Geophysical Research Abstracts
Vol. 21, EGU2019-15144, 2019
EGU General Assembly 2019

Potential Water Quality Impacts of a Tidal Lagoon in Swansea Bay

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Concerns over climate change, global increase in the demand for energy and rapid depletion of fossil fuel reserves has led to an increased interest in the UK to generate electricity from renewable resources in recent years. Amongst these, marine energy resource is now being considered to form a significant part of the energy mix, with plans for the implementation of several marine renewable energy technologies such as tidal lagoons and tidal streams around the UK. Although marine energy presents a great potential for future electricity generation, there are major concerns over the impacts of these technologies on the hydro-environment. Previous studies which have evaluated the likely impacts of these technologies on the hydro-environment have overlooked changes to nutrients and their potential for eutrophication. Eutrophication is the enrichment of water by nutrients, especially compounds of nitrogen and phosphorus, causing the prolific growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. This is particularly important because eutrophication can lead to algal toxin production and increased mortality of aquatic invertebrates and fish populations. Therefore, this study provides insights into the hydro-environmental impacts of a tidal lagoon in Swansea Bay with emphasis on the nutrient concentrations using a 0-D computational model of a tidal lagoon in Swansea Bay. Field surveys were conducted to obtain dissolved nitrogen and phosphorus concentrations in the bay which served as input data. The presence of a tidal lagoon was found to alter the dissolved nitrogen and phosphorus concentrations, with ebb-only operation mode resulting in lower annual mean nutrient concentration compared with a no-lagoon scenario, while an increase in the annual mean nutrient concentrations was found under flood-only operation mode. The annual mean nutrient concentration under two-way operation mode was found to be comparable to that under the no-lagoon scenario. These findings are due to a combination of water residence time and light availability in the impounded water column. This study also examines the potential for eutrophication in Swansea Bay and wider ecological implications of these findings for the bay.