ICES Journal of Marine Science, 2023, **80**, 2233–2243
DOI: 10.1093/icesjms/fsac230
Advance access publication date: 17 January 2023
Original Article

A review of the blue economy, potential, and opportunities in seven Caribbean nations pre-COVID-19

Sui Phang[‡], Antaya March[*], Gregoire Touron-Gardic, Kieran Deane and Pierre Failler

Centre for Blue Governance, University of Portsmouth, Portsmouth PO1 2UP, UK

[*] *Corresponding author:tel: +447775802838;* e-mail: antaya.march@port.ac.uk.
[‡] *Present address: The Nature Conservancy, London, UK*

Caribbean countries face many challenges to effectively implement and benefit from the blue economy. This study synthesized current available information from the literature about the main blue economy activities in the Bahamas, Barbados, Belize, Guyana, Jamaica, Trinidad and Tobago, and Suriname, prior to the COVID-19 pandemic, to highlight their value in the context of blue economic recovery. This timestamp of data provides a point of comparison to understand the vulnerability of blue economy sectors to external shocks. The top performing sectors prior to the pandemic were shipping and tourism, both of which were significant contributors to the GDP. The other sectors (e.g. fisheries, aquaculture, pharmaceuticals, etc.) in some countries were well established and in others, at a minimum, displayed potential for continued development. To valorize the blue economy in a post pandemic recovery, there are three core areas of opportunity: sustainable resource extraction and production; cultivated economic development; and improved ecosystem economic valuations. Harnessing these opportunities will require a transition from a traditional ocean economy towards a coordinated blue economy, including the adoption of effective governance and sustainability principles, improved social, economic, and environmental valuations, and sustainable financing, as well as a more regional coordinated approach to the management of resources.

Keywords: blue economy, blue growth, Caribbean, economic trends, ocean economy, sustainable blue economy

Introduction

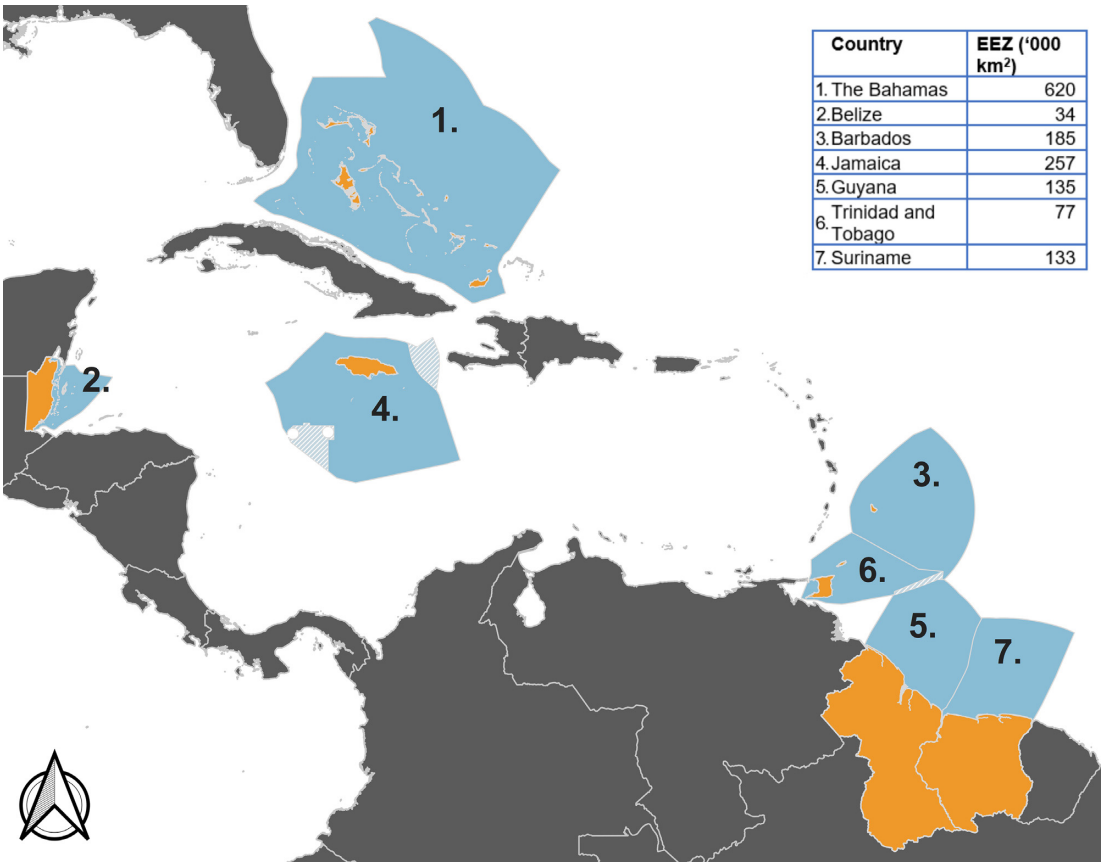
The blue economy describes the sustainable use and conservation of aquatic resources in both marine and freshwater environments (UNECA, 2016), and is a key development strategy in this post-pandemic period, including the Caribbean (World bank, 2016). Even over a decade ago, blue economy sectors generated 18% of GDP in the region (World Bank, 2016), but efforts of further development were severely impacted during the global recession caused by the COVID-19 pandemic. As the world recovers during this post-pandemic period, attention has returned to the potential of blue economy development in the region (UN ECLAC, 2021). Nevertheless, the same challenge remains of developing while safeguarding the health of the marine ecosystem and surety of the long-term provision of ecosystem services. The Caribbean has the potential to overcome these challenges, and further benefit from their blue economy sectors, given their large marine spaces, but the true potential of their blue economy sectors is yet to be harnessed.

The Caribbean countries face many challenges due to their small sizes (in terms of land and population) and the geographical and logistical challenges related to being surrounded by water. Caribbean countries are also considered to be the most vulnerable in the world to natural disasters (IMF, 2020) and climate change, as changes in sea level and increased global temperatures have greater effects in island states (IMF, 2016). The sum of the sea zone (exclusive economic zones—EEZs) of Barbados, the Bahamas, Jamaica, Trinidad and Tobago, and Suriname (estimated to be 1.439 million square km) is almost four times larger than the limited land area of 379110 square kilometres (Sea Around Us, 2016). These islands are also rich in marine biodiversity, and most have engaged in traditional exploitation of the surrounding sea with fishing, aquaculture, tourism, oil and gas mining, and shipping. The first case of COVID-19 in the region was on 1st March 2020, and governments imposed stringent controls to limit movement, including restrictions on gatherings and movement into countries (Murphy *et al.*, 2020) and ultimately lead to a severe contraction in economic activity in the region (UN ECLAC, 2020).

The Bahamas, Barbados, Belize, Guyana, Jamaica, Trinidad and Tobago, and Suriname (Figure 1) have been identified by the Inter-American Development Bank (IDB) as key countries to intervene in exploring new avenues for growth by tackling opportunities in the blue economy. The aim of this study is to synthesize information about the blue economy sectors prior to the COVID-19 pandemic in these seven Caribbean countries to provide a pre-COVID-19 pandemic reference point. This reference point provides a timestamp of blue economic activities from which recovery efforts towards a blue economy can be guided in this post-COVID-19 recovery phase. A secondary objective of this study is to assess the threats to and potential for implementation of the blue economy. This information provides valuable insights for decision-making processes and identifies areas that require further research, monitorin, and evaluation, particularly in blue economic recovery efforts.

The study utilizes a wide literature review and an extensive range of databases such as the United Nations Food and Agricultural Organisation (FAO) FishStatJ, the United Nations Environment Programme's World Conservation and Monitoring Centre (UNEP-WCMC) World Database on Protected Areas and Ocean Data Viewer, the United Nations World Trade Organisation database, The Caribbean Regional Fisheries

Received: 18 February 2022; **Revised:** 28 November 2022; **Accepted:** 28 November 2022



Country	EEZ ('000 km²)
1. The Bahamas	620
2. Belize	34
3. Barbados	185
4. Jamaica	257
5. Guyana	135
6. Trinidad and Tobago	77
7. Suriname	133

Figure 1. The location and the exclusive economic zones (EEZ) of The Bahamas, Belize, Barbados, Jamaica, Guyana, Trinidad and Tobago, and Suriname terrestrial (green) and marine environments (blue). Data for EEZ from the Sea Around Us (2016).

Mechanism Reports, and The United Nations Conference on Trade and Development to determine the economic value of the various blue economy sectors that contribute to the seven countries. The sectors defined are based on the World Bank's classification of blue economy sectors (World Bank, 2016) and are organized by the type of activity needed to produce the 15 blue economic sectors and industries (Table 1).

Ocean economy activities of the seven countries and their estimated values

Looking at the ocean economy activities, their economic value, and the threats and opportunities that face these economic sectors of the blue economy (Table 1) allows for a clearer picture to be drawn of the general situation for the seven focal countries.

Harvesting of living resources

For all countries analysed, fisheries had the most social and economic importance of all the extractive activities, with marine capture fisheries having the highest significance. It directly employed nearly 64000 people with landed marine fish and seafood valued at around 306.5 million US Dollars (Table 2). Trade imbalances of different intensities exist across the seven focus countries with high-value seafood often being exported and replaced with imported lower-value seafood, usually for consumption. Aquaculture has the potential to bring in extensive revenue as well as food security, but production is not large in the seven countries, and attempts to start aquaculture have had varying degrees of success (Table 2).

In terms of pharmaceuticals and chemicals, the industry in the focus is limited. The use of soft coral harvests in the Bahamas for cosmetics and pharmaceuticals is the most well-known. The anti-inflammatory and analgesic compounds isolated from a Bahamian soft coral, *Pseudopterogorgia elisabethae* (Kim, 2019), led to the development of bio-products now used in cosmetics lines, currently worth US$3–4 million per year (Bifani *et al.*, 2019). The Bahamas has a tripartite access and a benefit sharing agreement on the extraction of soft corals among the government, local community, and a foreign commercial company (ABS, 2014). The agreement provides capacity-building and training activities to the local community and income to the government through licensing. In the other focus countries, this activity is still relatively young. However, the potential for new pharmaceuticals and chemicals exists because of the high biodiversity and relatively unexplored EEZs are a rich environment for discovering new products.

Extraction of non-living resources, exploitation of new resources

In the seven focus countries, the marine oil and gas sectors play varying roles in current and future prosperity (Table 3). All seven countries have explored the sea floor for oil and gas reserves, but with very different results (Ochs *et al.*, 2015).

The seven focus countries, as part of the Caribbean Community and Common Market (CARICOM), have committed

Table 1. The relationship among ocean services and economic sectors by the type of activity (World Bank, 2016).

Type of activity	Ocean service	Blue economic sector/industry
Harvesting of living resources	Seafood	Fisheries Aquaculture
	Marine biotechnology	Pharmaceuticals and chemicals
Extraction of non-living resources, exploitation of new resources	Minerals, sand, and gravel	Seabed mining
	Energy	Oil and gas Renewables (marine)
	Freshwater	Desalination
Commerce, tourism, and trade	Transport and trade	Shipping Port infrastructure and services
	Tourism and recreation	Tourism
Indirect contribution to economic activities and environments	Carbon sequestration	Blue carbon (that is, coastal vegetated habitats)
	Coastal protection	Habitat protection, restoration
	Waste disposal for land-based industry	Assimilation of nutrients, solid waste
	Existence of biodiversity	Protection of species, habitats

Source: World Bank (2016).

Table 2. The production and contribution of marine capture fisheries and aquaculture in each of the focus countries with regards to supply (kg/capita/year), capture production (tonnes), number of people employed, value of the marine capture fish production, and percentage of the GPD.

Country	Bahamas	Barbados	Belize	Guyana	Jamaica	Suriname	Trinidad and Tobago
Capture fisheries supply (kg/capita/year)	27.31	29.97	12.16	25.41	30.48	16.69	23.85
Capture Production (tonnes, 2019)	11 625	1 735	4 315	42 142	15 346	46 980	13 176
Numbers employed by capture fisheries (2019)	10 000	2 200	2 200	8 175	25 274	4 500	3 347
Value of marine capture fish production (milion USD, 2019)	10.4	4.67	21.35	95.499	44.06	30.411	37.51
% of GDP by fisheries (2019)	0.32	0.06)	1.1	1.2	0.49	2.7	0.07
Aquaculture production (tonnes, 2019)	–	26	563	307	1 615	110	7
Numbers employed by aquaculture (2018)	20	–	2 284	131	1 800	40	42
Value of aquaculture fish production (2019, million USD)	–	0.3	2.92	1.78	4.93	0.8	0.01
% of GDP by aquaculture (2019)	–	0.064% 4.69-	1.495% 1.95	0.034% 5.17	0.031% 15.83	0.02% 3.98	–

Source: Production and Supply statistics—UN FAO FishStatJ and FoodBalance Databases; GVA Statistics from the UN Food and Agricultural Organization—Geographic Profiles; Employment and GDP Statistics from Caribbean Regional Fisheries Mechanism (CRFM) Secretariat Statistics and Information Report 2020 (Masters, 2020).

Table 3. Oil and gas reserves and oil revenue.

Country	Oil reserves (million barrels)	Oil revenue (% of GDP, 2019)
Bahamas	0	0
Barbados	2–3	0.21
Belize	7–8	0.6
Jamaica	–	0
Guyana	8 000+	12.3
Trinidad and Tobago	242	3.2
Suriname	84	7.6

Source: The Global Economy (2020).

to moving towards a future with renewable energy generation. The Regional Energy Policy and the Caribbean Sustainable Energy Roadmap and Strategy outlines the aims and path towards achieving this goal (Ochs *et al.*, 2015). Additionally, Guyana and Barbados are signatory members to the Barbados Declaration on Achieving Sustainable Energy for All in Small Island Developing States (SIDS), which seeks a path towards adoption for renewable energy to meet the specific challenges of SIDS. However, the actions undertaken by these countries have typically focused on terrestrial renewable technology systems. For example, Guyana is working with Brazil to generate power through hydropower dams. There have been the first steps towards installing marine renewable energy in the seven focus countries (Ochs *et al.*, 2015).

Deep water environments in the seven focus countries have not been extensively explored for deep sea minerals. There has been little interest in deep water mining within the borders of the seven countries currently. Some polymetallic nodules and cobalt-rich crusts are located in areas beyond national jurisdiction east of the region in the western Atlantic (Miller *et al.*, 2018). In international waters, Jamaica has recently entered the deep-sea mining sector through a Jamaican registered company, Blue Minerals Jamaica Ltd, and has signed a 15 yr contract as of 2021 Exploration Licence for Polymetallic Nodules with the International Seabed Authority.

Table 4. Maritime traffic and connectivity.

Country	Arrivals in 2018			Average container ship capacity (TEU)	Liner Shipping Connectivity Index (LSCI)	Contribution of maritime traffic to GDP ($US millions; 2018)	% Contribution to GDP
	Passenger ship	Container ship	All other ships				
Bahamas	3 326	1 209	1 503	4 266	31.4	11.489	5.05
Barbados	445	179	525	1 120	7.4	4.365	5.4
Belize	355	49	126	573	11.5	1.590	–
Guyana	0	184	899	1 189	9.2	5.751	13.19
Jamaica	443	1 325	2 186	2 537	33.2	13.894	–
Trinidad and Tobago	1326	688	2 605	1457	9.1	21.771	10.13
Suriname	0	155	708	1205	15.4	3.458	14.17

Source: United Nations Conference on Trade and Development; (IDB, 2020a)
Note: All other ship categories include Wet bulk, Dry breakbulk, Dry bulk, Roll-on/roll-off ship, Liquefied petroleum gas carriers, and Liquefied natural gas carriers. TEU = Twenty-foot equivalent units.

Table 5. Summary of tourist sector statistics.

Country	Overnight visitors 2018 (thousand)	Cruise visitors 2018 (crew and tourists, million)	Total tourism expenditure ($US million)	Direct employment	Total employment	Contribution of tourism to GDP ($US millions; 2018)	% contribution of tourism to GDP
Bahamas	1633	4878	280, 000	54 147	114 861	2, 389	19.23
Barbados	664	681	133 275	17 938	54 028	2, 122	13.13
Belize	489	1208	86.12	1 724	2 530	409	21.64
Jamaica	2473	1846	244.53	5 270	8 293	1, 200	7.63
Guyana	247	–	90	8 637	22 182	272	2.65
Trinidad and Tobago	395	126	891.23	23 802	64 037	1, 990	2.83
Suriname	275	0.9**	–	2 463	5 448	102	1.25

Source: United Nations World Tourism Organisation; Business Research and Economic Advisors -Economic contribution of cruise tourism to the destination economies 2018. ** Numbers from 2017.

Conventional seabed mining also occurs in the region. The Bahamas extracts and exports aragonite with government issued single licences valued at US$2.5 million. However, the overall potential economic value of aragonite is not well known and dependent on multiple factors like external supply and demand (Adderly, 2018).

In terms of the extraction of freshwater from marine environments, desalination plants have been set up in the Bahamas, Trinidad and Tobago, and Barbados (UNESCO, 2006). The Blue Hills plant in the Bahamas, for example, has the capacity for 12 million US gallons a day, and is one of the largest plants in the country. Desalination plants are especially important for smaller islands, which often do not have a sufficient supply of fresh groundwater to meet growing population and tourism demands. Moreover, extraction of freshwater from the sea can contribute to water security under climate change (World Bank, 2019).

Commerce, tourism, and trade

The focus countries have varying development in the transport sector (Table 4). Jamaica has the most established maritime and trade sector of the seven countries. It has been selected as the fourth "Global Logistics Hub," in part due to its location close to the Panama Canal, main shipping lanes accessing Europe, North America, and Africa, as well as reaching 800 million people within four hours (Durant, 2014). The Bahamas, in terms of fleet value, are one of the leading countries for flags of registration. The majority of the nearly 80000 registered vessels are chemical tankers, ferries, and passenger ships. Its role as a popular flag state means the Bahamas has an important role in driving the sustainability practises of its registered vessels. Ensuring compliance with key policies like fuel oil consumption and reporting on emissions will facilitate the transition towards a blue economy. The income generated by vessel registrations should have portions ring-fenced for compliance, enforcement, or emerging areas of sustainability agendas.

The tourism and recreation sectors are critical to the countries in this paper, with the exception of Suriname and Guyana, which have a less developed sector (Table 5). Pre-COVID-19 statistics indicate that tourism accounted for 50% of the Bahamas' entire GDP as well as employing nearly half of its entire workforce. Cruises are the biggest source of tourists bringing in ~75% of all tourists. Cruise visitors are also important to Belize, bringing in 70% of all tourists, with the entire tourism sector underpinning 38.1% of the country's economy. In Jamaica, the 1.8 million cruise visitors are smaller in number than overnight visitors, but still contributed ~US$250 million to the economy in 2018.

Indirect contribution to economic activities and environments

Coastal and marine ecosystems provide multiple important contributions to the blue economy (Tregarot *et al.*, 2020). In

Table 6. The extent of key coastal and marine ecosystems and their estimate values.

Country	Seagrass		Mangrove		Coral reefs	
	Area (km^2)	Annual value (US$ million)	Area (km^2)	Annual value (US$ million)	Area (km^2)	Annual value (US$ million)
Bahamas	8 700	18 200	1 000	2 300	2 300	4 500
Barbados	0	–	<1	<2	<40	<100
Belize	3 800	8100	500	1 100	900	1 800
Jamaica	<5	<12	100	200	420	800
Guyana	1 300	2 700	300	700	0	–
Trinidad and Tobago	500	1 000	<60	130	<40	<100
Suriname	800	1 700	800	1 900	0	–

Source: Surface areas from UNEP-WCMC Ocean Data Viewer database; Values from Failler *et al.*, 2015.

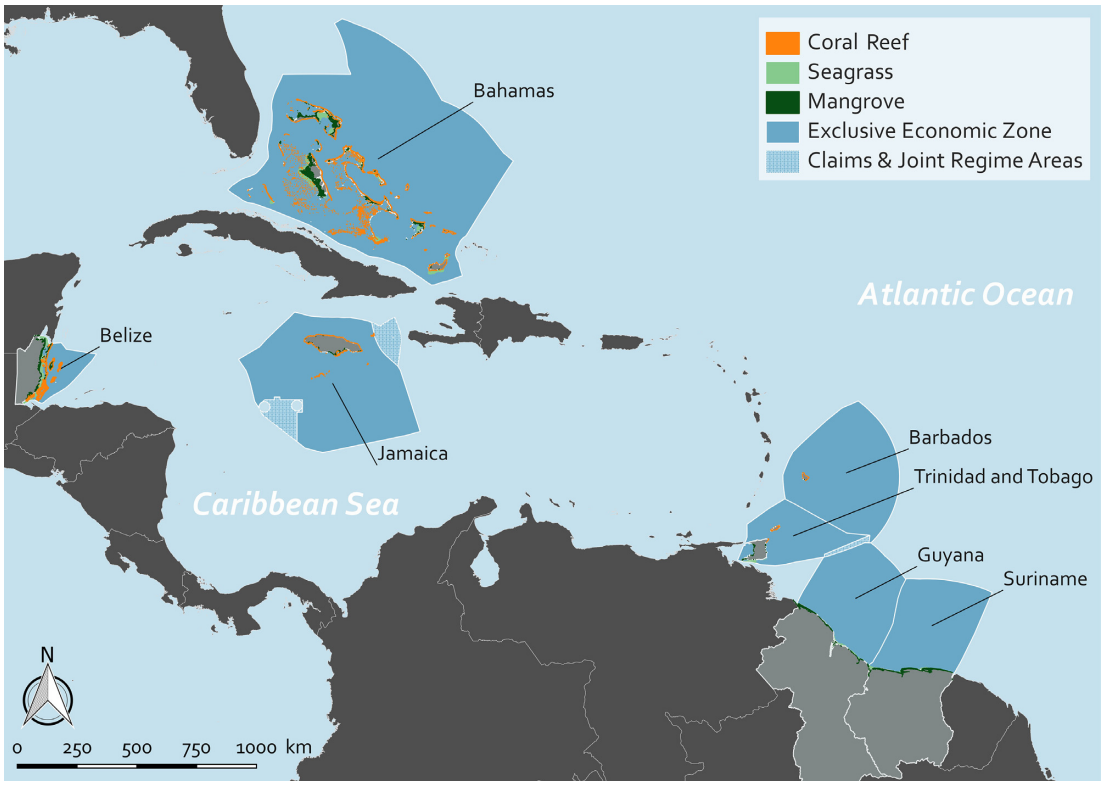


Figure 2. The distribution of key marine and coastal ecosystems providing indirect blue economy services. Source: Authors' own using data from the Flanders Marine Institute (2019).

many cases, healthy ecosystems underpin economic activities. Vital ecosystem services include carbon sequestration, coastal protection, and waste disposal for land-based industries. Direct uses of the marine and coastal environments include extraction of natural resources like (capture and recreational) fisheries, wood, and tourism associated with coral reefs. These ecosystems also provide ecosystem services associated with carbon sequestration, biodiversity, and waste water management. The removal and/or degradation of these ecosystems, either in area or health, will likely undermine the provision of these services. The economic cost of replacing these functions and services once lost will be extremely costly. Moreover, a single ecosystem type will concurrently contribute multiple services, underscoring the value of these systems to country wellbeing.

Among the seven focus countries, The Bahamas has the largest EEZ and areas of seagrass, mangroves, and coral reefs (Table 6, Figure 2). A rough estimate of the total contribution of these ecosystems is around US$25 billion annually for all of the focus countries (Failler *et al.*, 2015). The Bahamas has joined the Caribbean Challenge Initiative and committed to protecting 20% of the marine environment, and affirming its importance to its long-term strategy. Belize, with its second-largest EEZ, receives roughly US$11 billion annually from these same ecosystems. Belize's coral reefs, including the Belize Barrier Reef Reserve System, which is a UNESCO World Heritage Site, is globally recognized as a biodiversity hotspot and tourist destination.

Threats and opportunities to the blue economy of the seven countries

The key opportunities and threats to the blue economy in both scale and the sectors impacted varies between each of the seven focal countries depending on location, biodiversity, sector dominance, and other factors.

Threats to the blue economy

There are a large number of threats to the development of a sustainable blue economy, including competition for space, increased pressure on coastal land driven by population growth, and changing political cycles (Skewes *et al*., 2016). However, four key threats have been identified by the InterAmerican Development Bank (IDB, 2020a) and the Caribbean Development Bank (CDB, 2019) in collaboration with stakeholders as raising the largest concern: climate change; the existing relationship between economic development and environmental degradation; global market dynamics; and pandemics such as was demonstrated by COVID-19. Facing these threats through coordinated and innovative action will be paramount to secure the future of the seven nations under evaluation in this study.

Firstly, climate change is an all-encompassing threat to the blue economy of the seven countries and all blue economy sectors. The wide range of climate change impacts on marine systems includes changes in weather and extreme events, ocean acidification, sea-level rise, and changing marine ecosystems. Flood damage caused by sea level rise and extreme sea-level events will increase by 2–3 orders of magnitude by 2100 (Nurse *et al.*, 2014)). A large proportion of coral reefs die if sea temperature rises by 2C, which will negatively affect sectors they underpin like fisheries, tourism, and biodiversity. Furthermore, changing weather and possible saltwater intrusion due to sea level rise may impact the quality and abundance of freshwater. Especially pertinent is the potential increasing frequency and strength of Atlantic hurricanes due to climate change (Vosper *et al*., 2020). For example, Hurricane Dorian in 2019 caused >$3.4 billion in damage in the Bahamas (IDB, 2019). Their destruction also leads to long-lasting societal impacts, including contributing to a six-fold increase in displaced children across the Caribbean islands in the last five years (UNICEF, 2019).

Secondly, unsustainable economic development damages the marine environment and threatens the provision of current and potential ocean services. In this way, all seven countries as well as the blue economy sectors of fisheries, tourism and recreation, carbon sequestration, ecosystem services provision, and biodiversity are under threat. Moreover, multiple services co-depend on the environment, which means the health of one sector can be impacted by activities in another regardless of how well-managed the first sector is. This means an integrated approach is necessary to coordinate activities across the sectors. The co-dependence on the health of the marine environment is most obvious in the potential impact of oil and gas spills on other sectors as well as deep-sea mining. The consequences of deep sea mining are difficult to predict however the release of toxic elements during mining, long-term seabed alterations, and loss of deep sea biodiversity are definite concerns (Miller, K.A, 2018). The Caribbean Sea is one of the most intense maritime traffic areas in the world, and up to 83% of the sea is vulnerable to ship-generated oil pollution (Singh *et al*., 2015). Oil spills can also come from land events as well as accidents in oil drilling, which will still occur despite even the best mitigation planning. The 2010 Deepwater Horizon spill had a large-ranging and long-lasting impact on the Gulf of Mexico (Berenshtein *et al*., 2020), and effects are still impacting the ecosystem a decade after the spill. Oil pollution across the region will also most likely increase because of growth in oil production and maritime traffic arising from blue economy activities like Guyana's oil industry and Jamaica's selection as a global maritime trading hub.

In the third instance, global market dynamics directly impact all seven countries and particularly the blue economy sectors of tourism, oil and gas, shipping, and fisheries. The potential profit of the oil and gas sector also depends on the global market that has been increasingly volatile. Oil price volatility in 2018 ranged between USD50 and USD85/bbl (McKinsey, 2019). The price per barrel (bbl) is largely driven by production from the Organization of the Petroleum Export Countries (OPEC, two-thirds of total global oil production) and the USA. Notwithstanding the impact of the 2020 global COVID-19 pandemic (see below), oil production, demand, and price was expected to remain similar with increasing demand offset by US shale oil production however since December 2021 and August 2022, the bbl has ranged between 70 and 120 USD. The price per bbl is a critical driver of initial investment into oil and gas (i.e. Suriname and Guyana) and any final profits. Another external dynamic potentially affecting oil and gas are political decisions in other countries. In April 2020, the US Congress urged the US Government to pressure the Bahamas Petroleum Company to stop drilling to avoid another 2010 Deepwater Horizon oil spill. Potential fisheries profit is also impacted by global market prices. Current fish prices contribute to import and export imbalances in several of the seven focal countries, where high value commercial fish are exported and replaced with cheaper, often aquaculture produced, fish (e.g. Jamaica imports 65% of its consumed fish). The export of fisheries products can be an important source of commercial revenue, especially for spiny lobster and conch in the Bahamas and Belize, respectively, where the majority is exported to the United States of America. These fisheries exist and are managed because of their value driven by international demand, and changes in this demand (as well as oil and gas prices) will affect fishery dynamics, especially prices and profit, within the seven countries. Competing on the global market, especially with China, for immense aquaculture production, is a notable barrier to the profitability and development of aquaculture in the region.

Lastly, the global COVID-19 Coronavirus pandemic on the global economy represents a new and substantial hurdle towards the development in the seven focal countries and across all blue economy sectors. As a result, the worldwide economy shrank by 3% in 2020 (IMF, 2020). Oil prices fell to a low of USD20/bbl in May 2020 but have since increased to ~USD120/bbl in mid 2022. Indeed, exploratory drilling in the Bahamas was delayed significantly in part because of these low prices and the health and safety concerns of operations (Offshore, 2020). Maritime trade also experienced a large negative impact, especially in ports where changes in the crew occur and mandatory quarantine periods impacted this turnover. For example, in March 2020 in Barbados, the Braemar of Fred Olsen Cruise Lines was refused docking due to 40 of its crew members and passengers displaying possible COVID-19 symptoms (Reynolds and Oppmann, 2020). The blue economy tourism sector is also being severely impacted from the global pandemic. International tourist arrivals to the Bahamas in March 2020 fell 70% compared to March 2019 (UNWTO, 20210), an especially severe impact on countries with economies dependent on tourism. Tourist numbers dropped significantly even further in April of 2020 due to the introduction of social distancing, a travel ban, and quarantine measures in the United States, the dominant source of

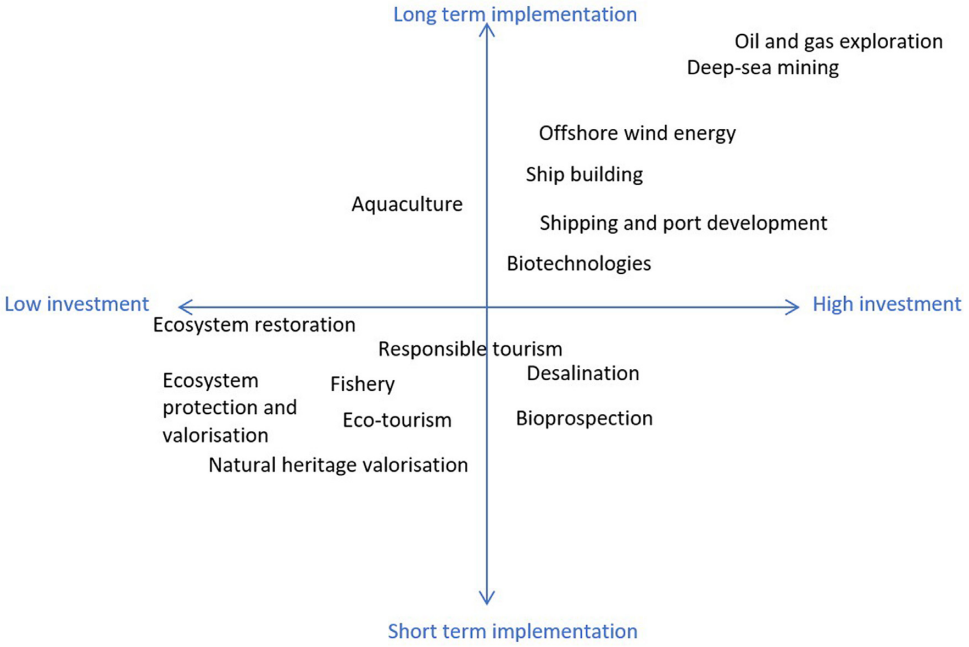


Figure 3. Funding and time scale of investment in some blue economy sectors. Source: IDB, 2020b.

tourists to the region, and by May 2020, cruise ship tourist numbers had dropped to zero for all Caribbean islands (Mulder, 2020). The expected long-term trend of the worldwide economy is positive and sectors like oil, tourism, and trade are likely to recover. However, given that the frequency and intensity of epidemics are increasing, the likelihood of another global pandemic as deleterious as COVID-19 occurring in the next 25 yr reaches around 50% (CGD, 2021). This is a worrisome prospect for nations such as those of this paper, where a significant portion of national revenue is impacted in pandemic scenarios. In this regard, early action, effective preparedness, and diversification of blue economy revenues are of high importance to ensure consistent development of blue economy sectors.

Opportunities in the blue economy

Blue economic opportunities vary across the seven focus countries. The situational review of respective current ocean economies shows differences in sector development and the availability of resources. To transition from an ocean economy towards a coordinated blue economy requires the adoption of good governance and sustainability principles, such as those outlined by the World Bank (2016). The benefit of implementing robust blue economy principles is to overcome the threats described in the previous section. Alongside these, existing opportunities should be harnessed. Figure 3 identifies the funding implications and time scale of investment into sectors that offer opportunity for the development of the blue economy. It has been elaborated using expert knowledge captured during a regional workshop organized by the IDB in Nassau, Bahamas in January 2020. Using real examples for each activity/sector, an investment mapping using time and financing importance was made. In this regard, three key areas of opportunities are evident across the seven countries; sustainable resource extraction and production; cultivated economic development; and improved valuing of the ecosystems.

Discussion: harnessing the potential of the blue economy in the Caribbean

From the 14 blue economic sectors outlined in Table 1, pre-COVID-19, the top performing sectors were shipping and tourism, both of which were significant contributors to the GDP of many of the subject countries. The other sectors (such as fisheries, aquaculture, pharmaceuticals and chemicals etc) in some countries were well established and in others, at a minimum, displayed potential for continued development. When these sectors are cross-referenced with the three areas of opportunity presented in section 3.2 (sustainable resource extraction and production; cultivated economic development; and improved valuing of the ecosystems), the potential for blue economy development in the post-COVID-19 climate can be realized.

Sustainable resource extraction and production

There are a number of areas related to production and resource extraction that have significant potential for development if managed sustainably to ensure long-term viability and minimize direct and indirect environmental impacts.

Capture fisheries was a relatively mature sector pre-COVID-19 however appeared underinvested in a few of the current focal countries. In the post-COVID-19 climate, modernization through improved technology and increasing capacity in fishing fleets can help develop commercial off-shore and deep-sea fishing activities in a way that ensures the long-term security of the sector (Oxenford and Mcconey, 2020). Current fishing is majority small-scale, near-shore activities by small boats (<6 m). Despite this, fishing intensity can be high, and exploited stocks are likely to be at full or overexploited rates (Oxenford and Monnereau, 2017). For future it is important there is robust assessment of the potential for pelagic and demersal fish stocks to establish the viability of these operations. Certification can increase the value of exported fish products (e.g. Marine Stewardship Council Certification). Al-

ternatively, income can be generated through the sale of fishing licences to foreign nations or commercial operations, although the details of this need to be transparent, and the income generated should be directed to improving ecosystems essential to the delivery of ecosystem services, marine-related development projects that support the fisheries, or fisheries livelihoods programmes to benefit the fisher communities, which are invariably impacted by these agreements (Le Manach, 2013). Investment in fishery management infrastructure and expertize is necessary to ensure current and future expansion in fisheries are sustainable to achieve blue economy objectives.

Aquaculture technology globally is mature but within the seven focus countries, is underdeveloped, despite a history of government-led initiatives to grow the sector (Wurmann et al., 2020). Opportunities in the sector are constrained by having to compete against cheaper production on the global market and the occurrence of hurricanes in the region, which can destroy coastal and offshore operations (Wurmann et al., 2020). Technological advancements such as caged offshore farms or land-based marine aquaculture, may open up new opportunities and reduce cost. Ongoing aquaculture operations, especially shrimp farms, can also be improved in their sustainability through reducing the environmental damage that they cause (Páez-Osuna, 2001). The rearing of algae and other non-animal species that are more resilient to extreme events and require less input can also be promising activities for the region. Similar to the capture fisheries, certification can increase the value of products to customers (e.g. Aquatic Stewardship Council).

The potential for expansion into maritime biotechnology, pharmaceuticals, and chemical sectors is high across the countries given the region's high marine biodiversity and the genetic diversity this represents (Miloslavich de Klein et al., 2010). Current exploration in this sector can be considered negligible, as the number of successful examples identified earlier in this paper is limited. Prohibitive barriers to investment are; high costs, the potential long process, and the absence of guarantee of success of bringing a product to market (Piker, 2016). However, there is potential for substantial societal and economic benefit given the proven success of finding, for example, anticancer medicines, from marine biodiversity. It will be important that any bioprospecting is undertaken with robust accounting and regulation to protect ownership rights (e.g. the Convention of Biological Diversity and the Nagoya Protocol) and ensure environmental regulations are kept to a high standard.

There has been a long history and repeated attempts to explore for oil and gas across the seven focal countries, and the potential for new growth in this area is mixed. Discovery of new wells is possible, and Suriname and Guyana are the countries with the largest growth potential with their recent discoveries (Platon, 2017). Trinidad and Tobago's oil and gas sectors are already mature and contribute adequately to the GDP (Khadan and Ruprah, 2019). Other countries have explored for oil with less positive results and unproven or small wells. Belize has implemented a moratorium on new offshore drilling to protect its marine biodiversity (Baxter, 2017). Beyond wells, opportunities for growth exist in providing downstream activities and services, especially given the potential influx of crude oil from Suriname and Guyana. Shifting towards the blue economy will require continued improvements in the sector's regulations and control given that it is intrinsically at odds with environmental sustainability.

Significant opportunities also exist in marine renewable energy for the seven focus countries. Harnessing tidal, wave, and thermal ocean energy is a globally young but emerging sector and could also provide new opportunities. Countries in the region have already taken steps towards implementing the marine renewables sector (Silva et al., 2021). Key initiatives in the sector for the region are the Regional Energy Policy, the Caribbean Sustainable Energy Roadmap and Strategy, and the Barbados Declaration on Achieving Sustainable Energy for All in SIDS. The investment needed to grow this sector should take the form of monetary incentives (i.e. seed funds, research and development etc.) and supportive policies (e.g. government and community support, connecting research and industry). Technological improvements will lower start up and running costs and provide new opportunities, like exploiting thermal and salinity gradients and floating wind farms (IDB, 2014). Expansion will require technological advances to mitigate damage from hurricanes in existing hurricane pathways or if climate change alters their movement patterns.

Desalination of saltwater plays an important role for island states as stated in section 2.2 where desalination plants have been set up in the Bahamas, Trinidad and Tobago, and Barbados (UNESCO, 2006). The Bahamas has a long history of water desalination (started in 1958), and operates several reverse osmosis plants across its islands (Welsh and Bowleg, 2022). Expanding operations in this sector will increase water security for drinking water (reverse osmosis desalination) and industrial applications (thermal desalination). Investment costs are falling as technology improves, but desalination of saltwater is costlier than groundwater. Other factors involved include the location, quality of water, infrastructure, and energy costs. Expanding this sector may become a necessary investment due to climate change (Welsh and Bowleg, 2022). Rising sea levels and increased inundation of the shoreline can affect groundwater quality. Changes in climate patterns and rainfall may also affect local supply. Furthermore, demand for water may increase as countries undergo economic development and population growth, as well as increasing pressure on water demand associated with tourism development.

Cultivated economic development

The Caribbean is ideally located as a transport and trade hub, and several countries have taken steps to expand in this sector. The most notable of these is Jamaica with its aims to be a global shipping and airline hub. Investment in this sector includes improving maritime access, modernization equipment and superstructures, expansion of port capacity for larger ships, smoothing intra-port transport flows, hinterland strategies, the development of port-related industries, and energy-related infrastructure (e.g. bunkering) (Corey *et al.*, 2022). Improving the environmental sustainability of port operations is important under the blue economy and can be achieved through the use of more renewable energy and improving efficiency (i.e. reducing wait times) for incoming ships. Investment costs in this sector will be significant long-term outlays. Government and private sector (local and international) partnerships are needed. Moreover, expansion of this sector must be part of the strategy of the country and consider the actions of neighbouring countries (Aiken, 2014).

The tourism and recreation sectors are of vital importance and underpin the economy of several of the focal countries of this paper. A large driver of tourism in the seven countries is the global attraction of their beaches, marine

biodiversity, and the ocean-based recreational activities. Minimizing the threat tourism activity poses to the health of the marine environment is critical to its profitability (Failler *et al.*, 2015). This sector is relatively mature, but the long-term dependence on the high-volume cruise tourism model may require re-consideration. While total contribution by cruise passengers is high, the economic spend in the local economy per passenger is less than overnight tourists (IDB, 2020a). Moreover, the impact of the novel COVID-19 global pandemic and the sensitivity of cruises in particular threatens the long-term model for these islands. A greater emphasis on the health of passengers is likely to drive post-pandemic decisions. A shift towards higher-value overnight tourists to stay longer on their beaches is a potential growth area but will require coordination across the region.

Improved valuing of the economic contribution of ecosystems

The indirect contribution of marine and coastal ecosystems (described in section 2.4) is still undervalued and overlooked in current ocean policies, and is evidence in the state of knowledge of the value of ecosystems in the seven focus countries. This is in line with the work by Patil *et al.*, (2016), who highlighted that with greater clarity on the value of ecosystems in the Caribbean to drive growth in the blue economy, there is also the opportunity to build greater resilience to external shocks. These ecosystems underpin many blue economy sectors, most notably fisheries and tourism (Failler *et al.*, 2015). However, by definition, the indirect services provided by these ecosystems, which are essential to the social and economic wellbeing of the countries, are hard to quantify and thus not sufficiently incorporated in long-term policy strategy. This is despite a growing appreciation for the need to protect them. A critical need is the robust evaluation of the contribution provided by marine and coastal environments in economic and intrinsic values . Mangroves, seagrass beds, and kelp forests are among some of the highest carbon-sequestering habitats in the world. Reducing atmospheric carbon helps address the threat of sea-level rise that disproportionately affects islands and coastal countries (Trégarot *et al.*, 2021). Direct income could also be sought under the proposed carbon emissions trading systems under a global polluter pays principle. Additionally, wide mangrove belts provide protection against storm surges and mitigate economic damage. Coral reefs provide similar protection against waves, enhance fisheries, and attract tourists (Failler *et al.*, 2015). These contributions need to be valued in order for policy decisions to be evidence-based for an integrated approach to the blue economy.

Conclusion

The situational review of the current ocean economies of the Bahamas, Barbados, Belize, Guyana, Jamaica, Trinidad and Tobago, and Suriname provides a temporal stamp of the status of the countries' blue economy activities prior to the COVID-19 pandemic, acting as a point of comparison to understand the sensitivity of resilience of blue economy sectors to external shocks such as pandemic. The study shows differences in sector development and the availability of resources, and in this regard, country-specific measures to grow the nations' economies are needed. This research does not present an analytical framework for evaluation, but rather provides an overview of the situation prior to the COVID-19 pandemic and the blue economic potential in a post-COVID-19 recovery climate. This lack of an analytical framework for evaluating the blue economy is a general weakness within the blue economy, and could be addressed through the UN Decade of Ocean Science or the Convention for Biological Diversity Post-2020 Framework, where the reporting mechanisms could be more streamlined. Follow-up analysis post-COVID-19 for the blue economies of the countries in this study would be useful to better understand the specific impacts and recovery efforts of the different sectors to the pandemic.

Our results suggest that overcoming the threats to the blue economy, and truly harnessing the opportunities identified in the seven countries will require a transition from a traditional ocean economy towards a coordinated blue economy. Successful implementation of a blue economy needs a dedicated and coordinated policy agenda. Synergistic policies at the national and regional scales must address the challenges of transitioning an ocean economy into a blue economy. To develop and implement these policies, there are a number of key tools that need to be in place. These include good governance and the support of a blue economy coordination unit, a blue economy strategy with a clear plan of action, sustainable financing mechanisms, improved economic valuations of ecosystems and the services they provide, and strong regional coordination. Prioritizing nature-based solutions presents a notable opportunity to ensure the long-term provision of ecosystem services, which underpin the economies of all of the focus countries.

Supplementary data

Supplementary material is available at the *ICESJMS* online version of the manuscript.

Conflict of 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.

Data availability

The data underlying this article are available within the article text and referenced accordingly.

Author contributions

S.P.: conception, data collection, and write up; A.M.: conception, data collection and harmonization, write up, and revisions; G.T.G.: data visualization, maps, write up, and revisions; K.D.: data collection, write up, and revisions; P.F.: conception, data collection, and supervision.

References

ABS. 2014. Factsheet: Relevance of Marine Bioprospecting for ABS Frameworks. The Access and Benefit Sharing (ABS) Initiative. last accessed 21 August 2019. Available at: http://archive.abs-biotrade.info/fileadmin/media/Knowledge_Center/Pulications/Fact_sheet/Relevance_of_Marine_Bioprospection_in_ABS_context_July_2014.pdf

Adderly, M. 2018. Aragonite value 'still unknown'. The Tribune. accessed date 22 August 2019. Available at: http://www.tribune242.com/news/2018/jun/13/aragonite-value-still-unknown/

Aiken, D. M. 2014. Assessment of the maritime legislative regulatory framework relating to the Jamaica logistics hub with special reference to selected contemporary maritime issues. [Accessed 29 July 2022] Available at: https://commons.wmu.se/cgi/viewcontent.cgi?article=1447&context=all_dissertations

Baxter, A. 2017. Belize makes history by introducing offshore oil moratorium legislation. Oceana, Belmopan. [Accessed 22 February 2022] Available at: https://oceana.org/press-releases/belize-makes-history-introducing-offshore-oil-moratorium-legislation/

Berenshtein, I., Paris, C. B., Perlin, N., Alloy, M. M., Joye, S. B., and Murawski, S. 2020. Invisible oil beyond the Deepwater Horizon satellite footprint. Science advances, 6:eaaw8863.

Bifani, P., Agardy, T., Vivas Eugui, D., Jaramillo, L., Gómez-García, R., and Vignati, F. 2019. Blue BioTrade: Harnessing Marine Trade to Support Ecological Sustainability and Economic Equity. UNTCAD.

CDB. 2019. Advancing the Caribbean blue economy. Understanding risk Conference. Caribbean Development Bank. Workshop slides and notes. Unpublished. Workshop held on 28 May 2019.

CGD. 2021. The Next Pandemic Could Come Soon and Be Deadlier. Commentary and Analysis of the Centre for Global Development (CDG) workshop.: [Accessed 28 March 2022] Available at: https://www.cgdev.org/blog/the-next-pandemic-could-come-soon-and-be-deadlier

Corey, J., Wang, Q., Zheng, J., Sun, Y., Du, H., and Zhu, Z. 2022. Container transshipment via a regional hub port: a case of the Caribbean Sea region. Ocean & Coastal Management, 217: 105999.

Durant, I. 2014. Jamaica logistics hub and Jamaica growth Agenda: implementation for funding and international competition. World Development Bank. Logistics Hub Symposium [Accessed 29 August 2022]. Available at: https://ran-s3.s3.amazonaws.com/businesseventsja.com.jm/s3fs-public/ian-durant-presentation-logistics-hub-symposium.pdf.

Failler, P., Pètre, É., Binet, T., and Maréchal, J. P. 2015. Valuation of marine and coastal ecosystem services as a tool for conservation: the case of Martinique in the Caribbean. Ecosystem services, 11: 67–75.

Flanders Marine Institute 2019. Maritime Boundaries Geodatabase: Maritime Boundaries and Exclusive Economic Zones (200NM), version 11. accessed date 20 March 2020. Available online at https://www.marineregions.org/. https://doi.org/10.14284/386

IDB. 2014. Study on the development of the renewable energy market in Latin America and the Caribbean.. Inter-American Development Bank. [Accessed 29 July 2022]: Available at https://publications.iadb.org/publications/english/document/Study-on-the-Development-of-the-Renewable-Energy-Market-in-Latin-America-and-the-Caribbean.pdf

IDB. 2019. Assessment of the effects and impacts of hurricane Dorian in the Bahamas. accessed date 22 March 2020. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/EZSHARE-1256154360-486.pdf

IDB. 2020a. Economic evaluation of the blue economy in the Caribbean. To produce an economic valuation tool of the current and potential economic activities in the Caribbean Inter-American Development Bank *Unpublished*.

IDB. 2020b. Bahamas Strategy for Blue Economy Activities. Inter-American Development Bank. *Unpublished*

IMF. 2020. World Economic Outlook, April 2020 IMF. [Accessed 18 February 2022] Available at: https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020

Khadan, J., and Ruprah, I. J. 2019. The economic and political costs of diversification as a way out of a recession: the case of Trinidad and Tobago. In Bissessar, A. (eds) Development, Political, and Economic Difficulties in the Caribbean. pp. 117–148. Palgrave Macmillan, Cham.

Kim, S. K. 2019. Essentials of Marine Biotechnology. Springer, 145–196.10.3389/fmars.2021.629629

Le Manach, F., Andriamahefazafy, M., Harper, S., Harris, A., Hosch, G., Lange, G. M., Zeller, D. *et al.*, 2013. Who gets what? Developing a more equitable framework for EU fishing agreements. Marine Policy, 38: 257–266.

McKinsey. 2019. Global Oil supply and demand outlook 2019, Mckinsey Energy Insights. [Accessed 07 March 2022] Available at: https://www.mckinsey.com/solutions/energy-insights/global-oil-supply-demand-outlook-to-2035/~/media/231FB01E4937431B8BA070CC55AA572E.ashx

Miller, K. A., Thompson, K. F., Johnston, P., and Santillo, D. 2018. An overview of seabed mining including the current state of development, environmental impacts, and knowledge gaps. Frontiers in Marine Science, 4: 418.

Miloslavich de Klein, P., Díaz Merlano, J. M., Klein Salas, E., Alvarado Barrientos, J. J., Díaz, C., Gobin, J. F., Escobar Briones, E. *et al.*, 2010. Marine Biodiversity in the Caribbean: regional estimates and distribution patterns.

Mulder, N. (coord.), 2020. The impact of the COVID-19 pandemic on the tourism sector in Latin America and the Caribbean, and options for a sustainable and resilient recovery, International Trade series, No. 157 (LC/TS.2020/147), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC). [Accessed 15 August 2022] Available at: https://www.cepal.org/sites/default/files/publication/files/46502/S2000751_en.pdf

Murphy, M. M., Jeyaseelan, S. M., Howitt, C., Greaves, N., Harewood, H., Quimby, K. R., Sobers, N. *et al.*, 2020. COVID-19 containment in the Caribbean: the experience of small island developing states. Research in Globalization, 2: 100019.

Nurse, L.A., McLean, R.F. , Agard, J. , Briguglio, L.P. , Duvat-Magnan, V. , Pelesikoti, N. , Tompkins, E., and Webb, A. 2014. Small islands. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 1613–1654. V.R. Barros, C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandreaand and L.L. White. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Ochs, A. *et al.* 2015. Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS): Baseline Report and Assessment. Washington, DC: Worldwatch Institute. [Accessed 29 August 2022] Available at: https://tapsec.org/wp-content/uploads/2021/05/C-SERMS.pdf

Offshore. 2020. BPC pushes back offshore Bahamas well to late-2020. Offshore Mag. [Accessed 14 July 2022]. https://www.offshore-mag.com/drilling-completion/article/14172749/bahamas-petroleum-company-pushes-back-offshore-bahamas-well-to-late2020

Oxenford, H. A., and McConney, P. 2020. Fisheries as a key component of blue economies in the Wider Caribbean. In The Caribbean blue economy(pp. 118–130). Routledge. London.

Oxenford, H. A., and Monnereau, I. 2017. Impacts of climate change on fish and shellfish in the coastal and marine environments of Caribbean Small Island developing states (SIDS). Caribbean marine climate change report card: science review, 2017: 83–114.

Páez-Osuna, F. 2001. The environmental impact of shrimp aquaculture: causes, effects, and mitigating alternatives. Environmental Management, 28: 131–140.

Patil, P. G., Virdin, J., Diez, S. M., Roberts, J., and Singh, A. 2016. Toward A Blue Economy: A Promise for Sustainable Growth in the Caribbean; An Overview. The World Bank, Washington D.C.

Piker, L. 2016. Overcoming the barriers in developing marine biotechnology enabled products Marine Biotechnology - enabling future innovations. Symposium.. oceanBASIS, Brussels.

Platon, C. 2017. Guyana-Suriname Basin, South America: hot ultra-Deepwater exploration opportunities and Liza Field: worldwide largest 2015-2016 hydrocarbon discovery. AAPG Annual Convention and Exhibition.

Reynolds, E., and Oppmann, P. 2020. March 16, coronavirus-hit cruise ship in diplomatic scramble to find somewhere to dock, CNN. [Accessed 17 July 2022]. Available at: https://edition.cnn.com/travel/article/cruisetransatlantic-coronavirus-gbr-intl/index.html.

Sea Around Us 2016. Tools and data: exclusive Economic Zone. accessed date 27 August 2019. Available at: http://www.seaaroundus.org/data/#/eez

Silva, N., Fuinhas, J.A., and Koengkan, M. 2021. Assessing the advancement of new renewable energy sources in Latin American and Caribbean countries. Energy, 237: p.121611.

Singh, A., Asmath, H., Chee, C. L., and Darsan, J. 2015. Potential oil spill risk from shipping and the implications for management in the Caribbean Sea. Marine pollution bulletin, 93: 217–227.

Skewes, T. D., Hunter, C. M., Butler, J. R. A., Lyne, V. D., Suadnya, W., and Wise, R. M. 2016. The Asset Drivers, Well-being Interaction Matrix (ADWIM): a participatory tool for estimating future impacts on ecosystem services and livelihoods. Climate Risk Management 12:69–82.

The Global Economy. 2020. Industry: oil, coal, and electricity indicators. [Accessed date 16 August 2022]. Data available to download at https://www.theglobaleconomy.com/download-data.php

Trégarot, E., Caillaud, A., Cornet, C. C., Taureau, F., Catry, T., Cragg, S. M., and Failler, P. 2021. Mangrove ecological services at the forefront of coastal change in the French overseas territories. Science of the Total Environment, 763: 143004.

Tregarot, E., Touron-Gardic, G., Cornet, C. C., and Failler, P. 2020. Valuation of coastal ecosystem services in the large Marine ecosystems of Africa. Environmental Development, 36: 100584.

UN ECLAC. 2020. Report on the economic impact of coronavirus disease (COVID-19) on Latin America and the Caribbean. Study prepared by the Economic Commission for Latin America and the Caribbean (ECLAC), at the request of the Government of Mexico in its capacity as Pro Tempore Chair of the Community of Latin American and Caribbean States (CELAC), at the virtual ministerial meeting on health matters for response and follow-up to the COVID-19 pandemic in Latin America and the Caribbean, held on 26 March 2020. [Accessed 24 July 2022]. Available at: .https://www.cepal.org/en/publications/45603-report-economic-impact-coronavirus-disease-covid-19-latin-america-and-caribbean.

UN ECLAC. 2021. Reckoning With Covid-19: Pursuing A People Centered Recovery And More Resilient Future For The Caribbean. Twentieth meeting of the Monitoring Committee of the Caribbean Development and Cooperation Committee of the Economic Commission for Latin America and the Caribbean. [Accessed 24 July 2022] Available at: . https://www.cepal.org/sites/default/files/events/files/20_mccdcc_ddr1_-_conference_document_2_nov_2021.pdf.

UNECA. 2016. Africa's blue economy: a policy handbook. Addis Ababa. © United Nations. Economic Commission for Africa. [Accessed 22 February 2022]. Available at: https://hdl.handle.net/10855/23014.

UNESCO, 2006. The use of desalination plants in the Caribbean. Caribbean Environmental Health Institute. Documentos Técnicos del PHI- LAC, N° 5 [Accessed 13 January 2022]. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000228110.locale=en.

UNICEF. 2019. Children uprooted in the Caribbean: how stronger hurricanes linked to a changing climate are driving child displacement.[Accessed 29 January 2022]. Available at: https://www.unicef.org/reports/children-uprooted-caribbean-2019

UNWTO. 2021. International tourism and Covid 19 – United Nations World Tourism Organisation. [Accessed 2 January 2022]. Available at: https://www.unwto.org/international-tourism-and-covid-19

Vosper, E. L., Mitchell, D. M., and Emanuel, K. 2020. Extreme hurricane rainfall affecting the Caribbean mitigated by the Paris Agreement goals. Environmental Research Letters, 15: 104053.

Welsh, K., and Bowleg, J. 2022. Interventions and solutions for water supply on small islands: The case of New Providence, The Bahamas.Frontiers in Water. 4:983167,171.

World Bank. 2019. The Role of Desalination in an Increasingly Water-Scarce World. World Bank Washington DC. © World Bank. [Accessed 19 August 2022]. https://openknowledge.worldbank.org/handle/10986/31416. License: CC BY 3.0 IGO.

World Bank. 2016. Toward a blue economy: a promise for sustainable growth in the Caribbean. [Accessed 15 June 2022]. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/25061/Demystifying0t0the0Caribbean0Region.pdf

Wurmann, C. S., Soto, D., and Norambuena, R. 2020. Regional review on status and trends in aquaculture development in Latin America and the Caribbean–2020. [Accessed June 15 2022]. Available at: https://www.aqua.cl/wp-content/uploads/2022/01/FAO-2020-REVIEW.pdf

Handling Editor: Sean Pascoe