Rooftop dew, fog and rain collection in southwest Morocco and predictive dew modeling using neural networks

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S U M M A R Y

Two coastal sites were investigated in an arid region of southwest Morocco to determine the amount of dew, fog and rain that could be collected from rooftops for household use. Systematic measurements were performed in Mirleft (43 m asl, 200 m from the coast) for 1 year (May 1, 2007 to April 30, 2008) and in Id Ouasskssou (240 m asl, 8 km from the coast) for three summer months (July 1, 2007 to September 30, 2007). Dew water was collected using standard passive dew condensers and fog water by utilizing planar fog collectors. The wind flow was simulated on the rooftop to establish the location of the fog collector. At both sites, dew yields and, to a lesser extent, fog water yields, were found to be significant in comparison to rain events. Mirleft had 178 dew events (48.6% of the year, 18 ± 2 L m⁻² cumulated amount) and 20 fog episodes (5.5% of the year, 1.4 L m⁻² with uncertainty ±0.2/+0.4 L m⁻² cumulated amount), corresponding to almost 40% of the yearly rain contribution (31 rain events, 8.5% of the year, 49 ± 7 mm cumulated amount). At Id Ouasskssou there were 50 dew events (7.1 ± 0.3 L m⁻², 54.3% frequency), 16 fog events (6.5 L m⁻² with uncertainty ±0.1/+1.8 L m⁻², 17.4% frequency) and six rain events (16 ± 2 mm, 6.5% frequency).

Meteorological data (air and dew point temperature and/or relative humidity, wind speed and wind direction, cloud cover) were recorded continuously at Mirleft to assess the influence of local meteorological conditions on dew and fog formation. Using the set of collected data, a new model for dew yield prediction based on artificial neural networks was developed and tested for the Mirleft site. This model was then extrapolated to 15 major cities in Morocco to assess their potential for dew water collection. It was found that the location of the cities with respect to the Atlas mountain chain, which controls the circulation of the humid marine air, is the main factor that influences dew production.

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1. Introduction

The region of Mirleft, situated on the Atlantic Ocean coast of southwestern Morocco, lies within an arid to semi-arid belt and is experiencing strong exploitation of available water resources (MEMEE, 2008). The climate is characterized by low annual precipitation distributed over about 30 rain days; in 2007 the annual rainfall was 49 mm. In order to confront water limitations and rising prices of obtaining conventional water, alternative water sources have been considered since the beginning of the 1990s – mainly waste-water re-use, demineralization of brackish water and desalination of marine water. However, the price of such water remains more than 10 times higher than the price of conventional water.

Dew has been considered as a potential source of water and a number of studies have been carried out around the world following the pioneering and rather unsuccessful attempts by Zibold in Feodosia (Crimea, Ukraine) in 1912 and later in France using massive condensers (see Nikolayev et al., 1996 and references therein). Light condensers based on radiative deficit cooling were more successful (Nilsson, 1996; Alnaser and Barakat, 2000; Muselli et al., 2002; Berkowicz et al., 2004; Gandhidasan and Abualhamayel, 2005; Beysens et al., 2003, 2006; Sharan et al., 2008; Jacobs et al., 2008; Sharan et al., 2011). Dew formation is influenced by both meteorological parameters and condenser architectures (Berdahl, 1995; Muselli et al., 2006; Beysens et al., 2003, 2006; Jacobs et al.,...