Chapter S10.0. Potential Environmental Effects of Marine Renewable Energy in Tropical and Subtropical Ecosystems

Supplementary Material

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S10.1. Methods

Four different approaches were used to gather information on the environmental effects of marine renewable energy (MRE) in tropical and subtropical ecosystems: a literature review, an online public survey, a series of interviews with experts, and workshops.

The literature review focused on peer-reviewed articles and grey literature reports. Using Scopus and the *Tethys* Knowledge Base, the OES-Environmental team identified 88 documents related to the environmental effects of marine energy in tropical and subtropical regions. Keywords used to identify relevant documents included: environmental effects, environmental impacts, marine energy, MRE, tropical, subtropical, wave energy, tidal energy, ocean current energy, ocean thermal energy conversion (OTEC), and ecosystem. All relevant documents were compiled into an Excel spreadsheet which included separate tabs for each topic and listed author(s), date, title, study type (i.e., desktop, field, laboratory, modeling), technology, focus (i.e., engineering, environmental, socio-economic), relevance (i.e., not likely, possibly, yes, uncertain), and project location.

Knowledge of the environmental effects of MRE in tropical and subtropical countries was collected from stakeholders and subject matter experts through an online survey, interviews, and workshops. A short public online survey was conducted to collect existing information relevant to the environmental effects of MRE in tropical and subtropical countries. The survey was available in both English and Spanish and was distributed to the MRE community through the *Tethys* biweekly newsletter (*Tethys* Blast). It requested information on any ongoing or emerging MRE projects in these regions; any research, monitoring, or modeling efforts that may be relevant; any literature or other resources that may be relevant; inputs on stressor-receptor interactions (displacement was not listed as an interaction in the survey); and any specific contacts and/or organizations with relevant experience in these areas. The complete list of survey questions (in English) is available below in the Survey Question section. Overall, the survey received 22 responses from individuals with experience working in over 25 different tropical and subtropical countries or regions. Some survey respondents who shared their information were invited for interviews.

A total of 33 interviews were conducted with stakeholders to collect information, identify knowledge gaps, and determine future research needs. Stakeholders interviewed were from research institutions, non-governmental organizations, universities, industries, and small and medium-sized enterprises. The consultation covered 15 countries including Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Philippines, Indonesia, Maldives, Thailand, Australia, Japan,

Portugal, Sweden, and the United States. Semi-structured interviews were conducted online between February 2022 and December 2023 and ranged between 30 and 60 minutes each. The invitation to participate in the interviews was delivered to stakeholders who work in MRE, in fundamental sciences associated with marine ecology, or both. This approach was selected to widen the coverage of local expertise that may provide relevant insights, taking into consideration the current lack of specific research oriented to MRE environmental effects in these regions when compared to Northern hemisphere regions such as Europe (see the Interviews with Stakeholders section).

To further the collection of scientific knowledge on the environmental effects of MRE in tropical and subtropical countries, two workshops were conducted. OES-Environmental hosted the first workshop as part of the Chile Riding the Blue Wave International Conference, held online on 12 April 2021. The workshop covered the environmental effects of MRE and floating offshore wind from an international perspective as well as from the Chilean context. There were 26 workshop attendees from several countries, including Chile, Argentina, Mexico, Portugal, Canada, Egypt, and the United States. The workshop also involved breakout group discussions to capture participant ideas around environmental and socio-economic concerns specific to Chile. The second workshop was hosted in person on 18 June 2022 at the Pan American Marine Energy Conference (PAMEC) in Ensenada, Mexico. During the workshop, OES-Environmental provided an overview of the potential environmental effects of MRE on marine animals, habitats, and ecosystem processes, including monitoring methods and results. Since the information collected to date has primarily focused on wave and tidal energy converters in temperate regions, OES-Environmental organized the PAMEC workshop to expand on this understanding and discuss potential effects specific to MRE in tropical and subtropical environments, including the potential for using OTEC in tropical regions to harvest energy. The workshop also involved breakout group discussions focused on how MRE systems may affect the biodiversity of tropical ecosystems, and particularly how stressor-receptor interactions in tropical ecosystems may differ from those in temperate ecosystems. The questions used to drive the breakout discussions are listed in the Workshop Questions section.

S10.2. Survey Questions

OES-Environmental conducted a short, online survey to collect existing information relevant to the environmental effects of MRE in tropical and subtropical countries. The survey is available in English and Spanish. The complete list of survey questions (in English) is provided below:

1. In which tropical or Southern Hemisphere countries do you work?
2. Are there ongoing or emerging projects using MRE (e.g., wave, tidal, ocean current, salinity gradient, ocean thermal energy conversion, seawater air conditioning, floating solar, or hybrid technologies)? Please list them below.
3. What environmental effects or concerns are most prevalent in these countries? Please rank them as either Not Important, Somewhat Important, or Very Important.
    - Collision between MRE devices and marine animals
    - Underwater noise effects on marine animals
    - Electromagnetic field effects on marine animals
    - Changes in habitat caused by MRE devices
    - Changes in oceanographic systems caused by MRE devices
    - Encounters between marine animals and MRE mooring lines/cables
4. Are there key resources that you would use to understand or assess the effects of MRE on the environment in these countries (e.g., websites, databases)? If so, please list them below.
5. Are there key research publications, reports, or other documents that you would recommend that describe the environmental effects of MRE in these countries? If so, please list them below.
6. Are there organizations or specific individuals with relevant experience in this area that you would recommend reaching out to for more information? If so, please list them below.
7. If you would like to connect with the research team, or have additional information to provide, please list your contact information below.

S10.3. Interviews with Stakeholders

Although informally conducted to allow for better communication dynamic and freedom to touch different topics, the interviews with stakeholders were semi structured in an effort to answer the following questions:

1. Please give a brief introduction of affiliation, country and role, experience in the region, and a description of your work within MRE.
2. What is your knowledge on potential environmental effects as it relates to their specific country such as experience with dealing with/researching potential environmental effects of MRE technologies, and knowledge on potential environmental effects of MRE technologies?
3. What do you know about MRE resources in your country?
4. What are the barriers to MRE development and growth of the sector in your country?
5. What are the opportunities and challenges for the blue economy in your country?

S10.4. Workshop Questions

An in-person workshop was hosted on June 18, 2022, at the Pan American Marine Energy Conference (PAMEC) in Ensenada, Mexico, to further the collection of scientific knowledge on the environmental effects of MRE in tropical and subtropical countries. The workshop also involved breakout group discussions focused on how MRE systems may affect the biodiversity of tropical ecosystems, and particularly how stressor-receptor interactions in tropical ecosystems may differ from those in temperate ecosystems. The questions used to drive the breakout discussions were:

- Which stressor-receptor interactions are relevant to MRE development in tropical regions (wave, tidal, OTEC)?
- What are other unique receptors to consider in tropical regions? Do they differ depending on the country?
- Do the estimated levels of risk for OTEC seem appropriate?
- What are the preferred methods for environmental monitoring in tropical regions?
- Where are the opportunities for development and collaboration within the PAMEC region?