

HYDRO RESOURCES AND SOCIOECONOMIC DEVELOPMENT IN ARID ZONES: THE IMPORTANCE AND PERSPECTIVES OF NEW TECHNOLOGIES FOR THE TREATMENT OF NATURAL AND/OR WASTE WATER

Deserts or arid zones are regions of the planet characterized by factors that limit the settlement and development of living organisms. In these zones the aridity is directly related to the scarcity of water, a condition due not only to a lack of rain but also to the limited ground humidity, permeability, evaporation and transpiration of the plants. Environmental conditions such as the intensity and duration of sunlight, heat, atmospheric humidity and wind are also relevant. If we try to identify the combination of elements that provoke arid conditions, the most frequent and significant factors are those of water scarcity and extreme temperatures.

In the Arica and Parinacota region, a zone located in the Atacama Desert, the annual precipitation on the coast tends to be less than 3mm per year, and it is possible to identify places where the average precipitation is zero. As well as the lack of humidity, there are also considerable thermal variations between the day and the night, which cause even greater dryness with a poor soil composition and reduced flora and fauna. These characteristics accentuate the conditioning character of the habitat, and humans have to make greater efforts to adapt to this environment than those in communities located in different geographical realities. Without a doubt, in the environment of the north of Chile the water/desert relationship is so influential and important that the scarcity or abundance of this basic resource is, in addition to other knowledge, responsible for the natural delineation of the boundaries of what we define as desert.

From the point of view of living systems, water is a substance known to be essential for their existence, allowing internal transport of nutrients and waste products generated by cellular activity. Nonetheless, diverse studies have shown that the consumption of contaminated water or water that has low physical, chemical or microbiological quality can lead to illness (e.g. Chronic Endemic Hydro Arsenicosis). The contamination of water resources and limited access to drinking water cause social, economic and health-related problems in rural populations. From the point of view of a country's economy, the existence, quality and quantity of water are, without doubt, a part of its wealth.

It is widely known that three quarters of the earth's surface are covered with water, although much of this water is not apt for human consumption. This is also the reality with regard to the water resources available in our region; these resources are greatly affected by their origin in the high plateau of the Andes and have a high mineral content related to the constant geothermal activity in this area. As a result, some of the main rivers in this region have high levels of salinity, boron and arsenic (Lluta: 200 µg As/L, 30 mg B/L; Camarones 1000 µg As/L, 10 mg B/L) that limit and condition the use of this resource to certain economic activities that do not have demanding requirements with respect to the quality and/or quantity of the water.

In contrast to the so-called high-plateau winter which occurs in the Andes foothills (with an average annual rainfall of 300 mm/year for areas 3000 m above sea level), the precipitation in the lower zones is practically zero and as a consequence, the rising of subterranean water tables is rare. An example of the complex water dynamics at local level can be found in the two main valleys: Lluta and Azapa. The Lluta River is permanent and reaches the sea; the water contains high levels of boron and arsenic as well as chlorine and sulfur. The Azapa Valley is watered by the San José River which only reaches the sea when there are floods from the high-plateau winter, in January and February. The main way in which this valley is watered is via the Azapa Canal, which transports water from the Lauca River basin. Even though Azapa has water of adequate quality, it has two main disadvantages: the water is superficial and does not meet the demanding agricultural needs of the valley, and as a result, its aquifer is overburdened

Currently, research is being carried out to improve the use of the available water for agricultural aims, and to improve its quality, with low levels of specific toxic elements for certain susceptible vegetables. This will facilitate the introduction of new crops to the valley, and thus, a greater economic development. This is the only way in which agriculture will be able to become one of the sustainable economic resources in this new Region.

Conventional water treatment processes, such as inverse osmosis, flocculation, decantation, ultrafiltration and others, generally involve high implementation, operational and maintenance costs, as well as a need for highly specialized supervising staff. This makes it difficult to apply these technologies in an area with low population and limited economic income, due to the high initial investment costs.

However, the new technologies for water treatment for different uses could be an interesting alternative for resolving the increasing demand for this vital element. These technologies are an innovative development that enables water that is safe for human consumption, both chemically and microbiologically, to be provided from the water that is naturally available in the region, as well as the development of new processes for the treatment of the diverse types of waste water.

The use of solar radiation is today one of the most popular objectives in the field of technological innovations that seek to obtain new sources of energy for the development of sustainable economic activity.

Solar radiation is a permanent natural energy source that has great potential for a wide variety of applications given its important advantages of abundance and accessibility. Developed countries advance active policies for using this solar energy, transforming it into an economically viable and adequately competitive alternative.

In developing countries, it is more difficult to implement these incipient technologies due to the investment and conditions that they require. In this context, it is very important to consider alternatives that allow the use of this resource with technologies based on advanced scientific concepts and ideas that do not require excessively high initial investment. Moreover, the development of these methods, due to the benefits that they bring to rural populations with low socioeconomic incomes, should be a priority for state policies in developing countries.

The ultraviolet radiation in the solar spectrum allows for a very simple disinfection method to neutralize pathogens in water contained in closed systems, such as the use of polyethylene bottles, since it has a proven capability for destroying the DNA of the pathogens and preventing their reproduction.

In this context, and through the application of a research project, a technology that is adapted to the environmental and physical-chemical characteristics of the water has been developed for our Region. With this research, utilizing common materials, it has been demonstrated that it is possible to use solar energy to disinfect and decontaminate natural water and prepare it for human consumption. In this sense, the development and optimization of simple, efficient, economic and socially acceptable procedures have been prioritized for the purification and disinfection of water in isolated communities, mainly located in rural zones.

Thanks to the results of this research, it has now been possible to develop innovative technologies that make it possible to provide efficiently safe and disinfected water on a domestic scale in a way that is perfectly operable for the members of a rural family. Thus the challenge for tomorrow is to employ the principles and experience obtained in the treatment of water for domestic use in pilot plants that can be a real alternative to conventional treatment processes due to their low cost and better water treatment flow. That is to say, pilot units that combine high productive efficiency with low implementation costs.

It is hoped that all the research related to this theme will also produce an increase in the development of water treatment in the next few years, as a consequence of the increase in demand for quality drinking water and the establishment of increasingly strict regulation of the limits allowed for the discharge of effluent water. In the near future, technological advances should be aligned beforehand with governmental requirements for improving water quality. With the advances in material sciences, nanotechnology and the adequate use of solar radiation new developments will be possible in filtration membranes, ionic exchange resins, sorption technologies and decontamination and disinfection methods.

Finally, it is important to mention the announcement by the Pan American Health Organization (PAHO) in response to the Center for Sanitary Engineering and Environmental Sciences (CEPIS) that, based on new technologies, “it is possible to design, build, operate and maintain highly efficient water treatment plants, at a cost that is less than 50% of that of other technological solutions”. Furthermore, these new technologies will allow the continuation of research and development of new solutions to resolve the problem of providing drinking water, reducing the importation of conventional processes from developed countries, giving an opportunity to regionally based systems that are *made in Chile*.

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