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DEVELOPMENT OF A SMALL-SCALE WAVE-POWERED PUMP FOR FRESH WATER PRODUCTION

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INTRODUCTION

The problem of water supply worsens every day due to multiple factors such as population growth, the effects of climate change and incorrect management of water resources. In the search for new sources of supply, in some coastal regions fresh water is obtained directly from the sea through a reverse osmosis process, which requires a large amount of energy, typically obtained using fossil fuels.

To reduce the ecological impact, it is desirable that this energy comes from a renewable source, so the purposes of this work were a) to run a field test of a wave-powered pump which could be used to supply pressurized water to a commercial reverse osmosis system, and b) to monitor the possible aggregation of marine organisms to the anchoring system.

METHODOLOGY

For site selection, some regions were proposed in the coast of Manzanillo city, Mexico, looking for places that would not have conflicts with navigation activities, and where energetic waves were present through out the year.

The numerical model FLOW-3D was used to estimate the forces in the anchor lines due to the interaction of three different buoys (Hernández, 2019). A cylindrical buoy of 2m diameter x ½ m high was chosen, with a weight of 350 kg. The proposed anchor consisted of a 2x2x0.50m block made of reinforced concrete, with a compression resistance of 250 kg/cm^2, with a ½" thick steel plate embedded in the upper part to efficiently distribute the forces coming from the buoy.

Figure 1 shows the geometry of the hydraulic cylinder, which was used to pressurize the seawater, using the vertical movement of the waves and a spring as a restoring force.

Figure 1. Hydraulic piston activated by waves, used to pressurize seawater.

Figure 2 shows the connection of the different components of the WEC at the test site.

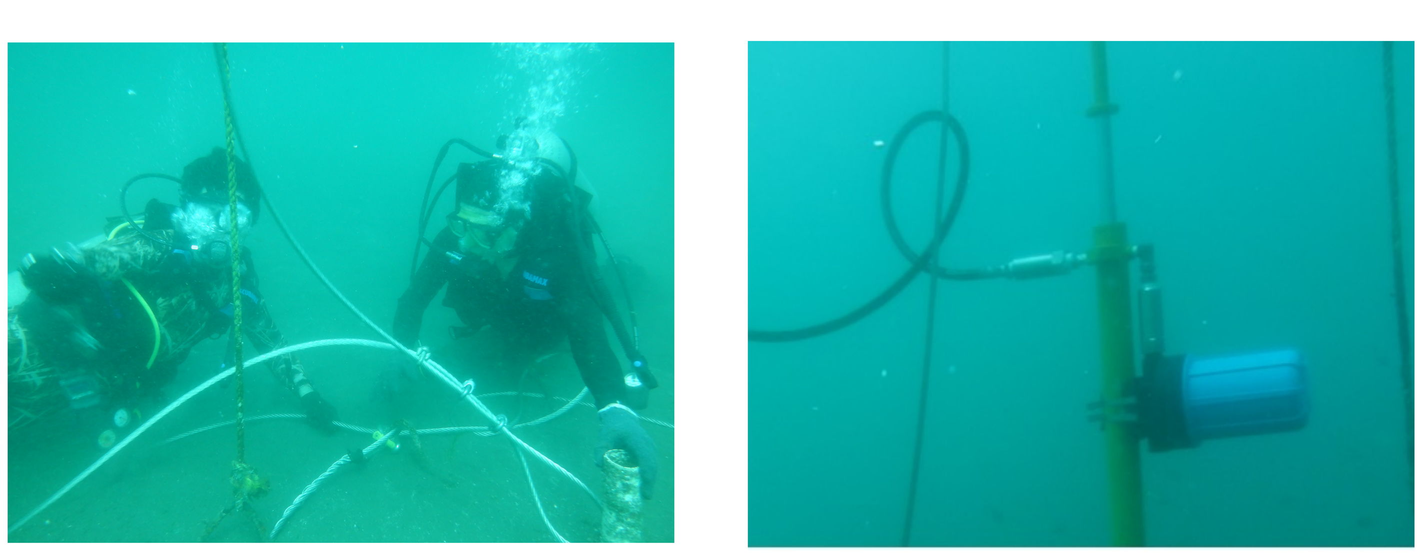

Figure 2. Connection of the WEC components: anchor, cylinder, filters and flotation system.

RESULTS

Considering the waves and bathymetry, as well as the navigation activities on the coasts of Manzanillo, a strategic point located in front of Playa Ventanas was selected (Fig. 3a), where a series of field tests were carried out (Fig. 3b) to estimate the potential energy obtained through the system, reaching 348.54 m, sufficient to carry out the reverse osmosis process in commercial equipment that has energy recovery systems.

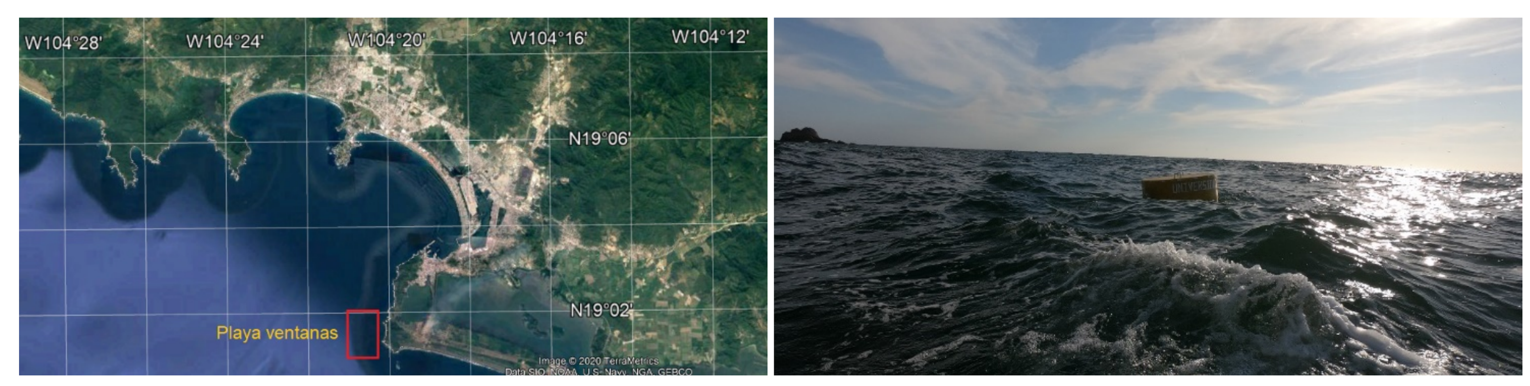

Figure 3. (a) Location of the study area; (b) WEC floating system.

After nine months of placing the bottom-based dead load, some aggregation of organisms was observed (Fig. 4), which probably use the structure as a shelter and/or feeding area, which suggests that the dead-load also served as an artificial reef capable of housing a new micro ecosystem.

Figure 4. Aggregation of organisms in the anchoring system and presence of fish around the cylinder.

CONCLUSIONS

- ✓ The calculations of potential energy achieved by the system suggest that the proposed pump is technically viable, since it reaches sufficient pressure to carry out the reverse osmosis process in commercial desalination equipment that has energy recovery technology.
- ✓ By analyzing the presence and abundance of organisms at the beginning and end of the project, it can be inferred that the device has a positive impact as an artificial reef capable of hosting a new micro ecosystem.

References

Hernández-Castillo, A., 2019. Diseño de una boya para transferencia de energía hacia un sistema de desalación de agua de mar impulsada por el oleaje. Tesis de Licenciatura, Universidad de Colima.

López, M. (2021) Análisis de la viabilidad técnica de un sistema de bombeo impulsado por oleaje, así como de su capacidad para fungir como arrecife artificial en la zona costera de Manzanillo, Colima. Tesis de maestría, Universidad de Colima.