be explained by the difference of materials of collection used (foil and paint) and the method of construction for each system. Indeed, it has been shown [4] that a suspended condenser of 30 m^2 condenses approximately 14% more than the identical condenser built on the ground.

4. Concluding remarks

The construction of these demonstration condensers, of three main types; CoG on ground, CoR, on roofs and CoT on terraces led to a great satisfaction in the village community. In particular, people were amazed to see the level of water rising although there was no rain.

A year after the construction, the President of the IMRJANE organization left the village. The CoR and CoT were still working a year and a half after their construction. However, due to a severe storm, the CoG was damaged. It is still partially functioning but the foil has not (yet?) been fixed by the inhabitants. They also did not connect the fog net to the tank.

In order to be sustainable and useful on the long term to the population, this kind of project would need a clear involvement of the local authorities to go beyond the good will of small private organizations.

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