VATTEN – Journal of Water Management and Research 70:103–106. Lund 2014

DEW WATER HARVEST EXPERIMENT IN A SEMI-ARID ENVIRONMENT, CHINA

Vattenutvinning från dimma, ett experiment i semiarid miljö, Kina

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Abstract

Fog collection by man-made collectors has been proved to be a non-conventional source of water. Applications exist in many countries where conventional methods cannot provide an adequate supply of water. Alternative ways of gathering water in arid and semi-arid environments have always meant a challenge for dwellers of those areas. Recently, fog-water harvest is becoming increasingly popular in places where despite the dry climate there is a significant volume of water nearby. A pilot experiment during a few summer days has been conducted in a semi-arid to arid environment in China to study its feasibility. The results show that it is highly possible to harvest dew water in these areas with relatively low investment in term of equipment.

Key words – water harvest, dew, fog, arid environment, sustainability.

Sammanfattning

Vattenutvinning från dimma av konstgjorda uppsamlare har visat sig vara en okonventionell källa till färskvatten. Applikationer finns i många länder där konventionella metoder inte kan ge en tillräcklig försörjning av rent vatten. Alternativa sätt att samla vatten i arida och semiarida miljöer har alltid inneburit en utmaning för invånarna i dessa områden. Nyligen har dagg- och dimmvattenskörd blivit allt populärare på platser där det trots det torra klimatet finns en betydande mängd vatten i omgivningen. Ett pilotexperiment har genomförts under några sommardagar i semiarid miljö i Kina för att studera dess användbarhet i torra miljö. Resultaten visar att det är mycket möjligt att skörda daggvatten i dessa områden med relativt låga investeringar med hänsyn till materialkostnader.

1 Introduction and Background

Precipitation is normally considered as the only source of water for watersheds. Measurements of drizzle, rainfall, and snowfall, in several locations, are integrated to estimate the annual water input. Lack of water has been a challenge for mankind since the dawn of societies in areas of arid and semi-arid climate. Even in other climates, water shortage during drought periods has cause struggle and death for human beings. This is the reason why an accessible, secure source of water is a common aspect of populated environments.

Running water from higher lands, storm water and underground reservoirs are often the sources of supply. However, in certain regions, some societies has succeed in finding alternative ways to find water, from covering the fields with volcanic stone in Lanzarote, to the so called 'air well' invented by the Belgian engineer Achille Knapen in 1928 (Knapen, 1930). Certainly alternative ways to harvest water look over the invisible: moisture contained in the air. Therefore, their aim is to use the physical process of condensation to collect the water turned liquid from the air humidity.

The most widespread system is the so-called 'Fog water collector', implemented for the first time in the mid-eighties by the Meteorological Service of Canada (MSC)

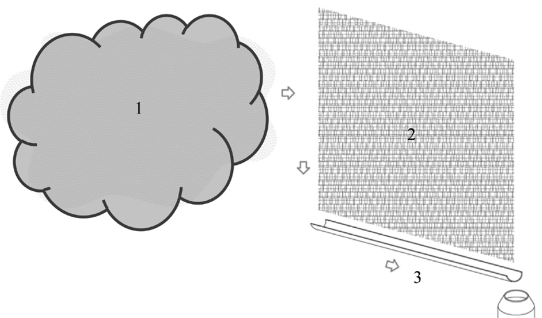

Figure 1. *Diagram of the DWH elements used in the study.*

Figure 2. *Close-up of the polypropylene net used in the experiment.*

on Mount Sutton – Quebec, with the aim of studying the constituents of the collected fog. However, the most successful and documented project regarding drinking water collection, took place since 1990 in El Tofo Mountain for use in the community of Chugungo in northern Chile (Dale, 2013), initiative of the National Forest Corporation and the Catholic University of Chile, with funding of the International Development Research Centre (IDRC) and the collaboration of the MSC from Canada.

Shortly after the success of the project in Chile, members of the participating institutions formed 'FogQuest', a non-profit organization which has set up facilities in Yemen, Chile, Guatemala, Haiti and Nepal. The easy, inexpensive fabrication of those devices make possible that villagers from 25 countries worldwide use them. A typical fog collector is made of fine-mesh net. The mesh is often suspended 1.5 m above the ground between two vertical posts. The size of the collector depends on topography and the intended use of the water. A typical fog collector used by Furey (1998). In the same study, besides a review of current status, Furey also described detailed technical design in a pilot study. A number of other summaries of fog collection experiments have been made (e.g., Kerfoot, 1968; Stadtmuller, 1987; Schemenauer and Cereceda, 1991; Vong et al., 1991). Some of them clearly show the importance of fog as a wet deposition pathway (Schemenauer and Cereceda, 1994).

This paper addresses the experiment carried out by the author in the city of Wuwei, in Gansu Province, China, regarding the mentioned concept applied to an arid region where is more suitable to call the device Dew Water Harvester (DWH), better than Fog Water Harvester, since there is hardly fog weather in the area. The experiment took place during two weeks in October 2013 in connection with a Master course field study.

The aims of this paper are to, through simple experiment, present and evaluate this system in the Northwestern part of China, in the city of Wuwei, Gansu Province. The system is named Dew Water Harvester (DWH) because it is assumed that the difference in temperature between night and day is what makes it to work.

2 Description of the Experiment

2.1 Fabrication of the Dew Water Harvester (DWH)

A Dew Water Harvester (DWH), as well as a Fog Water Harvester, consists of three elements: a net to condense the moisture in the air, a pipe to conduct the condensed water and a gathering point. In Figure 1 it is shown schematically how these elements are put together. Preferable materials for the net are polypropylene and nylon because the polymeric structure of those materials made them impermeable and therefore no water is absorbed. It must be as tensed as possible, in order to facilitate the drip of condensed drops all the way down to the pipe placed below. The pipe should be arranged in a way that conducts the water safely to the gathering point.

In this experiment the net was a polypropylene mesh, relatively thick, shown in Figure 2. The material of the pipe used was polyvinyl chloride (PVC). Its dimensions were originally 5 cm diameter by 1 m long. However, it was modified to meet the design requirements. First of all, holes were drilled along the pipe to attach it later to the net. Then, the pipe was cut in two halves longitudinally and each was again cut across in two halves for shipping reasons. With cable ties the pipe was fasten to the net. A thermos bottle was used as gathering point, partially covered to avoid evaporation.

2.2 Performance of the DWH

The device for the experiment was set up in the rooftop at the sixth floor of a building in the centre of Wuwei on October 12th at midnight. The net was double layer, covering a vertical surface of 1.75 m horizontally by 1.60 m vertically, as shown in Figure 3, reaching 2.8 m^2 of exposed surface. The device was partially protected by the building which hosted it towards south, east and west.

It was performing until the next day at noon, summing up 12 h in total. During that time, it has collected 15 ml of water in the thermos bottle and there was more water condensed along the collecting pipe. However, there was evidence of some spots where water was once condensed but had been evaporated at the time of evaluation.

3 Results

3.1 Evaluation of the experiment

The volume of water collected by 2.8 m^2 in 12 h was 15 ml. We could extrapolate this quantity to 10 ml per m^2 a day. Therefore, to achieve the volume of 2.5 l of drinking water per person a day, 250 m^2 of deployed net per capita would be required.

However, this estimation needs to be further examined for the reasons explained below:

– The device should be place in a completely exposed location, to be accessed by winds coming from any direction.
– The experiment should be carried out and performed during different seasons of the year in order to investigate the seasonal variations.
– Geometry and geographical location to place the DWH need to be further investigated for best performance.

3.2 Suggestions for improving performance of the DWH

Although gathering any volume of water in such a dry place as Wuwei means a success, the volume of water collected per square meter of net rate make difficult to implement this technology extensively, despite the inexpensive production cost.

In addition to the pinpointed issues of the previous section, there are two design advices to take into account for the construction of next prototypes:

1. Cover the device with a roof that will prevent evaporation of the water in the pipe before reaching the gathering point.
2. Stretch the net as much as possible to be tense in order to minimize its movement when wind blows and optimize the exposed surface.

Furthermore, there are ongoing research projects that might be useful in the near future for improving this device (Choo, 2011), regarding the nature of the materials used and also the overall geometry of the deployed structure.

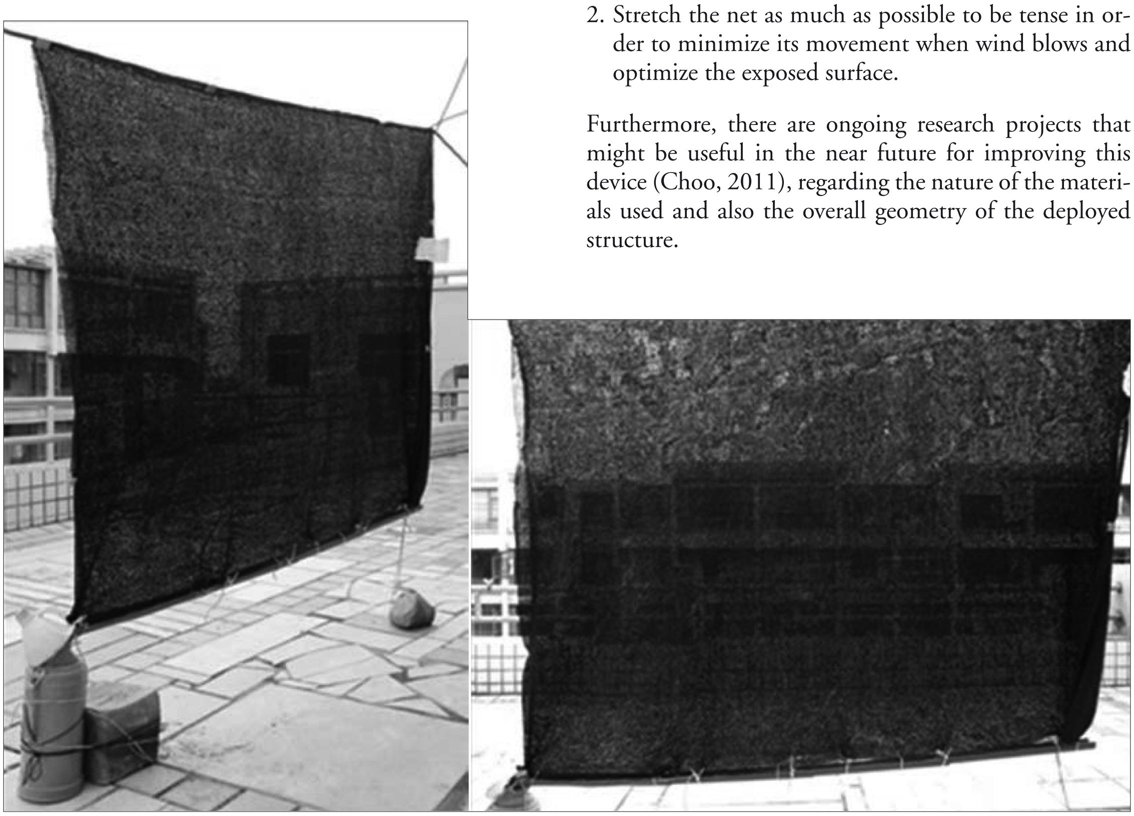

Figure 3. *Set up device to perform the experiment.*

4 Conclusions

Out experiment of dew water harvesting facility turns out to be an alternative system to get water in such a dry area as where Wuwei is located. However, it is necessary to carry out more extended and long-term research in order to have precise figures on its performance within the city, trying different locations, orientations and materials.

This is absolutely feasible due to the simplicity and affordability of the system and the high potential of having on-site water collection at a household level.

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