

PRODUCTION OF POTABLE WATER WITH THE USE OF SOLAR DESALINIZERS IN THE BRAZILIAN SEMI-ARID

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ABSTRACT

The semi-climatic conditions of the Brazilian Semi-arid have conditioned the water shortage, which has forced numerous rural families to consume brackish waters unfit for human consumption. Added to this is the fact that the poor management of local water resources is an aggravating factor to unavailability of water, especially drinking water. The technologies have proved to be medium for the efficient management of water resources. The present study aimed to analyze the use of solar desalinizers can offer drinking water with the use of solar energy. An experimental and qualiquantitative research was carried out, based: data collection; Field studies, with accounting for the production of drinking water; Conducting physical-chemical analyzes of water; And participatory research with families that consume the waters from desalinators. As result, there were: there is, locally, a great solar energy potential; There was an average production of 40 liters / day, which met the needs (2 liters / person / day) of 20 individuals distributed in 5 families; physico-chemical analyzes proved the potability of the water coming from the desalinators; And the use of desalinators has made possible socioeconomic and environmental benefits. It was concluded that desalinators are socially disseminable, economically viable, and environmentally sound technology.

Keywords: Water scarcity; Technology; Socioeconomic and environmental benefits.

PRODUÇÃO DE ÁGUA POTÁVEL COM O USO DE DESSALINIZAÇÃO SOLAR NO SEMIARIDO BRASILEIRO

RESUMO

As condições edafoclimáticas do Semiárido Brasileiro têm condicionado a escassez hídrica, a qual tem forçado inúmeras famílias rurais a consumirem águas salobras impróprias para o consumo humano. Somado a isso, tem-se o fato da má gestão dos recursos hídricos locais. Diante disso, as tecnologias têm se mostrado um meio para a gestão eficiente dos recursos hídricos. O presente estudo objetivou analisar como o uso de dessalinizadores solar pode ofertar água potável com o uso de energia solar. Para tanto, foi realizada uma pesquisa experimental e qualiquantitativa, baseada em: levantamento de dados; estudos de campo, com contabilização da produção de água potável; realização de análises físico-químicas de águas; e pesquisas participativas junto às famílias que consomem as águas advindas dos dessalinizadores. Obtiveram-se como resultados: há, localmente, um grande potencial de energia solar; houve uma produção média de 40 litros/dia, o que atendeu as necessidades (2 litros/pessoa/dia) de 20 indivíduos distribuídos em 5 famílias locais; as análises físico-químicas comprovaram a potabilidade das águas advindas dos dessalinizadores; e o uso dos dessalinizadores possibilitaram benefícios socioeconômicos e ambientais. Concluiu-se que os dessalinizadores solar são uma tecnologia socialmente disseminável, economicamente viável, e ambientalmente correta.

Palavras-chave: Escassez de água; Tecnologia; Benefícios socioeconômicos e ambientais.

INTRODUCTION

The problematic that involves the availability of water to meet human needs becomes more strongly observable in semi-arid regions, which present adverse climatic conditions: low rainfall; High evapotranspiration index; High temperatures, and rains distributed irregularly in both time and space. In addition to the climatic scenario described previously, Marinho et al. (2012) state that much of the Brazilian semi-arid (SAB) has limited and irregular availability of water resources, in addition to high levels of salinity in soils and waters, especially in crystalline areas. This edaphoclimatic reality has conditioned a lack of water resources that directly affects the quality of life of local populations. In this sense, Amaral et al. (2003) state that: in some semi-arid regions, the extreme shortage of good quality water forces populations to consume water with high salt levels or contaminated by pathogens, with consequent health damage.

In the search for a solution to obtain potable water in the Brazilian semi-arid region, we have the desalination and disinfection of the waters from the use of solar desalinizers. In summary, the solar desalinator uses solar radiation to heat the water, which will evaporate and condense inside the desalinator. Thus, the water becomes potable due to the high temperatures inside the desalinator, to eliminate the pathogenic microorganisms, and to allow the withdrawal of the salts dissolved in the water (MARINHO et al., 2015). At the same time, the desalination and disinfection of water through the solar desalinator is already applied in several countries, with good family acceptance for drinking water production. It has as a stimulus: it does not have electricity costs and it is considered a clean and sustainable technology (BOUKAR & HARMIN, 2001).

It is important to remember that solar energy in the Brazilian Semi-arid is variable throughout the year, but presents a great potential for water desalination (SOARES, 2004). Thus, the present study also sought to answer: What is the potential of solar energy available, locally, to promote disinfection and desalination of water? What is the maximum and minimum daily water production that can be achieved based on local solar energy? How does the production of drinking water vary throughout the year? Is the water from solar desalinisers truly conducive to human consumption? What are the socioeconomic and environmental benefits of using solar desalinators?

To answer the previous questions, an experimental, descriptive and qualiquantitative research was carried out, based on: theoretical and documentary foundations; Technical visits and on-site observations; Data collection and statistical calculations; Questioning with local

families; as well as laboratory analyzes of water samples collected before and after the use of solar desalinators.

Finally, it is known that in Brazil, especially in the Brazilian semi-arid, there is a great potential of solar energy for the treatment of water through solar desalinizers (LOPES, 2004), the present study aimed to analyze the water production of solar desalinizers , And with that, to identify the socioeconomic and environmental benefits derived from this water management technology. Considering the context, the present study evaluated the production of drinking water from solar desalinizers installed in the city of Seridó-PB, semi-arid region of Paraíba. In this sense, it was possible to evaluate how the use of solar desalinizers can increase the supply of drinking water and, with this, to allow socioenvironmental benefits. For this purpose, the daily production of drinking water from solar desalinators was evaluated during 20 (twenty days) distributed throughout the year.

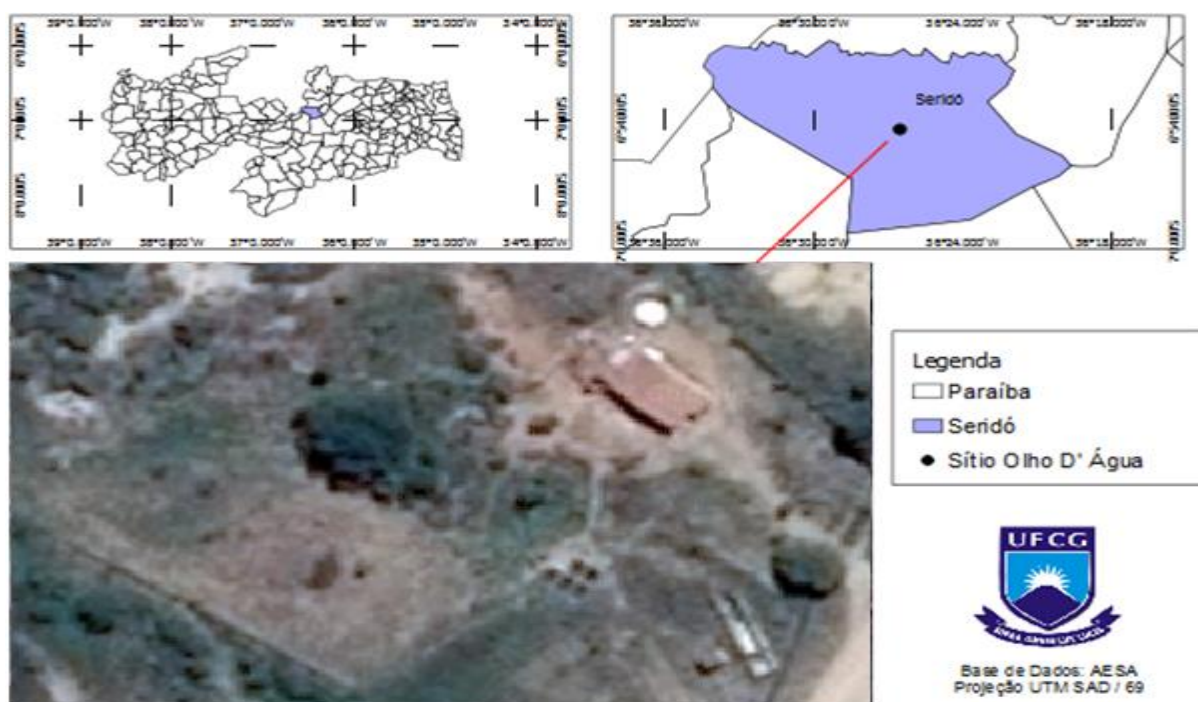
MATERIAL AND METHODS

Research space and the solar desalinator model

The research was carried out in the site Olho D'água (6 ° 55'58 "S and 36 ° 23 '8" W), located in the municipality of Seridó-PB, which is inserted in the Meso-region of Borborema and in the Eastern Seridó Microregion Paraíba (Figure 1).

The choice of the municipality of Seridó-PB as a research space, was due to the fact that it presents some criteria essential to this research, such as: 1) the population, especially the rural population, lives with the periodic water shortage due to the Local climatic conditions; 2) 90% of the rural population (5,126 inhabitants) survive with inadequate basic sanitation conditions: water and sewage (IBGE, 2010); 3) a large part of the rural population consumes water from wells, ponds or cisterns without any water treatment, which has increased the cases of waterborne diseases; and 4) the fact that innumerable locally drilled wells offer saline waters, which are unfit for human consumption, but could be consumed after desalination and disinfection with the use of solar desalinators.

Figure 1 - Location of the Olho D'água site, in the municipality of Seridó-PB.



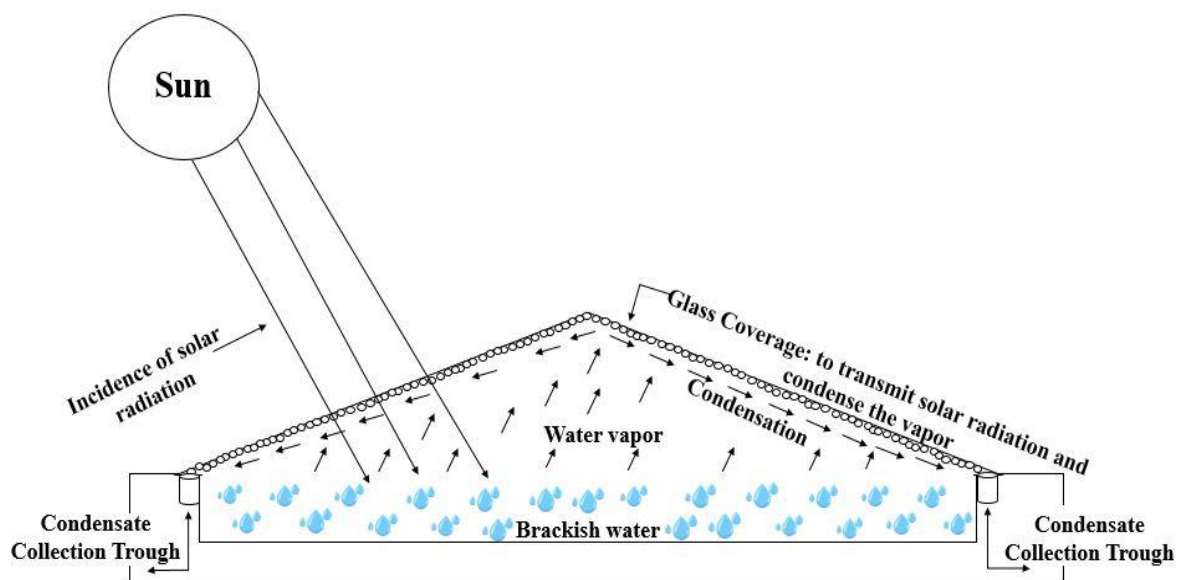
Thus, five solar desalinators (Figure 2) were installed in the Olho D'Água settlement, Seridó-PB, to produce potable water and meet the water needs of 5 local families.

Figure 2 - Solar desalinizers installed in the Olho D'Água settlement, Seridó-PB.



The solar desalinator model analyzed in this study consists of a box constructed with precast concrete plates, totaling an area of 4m². The cover is composed of glass, which allows the passage of solar radiation (short waves), but inhibits the long waves out of the solar desalinator. This increases the temperature inside the desalter, causing evaporation of water stored on a cotton tarpaulin (commonly known as a "tarpaulin") that serves as a base / floor. Thus, the evaporated water comes in contact with glass, which causes the condensation of this water vapor and the obtaining of drinking water, which is conducted through channels to a reservoir (310 liters PVC box), said desalinator, and its functionality, can be seen in Figures 2 and 3.

Figure 3 - Schematic drawing of solar desalinator.



With the construction of solar desalators, the present study performed some methodological procedures, which are described next.

Estimation and Measurements of Variables

During the study, the following variables were counted or measured: 1) the potential of solar radiation incident on the surface; 2) the values of daily temperatures and rainfall; 3) the productivity (liters.m².day) of drinking water.

The values of the solar radiation incident on the surface (in kJ.m²) and the daily temperatures (in ° C) were collected from the INMET National Meteorological Institute, which has a Meteorological Station for the collection of these.

The daily data of incident solar radiation, air temperature and water production were collected during 20 days throughout the four seasons of the year 2016: summer (January 26-30); Autumn (May 21-25); Winter (21 to 25 June); and spring (October 26-30). The average solar radiation incident to the surface was calculated from the daily data of insolation, which occurred between 06:00 and 18:00 hours. Thus, daily averages of insolation and incident solar radiation were obtained for the period of 5 consecutive days of each season of the year.

Regarding the average daily temperature, it was obtained from the temperatures found in the daily hours of 00:00 to 23:00 hours. Thus, with the data of the temperatures of each hour, the average daily temperature was calculated. Once the average temperature of each of the 20 days surveyed was calculated, the average temperature of each season of the year was estimated. For this, the data of the five sequential days of each station were collected, and the average temperature of each station was calculated.

Based on the solar radiation and average daily temperature of each season of the year, the potential of locally available solar energy was obtained. With these data, it was possible to analyze the maximum and minimum daily production of water achieved as a function of local solar energy; and how potable water production varies throughout the year.

Finally, graphs were elaborated on: i) mean values of daily solar radiation for each season of the year; ii) average temperatures as a function of time and season; and iii) relation between the obtaining of drinking water and the average temperature of each season of the year.

Analysis of the production of drinking water by desalinators

In the analysis of potable water production, daily volumes of drinking water obtained by solar desalinators were recorded.

To estimate the desalinated / disinfected water productivity, daily readings were taken, always at 8:00 a.m., for 20 days distributed in: 5 days of summer (January 26-30); 5 days of autumn (21 to 25 of May); 5 days of winter (21 to 25 of June); And 5 days in the spring (October 26-30).

Thus, it was possible to analyze the production of water in several days and with several climatic conditions (cloudy days or of clear Sky, with high or low temperatures).

With the measurements of the water production obtained, and in conjunction with the daily temperature and radiation data, the construction of correlation graphs was performed focusing on the interrelation between solar radiation, temperatures and production of drinking water.

Analysis of water samples

The physicochemical and microbiological analyzes of water samples collected before and after the use of desalinators were carried out at the Laboratory of Reference in Desalination (LABDES), Federal University of Campina Grande. Thus, samples of in natura water of a local well were analyzed, as well as water samples after the desalination / disinfection process carried out by solar desalinators.

To evaluate the presence of dissolved salts in the water, the presence and quantity of some elements such as chlorides, sulphates, calcium, magnesium, sodium, potassium etc. should be analyzed. (AMORIM et al., 2010). Thus, in the physical-chemical analyzes carried out, all previously mentioned elements, and still others, were evaluated in the water samples (from the well and the desalinator); And with that, it was possible to observe if the quantity of each one of the elements was in agreement with the Ordinance Ministry of Health Ordinance 2914/11, that governs the quality and potability of the waters.

Regarding the biological contamination indexes of the waters, the presence of bacteria of the coliform group was analyzed. This group is further divided into three other subgroups:

- 1) Total coliforms: they were the first to be adopted as indicative of human pollution, but the presence of this group in a water does not mean that it is human or animal contribution, because these organisms can develop in the vegetation and the soil.
- 2) Fecal or thermotolerant coliforms: are a group of bacteria indicative of organisms originating predominantly from the human intestinal tract and other animals. To identify them, the test is done at a high temperature, aiming at the suppression of bacteria of non-fecal origin; and
- 3) *Escherichia coli*: is the main bacterium of the group fecal coliforms. Unlike total and fecal coliforms, *E.coli* is the only one that provides guarantee of exclusively fecal contamination.

In summary, samples of freshwater (from the local well) and water from the desalinator were collected, analyzed and compared. This initiative was valid to analyze, in a comparative way, the quality / potability of the water before and after the use of the solar desalinator.

Data collection on the socioenvironmental importance of the solar desalinator

To identify the socioeconomic and environmental importance of solar desalinators, a participatory research was carried out among the rural families that consume the waters of

solar desalinators. In this sense, informal conversations were conducted seeking to identify some aspects and information, namely:

- 1) The costs for the construction of a solar desalinator;
- 2) Possible benefits / problems with the use of solar desalinator;
- 3) The increase in the supply of drinking water;
- 4) Reduction of costs in obtaining and consuming fresh water;
- 5) Meeting the water needs of rural families without water supply; and
- 6) The environmental benefits of solar desalinator, and the increased management of locally available water resources.

Finally, it was investigated with the Health Agents, the possible reduction of cases of waterborne diseases, given that the supply of drinking water obtained by desalination and solar disinfection tends to contribute to reduce, locally, the cases of diseases of Flow.

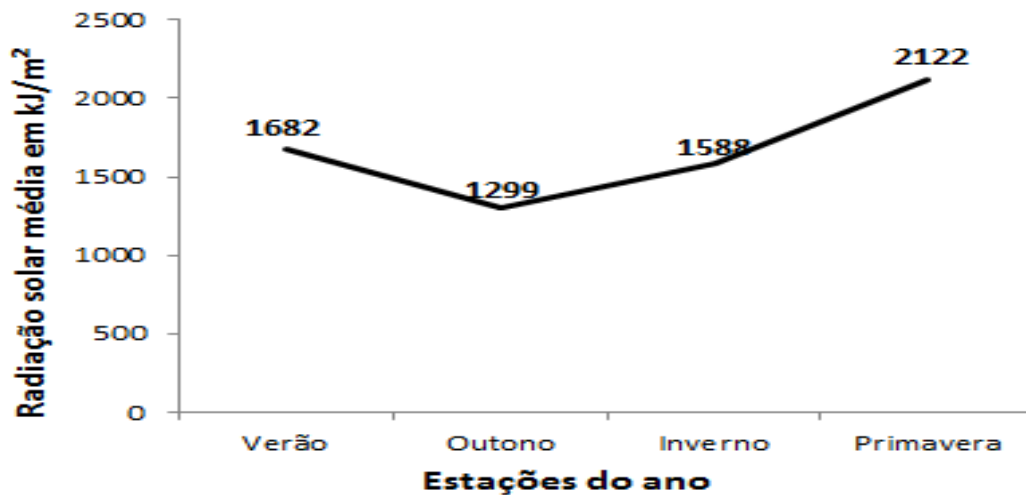
RESULTS AND DISCUSSIONS

Solar and daily temperature potential

During the research period, contemplating 5 sequential days of each season of the year (summer: from 26 to 30/01/2016, autumn: 21 to 25/05/2016, winter: 21 to 25/06/2016, spring: 26 On 10/30/2016), the average daily solar radiation of each season of the year was estimated (Figure 4).

The highest solar radiation potential was in the spring (average of 2122 kJ / m²), while the lowest was in autumn (1299 kJ m⁻²). In relation to the average potential of solar radiation incident on the surface during the 20 days surveyed, an average daily value of 1672 kJ m⁻² was obtained.

Figure 4 - Mean values of daily solar radiation as a function of the season.



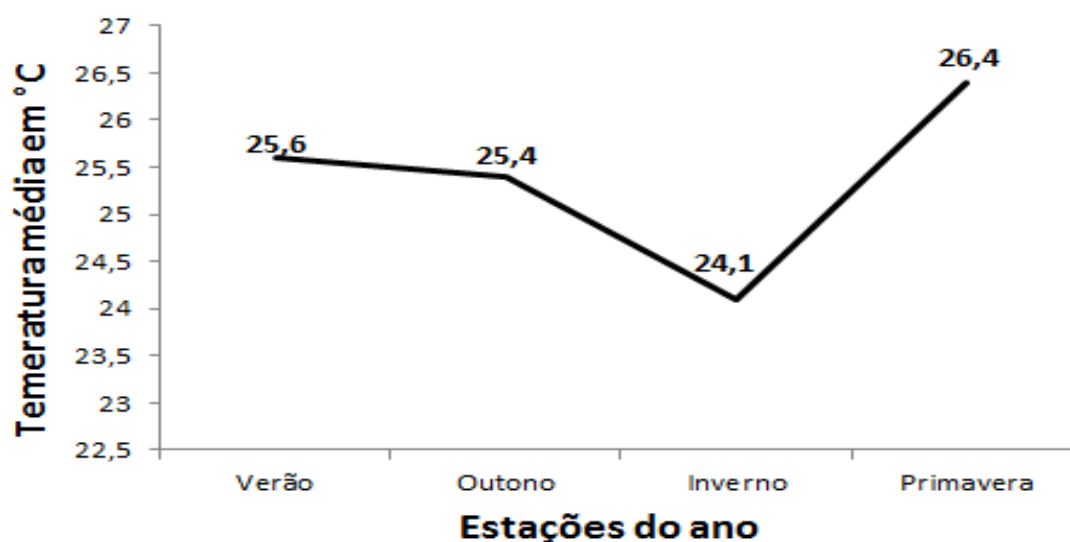
It is generally thought that summer (because of longer days) is the season that should have higher radiation reaching the surface, whereas in winter (where day length is less) it should have the lowest solar radiation on the surface. Such a thinking would be universal if there were no interference, especially cloud cover, since: a considerable part of the enormous amount of energy coming from the sun is reflected by the surface of the clouds and therefore does not contribute to the sunshine on the surface (MOOJEN et al., 2012).

The previous statement explains why the greatest amount of solar radiation incident on the surface occurred in Spring (and not in Summer), and the lowest incidence in Autumn (not in Winter), because: on the days surveyed, both Summer (January 26 to 30), and in the Fall (May 21 to 25) clouds were present, which reduced the solar radiation incident on the surface.

In summary, cloud cover influences the amount of solar energy incident on the surface, because according to Moojen et al. (1990), with increasing cloudiness, global radiation declines, and that although the share of diffuse radiation increases with cloudiness, when the gross value of this parcel reaches values greater than its maxim.

With the knowledge of the values of solar radiation incident on the surface, and the influence of cloud cover, the average daily temperature was analyzed. In this sense, daily average temperature data were analyzed for the 20 days surveyed (five of each season). Thus, the average temperature of each season of the year was calculated (Figure 5).

Figure 5 - Average daily temperature of each season of the year.

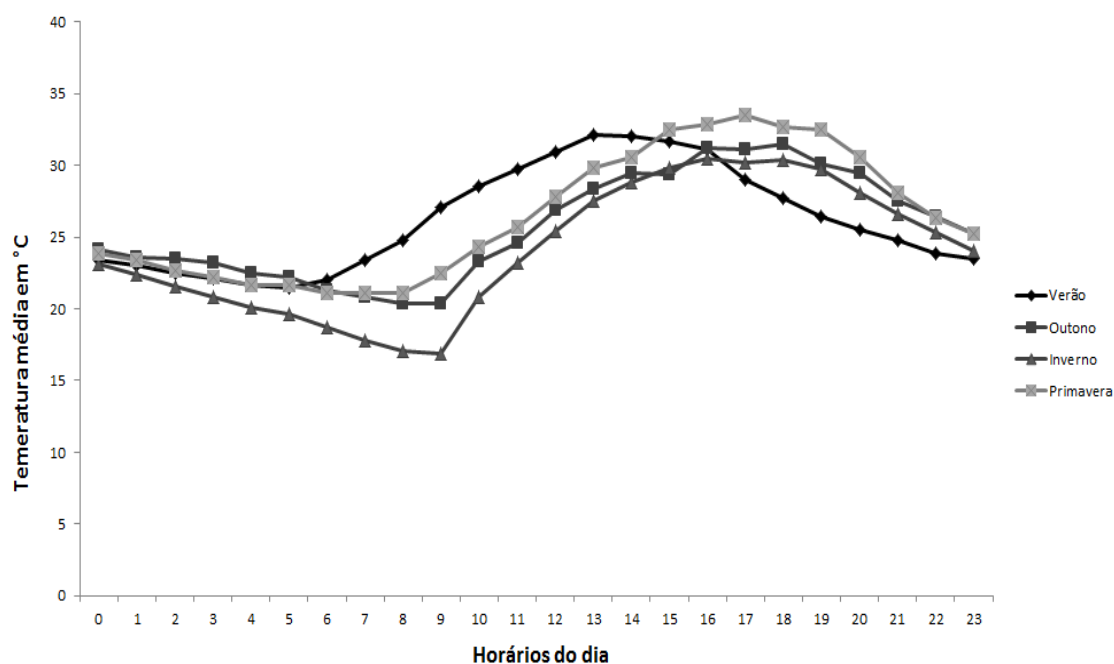


Observing the data of figure 5, it can be seen that the highest daily average temperatures were, sequentially, in spring (26.4 °C, with variation between 21.1 and 33.5 °C) and Summer (25.6 °C, ranging from 21.5 to 32.1 °C); and that the lowest daily average was in the Winter (24.1 °C, with a variation between 16.9 and 30.4 °C). The average temperature for the 20 days surveyed was 25.4 °C. Thus, it is observed the existence of high values of average daily temperature, even in the winter, which justifies the implantation of technologies like solar desalinizers, to use solar energy available locally.

Comparing the data of figures 4 and 5, it can be seen that: autumn, even with lower solar radiation incident due to cloud cover, remained with the average daily temperature higher than in winter (which obtained higher incident solar radiation).

In addition to the above, it can be observed in figure 6 that the mean temperature of Autumn remained higher than that of Winter in almost all daily schedules; or that during the whole night in the Fall, temperatures were higher than those on Summer nights (which obtained the highest solar radiation incident during the daytime).

Figure 6: Average temperature of the daily schedules of each season of the year.

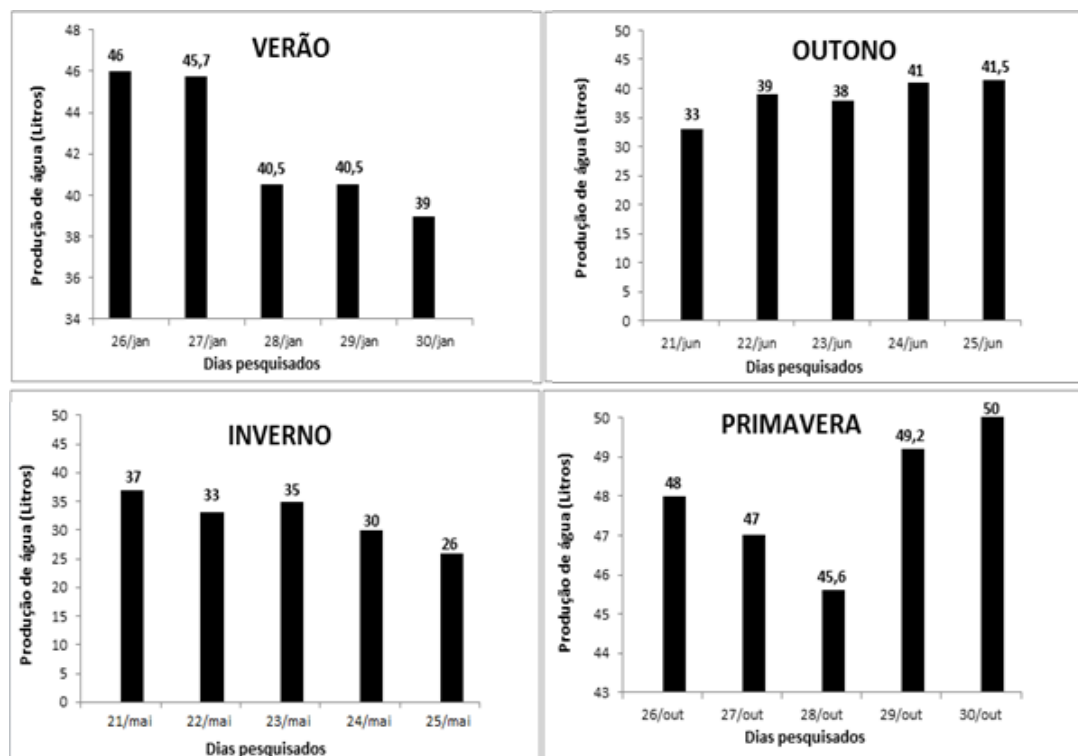


The reality explained above is justified by the fact that cloud cover has two distinct characteristics: on the one hand, cloud cover decreases the incident solar radiation by inhibiting or reflecting the direct radiation from the sun; on the other hand, clouds slow the loss of terrestrial radiation and "radiate" heat to the earth. So, what happened was that cloud cover during the Fall inhibited the higher direct radiation (R_{dir}) of solar energy during the day, but made it possible to delay the loss of temperatures at night. This made it possible, in the Autumn, to have a higher temperature during the night than that found in Winter and Summer. In Summer, it can be seen that the incident solar radiation on the surface explains a great potential of solar energy available locally during the whole year; and that the high values of average daily temperature make possible a great production of water vapor.

Daily production of drinking water

The production of potable water provided by the solar desalinators was recorded daily (Figure 7), for each of the 20 days of research that covered the seasons, namely January 26-30, 2016 (Summer); from 21 to 25 May 2016 (Autumn); from 21 to 25 June 2016 (Winter); October 26 to 30 (Spring).

Figure 7: Daily production of drinking water in the 20 days surveyed from the four seasons.



Initially, water desalination data were collected during the five consecutive days of research in each season of the year. With this, the following data were obtained:

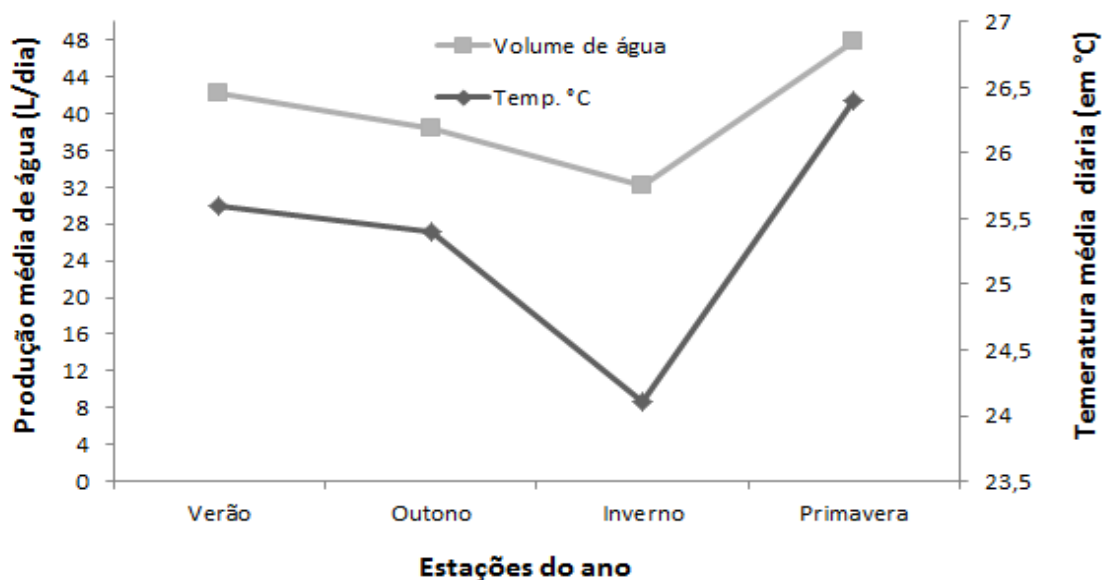
- (I) in Summer: there was a total production of 211.7 liters, ie an average daily production of 42.3 liters;
- (ii) in Autumn: there was a total production of 192.5 liters, ie an average daily production of 38.5 liters;
- (iii) in Winter: a total of 161 liters was produced, ie an average daily production of 32.2 liters; and
- (iv) in Spring: a total of 239.8 liters was produced, ie an average daily production of 47.9 liters.

In view of the aforementioned data, it can be observed that the highest average daily water production was in the spring: average of 47.9 liters.day⁻¹. The lowest average daily water production was in the winter: average of 32.2 liters day⁻¹.

If the production of the entire field data collection period (20 days distributed in 5 days of each season) was recorded, it was observed that solar desalinators produced 805 liters, which is equivalent to an overall average of 40 liters day⁻¹.

With the daily data of the water production and the average temperature of each station, it was possible to construct a graph relating the average daily temperature of the stations (Summer, Autumn, Winter and Spring) and the average water obtaining of the desalinizers (Figure 8).

Figure 8: Production of drinking water as a function of the average temperature of each season of the year.



It is observed in figure 8 that there is a relationship between the increase in temperature and the increase in the obtaining of drinking water. This can be observed when it is analyzed that: average daily temperatures are higher in Summer and Spring, which conditioned a higher water intake when compared to Autumn and especially Winter (lower temperatures and lower values of water). In summary, this means that the higher the average daily temperature, the greater is be the volume of water obtained.

Water quality

It is important to note that in order to control the quality of the water consumed by the population, it is necessary to analyze the capacity of the desalinators to supply drinking water to the rural families (MARQUEZI et al., 2010). In this sense, physical-chemical and microbiological analyzes were carried out, both in the freshwater of the well that supplies the families of the Olho D'água settlement, and in the waters from the solar desalinators. Comparing water quality (in natura and desalinized / disinfected).

In the physical-chemical analysis, 24 parameters were evaluated. However, Table 4 shows the parameters that indicated values not recommended by the Brazilian Legislation.

Therefore, analyzing the samples of water withdrawn from the artesian well, it was observed very high levels of salinity, among them we can mention:

- i) chloride (1370.3 mg L^{-1}), a value 5 times higher than that allowed by Ministry of Health Ordinance 2914/11 (BRAZIL, 2011), which is 250 mg L^{-1} ;
- ii) sodium obtained 541.9 mg / L , a value 2 times higher than that recommended by the Ministry of Health (BRAZIL, 2011) and;
- iii) Total Solids Dissolved (STD) reached 3141 mg L^{-1} , a value 3 times higher than allowed by Brazilian Legislation. However, when analyzing the water after the desalination process, the desalinizers obtained physicochemical results compatible with the parameters of potability established by the Ministry of Health (BRAZIL, 2011). In this sense, it is sufficient to verify (in Table 4) that the values of chlorides, sodium, ammonia, etc., are within the maximum values allowed by Ordinance Ministry of Health Ordinance 2914/11, which confirms the efficiency of solar desalinators in the treatment of salt water.

Table 4: Result of physical-chemical analysis of fresh and desalinated water.

Parameters (Non-admissible values found)	Fresh water (artesian well)	Desalinated water	Permitted limit (Ministry of Health Ordinance 2914/11)
Chloride (Cl ⁻)	1370.3	8.5	250 mg.L^{-1}
Sodium (Na ⁺)	541.9	2.9	200 mg.L^{-1}
Total Hardness (CaCO ₃)	1390	10	500 mg.L^{-1}
Ammonia (NH ₃)	3.04	1.18	1.5 mg.L^{-1}
STD (Total Solids Dissolved at 180 °C)	3141	22.2	1000 mg.L^{-1}

In terms of microbiological analyzes, expressive values were identified for both total coliforms and *Escherichia coli*. These data can be visualized in table 5, where it is observed that:

- a) In the in natura waters of the artesian well, high levels of biological contamination ($2,024 \times 10^3$) were found for total coliforms and *E. coli*. Thus, this water is considered unfit for human consumption, since the presence of *Escherichia coli* can cause urinary infection, liver abscess, pneumonia, meningitis, arthritis, diarrhea, etc. In order to get a sense of the seriousness of the presence of *E. coli*, it is enough to recall that in 2009, acute diarrheal

diseases caused 3.1% of the deaths of children under five years of age (MOURA et al., 2012). This represents hundreds of deaths. Thus, any presence of *E. coli*, as occurred in samples of the fresh water of the artesian well, makes water unfit for human consumption;

- b) Regarding water from the desalinator, the absence of *E. coli* (0 in 100 mL) was observed, which makes water free of disease-causing bacteria. However, the presence of total coliforms (0.02×10^3) was observed, which is justified by the small presence of heterotrophic bacteria, which do not cause disease and are always present in any type of water. However, Order 2914/11 requires that the presence of total coliforms, regardless of the quantity, must undergo a treatment. Thus, the waters after desalination and disinfection by the desalinizers are treated by the family itself with the application of chlorine, which has a germicidal, fungicidal, algicidal, protozoocid and viricide action, in addition to combating other vegetative forms of bacteria (RUI et al., 2011).

Table 5: Result of microbiological analyzes of fresh and desalinated water.

Microbiological parameters	Fresh water (artesian well)	Desalinated water	Permitted limit (Ministry of Health Ordinance 2914/11)
Total coliforms	2.024×10^3	0.02×10^3	0 em 100 mL
<i>Escherichia coli</i>	2.024×10^3	0	0 em 100 mL

It is important to remember that in the case of groundwater, pathogenic organisms are eliminated or removed by the absence of oxygen and by filtration, depending on the permeability and conductivity of the aquifer or the subsoil (SANTOS et al., 2013). In this sense, most groundwater does not contain pathogenic bacteria due to high conductivity and lack of oxygen. Thus, it can be deduced that water in contact with PVC pipes may have acquired heterotrophic bacteria, which do not cause disease to humans.

It is also worth noting that the high temperatures inside the solar desalinators (50 °C) allowed the water inside the desalinator to reach temperatures above 50 °C, which contributed to the death of pathogens. This reveals the importance of desalinators as a technique for water disinfection.

Finally, the results of the physico-chemical and microbiological analyzes confirmed that: artesian well water, with high levels of chemical and bacteriological contamination,

became viable for human consumption after the desalination and disinfection processes using solar desalinators.

Socioeconomic and environmental benefits

From field studies, it was noticed, especially through the speech of the rural families, that solar desalinizers allow numerous socioeconomic and environmental benefits, namely:

- 1) With the solar desalinizers it is possible not only to desalinate waters, but also to disinfect them. In this way, it can be seen that desalinators can offer safe water for human consumption;
- 2) During the study period, there was an average daily production of 40 liters day⁻¹, which was sufficient to meet the water needs of 20 people distributed in 5 local families. In this sense, it was offered 2 liter person⁻¹ day⁻¹ (UN determination, 2015);
- 3) The quality of the water coming from the desalinators complied with the legal norms regarding the physical and chemical aspects;
- 4) It was observed that the desalinizers are a simple technology, of low implantation and maintenance costs; enables individual or collective use; does not cause negative environmental impacts; does not have electricity costs due to the use of solar energy; and is a clean and sustainable technology.

It is worth remembering that, during the studies, a possible reduction of cases of waterborne diseases was investigated with the local Health Agents. In this sense, satisfactory results were obtained: according to the local Health Agents, for people who consumed water from the desalinators, there were no cases of waterborne diseases, such as: cholera, typhoid, hepatitis A and diarrheal diseases. Thus, it has been proven that desalinators can provide safe water and, consequently, contribute to the reduction of cases of waterborne diseases.

In view of the above, the construction of solar desalination plants is justified by three aspects:

Social viability: it is able to offer potable water to meet, in adequate quantity and quality, the rural families of the semiarid; It is a technology socially disseminable by virtue of its technical simplicity; and it is capable of enabling its individual use (one unit per family) or collective (several units to serve a community);

Economic feasibility: the costs involved in the construction of the desalinator is in the order of R\$ 900.00 reais, less than 1 current minimum wage (R\$ 937.00). Knowing that the average value of a bottle of drinking water of 20 liters is, in average, R\$ 5.00 reais, we have that the value of the investment (R\$ 900 to provide 11.5 liters and meet 5 persons day⁻¹) will be equal

to the amount spent in water bottles over a period of 12 months, that is, the value of the investment will be compensated in one year after its construction. Thus, it is perceived that the costs and the time of return of the investment are relatively small;

Environmental viability: The use solar radiation that is clean and renewable; Reduces energy costs in the use of potential desalination techniques (such as reverse osmosis treatment systems); does not cause negative impacts on natural resources (fauna, flora, air, etc.); and it use the great natural potential of solar energy to promote the good management of the water resources available locally.

Added to the previous context, it can be seen that the solar desalinator can be considered a Social Technology as it has met some prerequisites: low economic cost; It is easy to build and socially disseminate; In addition to contributing to social transformation in relation to the management of locally available water resources.

It is also worth noting that in addition to having characteristics common to those of a Social Technology, desalinators can be considered a Sustainable Technology, given that it is configured in technologies that meet social and environmental needs in a way that does not compromise natural resources For future generations (MENEZES et al., 2010). Thus, the use of solar desalinators as a technology not only social, but also sustainable, since it is simple, cheap, does not harm the environment, and has used sunlight to remove salts and impurities from the water. Given the context, and knowing that sustainable technologies do not have energy costs, and use clean and renewable energy (BOUKAR & HARMIN, 2001), it can be said that the solar desalinator is a sustainable technology as it is economically viable, socially fair / disseminable, and environmentally sound.

CONCLUSIONS

In view of the objective of analyzing how the use of solar desalinizers could offer drinking water and provide socio-environmental benefits, it was concluded that:

- 1 - There is, in loco, a great potential of solar energy, which besides promoting high average daily temperatures, also makes viable the use of technologies like solar desalinizers for the treatment of saline waters;
- 2 - Radiation and average daily temperature vary over time of the year. Therefore, the production of water also varied according to the average temperature of the stations, showing that: the higher the average daily temperature, the higher the production of drinking water;

- 3 - The average daily production, obtained for the 20 days surveyed, was 40 liters day⁻¹, which is sufficient to meet 20 people: each individual consuming 2 liters day⁻¹ (UN, 2015);
- 5 - Desalinators provide safe water, since the analyzed water have met the legal norms regarding the physical-chemical aspects;
- 6 - With regard to the socioeconomic and environmental benefits, there are: a) desalination and disinfection of water unfit for human consumption; b) allows individual or collective use; c) better management of locally available water resources; d) greater supply of safe water for human consumption, which has contributed to the reduction of cases of waterborne diseases; e) low economic cost for the construction and maintenance of desalinators; f) use of clean and renewable solar energy; and g) does not promote negative impacts on natural resources (water, soil, fauna, flora, etc.).

In view of the aforementioned data, it is believed that the use of solar desalinisers has been shown to offer potable water and, thus, to provide socioeconomic and environmental benefits. However, new research is needed to repeat the studies in order to compare / prove the efficiency of desalinators in obtaining a higher production of drinking water.

It is important to emphasize that this study does not comprise an end point for the issues related to desalination and disinfection of water, but rather represents the beginning for new investments in the promotion of water supply in quantity and quality to meet the needs and interests of countless families living with the scarcity of water resources.

Thus, from this study, it is opportune to carry out new research that seeks to use techniques and instruments to efficiently manage the locally available water resources, which will contribute to the coexistence with the soil and climatic conditions of the semiarid.

Finally, it is known that the insufficiency and irregularity in the rainfall distribution, associated with a high rate of evaporation, are climatic characteristics that projects radical derivations to the world of waters and to the socioeconomic world of the living in the backlands (AB'SÁBER, 2003), it becomes imperative to devise social technologies that foster the water security of numerous families living with water shortages in semi-arid regions.

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