REGIONE DEL VENETO

SOLWA (SOLar WAter)

Solar still for drinkable water production from polluted or salt waters

IDeass

Veneto, Italy

Innovation for Development and South-South Cooperation

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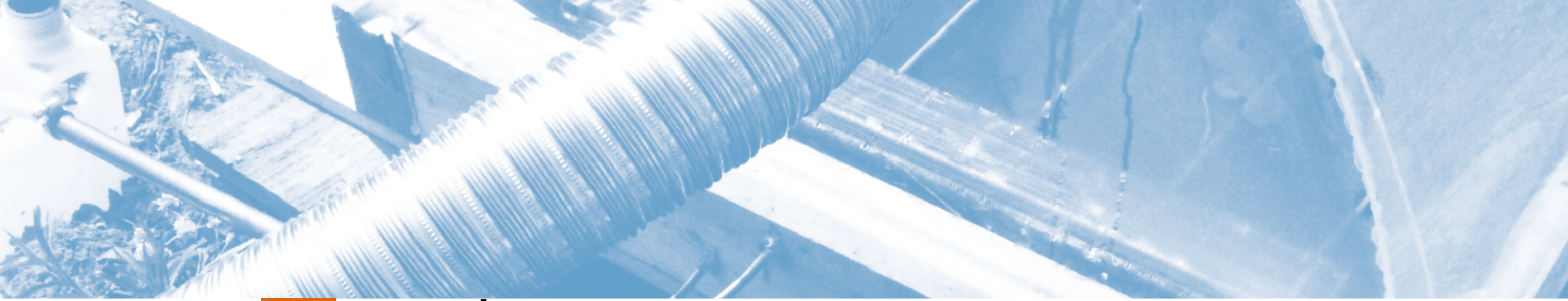


Introduction

by Paolo Franceschetti

SOLWA (SOLar WAter) solar still consists in a new system of producing drinkable water from the desalination of waters with elevated salt concentration or polluted waters, with the sole use of solar power. In recent years public opinion has become more aware of environmental issues, of the scarcity of environmental resources and of the necessity to guarantee their best use. Environmental resources are no longer perceived as renewable and inexhaustive, but as assets that are, at the same time, insufficient and fundamental to life, and requiring particular care for their management and use. Certainly, water is one of the fundamental assets at risk.

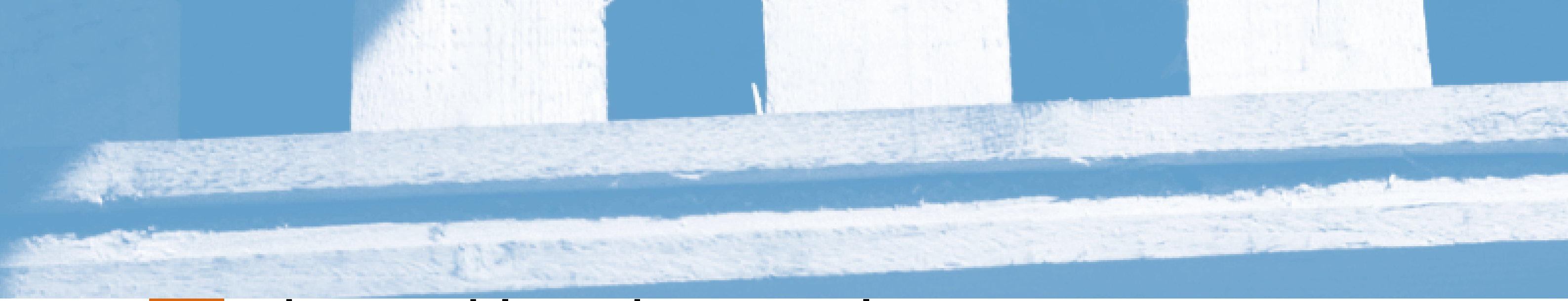
Water pollution and water scarcity do not only entail problems for human consumption, but they have also created usage of low quality water irrigation in many barren areas. The use of qualitatively insufficient waters creates a decrease of agricultural production and causes damages to the atmosphere, the ground and the aquifers [Thameur 2003]. The second global report by the United Nations on the promotion of water resources evidences that nearly one inhabitant of the planet in five has no access to drinkable water and that 40% of the world-wide population do not have a basic service of water depuration. In the course of the 20th century, water consumption increased sixfold, whilst world-wide population only increased threefold.

The barren and desert zones in the world are today facing huge issues due to an increase of desertification. This phenomenon, characterized by the decrease of the water table levels and by an increase of the salts contained, leads to the demise of life forms present within [National Academy of Sciences 1973]. At the same time, these regions present a high energy potential from the sun, which can probably be the best resource for their development, as S. Galal and A.A. Husseiny have noted. During the last few years, water desalination has compensated for these problems by supplying drinkable waters at decreasing costs and developing ever efficient technologies. Among these desalination technologies, some suggest an "environmentally friendly" approach. In particular, ever efficient and productive models of solar still have been realized simulating the natural water cycle. The solar still called SOLWA strengthens some aspects of this cycle, in particular water evaporation and condensation.

The SOLWA solar still helps solving the problem of the scarcity of drinkable water for populations living in poor areas. It helps producing discreet amounts of drinkable water starting from polluted waters, from waters that are not fit for human consumption or from waters with elevated salinity, like sea water.

Unlike other methods currently in commerce, this technology employs solar energy as its only source. Its characteristics avoid corrosion and require only low quantity of labor. Moreover, the solar still can be easily moved and located in any territory with certain characteristics, subject only to the presence of the sun. The solar still has a very contained cost of installation (approximately 50 €/m2), and does not require additional costs, thus satisfying day-to-day human requirements of good quality water.

The SOLWA helps solving an issue of primary importance for human development, such as water supply, even in areas not provided with normal connections to traditional energy resources. It can be installed in any tropical and equatorial territory.



What problem does it solve?

Low quality water plays a key role in bad health and living conditions. It is estimated that approximately 1.6 million human lives could be saved every year if access to drinkable water, services of water depuration and hygiene could be improved upon. We can enumerate in the world at least 50 conflicts between countries for causes tied to the property, the distribution and the use of water, and it is likely that an ulterior decrease in water resources will make these conflicts more acute and will provoke new ones (Legambiente Veneto 2007). The not homogeneous distribution of water has been one of the major causes of social inequalities: the population of the richest countries (approximately 11% of humanity), besides owning 84% of the wealth, consumes 88% of the resources, including water.

Many technologies for water desalination have been developed, particularly in tropical zones, in order to solve these problems. Desalination is a fast-growing global technology, with a production of 26 million m3 per day and with an investment estimated to be equal to 70 billions of dollars in next the 20 years (data from ESCWA 2001 - United Nations Report).

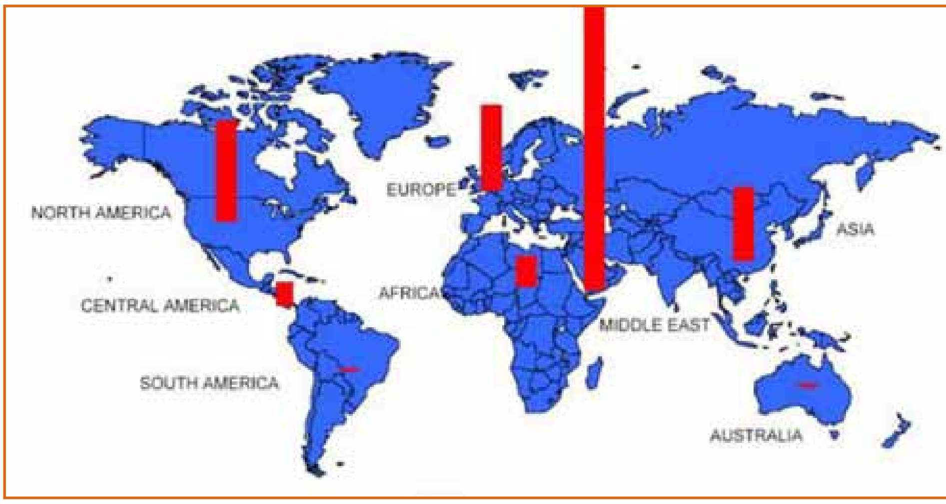


Figure 1. Ability to the systems of desalination in various zones (Häberle 2001)

Desalinated water production, however, is more pronounced in industrialized countries, and excludes the territories that would mostly require technologies to facilitate the access to a primary resource like water.

The solar still imitates, within its isolated system, the natural cycle of water, forcing its yield and efficiency. The mechanism of water potabilization is based on the evaporation of the starting solution, generating condensation of the vapor itself and obtaining distilled and drinkable water. Salts and miscellaneous polluting agents present in the starting solution sink to the bottom and are eliminated afterwards.

The direct exploitation of the solar energy has always attracted researchers in several fields, including desalination. The first investigator who created a large-scale system of solar desalination was Carlos Wilson, in 1872, in Las Salinas (Chile). Wilson realized a system of solar stills, 4450 m2 large, with daily production of 17.8 m3, a yield of 4 l/m2/day and a 40 years life span. In the '40s many patents were filed pertaining small and practical portable solar stills that were adapted for life-rafts or ships and used extensively by the US Navy [Telkes, 1945]. Currently, this type of systems is used almost only for research.

Solar still solve important issues linked to water potabilization. They have been devised in order to desalinate sea water, producing drinkable water for human use. These solar stills can also be used in isolated areas and require low costs of installation and maintenance.

The solar still SOLWA, thanks to its features and with very simple modifications, presents a wider range of applications. Indeed, it can be used to purify not only water rich in salts but also waters with various miscellaneous polluting agents suspended within. It helps drying refuse sludge deriving from systems of biological depuration. It helps stabilize animal waste from farms, preventing the pollution of lands and reducing the volume to eliminate.

An important feature of the SOLWA solar still is that it does not require operating costs, being powered only by solar energy, as opposed to other conventional technologies in the field (inverse osmosis, MSF , MED, electrodialysis, etc). Furthermore, SOLWA does not require maintenance and operates immediately once set up, with no need for specific technical or manual knowledge.

SOLWA has 56% efficiency, compared to 50% of other solar stills. The estimated water production in tropical countries is more than 10 l/m2/day. The SOLWA does not produce pollution of any type, neither chemical nor thermal.

SOLWA in practice

Solar still is based on the conversion of the solar beams into heat. Inside an isolated structure (the greenhouse itself), solar beams radiate a salt water basin, heat up the solution and make it evaporate. The vapor condensates in the internal surface of the greenhouse and is collected, whilst the rich salt solution is eliminated. This is the basic principle of solar stills.

The SOLWA solar still forces the evaporation process even more and increases the drinkable water production, presenting two innovations that distinguish it from others currently in use: it does not need external maintenance, and it forces the evaporation of the solution at lower temperatures. A specifically designed software calculates the construction characteristics, based on the climatic conditions of the territory and of the solution to process through the solar still.

SOLWA is constructed from materials that are easily accessible in any country and territory, and it does not demand expert or qualified labor. Figure 2 illustrates the phases of construction of the SOLWA. The images show the simplicity of the construction and materials: common wooden pallets turned upside down, expanded polyurethane (a normal insulator for roofs) and Plexiglas. Other technical materials, such as small copper pumps or pipes, are also widely commercially available.

The employment of materials easily available and with contained costs allows the solar still to have a limited cost against its high social value, producing a necessary factor for life.

Figure 2. Building steps of the solar still, employing economic and easily available materials

The electric power necessary in order to make the entire system work is produced through a small solar panel. Indeed, solar radiation is the only energy source of this system, which allows it to be completely independent and to operate in any conditions.

The creation of elevated temperature inside the structure and the simplicity of the mobile structures used, allow the solar still to have other possible functions. The SOLWA can indeed produce drinkable water also from waters polluted by chemical or biological agents. The foreseen feasibility to decide the time of permanence of the solution inside the structure helps calibrate the inner temperature and helps deploying the solar still as a proper distillery for various uses. It can be used for drying sludge or waste of various nature, reducing the volume to eliminate.

Results

The SOLWA solar still is constructed from easily accessible parts and demands minimal technical and scientific knowledge for its construction. It can be easily transported and located anywhere, not requiring connections to conventional energy networks. This system allows therefore to solve the needs of water supply in small communities either isolated or with problematic connection to the energy network.

This type of solar still has been devised and researched by the University of Padua, Italy. The prototype model was tested during summer 2008 at the research institute of the University, by a pool of university professors of the Faculties of Sciences and Chemistry and in collaboration with the Faculty of Agrarian Science. At the experimental site of the University of Padua the solar still produced, during the test days and starting from a solution of sea water, the amount of water shown in Table 1.

DAY	YIELD PER SQUARE METER (l/m^2)	SOLAR RADIATION (W/M^2)
11/06/08	5,861145	31917194,1
12/06/08	5,497588	30800227,1
13/06/08	5,381156	30588595,1

Table 1.
Recorded drinkable water produced during the test period

In the diagram shown in Figure 3 (ingress radiation and drinkable water produced) the yield of SOLWA solar still is hypothesized in different climatic conditions. It is thought that in desert and tropical climates the water production per square meter will remain over 10 l/m^2/day, with a 56% efficiency.

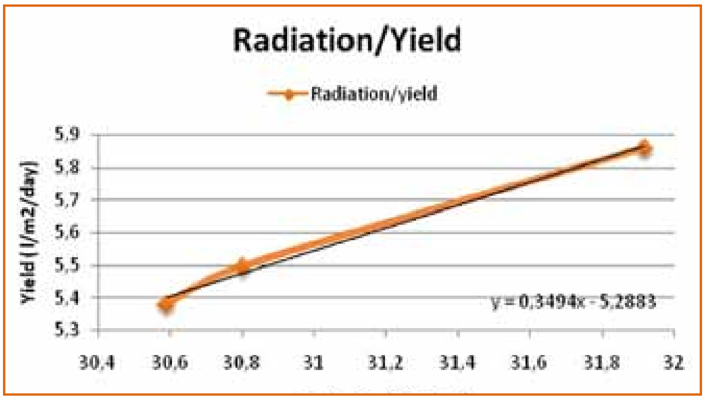


Figure 3.
Ratio between solar radiation and yield per square meter

The SOLWA solar still only uses renewable energy, does not require specialized maintenance and has a production cost of water to the m^3 close to zero. Other technologies that give the same product (inverse osmosis, diesel-powered MED or MSF stills), have a high environmental impact, since they require a “conventional” energy power (electric power and hydrocarbons). The costs of technologies used in great industrial systems range from 0.45 €/m^3 for inverse osmosis to 1.2 €/m^3 for other technologies. The current systems require highly specialized labor, the employment of chemical substances for pre and post treatment of waters and high quantity of energy.

Various scientific articles indicate that solar stills have a lifetime at least 20 years. Given the constructive and maintenance characteristics of SOLWA, it is estimated that its lifetime will be significantly longer.

International interest

SOLWA, its installation and tuning activities were presented in November 2009 at the International Conference held in Dubai, organized by IDA (International Desalinization Association), the most qualified international organization in the field of water desalination technologies.

SOLWA was constructed by the University of Padua and part of the studies was carried out at the Wageningen University and Research Centre in Holland.

For the distribution of the SOLWA, the University of Padua has established collaborations with the Department of Biology of the University of Trujillo (Peru) and with the National Research Council of Khartoum (Sudan).

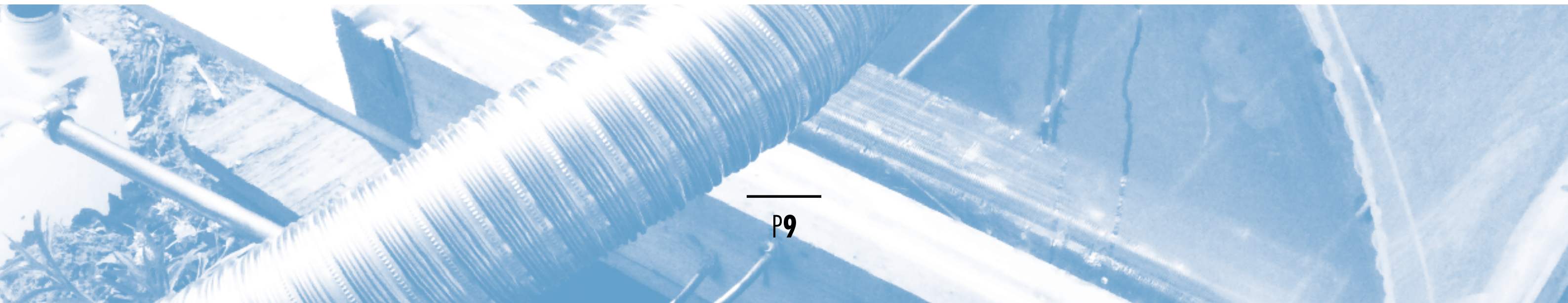
Test agreements at the Foundation of Research and Development of FUNACI (Teresina-Brazil) in collaboration with the Faculty of Agrarian of the Federal University of the Piaui (Brazil) are in the process of being formalized. The University of Padua has also established collaboration for the distribution of the SOLWA with the ONG Cesvitem of Mirano (VE) that supports cooperation initiatives in numerous countries.

Using SOLWA in other countries

Solar stills can generate maximum efficiency in tropical areas, rich in solar energy. The institutions directly interested in the transfer of this technology are those competent in the management of water resources. Additionally, these public institutions can involve private sector institutions in the production and use of this type of solar still.

The experimentation of the SOLWA solar still, in order to adapt it to the specific context, can be realized, with technical support from the University of Padua, in any university structure or research institute, prior to its national distribution.

Given the relatively technological simplicity of SOLWA construction and use process, it is not necessary to resort to high level development centres or to previous technical knowledge. In order to accelerate the experimentation operations, collaboration agreements between universities have already been developed, allowing the creation of Laboratories in interested countries, for the construction and the experimentation by academic researchers. The information on technique, technology or economics is free and available for the development of further research or local testing.



To learn more

More exhaustive and in-depth documentation on the SOLWA solar still is available at the University of Padua.

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Contacts

The Directorate for International Relations, International Cooperation, Human Rights and Equal Opportunities of the Veneto Region collaborates in the promotion of innovation at International level.

The University of Padua is available to supply technical support and innovation transfer in interested countries. ONG Cesvitem di Mirano (VE) also collaborates in the International promotion of the solar still.

In order to establish collaborations for the technological transfer in interested countries, the following people can be contacted directly :

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The IDEASS Programme - Innovation for Development and South-South Cooperation - is part of the international cooperation Initiative ART. IDEASS grew out of the major world summits in the 1990s and the Millennium General Assembly and it gives priority to cooperation between protagonists in the South, with the support of the industrialised countries.

The aim of IDEASS is to strengthen the effectiveness of local development processes through the increased use of innovations for human development. By means of south-south cooperation projects, it acts as a catalyst for the spread of social, economic and technological innovations that favour economic and social development at the local level. The innovations promoted may be products, technologies, or social, economic or cultural practices. For more information about the IDEASS Programme, please consult the website: www.ideassonline.org.

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It is in the framework of ART GOLD Programmes where IDEASS innovations are promoted and where cooperation projects are implemented for their transfer, whenever required by local actors.