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Coastal Defence Integrating Wave-Energy-Based Desalination: A Case Study in Madagascar

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Abstract: In arid, coastal cities, water demand is often met through large-scale desalination systems. However, the energy required to run desalination plants remains a drawback. Further, numerous low-density population areas lack not only fresh water availability, but in most of the cases electrical grid connection or any other energy source as well. The challenge, consequently, is to ensure adequate fresh water supplies at the lowest possible cost. The main objective of this work is to assess the freshwater production from a reverse osmosis desalination system powered by a wave energy converter, the Overtopping Breakwater for Wave Energy Conversion (OBREC). The desktop analysis is illustrated through a case study on the Fenoarivo Atsinanana coast, along north-eastern Madagascar. The novel aspect of the analysis method is the application of a specific numerical code calibrated using preliminary results from a two-year monitoring campaign of the first OBREC prototype in operation in Naples Harbour (Italy). Instead of dissipating the incoming wave energy, the system collects the overtopping water above the sea level and the potential energy is converted into electricity through low head turbines. Then, the flow will be driven towards the desalination system. This configuration seems like a promising opportunity for developing countries to meet their water supply needs while at the same time developing their renewable energy potential.

Keywords: desalination; wave energy; OBREC; green ports

1. Introduction

Today, over 1.76 billion people live in places with a high degree of water shortage, since they do not have access to freshwater, or, if they have, such water is unable to be used [1]. Due to the unfair distribution of water resources in the world, the quality and the quantity of water are not sufficient to ensure minimum conditions of wellness in several countries, first and foremost the African countries facing the ocean. Here, many cities and small villages along the coastline are experiencing a real freshwater crisis, but at the same time have abundant salt water sources. This difficulty in providing water has caused many countries in the world to look for new water sources, and to find in seawater desalination a valid alternative to alleviate this crisis situation. Data supplied by the International Desalination Association for the year 2015 [2], show that the total number of desalination plants installed was 18,426, serving more 300 million people in 150 countries throughout the world. The global capacity is more than 86.8 million m^3/day, and about 60% of the feed water used is seawater [2].

Like any other water treatment technology or separation processes, seawater desalination, requires the use of energy to produce freshwater. However, numerous low-density population areas