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Blue economy and the total environment: Mapping the interface

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ABSTRACT

The term 'Blue Economy (BE)' is increasingly popular in modern environmental research. The concept seeks to explore ocean-based development opportunities with environmental stewardship and protection. Yet different scholars and actors adopt this term often in conflicting ways without attempting to explore the relevance and the link between the blue economy and the broader environment viz., total environment. The potential opportunities to resolve the conflicts require a better understanding of the impacts and/or interactions of the BE on the total environment. This paper aims to map the interface between the two for a better understanding of the total environment and implications for the BE. Using a systematic literature review, this study finds that the field of the blue economy in association with the total environment is very new and emerging in the literature, and the link between the BE and the total environment is increasingly being invoked, yet clarity on the link or interactions remain vague. By analysing the co-occurrence of selected keywords and networks, we present six clusters (three for general relationship, and the other three for specific dimensions of total environment). In a general relationship between the BE and the total environment, clusters of environmental sustainability, marine resource, and economic development are identified to link directly to the BE. In specific dimensions of the total environment, clusters of growth and sustainable development, spatial planning and environmental management, and environmental sustainability and the BE are presented. The analysis outcomes show that specific areas from the total environment (growth, spatial planning, environmental management, and environmental sustainability) are directly linked to the BE where a call for a wider range of studies in the future is identified.

1. Introduction

From the inception of the Environment International (EI) in 1978, the journal has set the boundary for the total environment to include the atmosphere, lithosphere, hydrosphere, biosphere, and anthroposphere. Over the six decades, EI has been well placed as a premier journal in scientific research to advance our understanding and knowledge on the interconnections of multiple spheres under the total environment and interactions between the total environment and humans. One of the emerging movements in the global society is the Ocean Decade. The United Nations' Ocean Decade of Ocean Science for Sustainable Development commenced on 1st January 2021. Since the concept of 'Blue Economy (BE)' has been originated from the United Nations Conference on Sustainable Development in 2012 (UNCTAD, 2014), scientists, governments, international organisations, and NGOs used this concept different ways and interchangeably with ocean economy or marine economy. More recently, the United Nations' declaration on the 'Decade of Ocean Science for Sustainable Development (2021 to 2030)' seeks to support ocean health and gather ocean stakeholders worldwide to develop a common framework for the blue economy (Lee et al., 2020). As many scientists (e.g., Ehlers, 2016; Winder and Le Heron, 2017; Ahmed and Thompson, 2019; Schupp et al., 2019; Lee et al., 2020) expect the Ocean Decade will provide an opportunity for interactions and/or interconnections of multiple environments to tackle global ocean and sustainability challenges, we aim to explore the connections and interactions between the blue economy and a broad range of total environment to map the interface.

The primary motivations we focus on in the blue economy are twofold. First, the Blue Economy has been widely advocated to safeguard the world's oceans and water resources (AIMS, 2018; Lee et al., 2020). As the world oceans provide critical resources for human health, energy production, and economic prosperity, the BE should be sustainable. According to the World Bank (2017), the BE is defined as "the sustainable use of ocean resources for economic growth, improved

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livelihoods, and jobs, while preserving the healthy ocean ecosystem (2017, p.6). Despite the importance of the BE in our society, we know very little about the interactions and/or interconnections between the BE and the range of multiple environments (i.e., total environment). The lack of understanding of the link between the BE and the total environment may hinder achieving the BE's goals above defined by the World Bank.

Second, the BE holds the inherent conflicts between growth/development and protection of ocean resources. Without resolving the inherent conflicts, the BE cannot be sustainable (Ehlers, 2016; Burgess et al., 2018; Keen et al., 2018; Voyer et al., 2018). The potential opportunities to resolve the conflicts require a better understanding of the impacts and/or interactions of the BE on the total environment. Mapping the interface between the two will contribute to a better understanding of the total environment and implications for the BE. In particular, linking the BE to the total environment is not easy, but challenging, especially when there are certain levels of conflicts between individual or industrial (even regional or global scales) interests such as carbon emission reductions and renewable energy provision. However, the identification of the scopes, intersections between the BE and the total environment is vague.

Based on the EI and two leading environmental science journals' (Science of The Total Environment, Environmental Science and Technology) boundary of the total environment, we adopted five environmental spheres including the atmosphere, hydrosphere, biosphere, lithosphere, and anthroposphere. The atmosphere includes the greenhouse effect and climate change. The hydrosphere includes freshwater, wastewater, and evaporation. The biosphere includes species/diversity and terrestrial biomes while the lithosphere includes soil and landforms. Finally, the anthroposphere which is human-made for human activities includes artificially-built environments, technology, social culture, and associated activities. In order to set the areas of investigation, we describe the link between the BE and the total environment as follows.

BE and the atmosphere: The relationship between the BE and the atmosphere is straightforward and strongly linked to the ocean, air pollution, and greenhouse effect. One of the most evident impacts resulting from human economic activity is the increase of atmospheric CO_2 mainly due to industrial production and consumption activities. Increased economic activity, industrial production, and resource use contribute directly and indirectly to climate change, and as a result, make our economy and environment vulnerable.

BE and hydrosphere: The ocean provides a plethora of water resources and development opportunities, while water resource scarcity requires a comprehensive and appropriate approach to protect water resources and efficient use of them. The relationship between the BE and the hydrosphere has a strong link to water pollution and water resource development. Industries such as aquaculture and renewable ocean energy benefit from water resources. However, some environmentally harmful by-products like water pollution due to industrial activities seem inevitable.

BE and lithosphere: The link between the BE and the lithosphere is brought on by human and industrial activities in environmental modifications, such as oil and gas extraction in oceans. Lithosphere extractivism results in erosion and deposition, rapid changes to the ecosystems, ecological stress leading to habitat destruction. The scalable BE application to the lithosphere may reduce the risks of a decrease in natural habitats in oceans.

BE and biosphere: Traditionally the biosphere surrounding human and industrial activities is inherently fragile. Human exploitation on the biosphere has been criticised for many years, and many researchers call for concrete actions to consider the interdependencies of humans, animals, and ecosystems. The link between the BE and biosphere is directly related to identifying the interdependent association between these. In particular, the BE aims to achieve the sustainable use of marine resources to protect biodiversity, and the detailed interactions and/or interdependencies of humans, animals, and ecosystems will help achieve the goals of BE.

BE and anthroposphere: The link between the BE and the anthroposphere is diverse and complex as biological and socio, technical, economic and cultural interactions mutually influence each other over time. As an individual, group and/or societal decision making body at local, regional, national and global levels, contribution to the development of the BE, engaging with multi-decision making groups at multi-levels is an important approach to capture the interconnections across human agents ranging from individuals to global organisations, in order to identify the link between the BE and the anthroposphere.

Based on five links between the BE and the total environment, this research seeks to address a comprehensive literature map across different areas and disciplines to interface between the two and provides some evidence and directions for key areas of development and future studies. The rest of this paper is organized as follows. Section 2 describes the research methodology used in this study. Section 3 provides an overview of the general findings. Section 4 presents the results and findings from the co-occurrence and cluster analyses, followed by the conclusion.

2. Research methodology

The objective of this study was to explore the connections and interactions between the blue economy and a broad range of total environments and to map the interface between them. A systematic review, described as a research method, attempts to collate all empirical evidence that fits pre-specified eligibility criteria to answer a specific research question or purpose (Higgins and Green, 2008). We took a three-step process to conduct a systematic literature review: (1) identification of literature via database; (2) screening of the identified literature to ensure appropriateness for the research purpose of this study; and (3) eligibility assessment in which pre-specified eligibility criteria had to be satisfied being included in the subsequent analysis. These steps are described in detail below.

2.1. Identification of literature

All of the relevant literature was identified through an initial search. This was conducted by searching databases with the search terms (keywords). We used the Scopus database to search and extract scientific and academic publications. While there were other databases of scientific literature (e.g., Web of Science and Google Scholar), Scopus was recognized to be highly useful for bibliometric analysis as it contains a large volume of peer-reviewed articles from various scientific fields (Nascimento and Rodrigues, 2015). In order to make a comprehensive literature identification, we followed a criterion as mentioned below:

- Database: Scopus (www.scopus.com)
- Search conditions:
  - English-language journals limited
  - Peer-reviewed journals only (excluding books, book chapters, conference proceedings, policy reports, and consulting reports)
  - Time period: 2000–2020 (20 years)
- Search strings:
  - Approach I: "blue economy" AND ("total environment" OR "environment")
  - Approach II: "blue economy" AND (("atmosphere" OR "climate") OR ("hydrosphere" OR "river" OR "estuary" OR "ocean") OR ("biosphere" OR "ecosystem") OR ("lithosphere" OR "land" OR "soil") OR ("anthroposphere" OR "community" OR "human"))

Based on the above search conditions, we searched keywords within the title, abstract, and keywords fields in the peer-reviewed English journals, and repeated the search for the two strings. Since the terms of singular and plural forms are used interchangeably in the literature, we included both in our keyword search. Particular attention was given to

studies that investigated the relationship between the blue economy and the five spheres: atmosphere, hydrosphere, biosphere, lithosphere, and anthroposphere of the total environment.

The initial search yielded 490 documents (145 in Approach I and 345 in Approach II), after being filtered by year, source type, and language, namely, subject area limited to English-language and peer-reviewed journals during 2000–2020 (Fig. 1). Then, a scope of document types including article, review, short survey, note, editorial, conference paper, policy and consulting reports, and data papers selected for inclusion in the systematic review went through several stages of eligibility assessment. Finally, a total of 321 documents, 94 in Approach I (Table S1) and 227 in Approach II (Table S2), were sorted and included in the quantitative bibliometric analysis.

2.2. Data analysis

The database analysed for the present study consisted of bibliographic information providing features of the 321 Scopus-indexed documents. These 'meta-data' included authors, journal titles, publication years, author's affiliations and territories, and subject area-related documents. Statistical descriptions were used to evaluate trends in temporal growth, geographical and national interests in the BE literature.

Bibliometric analyses based on author and index keywords conducted in VOSviewer software (Van Eck and Waltman, 2014) were employed to scrutinize interrelation and patterns of knowledge production between the BE literature and the total environment. To avoid the use of interchangeable keywords and provide succinct network graphics, we combined similar keywords into one for each, as well as, all plural forms were changed into singular forms (Fig. 1). Co-occurrence analysis was employed to analyse networks in respect of the intellectual structure and terminological interrelation, that have evolved in this knowledge base (Udomsap and Hallinger, 2020). Minimum five-times occurred keywords were selected and analyzed for the network analysis; as a result, 27 keywords in 836 of the total in Approach I (Table S3) and 56 keywords in 1547 of the total in Approach II (Table S4) meet the threshold, respectively.

When certain keywords occurred 'several times' in multiple documents, they led to the number of publications in which these keywords occur together in the title, abstract, and keyword list of documents in the present review. In addition, when two keywords are frequently 'co-occurred together' in the searching fields, they (viz., link strength) link strongly to each other. To visualize a network, the relatively different size of each node-assigned keyword expressed that a keyword in a bigger node indicated a more occurred one in the whole network compared to a smaller one. Also, link strength was expressed as the relative width of the line width in the network structure. Altogether, occurrences, link strength to the BE, and total link strength of keywords were analysed and organized using cluster analysis; they were clustered into three groups for Approach I and II, respectively.

3. Overview of the blue economy and the total environment

In this section, we describe the distribution characteristics of two approaches (Approach I and II) in search terms. The findings contribute to a better understanding of the global research contribution, publication development process, and peer-reviewed journal coverage, as well as highlighting the popular topics and areas of the field overall.

3.1. General description

Fig. 2 describes the historical development of the research and geographical location of each author's organization that has contributed to the blue economy and the total environment research. Approach I (n = 94) captures the general relationship between the blue economy and the total environment (or environment). Fig. 2 illustrates that the research area is a relatively new and emerging field to study and that notably scholars from the UK, the US, and Australia publish actively in the field. The subject areas also indicate the wide range of disciplines encompassing environmental science, social science, agricultural and biological science, earth and planetary science, and economics and finance. Although, the field of the blue economy and the total environment is a complex and challenging area it also offers new opportunities for global sustainable development challenges such as climate change, biodiversity, and health.

Approach II also shows similar trends and distributions from Approach I. With a large number of publications (n = 227), Approach II provides solid evidence to demonstrate the association between the blue

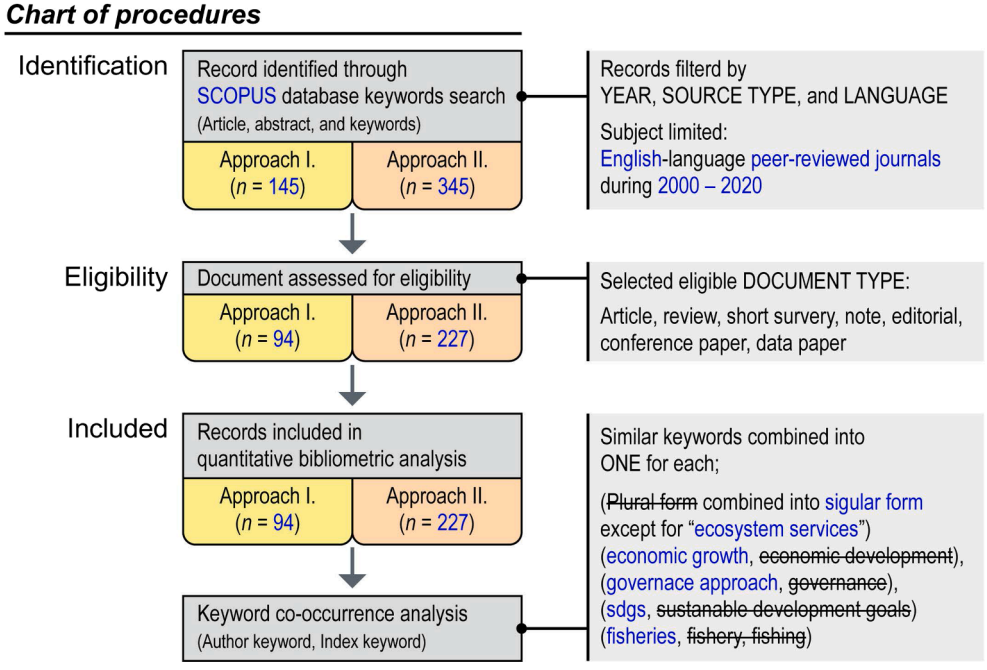

Fig. 1. Research flow chart of procedures used in the identification of sources for the Approach I and II in the present study.

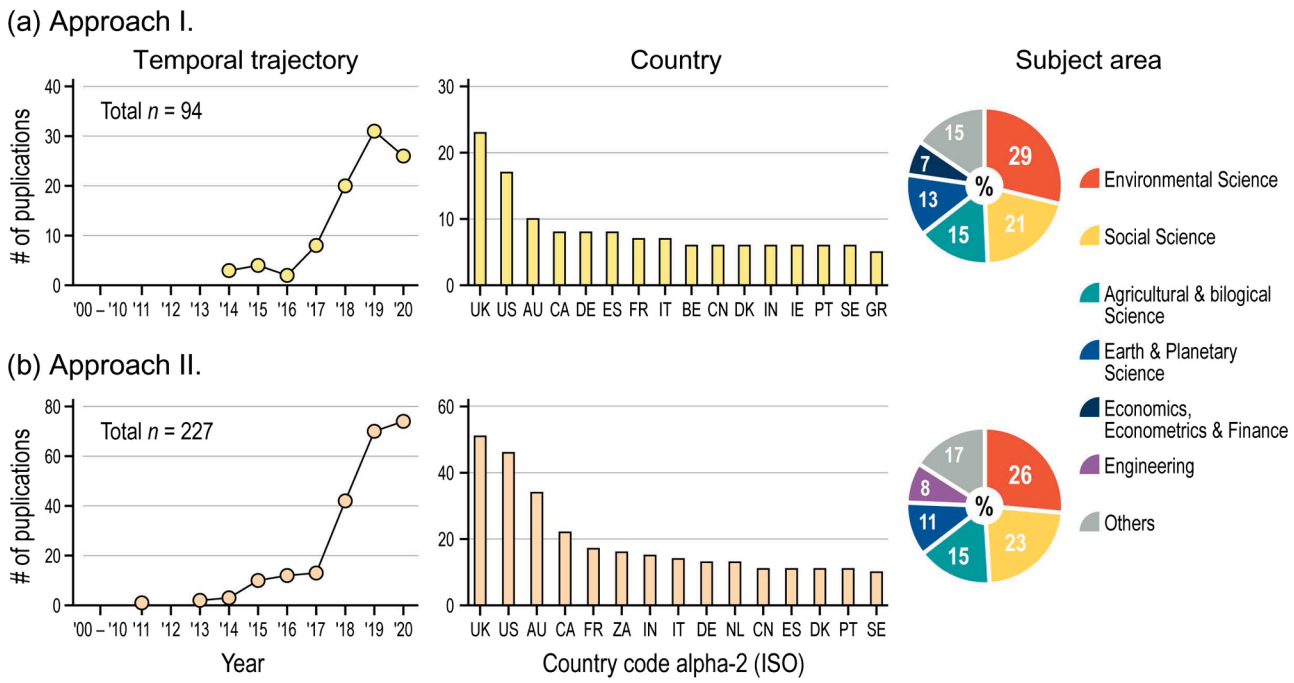

Fig. 2. The temporal trajectory, global distribution, subject area of publications from (a) Approach I and (b) II analysed in the present study. Countries in global distribution show more than 5 and 10 publications in the Approach I and II, respectively. All data collected from Scopus search (www.scopus.com).

economy and five areas of the total environment. Notably, both disciplines of environmental science and social science are leading disciplines to explore the specific relationship between the blue economy and each dimension of the total environment.

Recently, an increasing number of scholars have published papers on the blue economy and the total environment. Table 1 presents the summary of papers distribution in the top fifteen journals. In terms of the number of publication documents, the journal *Science of The Total Environment* was placed on the top as number one. However, the emerging field of the blue economy in association with the total environment is very novel in the journal. Similar trends are also found in IEEE Access and Sustainability journals. Notably, the journal *Marine Policy* published a high number of papers in the field. It is not surprising to see that Marine Policy has more focus on the ocean and marine-related research.

Although the blue or ocean economy has been researched for over sixty years and across countries in the world, the sea has traditionally been the driver for the economy, and research on its link to the broader environment (or total environment) has been limited (Katila et al., 2019). Despite the emerging interests and research on the blue economy and the link between the BE and the total environment is increasingly being invoked, yet the clarity on the link or interactions remains vague.

4. Findings and analysis

In the Approach I, we aim to understand the relevance and association of BE in the total environment field and assess major networks to significantly related study topics (i.e., co-occurrence keywords). While, in the Approach II, we tried to explore key links of BE to environmental boundaries and/or territories such as atmosphere, hydrosphere, lithosphere, biosphere, and anthroposphere. In particular, Approach II aims to address how the BE is being a subject and associated with any key topics in the varying environmental fields.

Table.1
Summary of the most productive journals by sample (Top 15 journals).

No.	Journal title	Number of documents				Journal statistics			
		Total	App. 1	App. 2		IF-1999	IF-2019	C/D (3 yrs)	H-index
1	Science of The Total Environment	41,099	2	3		1.126	6.551	7.102	224
2	IEEE Access	40,691	2	1		–	3.745	5.302	86
3	Sustainability (Switzerland)	28,713	2	3		–	2.576	3.109	68
4	Journal of Coastal Research	9,319	4	4		0.464	0.793	0.994	84
5	Marine Policy	4,952	14	27		0.679	3.228	3.593	86
6	Ocean and Coastal Management	3,551	4	5		0.272	2.482	3.023	77
7	Frontiers in Marine Science	3,379	6	20		–	3.661	3.819	38
8	Marine Technology Society Journal	1,960	1	6		0.164	0.619	1.046	40
9	Coastal Management	985	1	4		0.711	1.547	1.587	46
10	Sustainability Science	826	2	6		–	5.301	5.293	48
11	Dialogues in Human Geography	486	4	5		–	10.231	3.561	25
12	Journal of Political Ecology	313	4	7		–	1.747	1.747	19
13	Journal of The Indian Ocean Region	206	1	17		–	0.709	0.709	10
14	Journal of Operational Oceanography	187	2	3		–	4.040	3.313	24
15	Maritime Affairs	118	–	6		–	0.537	0.537	4
	Subtotal	**136,785**	**49**	**117**	***Mean***	**0.569**	**3.184**	**2.982**	**59**

4.1. Co-occurrence of keywords

Co-occurrence refers to the issue that two keywords are used jointly in publications. Figs. 3 and 4 present the keywords co-occurrence network, which includes 27 nodes and 234 links and 56 nodes and 799 links, respectively. The node size in a keywords co-occurrence network indicates the frequency with a specific keyword occurs and the line width between the two keywords indicate the co-occurrence in the searching fields such as title abstract and keyword list of the publications. Keywords in the top 10 link strength to the BE in Approach I include "marine environment" (frequency = 27), "sustainable development" (frequency = 12), "sustainability" (frequency = 10), "economic growth" (frequency = 9), "governance approach" (frequency = 7), "fisheries" (frequency = 7), "environmental management" (frequency = 6), "marine spatial planning" (frequency = 6), "marine resource" (frequency = 6), and "spatial planning" (frequency = 37). Similarly, in Approach II, include "marine environment" (frequency = 26), "sustainable development" (frequency = 23), "sustainability" (frequency = 23), "economic growth" (frequency = 16), "governace" (frequency = 15), "blue growth" (frequency = 13), "fishery management" (frequency = 11), "spatial planning" (frequency = 10), "marine spatial planning" (frequency = 10), and "environmental economics (frequency = 10)". The above strongly BE-linked keywords, which also occurred frequently, have played a pivotal role in the whole network.

4.2. The keyword cluster analysis for mapping

In a cluster analysis, information is collected and different subgroups are derived to represent the structure of the research themes. Based on their co-occurrence and researchers' evaluation, the relationships among keywords (terms) and categorisation of the keywords (terms) are made into different clusters. Our keywords maps for the BE and the total environment show that these domains have in common the presence of clusters related to environmental sustainability and economic growth. Comparing the keywords maps for Approach I and II, we can see the differences and inter-linkages of the BE and the total environment. Despite the noticeable overlaps between the keywords maps between Approach I and II, topical and thematic dimensions of the total environment show key groups of the research map.

In Approach I, three groups are identified below:

4.2.1. Cluster Group A: Environmental sustainability and blue economy

The concept of BE has a general economy attribute to revitalize the marine industrial activities including construction, transportation, mineral resources development, shipbuilding and ocean renewable energy development. Importantly, the BE needs compliance with Sustainable Development Goal 14, with the focus on conservation and sustainable use of the oceans, seas, and marine resources. The core is to balance of environmental sustainability and an ocean-based economy (i.e., BE).

4.2.2. Cluster Group B: Marine resource and blue economy

Since the BE addresses ocean's resources directly, the concept of BE captures sustainable and responsible use of marine resources for economic activities. Even the blue economy can be seen as 'a group of interconnected industries', as the BE sectors and actors engage and interact with each other. The economic activities of the BE cover all aspects of the marine, maritime and coastal regions that have a direct or indirect impact on the economy (Wenhai et al., 2019). The challenge of measuring and accounting for the economic value of the marine resources is also addressed in blue economy to recognize the importance of measurable benefits from oceans, in particular marine resources (Barbier et al., 2011; Jobstvogt et al., 2014; Silver et al., 2015).

4.2.3. Cluster Group C: Economic development and blue economy

The ocean has traditionally been the driver for economic development. About 90% of world trade is transported by sea, and about 155 million tonnes of seafood are produced and consumed each year. The blue economy activities have a range of economic activities from shipping, shipbuilding and tourism to offshore oil and gas, renewable energies, to desalination, etc. contributing approximately 2.5% to the world's output in 2010 and employing around 31 million people (OECD,

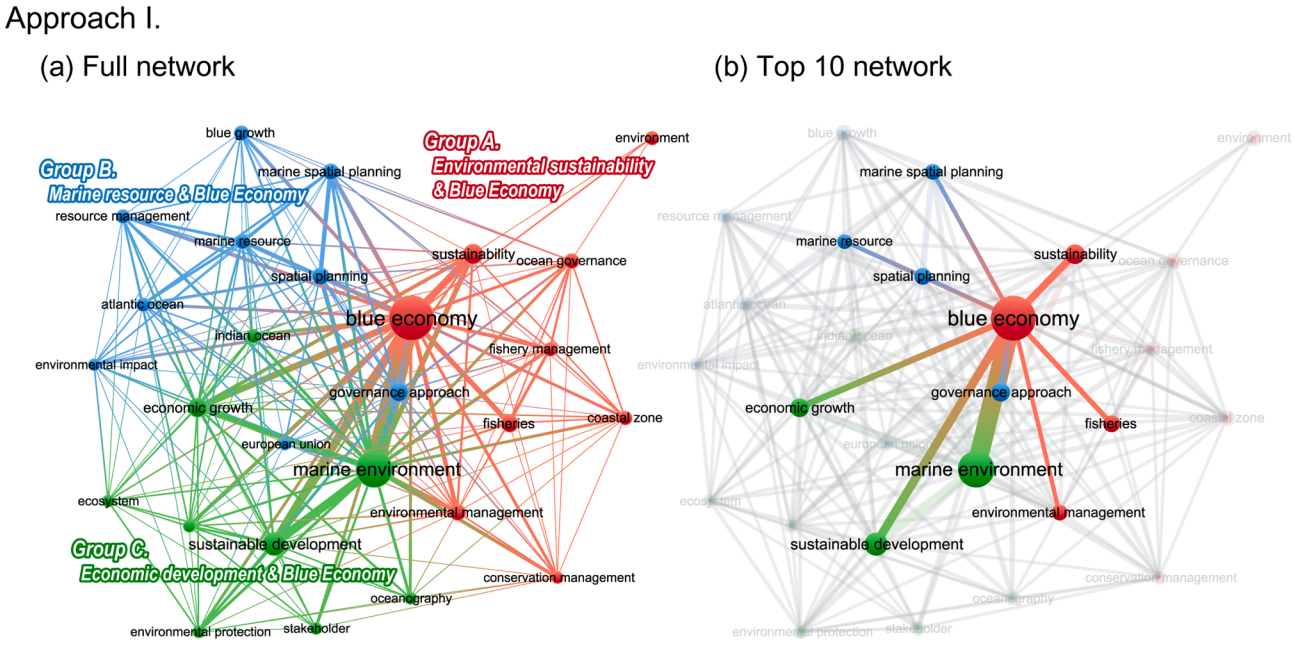

Fig. 3. Keyword network in the literature based on co-occurrence analysis from Approach I in the present study. (a) Total 234 links of whole network, threshold of 5 occurrences with display of 27 nodes in three groups; A–C groups in red, blue, and green, respectively). Size of node refers to frequency of occurrences in references of the review documents; proximity (line width) refers to frequency with which two keywords have been co-occurred; colour refers groups from cluster analysis of keywords based on patterns of co-occurrence in the review documents. (b) Network showing top 10 keywords (link strength) linked to "Blue Economy" highlighted. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

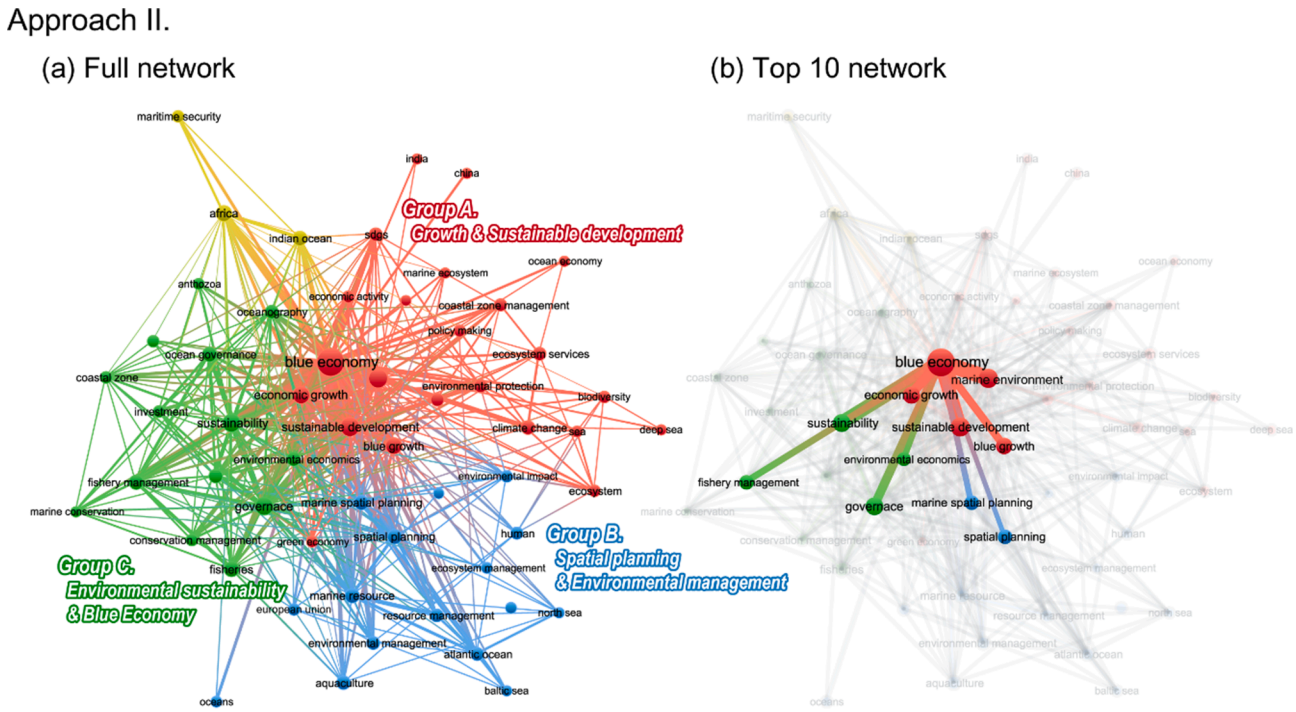

Fig. 4. Keyword network in the literature based on co-occurrence analysis from Approach II in the present study. (a) Total 799 links of whole network (only top 400 links drawn), threshold of 5 occurrences with display of 56 nodes in four groups; A–C groups in red, blue, and green, respectively with others in yellow). Size of node refers to frequency of occurrences in references of the review documents; proximity (line width) refers to frequency with which two keywords have been co-occurred; colour refers groups from cluster analysis of keywords based on patterns of co-occurrence in the review documents. (b) Network showing top 10 keywords (link strength) linked to "Blue Economy" highlighted. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2016). According to the OECD (2016), the gross value added (GVA) of the global blue economy in 2010 was USD 1.5 trillion, contributing 2.5% to the GVA, and employing about 31 million full-time employees. GVA distribution across blue economy sectors include offshore oil and gas (34%), maritime and coastal tourism (26%), port activities (13%), and maritime equivalent (11%). As observed, the blue economy as 'a cluster of interconnected industries', and therefore, understanding the interactions between blue economy sectors helps to not only evaluate their performance but also to foster economic development. Fig. 5 shows the summary of three groups based on the top 10 keywords correspondence.

In Approach II, the following three groups are identified as mentioned below:

4.2.4. *Cluster Group A: Growth and sustainable development*

The term 'Blue Economy' refers to the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health (The World Bank, 2017). Competition for ocean space and access to its resources is rapidly increasing (Hodgson et al., 2019). The ocean economy has a long history of resource extraction and exploitation (Bugnot et al., 2021). As a result, interactions between

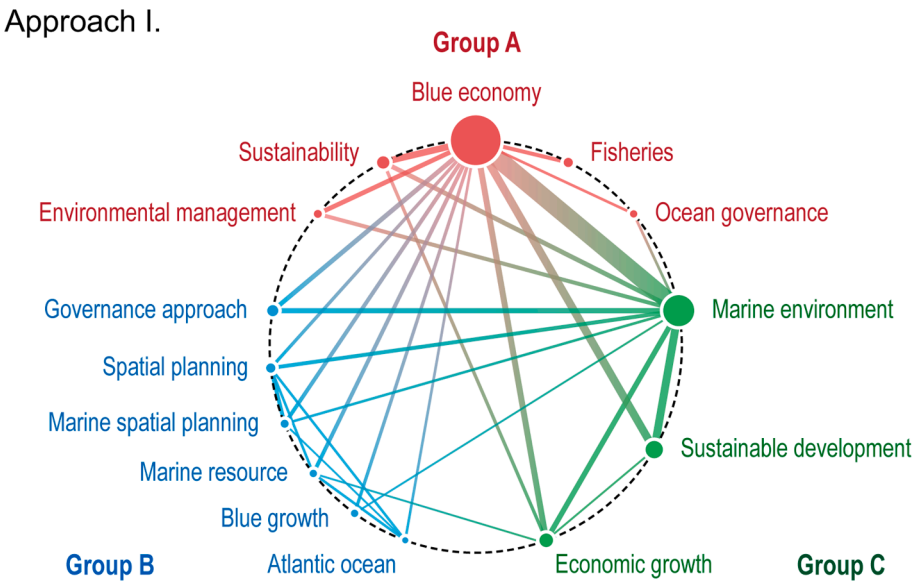

Fig. 5. Keywords corresponding to the top 10 in "occurrence" or "link strength to Blue Economy" collected from the Approach I in the present study. Size of node refers to frequency of occurrences in references of the review documents; proximity (line width) refers to frequency with which two keywords have been co-occurred; colour refers groups from cluster analysis in Fig. 3. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

economic growth and sensitive environments potentially create trade-offs among the triple-bottom-line of social, economic, and environmental outcomes. Some challenges for the BE activities have been identified, such as overexploitation of the ocean, pollution, habitat degradation, climate change, competing development objectives, lack of collaboration, managing the ecosystem, lack of awareness and knowledge, limited technical and human capacity and resources including financial resources, insufficient governance, and regulation. The growth of Blue Economy needs be in line with the UN's Sustainable Development Goal 14 with managing the ocean as an essential global natural resource for a sustainable future.

4.2.5. *Cluster Group B: Spatial planning and environmental management*

Spatial planning is commonly identified as directly linked with environmental management from the network analysis. Primary purposes of spatial planning include identifying and assessing ecological, environmental, and operational suitability for resource utilisation, and assessing operational (cumulative) effects and trade-offs, with the goal of adaptively monitoring and improving environmental sustainability outcomes. As efficient spatial planning relies on accurate information from diverse sources tailored to address specific planning objectives, many scholars and researchers utilise spatial static tools, which often involve geographic information system (GIS), to overlay environmental attributes, fishery areas, habitats distributions, marine protected areas, threats or conflicts to inform marine spatial planning (Yates et al., 2015; Schupp et al., 2019; Falconer et al., 2020).

4.2.6. *Cluster Group C: Environmental sustainability and blue economy*

The BE activities can affect the environment, particularly marine environments simultaneously to produce cumulative effects (Halpern et al., 2008), and there may be the BE and environmental sustainability interactions such as trade-offs (e.g., economic, spatial, operational) and competition for space and resources. The cumulative environmental effects of the BE are complex. Because of the fluid and dispersive nature of the environment, it is important to consider the spatiotemporal footprint of activity well beyond its strict geographic bounds. There may be significant opportunities to plan for synergistic outcomes that enhance economic benefits and minimize environmental impacts, however, this requires an understanding of the complexity and nature of the different forms of interactions between the BE and the total environment.

As Figs. 5 and 6 illustrate, the occurrence and linkage strength of keywords became stronger and clearer in Approach II. That is, while the keywords mapping shows a general and relatively 'soft' or 'weak' link between the BE and the total environment in Approach I (Fig. 5), the keywords map in Approach II shows a 'hard' and 'strong' link between the BE and the selected core themes of the total environment (Fig. 6).

Based on the results of keyword cluster analysis (Approach I and II), the six clusters were qualitatively condensed into three common groups to facilitate a better understanding and structuring of future research. The three groups include (i) Environmental sustainability and Blue Economy, (ii) Economic growth and Sustainable Development, (iii) Marine resource and spatial planning.

5. Conclusions

Over the past six decades, the ocean (blue) economy has attracted increasing attention in both developing and developed nations. These issues involve a wide range of disciplines and topics, including environmental science, social science, agricultural and biological science, earth and planetary science, and economics. Scientists and researchers have argued that scientific research should play a central role in new ideas development and generation, but is often challenged and hindered by a division between the interests and thematic foci of academics and researchers (Ehlers, 2016; Winder and Le Heron, 2017; Ahmed and Thompson, 2019; Schupp et al., 2019; Lee et al., 2020). Our research highlights common and specific areas in the BE and related topics to the total environment. Our analysis demonstrates that the three knowledge domains have made important contributions to research in the interlinked fields between the BE and the total environment.

This study has employed a scientometric approach to explore the status and trend of the blue economy in line with the total environment. A total of 227 peer-reviewed journal papers were selected from the Scopus database. Descriptive statistics and keywords co-occurrence analysis were employed to identify the characteristics of the blue economy research in the total environment.

The descriptive statistics demonstrate that the top three journals include Marine Policy ($n = 14$ in App. I and $n = 27$ in App. II), Frontiers in Marine Science ($n = 6$ in App. I and $n = 20$ in App. II), Journal of the Indian Ocean Region ($n = 1$ in App. I and $n = 17$ in App. II) (Table 1). In the case of Marine Policy and Frontiers in Marine Science, there has been a gradual increase of BE researches in various fields, in particular, including marine policy and management. Geographically, top three countries for several publications include the UK, the US, and Australia.

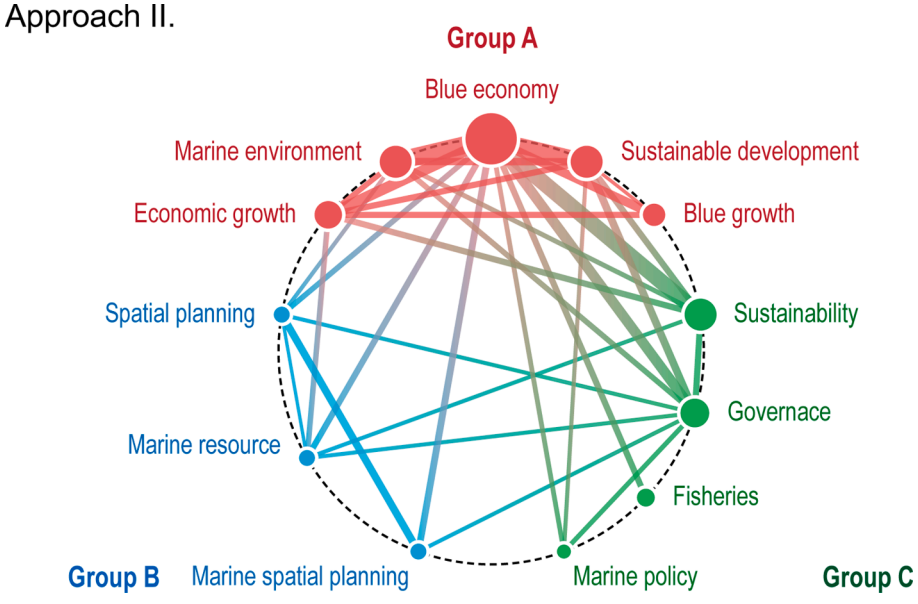

Fig. 6. Keywords corresponding to the top 10 in "occurrence" or "link strength to Blue Economy" collected from the Approach II in the present study. Size of node refers to frequency of occurrences in references of the review documents; proximity (line width) refers to frequency with which two keywords have been co-occurred; colour refers groups from cluster analysis in Fig. 4. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Recently, topics on prospects and challenges toward BE in developing countries were increasingly published in the Journal of the Indian Ocean Region, implying future direction and potential issues on the sustainable growth and development within the BE field (Tables S1 and S2).

According to the keywords co-occurrence network analysis, the current status of the BE and its link to the total environment research show a clear path in development with some lacking or fragmented areas of development. The keyword cluster analysis has identified six major themes in the research, including environmental sustainability, marine resource, economic development, growth and sustainable development, spatial planning and environmental management, and environmental sustainability and Blue Economy.

Our approach allows comparative analysis of the relevance and cluster analysis, combining bibliometrics with text analysis. We also acknowledge some limitations associated with bibliometric research. In particular, bibliometric analysis and the use of keywords as an element of analysis to examine the conceptual domains in the BE and the total environment have allowed a large volume of scientific publication analysis but it could use thematic analysis (qualitative) and meta-analysis (quantitative) of systematic literature reviews to delve deeper into areas of the knowledge outlined here.

In addition, our work has important implications for future studies. The identified research clusters show key knowledge domains and suggest that researchers working within these domains could do more to align their research agenda with the needs of the BE. The analysis of keywords maps also reveals the importance of several key topics, that might be embedded, but are not explicitly included in the interlinkages between the BE and the total environment. This may suggest new rooms and interdisciplinary research agenda for academics to explore in the BE and the total environment fields. Further, researchers may benefit from more quantitative studies to investigate the interlinkages between the BE and five environmental spheres of the total environment to advance our understanding and knowledge in the field.

CRediT authorship contribution statement

Ki-Hoon Lee: Conceptualization, Formal analysis, Writing – original draft, Funding acquisition. **Junsung Noh:** Conceptualization, Investigation, Methodology, Visualization. **Jongmin Lee:** Investigation, Formal analysis. **Jong Seong Khim:** Conceptualization, Project administration, Funding acquisition, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envint.2021.106796.

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