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Challenges of the Blue Economy: evidence and research trends

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Abstract

Background: The Blue Economy is a recent field of study that encompasses economic activities that depend on the sea, often associated with other economic sectors, including tourism, maritime transport, energy and fishing. Blue growth supports the sustainable growth of the maritime and marine sectors as the oceans and seas are engines of the global economy and have great potential for growth and innovation. This article undertakes a bibliometric analysis in the terms of Blue Economy (BE), Maritime Economy (MAE), Ocean Economy (OE), Marine Economy (ME), and Blue Growth (BG) to analyze the scientific production of this field of study. Analysis of the authors' definitions of BE, BG, ME and OE provides interesting relationships divided into sustainability and governance; economics and ecosystem protection; industrial development and localization; and the growth of the ocean economy, with development as the central axis that encompasses them. The main contribution is to find out if there is a link between the BE and the CE through the keyword study.

Results: The results show a significant increase in articles and citations over the last decade. The articles address the importance of different sectors of BE and the interest of governments in promoting it for the development of their national economies. Using bibliometric mapping tools (VOSviewer), it is possible to find possible links between concepts such as CE and BE through the BG and to visualize trending topics for future research. Nascent and future research trends include terms such as small-scale fisheries, aquatic species, biofuel, growth of the coastal BE, internationalization and blue degrowth (BD), the latter approaches aspects of BG from a critical perspective.

Conclusions: In conclusion, it highlights the need for alliances between the sectors that compose BG with the incorporation of the CE in order to achieve a sustainable BE in both developed and developing countries. Through the keyword analysis it is shown that the BG strategy is the bridge between the BE and the CE. The CE presents itself as a promising alternative that could mitigate tensions between stakeholders who support both growth and degrowth positions.

Keywords: Blue Economy, Blue growth, Ocean economy, Maritime economy, Marine economy, Bibliometric analysis

Background

Throughout history, the sea has always been present in the economic activities of all civilizations as a food resource, a means of transportation and commercial trade. In recent years the term Blue Economy (BE) has become a concept closely related to maritime resources and developed economies in the oceans. Its growing

expansion and the emerging needs of a circular economy (CE) herald challenges in both new and established treatments and materials [30]. CE is understood as an economic model oriented towards the elimination of waste generated, efficient use of resources, recycling and recovery [79, 117].

The BE aims to promote economic growth, improve life and social inclusion without compromising the oceans' environmental sustainability and coastal areas since the sea's resources are limited and their physical conditions have been harmed by human actions [40].

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The first appearance of the term BE dates back to 2009, at the congress of the Senate Committee on Commerce, Science and Transportation of the United States. The importance of the BE for the USA's overall economy, the excellent business opportunities it provides, and the concerns about climate change are excellent opportunities for new blue jobs in renewable energy [19]. In that same year, the International Symposium on Blue Economy Initiative for Green Growth in Korea took place, where *"the concept of using ocean resources in a way that respects the environment can evaluate how both business activity models and new technologies satisfy economic and environmental conditions, contributing to the sustainability of these resources"* [62].

Subsequently, Pauli [94], a leading proponent of the BE's economic model, published a book entitled, *"The Blue Economy"* [7, 16, 45, 110] which proposed it as a model based on technological innovation to supply products at low cost, promote local job creation and a model that is respectful of the environment and competitive in the markets.

At the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012, the oceans were deemed to be priority areas, with some initial objectives being proposed such as the "sustainable consumption and production patterns", food security, sustainable energy for all and disaster risk reduction and resilience [124].

Undoubtedly, ocean resources generate numerous benefits to the world economy and offer essential opportunities for transportation, food production, energy, mineral extraction, biotechnology, human settlement in coastal areas, tourism and recreation, and scientific research [64].

In academic research, a literature review on the BE also needs to include similar concepts. Lee et al. [74] state that *"the term BE has been used in different ways and similar terms such as "ocean economy" or "marine economy" are used without clear definitions."* At the same time, when analyzing other articles that address BE, it was observed that ocean economy (OE), marine economy (ME), and blue growth (BG) were also used as synonyms [64, 121]. Table 1 shows some of the definitions of these terms.

Figure 1 presents an analysis of the similarities and differences of the above definitions, where each color of the circumference represents a concept (BE, BG, ME and OE) and within it the authors are positioned. The most interesting finding arises in the intersections, with the common element for BE and BG being the economy and the protection of marine ecosystems to ensure sustainability, ME and OE share industry development and location, in BE and ME we find governance and sustainability and finally BG and OE cooperate in the growth of

the ocean-based economy. In relation to the differences, they are placed outside the quadrant, with aspects pointing to a social and complex system, a green and inclusive economy, as well as the existence of operational risks.

The central point is ocean development promotion as a sign of progress and economic, political, social and cultural growth without losing the focus on sustainability.

It is important to highlight that the concept of BE gives rise to two conflicts of interest. On the one hand, those linked to economic growth and development, and on the other, those linked with safeguarding and protecting the ocean's resources. Kathijotes [67] states that the objective of BE models is to transfer resources from scarcity to abundance and address the issues that cause environmental problems.

For this reason, it is necessary to propose solutions that take advantage of all available opportunities and analyze the threats to the OE. Lee et al. [74] link the BE and the UN sustainable development goals (SDGs) and conclude that the objectives that are linked to the BE are: underwater life (14), land ecosystems (15); peace, justice, and stable institutions (16) and alliances to achieve the objectives (17). Linking BE with SDGs is challenging on the basis that the common element of both is in objective 14 [59, 88, 130]. In relation to hot spots, firstly, the starting point for achieving the SDGs is not homogeneous, with large differences between developed and developing countries [58, 61] due to the economic, political, social, cultural and environmental context [51]. Secondly, there are areas of conflict mainly around divergent views on the legitimacy of different sectors as components of BE, in particular carbon-intensive industries such as oil and gas and the emerging deep-sea mining industry [131], as well as large fisheries versus those coastal areas where artisanal fisheries are in danger of extinction [109].

Furthermore, the increase in human activity, in the form of new or intensified uses, such as the generation of renewable marine energy, exert greater influence and cause conflicts between BE sectors [56].

In 2012 the European Union implemented its BG strategy and established subsectors within the field of the BE [41, 96]. The BG Strategy breaks down the BE into five main sectors: Biotechnology, Renewable Energy, Coastal and Maritime Tourism, Aquaculture and Mineral Resources, and integrates other sectors such as fishing, transportation, offshore oil and gas extraction, and ship construction and repair.

Biotechnology presents excellent opportunities to produce natural products with possible applications in the food and pharmaceutical sectors [105, 119]. It is a recent and developing sector that is part of the bioeconomy, the latter developing and using renewable biological resources from the land and sea. For example, the

Table 1 Definitions of BE, BG, ME and OE

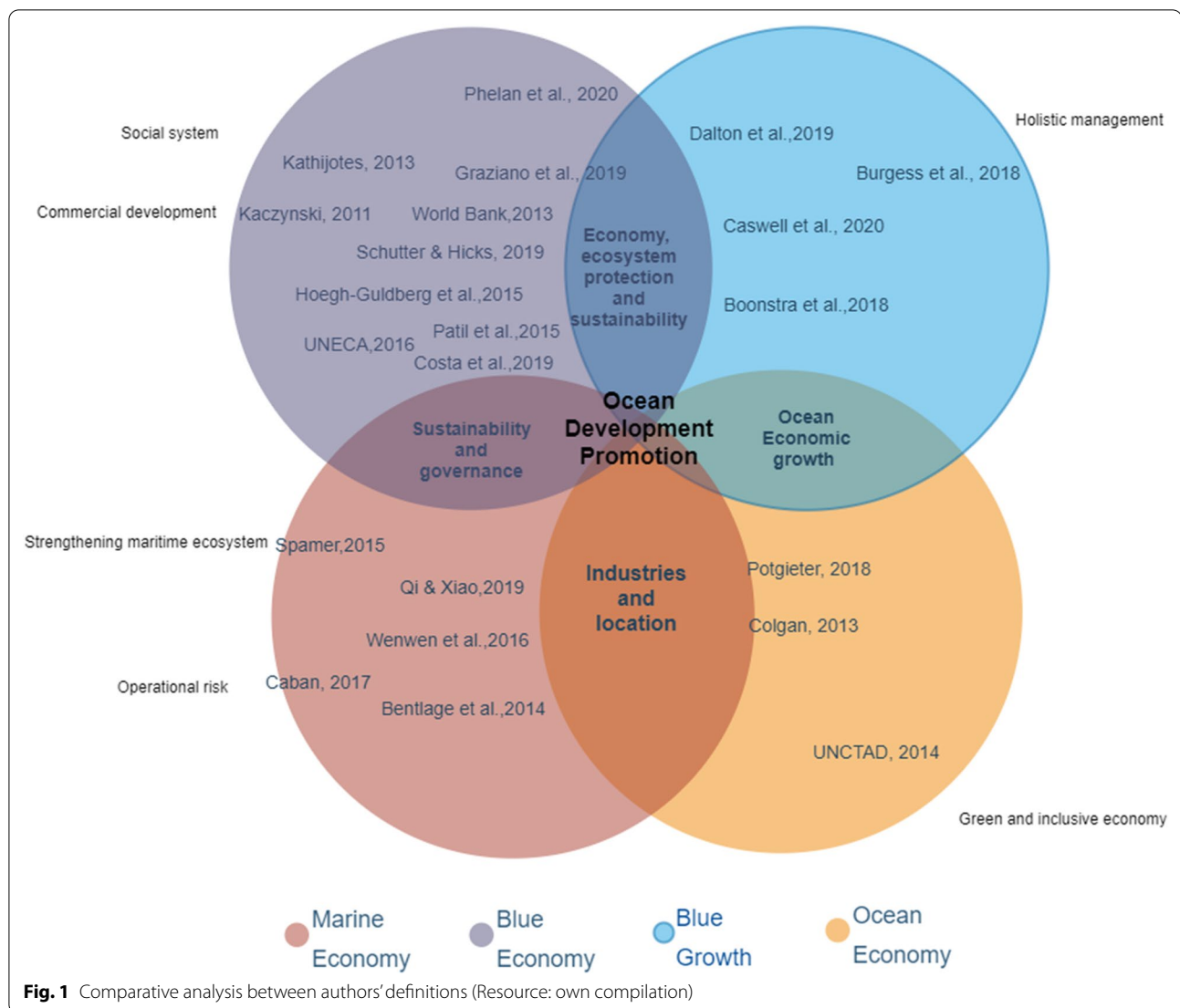
Concept	Authors	Definitions and related concepts
Blue Economy	World Bank [137]	The sustainable use of ocean resources for economic growth, the improvement of livelihoods and jobs, and the health of ocean ecosystems
	Costa et al. [29]	The concept of rethinking industrial processes and searching for a viable biological solution that reduces contamination
	Phelan et al. [95]	It has become synonymous with generating wealth from activities related to the oceans while protecting and supporting marine ecosystems
	Graziano et al. [48]	It arises from the growing worldwide interest in the growth of water-based activities
	Schutter and Hicks [113]	It seeks to curb biodiversity loss while stimulating economic development, thereby integrating environmental and economic interests
	Kathijotes [67]	It is the mainstream of national development and can integrate land and sea-based socio-economic sustainable development
	Kaczynski [64]	It refers to the commercially sustainable development of the oceans
	Hoegh-Guldberg et al. [55]; Patil et al. [93]; UNECA [125]	It has emerged in the last two decades from various forums, but above all from within the policy and practice of environmental development
Blue growth	Caswell et al. [23]	Emerging from national and international marine policy, it aims to promote the growth of ocean economies and at the same time holistically manage marine socio-ecological systems
	Dalton et al. [33]	The creation of economic activity and jobs at sea, while the multiple uses of spaces make efficient use of the available sea surface by combining industries
	Boonstra et al. [14]	It is relatively new and aims to achieve economic growth based on the exploitation of marine resources while avoiding their degradation, excessive use, and pollution
	Burgess et al. [17]	It is the most recent term to refer to the most holistic management of complex marine socio-ecological systems. It is a dynamic and complex system that covers all industries and regions
Marine economy	Qi and Xiao [102]	It is a dynamic and complex system that covers all industries and regions
	Wenwen et al. [134]	It is a new economic form that emphasizes a new development concept, a new operating mechanism, and a management model
	Caban et al. [18]	It is particularly exposed to dangers due to the environment of its operations. These risks are the result of deliberate and incidental actions (hydrometeorological, mechanical conditions, etc.)
	Bentlage et al. [12]	A heterogeneous innovation system with enduring relevance to the spatial and functional development of European regions
	Spamer [121]	It simultaneously fosters social inclusion, environmental sustainability, strengthening maritime ecosystems, transparent governance, and economic growth and development
Ocean economy	UNCTAD [124]	A subset and complement of the evolving development paradigm emphasizing greener, more sustainable, and more inclusive economic pathways
	Potgieter [99]	It is considered a crucial factor for global economic growth and development, offering excellent opportunities, challenges, and risks
	Colgan [28]	They are marine construction, resource, shipping, and tourism and recreation industries whose establishments are located near ocean shorelines or large lakes

cultivation of seaweed is expected to provide sustainable biomass that facilitates the development of the marine bioeconomy through BG [43] and is considered an industrial benchmark for achieving a competitive, circular, and sustainable economy that is less dependent on fossil carbon [9].

Renewable wind energy from marine sources and the conversion of thermal energy from the ocean is increasingly present at the global ocean level [126, 129]. Novel hybrid robust/stochastic approaches are used to participate in the electricity market, including renewable energy procurement through large consumer purchases that respond to the energy demands of wind turbines (WT), photovoltaic systems (PV), bilateral contracts

(BCs), and micro-turbines (MTs), and energy storage systems (ESS) [1]. Other strategies focus on the optimal programming of electrical energy consumption in multiple cooling systems [108] or models based on heat and energy centers [70].

Tourism has played a decisive role in developing many island economies, triggering other activities to obtain local economic returns. Similarly, aquaculture and fisheries have contributed to the economic development of certain regions without jeopardizing access to essential resources such as small-scale fisheries [15, 39, 109]. The exploitation and extraction of offshore oil and gas is a reality in many economies around the world wherein nations must weigh the economic benefits against the



negative impact it may have on living marine resources [78, 92, 131].

Globally, shipping is the primary means of supplying raw materials, consumer goods, and energy, becoming a facilitator of world trade and contributing to economic growth and employment, both at sea and on land [81]. In addition, the shipbuilding industry provides real added value to numerous coastal communities [114].

Through bibliometric analysis, this study's main objective is to explore the evolution of worldwide scientific production on BE between 1979 and 2020. The purpose is also to identify those concepts that are related to BE in order to subsequently carry out the study of keywords and establish future research trends.

Its main contribution is the assimilation of the BE into the CE since both are key to supporting BG and guaranteeing the sustainability of economic activities developed

within the blue context. BE encompasses activities related to renewable energy use, waste management, climate change, fisheries and tourism, where the concept of economic circulation (based on recycling, extension, redistribution and manufacturing) can be integrated, moving from a linear economy to an economy that makes the most of waste through circular flow [60, 112, 133]. Analyzing the possible connections, we start from the study carried out by Ruiz-Real et al. [107], referring to the analysis of the global dynamics of the CE, where trend words related to renewable energy, climate change and waste management are located, finding an explicit link with almost all of the activities promoted by the BE shown in Fig. 2. Furthermore, although there is no visible link on the fisheries and water issue in the BE and CE, it should be mentioned that fisheries depend on water, as their life cycle depends on this natural environment and

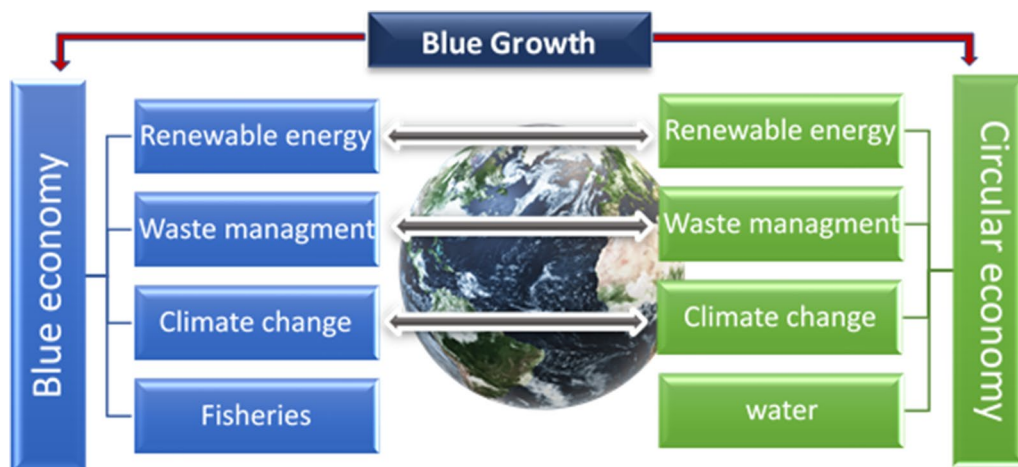


Fig. 2 Analysis of relationships between BE and CE

both its conditions (quality, temperature, salinity) and its proper management influence the sustainability and conservation of marine species [36, 106].

An important aspect relates to the conflict between the interest groups of BD versus the economic development proposed by both the BE and the BG. Thus, the CE presents itself as a mediator between growth, economic development and employment while extending resource availability and reducing environmental and social pressures.

Methodology

Bibliometry offers useful results from the authors' production in a field of research, trends, the most cited articles, and the concentration of documents in impact journals [63].

The first step was to select the terms through a prior review of those economies linked to the seas and oceans, with BE, BG, ME, and OE being the most representative terms.

The next step involved locating and extracting data on all the documents in the Web of Science (WoS) Core Collection that contain the terms established in the search criteria in order to visualize the behavior of scientific production over time, providing high-quality data and a complete description that facilitates data processing and for the broad recognition it has obtained in the scientific community [89, 98]. For this study, the WoS database was selected. This database is widely recognized for gathering reliable and multidisciplinary research, with studies recommending its use due to the high proportion of exclusive journals [83].

A similar search query was carried out on the Scopus database using the same criteria to guarantee the data's

completeness. The results were similar to those obtained from WoS [44, 53, 80].

The data was then processed to analyze the number of articles published per year, the number of citations, and their h-index. Bibliometric analysis, the study of the scientific activity of authors, has been used to prepare this article and has been used in various areas.

Figure 3 depicts the descriptive statistical analysis of the main variables: cites per article, total cites, h-index, year, and articles. The matrix indicates the correlation between them (the closer to 1, the stronger the correlation; if the values are closer to -1 , there is an inverse correlation between variables, while if there is a zero value, there is no correlation). In the present case, the articles

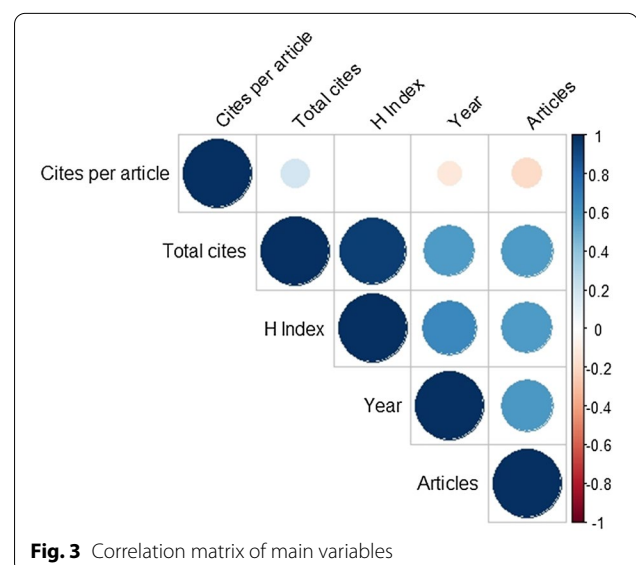


Fig. 3 Correlation matrix of main variables

variable is highly correlated with the total of citations, h-index, and years. In contrast, there is an inverse correlation with the variable cites per article and year.

In this work, the number of articles, citations, citations per article, and h-index, the most relevant countries, institutions, and authors are studied. The keywords are also taken into account in order to discover new lines of research. A database search has been carried out, filtering by topic in the title, the abstract, author keywords, and Keywords Plus. The search for the keywords was carried out using the terms: “blue economy” or “ocean economy” or “blue growth” or “maritime economy” or “marine economy.” In the next stage, 780 results were obtained, from which articles were filtered, leaving 499 articles to be processed and analyzed in the fourth stage. The results were then filtered to include only articles as many of them have been published in journals with an impact factor in Journal Citation Reports (JCR). This indicator is highly regarded and valued by organizations that evaluate research activity, guaranteeing a strict review process and high-quality results [32, 47, 82].

Lastly, once the document search was filtered to include only articles, the data were exported and processed using two tools: Vosviewer and Biblioshiny. In this way, clusters can be created by downloading information from the Web of Science database.

The VOSviewer program offers the basic functionality necessary to visualize bibliometric networks, citation links between publications, collaboration between researchers, and co-occurrence links between scientific terms [128]. According to a logical bibliometric workflow, the Bibliometrix tool, developed in the statistical and graphical language R, is also used to add weight to the study. R is highly extensible as it uses a functional, object-oriented programming language, and therefore it is relatively easy to automate parsing and create new functions. It is utilized to create graphs for three metrics at different levels: sources, authors, and documents, and analyzing knowledge structures at the conceptual, intellectual and social level [5] (Fig. 4).

Results

Descriptive analysis

Figure 5 represents a descriptive analysis of the terms ME, OE, BE, and BG, making a note of the chronological order of the articles when these concepts first appeared.

The first mention of ME appeared in 1979 in the article entitled “*Marine Economy of Poland 1945–1975*”. It addressed the growth of two port complexes located on the Polish Baltic Sea coast, Gdansk-Gdynia and Szczecin-Swinoujście, pointing to the important economic activities in the area such as the export of coal and coke, ships, minerals, cereals, gypsum, rolled steel products, wood,

cement, and food. It also pointed to tourism development along the coastal regions that required environmental protection [75]. Later, in 1992, the article “*The Intercolonial Railway, Freight Rates and The Maritime Economy in Canada*” stated that this infrastructure was a crucial piece in the history of MAE development and a transport link between the maritime islands and the center from Canada [31].

In 2004 the article “*Employment and Wages for the U.S. Ocean and Coastal Economy*” was published on the subject of OE and performed a preliminary analysis of the United States’ coastal and ocean economy between 1990 and 2001 to prepare coherent national estimates of economic values, based on economic and other measures related to the coasts and the oceans [27].

The article “*The Future of Blue Economy: Lessons for European Union*” marked the beginning of research on BE and made some preliminary considerations about the growing convergence of economic, social, technical, and environmental factors that contributed to generating new opportunities in the world’s oceans. Furthermore, thanks to the cooperation between European ocean industries and government institutions, together with the training of various experts, they became the epicenter of applying the European BE at sea [64].

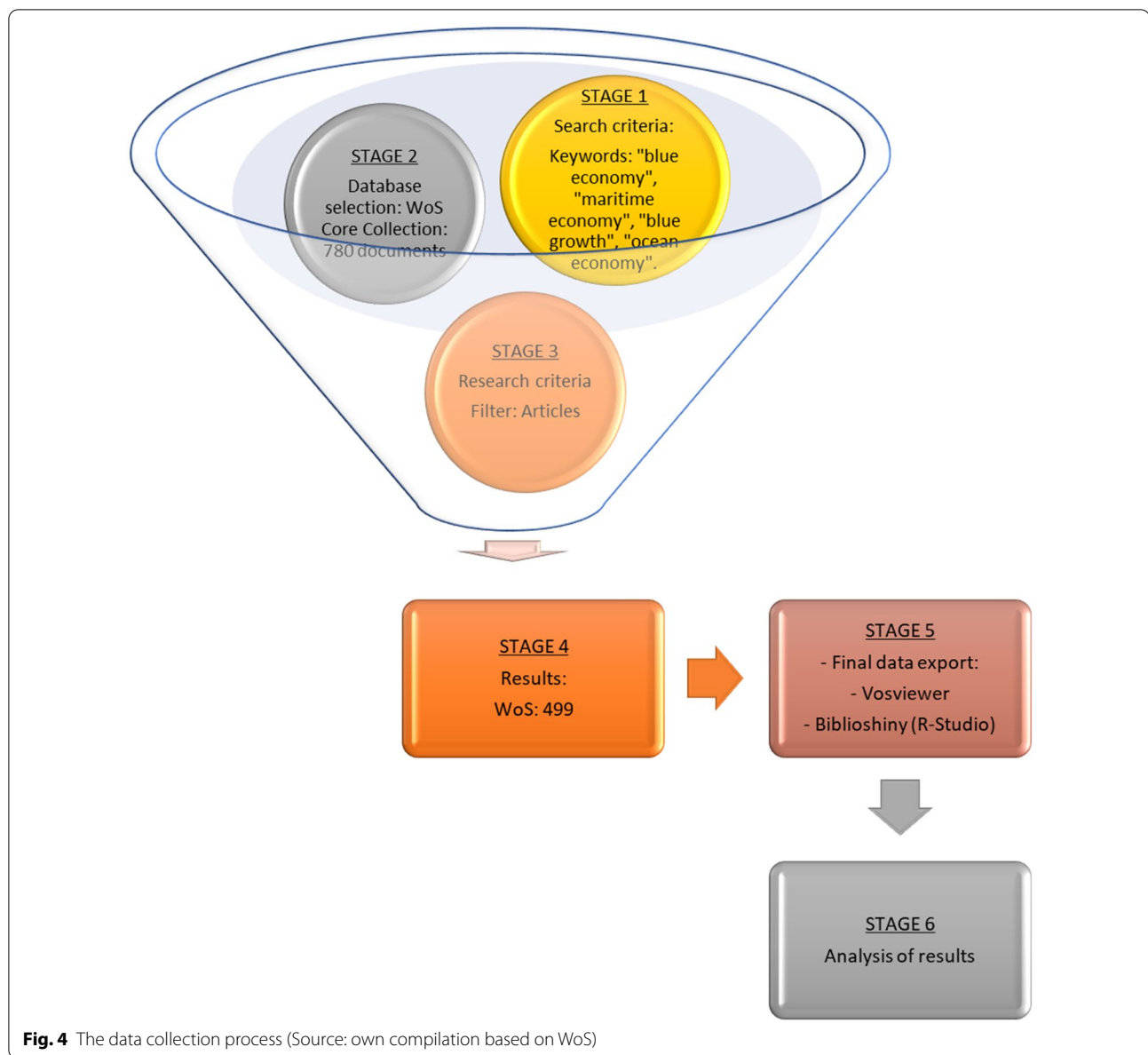
In 2013 the BG Strategy, “*Scenarios for Selected Maritime Economic Functions Union*,” appeared and examined the usages of the scenarios of the BG project. It aimed to develop the maritime dimension of the Europe 2020 strategy, with a 15-year horizon (2025–2030). In this regard, the scenarios were understood and developed in two ways: the micro-future scenarios and the general scenarios [136].

Scientific production analysis

Table 2 shows the evolution of scientific production in the period (2020–1979) by the number of articles, citations, citations per article (average), and the annual h-index.

In 2010, there was an increase in the number of articles and citations resulting from the article, “*The importance of estimating the contribution of the oceans to national economies*” by Kildow and McIlgorm [71]. The authors stated that the oceans were in trouble and experienced changes that could compromise life on both the sea and the land, affecting the economy and the environment.

The year 2018 stands out for the number of citations, reaching its maximum value of 531 (Fig. 6). The most cited article, “*Blue growth: savior or ocean grabbing?*” questions political proposals and places them within the framework of the broader debates on the neo-liberalization of nature [8]. Other authors with a high number of citations address BG, tracing its roots to the



conceptualization of sustainable development under the title “*What is blue growth? The semantics of “Sustainable Development” of marine environments*” [37]. The authors further manifest the complexity of ocean systems, combined with data and capacity constraints, demanding a pragmatic management approach [17].

The most cited articles closely related to the terms “BE, BG, ME, and OE,” in addition to the authors, journal, date of publication, and total citations, are listed in Table 3. Of note is the article by Silver et al. [118], with 89 citations, which addresses how BE became operational and how it was articulated in four factors: oceans as natural capital, good business, the integral part of the Pacific Small

Island Developing States (SIDS) and small-scale fisheries livelihoods. The second-ranked article by Kildow and McIlgorm [71] addresses the importance of knowing the oceans so that governments can have proactive behaviors in response to the demands of the population and nature in coastal and ocean environments. The third-ranked article, “*BG: savior or ocean grabbing?*”, critically addresses the political proposals, which fail to envision the problems of the environment and climate change.

The remaining articles address the marine sector’s role in the national economy, the concept of BG in the marine environment, the integrated maritime policy, and platforms for harvesting marine renewable energy.

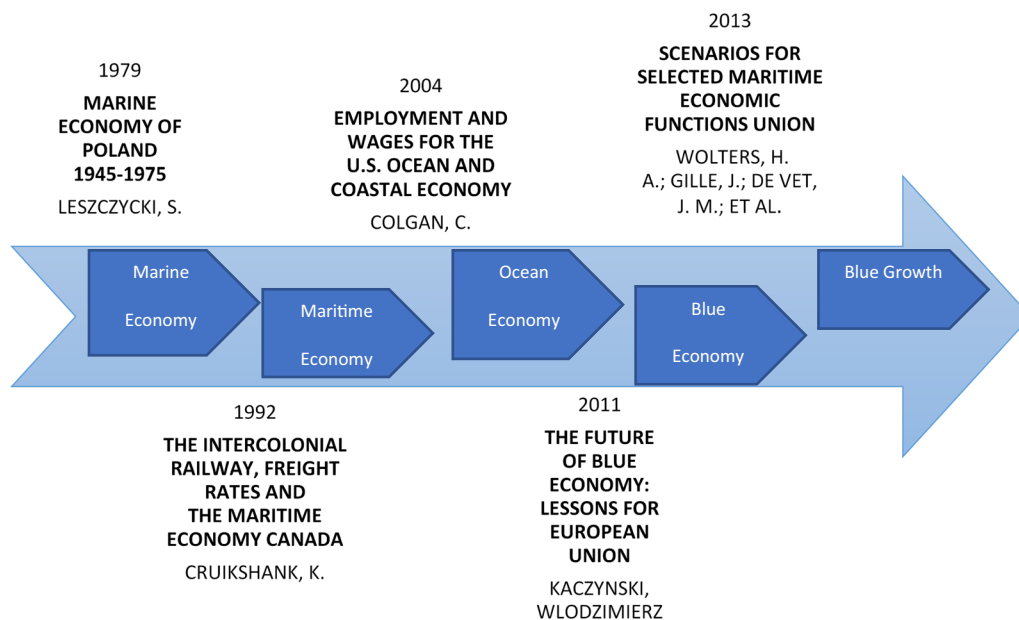


Fig. 5 Timeline of first published articles related to BE, BG, ME, and OE (Source: own compilation based on WoS data)

Table 2 Evolution in the number of articles, citations, average citations per article and h-index

WOS				
Year	Articles	Citations	Cites per article	h-index
1979	1	0	0.00	0
1992	2	22	11.00	2
1997	1	10	10.00	1
1998	2	156	78.00	1
1999	1	0	0.00	1
2001	1	7	7.00	1
2004	2	3	1.50	1
2006	1	7	7.00	1
2007	4	12	3.00	2
2008	3	8	2.67	1
2009	2	5	2.50	1
2010	9	116	12.89	5
2011	9	265	29.44	6
2012	7	100	14.29	5
2013	13	145	11.15	5
2014	26	315	12.12	10
2015	23	327	14.22	12
2016	41	377	9.20	12
2017	59	391	6.63	11
2018	104	531	5.11	12
2019	143	146	1.02	6
2020	37	5	0.14	1

Figure 7 depicts the authors and their links to scientific journals and the most representative keywords. In this instance, Morrissey, McIlgorm, Van der Burg, Morato, Bennett, and Soma have published the greatest volume of articles in *Marine Policy*, the scientific journal with the highest impact and the greatest number of relevant keywords.

Analysis of keywords

The keywords used in the article titles and abstracts are then analyzed according to their relevance and co-occurrence to create a co-occurrence map of all the terms used in the 499 selected articles (Fig. 8), using Vosviewer software. The minimum number of occurrences of a selected term is set at 25. Of the 12,858 terms found, 133 met the threshold and were included in the final analysis. From these results, a relevance score was calculated. The title and abstract fields were used to extract data. To extract the highest number of terms from the publications, the labels of the structured abstracts and the copyright statements are included.

An analysis of the results reveals that the most productive period, between 2016 and 2020, has produced the most relevant terms. The ten most relevant terms are linked to maritime spatial planning, China, ME, OE, economic development, efficiency, and coastal areas. The most current terms have to do with the marine industry and access. In this sense, due to the boom in emerging marine industries and the support of nation states for marine technology, many Chinese universities have

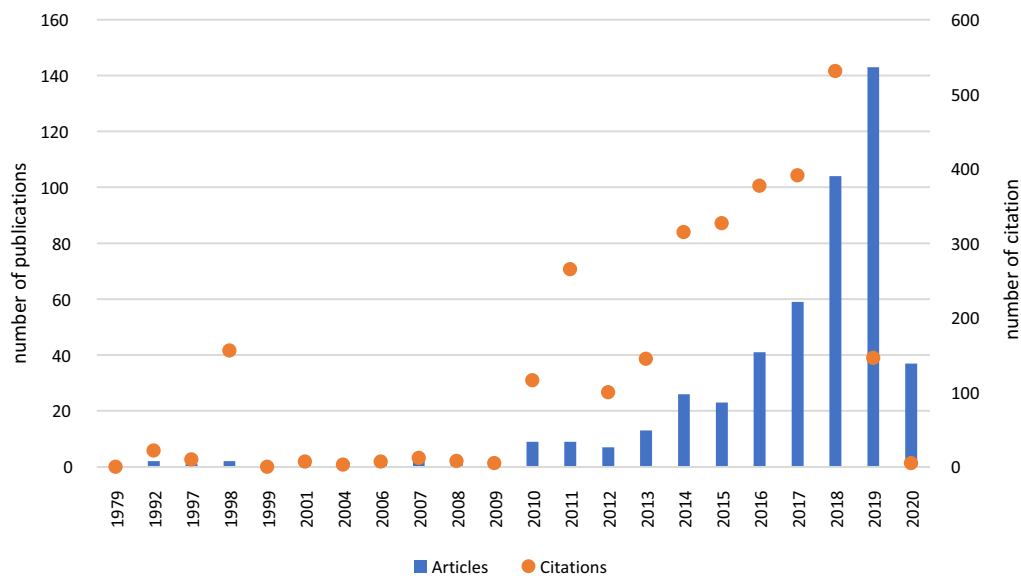


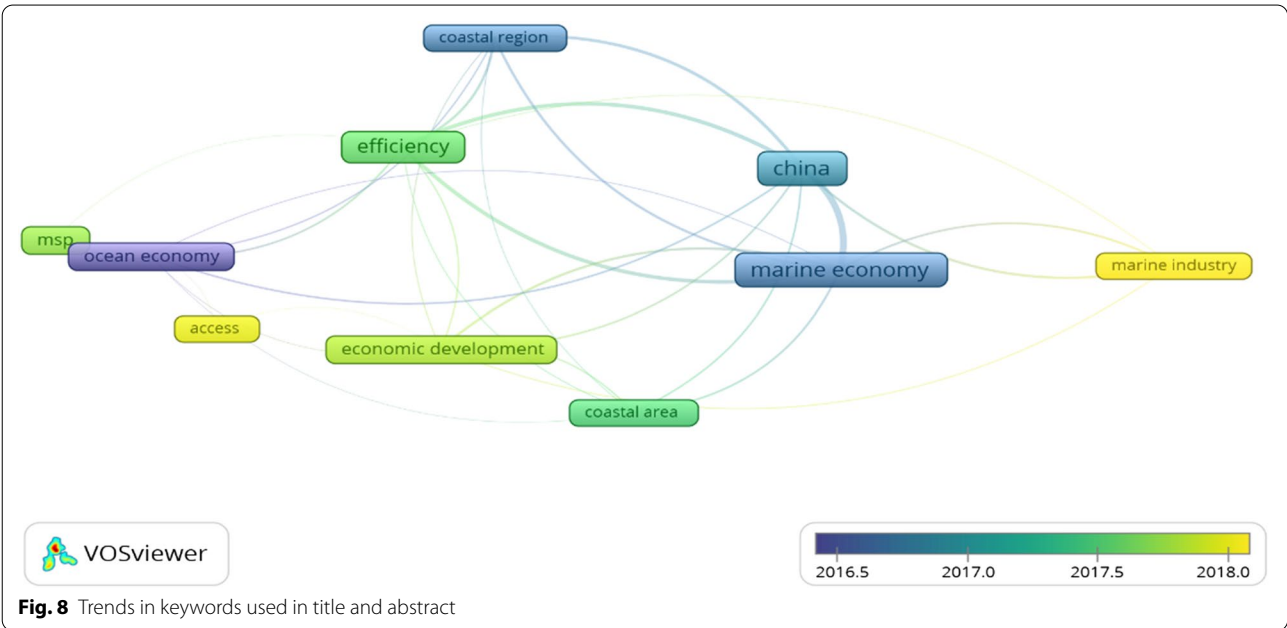
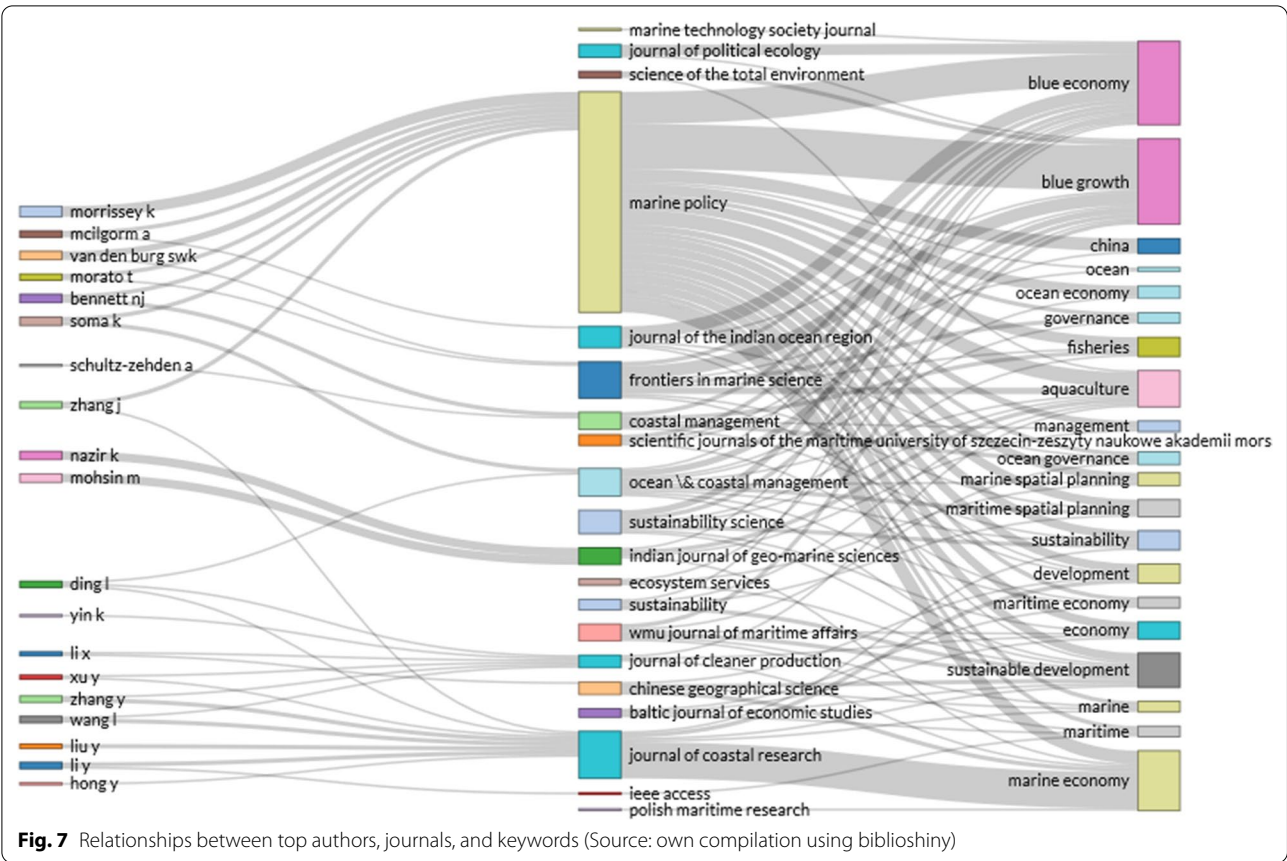
Fig. 6 Evolution in the number of publications and citations

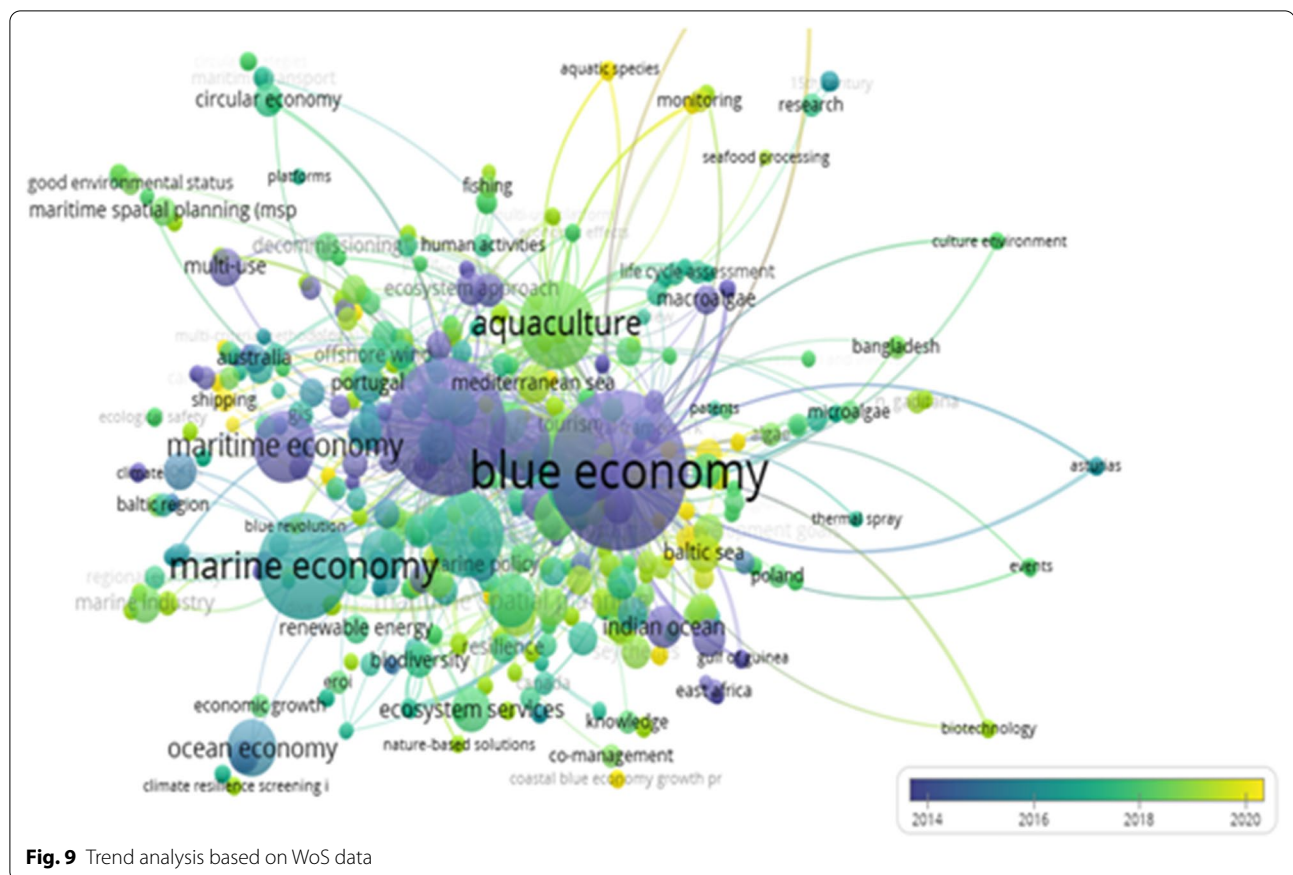
Table 3 Most cited articles

Articles (ordered by number of citations)	Authors	Journal title	Citations
BE and competing discourses in international oceans governance	Silver et al. [118]	Journal of Environment & Development	89
The importance of estimating the contribution of the oceans to national economies	Kildow and McIlgorm [71]	Marine Policy	66
BG: savior or ocean grabbing?	Barbesgaard [8]	Journal of Peasant Studies	62
The role of the marine sector in the Irish national economy: an input–output analysis	Morrissey and O'Donoghue [86]	Marine Policy	60
What is BG? the semantics of sustainable development of marine environments	Eikeset et al. [37]	Marine Policy	50
Assembling a BE moment? geographic engagement with globalizing biological–economic relations in multi-use marine environments	Winder et al. [135]	Dialogues in Human Geography	46
Quantifying the value of multi-sectoral marine commercial activity in Ireland	Morrissey et al. [87]	Marine Policy	42
The Spanish approach to marine spatial planning. marine strategy framework directive vs. EU integrated maritime policy	De Vivero and Mateos [34]	Marine Policy	42
A methodology for multi-criteria design of multi-use offshore platforms for marine renewable energy harvesting	Zanuttigh et al. [138]	Renewable Energy	41
Ecosystem-based marine management in European regional seas calls for nested governance structures and coordination—a policy brief	Raakjaer et al. [103]	Marine Policy	40

added specialties related to marine technology [76, 134]. This industry has become a significant growth engine for China's economic development [77]. Access refers to the exploitation of marine resources, coastal and fishing resources, spatial access to coastal communities, and the rights and property related to marine governance [2, 11, 69, 109].

An analysis of the keywords identifies the most used terms and the most current trends related to the new areas of the concepts studied. The trend analysis depicted in Fig. 9 uses a color scale that goes from blue to yellow and categorizes the terms used in this field of study from the least to the most innovative in the period studied. Trends linked to concepts such as small-scale fishing,





degrowth, aquatic species, biofuel, growth of the coastal BE, and internationalization are observed. These recent trends arising from the BE address the need to connect human and industrial activities that obtain their inputs from the sea by creating cooperative alliances at an international level, promoting sectors such as fishing, tourism, and energy. In addition, BE favors environmental sustainability since it uses renewable energy.

The growth of the coastal BE can be linked to the government of Taiwan [20, 116, 141], which proposes a growth program for the coastal BE at the national level to promote ocean-related industries based on sustainable development by integrating different theoretical frameworks, methodological approaches, modeling and management of ecosystem frameworks. In general, farming the sea is based on artificial technologies and it is argued that by developing marine fish farming, it is possible to contribute to the transformation of capture fisheries by integrating the concept of BE [24]. As for the term BD is understood as the need to address the dominance of the BG by seeking greater integration between society and the oceans [38]. This requires the withdrawal of specific activities currently in the hands of large corporations, ending the exploitation of localized production. It aims

the decommodification of labor and the recovery of the common goods to protect diversity. It is therefore necessary to make visible the risks of strategies based on economic development by suggesting a rethinking of the BE [52, 65]. In this sense, the decrease is intended to criticize the traditional ideas of growth and sustainability by promoting an equitable reduction in production and consumption, along with a socially transformative vision [22]. The role of biofuels in the BE is gaining momentum. The research of Kaşdoğan [66] examines algae-based biofuel production systems designed on the high seas and integrated with wastewater treatment and carbon dioxide absorption processes to revitalize faith in biofuels in the BE.

Discussion

Past research has addressed aspects of OE and ME from the perspective of the economic activities derived from the sea, specifically food catches, commercial transport, and the maritime industry [10, 68]. Subsequently, the sustainability approach within the MAE was included [140] along with the specific characteristics, the type of risk, and the uncertain areas of this economy [35, 46, 111] and

the continued development of integrated marine policies [21, 34].

Despite the tremendous potential of ensuring the oceans' sustainability, the growth of the BE presents some challenges. One of the most obvious obstacles is the lack of common and agreed-upon goals of BG. For some, BG revolves around maximizing economic growth derived from marine and aquatic resources [14, 57]. However, for others, it means maximizing "inclusive" economic growth derived from marine and aquatic resources [37, 54, 101, 120]. A real example of inclusion is in the Pacific Small Island Developing States (SIDS), which, like many developing countries, the issues of oceans, climate change, and energy are essential to poverty eradication. It is impossible to suppress poverty unless the health of ocean ecosystems is guaranteed and preserved as they are essential for food security, livelihoods, and economic [6]. Following the sustainability approach, the CE is building a strong emphasis on becoming a model that brings significant social, economic and environmental benefits [26].

The concepts of the "BE" and "BG" have been grouped together in a conceptual framework and are used as political discourse throughout the world as a way of representing the possible contribution to human well-being that both aquatic and marine spaces can make. Different interpretations of the concept of the BE are recognized. It is the very diverse definitions that generate a certain imprecision that allows the BE to encompass divergent visions and ideologies [25].

Fernández-Macho et al. [42] express the need to promote the BE to foster the progress and growth of maritime sectors, which can and should be sustainable. In this context, the development of integrated maritime policies is based on the belief that maritime zones can achieve higher growth rates, pointing out that the European Atlantic Arc could contribute to this BG.

Most activities related to the economic exploitation of the maritime environment carried out by humans do not conform to the notions of a "BE" since this economic exploitation does not often focus on a sustainable maritime environment [104]. Conflicts between sectors can emerge due to the nature of the resource itself (as it is a limited resource), its use and the commitment to develop efficient management of ocean resources, for example tourism versus offshore hydrocarbon extraction [72] or even within the same sector, with differences between the fishing fleet, fish farms and small-scale artisanal fisheries. Therefore, it is important to generate synergies between the different sectors that make up the BE in order to contribute to the economic development of the area and achieve the SDGs together, this being a local challenge (bottom-up strategy). Decisions could influence the sustainable growth of the BE in highly contested

regions because both companies and political authorities are influenced by economic interests and by stakeholders that have power in decision-making. This could result in sustainable growth having a stronger influence than the effects of climate change, making it a more flexible and adaptable approach to policymaking that considers changing economic, social, and environmental realities [56].

Coastal communities are directly affected by the BE and the effective management of ocean resources for BG. Although the term ocean economics is often promoted as something new, there are historical analogies that can provide insights for contemporary planning and implementation of BG [99]. In this sense, thanks to the use and treatment of raw materials of marine origin, such as macroalgae, their multiple uses are essential for the efficient recovery of marine biomass [100].

While the protection of marine areas is considered a fundamental part of mitigating climate change, on a practical level, its success is overshadowed by the current expansion of offshore drilling for oil and gas [15]. The prospects for growth in the OE are promising because ocean industries address issues such as food security, energy security, and climate change [139]. On the other hand, there are discrepancies regarding the legitimacy of the different sectors that make up the BE, specifically the industries with high carbon intensity and the emerging seabed mining industry [132]. Numerous authors warn of the danger of privatizing ocean spaces through the BE [13, 15, 109, 132].

Due to the current transformation of the oceans as places of integral industrialization, it is necessary to reflect on the experiences obtained from fishing and fisheries policies to understand and intervene in modernization processes and practices [4].

Another aspect to consider is climate change. Due to the negative consequences for coastal populations caused by rising sea levels, it is vital to develop defensive infrastructures. Since the turn of the century, the loss of landmass in the Greenland ice sheet has been accelerating [127]. It is a topic of great interest for both scientific research and public policy as sea level rise is influenced by regional and local factors, with coastal areas suffering the consequences of sea-level rise [3, 49, 50, 91, 115, 123].

Changes in the balance of surface mass, relative to changes in solid ice discharge, are vitally important across the Arctic areas and will continue in the future [84]. For example, the Netherlands, a region crisscrossed by large rivers such as the Rhine, Meuse, and Scheldt, is protected by a network of levees. Approximately 59% of its territory is at risk of flooding, 26% is under the sea level and 29% can flood if the rivers overflow. According to the commission that manages the Delta Plan, which addresses the

threat of water, a temperature increase of two degrees in the North Sea could mean a rise of between 1 and 2 m.

Scientific studies about New York City reveal that the sea level could rise by 2 m by 2100, endangering the survival of Manhattan, a threat for which the city is already taking measures [90]. In Florida, the effects of climate change are likely to include flooding associated with rising sea levels, increased invasive species, damage to coral reefs, and increasing frequency of damaging hurricanes. Tide levels along the US eastern seaboard of the United States during the past century were spatially variable, with the relative sea level rising more rapidly along the Mid-Atlantic Bay than along the Bay of the South Atlantic and the Gulf of Maine [97]. Other authors [73] state that rising sea levels, tides, extreme weather conditions, high temperatures, and ocean acidification present serious problems that could affect shipping, shipbuilding, the fishing industry, and coastal tourism and even compromise human health and labor-intensive production activities, such as the sea salt industry, sea fishing and the use of seawater.

In our view, there is a need to encourage international cooperation with countries with a lower HDI in aspects related to the BE, CE and BG through the transfer of knowledge, skills, experiences and technologies that will contribute to achieving the SDGs, bringing significant benefits to both the community and the environment.

Conclusions

The BE presents significant challenges at an economic, social, and environmental level, which is why the BG strategy is presented as the key piece of the puzzle to guarantee environmental sustainability and efficient management of the seas and oceans' resources. In this context, the SDGs imply that economic development is both inclusive and respectful of the environment, and it is necessary to find a balance between economic, social and environmental spaces. For example, one cannot consider eradicating poverty without guaranteeing the health of ocean ecosystems that are fundamental to food security, livelihoods, and economic development. Therefore, it is urgent to set goals with objectives and indicators that demand productive, healthy, and resilient oceans.

As analyzed, BE is a recent term rooted in sustainable development, so it needs more time for it to be adopted by all economic agents, politicians, and society in general. Thanks to the BG Strategy, it is possible to continue with economic activities arising from the seas and oceans in a more sustainable way that reduces the direct and indirect effects of its execution and minimize the negative impact on the ecosystem.

Regarding scientific production related to these concepts, there is a noticeable growing trend in the number

of articles published in journals with high impact factors, especially in the last decade, which is evidence of a growing interest in investigating these terms and this novel field. Although in practice, the BE has always been present in the economic activity and the political agenda of all the countries of the world.

Analysis of keyword trends shows the need to protect coastal areas and traditional activities against the marine industry. These include the urgent transformation of large farms, waste treatment, and a commitment to cleaner energy that respects maritime ecosystems. The oceans are recognized as being essential to sustaining life on Earth, and the overexploitation of their resources jeopardizes their ability to continue to provide food, economic benefits, and environmental services to society. Another critical issue is the role that community ecotourism plays within the dynamics of the BE since marine and coastal tourism constitutes one of the largest and fastest-growing segments of tourism. There are sustainability problems related to the marine tourism sector, especially in protected areas, which could be reduced if the BG strategy is further promoted.

The main conclusion of this research is that BE poses some fundamental conflicts of interest. On the one hand, some studies support growth and development, while others prioritize the protection of ocean resources. Thus, it is essential to harness resources and promoting renewable energies with the resources offered by the oceans and seas, create alliances with different stakeholders, unite efforts, and find common elements to continue with the BG, taking into account each community's problems and constituting a significant global challenge.

One of the limitations of this study is the difficulty in measuring the impacts of economic activity and therefore quantifying the environmental impacts. Therefore, it would be interesting to carry out studies that can provide solid arguments to support it [85, 122].

Possible future lines of research on the BE could focus on incorporating this model of the CE since few articles have addressed this aspect jointly. The relationship between BE and CE should go beyond addressing the issue of global marine waste, renewable energy and climate change but rather be an integrated part of the BG strategy, the circular BG strategy in a broader sense: new components and more respectful treatments, less polluting marine minerals, sustainable management and the equitable distribution of marine resources. Regarding the political agenda, there should be specific lines of financing that support research into the CE and sectors of the BE. Together, the two must be integrated to achieve more efficient and sustainable results.

New researchers, experts, public institutions, and private companies who wish to understand the roots of the

BE and its evolution over time may find this article useful to design and develop strategies that lead to its efficient management, preservation, and sustainability.

Abbreviations

BCs: Bilateral contracts; BE: Blue Economy; BD: Blue degrowth; BG: Blue growth; CE: Circular economy; ESS: Energy storage systems; HDI: Human Development Index; MAE: Maritime economy; ME: Marine economy; MTs: Micro-turbines; OE: Ocean economy; PV: Photovoltaic systems; SDGs: Sustainable development goals; WT: Wind turbines.

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Authors' contributions

Conceptualization: RMMV, JMG and JDPV; methodology: RMMV, JMG and JDPV; software: RMMV, JMG and JDPV; validation: RMMV, JMG and JDPV; formal analysis: RMMV, JMG and JDPV; investigation: RMMV, JMG and JDPV; resources: RMMV, JMG and JDPV; writing—original draft preparation: RMMV, JMG and JDPV. All authors have agreed to the published version of the manuscript. All authors read and approved the final manuscript.

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