Geophysical Research Abstracts
Vol. 19, EGU2017-8838, 2017
EGU General Assembly 2017

Assessment of Power Potential of Tidal Currents and Impacts of Power Extraction on Flow Conditions in Indonesia

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Climate change is an urgent and potentially irreversible threat to human societies and the planet and thus requires an effective and appropriate response, with a view to accelerating the reduction of global greenhouse gas emissions. At this point, a worldwide shift to renewable energy is crucial. In this study, a methodology comprising of the estimates of power yield, evaluation of the effects of power extraction on flow conditions, and near-field investigations to deliver wake characteristics, recovery and interactions is described and applied to several straits in Indonesia. Site selection is done with high-resolution, three-dimensional flow models providing sufficient spatiotemporal coverage. Much attention has been given to the meteorological forcing, and conditions at the open sea boundaries to adequately capture the density gradients and flow fields. Model verifications using tidal records show excellent agreement. Sites with adequate depth for the energy conversion using horizontal axis tidal turbines, average kinetic power density greater than 0.5 kW/m^2, and surface area larger than 0.5km^2 are defined as energy hotspots. Spatial variation of the average extractable electric power is determined, and annual tidal energy resource is estimated for the straits in question. The results showed that the potential for tidal power generation in Indonesia is likely to exceed previous predictions reaching around 4,800MW. Models with higher resolutions have been developed to assess the impacts of devices on flow conditions and to resolve near-field turbine wakes in greater detail. The energy is assumed to be removed uniformly by sub-grid scale arrays of turbines. An additional drag force resulting in dissipation of the pre-existing kinetic power from 10% to 60% within a flow cross-section is introduced to capture the impacts. k-ε model, which is a second order turbulence closure model is selected to involve the effects of the turbulent kinetic energy and turbulent kinetic energy dissipation. Preliminary results show the effectiveness of the method to capture the effects of power extraction, and wake characteristics and recovery reasonably well with low computational cost. It was found that although there is no significant change regarding water levels, an impact has been observed on current velocities as a result of velocity profile adjusting to the increased momentum transfer. It was also seen that, depending on the level of energy dissipation, currently recommended tidal farm configurations can be conservative regarding the spacing of the tidal turbines.