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A revised assessment of Australia's national wave energy resource

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ABSTRACT

Australia is widely recognised as having an abundant wave energy resource which could contribute to the country's future energy mix. Prior assessments have provided general broad scale information on the resource magnitude, but detail needed to support next level site assessments has been deficient. Aiming to support all stakeholders in Australia's emerging wave energy industry, this study presents a revised assessment of Australia's national wave energy resource. The assessment is based on a state-of-the-art global wave hindcast, with higher resolution in the Australian region. Validation of the hindcast relative to in-situ wave buoy and satellite altimeter observations show better comparison than prior assessments. The total nationally available resource is similar in magnitude to earlier studies, but regional differences are evident. The total integrated energy flux across the 200 m contour is approximately 2730 TWh/yr, with estimates of resource along the north and eastern coasts being less than previously estimated. This revised pre-competitive resource information is delivered coincidently with marine management and alternative use (constraint layers), and energy infrastructure, spatial information via the open-access Australian Wave Energy Atlas (AWavEA), served through the Australian Renewable Energy Infrastructure (AREMI). The Atlas serves to reduce barriers to emergence of an Australian wave energy industry.

1. Introduction

In May 2015, the Australian Government revised the Renewable Energy Target (RET) to 33,000 GWh/yr by 2020 (downgraded from 41,000 GWh/yr, [1]). In 2015, approximately 17,000 GWh of large scale renewable energy was produced in Australia, and to meet the current RET will require approximately 6000 MW of new generating capacity to be built before 2020 [2]. Australia has no policy in place for the renewable energy target beyond 2020, however if Australia is to meet its commitments under the Paris Agreement to reduce greenhouse gas emissions to 26–28% below 2005 levels by 2030 [3], extended commitment to further uptake of renewable energy will be required.

In recent years, the Australian Government has made significant investment in pre-commercial wave energy developments on the Australian coast [4] in recognition of the potential contribution of wave energy to Australia's future low carbon energy mix. This funding is provided to help address the many issues needed to support the nascent wave energy industry (e.g., demonstrating operational reliability, establishing a supply chain, policy drivers, amongst others discussed in prior reviews, e.g., [5]).

Although wave energy is recognised as a considerable natural resource for Australia (Fig. 1), previous assessments are limited by several factors and do not meet the needs of the many stakeholders in this emerging industry. These limitations include: low spatial resolution and associated inability to resolve near-shore wave transformations which influence the resource available near-shore [6,7]; lack of validation (e.g., [8]); limited spatial coverage as a result of methodology [9]; or limited data availability (arguable for all studies). Morim et al. [10] identified that as a consequence of these shortcomings, available estimates of wave energy resource along Australia's southern margin – an area with attractive resource for the emergent wave energy industry – could differ by almost 100%.

High quality information of the available resource is needed by a range of stakeholders when establishing new energy projects (see summary in Table 1). Each set of users has different requirements of

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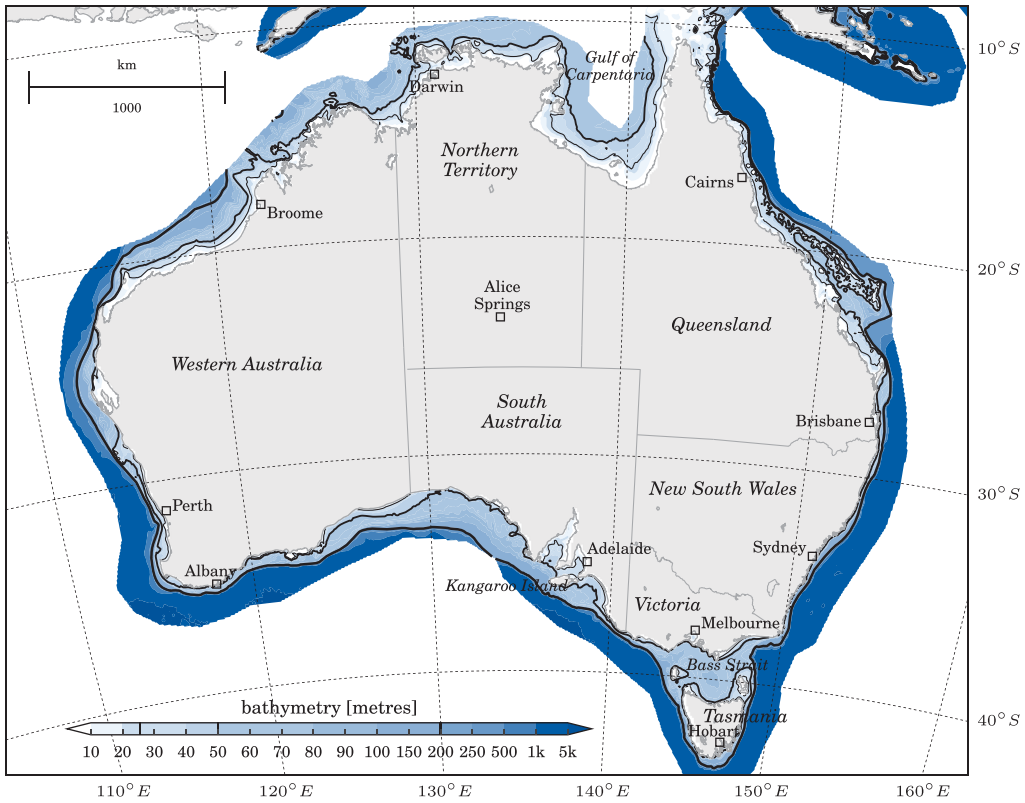

Fig. 1. Map of Australia displaying bathymetry, including 25 m, 50 m and 200 m depth contours, and locations mentioned in the text.

Table 1
Summary of ocean renewable energy stakeholder groups with interest in wave resource information.

Stakeholder group	Purpose/Interest
Developers of Wave Energy Converter devices	Require knowledge to enable optimisation of device for available resource
Project prospectors	Seeking commercially viable projects
Marine spatial planners	Looking to incorporate resource knowledge into multiple-use management and policies for the marine domain
Environmental managers	Seeking benchmark information for pre-deployment environmental conditions
Financiers	Seeking independent information to assess whether projects are bankable, allowing developers to access capital
Energy load managers	For assessment of potential power delivery/integration to user/electricity network, to negotiate reliable power purchase, and investigate other grid integration issues.
Maintenance engineers	To determine engineering installation, operations and maintenance requirements.

a resource assessment, and this is commonly acknowledged via three classes of assessment – '(I) reconnaissance', '(II) feasibility' and '(III) design-scale' [11]. Prior pre-competitive assessments of wave energy resource in Australia have gone some way to delivering reconnaissance class assessments, but each is limited in some way, with no single assessment providing an adequate level of information to support all activities. This study seeks to address this gap and deliver a national dataset which supports not only the broad scale reconnaissance assessments (class I), but also openly provide data required to support higher resolution class II and class III assessments.

Internationally, wave energy resource assessments have been carried out in many regions, seeking to address these needs for their region of interest. These include studies of the UK and European shelf seas (e.g., [12,13]), the Mediterranean Sea (e.g., [14,15]), North America (e.g., [16]), Asia (e.g., [17,18]), South America (e.g., [19,20]), amongst many others. These studies each address the challenge of quantifying a regional wave energy resource using different methods, and as a consequence International standards for the quantification of resource have been established [11] to aid the quantitative comparison of calculated resource from all studies.

In recent years, the Centre for Australian Weather and Climate Research (CAWCR: a partnership between CSIRO and the Bureau of Meteorology) has undertaken a global wind-wave hindcast, with focussed attention (nested grids) on the South-Pacific and Australian domains ([21]; Fig. 2). This dataset spans more than 34 years; is forced with the best identified global wind reanalysis; provides the highest spatial and temporal resolution wave data currently available for the Australian region; and has broad application across a number of coastal and offshore interests. However, the performance of the CAWCR wave hindcast relative to observational data in Australian waters has not been previously established. In this study, we compile available wave observations in the Australian domain (including satellite altimeter data and in-situ buoy data), establish the skill of the CAWCR wave hindcast in the Australian region, and use this state-of-the-art wave hindcast to update estimates of Australia's wave energy resource. This forms the basis of the publicly available Australian Wave Energy Atlas (AWavEA),

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