Title: Designing Desalination Plant for Groundwater and Seawater by Using an Evaporation-Condensation System with Solar Cells.

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Subtheme of the congress: Non-conventional sources of water: Water reuse and desalination as part of management schemes.

Introduction: In Colombia, the frequency and intensity of rainy seasons have been changing mainly due to El Niño Southern Oscillation (ENSO) which is an event of marine and atmospheric nature where surface waters in the central and eastern tropical Pacific suffer abnormal heating and cooling.Waters of Colombian south coast are influenced by this phenomenon and the entire territory has suffered ENSO consequences during its warm (El Niño events) and cool (La Niña events) phases. Both El Niño and La Niña strong events have been occurred in Colombia with a frequency of 10 years; likewise in the last decade, El Niño and La Niña moderate events have been observed in 2002–03 (El Niño), 2007–08 (La Niña) and 2009–10 (El Niño) (NOAA, 2015).

For Colombian Andean and Interandean Zones, the El Niño strong events usually decrease the annual precipitation by 50%. Also, strong reductions of precipitation have been observed for periods with no El Niño and La Niña events registered, such as the reduction of precipitation observed in 2013, where only a rainy season (between April to June) was recorded instead two rainy seasons (as usually occurs) and total annual precipitation was 60% less than the historical averages.

This situation have been decreasing the amount of natural freshwater runoff, specifically in the interandean zones where precipitation is a natural source of supply for agricultural production systems and ecosystems. Actually, the interest to use groundwater and seawater has been increasing in zones with water supply problems, but these water sources contain high levels of salt and minerals such as S, Zn, and K. Thereby, chemical treatments of seawater and groundwater are necessary for domestic and agricultural water consumption (Karagiannis & Soldatos, 2008). The goal of this study was to design a desalination plant for groundwater and seawater by using an evaporation-condensation system with solar cells, in order to supply water in those zones with water deficit.

Method: The design of the Desalination Plant included: i) an electric motor which works with kinetic generators through finite magnetic fields, ii) a system of pools to store both salinized water (mass input) and desalinated water (mass output), iii) a system of heat cells to condensate the salinized water, and iv) two gutters to decant and extract salt (Figure 1). Similar methods have been used by Khawaji & Kutubkhanah (2008). The operation scheme is briefly described as follows: step one: The water is stored in a receiver tank, step two: The water is conducted to condensation cells which generate heat coming from kinetic power plant, step three: The evaporated water (without salt) is transported toward a storage tank where water is agitated to increase its level of oxygen, step four: The salt coming from condensation cells is conducted to receiver tank of salt.

This desalination plant was designed to treat a total uptake flow of 0.24 m3 s-1, driving average flows of 0.0171 m3 s-1 in each condensation cell. Likewise, the desalination plant is designed to operate at longitudinal slopes about 0.75%, with a run length of 20 m. In order to test the efficacy of this design, a water quality meter (HI 9828, Hanna Instruments, Texas, USA) was used to assess electrical conductance before and after treatment.

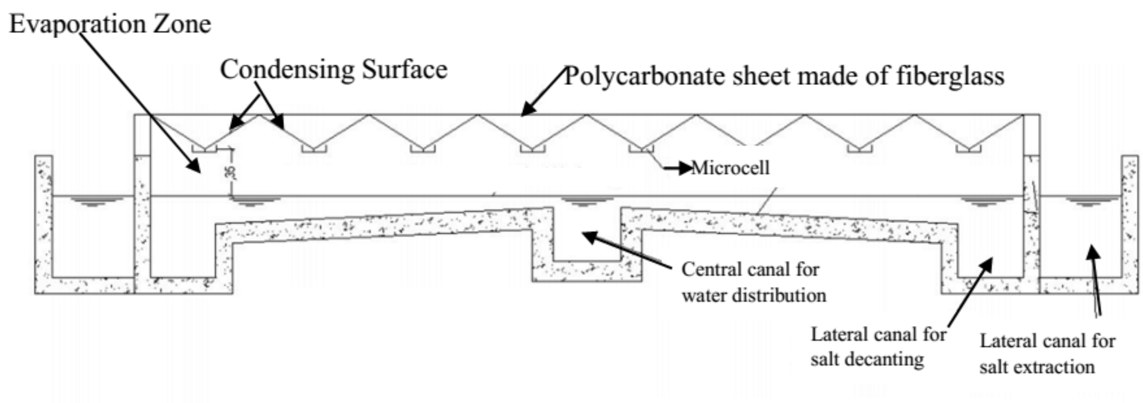

Figure 1. Cross section of the evaporation and condensation cells

Results: A scale model of the desalination plant (Figure 1) was constructed in the Laboratory of Hydraulics located in the University of Tolima.

In order to conduct a performance testing and adjust the plant design, 20 liters of groundwater with a salinity of 2.8 dS/m were treated by using the desalination plant in July 2014. Water electrical conductance was measured when groundwater was inside the evaporation zone, this measurements continued until groundwater reached the condensing surface (Time=12 h, Figure 2). The salinity reduction was positively related to the evaporation time as shows Figure 2. The salinity of groundwater was 1.7 dS/m after treatment with the plant, indicating a salinity reduction of 64%.

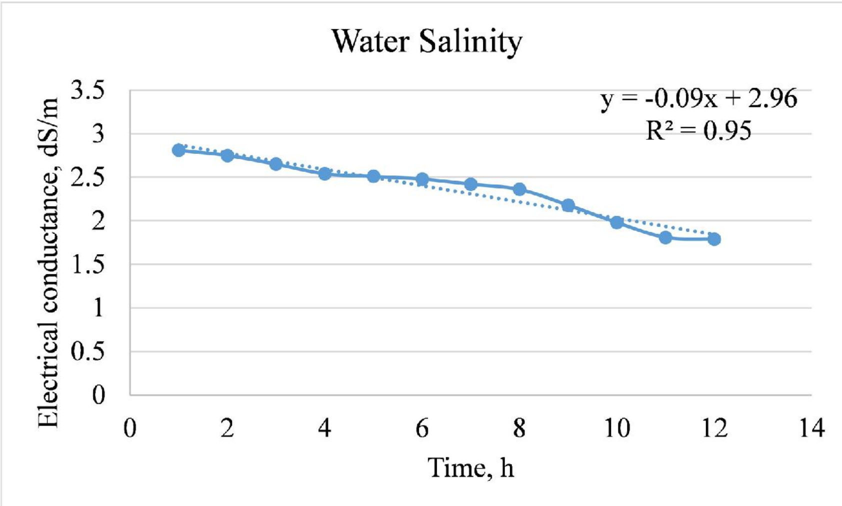

Figure 2. Water electrical conductance measured inside the evaporation zone of the plant.

Conclusions: The result of this study suggests that it is feasible to build a second scale model to treat 1 m3 water. Furthermore, this result suggests that the desalination plant could be a supply option for sites with low rainfall and high evaporative demand. The design of this desalination plant also includes a water distribution and collection system to provide to the consumers a closed water supply system and thus, promote water reuse.

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