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EDITORIAL

Climate Change Effects and Marine Renewable Energy Important Topics Targeted by the *Journal of Marine Science*

Eugen Rusu[1,2*]

1. Editor in Chief, Journal of Marine Science
2. Faculty of Engineering, "Dunărea de Jos" University of Galati, 800201, Galati, Romania

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The higher dynamics in the climate change became quite visible in the last decades. Although there are still theories assuming these changes to the cyclic character of the climate, it is obvious that this dynamics is also driven to a large extent by the human activities. According to the Intergovernmental Panel on Climate Change (IPCC), which is the United Nations body for assessing the science related to climate change, various climate scenarios have been designed. Thus, in the framework of the Fifth Assessment Report (AR5) [1], the RCP concept has been introduced. RCP stands for Representative Concentration Pathway and represents the greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were initially used for climate modelling, describing different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come. The RCPs - originally RCP2.6, RCP4.5, RCP6, and RCP8.5 - are labelled after the possible range of radiative forcing values in the year 2100 (2.6, 4.5, 6, and 8.5 W/m^2, respectively). Further on, according the Sixth Assessment Report (AR6) [2], the original pathways are considered in the framework of a wider concept, which is the Shared Socioeconomic Pathways (SSPs). Furthermore, new RCPs were also designed, such as RCP1.9, RCP3.4 and RCP7. These SSPs are holistic approaches describing scenarios of projected socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios with different climate policies. The new designed scenarios are: SSP1: Sustainability (Taking the Green Road), SSP2: Middle of the Road, SSP3: Regional Rivalry (A Rocky Road), SSP4: Inequality (A Road

*Corresponding Author:
Eugen Rusu,
Editor in Chief, Journal of Marine Science; Faculty of Engineering, "Dunărea de Jos" University of Galati, 800201, Galati, Romania;
Email: eugen.rusu@ugal.ro

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divided) and SSP5: Fossil-fueled Development (Taking the Highway). Under these circumstances, it is obvious that decarbonisation should become a high priority, and an important step towards a significant emission reduction is represented by increasing substantially the percentage of the Green Energy in the global energy portfolio.

Marine environment is very sensitive to the climate changes [3] and the effects can be locally much more dramatic even than the most pessimistic climate scenarios [4]. On the other hand, marine areas are very rich in various forms of clean energy that can be extracted. In the first place, ocean energy is very significant for island environments [5,6]. These are in general remote areas where the conventional sources of energy are quite expensive, but where marine renewable energy is abundant [7]. Marine renewable energy can represent also a viable solution for the developing countries [8], as for example those from South America [9] that have extended coast both at Atlantic and Pacific oceans. Furthermore, besides providing clean energy, the marine energy farms can play an active role also in coastal protection [10-15]. Thus, by absorbing the energy of the incoming waves the marine power projects can influence in a significant way the coastal dynamics contributing in reducing the erosion and attenuate many nearshore processes. Thus, the marine projects can act as drivers for the nearshore currents changing the costal circulation and modelling the sediment transport patters.

As regards Europe, this is not only a pioneer in relationship with the development of the marine energy projects, but at the same time, is still the world leader in ocean energy extraction. In fact, the first offshore wind farm in the world (Vindeby) was installed in 1991 in the Baltic Sea by Denmark and at this moment this wind project is still operational. Furthermore, the Baltic Sea is among the coastal environments where the offshore wind farms have been systematically implemented in the last decades, with 18 operational wind farms [16]. However, the most significant European marine area, and probably one of the most significant in the world, from the point of view of harnessing the marine energy resources is the North Sea, where around 40 wind projects are nowadays operating [17]. Furthermore, huge projects are planned for this marine area, where an artificially constructed island is planned to be built by Denmark 80 kilometres from the shore of the Jutland peninsula. Thus, around 200 wind turbines with a combined capacity of 3 GW are expected to be installed in the first phase of the project by 2030.

In the global context of following the green path and reducing the CO_2 emissions, European Union developed a coherent and ambitious strategy. From this perspective, in December 2019 the European Green Deal was publically released [18]. This document presents the European strategy for decarbonisation, according to which the European Union is assumed to become climate neutral by 2050. An important step in achieving such ambitious target is represented by a significant enhancement in extracting marine renewable energy. Thus, although the offshore wind industry has had an exponential increase in the last decade, the EU target assumed for 2050 is a 25 times increase than the current operating capacity of 12 GW (in 2021). It is obvious that such target implies both high technological advance and wide geographical extension. From this perspective, besides the traditional areas represented by the Baltic and the North seas, this includes many other coastal environments [19], such as the Iberian nearshore [20], the Mediterranean [21] and the Black [22] seas. If the targets set by the European Green Deal in terms of offshore wind can be considered ambitious, those related to the other types of ocean energy are really spectacular. Thus, an increase of more than 3000 times is assumed by 2050 from the currently operating capacity of 13 MW (in 2021). These kinds of marine renewable energy include the floating solar panels [23], which are considered very promising since they are based on a proven technology and can be easily combined with the floating wind. The wave and tide technologies, although are not yet fully mature and economically effective, present the advantage that there are abundant resources, which are more predictable than wind or solar and have a higher power density. In a first approach, collocation with the existent wind energy projects and/or hybrid solutions [24-26] might increase the economic efficiency, especially as regards the wave energy extraction. A solution envisaged to make the marine renewable energy more viable is represented by the Power to X technology. This approach considers hydrogen as an energy vector and in this way the costs of the marine renewable energy may decrease being possible to extract energy in remote locations without a shore connection.

Other kinds of marine renewable energy sources are salinity and thermal gradients that originate from the differences in the salinity and temperature, respectively, of sea water masses. Also, another energy source is represented by the marine biomass energy (marine bioenergy) which involves the use of marine algae and other viable sources for the production of biofuels (i.e., biogas, biodiesel, bioethanol, and other liquid biofuels). Furthermore, another potential marine renewable energy is represented by ocean floor geothermal energy, which considers the use of supercritical geothermal resources in the sea floor.

Finally, it has to be highlighted that the *Journal of Marine Science* represented even from the beginning an open framework dedicated to the presentation of the most significant discoveries and insights in marine science research. Taking into account the high concern of the scientific community related to the climate dynamics, on one hand, and the expected development and very ambitious targets related to the marine renewable energy sector, on the other hand, climate change effects in marine and coastal environment, as well as the assessment of the main challenges and advances associated to the extraction of marine renewable energy are considered topics of extremely high interest for our journal. In this way, we hope that *Journal of Marine Science* will play an active role in following the green road towards a low carbon future.

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