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"Direct" and socially-induced environmental impacts of desalination

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Abstract

Since environmental impacts of desalination processes are intrinsically related to system efficiency, per water-unit produced loads have constantly decreased over the past decades. However, some significant fouls remain. The example of Spain is punctually used throughout this paper, to illustrate the main environmental impacts of the desalination technology. One major concern is the potential environmental impacts caused by extensive brine discharge; unavoidable desalination sub-product that may heavily affect marine biota. Recommendations are outlined to reduce environmental degradation related to hypersalinity. A further drawback is the production of greenhouse gases associated with the required power generation. Environmental loads of any process can be considerably reduced when integrated with renewable energy production systems. After these two 'direct' environmental impacts are addressed, some socially-induced factors leading to unsustainable water management are identified.

Keywords: Desalination; Environmental impact assessment; Brine pollution; Greenhouse gas emissions; Renewable energies; Integrated water resource management

1. Introduction

Desalination has proven to be a readily available way to alleviate freshwater scarcity. During the past decades, technological progress increased process efficiency, and although socio-economically context dependent, desalination turned into an extensively applied solution for an increasing number of regions around the world, and in particular in various countries of the Mediterranean region [1]. This is notably the case in Spain, where the number of desalination facilities, projected and under construction, has significantly increased in the past years. The recent political change that occurred in this country also offers a perfect discussion frame to review different water resource management options. In this paper,

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the new Plan Hydrologico Nacional[1] (PHN) will therefore serve as a debate ground to analyse current water management trends embedding the desalination technology. The former PHN's main subproject [2,3] which was to transfer yearly 1050 Hm^3 from the Ebro River over a 900 km-long aqueduct to "water-deficit river-basins" has been officially repealed by the new government and previously rebuked by EU disagreements. The present alternative – the so-called Programa AGUA – plans to provide the same flow at a lesser cost, in less time. It is mainly based on a fleet of 14 new Reverse Osmosis (RO) desalination facilities that would provide an additional[2] 600 Hm^3/y.

Besides serving as an electoral campaign weapon, the desalination alternative proposed by the new government is a more economic and environmental effective option than gargantuan civil works such as large dams and inter-basin water transfers, which often have striking social and environmental repercussions. Similarly, desalination is often praised as an alternative to fossil groundwater mining or overexploitation of coastal aquifers leading to quasi-irreversible seawater intrusion. These apparent environmental advantages should however be taken with great care as they could easily lead to statements such as the following:

"Despite the environmental impact associated to industrial desalination it should always be remembered that desalination plants are both preserving existing natural sweet water resources and contributing to develop agricultural areas, gardens even forests (in the Emirate of Abu Dhabi) where desert was before. Therefore the question whether desalination plants are environmentally friendly is not really relevant" [4; p. 439].

In this paper, various environmental aspects of the desalination technology will therefore be analysed with greater care.

2. A material and energy flow approach

Although various desalination methods exist – most commonly, distillation (thermal separation) and membrane technologies- the overall process metabolism is generally the same. Since, from an ecological economic point of view [5], the economic process is seen as an open system (to the entry of both matter and energy) [6], the use of material and energy flow analysis referring to a broad palette of bio-physical indicators- appears as a well-suited methodology to pre-determine and assess environmental impacts. Fig. 1 shows that, when considering the desalination process as a black-box, the overarching principle is to turn a saline solution into freshwater. This requires an energy input and triggers the output of a concentrated saline brine as well as energy-associated green house gas emissions.

RO membrane separation is a process based on physical-chemical filtration rather than distillation. Because of its greater

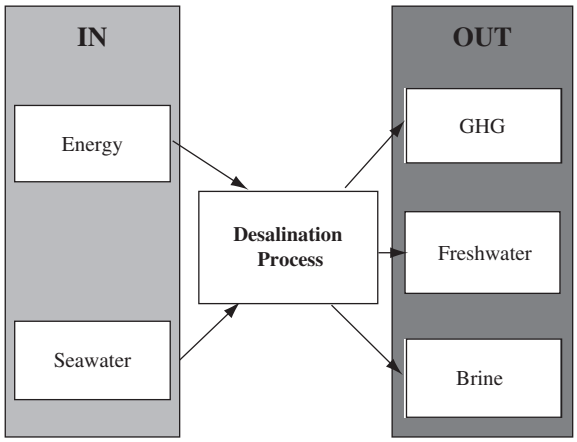

Fig. 1. Overall metabolism of the desalination process (own elaboration)

[1]Spanish National Hydrological Plan.
[2]Please note that the figures given by the new Plan are still subject to change.