Marine current energy from the Gulf of California, Mexico? An initial resource assessment and site selection

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Tidal current energy assessment

Introduction

The Gulf of California, which is located between mainland Mexico and the Baja California peninsula, has sites with appreciable potential for marine current energy. To date, no assessments of the available potential for energy generation have been published. This work aims to address this gap by quantifying the tidal energy resource in the site using the results of an existing a three-dimensional model of the Gulf of California.

Input data

The numerical modelling results used in this resource assessment study were provided by the author of [2], who adapted the layer-wise vertically Integrated Hamburg Shelf Ocean model (HAMSOM) developed by Backhaus [1] to the Gulf of California [2]. The surface elevation data were estimated from several years of observation mainly on Mazatlán in the mainland side of the Gulf entrance. The model's ability to reproduce the tidal currents and elevations, (barotropic and baroclinic) was compared with observations by Marinone [2] and in general terms the errors are acceptable.

Methodology

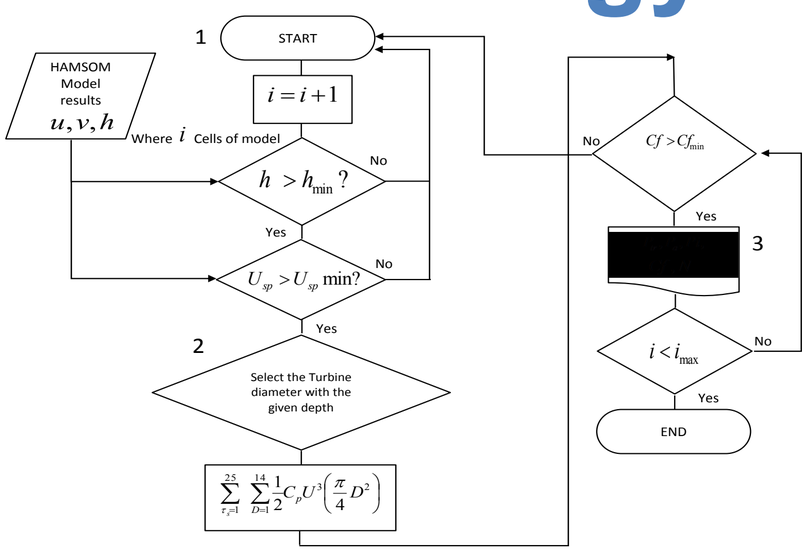

Figure 1. Selecting areas based on the potential characteristics of the site including the bathymetry data and the variables of the model in conjunction with the assumptions in Table 1.

Variables:

h = depth

u, v = vertical and horizontal flow velocities

C_f = capacity Factor

U_{sp} = peak flow velocity

C_p = Turbine efficient

P_a = total annual energy from all turbines in the cell (GWh).

N_t = Number of turbines

Table 1: Main resource assessment assumptions

Oceanography parameters		Turbine parameters		Array parameters	
Parameter	**Value**	**Parameter**	**Value**	**Parameter**	**Value**
Minimum spring peak tidal current (m/s).	0.7	Rotor Diameter (min/max in meters)	10-20	Lateral spacing between MCT's (times the diameter).	2
Density (kg/m^3).	1025	Turbine Efficiency	0.40	Longitudinal spacing between MCT's (times the diameter).	15
Spring and neap ratio	2	Capacity Factor (min %).	15	Bottom + Top clearance distance (m).	5
Spring-neap half-cycle period (in days).	14.8/2	Cut-in flow speed (m/s)	0.20	Cell size based on the Model grid (km).	5 x 5

Once the capacity factor converged to greater than the minimum acceptable, the final variables were recorded.

Results

The initial results are show in table 2. The results of the peak flow velocities (figure 2) and power density (figure 3) indicate potential areas that are suitable for marine energy device installations. The peak flow velocities are located in three areas: In front of Angel de la Guarda Island in a place named Ballenas channel (yellow dash line). The narrow part of the Gulf around the islands of Tiburon and Near from San Lorenzo Island (blue dash line) (See figure 4)

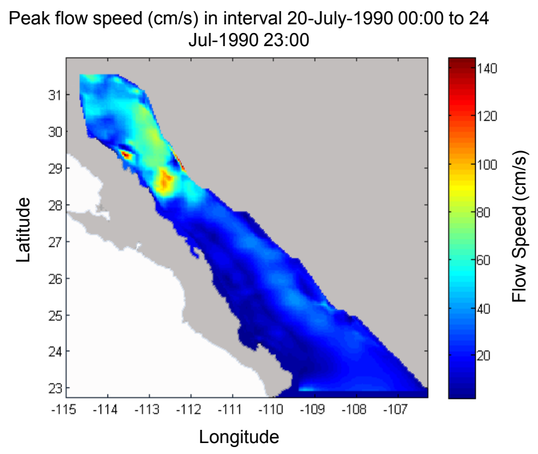

Figure 2. Peak flow velocities

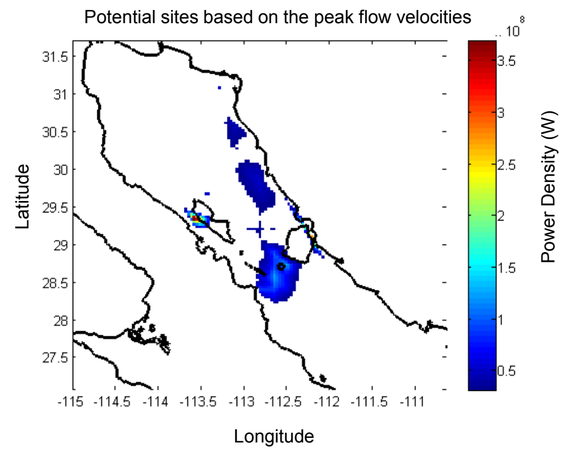

Figure 3. Power density potential sites

Table 2 Initial results

Parameter	Results
Average power per year (GWh)	1570
Number of turbines located in the selected cells	14560
Rotor diameter (m)	20

Figure 4. Location of the potential site in the Gulf of California.

Conclusion

The results indicate a localized, but significant tidal current resource in the narrow part of the Gulf around the islands of Angel de la Guarda, Tiburon and San Lorenzo. The model results indicate that an installed capacity of tidal turbines of up to about 1 GW may be theoretically feasible. However, it is worth noting that these areas are very sensitive from an ecological perspective.

References

1.Backhaus, J.O., 1985. A three-dimensional model for simulation of shelf sea dynamics. Deutsche Hydrographische Zeitschirft 38 (H.4), 164–187.

2.Marinone, S.G., 2003. A three-dimensional model of the mean and seasonal circulation of the Gulf of California. Journal of Geophysical Research 108 (C10), 3325, doi: 10.1029/2002JC001720.