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Toward a Blue Economy:
A Pathway for Sustainable Growth in Bangladesh

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Toward a Blue Economy: A Pathway for Sustainable Growth in Bangladesh

Pawan G. Patil
John Virdin
Charles S. Colgan
M.G. Hussain
Pierre Failler
Tibor Vegh

BLUE ECONOMY
GROWING OCEAN WEALTH

A COLLABORATIVE PARTNERSHIP

WORLD BANK GROUP
Environment & Natural Resources

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Middlebury Institute *of* International Studies at Monterey
Center for the Blue Economy

Acronyms and abbreviations

BBS	Bangladesh Bureau of Statistics
BOBLME	Bay of Bengal Large Marine Ecosystem
CICES	Common International Classification of Ecosystem Services
CMSP	Coastal and Marine Spatial Planning
CO2Eq	Carbon Dioxide Equivalent
DOWA	Deep Ocean Water Applications
EEZ	Exclusive Economic Zone
EIA	U.S. Energy Information Administration
ENOW	Economics: National Ocean Watch
ESESA	Experimental System of Ecosystem Service Accounts
FOSP	Future Ocean Spatial Planning
FY	Fiscal Year
FYP	Five-Year Plan
GDP	Gross Domestic Product
GEF	Global Environment Facility
GNI	Gross National Income
GVA	Gross Value Added
IEA	International Energy Agency
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
INDC	Intended Nationally Determined Contributions
ISIC	International Standard Industrial Classification
IUU	Illegal, Unregulated, and Unreported
IRENA	International Renewable Energy Agency
LME	Large Marine Ecosystem
MEA	Millennium Ecosystem Assessment
MOEF	Bangladesh Ministry of Environment and Forests
MPA	Marine Protected Area
MSP	Marine Spatial Planning
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
REDD+	Reducing Emissions from Deforestation, Forest Degradation and the Role of Conservation, Sustainable Management of Forests, and Enhancement of Forest Carbon Stocks in Developing Countries
SDG	Sustainable Development Goal
SEEA	System of Environmental and Economic Accounts
SIDS	Small Island Developing States
TEEB	Economics of Ecosystems and Biodiversity
TEU	Twenty Foot Equivalent Units
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
WTTC	World Travel and Tourism Council
WWF	World Wide Fund for Nature

Glossary of terms

Ocean economy **a.** Ocean economy Sector	The sum of the economic activities of ocean-based industries, and the assets, goods, and services of marine ecosystems (OECD 2016). Note that this definition does not imply any measure of the sustainability of these activities. **a.** A specific area or group of industries in the ocean economy. Also includes groups of ecosystem services for which markets do not exist and that are not reflected in measures of other industries or ecosystem services.
Blue economy	A concept applied to the ocean economy to reflect its level of sustainability, and defined here as simply "sustainable development of the ocean economy." This definition is based on characterizations of the concept as: • "A sustainable ocean economy, where economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy" (Economist Intelligence Unit 2015); and • "comprising the range of economic sectors and related policies that together determine whether the use of oceanic resources is sustainable" (World Bank and UN DESA 2017). The concept uses a metaphor with colors, describing an ocean economy as "brown" (not sustainable), or "blue" (the equivalent of "green" and sustainable), or somewhere in between the two. The blue economy is defined here as a sustainable ocean economy, in which economic wealth is balanced with the health of ocean ecosystems and their natural assets, and is socially sustainable.
Ocean's natural capital	Natural capital has been defined as the stocks of Earth's natural assets and resources, such as soil, water, air, and biodiversity (Brown et al. 2016). The ocean's natural capital is defined here as those natural assets and resources that are linked to the ocean environment. These assets and resources can be further defined as (i) stocks of natural resources, such as offshore deposits of fossil fuels, minerals, and aggregates, and (ii) spatially-defined stocks of "ecosystem assets" cycled and renewed as part of wider ecosystem functions and which yield a flow of valuable ecosystem services (Brown et al. 2016).
Ecosystem services	The benefits that people get from ecosystems (MEA 2005 and TEEB 2010).
Ecosystem functions	The capacity or capability of an ecosystem to produce or provide an outcome ("service") of potential use to people (Brown et al. 2016).

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The team that prepared this report was led by Pawan G. Patil, Senior Economist, Environment and Natural Resources Global Practice, World Bank, in collaboration with Manfred Fernholz, Team Leader of Food & Nutrition Security and Sustainable Development, the EU Delegation to Bangladesh. Core contributors and co-authors are John Virdin, Director of the Ocean and Coastal Policy Program at the Nicholas Institute for Environmental Policy Solutions at Duke University, Charles Colgan, Director of Research for the Center for the Blue Economy at Middlebury Institute for International Studies, M. Gulam Hussain, former Director General of Bangladesh Fisheries Research Institute, Bangladesh, Pierre Failler, Reader in Economics at the University of Portsmouth, United Kingdom, and Tibor Vegh, Policy Associate at the Nicholas Institute.

World Bank team members and contributors to the report include Tapas Paul (Lead Environmental Specialist), Md. Istiak Sobhan (Environmental Specialist), Nadia Sharmin (Senior Environmental Specialist), Nimanthi Attapattu (Operations Analyst), David Kaczan (Young Professional), Angie Harney (Program Assistant), and Jorge Guillermo Barbosa (Consultant).

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Executive summary

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This report aims to synthesize current theory and practice of the blue economy concept to govern economic activity linked to the ocean, and to provide a framework for the Government of Bangladesh to analyze its potential. With the peaceful resolution of maritime boundary disputes with its neighbors in 2012 and 2014, the Government has recently defined the ocean space under its jurisdiction. The country's sovereign ocean area is now on par with its land area, and if the 32 percent of the country's terrestrial area which is defined by interaction with the sea is included, blue spaces would exceed land. For this reason, the Government has prioritized the use of blue spaces as a key source of future growth. However, questions remain about how to embark on a policy planning process to achieve Bangladesh's blue economy aspirations, including measures of the current economic uses of the ocean space, the identification of clear targets for sustainable growth of use of this space, and a policy pathway to get there.

Global Concepts and Measures of an Ocean Economy and a Blue Economy Development Pathway

Described as an economic frontier, the term "ocean economy" applies collectively to ocean-based industry activities and the assets, goods, and services of marine ecosystems. Although defined differently by different countries, in Bangladesh the ocean economy consists of the following broad and growing economic sectors: living resources, minerals, energy, transport and trade, tourism and recreation, carbon sequestration, and coastal protection. These industries and ecosystem services do not develop in isolation, but rather interact as a system with a common denominator: the fluid, buoyant, three-dimensional environment of the ocean.

Ocean ecosystems provide the natural capital inputs that combine with produced and human capital to underpin the ocean economy. On a global scale, human-driven change to ocean ecosystems may profoundly affect human well-being, according to the G7 Science Academies (2015). Researchers have identified at least three significant human drivers of change in Bangladesh's ocean ecosystems: (i) increasing fishing capacity and effort (some illegal), as well as ecologically damaging fishing practices, (ii) coastal development (including altered habitats for aquaculture), and (iii) pollution, particularly pollution of waterways from urban centers. These drivers are mutually-reinforcing and exist in addition to climate change and other external drivers.

The concept of a "blue economy" emerged in 2012 as countries around the world grappled with the twin trends of accelerating growth in the ocean economy and changes in the underlying ecosystems. The blue economy concept is shorthand for policies that promote sustainable development of the ocean economy, where economic growth does not reduce the aggregate natural capital, and conservation of ecological commons contributes to poverty reduction. Such policies are commonly described as those that enhance simultaneously the three dimensions of ocean use embodied in the sustainable development paradigm: social, environmental, and economic. However, even as a number of national blue economy strategies have been prepared over the last five years, the definition of the concept has continued to fluctuate among different countries.

A blue economy aims for a balance between economic opportunities and the environmental limitations of using the ocean to generate wealth. In 2017 the World Bank and UN DESA described the concept as "comprising the range of economic sectors and related policies that together determine whether the use of oceanic resources is sustainable." The difference between "ocean economy" and "blue economy" is that the former provides no measure or indication of sustainability (and could be considered environmentally damaging, or "brown" in some instances). Given the status of the world's ocean ecosystems, the challenges of ensuring that an ocean economy becomes or remains "blue" are formidable for many countries, but particularly for developing coastal and island states that have the greatest need for intensive and extensive use of the ocean. For this reason, the blue economy concept has been described as both a "bold vision and an excruciatingly delicate balancing act."

Despite much discussion since 2012, few documents exist to describe how countries can transition their ocean economies toward a blue economy—but this report fills that gap by offering a conceptual framework to guide policy makers in Bangladesh. The report proposes specific reforms by illustrating the economic activities of the ocean economy together with the underlying natural capital, as well as other types of capital. The framework suggests entry points for policy reforms to change the flow of inputs from ocean ecosystems to the ocean economy over time, or conversely to reduce outputs from economic activity (such as pollution) that may impact the functioning of ocean ecosystems. The report also synthesizes principles that may help guide such policy reforms. Most importantly, the report summarizes the information base that the Government of Bangladesh will need to set realistic targets for a blue economy development pathway and to monitor progress.

Initial Baseline Measures of Output from Bangladesh's Ocean Economy, and a Summary of the Status of the Underlying Ecosystems

Efforts to measure the output from Bangladesh's ocean economy have only recently begun. The Government has not traditionally disaggregated and organized data in a way that permits analysis over time. To provide an initial conservative snapshot of the magnitude of the country's ocean economy, this report synthesizes disaggregated data provided by the Bureau of Statistics for key ocean-based industries. While this represents the best information available, it provides only a partial baseline of the size of the ocean economy, for several reasons: (i) The measures reflect an imperfect separation of ocean and non-ocean related economic activities, for example, the distinction between marine and inland capture fisheries and aquaculture; (ii) The measures of economic output do not include the economic value of number of ecosystem services without the market transactions; and (iii) The measures do not subtract the costs to the country from environmental degradation resulting from various activities in the ocean economy, such as pollution from ship breaking. Factoring in the costs of this degradation will reduce the estimated size of the country's ocean economy.

Available data suggest that the ocean economy contributed US$6.2 billion in gross value added (GVA) to the Bangladesh economy in 2015, or approximately 3 percent. This rate of contribution held relatively constant over the five-year period from 2010 to 2015 for which data are available. Bangladesh's current ocean economy is comprised largely of tourism and recreation (25 percent), marine capture fisheries and aquaculture (22 percent), transport (22 percent), and offshore gas and oil extraction (19 percent). Employment data is limited; in marine capture fisheries and aquaculture, estimates have suggested full and part-time employment over 1.3 million. An estimated six million people are employed in sea salt production and ship breaking. Recent reports cite as many as 30 million people dependent upon the country's ocean economy, a number that likely reflects both employees and household dependents.

Future growth in the Bangladesh ocean economy will likely focus on specific key sectors. Perhaps most prominently, the new maritime boundaries give Bangladesh some of the largest estimated gas and oil reserves in the region, though specific projections for production and revenues are not yet available. In the next decade, shipbuilding (a highly competitive global industry) shows the potential to grow moderately, and investment in the tourism sector (which includes coastal and maritime tourism) is expected to grow more than 9 percent annually. In addition, a number of potential new ocean industries have been identified in Bangladesh, such as mariculture of seaweed and other macro algae, as well as mussels, oysters, marine pearl, sea cucumbers, and sea urchins. Biotechnology may offer potential applications in Bangladesh, as well as coastal and offshore wind generation technologies.

Damage to ocean ecosystems threatens to pose a significant risk to the future growth of Bangladesh's ocean economy. Three human drivers of change hold particular potential for harm to ecosystems: increasing fishing capacity, coastal development, and pollution—all occurring in the context of climate change. Fishing capacity has been growing, notably in the large-scale trawl fleet which targets a number of overexploited species. Limited information is available on the status of the fish stocks supported by Bangladesh's ocean ecosystems, but the stocks appear to be under stress. In coastal development, the population residing in the low-elevation coastal zone is projected to grow from 64 million in 2000 to 85 million in 2030, and potentially to over 100 million by 2060. This expanding coastal population faces the growing risks of sea level rise and flooding, which could inundate up to 17.5 percent of the country's total land mass. This makes Bangladesh one of the world's most climate-vulnerable countries. Lastly, pollution in the form of high-nutrient inputs from untreated sewage contribute to coastal eutrophication and declining water quality, while pesticide residues enter the ocean via rivers and streams, and in some coastal areas ship-breaking activities release pollutants. Together these three human drivers are changing ocean ecosystems that are inextricably linked to the performance of the ocean economy.

At least four external drivers will likely shape the future of Bangladesh's ocean economy: (i) demographic change, (ii) global markets and the economy, (iii) science and technology, and (iv) climate change. These drivers reflect the controlled variables, which together with the independent variable—policy decisions by the Government of Bangladesh—will determine the dependent variable: future growth in the ocean economy, in terms of annual output and the underlying capital stocks.

The Way Forward to Apply the Blue Economy Concept in Bangladesh

Rather than proposing specific actions on a sector-by-sector basis, this report suggests key elements of a coordinated policy planning process to help guide a strategic and long-term transition to a blue economy in Bangladesh. The range of opportunities and risks to achieving Bangladesh's blue economy objectives is daunting in its complexity. For example, traditional industries such as capture fisheries are likely to remain the focus of a blue economy development pathway, but will require measures to address overexploitation, notably in the coastal waters as a result of growing trawl capacity and operations (including non-compliance with regulations). In other traditional industries such as transport, shipbuilding, and tourism, blue economy opportunities may arise based on lessons from neighboring countries, needing coordinated support to address resource overexploitation and constraints on investment (such as building of infrastructure). At the same time, the emerging ocean industries that researchers have identified in Bangladesh, including mariculture, marine biotechnology, and coastal and offshore wind energy, will require special nurturing.

So far, a coordinated policy planning process for the ocean economy is not in place in Bangladesh, one that could set measurable targets and consistently monitor progress. The benefits from such a process could include lower costs for shared common infrastructure, support for cross-fertilization of technologies and innovation, enhanced or rebuilt natural capital assets underpinning a range of activities, and, broadly, a more effective use of shared ocean space.

A first recommendation for a blue economy planning process is to begin developing systems to measure and monitor the performance of Bangladesh's ocean economy along targeted development pathways. To achieve its blue economy aspirations, Bangladesh will need basic measures of the ocean economy—if only as a snapshot in time. Currently, data on the gross value added of ocean industries and services with markets are not disaggregated in the national accounts, which are constructed by collecting administrative data from different public and private agencies and BBS census surveys. As a result, ocean data are only available through significant effort. The country would do well to develop an "ocean account" at BBS, beginning with steps to (i) identify the country's ocean economy industries at appropriate levels of precision, and (ii) include a geographic measure of proximity to the ocean and coast for these industries.

Over time, the aim would be to incorporate measures of the economic value of natural capital. An ocean account at BBS will provide a snapshot in time of the contribution of the ocean economy to Bangladesh's national economy, but an incomplete one given the lack of information on ecosystem services that have no markets. Even if such services were included in the snapshot, it would only reflect the annual return on capital and not the status of the underlying capital assets (e.g. natural capital). It would not indicate whether annual withdrawals were sustainable. Supplementing the data from an ocean account established at BBS with relevant data for ecosystem assets and non-renewable ocean resources could help create a consolidated "blue economy account." This account would still provide the snapshot of the ocean economy's contribution to the national economy in Bangladesh measured on a value-added basis—the "gross ocean product"— and would also provide the "net ocean product" reflecting the gain (or loss) in physical and natural capital for any given period. Expanding an ocean account to include net ocean product could provide a much more complete picture of the withdrawals of natural capital from the ocean economy, as compared to investments in it. However, valuation of many of the non-market ecosystem services will likely remain a challenge. Moreover, this measure would not account for human capital.

A second recommendation for a planning process is to articulate a range of policy scenarios for development of the country's ocean economy, and set clear targets for its transition to a blue economy. Building upon the initial assessment of the size and scope of this segment of the national economy as a baseline, together with the summary of information available on the status of the underlying natural capital assets, various scenarios of growth in Bangladesh's ocean economy could be analyzed. These could include business-as-usual, a "blue economy scenario," and a "brown economy scenario," taking into account what is known about the various external drivers. The output from modeling these scenarios would be clear targets for a blue economy development pathway, along with estimates of the costs and benefits to Bangladesh from the policies and investments needed to get there. As a starting point, scenarios may be developed and modeled for priority blue economy sectors such as capture fisheries, leading to estimates of the economic benefits and return on investment from improved resource management and larger fish stocks, with accompanying benefits of enhanced food security.

Creating a planning process for sustainable development of the country's ocean economy will require active participation and decisions by a wide range of public agencies, linked by common objectives and active sharing of information. In recognition of this challenge, a "Blue Economy Cell" has recently been established at the Ministry of Power, Energy, and Mineral Resources. While a good first step, this cell will likely need to be supported by a stronger coordination mechanism linked to the Planning Commission. This would facilitate carrying out the recommendations of measuring the ocean economy and modeling its future potential, and subsequently setting clear and realistic targets for the benefits that could be generated from a blue economy. Government success in coordinating a policy planning and implementation process will go a long way toward lowering transaction costs and ultimately enhancing the investment climate.

1 Introduction: A Growing Ocean Economy

"Mr. President, we must join ranks to preserve our natural resources for our succeeding generations. Bangladesh reaffirms the need for conservation and sustainable use of marine resources for tapping the potential of a Blue Economy."

– H.E. Sheikh Hasina, Prime Minister of Bangladesh, addressing the United Nations General Assembly in 2016

With the resolution of maritime boundary disputes in 2012 with Myanmar and in 2014 with India, the Government of Bangladesh defined the ocean space under its jurisdiction (Figure 1). That space is now almost equivalent in size to the country's land mass, and the Government has prioritized its use as a key source of future growth. To guide the ocean space's development, the Government has embraced the emerging concept of a "blue economy," in which economic activity linked to the ocean is balanced with the capacity and resilience of ocean ecosystems. This concept features prominently as a policy objective in the Seventh Five Year Plan completed in 2015 (GED 2015). Such objectives for the ocean reflect the country's experience with the costs of environmental degradation that has accompanied economic growth in terrestrial areas. For example, the estimated costs of air pollution associated with the expansion of cities in Bangladesh are on the order of one percent of Gross Domestic Product (World Bank 2018a).

Since 2015, the Government has undertaken a number of consultations to elaborate the concept in the context of Bangladesh, most recently in the Second International Blue Economy Dialogue hosted by the Ministry of Foreign Affairs in late 2017. Given the breadth of economic activity in Bangladesh's ocean space, the Government's objective to promote a blue economy touches upon the responsibilities of numerous sectoral policy makers and regulatory agencies. For this reason, a high-level committee was formed under the direction of the Secretary to the Prime Minister's office to coordinate efforts and inputs to develop policies and operational strategies (Alam 2014 and Hussain et al. 2017a and 2017b). In 2017, following the guidance of the Planning Commission, the Government established the Blue Economy Cell, with a mandate to coordinate across sectoral ministries to better chart a path toward sustainable development of the ocean area and answer key questions to best support the five-year development plan.

However, a number of questions remain concerning a policy planning process to achieve the country's blue economy aspirations, including how to better measure the current economic uses of the ocean space, identify clear targets for sustainable growth of the use of this space, and set a policy pathway to get there. Bangladesh is not alone in facing these questions, nor in grappling with the complexities of the blue economy concept. In recent years, many of the world's coastal and island governments have looked to the ocean as a new economic frontier, and developed growth policies based on the concept of a blue economy (Economist Intelligence Unit 2015). Definitions

Figure 1: **Bangladesh's Exclusive Economic Zone**

and applications of the concept have differed significantly among countries, and the basic information requirements for such an approach are often lacking (Colgan 2017a).

To assist in answering these questions, the European Union (EU) has been providing a two-year technical assistance program in collaboration with the World Bank, including preparation of this report. With support from this joint high level, non-lending technical assistance, this report offers answers to some fundamental questions, including initial (and admittedly incomplete) estimates of output from the economic activity linked to Bangladesh's ocean space as a baseline measure. The report also suggests ways for the Government to incorporate the missing costs of environmental degradation and to consider the size and distribution of the economic costs and benefits of possible development pathways forward. This would help it set clear targets and monitor progress.

The rationale for such action is simple: it is difficult for a country to manage what it can't measure, particularly when economic benefits depend upon maintaining the health of the natural capital stock. In effect, this report provides a partial baseline on which policy and reform pathways can be assessed and growth measured as Bangladesh begins in earnest to sustainably derive economic value from its ocean space.

Chapter Two of the report describes the global concepts and measures that underpin Bangladesh's blue economy aspirations, based on a review of literature on the ocean economy. It includes foundational research and past work by the Center for the Blue Economy on the National Ocean Economics Program in the United States. It features a literature review of the term "blue economy," along with foundational research such as the report by the World Bank and UN DESA (2017) and country case studies.

Chapter Three applies the conceptual framework described in the previous chapter to Bangladesh, summarizing output from the ocean economy at given points in time with the best data available from the Bangladesh Bureau of Statistics (BBS) and other sources. The chapter summarizes the status of ecosystems that enable this economic output, with literature reviews for specific ecosystems and topics. This initial assessment of the size of Bangladesh's ocean economy provides a partial baseline, but does not include the economic value of non-market ecosystem services nor the external costs of environmental degradation from ocean economy activities.

Chapter Four provides considerations for a way forward to improve measures of the baseline for Bangladesh's ocean economy, establish a planning process that sets realistic targets for a blue economy, and identify the policies needed to get there. The chapter suggests key next steps, building upon the baseline presented in Chapter Three and considering the likely external drivers influencing change in the country's ocean economy, in order to assess the costs and benefits of potential blue economy scenarios.

Preliminary findings of this report were presented for discussion at the Second International Blue Economy Dialogue hosted by the Ministry of Foreign Affairs on November 23, 2017. See Annex I for a more detailed description of the methods used to prepare the report.

2 Global Concepts and Measures for the Blue Economy

PHOTO CREDIT: PIERRE FAILLER

1.1 The Concept and Measurement of an 'Ocean Economy'

1.1.1 Context: Growth in Economic Activity Linked to the Global Ocean

The ocean has been a source of wealth for millennia, linking economies around the world. Many large cities and centers of commerce developed based on access to the sea, and now some 38 percent (and growing) of the global population is estimated to live within 100 kilometers of the coast (United Nations 2016). The ocean is integral to the global economy. Submarine cables cross the ocean's floor to carry 90 percent of the electronic traffic upon which global communications rely (United Nations 2016). Oil and gas from the ocean's floor provided 30 percent of global consumption needs in 2014, up from 20 percent in 1980 (Brakenhoff 2015). In 2013 fishery resources—mostly from the sea—provided more than 3.1 billion people with almost 20 percent on average of their consumption of animal protein (FAO 2016). The estimated 1 to 1.4 million different species that live in the ocean support a growing commercial interest in marine genetic resources that is leading to the commercial development of pharmaceuticals, enzymes, and cosmetic products. The rate of patent applications related to marine genetic material increased at rates exceeding 12 percent per year from 1999 to 2008. Over 5,000 genes derived from marine organisms had been patented by 2010 (Costello et al. 2010, Montaser and Luetsch 2011, and Arnaud-Haond, Arrieta, and Duarte 2011 in World Bank 2017).

Yet economic activity linked to the ocean may be set to become even greater. In recent years the ocean has been labeled an "economic frontier" as the expanding global population searches for new sources of growth, while rapid technological advances make new resources and spaces accessible (Economist Intelligence Unit 2015 and OECD 2016). The physical context of the ocean shapes this frontier: a fluid, buoyant, three-dimensional environment, where resources such as fisheries can span multiple jurisdictions and political boundaries. Economic activity in this space has traditionally focused on such industries as shipping, shipbuilding and marine equipment; coastal and maritime tourism; inshore and offshore marine aquaculture; fishing and fish processing; port facilities and cargo handling; and offshore oil and gas. The mix will change dramatically in the coming decades, according to the OECD (2016), with a bigger role for emerging industries that include offshore wind, tidal, and wave energy; oil and gas exploration and production from previously inaccessible waters; offshore aquaculture; seabed mining; and marine biotechnology. Additional industries yet to be "born" at all may join this list: carbon capture and storage, for example. Whether established or emerging, these industries are experiencing innovation and change. The potential benefits are considerable and could help address many of the key challenges facing the expanding global population in coming decades, from food insecurity to the search for new sources of energy and jobs (OECD 2016).

The projected growth presents both opportunity and risk for coastal states like Bangladesh. For example, new sources of economic growth come with risks of adverse social impacts in coastal communities and environmental degradation. Many countries around the world have started to examine these potential outcomes, putting forward integrated policies that seek to maximize the opportunity and minimize the risk.

2.1.2 The Concept of an "Ocean Economy" to Synthesize the Economic Activity Linked to the Ocean

Given the wide and growing range of economic activity dependent upon and shaped by the ocean, economists in recent years have begun to measure this activity collectively, as a unique segment of the global economy which they designate as the ocean economy. The term has not been consistently defined, with 14 different countries using 14 different definitions at one point (Park and Kildow 2014). To promote greater coherence, the OECD suggested in 2016 that the ocean economy be defined as the sum of the economic activities of ocean-based industries,[1] and the assets, goods, and services of marine ecosystems.[2] This definition includes direct and indirect supporting activities necessary for the functioning of ocean-based industries, even if they are located in landlocked countries (OECD 2016).

Identifying the portions of a national economy tied to the ocean is not always straightforward—what is ocean and what is not? For example, coastal electric power generation, marine-related pharmaceuticals, and salt (the removal of which from water has value for food, potable water, or both) are included by some countries but not by others (Colgan 2017b).

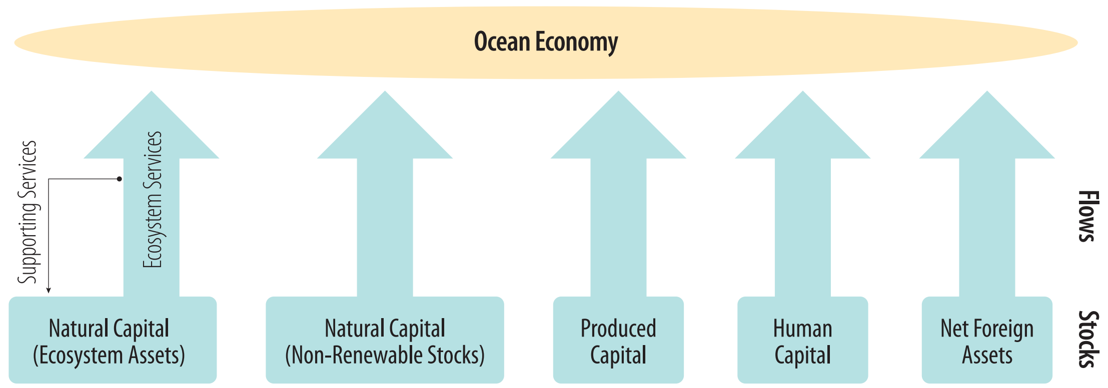
However one defines the ocean economy and measures its output, policymakers should understand the foundations upon which it rests. Following the framework used in Lange et al. (2018) for describing the asset base upon which national economic output rests, four classes of assets (capital) are characterized as underpinning output from the ocean economy:

1. **Natural capital,** defined as the stocks of natural assets and resources, such as soil, water, and biodiversity, and further sub-divided into (i) stocks of natural resources that are considered "non-renewable," such as offshore deposits of fossil fuels, minerals, and aggregates, and (ii) spatially-defined stocks of "ecosystem assets" which are cycled and renewed as part of wider ecosystem functions and which yield a flow of valuable "ecosystem services."
2. **Produced capital and urban land,** defined as machinery, buildings, equipment, and urban land (residential and non-residential), measured at market prices.
3. **Human and social capital,** defined as the value of skills, experience, and effort by the working population, disaggregated by gender and employment status (employed, self-employed) and measured as the discounted value of earnings over a person's lifetime.
4. **Net foreign assets,** defined as the sum of a country's external assets and liabilities, for example, foreign direct investment and reserve assets (Lange et al. 2018, Colgan 2017a, Brown et al. 2016, and World Bank 2006).

The first type of capital underpinning an ocean economy bears further description. The ocean's natural capital includes not only the physical marine environment itself and the stocks of non-renewable natural resources it contains, but also spatially-defined stocks of ecosystems. The latter are described as ecosystem assets and include stocks typically defined as "renewable resources." Spatially defined stocks of ecosystems include processes of multi-species activity taking place in the physical marine environment (Brown et al. 2016). These ecosystem processes ultimately generate what are called *ecosystem services*[3]—a flow of benefits described as the "interest" that society receives on the ecosystem assets included in the ocean's natural capital. The flow of ecosystem services is valued by economists as the discounted stream of benefits (TEEB 2010 and Liquete et al. 2013). From this perspective, the ocean's "natural capital assets"

1 The term "industry" embodies only market-based activities in the private and public sectors, while the term "economy" captures both the values embodied in market-based exchanges and the values placed on goods and services but not determined in markets (OECD 2016).
2 The term "ecosystem" is used here to characterize the interaction of communities of living organisms with the abiotic environment. Ecosystems vary both in size and, arguably, complexity, and may be nested within one another. In practice, use of the term is more intuitive than based on any distinct spatial configuration of interactions (TEEB 2010).
3 The term "ecosystem services" is defined as the benefits that people get from ecosystems (MEA 2005 and TEEB 2010).

Figure 2: The Four Types of Capital Underpinning the Ocean Economy



Sources: Based on definitions in Lange et al. 2018 and Brown et al. 2016.

include the stocks of non-renewable natural resources and the stocks of ecosystem assets and their ecosystem services (Narloch et al. 2016).

Research on the flow of ecosystem services provided by ecosystem assets has grown exponentially since the Millennium Ecosystem Assessment (MEA 2005) defined the field. The MEA's framework has been used to characterize ecosystem services as follows:

- ***Provisioning services*** that provide raw materials, food, and energy (e.g. seabed deposits, fish stocks, genetic resources, biofuels, and abiotic outputs such as minerals);
- ***Supporting services*** that support and enable the maintenance and delivery of other services (e.g. photosynthesis, nutrient cycling, soil, sediment, and sand formation);
- ***Regulating services*** derived from the natural regulation of ecosystem processes and natural cycles (e.g. water regulation, natural hazard regulation, shoreline stabilization, and carbon sequestration); and
- ***Cultural services*** that represent the benefits received from experiences in natural environments (e.g. tourism, recreation, spiritual inspiration, aesthetics, and education) (CICES 2017, OECD 2016, Liquete et al. 2013, and MEA 2005).

Table 1 applies this framework to ocean ecosystems, as catalogued by the United Nations Environment Program (UNEP).

Ocean ecosystems exhibit complex and dependent interactions that generate trade-offs in the delivery of ecosystem services (OECD 2016). The quantity, quality, and economic value of these services will depend on the functioning of the ecosystems, and particularly the resilience of these functions to exogenous shocks.

Unlike ecosystem services, the produced capital underpinning the ocean economy is relatively well known (e.g. ports and harbors, ships and boats, dry docks and cranes, tourism facilities such as hotels, and research and education centers). The produced capital is created and owned by the public or private sector or a mix of the two (Colgan 2017a).[4] Similarly, the human capital underpinning the ocean economy ranges from the traditional knowledge that a small-scale fisher has about how to catch a school of fish to the skills of a master mariner guiding a container ship through a narrow strait (Colgan 2017a).

The four types of capital support of the ocean economy involve multiple economic sectors, each including specific industries or services. For instance, 25 countries have identified 54 industries as part of the ocean economy, based on context. Despite differences, these efforts have typically identified a core group of sectors and industries in the ocean economy: living resources, marine construction, tourism and recreation, boat building and repair, marine transportation, and minerals, including oil and gas (Colgan 2017b).

4 Physical capital that provides a public good is often referred to as "infrastructure."

Table 1: Ecosystem Services in Marine and Coastal Environments

Ecosystem Services	Coastal									Marine		
	Estuaries & marshes	Mangroves	Lagoon and salt ponds	Intertidal	Kelp	Rock & shell reefs	Seagrass	Coral reefs	Continental shelf	Outer shelves edges slopes	Seamounts & mid-ocean ridges	Deep sea and central gyres
Biodiversity	x	x	x	x	x	x	x	x	x	x	x	x
Provisioning services												
Food	x	x	x	x	x	x	x	x	x	x	x	x
Fiber, fuel, timber	x	x	x						x	x		x
Medicines, other resources	x	x	x		x			x	x			
Regulating services												
Biological regulation	x	x	x	x		x		x				
Freshwater storage and retention	x		x									
Hydrological balance	x		x									
Atmospheric and climate regulation	x	x	x	x		x	x	x	x	x		x
Human disease control	x	x	x	x		x	x	x				
Waste processing	x	x	x				x	x				
Flood/storm protection	x	x	x	x	x	x	x	x				
Erosion control	x	x	x				x	x				
Cultural services												
Cultural and amenity	x	x	x	x	x	x	x	x	x			
Recreational	x	x	x	x	x			x				
Aesthetics	x		x	x				x				
Education and research	x	x	x	x	x	x	x	x	x	x	x	x
Supporting services												
Biochemical	x	x			x			x				
Nutrient cycling and fertility	x	x	x	x	x	x		x	x	x	x	x

Source: Adapted from UNEP 2006.

Drawing from these cases around the world, the sectors and industries or services that constitute the ocean economy at the global level are broadly categorized in Table 2.

The ocean's natural capital and the flow of ecosystem services shown in Figure 1 provide an integral part of the ocean economy (OECD 2016). Indeed, most of the sectors of the ocean economy described in Table 2 draw upon natural capital to some extent. In addition, a number of ecosystem services have been recognized (Liquete et al. 2013) but are combined in Table 2 for easier measurement, or excluded because they are considered to be reflected in measures of other service categories (e.g. supporting services such as nutrient cycling).

Table 2: Components of the Global Ocean Economy

Ocean economy sector	Ocean economy industry/service
Living resources	Capture fisheries Finfish Shellfish Other (e.g. echinoderms such as sea cucumber, sea urchin)
	Marine aquaculture Finfish Shellfish Sea Plants (seaweeds and other macro and micro algae) Mollusks (mussels, clams and pearly oysters) Other (e.g. sea cucumber and sea urchin)
	Processing and retailing Marine aquatic product preparation and packaging Marine aquatic product canning Fresh and frozen seafood processing Fish and seafood markets Fish and seafood merchant wholesalers
Minerals	Aggregates mining Sand and gravel mining Other minerals Support activities for non-metallic minerals mining
	Marine (including deep sea) minerals mining
	Sea salt production
Energy	Offshore oil and gas Crude petroleum and natural gas exploration Crude petroleum and natural gas field development Crude petroleum extraction Natural gas (liquid) extraction Support activities Oil and gas pipeline and related structures
	Coastal electric power generation (when ocean/estuary waters are used for cooling)
	Renewable energy sources Wind (onshore in coastal locations and offshore) Wave Tidal Ocean thermal energy conversion Osmotic energy
Coastal and maritime research and education	Research and training institutions and projects Secondary and higher education institutions
Ocean support services	Insurance and inspection services
Desalination	Desalination plants and construction of related water supply systems
Maritime safety and security	Military, coast guard, and other public safety organizations; private security
Other raw materials (e.g. for marine biotechnology)	Pharmaceuticals, chemicals, bio-fuels, bio-fertilizers, bio-polymers.

Ocean economy sector	Ocean economy industry/service
Transport and trade	Transport Maritime freight transportation Coastal freight transportation Maritime passenger transportation Coastal passenger transportation Navigational services to shipping Port and harbor operations Marine cargo handling Production of navigational products Other support activities to water transportation
	Ship and boat building Ship building and repair Ship breaking Boat building and repair Boat sales
Tourism and recreation	Tourism Scenic and sightseeing transportation, water, and other Recreational activity or sporting goods (sale or rental)—e.g. recreational fishing equipment Sports and recreation instruction Zoos and aquaria Nature parks and other similar institutions Marinas Hotels and motels Bed and breakfast inns Full-service restaurants Limited service eating places Snack and non-alcoholic beverage bars
Coastal development	Marine-related construction (infrastructure development)
Carbon sequestration	Blue carbon (i.e. coastal vegetated habitats)
Coastal protection*	Habitat protection, restoration
Waste disposal	Assimilation of nutrients, solid waste
Existence of biodiversity	Protection of endangered marine species, protection and restoration of habitats
Cultural, religious, spiritual, and emblematic services	Value attributed to ecosystems, e.g. to an estuary or river

** Coastal protection services refers to the risk-reduction role of either natural or nature-based features (Arkema et al. 2017).*
Note: Blue shading indicates ecosystem services for which markets do not yet exist.

2.1.3 Brief Summary of Efforts to Measure the Size of the Ocean Economy

Efforts to measure the size of the ocean economy began in the United States with a focus on output, with researchers attempting since 1974 to gauge the contribution of ocean-related economic activity to the Gross Domestic Product (GDP). Subsequent efforts were undertaken before 2008 in Australia, Canada, France, and the United Kingdom. As a result of its long efforts, the United States has established the Economics: National Ocean Watch Program (ENOW) at the National Oceanic and Atmospheric Administration (NOAA). The program maintains data on output from the country's ocean economy, in terms of contribution to

Gross Domestic Product (GDP, measured on a gross value added basis), employment, number of establishments, and total wages (Colgan 2013).

Some recent examples of calculations of the ocean's economic contributions at the regional, national, and sub-national levels include:

- ***Australia:*** contribution of AU$47.2 billion to GDP in 2012, or over 3 percent of the total (National Marine Science Committee 2015);
- ***China:*** total gross value added (GVA) of US$239 billion in 2010, or 4 percent of GDP, employing over 9 million people (Zhao et al. 2014);
- ***European Union:*** total GVA of €500 billion annually, employing over 5 million people (EC 2017a);
- ***Ireland:*** total GVA of €3.37 billion in 2016, or 1.7 percent of GDP (Vega and Hynes 2017);
- ***Mauritius:*** 10 percent of GDP on average for the period from 2012 to 2014 (Cervigni and Scandizzo 2017);
- ***United States:*** contribution of US$359 billion to GDP in 2013 or more than 2 percent of the total, employing 3 million people (Kildow et al. 2016).
- ***U.S. State of California:*** contribution of US$44.8 billion to GDP in 2012, or 12 percent of the state's total;
- ***U.S. State of Louisiana:*** contribution of US$11.3 billion to GDP in 2011, or 4.8 percent of the state's total (Young 2014); and
- ***U.S. State of North Carolina:*** contribution of US$2.1 billion to GDP in 2013, employing more than 43,000 people (Harrison et al. 2017).

Such efforts to measure output from the ocean economy are receiving greater attention around the world. A number of countries have establishing dedicated ocean accounts that derive from and add to their national income and product accounts, as well as statistical series such as employment, income, and population (Colgan 2017b). The methods used and the industries categorized vary, but the accounts typically include a core group: living resources, marine construction, tourism and recreation, boat building and repair, marine transportation, and minerals including oil and gas (Colgan 2017b). The two measures of economic output that governments commonly use are GDP and gross value added (GVA), with employment and total wages used in some cases. Both GDP and GVA measure the total value of goods produced and services provided in an area, industry, or sector (i.e. economic output), but GVA is typically used for entities smaller than the whole economy. GVA is used in this report for the ocean economy, as in OECD 2016. GDP is calculated as GVA plus taxes minus subsidies in a given sector.

A number of estimates have emerged in recent years for total output from the global ocean economy. For example, a report by the World Wide Fund for Nature (WWF) proposes the world's "gross marine product" at an annual value of US$2.5 trillion. It averages a "top-down" analysis extrapolating the percentage of known ocean economy contributions to GDP, and a "bottom-up" analysis estimating the value of marketed goods and services produced by industries, as well as other benefits (Hoegh-Guldberg 2015). The Global Ocean Commission estimated the market value of marine and coastal resources at US$3 trillion annually (Global Ocean Commission 2014), and annual gross revenues have been estimated on the order of US$2.6 trillion (Golden et al. 2017).

The OECD Ocean Economy Database has made the most extensive measurement effort to date in terms of countries covered. It suggests a global contribution of US$1.5 trillion in value added in 2010, representing 2.5 percent of world gross value added, and 31 million direct full-time jobs. These measures did not include small-scale fisheries, however, and should be considered as very conservative (OECD 2016). In coastal and island states with large ocean areas, the relative contribution of the ocean economy is estimated much higher: 10 percent of China's GDP in 2014, and 20 percent of Indonesia's (Economist Intelligence Unit 2015). In global terms, the ocean economy ranks in size among the twelve largest national economies in the world (Figure 3).

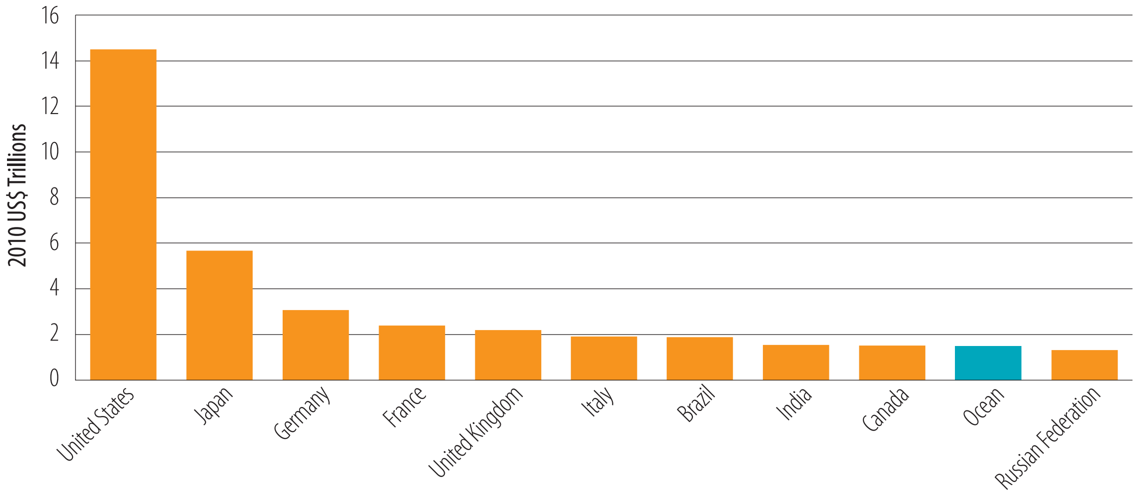
Box 1: OECD's 2016 Measure of Output from the Global Ocean Economy

The OECD's measure of output from the global ocean economy is gross value added (GVA) at basic prices, as recommended by the System of National Accounts in order to compare an industry's contribution to the economy across countries. The difference between total industry GVA and total GDP is taxes less subsidies on products. These calculations were made for selected ocean-based industries captured in the OECD Ocean Economy Database, consisting of 169 coastal countries and drawn heavily from UN and OECD sources. Where official data were patchy, proxies were used based on national reports and secondary sources. Of the industries included, one third of the value added of the global ocean economy was derived from offshore oil and gas, another 26 percent from ocean and coastal tourism, and 13 percent from ports.

Source: OECD 2016.

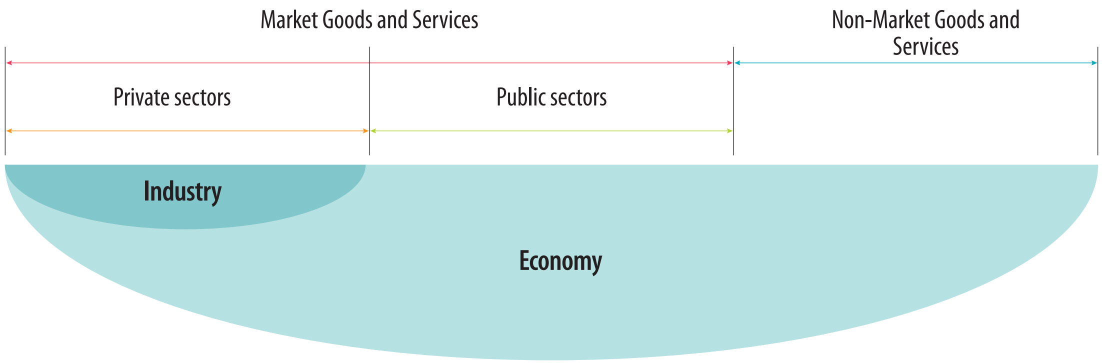
Figure 3: The Global Ocean Economy Compared to the Top National Economies in 2010

(2010 Gross Value Added at Factor Cost, Constant 2010 US$)



Note: Data not available for China.
Sources: World Bank 2017 and OECD 2016.

Figure 4: The Portion of the Ocean Economy Measured by Markets



Source: Park and Kildow 2014.

These estimates of output from the ocean economy do not include a number of ecosystem services that constitute an essential part of the ocean economy but for which markets do not exist (see Figure 4). However, these ecosystem services provide significant benefits to well-being: carbon sequestration, coastal flood protection, and waste disposal, among others. For example, one study examined mangrove ecosystems in 46 countries (over 53 percent of estimated mangroves worldwide) and found that the ecosystems may reduce the area of coastal zone subject to storm surge by some 30 percent, or 36,061 square kilometers

(Blankespoor, Dasgupta, and Lange 2016). Without estimates of the economic value of such services, measures of output from the ocean economy will always be incomplete (OECD 2016). Essentially, estimates of economic output from industries in the ocean economy that are not accompanied by estimates of the economic value of ocean ecosystem services provide only part of the picture. They would not, for example, include the costs of industry activities that impact or draw down the underlying ecosystem assets and hence reduce their flow of services.

Quantitative measurement of ecosystem services as an economic value is a relatively new research field. It has evolved rapidly, despite limits to methodology and data collection in some cases (Colgan 2017a and OECD 2016). The Economics of Ecosystems and Biodiversity (TEEB) initiative identifies widely accepted methodologies for valuing ecosystem services (TEEB 2010). New work continues to emerge (e.g. Beck and Lange 2016 and the Natural Capital Project).[5] When marine ecosystem services do not result in market transactions, economists measure revealed or stated preferences for the outputs, or the cost of appropriate substitutes for the service (Colgan 2017a). Through efforts like these, they try to fill holes in our current measures, which do not reflect the full size of the ocean economy in terms of output.

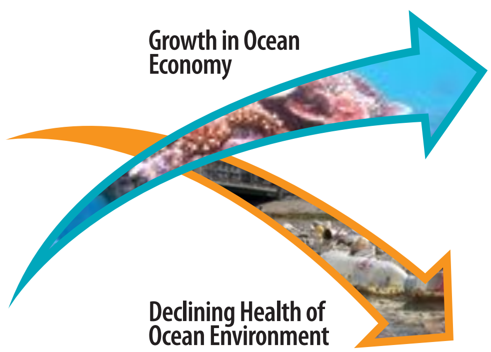
For now, however, measures of annual output from the ocean economy (e.g. as gross value added) are at best ambiguous indicators of sustainability and more commonly do not reflect sustainability at all. Such annual output measures ignore changes to underlying natural capital stocks and the future benefit streams that they can provide (World Bank 2012). At best, such measures provide a snapshot in time of the size of the ocean economy (Colgan 2017a).

2.2 The Concept of A Blue Economy

2.2.1 Emergence of the Blue Economy Concept

At the same time as the ocean economy has grown, the ecosystems underpinning this activity have undergone significant human-driven changes, in some cases towards ecological collapse (Jackson et al. 2001). Two overarching global trends are shown below in Figure 5: growth in the ocean economy and human-driven changes to underlying ocean ecosystems which may in turn reduce that growth. (See Annex II for a summary of the status of ocean ecosystems).

Figure 5: Two Concurrent Trends in the Global Ocean



Source: Patil et al. 2016.

The status of ocean ecosystems will define how productive and efficient the future ocean economy will be (OECD 2016). Concerned by the magnitude of these changes, the UN General Assembly adopted Sustainable Development Goal (SDG) 14 in 2015 focused on ocean conservation and sustainable use (see Box 2).

5 See https://www.naturalcapitalproject.org/

Box 2: Sustainable Development Goal 14 Summary:

"to conserve and sustainably use the oceans, seas and marine resources for sustainable development"

- Prevent and significantly reduce marine pollution of all kinds by 2025;
- Sustainably manage and protect marine and coastal ecosystems by 2020, including restoration, to achieve healthy and productive oceans;
- Effectively regulate harvesting of fish stocks and end overfishing, illegal, unreported and unregulated (IUU) fishing by 2020 (including prohibiting subsidies that contribute to overfishing), to restore fish stocks in the shortest time feasible to levels that can produce the maximum sustainable yield;
- Conserve at least 10 percent of coastal and marine areas by 2020; and
- Increase the economic benefits to SIDS from sustainable use of ocean resources by 2030.

As described by the OECD (2016), damage to ocean ecosystems can act as a drag on the growth of the ocean economy, and hence comprise a risk to future growth in this segment of the global economy. Policies to address and reduce this risk may also help countries prepare for the impacts of external drivers of change in an ocean economy, such as climate change.

In the past decade, as countries around the world have attempted to grapple with these twin trends of accelerating growth in the ocean economy and decline of the underlying ecosystems, they have increasingly used the perspective of the "green economy" as a lens for viewing risks and opportunities in the ocean (Patil et al. 2016). The term was widely applied to the ocean at the 2012 reunion of the Earth Summit in Rio. Subsequently the term "blue economy" emerged rapidly as shorthand for policies that promote sustainable development of the ocean, in which economic growth does not reduce the aggregate natural capital, and conservation of ecological commons contributes to poverty reduction (World Bank 2017, Colgan 2017a, Colgan 2017b, and Patil et al. 2016). Such policies were commonly described as those that simultaneously enhance the three dimensions of sustainable ocean use embodied in the sustainable development paradigm: social, environmental, and economic sustainability (WCED 1987).

However, the blue economy concept emerged from the 2012 Rio Summit without unanimous definition, and was reflected in a number of different and competing discourses on human-ocean relations, including (i) the oceans as natural capital, (ii) the oceans as "good business," (iii) the oceans as integral to Pacific small island developing states (SIDS), and (iv) the oceans as a source of small-scale fishing livelihoods (Silver et al. 2015). Subsequently, a number of national strategies were prepared and international summits held on the blue economy concept, such as FAO's 2014 State of World Fisheries and Aquaculture (Patil et al. 2016). Yet even after these discussions, the definition of the blue economy has remained very much in flux among nations (Colgan 2017a). It has been characterized as a "buzzword" with general agreement in the abstract but not in practice, which may permit broad coordination among countries but locally different applications (Voyer et al. 2017 and Bueger 2015). Voyer et al. (2017) conducted a cluster analysis of 35 policy documents, conference proceedings, position papers, and reports on the blue economy, resulting in the figure below.

In view of such variation, a global definition devised by the Economist Intelligence Unit (2015) has been repeatedly cited: "A sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy" (EIU 2015). In a similar vein, the World Bank and UN DESA (2017) describe the concept as "comprising the range of economic sectors and related policies that together determine whether the use of oceanic resources is sustainable." In these definitions, the concept refers to the decoupling of socio-economic development through ocean-related sectors and activities from environmental degradation (UNCTAD 2014, UN DESA 2014, cited in World Bank 2017). Such definitions trace their lineage to concepts of the green economy and "green growth," which the World Bank (2012b) has defined as "growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it

Figure 6: Word Frequency in 35 Documents on Blue Economy

Source: Voyer et al. 2017.

accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters."

Characterized in these terms, what is the difference between "the blue economy" and "the ocean economy?" Essentially, the blue economy concept focuses on the sustainability of the ocean economy, by addressing the human drivers of change in marine ecosystems, e.g. increasing fishing capacity and effort, coastal development, and pollution (World Bank and UN DESA 2017). Perhaps more succinctly, the essential feature of the blue economy concept is that it aims to balance both the economic opportunities and environmental limitations of using the ocean to generate wealth—in one sense aiming to do more with less (Colgan 2017a and Colgan 2017b). The ocean economy term simply refers to a group of economic activities, linked by their relationship to the ocean (in many cases with ocean ecosystems services as inputs), but provides no measure or indication of the environmental sustainability of these activities. Using the metaphor of colors, an unsustainable ocean economy is "brown," while a sustainable one is "blue,"

At the same time, some organizations have also emphasized the social dimensions of the ocean economy in their definitions of a blue economy, following the three dimensions of the concept of sustainable development. For example, FAO (2014) has promoted the concept of a blue economy as a "coherent approach for the sustainable, integrated and socio-economically sensitive management of oceans and wetlands, focusing on capture fisheries, aquaculture, ecosystem services, trade and social protection of coastal communities."

Similar to definitions proposed by the EIU (2015) and the World Bank (2017), and reflecting the social dimensions of sustainable development emphasized by FAO (2014), the Government of Bangladesh defines the blue economy concept as a sustainable pathway forward for growth of the ocean economy (as opposed to a less sustainable or "brown" pathway). Box 3 below provides details.

In order to establish a common denominator between the international definitions of the blue economy concept and the definition in Bangladesh, a blue economy is defined here simply as sustainable development of the ocean economy. Given the status of ocean ecosystems, the challenges of ensuring that an ocean economy stays or becomes "blue" are formidable for many countries, but particularly for developing

Box 3: The Government of Bangladesh's Definition of the Blue Economy Concept

"Blue Economy comprises activities that directly or indirectly take place in the seas, oceans and coasts using oceanic resources and eventually contributing to sustainable, inclusive economic growth, employment, [and] well-being, while preserving the health of ocean. It includes activities such as exploration and development of marine resources, appropriate use of ocean and coastal space, use of ocean products, [and] provision of goods and services to support ocean activities and protection of ocean environment. The Blue Economy approach emphasizes that ideas, principles [and] norms of Blue Economy lend significant contribution[s] towards eradication of poverty, contributing to food and nutrition security, mitigation and adaptation of climate change and generation of sustainable and inclusive livelihoods. It is needless to say that for most developing States particularly for Bangladesh, making [the] transition to [a] Blue Economy would entail fundamental and systemic changes in their policy-regulatory-management-governance framework(s) and identification of various maritime economic functions.

"The Blue Economy conceptualizes oceans and seas as 'Development Spaces' where spatial planning integrates conservation, sustainable use of living resources, oil and mineral wealth extraction, bio-prospecting, sustainable energy production and marine transport. The Blue Economy approach is founded upon the assessment and incorporation of the real value of the natural (blue) capital into all aspects of economic activity (conceptualization, planning, infrastructure development, trade, travel, renewable resource exploitation, energy production/consumption). Thus Blue Economy requires a balanced approach between conservation, development and utilization of marine and coastal eco-systems, all oceanic resources and services with a view to enhancing their value and generating decent employment, secure productive marine economy and healthy marine eco-systems."

Sources: Seventh Five Year Plan (GED 2015) and Alam 2015.

coastal and island states such as Bangladesh where the need for intensive and extensive use of the ocean for growth is greatest (Colgan 2017b). For this reason, the blue economy concept has been described as both a "bold vision and an excruciatingly delicate balancing act" (Colgan 2017b).

Despite all of the discussion on the blue economy concept since 2012, few documents suggest what activities in the ocean economy might actually fit in the overlap between the social, environmental, and economic dimensions of sustainable development—and many of the policy dialogues in specific coastal and island nations focus on identifying these opportunities, or even more broadly, on developing new sources of wealth from the ocean (Colgan 2017b).

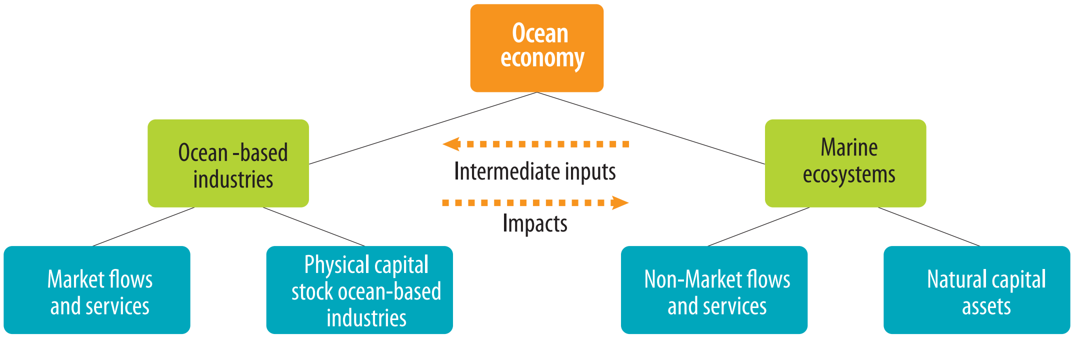
While the blue economy concept has become more widespread, specific policies and strategies at larger spatial scales are still relatively recent (Colgan 2017b). As these policies emerge, guiding frameworks may be helpful for application to particular contexts. In particular, as the World Bank and UN DESA (2017) note, small island developing states (SIDS) and lower-income coastal countries such as Bangladesh may have the most potential for application of the blue economy concept through such frameworks, given their significant reliance on marine renewable resources and other ecosystem services.

One key question to pose (Colgan 2017a) is how the impacts of climate change can be incorporated into the blue economy concept. Currently, the concept does not explicitly target low-carbon activities, nor include climate change adaptation and mitigation in definitions, though some climate-related activities such as renewable energy and carbon sequestration may be included when they are measured in a given context (Colgan 2017a). Remedies may include measuring emerging industries in national income accounts such as habitat restoration and maintenance, building, and repair of energy-efficient ships and boats (Colgan 2017a).

2.2.2 Conceptual Framework for the Blue Economy

A conceptual framework explains graphically the key factors, constructs, or variables to be studied and the presumed relationships among them—essentially creating intellectual "bins" containing several discrete events and behaviors (Jabareen 2009 and Miles and Huberman 1994). The OECD's depiction of the linkages in an ocean economy provides the basis of a blue economy conceptual framework (OECD 2016).

Figure 8: OECD's Conceptual Framework for the Ocean Economy



Source: OECD 2016.

The framework above illustrates the relationship of ocean ecosystems as natural capital assets underpinning ocean-based industries. In addition to this framework, the blue economy concept defines a pathway over time: an ocean economy that transitions via policy reforms towards a blue economy where ecosystem service flows are sustainable inputs to ocean-based industries and the impacts from these industries upon the ecosystems are reduced. As such, the circularity of the system can be illustrated, as well as the interdependence of ocean industries and ecosystems, where investment in natural capital can drive growth in the broader ocean economy (World Bank and UN DESA 2017).

Many coastal or island nations have introduced a mix of policies to translate the blue economy concept into an operational policy agenda (Colgan 2017a). In general, public policies are based on a range of implicit or explicit principles, and include clear objectives that may be embodied in rules or regulations (Gupta 2010). Such principles may help guide regulatory agencies as well as private investors, particularly for emerging industries, and as Porter (1979a, 1979b, and 2008) suggested for environmental regulation in general, can actually enhance the investment climate (Colgan 2017a). For policies that promote the blue economy concept, the following principles proposed by WWF in 2015 provide an example or reference (World Bank and UN DESA 2017):

Similarly, the World Bank and UN DESA (2017) suggest the following principles to guide blue economy policies:

Box 5: Blue Economy Principles Proposed by WWF

A blue economy is a marine-based economy that…

- Provides social and economic benefits for current and future generations by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity, and political stability.
- Restores, protects, and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems—the natural capital upon which its prosperity depends.
- Is based on clean technologies, renewable energy, and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet.
- Is governed by public and private processes that are . . .
  - Inclusive
  - Well-informed, precautionary, and adaptive
  - Accountable and transparent
  - Holistic, cross-sectoral, and long-term
  - Innovative and proactive

Source: WWF excerpted in World Bank and UN DESA 2017.

- Interventions should promote at least two of the four elements of resource efficiency: reducing food loss and waste along the value chain, energy efficiency (reducing the carbon footprint), decent employment and innovative financing or technologies; and
- Interventions should provide environmental, social and economic benefits.

One of the key tools often recommended for guiding the design of blue economy policies is coastal and marine spatial planning (CMSP) processes. CMSP can be defined broadly as a public process of analyzing and allocating ocean uses over space and time to achieve economic, ecological, and social objectives (Ehler and Douvere 2007). Following long traditions of regulating conflicts between different land uses through a place-based planning approach that utilizes zones or permissible and impermissible uses, CMSP has in many cases resulted in ocean plans and zoning. Maps categorize the ocean space for a particular use or array of uses (as "development spaces"), in order to reduce conflicts and achieve ecological, economic, and social objectives (Agardy 2009 in Patil et al. 2016 and OECD 2016). The process reflects a growing recognition that regulation of ocean use needs a more spatial dimension, based on consideration of the underlying ecosystems in a specific place and the accounting of natural capital (OECD 2016). Indeed, the OECD (2016) states that for the ocean economy, "the interrelationship among uses and processes in the coast and ocean makes it imperative that ocean governance be integrated, precautionary and anticipatory…As long as maritime industries and the exploitation of marine resources are perceived as individual and separate activities, approaches to their development and sustainable management risk remaining piecemeal and limited in their effectiveness."

A recent review of CMSP noted 59 ocean plans in preparation or completed as of mid-2014, and included case studies for five of these plans, which in aggregate created an estimated US$310 million in new economic value, largely through offshore wind developments in the northern United States and Belgium. The plans studied helped to reduce conflicts between different ocean users, for example, wind developers and fishers. They also expanded ocean area under protection, with fishers gaining protection of key fishing grounds from wind farms or other uses in some cases (Blau and Green 2015 and in Patil et al. 2016). By around the same time period, some 50 countries around the world had some form of spatial ocean management initiative underway, including eight with government-approved marine plans covering an aggregate 8 percent of the world's EEZs (OECD 2016).

Beyond the tool of CMSP, a number of countries have pursued broad policies for a blue economy under different definitions (see Annex III for more information on selected of these efforts). Though reflecting different circumstances and contexts, common elements in these countries' efforts include:

I. Some form of baseline measures of the size of the ocean economy and indications of sustainability, and often targets for sustainable growth;

II. Strategies to encourage private investment in traditional or emerging ocean industries along principles of sustainability, often through public investment in research; and

III. Some form of coastal and marine spatial planning to ensure that "we do not repeat the same mistakes on sea as we did on land."

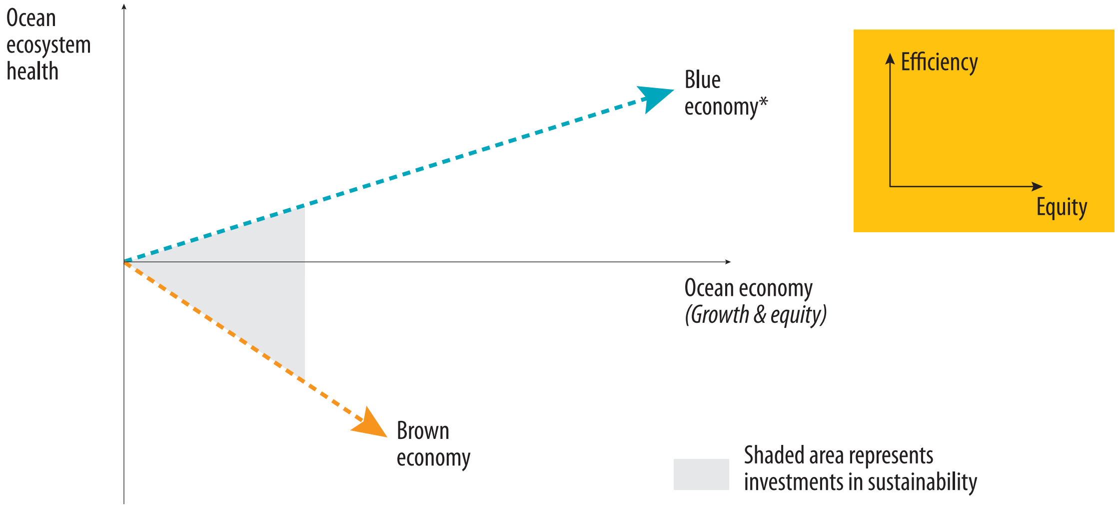
2.3 Summary of Key Concepts

In summary, while a range of definitions of the blue economy have emerged, this report uses the following:

- ***Ocean economy:*** The sum of economic activities in ocean-based industries, and the assets, goods, and services of marine ecosystems. This definition is based on the OECD's 2016 report, which stands as the most extensive global survey to date, and measures in terms of gross economic output (gross value added), following the OECD's methodology.
- ***Ocean ecosystems and natural capital:*** Natural capital defined as the stocks of Earth's natural assets and resources, following UNEP's methodology for natural capital accounting (Brown et al. 2016). According to these methods, and consistent with the characterizations used by the World Bank (Lange et al. 2018)

in "The Changing Wealth of Nations," the ocean's natural capital is defined as those natural assets and resources linked to the ocean environment, consisting of (i) stocks of natural resources, such as off-shore deposits of fossil fuels, minerals, and aggregates; and (ii) spatially-defined stocks of "ecosystem assets" cycled and renewed as part of wider ecosystem functions and which yield a flow of valuable ecosystem services (Brown et al. 2016).

Figure 9: Theoretical Illustration of the Relationship between Key Concepts



Note: Two dimensional representation of a three-dimensional concept, as the blue economy represents improved measures of social dimension (equity), environmental dimension (biophysical), and economic dimension (efficiency).

- ***Blue economy:*** Sustainable development of the ocean economy. This definition is based on the World Bank and UN DESA (2017) framework for a blue economy, as well as the definition of FAO (2014), to be consistent with the three-dimensional sustainable development paradigm (social, environmental, and economic dimensions) underpinning the Sustainable Development Goals.

3 Current status of bangladesh's ocean economy and ecosystems (a baseline for targets)


PHOTO CREDIT: PIERRE FULLER

3.1. Current Policy Framework in Bangladesh for the Ocean Economy

Following the resolution of its maritime boundaries in 2014, the Government of Bangladesh stated its interest in pursuing the blue economy concept as part of the country's growth strategy (Alam 2014 and Hussain et al. 2017a, 2017b). In a speech given in September of that year, Prime Minister Sheikh Hasina characterized the blue economy as a window of opportunity for the country's sustainable development, and advanced an objective of turning the Bay of Bengal into a hub of economic development and prosperity, contributing to poverty reduction, food security, and climate resilience (Alam 2014). Subsequently, the Ministry of Foreign Affairs (MoFA) prepared a concept note articulating the blue economy concept in terms of the sustainable development paradigm (World Commission on Environment and Development 1987), and highlighting the Government's interest in developing pathways forward (Alam 2014).

In 2015, the Prime Minister emphasized cooperation with India in development of the blue economy (Ministry of External Affairs 2015), and the two governments signed a memorandum of understanding to promote the effort (Ministry of External Affairs 2015b). That same year the Government's Seventh Five Year Plan (FY2016-2020), "Accelerating Growth, Empowering Citizens," identified the blue economy as a potential driver of growth, adopting much of the language of the MoFA concept note (GED 2015). Furthermore, the OECD in 2016 estimated that on a global scale, ocean-facing countries would likely see a rapid increase in new jobs (equivalent to the growth of on-land employment) in ocean economy sectors alone up to 2030.

Bangladesh's Seventh Five Year Plan (FYP) emphasizes that growth in the country's ocean economy is contingent upon the status of ocean ecosystems and natural capital, and suggests that while "there are some prospects for oil and gas resources, the potential is most promising for marine fishing, marine transportation and coastal and marine tourism" (GED 2015). However, the plan goes much further. Spanning fiscal years 2016-2020, it lays out a reform agenda of laws, policies, and institutions that with modifications could effectively guide the country forward with respect to "blue economic functions" of the nation's blue economy aspirations. The FYP focuses on three themes, one of which aims to implement "a sustainable development pathway that is resilient to disaster and climate change; entails sustainable use of natural resources; and successfully manages the inevitable urbanization transition"—consistent with the definition of the blue economy concept (GED 2015). The 7th FYP calls for the following twelve actions to be undertaken "to create and maintain a prosperous and sustainable blue economy:"

- **I.** protecting and managing the fisheries for the present and the future generations,
- **II.** developing a strong renewable energy sector using ocean and atmospheric forces,
- **III.** maintaining existing (e.g., ship building) and developing new maritime industries;

IV. extending fishing areas using new technologies and methods even beyond EEZ in the international waters,

V. developing a strong human resources base for domestic utilization, and export to foreign job markets,

VI. substantially increasing fisheries production and export earnings through improved aquaculture and introduction of mariculture.

VII. creating a competitive tourism industry, including ecotourism and marine cruises,

VIII. increasing revenue from shipping, commerce by expansion of domestic fleet, destinations, trans-shipment, transit provisions, linking sea-ports.

IX. give special priority to anticipated Climate Change impacts on all relevant matters, and adjust policies and plans,

X. maintain the inland river systems and ecosystems for fishery, sediment transport, and inland shipping,

XI. building a solid science, research and education base and

XII. along with other coastal areas, establishment of a marine academy in Khulna.

These twelve national actions areas are supported by three strategic policies, strategies, and plans currently under development. (Further support comes from dozens of related policies, laws, and institutional frameworks currently under review and revision at various levels of government.) The three major initiatives include:

- ***Bangladesh's Integrated Coastal and Ocean Management Policy (ICOMP):*** This umbrella policy, currently under preparation, organizes amended laws, policies, and institutions connected to 27 "blue economic functions" covering six broad areas: (i) maritime trade and shipping; (ii) food and livelihood; (iii) energy; (iv) tourism; (v) coastal protection, artificial islands, and greening coastal belts; and (vi) human resource development, maritime surveillance, and marine spatial planning.
- ***Bangladesh's National Sustainable Development Strategy (NSDS):*** With support from the United Nations Environment Programme (UNEP), the NSDS has been drafted to guide the nation on how to address environmental challenges hindering Bangladesh's overall development pathway. It identifies environment, natural resource management, and disaster management as strategic priority areas and articulates a wide variety of actions needed to support the country's sustainable development, including the sustainable development of coastal and marine spaces.
- ***Bangladesh's Climate Change Strategy and Action Plan (BCCSAP)***: The 2009 plan, currently under review and revision, seeks to build a medium- to long-term program for enhancing resilience to climate shocks and facilitating low-carbon, sustainable growth, including blue growth as linked to coastal ecosystems such as mangrove conservation and coastal resilience. The plan seeks to expand social forestry on government and community land throughout the country. It also suggests expansion of the "greenbelt" coastal afforestation program to include mangrove afforestation along the shoreline.

In sum, the Government of Bangladesh has articulated a policy objective to apply the blue economy concept to the ocean economy in the Bay of Bengal, identified a number of initial activities and programs to start down this pathway, and is in the process of preparing an integrated policy as well as reviewing or developing related sectoral policies.

Going forward, a key next step based on the experience of other countries, would be to measure the current output from economic activity linked to the ocean (the ocean economy) and indications of sustainability, and then to formulate clear targets for achieving the FYP's objectives of sustainable development of this segment of the national economy—a blue economy development pathway. To assist in this effort, the next chapter provides a partial assessment of this baseline (gross output from the ocean economy) and indicates the types of information required to set targets to set the country along a blue economy pathway.

Table 3: Policies Currently under Review or Development, Related to the Blue Economy in Bangladesh[1]

Sector	Policies	Laws and acts	Responsible institutions
Coastal Protection Climate change resilience and adaptation (including coastal protection)	*Bangladesh Climate Change Strategy and Action Plan (BCCSAP)* is to be completed by 2020.[I] *National Action Plan for Adaptation (NAPA)* is to be completed by 2020.	The 2010 Climate Change Trust Act established the Bangladesh CC Trust, the Bangladesh CC Trust Fund , and the Bangladesh Climate Change Resilience Fund.	Ministry of Environment and Forests Disaster Management Information Centre of Ministry of Food and Disaster Management
Existence of Biodiversity, including mangrove ecosystems ("blue forests")	*Coastal and Wetland Biodiversity Management Plan* is under review.[II]	Wetland Conservation Act;Environment Conservation Act, 1995, 2000, and 2002 Environment Conservation Rules, 1997, 2000, 2001 National Conservation Strategy, 2005 National River Protection Commission Act, 2013 Forest Act, 1927 Wildlife Protection and Security Act, 2012	The Ministry of Environment and Forests The Bangladesh National Herbarium
Waste Disposal, including addressing externalities from industrial and agriculture pollution creating marine dead zones	*Bangladesh Water Act* is under review and revision.[III]	Integrated Water Resources Management (IWRM), 2005 Participatory Water Management Regulations, 2014	Ministry of Water Resources
Energy (including renewable energy from wave, wind, and solar from ocean areas and explicit gender dimensions[IV])	*Renewable Energy Policy, 2008 and National Energy Policy, 2004* are under review.[V]	The Bangladesh Petroleum Act of 1974 supports planning, organizing, and implementation of exploration, exploitation, development, and production of petroleum wealth from the sea (including all territorial waters, continental shelf, and EEZ).	Ministry of Power, Energy, and Mineral Resources Sustainable and Renewable Energy Development Authority (SREDA) Bangladesh Power Development Board (BPDB) Local Government Engineering Directorate (LGED) Blue Economy Cell
Living Resources: Capture Fisheries, supporting sustainability	*National Marine Fisheries Policy,* undergoing consulta-tions and review[VI]	The proposed National Marine Fisheries Policy includes provision for development of new laws in support of sustainable capture fisheries.	Ministry of Fisheries and Livestock, Dept. of Fisheries Bangladesh Fisheries Development. Corp.; Bangladesh Coast Guard; Bangladesh Navy
Living Resources: Aquaculture, including mariculture	*National Aquaculture Development Strategy and Action Plan (2013-2020)* is reviewed annually. *2014 National Shrimp Policy* is under review.[VII]	Fish Hatchery Act 2010; Fish Hatchery Rules 2011; Fish Feed and Animal Feed Act 2010; Fish Feed Rules 2011; Fisheries Research Institute Ordinance, 1984	Ministry of Fisheries and Livestock
Tourism, including marine tourism	*National Tourism Policy, 2009* is under review.[VIII]	Tourism Board Act, 2010 Bangladesh Tourism Protected Areas and Special Tourism Zone Act, 2010; Bangladesh Tourism Protected Areas and Special Tourism Zone Rules, 2011	Ministry of Civil Aviation and Tourism Chambers of Commerce Bangladesh Parjatan Corp. Ministry of Shipping

1 This is not an exhaustive list, but rather a distillation of key reforms (policies, laws, institutions) under revision in support of the nation's blue economy aspirations.

Sector	Policies	Laws and acts	Responsible institutions
Shipping and Transport including measures to address marine pollution	***Maritime and Shipping Strategy of Bangladesh***[IX]	Clean Air Act; Import Policy Orders; 2012-2015; Payra Port Authority Act, 2013; Chittagong Port Authority (Amendment) Act, 1995; Mongla Port Authority (Amendment) Act, 1995; Navy Ordinance, 1961; Coast Guard Act, 1994	Ministry of Power, Energy and Mineral Resources Infrastructure Financing Facility Inland Water Transport Authority
Ocean-based industry development and growth via access to finance	***Comprehensive Credit Policy for SMEs,*** including encouraging investment in ocean industries[X]	Inclusive Digital Financial Systems, 2015	Ministry of Industries Bangladesh Standards and Testing Institution Bangladesh Small and Cottage Industries Corporation Bangladesh Chemical Industries Corporation Bangladesh Bank

I. Policies under revision point to improved watershed management, greater (and gender-sensitive) pro-poor afforestation efforts, and other specificity concerning climate change adaptation and mitigation measures.
II. This plan was developed to counter loss of biodiversity. Under the plan and associated projects, protected areas such as dolphin sanctuaries and conservation sites including botanical gardens and eco-parks have been created. The objectives include to undertake all possible interventions to conserve biodiversity of the Sundarbans Mangrove Areas, mandating a ban on extraction of forest resources there.
III. The Ministry of Water Resources will strengthen regulatory provisions for groundwater monitoring, licensing, and charging as part of amended rules supporting the Bangladesh Water Act, so as to reduce environmental externalities (especially in the textile sector) and untreated effluent that currently contributes to "dead zones" in ocean areas that degrade natural capital assets. In addition to variation of fees, meter cost, and price by types of water usages, authorities will introduce differential fees, costs, and price structures for metropolis, urban, and semi-urban areas. These recommendations will be incorporated into the rules supporting the Bangladesh Water Act. Municipal water utilities (Dhaka and Chittagong WASA) will review licensing arrangements for large commercial and industrial customers, including scope for redrawing jurisdictional boundaries to include major industrial clusters outside the Dhaka city limits; revising volumetric tariffs to reflect environmental externalities; rolling out metering; developing effective bill collection systems; and installing effluent treatment plants within textile factory premises. Connection to a combined treatment plant is mandatory for all washing, dyeing, and finishing (WDF) firms under the Environmental Conservation Rule 97 because these firms belong to Orange-B and Red categories. Ministry of Industries and MOE will conduct a comprehensive survey to determine compliance with this provision by WDF firms. Based on the survey, a plan will be formulated for achieving 100 percent compliance by specified target dates. The cost of adopting best practices for cleaner production appears affordable. Through appropriate monetary policy measures or fiscal incentives, WDF textile factories will be encouraged to adopt low-cost cleaner production practices. Cluster-level stakeholder consultations would be the best way to motivate the wet processing units. Observed anomalies regarding duty rates for environment merit items in the CD/SD rate structures will corrected and thereafter overseen regularly by a committee comprised of representatives from Government, the private sector, and civil society organizations.
IV. The Renewable Energy Policy has explicit gender dimensions by which women's expanded access to renewable energy is promoted in both grid and off-grid areas to facilitate their economic gains as well as sustainable use of resources. The policy strives to advance women's access to solar power, bio-gas, improved cook-stoves, and other aspects of renewable energy.
V. The Renewable Energy Policy 2008 envisages total generation of five percent of energy from renewable sources by 2015 and ten percent by 2020, taking advantage of Bangladesh's 700-kilometer coastline and nearshore areas suitable for wind energy. The National Energy Policy of 2004 covers a wider energy mix, including petroleum resources, recognizing that economic growth and development are dependent on secure supplies of energy. It guides the state in using energy from various sources, including fossil fuels (imported oil, gas, and coal) and renewable energy from tidal power, ocean wave, solar radiation, and wind power.
VI. The proposed National Marine Fisheries Policy would establish a comprehensive plan for sustainable conservation, management, and exploitation of resources across the expanded EEZ. It would explore new economic opportunities in the fisheries sector as a major contributor to the blue economy. In this regard, the new policy calls for fish stock assessment, restrictions and controls on poaching and IUU fishing by foreign trawlers, and collaboration for distant water fishing to explore harvesting of tuna and large pelagic fish.
VII. This policy guides the regulation of shrimp brood stock collection from the sea, technology development to mitigate impacts of climate change, job creation, and poverty reduction in the shrimp farming sector, improved cultivation and enhancement of shrimp production, and protection of natural breeding and nursing grounds of shrimps. It also sets forth regulatory actions for zoning of coastal land for shrimp farming and supports export promotion, education, research, credits, insurance, database creation, and data collection.
VIII. The policy aims to develop the country's tourism industry to increase foreign currency earnings, improve livelihoods, and reduce poverty. The policy stipulates attracting tourists to places of interest including environmentally and archaeologically sensitive sites such as the Sundarbans, while at the same time providing for appropriate conservation. The existing policy calls for (i) establishing three premium shopping outlets that meet international standards in the cities of Dhaka, Chittagong, and Sylhet; (ii) developing eco-nature integrated resorts near the Sundarbans; (iii) developing a strait Riviera linking Teknaf to the Sundarbans; (iv) promoting archaeological sites; (v) establishing eco parks in Chittagong and Sylhet; and (vi) developing professional tourist agencies and guides. New policies are being formulated to more systematically advance marine tourism.
IX. This strategy is aimed at ensuring safety of sailors and property at sea, and reducing ship-generated air and marine pollution. Associated shipping policies aid in the treatment and abatement of hazardous waste generated from ship breaking practices in Bangladesh.
X. Under this policy, commercial banks and other financial institutions are required to disburse SME credit according to targets set by Bangladesh Bank and send disbursement reports to the bank. Activities undertaken in coastal and marine areas are eligible for finance and are encouraged.

3.2. Bangladesh's Ocean Economy

3.2.1. Defining the Ocean Economy in Bangladesh

Some 38 percent of the Indian Ocean is under the jurisdiction of coastal or island states, declared as Exclusive Economic Zones (EEZs), as shown in Table 4 below (Colgan 2017b).

As the northeastern extension of the Indian Ocean, the Bay of Bengal large marine ecosystem (LME)[6] is bordered by eight countries[7] and contains 6.2 million square kilometers of highly productive waters. It is fed

6 Large marine ecosystems are areas of the ocean characterized by distinct bathymetry, hydrography, productivity, and trophic interactionshttps://celebrating200years.noaa.gov/breakthroughs/ecosystems/lme_map.jpg.
7 Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand.

Table 4: Areas of the Indian Ocean under National Jurisdiction

	Population density (people per sq. km. of land area)	EEZ (sq. km.)	Internal area (sq. km.)	EEZ/Internal area
Australia	3	8,505,348	7,692,116	1.11
Bangladesh	1,252	86,392	143,998	0.60
Comoros	428	163,572	2,415	67.73
India	445	2,305,143	3,287,263	0.70
Indonesia	144	6,159,032	1,904,769	3.23
Iran, Islamic Rep.	49	168,718	1,628,750	0.10
Kenya	85	116,942	580,367	0.20
Madagascar	43	1,225,529	586,771	2.09
Malaysia	95	334,671	330,803	1.01
Maldives	1,392	923,322	300	3077.74
Mauritius	622	1,284,997	2,040	629.90
Oman	14	533,180	309,500	1.72
Pakistan	251	222,255	796,095	0.28
Seychelles	206	1,336,539	475	2813.77
Singapore	7,909	1,067	705	1.51
Somalia	23	825,052	637,657	1.29
South Africa	46	1,535,538	1,221,037	1.26
Sri Lanka	338	532,619	65,610	8.12
Tanzania	63	241,188	945,787	0.26
Thailand	135	299,397	513,120	0.58
United Arab Emirates	111	58,218	83,600	0.70
TOTAL		26,636,464	19,937,083	1.34

Sources: World Bank and Sea Around Us Project in Colgan 2017b.

annually by 1.6 trillion cubic meters of nutrient-rich fresh water from rivers that collectively form the largest hydrologic basin in the world (BOBLME 2015, Madhupratap et al. 2003, and Subramanian 1993). The Bay of Bengal LME is rich in natural capital, including extensive mineral and energy resources, significant marine living resources, and mangrove forests, among others (BOBLME 2015). The LME exists in one of the more hydrocarbon-rich areas of the world, comparable to the Gulf of Mexico, Persian Gulf, and Bohai Bay in China (BOBLME 2015). At the same time, it is a hotspot for 7 percent of the world's tropical cyclones (Hossain et al. 2014 and Gray 1968).

Within this large marine ecosystem, Bangladesh has a coastline approximately 710 kilometers long measured in a line from its westernmost to easternmost points. The coast contains the world's largest delta,[8] formed by the Padma and Meghna Rivers (BOBLME 2015, Hussain 2010, and Hossain et al. 2014). Interaction with the ocean has shaped the country, and indeed some 32 percent of the terrestrial area of Bangladesh is defined as the coastal zone (Iftekhar 2006). Following decisions in 2012 and 2014 by the International Tribunal for the Law of the Sea (ITLOS) that resolved maritime boundary disputes, Bangladesh now exercises jurisdiction over the use of ocean resources in an area estimated to cover 121,110 square kilometers—equivalent to more than 80 percent of the country's total land area (Chowdhury, 2017, Islam et al. 2017, Hossain et al. 2014, and FAO, 2014).[9] The resolution of maritime boundaries has allowed Bangladesh to begin to define its ocean economy. However, given the extent of the delta and the influence of the sea throughout the country's terrestrial area, defining which economic activities take place in the ocean,

8 Characterized by the interplay between rivers, lands, and oceans and influenced by a combination of river, tidal, and wave processes, deltas are coastal complexes that combine natural systems in diverse habitats (e.g., tidal flats, salt marshes, mangroves, beaches, estuaries, low-lying wetlands) and human systems (e.g., houses, agriculture, aquaculture, industry, and transport) (Wong et al. 2014).

9 This area includes major river inlets and estuaries (Hossain et al. 2014).

receive outputs from the ocean, and provide inputs to the ocean is extremely challenging. More than most countries, in Bangladesh the ocean economy encompasses a wide range of activity that takes place on land.

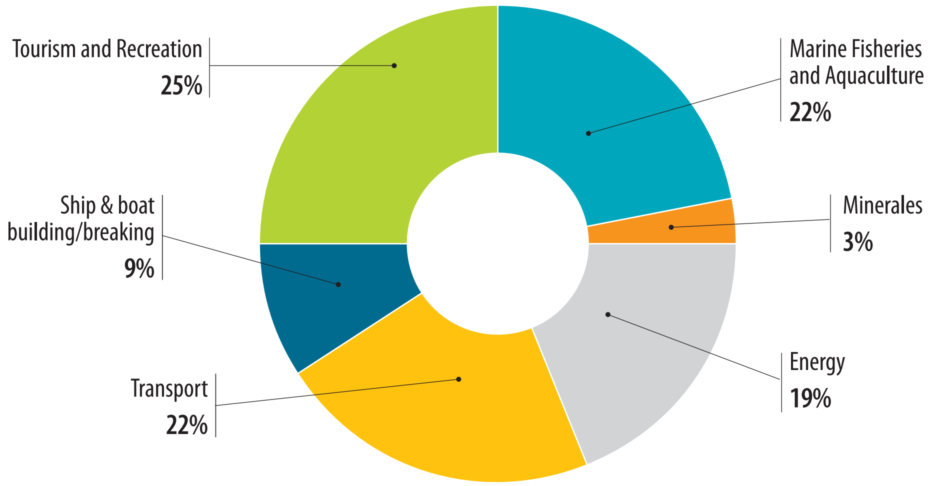
Efforts to define and subsequently measure the ocean economy in Bangladesh have only recently begun (Failler et al. 2017). As mentioned in Chapter Two, typical measures of the ocean economy include estimates of its size in terms of annual output, e.g. the contribution to Gross Domestic Product, total employment, and wages in each industry, using the United Nations International Standard Industrial Classification (ISIC) system. More detailed measures of annual output might include the direct (within an industry), indirect (between industries, such as supplying industries), and induced (local spending linked to industry sectors) contributions of the ocean economy. However, these data are not systematically available in disaggregated form in Bangladesh, though many industries of the ocean economy are measured in aggregate by the Bangladesh Bureau of Statistics BBS (Alam 2014). Yet the ambiguity of what is included in the definition of the ocean economy in the country and what is not makes even initial measures of output difficult.

3.2.2 Initial Estimates of the Annual Output from Bangladesh's Ocean Economy: Gross Value Added

As in past descriptions by the Government of Bangladesh (Alam 2014), the country's ocean economy is characterized here as comprised of twenty-six industries and services, defined in order to align with ISIC categories and data availability. These industries and services reach across seven sectors: living resources, minerals, energy, transport and trade, tourism and recreation, carbon sequestration, and coastal protection.[10]

10 The Government of Bangladesh gives a slightly different break-down, into six sectors: fisheries, maritime trade and shipping, energy, tourism, coastal protection/artificial islands/greening coastal belts, and maritime monitoring, surveillance and spatial planning (Alam 2015 and GED 2015).

Figure 10: Composition of the Ocean Economy in Bangladesh, Percent of Gross Value Added (2014-15)



Source: Table 5 above.

Using disaggregated data provided by the statistics bureau for these industries, and supplemented by reports from industry and other agencies where available, Table 5 provides an initial estimate of the gross value added (GVA) to the Bangladesh economy from ocean activity in recent years.[11] These estimates are coarse and should be seen as indicative of only the order of magnitude of the annual output from Bangladesh's ocean economy, given their reliance on heterogeneous data sources (see Annex 1 for the methodology). However, such estimates of a baseline measure of the ocean economy can be a useful starting point for setting targets for Bangladesh's blue economy aspirations.

Key caveats. The above table summarizes the best information available yet provides only a partial baseline of the size of Bangladesh's ocean economy, for several reasons:

a. The measures of economic output are incomplete in that they exclude (i) industries such as any marine-related construction, recreational fisheries, coastal and maritime research and education, and maritime safety and security; and (ii) a number of ecosystem services that lack market transactions but which may constitute a significant portion of the ocean economy (e.g. the carbon sequestration and coastal protection services of the country's mangroves, which may provide a value of US$786 million over 20 years).

b. The measures do not subtract the costs to the country from environmental degradation resulting from various activities in the ocean economy, that is, externalities to the ocean economy such as pollution from ship breaking (see Section 3.2 for a summary of available information on the extent of these externalities).

c. The measures reflect a very ambiguous distinction between activities considered to be ocean-related and not ocean-related, as the country is so heavily influenced by the sea and its large estuaries.

Composition of Bangladesh's Ocean Economy. As shown in Figure 10, most of the gross value added is derived roughly equally between tourism and recreation, capture fisheries and aquaculture, transport, and energy.

11 Each industry's value added does not equate to its contribution to GDP, since the latter includes the gross value added plus product taxes minus subsidies not already included.

Table 5: Annual Gross Value Added from Bangladesh's Ocean Economy (Nominal US$ Millions)

Ocean economy sector	Ocean economy industry/service	ISIC Code*	2009-10**	2010-11	2011-12	2012-13	2013-14	2014-15
Living Resources	Marine capture fisheries	0311	664.00	777.00	786.23	907.49	1,037.49	1,167.79
	Marine aquaculture Shellfish farming (shrimps and crabs)	0322*	78.65	92.48	99.76	122.05	144.99	163.20
	Fish processing and retailing	0311	0.19	0.22	0.21	0.19	0.18	0.17
Minerals	Sea salt production	0893	123.20	124.11	145.51	184.35	195.45	197.88
Energy	Offshore gas and oil:	0610, 06w20	993.55:	972.26:	943.63:	1,011.41:	1,068.27:	1,205.14:
	Crude petroleum extraction		22.42	23.65	23.69	25.16	26.40	30.55
	Natural gas (liquid) extraction		971.13	948.62	919.94	986.25	1,041.87	1,174.58
Transport and Trade	Transport:	5222	1,030.46:	1,082.11:	1,038.04:	1,108.79:	1,220.21:	1,366.10:
	Maritime freight transportation		307.90	319.55	295.81	300.33	327.15	375.58
	Maritime passenger transportation		617.61	659.27	606.66	663.14	720.69	788.35
	Port and harbor operations		104.95	103.29	135.57	145.32	172.37	202.17
	Ship and boat building/breaking:[12]	3011, 3315, 3830	237.71:	245.57:	240.95:	246.41:	246.90:	525.27:
	Ship building and repair		110.32	114.77	106.68	109.58	108.59	387.06
	Ship breaking***		127.39	130.80	134.27	136.83	138.31	138.21
Tourism and recreation	Coastal and maritime tourism Scenic and sightseeing transportation, water and other Recreational goods (rental) Sports and recreation instruction Zoos and botanical gardens Nature parks and other similar institutions Marinas Hotels and motels Bed and breakfast inns Full service restaurants Limited service eating places Snack and non-alcoholic beverage bars	Multiple	901.39	819.16	967.76	1,038.64	1,379.96	1,567.43
Carbon sequestration	Blue carbon	N/A	A market does not exist for the flow of benefits generated from sequestration of additional stocks of carbon.					
Coastal protection	Habitat protection, restoration	N/A	A market does not exist for the flow of protection benefits provided by natural habitats as resource stocks.					
Total ocean economy GVA****			4,029.15	4,112.91	4,222.09	4,619.33	5,293.45	6,192.98
Bangladesh GVA *****			110,046.00	122,120.00	126,250.00	142,783.00	164,758.00	186,042.00
Taxes-subsidies			5,239.00	6,561.00	7,152.00	7,214.00	8,128.00	9,117.00
Bangladesh GDP			115,285.00	128,681.00	133,402.00	149,997.00	172,886.00	195,159.00
Ocean economy GVA as a % of Bangladesh GVA			3.66%	3.37%	3.34%	3.24%	3.21%	3.33%

*International Standard Industrial Classification of All Economic Activities, by which value added and contributions to GDP are categorized. Note marine aquaculture, consisting of sh
** Gross value added by ocean industry is available for the fiscal year, i.e. June 2009 to July 2010.
*** Data were obtained for 2015 only, and were assumed constant in real terms over the study period.
****Exchange rates used: 2009/2010 – 69.18 Taka per US$; 2010/2011 – 71.17 Taka per US$; 2011/2012 – 79.1 Taka/US$; 2012/2013 – 79.93 Taka/US$; 2013/2014 – 77.72 Taka per US$; 201
*****GVA and GDP amounts given for second year in the period, e.g. for 2009-2010, the GVA given is for 2010, as GVA and GDP are recorded annually by calendar year.
Sources: Unpublished BBS statistics and World Bank, supplemented with DoF 2017, Failler et al. 2017, UNSNA 2017, EIA 2017, Shamsuzzaman et al. 2017, Dausendschoen 2016, Meisner

	Employment	Comments
	Data are often aggregated with inland fisheries and aquaculture. Total estimates range as high as 17.8 million in 2014, of which marine capture fisheries and aquaculture were 1.35 million.	Data for fishing are reported according to ISIC code for marine capture fisheries only. For marine aquaculture, only data for shellfish farming (shrimp) are available. For processing and retailing, data are limited to fresh and frozen seafood processing.
	5.00 million people directly and indirectly employed	Another estimated 25 million livelihoods depend on people directly and indirectly employed in the sector.
		Over 90 percent of Bangladesh's external freight trade is seaborne.
	1.00 million direct and indirect employment in ship breaking	Data on ship breaking are not available at BBS. Based on Hossain (2015), estimates assume average gross value added of US$0.92 million, multiplied by 150 large ships dismantled per year.
		Satellite accounts for tourism are not available at BBS, so data are aggregated for the entire country. The estimate assumes that 16% of gross value added from tourism is coastal- and marine-related.
		US$13.4 million annual value is estimated for carbon emission credits, based on a global loss rate of 0.7 percent per year, and a price of US$5/Mg CO_2 eq. With a discount rate of 8%, the total value over 20 years is equal to US$122.8.
		US$663 million was estimated using benefit transfer and proxy estimates for the storm protection defenses of a hectare of mangrove forest in the Bay of Bengal region.

rimp aquaculture in the case of Bangladesh, has been recorded under the ISIC code for freshwater aquaculture.

4/2015 – 77.67 Taka per US$

et al. 2016, Hossain 2015, WTTC 2016, FAO 2014, 2016, Al Mamum et al. 2014, Kabir 2016, Sea Around Us Project 2017, Emerton 2014, and Alam 2014.

Table 6: A Snapshot of Bangladesh Fisheries and Aquaculture Industries in 2012*vw

	Marine capture fisheries	Inland capture fisheries	Aquaculture
Type of production systems	• Small-scale vessels 12 m. long or less, roughly 50% motorized, e.g.: – Near-shore fry fishing with push and drag nets – Boats deploying set nets, gill nets, and longlines • Semi-industrial wooden, mechanized vessels up to 20 m. long, fishing with gill nets • Industrial trawl fleet targeting shrimp and demersal finfish (approx. 200 vessels) • Small-scale and semi- industrial vessels produce 93% of catch volume, with more than 40,000 vessels estimated.	All small-scale operations, either without boats or from small, wooden, and non-motorized boats, using gear based on ecological conditions, including gill nets, seine nets, push nets, drag nets, lift nets, hook and line, and various types of traps.	Extensive systems rely on stocking with Indian major carp, with no fertilization or feeding. Improved extensive systems complement these with exotic carp and irregular fertilization. Relatively few semi-intensive or intensive systems occur. These include the culture of catfish (primarily striped catfish known as Thai *pangas*) and monosex tilapia. Ponds are fertilized and fish feed applied.
Production volume (mt) per year	579,000, including • Hilsa: 202,951 • Bombay duck: 58,263 • Shrimp: 52,217 • Pomfret: 46,643	957,000 The peak was in 2009, with an average of 967,401 mt/year from 2003-12, and harvests of 995,805 mt in 2014. Roughly half of production consists of carp (indigenous species such as rui, catla, and mirgal and exotic species such as silver carp, common carp, mirror carp, and grass carp). Other prominent species are cat fish, snake head, hilsa, and prawn.	1,726,000 This number increased to 1,956,900 mt in 2014, of which 1,733,100 mt were finfish from inland aquaculture, 93,700 mt were finfish from coastal and marine aquaculture, and the remaining 130,200 mt were crustaceans. The majority of finfish are carp, which are a relatively cheap source of protein in the domestic market.
Principal markets	Roughly 90% serves domestic consumption (often salted and dried), with shrimp as the main export.	Almost all catch is for domestic consumption.	Less than 10% is exported, mostly shrimp.

*Updated with data from 2014 where available
Source: FAO 2014, 2016.

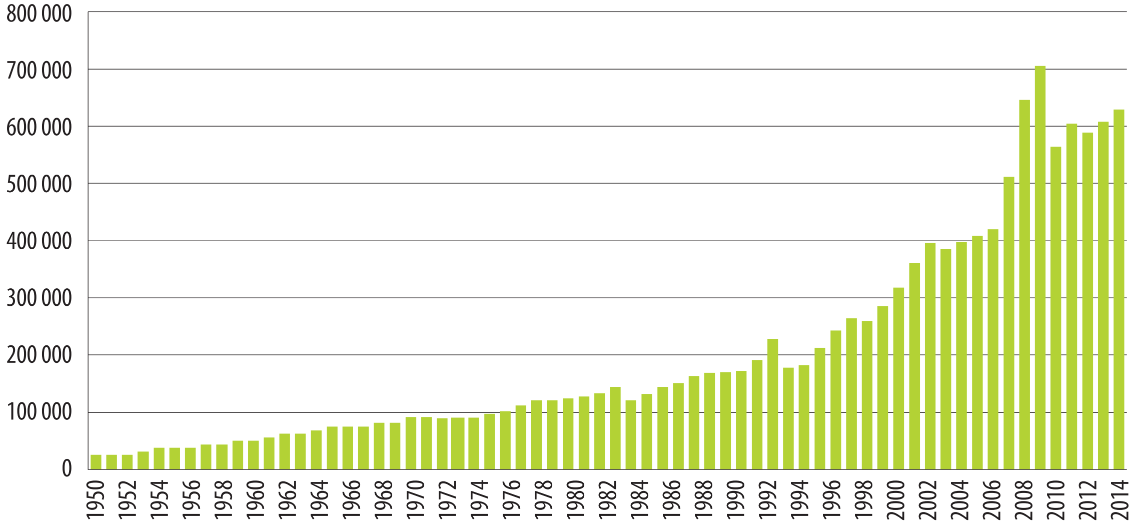
3.2.3 Employment in Bangladesh's Ocean Economy

Employment data in the Bangladesh ocean economy are limited. Estimates suggest more than 17 million people in fisheries and aquaculture (full and part-time, including inland production), of which some 1.35 million work in marine capture fisheries and aquaculture (Meisner et al. 2016). An estimated 6 million more people are employed in sea salt production and ship breaking. Other reports cite estimates as high as 30 million people dependent on the ocean economy in Bangladesh (Failler et al. 2017), or almost 20 percent of the total population in 2015 (UN DESA Population Division 2017).

3.2.4 Overview of the Sectors of Bangladesh's Ocean Economy

Living Resources. Bangladesh ocean waters cover the widest continental shelf area in the Bay of Bengal. These highly productive ecosystems support a range of shallow water fisheries accessible to several types of gear (Hussain et al. 2017a, 2017b, Failler et al. 2017, and Shamsuzzaman et al. 2017). The coastline includes a number of estuaries, and further inland some 230 rivers running 24,000 kilometers long support large freshwater fisheries, along with small lakes (beels), permanent bodies of floodplain water, and temporary lakes created by rains or floods (FAO 2014). Some 5.5 million hectares of fertile floodplains support a large volume of aquaculture production, as part of the global "blue revolution" of the last 35 years (Economist 2003). Annual production levels increased from 91,000 tons in 1980 to 1.7 million in

Figure 11. Trends in Bangladesh Marine Capture Fisheries Production (mt)



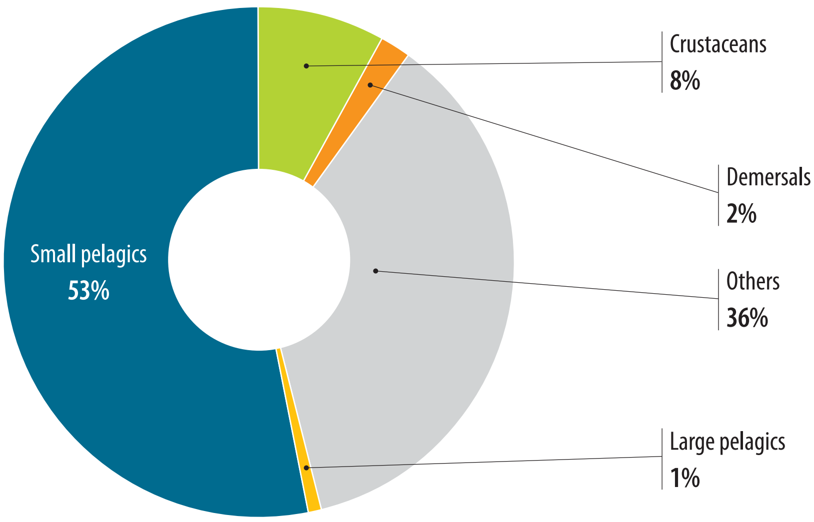
Source: FAO FishStatJ 2017.

2012, making Bangladesh the world's fifth-largest aquaculture producer (FAO 2014, 2016). Although many countries do not consider fishing and aquaculture that are categorized as "freshwater" or "inland" to be part of the ocean economy, the geography of Bangladesh makes it logical to include them in Table 6 to display a shared economic sector and food production system.

These production systems have followed different trends, with explosive growth in aquaculture over the last 35 years and steady growth in marine capture fisheries, peaking in 2010 at roughly 700,000 tons and then averaging 600,000 tons per year, as shown in Figure 11 (FAO FishStatJ 2017).

Estimates are available for illegal and unreported fishing both globally and in the Indian Ocean (Agnew et al. 2009). The Sea Around Us Project at the University of British Columbia has attempted to adjust the numbers of catches reported to FAO in Figure 17 with unreported catches discarded after landing, discarded at sea, or taken illegally (Pauly and Zeller 2015). These "reconstructions" suggest levels of catch that were higher than previously reported and peaked at 1,051,792 metric tons in 2010 (Sea Around Us Project 2017). Figure 12 shows that the bulk of production from marine capture fisheries in Bangladesh (as in many other tropical nations) consists of small pelagic species (e.g., hilsa shad, 53 percent), with high-value

Figure 12: Composition of Marine Catch in Bangladesh



Source: FAO FishStatJ 2017.

crustaceans (e.g. crabs and shrimp), large pelagics (e.g. tuna and sharks), and demersals (e.g. croaker) making up a total of roughly roughly 11 percent (FAO FishStatJ 2017).[12]

This relatively mature sector of the country's ocean economy (including inland production systems) provides benefits that extend far beyond the economic measures presented here. Together with rice, fish is the backbone of the Bangladeshi diet, providing 60 percent of the animal protein intake in the country, as well as other essential vitamins and nutrients (DoF 2017). For poorer groups in Bangladesh, fish is often the only source of protein. An estimated 70 percent of the rural population occasionally fishes for subsistence (FAO 2014).

Minerals. Salt mining has taken place along the coasts of Bangladesh for centuries, currently supporting an estimated 5 million direct and indirect jobs, which in turn underlie as many as 25 million livelihoods[13] (Al Mamun et al. 2014). The system includes a network of mobile mills that refine crude salt mined from saltpans on the beaches of Cox's Bazar. This region produces some 95 percent of the country's salt, with about 15 percent of all rural households taking part (Al Mamun et al. 2014). The roughly 1.7 million tons of salt that is produced each year, largely for domestic consumption, derives from an average seasonal production of 7-10 thousand kg/ha of crude salt (Al Mamun et al. 2014 and Alam 2014). Experts suggest that crude salt yields in some places could increase significantly with improvements in production processes, to as much as 20 thousand kg/ha per season (Alam 2014). Recent advances in production techniques in Europe and North America could be brought to Bangladesh (Hussain et al. 2017a, Hussain et al. 2017b, Failler et al. 2017). However, the industry faces significant risk from losses due to rains and the high cost of capital from largely informal institutions (Al Mamun et al. 2014).

Several studies have found sands containing valuable heavy minerals intermittently over the 250 kilometers of coast from Patenga to Teknaf, including zircon, rutile, ilmenite, leucoxene, kyanite, garnet, magnetite, and monazite. If extractable, these minerals could contribute to a range of existing industries such as paper, glass, chemical, ceramic, and welding electrodes (Hossain et al. 2014).

Energy. Relatively little oil and gas production has occurred to date in Bangladeshi waters, despite significant potential. Before 2014, twenty exploratory wells were drilled, of which two led to discoveries of relatively small reserves of gas, the Sangu and Kutubdia fields (Hossain et al. 2014). Production began in the Sangu, but in 2013 it was later closed, which shut down this sector of the country's ocean economy for the current time (Kabir 2016). The resolutions of maritime boundary disputes in 2012 and 2014 have generated new interest in offshore exploration, as the newly established boundaries give Bangladesh one of the largest estimated oil and gas reserves in the region (Pakistan Defense 2017 and Petrobangla 2016). Shallow offshore blocks throughout the EEZ have attracted attention, in particular those adjacent to Myanmar, given their likely similar geological features to gas fields discovered in that country (Hossain et al. 2014). Bangladesh has recently discovered a new natural gas field in the southern island district of Bhola, estimated to contain 700 billion cubic feet of gas reserves (BAPEX 2017).

Transport and Trade. The year 2012 saw 231.5 million passengers transported through inland and coastal networks (Alam 2015). In maritime trade and other transport, a gross value of US$67 billion was carried by 2,500 foreign ships to and from Bangladesh in a one-year period in 2013-2014 (Alam 2014). Over a ten-year period, importers, exporters, and buyers paid a cumulative amount of about US$95 billion in freight and related charges to shipping companies, airlines, and freight operators (Alam 2016). The top import and export partners in 2011 were China, India, Europe, Indonesia, Singapore, and Thailand (World Bank 2017). However, this industry has since added relatively less value to the country's ocean economy than one might expect (Alam 2015). The country's ports are not located close to main international shipping lanes, which is a constraint. However, serving as a hub within the Bay of Bengal (along with Kolkata or Chennai) could be an opportunity. Given the strong growth in port activity throughout much of the world, further development of Bangladesh's ports will likely be a central focus of the country's future ocean economy.

12 The term "pelagic," as defined by the FAO, refers to fish that spend most of their life swimming in the water column with little contact with or dependency on the bottom. The term "demersal" refers to species living in close relation to the ocean bottom and depending on it.
13 The livelihood figure assumes five persons dependent on each direct and indirect job.

At the same time, increased traffic could raise the risk of oil spills and other forms of marine pollution in the Bay of Bengal (BOBLME 2012 and Rahman 2006).

Bangladesh's shipbuilding industry has potential to expand its output by 10 to 15 percent over the next decade (Dausendschoen 2016). Its contribution more than doubled in 2014-15, with construction and export of two large ships. Some 300 ship- and boat-building yards and workshops lie scattered throughout the country, supplying domestic needs for water transport (Alam 2014). Two major shipyards have delivered more than 20 vessels to European customers since 2005 (Dausendschoen 2016). In the face of declining market demand, a recent World Bank study recommended a strategy of (i) determining which types of vessels provide the best opportunities, and (ii) identifying key factors of successful shipbuilding in competing countries such as China and Vietnam. In particular, the study noted the need for additional investment in infrastructure, reputation, and experience to increase export business. The barriers are challenging but they are not impossible for Bangladesh to overcome (Dausendschoen 2016).

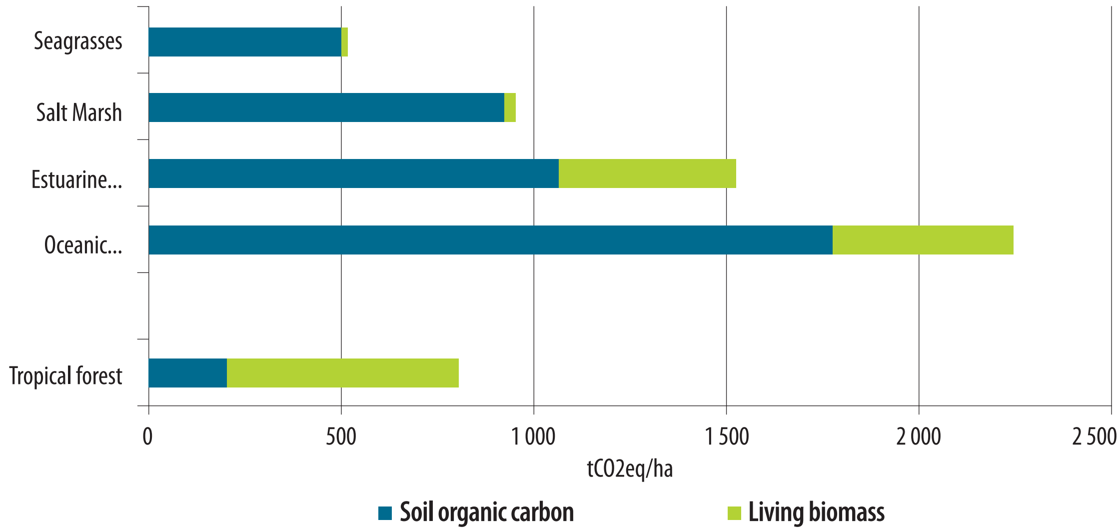
As an alternative to shipbuilding, Bangladesh has since the 1980s been a major center of the ship breaking industry (largely in Chittagong), together with India and Pakistan (Rahman 2017). Since 1980, the industry grew by an average of 14 percent annually, measured by the weight and number of ships recycled (Ahammad and Sujauddin 2017). The roughly 125 breaking yards in Bangladesh provide raw materials for a number of other economic activities in the country. The steel plates, equipment, navigation aids, deck fittings, and fixtures provide more than 60 percent of the materials for local shipbuilding. Ship breaking employs an estimated 200,000 workers in Chittagong and for the country as a whole provides some 1 million direct and indirect jobs (Alam 2015 and Hossain 2015). However, the benefits of growth in this industry have come with environmental and social costs, and may have an overall negative impact on the country's economy. The work can be hazardous and relies heavily on migrant labor (Hossain et al. 2016, Abdullah et al. 2013, and Sarraf et al. 2010). In addition, future growth is uncertain: the profitability and economic sustainability of the ship-breaking industry depends to a large degree on the global price of steel, and how Bangladeshi recycled steel can compete in that market, and on the global demand for seaborne transport and shipbuilding (Sarraf et al. 2010).

***Tourism and Recreation*.** Tourism and recreation contributed just over US$10 billion to GDP nationwide in 2016 and more than 2 million direct and indirect jobs (WTTC 2017). Dominated by domestic travel and tourism (98 percent of the total), this sector will likely grow at an annual rate of 6.1 percent from 2017 to 2027, placing Bangladesh among the top 25 countries in the world for tourism growth (WTTC 2017). Of course, not all this activity is considered part of the ocean economy. Marine and coastal tourism represent an estimated 16 percent of the country's total sector, in terms of leisure and recreation visitor days (Emerton 2014). Applying this percentage to the estimated gross value of the sector in 2013 suggests that US$1.6 billion is linked to the country's ocean economy. Hussain et al. (2017b) and Failler et al. (2017) report that the potential for ocean and coastal tourism growth mirrors the nationwide projections. They recommend following lessons from the nearby countries of Maldives, Malaysia, Myanmar, and Thailand. Similarly, while past policy has focused on domestic development, future growth would likely need to focus on the global market, while keeping in mind that the sector depends closely on maintaining the marine ecosystems (Roy and Roy 2015).

Recreational fisheries, an important part of travel and tourism in other countries, are increasing but remain relatively limited in Bangladesh. Key sites are Kaptai Lake in the Chittagong Hill Tracts and lakes in the major cities (FAO 2014). No recreational fishing occurs in the country's marine waters (Humayun et al. 2016). Data from the United Nations reinforce this picture of low levels of recreational fishing in Bangladesh, with imports of fishing rods, reels, hooks, and other tackle adding up to a total trade value of just US$127,180 in 2013 (United Nations Comtrade Database 2017).

***Blue Carbon*.** Carbon sequestration as an ecosystem service is often unpriced, though a recent study estimated that global mangrove destruction has resulted in up to US$42 billion in annual economic damage due to increased greenhouse gas emissions (UNEP 2014). Intact mangrove forests store carbon at rates that surpass those of tropical forests. Their recent deforestation has led to estimates of globally significant levels of carbon emissions (Pendleton et al. 2012, Sifleet et al. 2011, Nelleman et al. 2009, and Duarte

Figure 13: Global Averages for Carbon Pools (Soil Organic Carbon and Living Biomass) of Focal Coastal Habitats. Tropical Forests are Included for Comparison.



Source: Pendleton et al. 2014.

et al. 2005). Although an international market in carbon has not yet emerged, the carbon sequestered by mangroves (along with other coastal vegetated habitats referred to as "blue carbon") is eligible for inclusion in international financing mechanisms such as the Reducing Emissions from Deforestation and Forest Degradation (REDD+) market mechanism (UNEP 2016).

Mangrove forests in Bangladesh make up more than 3 percent of the global total (Giri et al. 2011 and Giri et al. 2015), ranking the country 12th in the world by mangrove area (Hamilton and Casey 2016). Almost all of these mangroves are located within the Sundarban forests, providing a range of ecosystem services (such as carbon sequestration) with benefits beyond the country (Das and Vincent 2009 and Miteva et al. 2015). The Sundarbans extend from the Hooghly River in India to the Baleswar River in Bangladesh, but today occupy only about half the area that they covered at the beginning of the colonial era. Current mangrove loss is reported to be concentrated in the Indian portion of the Sundarbans, while regrowth is actually happening in the eastern region in Bangladesh (Giri et al. 2015).

Estimating the potential value of carbon sequestration in the Sundarbans is difficult because the amount of carbon stored is still an area of research (Chowdhury et al. 2015), as is the annual rate of mangrove biomass and soil carbon change. Current research suggests a carbon density in the Sundarbans (including carbon stored above ground, below ground, and in the top meter of soil in mangrove ecosystems) of 239.91 Mg/ha for the 435,861 hectares of mangroves (Lee et al. 2015, 2016, and unpublished data). Mangrove carbon offsets have begun to achieve certification for inclusion in the voluntary carbon market (Vasconcelos et al. 2012), where willing buyers pay carbon project developers an average US$3 per ton of CO2 emissions avoided (Hamrick and Gallant 2017). However, the most relevant carbon credit prices concern forestry and land use, which traded at US$5.10 REDD+ (US$4.20), afforestation/reforestation (US$8.10), improved forest management (US$9.50), and grassland/rangeland management credits US$6.90).

To illustrate the scale of carbon emissions reduced by conservation of the Sundarbans mangroves, a global average loss rate of 0.7 percent per year was applied (Pendleton et al. 2012) and a price of US$5/Mg CO2eq. used. These calculations, while hypothetical, suggest a total value of US$122.8 million for carbon sequestration over 20 years.

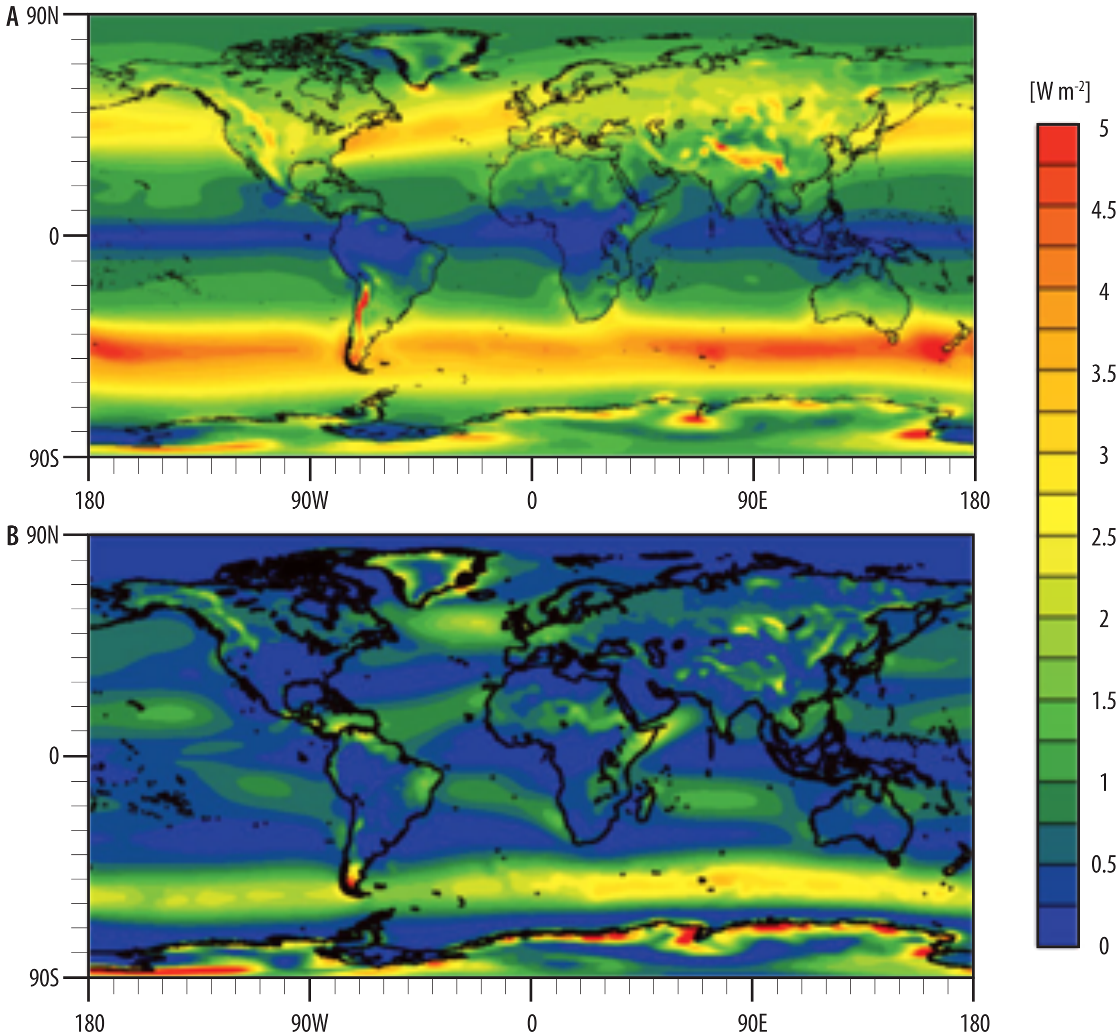
Coastal Protection. Natural or nature-based features can provide a significant service in reducing the risk of damage from coastal flooding (Arkema et al. 2017). The mangrove ecosystems of the Sundarbans offer coastal protection to millions of people in Bangladesh and India (Giri et al. 2015). The forests lie in a zone of tropical storms and tidal bores that originate in the Bay of Bengal and periodically strike the coastal areas (Giri et al. 2017). Estimating the economic value of coastal protection is challenging in the absence

of markets, but recent years have brought new methodologies and examples. The value estimates vary considerably due to the different statistical models used, assumptions, and study areas. These estimates should be treated with caution as they are derived using benefits transfers—applying proxy estimates developed elsewhere to the mangrove area in Bangladesh. However, they provide an indication of the order of magnitude for the economic value of this ecosystem service.

Barbier (2007) estimated the coastal protection service of mangroves in Thailand using the expected damage function approach to valuation. This approach values the protection service with respect to economic activities, property, and even human lives using count data econometric models. It also provides more reliable values of the storm protection service of coastal wetlands than other commonly used methods, such as replacement cost. The Thailand estimate showed a marginal effect of US$58.5 million per hectare of expected storm damages associated with mangrove loss. In other words, each hectare of mangrove forest lost corresponds to that amount of damage to property located on the landward side of the shoreline. More recently, Blankenspoor, Dasgupta, and Lange (2016) used a different method that involved the wave reduction and storm surge protection of mangroves. According to this study, the GDP and population in Bangladesh exposed to storm surges would rise from current levels of US$1.12 million and 30,052 people respectively, to US$2.13 million and 62,613 people under a future climate characterized by sea level rise, storm intensification, and mangrove loss. Emerton (2014) valued the coastal protection service of Bangladesh's mangroves at US$663 million in 2013 US dollars, using proxy estimates of the cost of coastal reclamation, coastal structures replacement, and engineered storm protection defenses in a hectare of mangrove forest in the Bay of Bengal.

***Hidden Services: Other Non-Market Ecosystem Services*.** Ocean and coastal ecosystems provide a range of services whose economic values are often not easily measured by market transactions. One example is the role of coastal ecosystems in waste disposal, i.e. in regulating water flow and quality. Emerton (2014) uses proxy estimates for a hectare of mangrove forests to estimate the total economic value of this service from Bangladesh's mangroves to be on the order of US$344 million (in 2013 US dollars).

Figure 14: Climatology of Kinetic Energy Extraction Rate for a Globally Homogenous Wind Turbine Density of One per Square Kilometer, Including Turbine-Atmosphere Interactions



Source: Caldeira and Possner 2017—copyright 2017 National Academy of Sciences.

Potential Industries. Researchers have identified a number of potential ocean industries that might succeed in Bangladesh. The mariculture of seaweed and other macro algae, mussels, clams, oysters, pearly oysters, sea cucumber, and sea urchin, among others, holds major opportunities (Hussain et al. 2017a, 2017b, and Failler et al. 2017). Biotechnology has evolved considerably over the last 30 years and will probably have a pervasive impact on the ocean economy, with positive implications for Bangladesh (Failler et al. 2017 and OECD 2016). Technologies for renewable energy from the ocean have entered various stages of commercialization, including the widely established offshore wind industry, the harnessing of wave, current, and tidal energy, and the capture of ocean thermal and salinity gradient energy (OECD 2016 and Bedard et al. 2010). Globally, the potential for wind energy may be greater at lower and higher latitudes, according to recent research (see Figure 20) which finds that kinetic energy extraction rates to be relatively lower in the tropics (Possner and Caldeira 2017). In Bangladesh, Hossain et al. (2014) recommend the exploration of coastal and offshore wind potential, notably in the upper Bay of Bengal, though little study has taken place to date.

3.3. Status of Bangladesh's Ocean Ecosystems: The Natural Capital

As mentioned previously, the coastal and marine ecosystems in Bangladesh provide services to society and can be characterized as natural capital assets. They make up one of the four types of capital underpinning output from the country's ocean economy. The status of these ecosystems will be a major determinant of the future growth and benefits from this segment of the country's economy, and its success in following a blue economy development pathway.

3.3.1. Overview of Bangladesh's Ocean Ecosystems

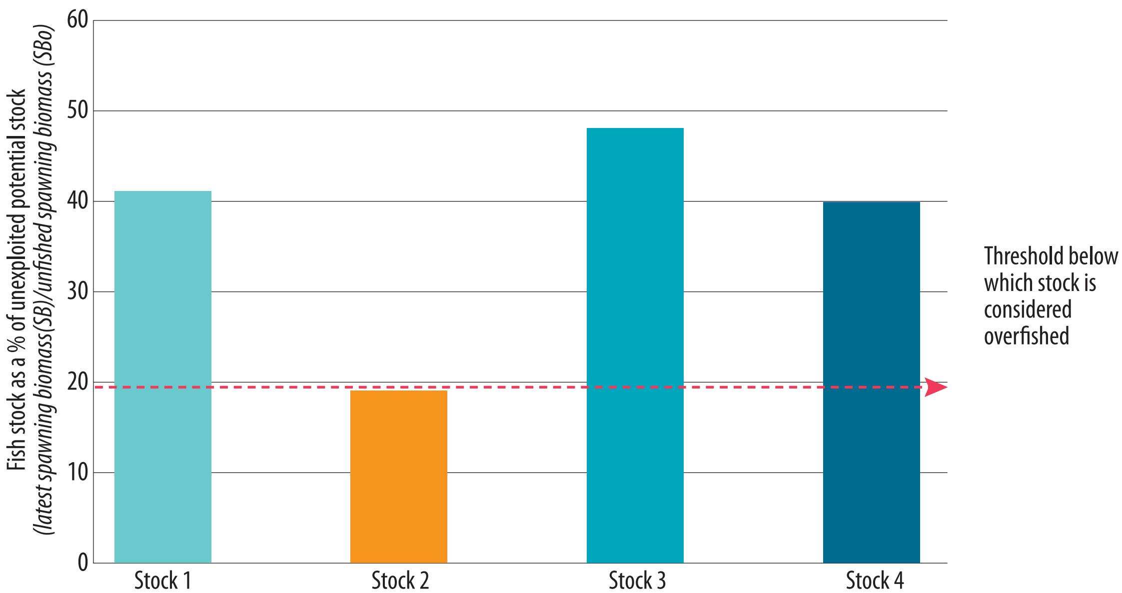
The Bay of Bengal provides natural capital in the form of non-renewable resources and ecosystem assets that provide a flow of services as inputs into Bangladesh's ocean economy. However, despite the widespread recognition of the flow of benefits from these ecosystem assets, measurement of the magnitude of these benefits is inherently difficult because many of the values are not determined in market exchanges.

Perhaps the best recognized form of natural capital underpinning Bangladesh's ocean economy is stocks of marine fish. These include demersal finfish (sedentary, bottom-dwelling) species, small and large pelagic species (many of which are harvested from stocks that span multiple jurisdictions within the Bay of Bengal), cephalopods and crustaceans, which are often classified according to depths harvested—in waters up to 40 meters deep, waters from 40 to 200 meters, and depths beyond 200 meters (Shamsuzzaman et al. 2017 and Hossain et al. 2014). These fish stocks are illustrated in Figure 15 as stocks in a hypothetical bank, with estimated economic returns.

However, little recent or comprehensive knowledge is available on the current or potential size of the country's fish stocks, making it hard to characterize the potential sustainable yields and economic returns from their use (Shamsuzzaman 2017). According to FAO (2014), the maximum sustainable yield of demersal finfish would be on the order 40,000 to 50,000 metric tons per year, but no estimates are available for pelagic finfish. The most recent estimates of the standing stocks, dating to 1973, 1981, and 1983 (Shamsuzzaman 2017 and Hossain et al. 2014), give the following levels:

- ***Demersal fish***—160,000 to 373,000 metric tons
- ***Pelagic fish***—90,000 to 200,000 metric tons
- ***Shrimp***—4,000 to 9,000 metric tons

Figure 15: Illustration of Bangladesh's Fish Stocks as a National Fish Bank



Source: Authors.

But trends in the catch suggest that these standing stock figures were significant underestimates. For 2012, total harvests were on the order of 579,000 metric tons, including more than 200,000 metric tons of Hilsa shad, 58,000 metric tons of Bombay duck, 52,000 metric tons of shrimp and 46,000 metric tons of Pomfret (FAO 2014). Indeed, in the absence of stock assessments (i.e. independent fisheries data), trends in catch rates are being used as clues about stock status for many species. Sometimes they show declining stocks. For instance, catch rates for finfish in coastal trawl fisheries[14] fell by 38 percent between 1999 and 2009, from 3,000 to 1,859 kg/day (FAO 2011). Using this type of evidence, several of the country's stocks have been characterized as biologically overexploited, with the age composition of harvests skewing toward a high proportion of juveniles (Shamsuzzaman 2017, Islam et al. 2017, BOBLME 2011, TDA Synthesis Report, and BOBLME-2012-Project-01). As shown in Table 7, a majority of the stocks harvested in waters less than 40 meters deep have been characterized as "fully fished" or "overfished" in a biological sense.

Table 7: Past Characterizations of the Status of Bangladesh's Marine Fish Stocks

Species groups	Harvested < 40 m deep	Harvested > 40 m deep
Demersal finfish	Overfished	Large demersal fully fished; Small demersal moderately fished
Small pelagic finfish	Fully fished	Fully fished
Large pelagic finfish	Fully fished	Moderately fished
Cephalopods (squids, cuttlefish)	Under fished	Under fished
Crustaceans	Fully fished	Moderately fished

Source: FAO 2011.

In terms of aquaculture, Bangladesh has a potential area of closed water bodies suitable for this activity estimated at 150,000 to 180,000 hectares in 2001, and more recently at 290,000 hectares (Shamsuzzaman et al. 2017 and Hossain 2001). The country's aquaculture operations have grown rapidly, resulting in an average rate of production growth over the last decade of 8.2 percent (Shamsuzzaman et al. 2017 and Hossain et al. 2013). The majority (more than 80 percent) of aquaculture production in Bangladesh takes place in inland freshwater ponds and other closed water bodies dominated by carps (and to a lesser extent Mekong pangasid catfish, tilapia, and Mekong climbing perch). A relatively small portion consists of coastal aquaculture (in ponds or enclosures) for shrimp and prawns (Shamsuzzaman et al. 2017).

Currently no significant deposits of minerals have been identified in the seabed under Bangladesh's jurisdiction. In terms of offshore oil and gas reserves, few detailed estimates of potential are available. In 2015 the Government stated that PetroBangla had initiated a 2D non-exclusive multi-client seismic survey within the EEZ in order to inform estimates and future bids for exploration (GED 2015). In 2017 experts suggested that a thorough survey of the zone remains to be conducted (Failler et al. 2017). Reports have suggested that the EEZ may hold one of the largest gas reserves in the region, as much as 200 trillion cubic feet of natural gas (Pakistan Defense 2017, Petrobangla 2016, and Detsch 2014). Potential increases in the country's current production of natural gas would depend on the location of the reserves, the market, and the onshore infrastructure needed. Increasing the proportion of natural gas in the country's energy mix will require additional infrastructure for processing and transmission, which could be a limiting factor.

For reference, the current nationwide production (including outside of the ocean economy) is roughly 986 billion cubic feet of natural gas per year (BDnews24.com 2017). The Government signed an agreement in March 2017 with Posco Daewoo for a five-year exploration phase in a block with an area of some 3,560 square kilometers, with other companies planning exploratory wells also (BDnews24.com 2017b;Oil and Gas Journal 2017). In addition, in October 2017 the Government announced that a new gas field had been found in the island district of Bhola, estimated to contain 700 billion to 1 trillion cubic feet of natural gas (BD24news.com 2017 and Jahangir 2017). As with other coastal and island states, such expansion

14 Catch rate is defined as the catch-per-unit of fishing effort (CPUE).

of offshore oil and gas exploration in Bangladesh increases the risk of spills and other environmental damage (O'Rourke and Connolly 2003).

In addition to fish stocks, mineral deposits, and oil and gas reserves, Bangladesh's marine natural capital includes extensive mangrove forests. The country is home to the planet's largest contiguous mangrove area located in the west of the Brahmaputra-Meghna river delta—the Sundarbans (Hossain 2001). By most estimates, the country has lost relatively little of the 435,861 hectares of mangroves in the Sundarbans in recent decades (Fatoyinbo, in review). These forests support a rich and diverse fish fauna, and are an important staging and wintering area for migratory birds (Hamilton and Casey 2016). Beyond the mangrove ecosystems, however, there is far less information on status of natural capital. There is some evidence for the presence of seagrass beds near Saint Martin's Island, as well as coral aggregations supporting 86 species of reef fish (IUCN 2004, Rajasuriya and Whittingham 2002, and Hossain 2001).

3.3.2 Human Drivers of Change in the Status of Bangladesh's Ocean Ecosystems

Changes in marine ecosystems will affect output from Bangladesh's future ocean economy. According to a recent assessment by the Bay of Bengal Large Marine Ecosystem Project (BOBLME 2012), at least three significant and mutually reinforcing local human drivers are altering the status of Bangladesh's natural capital: (i) increasing fishing capacity and effort, including ecologically damaging fishing practices and illegal fishing, (ii) coastal development, including the alteration of some natural habitats for aquaculture, and (iii) pollution, notably land-based sources of pollution from urban centers. All of these local drivers are occurring in the context of the larger drivers external to the country's ocean economy: (i) demographic change, (ii) markets and the economy, (iii) science and technology, and (iv) climate change.

The first human driver of marine ecological change in Bangladesh—fishing capacity (e.g. the number of fishing vessels operating) and overall fishing effort—has grown significantly in recent years, often causing biological overfishing. Perhaps nowhere is this more true than in coastal fisheries, where both trawl capacity and illegal fishing have grown (even though trawling at depths less than 40 meters is prohibited by the 1983 Marine Fisheries Ordinance). The number of total industrial trawl vessels nearly tripled between the years 2001 and 2016 (Islam et al. 2017).

With this growth, 299 trawlers (FAO 2014) are now reportedly operating in Bangladesh's waters, many with gear that can operate at the surface, midwater or bottom. About 100 vessels continue to bottom trawl despite a government ban. This increase has led to reports of conflicts with small-scale fishers and concerns for the physical alteration of the seabed in ways that affect habitats (Islam et al. 2017). The growth in trawl capacity and operations, as well as non-compliance with fishing regulations, follows a broader trend in some fisheries worldwide of growing fishing efforts (even as average catch rates have declined) acting as a key driver of the status of the country's fish stocks and wider ocean ecosystem processes. Beyond the waters of Bangladesh, the number of industrial freezer trawlers operating in the Bay of Bengal increased significantly between 1990 and 2014 (Kumar et al. 2016). In the bay as a whole, the trawl fishery currently contributes 14.2 percent—0.084 million tons (DoF 2016)—of total marine production, largely targeting *penaeid* shrimps and finfish at a depth of 40-100 meters (Hussain and Rahman 2010). Past assessments of the country's hilsa fishery have shown a similar trend, with estimates that the maximum sustainable economic benefits could be generated with just one-third of the fishing effort of the time (Mome 2007).

In terms of coastal development driving change in the country's ocean ecosystems, the population residing in the low-elevation coastal zone (40 percent of the country's land area)[15] is projected to grow from 64 million in 2000 to 85 million in 2030 and potentially more than 100 million by 2060. This is a result of factors including population growth, urbanization, and in-country migration (Neumann et al. 2015). This potent combination of population growth in a low-elevation coastal zone exposed to growing risks from sea level rise and flooding is likely to drive significant changes in the ecosystems underpinning the ocean

15 The low-elevation coastal zone is defined as the contiguous and hydrologically connected zone of land along the coast and below 10 meters of elevation (Neumann et al. 2015).

economy (Sarwar and Khan 2007). Already, for instance, ecosystem changes occurring as land use and urban areas expanded over recent decades have helped endanger 32 animal species in the coastal zone. These processes are only likely to intensify with climate change (Iftekhar 2006). Since the 1980s, coastal development, economic growth, and other factors have degraded coastal protection, water availability and quality, and land stability (Hossain et al. 2016).

One impact of coastal development has been changes in mangrove ecosystems in some areas. For example, old-growth mangrove forests known as the Chakaria Sundarbans, once located near Cox's Bazar, were lost completely due to clearing for multiple uses (Hossain et al. 2001). Mangrove forest loss continues to the present: a recent study estimated total mangrove losses to date of about 10,000 hectares, with a conservative total ecosystem service value of US$101.6 million, and associated blue carbon losses of 6.61 million tons (Ahmed et al. 2017). However, at the same time, the Government's Intended Nationally-Determined Contributions (INDC) states that the country's afforestation program has added 195,000 hectares of mangroves nationally (MOEF 2015).

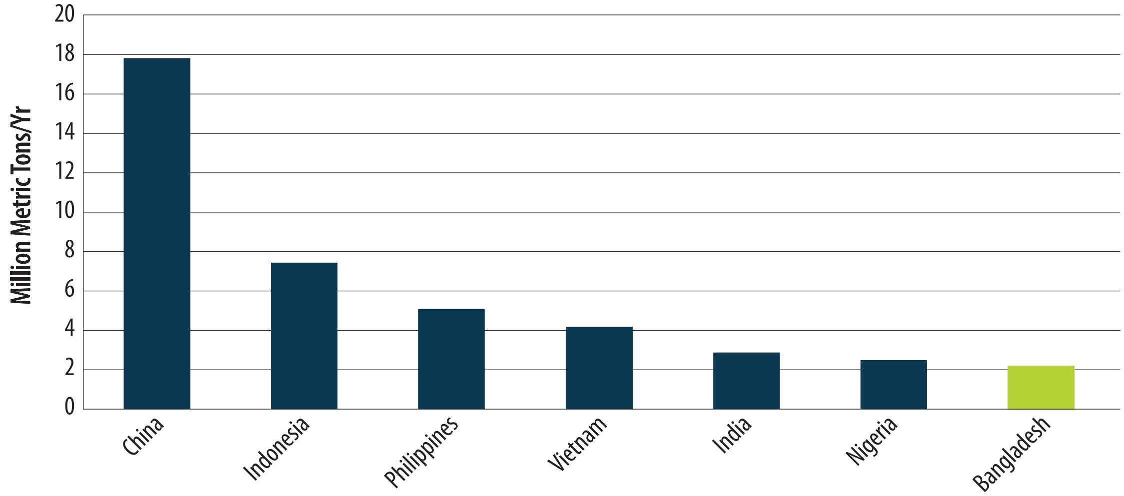
In terms of pollution of ocean ecosystems from land-based sources, Bangladesh's ship-breaking industry poses significant threats. Scrapping old vessels can release toxic materials that harm marine taxonomic groups such as fish, mammals, birds, reptiles, plants, phytoplankton, zooplankton, and benthic invertebrates (Abdullah et al. 2013 and Sarraf et al. 2010). A 2016 review of pollution levels in the marine waters and sediments around the country's ship-breaking yards identified a number of pollutants, including heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl compounds (PCBs), organotin, oil and grease, and asbestos, among others, altering the physiochemical properties of coastal waters (Hossain et al. 2016). For example, in the area from Foujderhat to Kumira at Sitakunda in the Chittagong district, ship-breaking activities were found to discharge a number of refuse materials and metal fragments into the coastal environment, resulting in ammonia concentrations at toxic levels for marine organisms, an increase in the pH of coastal waters, and an abundance of floatable materials (grease balls and oil films), and other ecological impacts (Islam and Hossein 1986).

In addition, coastal waters suffer due to pollutants carried in by rivers and streams from far inland, such as the estimated 9,000 metric tons of pesticides and more than 2 million tons of fertilizers used in Bangladesh (Islam and Tanaka 2004). In the early 2000s roughly 1,800 metric tons of pesticide residues were added to coastal waters annually as a result of runoff (Islam and Tanaka 2004). Recent estimates have suggested that nitrogen and phosphorus inputs into coastal waters as a result of untreated sewage are currently one to two orders of magnitude higher than previously thought and increasing, which could contribute to coastal eutrophication (e.g. creation of "dead zones" in the water) as well as health issues with consumption of fish caught near urban areas (Amin et al. 2017). Much of the worst pollution of the country's waterways originates from the growing urban centers. For example, the textile industry alone is estimated to discharge 140 million tons of effluents into Dhaka's rivers annually (World Bank 2018a).

Lastly, Bangladesh ranked tenth in the world in 2010 for mismanaged plastic waste, with 787,327 metric tons of plastic entering the ocean each year, or 2.5 percent of the global total (Jambeck et al. 2015). Projections show this volume increasing almost three-fold to 2,210,230 metric tons annually (3.2 percent of the global total) by 2025, the seventh-highest level in the world, as shown in Figure 17 (Jambeck et al. 2015).

In sum, changes in Bangladesh's ocean ecosystems, driven in part by increasing fishing capacity and effort, coastal development, and various forms of pollution, affect the size and economic value of the country's natural capital assets: non-renewable resources and ecosystem assets. Such changes in the natural capital, together with changes in the manufactured and human and social capital, will reduce the size and sustainability of annual output from the country's ocean economy, though these attributes are not reflected in output measures. The status of these ecosystems, often called "ocean health," is hence inextricably linked to the performance of the ocean economy in Bangladesh ("ocean wealth"), presenting both a risk and an opportunity.

Figure 17: Projected Mismanaged Plastic Waste in 2025



Source: Jambeck et al. 2015.

3.3.3 Incorporating the Costs of Environmental Degradation into Measures of Bangladesh's Ocean Economy

As mentioned earlier, the initial estimates of annual output from Bangladesh's ocean economy presented in Section 3.2 provide only a partial baseline. These estimates not only omit economic values for the contributions of a number of ecosystem services (e.g. coastal protection and carbon sequestration), but also the economic costs to society of environmental degradation associated with activities in the ocean economy (i.e. externalities to the ocean economy). For example, alteration of ecosystem structure due to coastal bottom trawling, clearing of mangrove forests for shrimp aquaculture, and toxic pollution from ship breaking would all be expected to impose economic costs on the country, but these costs have not been subtracted from measures of the ocean economy's annual output in Section 3.2. A more accurate measure of economic output from the ocean economy (i.e. "green GDP" or in this case "blue GDP") would subtract the costs of environmental degradation, as illustrated in Table 8.

Table 8: Annual Output from Bangladesh's Ocean Economy, Incorporating Costs of Environmental Degradation

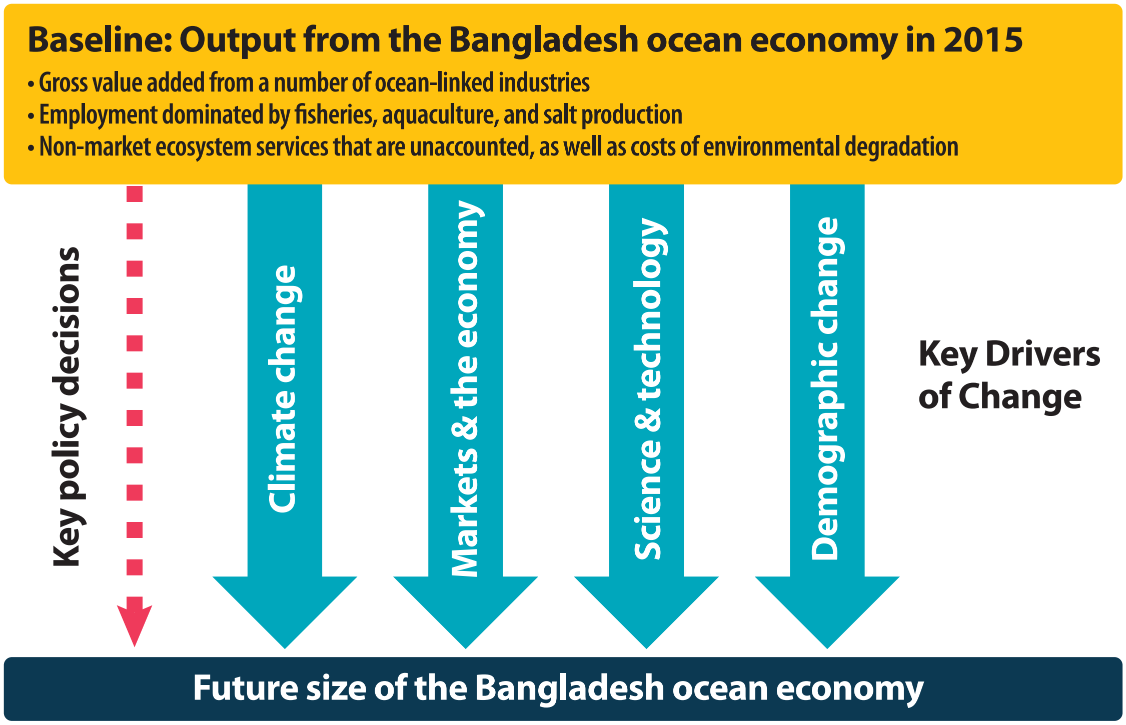
Ocean economy sector	Ocean economy industry/ service	Gross value added in 2014-2015 (nominal US$ million)	Economic costs of environmental degradation (damages)
Living marine resources	Marine capture fisheries	1,167.79	[-] damage from altering ecological structures by bottom trawling, for example
	Marine aquaculture	163.20	[-] damages from altering mangrove ecosystems to develop shrimp ponds
	Fish processing and retailing	0.17	[-] Improper disposal of solid and liquid wastes from processing
Minerals	Sea salt production	197.88	
Energy	Offshore gas and oil	1,205.14	[-] potential damages from oil spills
Transport and trade	Transport	1,366.10	
	Ship and boat building/breaking	525.27	[-] damages from pollutants released in ship breaking
Tourism and recreation	Coastal and maritime tourism	1,567.43	[-] Costs of improper and unplanned development
Carbon sequestration	Blue carbon	N/A	
Coastal protection	Habitat protection, restoration	N/A	
Total		6,192.98	

3.4. External Drivers of Future Growth in Bangladesh's Ocean Economy

This chapter provides a snapshot of the current size (in terms of annual output) of Bangladesh's ocean economy, summarizes the status of the natural capital assets that underpin this output, and describes possible economic costs of associated environmental degradation. This information may serve as a baseline for various future projections and policy scenarios, which will help define where the Government would like this segment of the economy to go, and possible pathways to get there. Such projections generally begin with a description of the main factors or "drivers" influencing change in the units of analysis, which in this case is output from Bangladesh's ocean economy (Alcamo 2001). The external drivers that will shape future growth in the ocean space can be drawn from OECD (2016) projections for the future of the global ocean economy, as well as more general work by Porter (1979, 2008) characterizing the major forces that affect industries, and Doyle and Windheim's 2014 adaptation of this approach to examine forces affecting environmental quality. The OECD has described the main drivers of the global ocean economy as world population trends, global economic developments, the effects of climate change, and advances in science and technology. It has also considered trends in the supply and demand of energy, food, metals and minerals, and geopolitical developments (OECD 2016). Drawing from this body of work, four major forces are summarized below as external drivers of future growth in the output from Bangladesh's ocean economy: (i) demographic change, (ii) markets and the economy (market size, profitability, micro- and macro-economic trends, and investment), (iii) science and technology (technology methods and innovations, intellectual property), and (iv) climate change (see Figure 18 below). These drivers (the controlled variables), together with policy decisions by the Government for management of the underlying capital stocks (the independent variable), will determine any change in the output from Bangladesh's ocean economy (the dependent variable).

Demographic Change. The world's population is projected to increase from 7.6 billion in 2017 to 9.7 billion in 2050, while in Bangladesh population is seen increasing from 164.7 million to 201.9 million (Figure 19). Under a medium fertility scenario in Bangladesh, the current annual growth rate of more than one

Figure 18: External Drivers of Change Expected to Affect the Future Size of Bangladesh's Ocean Economy



Source: Authors

Figure 19: Total Populations (Medium Fertility)

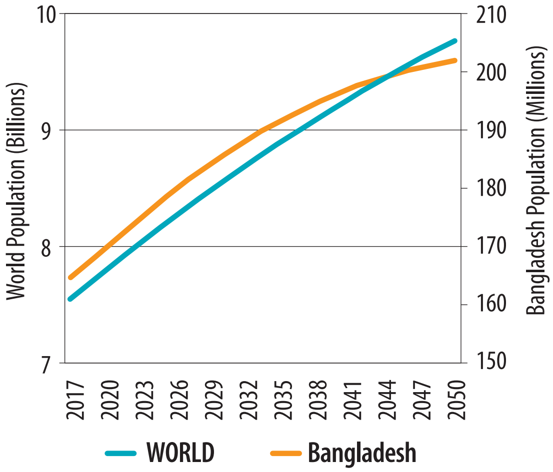
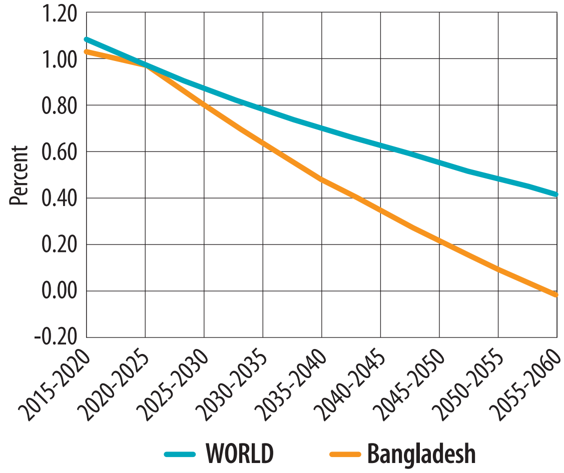


Figure 20: Annual Rate of Population Change



Source: Authors

percent starts to decline relative to the global trend between 2025 and 2030, eventually reaching zero growth after 2050 (Figure 20). This pattern will affect the future of the ocean economy when, for example, demands for fish products, maritime transport, and tourism increase.

As the population grows, an increasing share will live in urban areas—already 45 percent of the total in 2010 (Ellis and Roberts 2016). Home to one of the world's 29 megacities (Dhaka), Bangladesh experienced faster urbanization than South Asia as a whole between 2000 and 2010. Even if the urban population density remains constant, providing affordable housing will require the expansion of developable land around existing cities by more than 7,000 square kilometers (or almost 45 percent) between 2010 and 2050 (Ellis and Roberts 2016).

Markets and the Economy. Changes in the global economy will affect the ocean economy in Bangladesh. Recent projections suggest 2.7 percent growth in the global economy in 2017, strengthening further to 2.9 percent in 2018-19 (World Bank 2017). The global ocean economy is expected to grow at a faster rate between 2010 and 2030, doubling in gross value added from US$1.5 trillion to US$3.0 trillion (OECD 2016). The Economist (2015) has characterized the ocean as an economic force in the twenty-first century, with acceleration at a pace reminiscent of industrialization on land.

As the ocean economy grows, the markets for specific industries in Bangladesh will likely change, given the many competitive pressures from global markets. The OECD (2016) expects strong global growth in shipping, shipbuilding and repair, port activity, marine supplies, marine aquaculture, marine tourism, and offshore wind, to name a few, with less growth projected in capture fisheries and offshore oil and gas. Non-wind ocean renewable energy, marine biotechnology, and carbon capture storage also have significant potential after 2030, the OECD concludes. Table 9 below provides an overview of projected trends in global ocean economy industries in Bangladesh.

In addition to current industries and services, marine biotechnology is considered a growing opportunity at the global level, with a market of US$2.8 billion in 2010 increasing to an estimated US$4.6 billion by 2017 (OECD 2016). Offshore wind energy has major growth potential as well. Global installed capacity has increased from practically nothing twenty years ago to greater than 7 gigawatts (GW) today, while projections suggest the potential for 40-60 GW by 2020 and 100 GW by 2030. However, much of this development may take place at latitudes outside of the tropics (Possner and Caldeira 2017, OECD 2016, and IRENA 2016). In Asia, China is predicted as the main driver of market growth in offshore wind to 2045 (IRENA 2016).

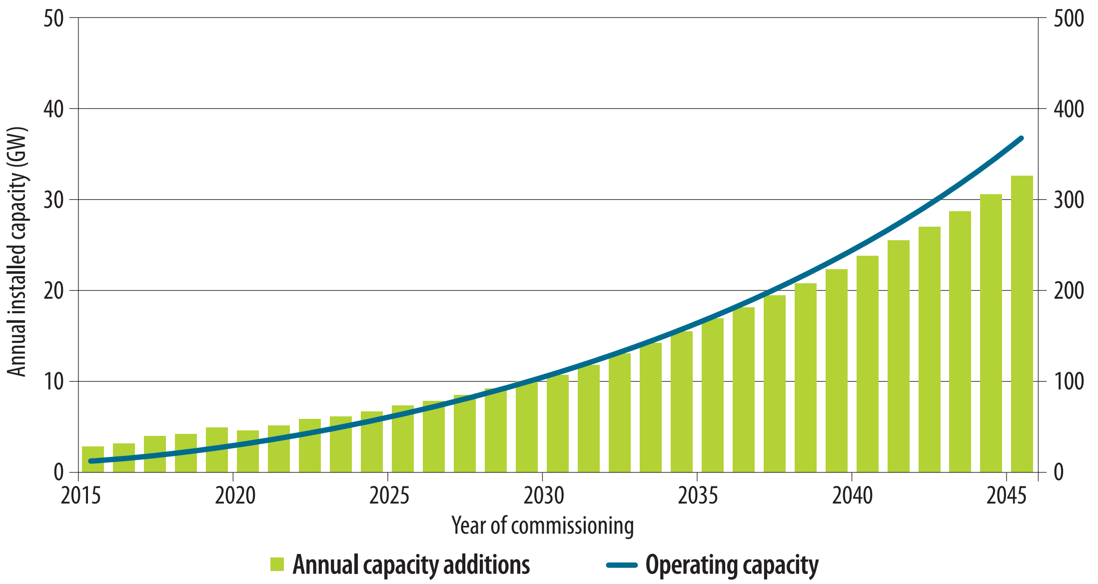
Science and Technology. In the next decade, the OECD predicts, many ocean economy industries will enjoy rises in productivity due to a range of new technologies: imaging and physical sensors, satellite systems, advanced materials (i.e. metallic, ceramic, polymeric, and composite materials), information and

Table 9: Projected Global Market Trends for Ocean Economy Industries Operating in Bangladesh

Ocean economy sector	Ocean economy industry/ service	Future trends
Living resources	Marine fisheries Marine aquaculture Processing and retailing	Worldwide demand for fish and seafood will continue to grow. To maintain current per capita consumption levels as the population increases will require aquaculture production to double by 2050, at a minimum, assuming global capture fisheries production continues to stagnate or decline. However, ending overfishing and rebuilding depleted stocks could increase marine capture fisheries production by as much as 20 percent (MEA 2005 and Waite et al. 2014). Bangladesh may pursue growth from capture fisheries through management and rebuilding of depleted stocks, while at the same time exploring hatchery-based seed production and mariculture of a number of marine species such as sea bass, grouper, marine eel, pomfret, mullets, and mud crab (*Scylla serrata*). Hussain et al. (2017a, 2017b) state that opportunities also exist for mariculture of nontraditional marine living species such as seaweed and other macro algae, mussel, oyster and other shellfish (edible oysters, *Crassostrea* sp. *Saccostrea* sp, pearl oyster, *Anadra* sp. green mussel, *Perna viridis*, clam, *Meretrix meretrix*, *Marcia opima*, sea snails), sea urchin, and sea cucumber.
Minerals	Sea salt production	Bangladeshi sea salt production has increased, but future projections are not currently available (Al Mamun et al. 2014). As the use of refrigeration increases, demand may decrease over the long term.
Energy	Offshore oil and gas	Offshore oil and gas share's of global production increased from 20 percent in 1980 to 30 percent in 2014, with total production projected to grow at a rate of roughly 3.5 percent annually up to 2030 (Brakenhoff 2015 and IAEA 2014). Gas extraction is expected to grow in both shallow and deep waters, from slightly above 17 million barrels of oil equivalent (mboe)/day in 2014 to 27 mboe/day in 2040 (OECD 2016). This trend is likely to influence Bangladesh, where production-sharing contracts for multiple ocean blocks have been signed recently. These contracts were based on estimates of large offshore hydrocarbon resources located near the maritime boundary with Myanmar, whose recent exploration activity confirmed recoverable gas resources (Imam 2017, OGJ 2017, and The Daily Star 2017). Globally, oil production is moving further offshore, with new discoveries in waters as deep as three kilometers , compared to one kilometer in the 1990s (Brakenhoff 2015). The coming 15 years could see a significant increase in deep water offshore production, while production from shallow-water fields may decrease (OECD 2016). This projection assumes that current policies and consumption patterns will not change, but does not consider alternative pathways towards achieving the goals of the Paris Agreement on climate change.
Transport and trade	Transport	Currently some 90 percent of global trade (by weight) is carried on the ocean. By 2050 maritime freight transport is projected to quadruple from 2010's rates (OECD and ITF 2015). Seaborne trade has been projected to grow at an annual rate of 4.1 percent over the period 2017-19, 4.0 percent on average over 2020-29, and 3.3 percent between 2030 and 2040 (OECD 2016). Port-related operations and services would rise by 4.7 percent annually from 2015 to 2020 (Lucintel 2015), with an increasing trend over the longer term given the rise in freight transport. At the same time, the sector is currently responsible for 2-3% of global greenhouse gas emissions, and under a business-as-usual scenario, the International Maritime Organization estimates that carbon emissions from shipping could increase by 50 to 250% between 2010 and 2050 (IMO 2015).
	Ship and boat building and breaking	Growth in Asia is foreseen in both the ship breaking and ship building industries. Ship building is a highly competitive global market, and thus the market share that Bangladesh obtains will depend on multiple factors. On the global market, tanker and container ship building is expected to grow in the next decade, at higher rates than the bulk carrier market (Hossain and Zakaria 2017). The future of ship breaking in Bangladeshi is highly uncertain given adverse environmental impacts and increasing application of global market regulations for social and environmental standards (Sarraf et al. 2010, Cairns 2014, and ILPI 2016). Indeed, the industry is threatened by competitive sources of steel and will not likely stay on its current growth trajectory once suppliers impose environmental and social standards (Colgan 2017b).

Ocean economy sector	Ocean economy industry/ service	Future trends
Tourism and recreation	Tourism	Global tourism and travel will grow its contribution to GDP (already over 10 percent) by a projected 3.8 percent per year from 2015 to 2025. As populations age and incomes rise in many countries and transportation costs remain low, coastal and ocean locations will become even more attractive tourist destinations. Recent developments suggest that marine tourism will grow at a faster rate than international tourism as a whole (OECD 2016). This trend is expected also in Bangladesh, where investment in the tourism sector is estimated to grow at a projected 9.3 percent per year from 2018 to 2027. International visitors during this period are expected to increase by 7.6 percent per year, driving a growth in total tourism GDP of 7.1 percent per year, and in employment of 1.8 percent per year (WTTC 2017). While urban areas may receive much of this growth, potential locations for coastal and ocean tourism have been identified at Patenga beach, Cox's Bazar beach, Himsory and Inani beaches, St. Martin's Island and beaches, Moheshkhai Island, the Sundarbans mangrove forests, Kuakata beach, and Bhola and Monpura Islands (Hussain et al. 2017a).
Coastal development	Marine-related construction (infrastructure development)	Migration and development in the coastal zone around the world (defined as land less than 100 km from the coast) have increased faster than in inland areas since 1970, leading to much higher population densities in most of the world's "mega-cities" such as Tokyo, New York, Seoul, Mumbai, Shanghai, and Jakarta. Development will affect a projected 91 percent of all inhabited coasts by 2050 (Neumann et al. 2015 and World Bank 2012), including infrastructure for coastal protection in response to sea level rise.
Carbon sequestration	Blue carbon	The full cost of carbon release by clearing mangroves has been estimated at between US$3.6 and US$18.8 billion per year, at a price (the true "social" cost) of US$41 per ton of carbon dioxide (Pendleton et al. 2012). Blue carbon conservation is expected to become a significant portion of reductions in tropical forest emissions.
Coastal protection	Habitat protection, restoration	Coastal habitats (coral reefs, mangroves, salt marshes, and seagrass/kelp beds) reduce wave height significantly (on average between 35 and 71 percent across 69 sites studied) and thereby help reduce flooding (Narayan et al. 2016). The need for restoration of such habitats will grow under various scenarios of climate change. As the sea level rises, at least 900 million people could be living in vulnerable low-lying coastal zones (that is, with less than 10 meters of elevation), mostly in Asia (Neumann et al. 2015).

Figure 21: **Forecasted Global Annual Installed and Operating Capacity of Offshore Wind, 2016-45**



Source: IRENA 2016 (© IRENA).

Box 7: Finding Opportunity in Responding to Climate Change in the Bangladesh Blue Economy

Bangladesh has long been recognized as one of the world's most vulnerable countries to natural hazards (MOEF 2015). Located on the deltas of three of the world's major rivers and in the regular path of tropical cyclones, Bangladesh is year after year at risk of severe damage from winds and river and coastal flooding. High population density, very low incomes, and weak infrastructure combine with natural hazards to be a constant constraint on the nation's development. Climate change will exacerbate all of the natural risks that Bangladesh faces. The net effect of climate change will almost certainly be to reduce long-term growth potential throughout the Bangladesh economy.

But some of these effects could offer opportunities in the blue economy as Bangladesh responds to climate change. These responses will consist of adaptation (adjusting to climate change and its effects) and mitigation (reducing the likelihood of climate change).

Adaptation of Bangladesh's ocean economy to the threats of sea level rise and flooding will require combinations of three strategies: building barriers against the water, changing structures to reduce damages, and relocating structures to areas with lower flood risks. Because of its history with flood hazards, Bangladesh is already well-practiced in each of these approaches. That experience will be called on as blue economy-related investments are made in infrastructure and ocean industries. The extra demands of adaptation will be both a funding challenge and an opportunity to create employment as the economy shifts away from unsustainable and environmentally damaging activities. For this reason, marine and coastal construction will likely change from having an ancillary role in the ocean economy to taking on a much more central role in the blue economy.

Bangladesh's past experience and its need to innovate and expand in addressing flooding has given it a body of expertise that could aid other countries as climate change brings threats similar to what Bangladesh has long confronted.

The threats to the natural capital of the ocean and estuarine habitats and the shoreline will require institutional responses that can accommodate rapid external changes. Fisheries management for sustainable species will not be able to focus just on reducing overfishing to sustainable historic levels, for instance. It will need also to adjusting fishing efforts to shifting sizes and composition of fish populations. Aquaculture will have to adjust to increases in salinity in estuarine and fresh water systems and to more acidic waters. These adjustments will be continuous.

Climate change mitigation also offers opportunities. Carbon sequestration ("blue carbon") in coastal wetlands, particularly mangrove forests, is among the most important mitigation strategies in global efforts, and Bangladesh has extensive resources of this type. Use of coastal wetlands as natural infrastructure to reduce flood hazards will provide both adaptation and mitigation benefits.

These examples suggest that investments in sustainability in response to climate change will become a more and more significant part of the blue economy.

communication technologies, big data analytics, autonomous systems, biotechnology, nanotechnology, and subsea engineering (OECD 2016). Of special note are the rising sophistication of ocean observing systems, new technologies for deep seabed mining, advances in renewable energy generation, and the potential for new pharmaceuticals from marine biotechnology. These and other trends could transform the composition of the ocean economy over the next several decades. For now, many of the associated industries barely register in the definitions and measures of the ocean economy (Colgan 2017a). Yet renewable energy generation will likely replace offshore oil and gas in many countries (Colgan 2017a). Naturally available energy sources such as marine wind, wave, solar radiation, tide, and water currents could provide low-cost electrification for homestead houses, small-scale mills and plants, and offshore islands in Bangladesh (Hussain et al. 2017a, 2017b).

Climate Change. The ocean (including the enclosed seas) has moderated climate change, capturing 28 percent of carbon dioxide emissions since 1750, at a cost of major changes in its fundamental chemistry and physics (Gattuso et al. 2015). These changes include the warming and acidification of ocean surface waters and rising sea level, which in turn impact marine ecosystem functions and the services they provide (Gattuso et al. 2015 and Wong et al. 2014). For example:

Box 8: Research on the Impact of Climate Change on Hilsa Shad Production and Consumption

Three universities (Harvard's T.H. Chan School of Public Health, the University of British Columbia, and Texas State University) are conducting research on climate change's effects on the abundance and distribution of the most commercially and nutritionally important fish species in Bangladesh. Researchers have examined scenarios that vary the intensity of sea temperature change, trajectories of aquaculture growth, price trends, and expenditure growth per capita. They found that Hilsha shad, the species caught in the greatest volume in Bangladesh, will decline 40 percent by 2050 in some scenarios. The rate of growth in aquaculture productivity strongly impacts fish consumption in rural coastal areas, but the effects are non-linear: slight changes in the relative price of aquaculture and wild capture fish have large impacts on overall fish consumption and nutrient intake. Under low aquaculture growth scenarios, protein, iron, and zinc from fish sources may drop 35-40 percent by 2050.

- Rising sea levels drown some plants and animals and induce changes in available light, salinity, and temperature, affecting the capacity of plants (e.g. mangroves) and animals (e.g. corals) to keep up with the rise;
- Warmer temperatures have direct impacts on species that need specific narrow temperature ranges, shifting the geographical distribution of many species towards the poles; and
- Acidification diminishes the amount of a key building block (carbonate) that marine "calcifiers" (such as shellfish and corals) use to make their shells and skeletons. It may ultimately weaken or dissolve them (Wong et al. 2014).

All of the projected impacts from climate change described in Box 7 will be exacerbated by human-induced drivers such as coastal development and pollution (Wong et al. 2014). In Bangladesh, sea level rise could inundate up to 17.5 percent of the country's total land mass, including the Sundarbans, increasing soil and water salinity throughout the coastal zone (Sarwar and Khan 2007). Under multiple climate and fisheries management scenarios and mortality targets, fish production and catch potential from ocean waters will fall by up to 10 percent in both the short and long term, and between now and 2050 the specific catch potentials for Hilsa shad will decline by 25.9 to 93.1 percent and for Bombay duck by 18.0 to 54.7 percent (Fernandes et al. 2016).

In the case of the Sundarbans, scientists project a 28-cm increase in sea level by 2070, shrinking the remaining tiger habitat by 96 percent and posing serious threats to the mangrove forests (Loucks et al. 2010). In addition to mangrove loss, changes in mangrove species composition will occur under most climate change and subsidence scenarios (Dasgupta et al. 2016). Higher-valued species are expected to decrease in favor of lower-valued species across the Sundarbans. Spatial distribution of projected mangrove species assemblages shows that the more salt-tolerant ones will dominate in the future (Mukhopadhyay et al. 2015).

The specific impacts of climate change on the ocean economy will vary by place and species. While the extent and effectiveness of mitigation efforts will determine the precise nature of these impacts, there can be no doubt that climate change will be a significant determinant of the future Bangladesh ocean economy. Managing climate change will require the same kinds of investments in technology, infrastructure, and coastal ecosystems that are needed to expand the ocean economy at large (Colgan 2017b).

4 The Way forward to a blue economy in bangladesh

PHOTO CREDIT: PIERRE FAILLER

4.1 Rationale for Recommendations to Inform a Coordinated Planning Process for Blue Economy Policy Design and Delivery

The previous chapters have attempted to summarize the current global concepts and measures relevant for Bangladesh to pursue its blue economy aspirations, and have provided a coarse initial baseline by which to measure progress. As mentioned, this baseline is incomplete and does not include the costs of environmental degradation nor the benefits from a number of ecosystem services that have no markets. However, such a partial baseline can at least form the starting point for a coordinated policy planning process for the blue economy in Bangladesh. The future size and sustainability of output from the ocean economy will depend upon the status and management of the country's underlying capital stocks (natural, produced, human, and net foreign assets), in the context of exogenous drivers such as demographic changes, markets and the economy, science and technology, and climate change.

A coordinated policy planning process is emphasized here because the range of opportunities and risks for Bangladesh to take a blue economy development pathway is daunting in its complexity. For example, traditional industries such as capture fisheries are likely to remain the core of any scenario for a blue economy for the foreseeable future, but will require policy instruments to address overexploitation, notably in the coastal waters as a result of growing trawl capacity and effort (including non-compliance with regulations). Similarly, transport may play a greater role as the country becomes a regional hub, and shipbuilding has potential to increase with investments in infrastructure and lessons learned from competing countries such as China and Vietnam. Salt mining has potential to capitalize on recent advances in production techniques in other countries, though financing is still largely informal and relatively expensive. Tourism carries opportunity, with the objective of increasing its share in the global market and drawing upon lessons from nearby countries such as Maldives, Malaysia, Myanmar, and Thailand.

All of these traditional industries will likely continue to generate opportunities in a blue economy scenario if the right policy choices are taken, notably to learn from neighboring countries and international examples, and to address resource overexploitation and constraints to investment, such as in infrastructure. At the same time, researchers have identified a number of potential emerging ocean industries in Bangladesh that will go beyond traditional ones. The mariculture of seaweed and other macro algae, as well as mussels, clams, oysters, pearly oysters, sea cucumber, and sea urchin holds real opportunities, as well as marine biotechnology. In addition, experts have recommended the investigation of coastal and offshore wind potential, notably in the upper Bay of Bengal, though little study has taken place to date. Finally, the offshore gas industry holds significant economic opportunity, as Bangladesh's waters may contain one of the region's largest gas reserves. However, the risks of oil spills from petroleum development and the costs of other environmental damages will require careful planning as part of a blue economy scenario.

Capturing all of this opportunity will require addressing the risks caused by environmental degradation and loss of natural capital, as well as vulnerability to climate change. Coastal waters are compromised by pollutants such as pesticides and fertilizers carried by rivers and streams from far inland, as well as increasing volumes of untreated sewage, all of which could contribute to coastal eutrophication (creation of "dead zones" in the water) and pose health issues with consumption of fish caught near urban areas. Indeed, investment in urban pollution abatement may be a key feature of any blue economy development pathway. The ship breaking industry is also a source of toxins in many nearby marine sediments and waters. This all takes place in a context of rapid development in the country's low-elevation coastal zone, where the population is projected to grow from 64 million in 2000 to 85 million in 2030, and potentially over 100 million by 2060.

Growth of population in the low-elevation coastal zone means higher risks from sea level rise, flooding, and other effects of climate change. Indeed, Bangladesh is one of the world's most climate-vulnerable countries. Sea level rise could inundate up to 17.5 percent of the country's total land mass, increasing soil and water salinity throughout the coastal zone and potentially flooding the Sundarbans. Under multiple climate and fisheries management scenarios, fish production and catch potential from ocean waters are reduced by up to 10 percent in both the short and long terms. Between now and 2050 the catch potentials for Hilsa shad declines by 25.9 to 93.1 percent and Bombay duck by 18.0 to 54.7 percent.

There is a wide range of opportunities and risks across different industries and ecosystem services, none of which develop in isolation but rather interact as part of a larger economic system. Given that, Bangladesh would benefit from undertaking a coordinated policy planning process to guide the ocean economy along a blue economy pathway—starting with the ongoing design of an Integrated Coastal and Ocean Management Policy. As highlighted in Chapter Three, many of the country's marine asset stocks are likely already overdrawn or depleted.

Bangladesh could deeply benefit by tapping the experience of other coastal and island nations that have begun such processes to translate the blue economy concept into an operational policy agenda. These processes have typically included:

I. Establishing a spatially and temporally consistent baseline measure of the size of the ocean economy and indications of sustainability, and targets for sustainable growth;

II. Developing strategies to encourage private investment in traditional or emerging ocean industries that reflect principles of sustainability, often through public investment in research; and

III. Conducting some form of coastal and marine spatial planning to ensure that "we do not repeat the same mistakes on sea as we did on land."

Where countries have undertaken such planning processes, aiming to simultaneously address performance of different sectors of the ocean economy, the benefits have been greater than the significant costs and high information requirements. These benefits include lower costs from shared common infrastructure, support for cross-fertilization of technologies and innovation, enhanced (or rebuilt) natural capital assets underpinning a range of activities, and broadly a more effective use of shared ocean space (Colgan 2017a and OECD 2016).

With the rationale outlined above, this report outlines key elements of a coordinated policy planning process to help the Government of Bangladesh develop the country's ocean economy along a blue economy pathway as described in the FYP, rather than through specific reforms or investments (which would be outputs from this process). The timing may be opportune to ensure that these key elements are included in a planning process, as the Government is currently embarking on the design and delivery of an integrated ocean policy, as well as review of a number of sectoral policies for the ocean economy. The following key elements are highlighted here: (i) steps to improve the baseline and ongoing measures of the country's ocean economy; (ii) proposed scenario modeling to establish targets; and (iii) some key considerations for coordinating the process.

Box 9: Summary of Blue Economy Approaches

Based on a range of international experiences to date, the following general approach is recommended for governments to apply the blue economy concept to the ocean space and resources under their jurisdiction. It is adapted from a framework which includes the five elements of (i) investment, (ii) customers, (iii) management, (iv) innovation, and (v) measurement. This integrated approach includes the following steps:

Step One: Measure the status of the ocean economy and ecosystems at the national level, as well as external driving forces such as climate change. Measurement sufficient for management will be facilitated by developing an ocean account to maintain a snapshot of the output from the country's ocean economy—a "gross marine product"—and by incorporating measures of the underlying natural capital assets into this account—a "net marine product."

Step Two: Manage the interactions between the ocean economy and ecosystems, and between sectors. The ultimate success of a country in achieving blue economy policy objectives depends upon the management decisions of public agencies charged with regulating ocean use. In countries around the world, numerous obstacles stand in the way of integrating such decisions in order to reflect the interactions between ocean ecosystems, between ocean economy sectors, and between the ecosystems and economy. To ensure that the design and enforcement of these ocean rules are as integrated as the ocean ecosystems and economy, CMSP processes have been developed over time. CMSP processes collect and translate information on the ocean ecosystems and economy spatially, providing a more integrated basis for management decision-making. Specific tasks may include:

- Establishing and strengthening the institutional framework for coordination of blue economy policy planning. In the case of Bangladesh, this could be the Blue Economy Cell of the Ministry of Power, Energy and Mineral Resources in collaboration with the Ministry of Foreign Affairs, Planning Commission, and Prime Minister's Office;
- Conducting coastal and marine spatial planning to develop an integrated ocean and coastal policy; and
- Setting and enforcing rules for the ocean economy that limit resource extraction and pollution levels.

Step Three: Invest in the transition to the blue economy, through clear principles and processes that encourage sustainable growth in private investment. Completing steps one and two could help attract foreign investment to Bangladesh to support the transition to a blue economy, and ensure that the investments help create the desired mix of underlying capital assets and that returns are measured in terms consistent with all three dimensions of sustainable development.

Step Four: Monitor progress towards agreed targets for the country's blue economy policy objective. These targets should include blue economy policy and investment scenarios and an integrated ocean and coastal policy.

Source: Colgan 2017a, Golden et al. 2017, Patil et al. 2016, and OECD 2016.

4.2. First Recommendation: Improve Measures of the Ocean Economy

"What you measure is what you manage" is a saying often, but probably apocryphally, attributed to management theorist Peter Drucker (Colgan 2017a). In order to inform a planning process and monitor progress along selected development pathways, basic measures of the ocean economy are required—if just as a snapshot in time. In Bangladesh, data on the gross value added of ocean industries/services with markets are not currently disaggregated in the national accounts (that is, constructed by collecting administrative data from different public and private agencies and BBS census surveys). Hence they are only available through significant and costly effort as shown in Chapter Three. This report presents the best information currently available to disaggregate the data, though with a number of caveats. These include an absence of measures of the economic value of a number of ecosystem services, lack of subtraction of the costs of environmental degradation beyond the ocean economy, and unclear boundaries between inland and marine fisheries and aquaculture. Simply updating the initial baseline presented in Chapter Three will require continuous monitoring over time, with significant effort. This effort could be reduced by developing an "ocean account" at BBS, beginning with steps to:

I. identify the country's ocean economy industries at appropriate levels of precision (in some cases in more detail than the ISIC codes as shown in Table 5); and

II. include a geographic measure of proximity to the ocean and coast for these industries.

One challenge to note is that of classifying "partials"—those industries that are only partly ocean-related but still fit within the definition of the ocean economy. This challenge can be addressed by a variety of methods, including consideration of the location of the economic activity, imputation from other data sources, and/or assessment of industry clusters (Colgan 2016). Eventually, collection of data following the steps described above could lead to the establishment of a full ocean satellite account with measurement at final demand, fully integrating the ocean within the national income and product accounts of the country.[16]

Over time, the aim would be to incorporate measures of the economic output from non-market ecosystem services, as well as the economic value of natural capital stocks. The value of such capital is rarely measured properly (World Bank 2017). An ocean account at BBS would provide a snapshot in time of the contribution of the ocean economy to Bangladesh's national economy, though admittedly an incomplete one given the lack of information on non-market ecosystem services. Even if such services were included in the snapshot, it would only reflect the annual return on capital and not the status of the stocks of underlying capital assets (e.g. natural capital) to indicate whether annual withdrawals are sustainable (World Bank 2012). Annex IV provides a brief overview of the concepts for such ocean wealth accounts.

Supplementing the data from an ocean account established at BBS with relevant data for ecosystem assets and non-renewable ocean resources would make it possible to envisage a consolidated "blue economy account" (Colgan 2017a and World Bank 2017). This account would provide the snapshot of the ocean economy's contribution to the national economy in Bangladesh measured on a value-added basis—the "gross ocean product" or output—but would also provide the "net ocean product" reflecting the gain (or loss) in physical and natural capital stocks for any given period (Colgan 2017a). Such an expanded ocean account would provide a much more complete picture of the withdrawals of natural capital in the output from the ocean economy, as compared to investments. However, valuation of many of the non-market ecosystem services presents challenges, and nor does this measure account for human capital (Colgan 2017a).

In sum, there are steps that the Government can take now to begin to establish a clearer baseline and more effectively track the contribution of the ocean economy to the national economy, i.e. the "gross ocean product." Essentially, this measure could be considered a lagging or coincident indicator (measuring the economy at present or in the recent past), while net ocean product would be a leading indicator (measuring the future economy). The net ocean product would require much more data and hence its creation would be an objective over time, whereas the former would be based on expanding existing data systems. Eventually, the net ocean product may function as a blue economy indicator, with targets set through the planning process. However, given that the natural capital accounting required will take some time to put in place, an interim blue economy index may be envisaged to track progress, using indicators such as the contribution to GVA, employment, and income, supplemented with intermediate output measures for key sectors, such as fisheries management targets and coastal zone management.

4.3 Second Recommendation: Model Policy Reform Scenarios for a Blue Economy, in Order to Set Targets and Develop Public Investment Strategies.

Building upon the baseline for Bangladesh's ocean economy, a key next step in the planning process would be to articulate a range of policy scenarios for development of this segment of the national economy. Various scenarios could be analyzed, taking into account what is known about the external drivers (see Chapter Three). The output from modeling these scenarios would be estimates of the costs and benefits to Bangladesh of different development pathways for the ocean economy, from which to set specific targets and identify public investment strategies.

16 See Colgan (2016) for more information on the steps to establish ocean satellite accounts.

Box 10: Reform Efforts in Capture Fisheries

The Government of Bangladesh is preparing a Sustainable Coastal and Marine Fisheries Program with financing from the World Bank, aimed at strengthening governance and sustainable performance of the coastal fisheries. The program aims to support the development of fisheries management plans to reduce capacity, while increasing surveillance to enhance compliance, and supporting alternative livelihoods to fishing, together with infrastructure investment to increase the value added to fish products. This program reflects the first major investment in the sustainable management of the "living" side of the ocean economy, in this case fisheries.

The OECD's 2016 assessment of future prospects for the global ocean economy provides an example for Bangladesh. This assessment calculated the gross value added and employment from a range of ocean economy industries in 2030, compared to 2010, under three scenarios: (i) business-as-usual (assuming a continuation of past trends, no major policy changes, no abrupt technological or environmental developments and no major shocks or surprises), (ii) a sustainable scenario (or alternatively a "blue economy scenario," that assumes high economic growth and low environmental deterioration due to the development of resource-efficient and climate-friendly technologies combined with a supportive policy framework that provides the right incentives to allow the ocean economy to thrive economically while meeting environmental standards), and (iii) an unsustainable scenario (or alternatively a "brown economy scenario" that assumes low economic growth and serious environmental deterioration).

Similarly, the Government of Bangladesh could draw upon existing forecasting models of the national economy, and run various ocean economy development scenarios (at least for selected sectors), in which the parameters are changed in order to reflect the status of the underlying capital assets and external drivers (demographics, science and technology change, global markets, and climate change). The output would be an estimate of the economic benefits to Bangladesh from various ocean economy development pathways, including one or more blue economy pathways, and identification of the policy reforms needed to get there. As a starting point, priority blue economy sectors such as capture fisheries could be a priority for such scenario modeling, which would estimate the economic benefits and upside to investment in resource management and the rebuilding of depleted fish stocks, with accompanying benefits from enhanced food security (see Box 10).

The experience of Mauritius (Box 11) shows the utility of modeling such scenarios through the construction of a social accounting matrix for the ocean economy and use of a CGE model, though in Mauritius this did not include environmental or experimental ecosystem accounts (Cervigni and Scandizzo 2017). Bangladesh may wish to draw upon this experience, as well as a global strategic analysis underway by the European Commission and the World Bank of pathways to a blue economy on a decadal time scale.

Box 11: Modeling Scenarios for Mauritius' Ocean Economy

A social accounting matrix (SAM) of national accounts was estimated in Mauritius for 2015, including the inter-industry linkages through transactions typically found in the input-output accounts and transactions and transfers of income between different types of economic agents (such as households, government, firms, and external institutional sectors). Data came from national accounts and other statistical sources. The SAM was used to calibrate a computable general equilibrium (CGE) model developed for the country. The model aimed to represent a structured framework that accounts for the economic potential of the country's ocean economy, distinguishing between ocean-based and non-ocean-based activities, as well as "blue" (marine ecosystems) and "green" (terrestrial ecosystems) natural resources. The CGE model estimated how the country's economy might react to changes in policy, technology, or other external factors, and specifically to a number of scenarios for growth in the ocean economy.

Source: Cervigni and Scandizzo 2017.

4.4 Coordinating the Planning Process and Future Directions

A coordinated policy planning process for sustainable development of the country's ocean economy will require active participation and decisions by a wide range of public agencies, linked by common objectives and actively sharing information. For example, at least five different ministries are currently reviewing or designing policies that would affect one or more of the sectors of the ocean economy in Bangladesh. Each of these ministries, as well as other public agencies, has a mandate to delivery on various actions and programs in the current Five Year Plan to move the country's ocean economy toward a blue economy, as indicated below according to each FYP action/program:

- ***The Ministry of Environment and Forests***
  - Maintaining the inland river systems and ecosystems for fisheries, sediment transport, and inland shipping.
- ***Ministry of Fisheries and Livestock***
  - Protecting and managing the fisheries for present and future generations;
  - Extending fishing areas using new technologies and methods even beyond the EEZ in the international waters; and
  - Substantially increasing fisheries production and export earnings through improved inland aquaculture and introduction of marine aquaculture.
- ***Ministry of Power, Energy and Mineral Resources***
  - Developing a strong renewable energy sector using ocean and atmospheric forces.
- ***Ministry of Shipping***
  - Further increasing revenue from shipping and commerce by the expansion of the domestic fleet and destinations, transshipment and transit provisions, and linking neighboring states to the sea-ports.
- ***Ministry of Civil Aviation and Tourism***
  - Creating a competitive tourism industry, including ecotourism and marine cruises.
- ***Cross-cutting***
  - Maintaining existing maritime industries (such as ship building) and developing new ones
  - Developing a strong human resource base for domestic utilization, and export to foreign job markets,
  - Giving special priority to anticipated climate change impacts in all relevant matters, and adjusting policies and plans,
  - Building a solid science, research, and education base, and
  - Along with other coastal areas, considering establishment of a marine academy in Khulna (GED 2015).

There is also a range of ecosystem services that may fall under the mandate of different agencies, as well as cause environmental degradation that affects the ocean economy, such as water pollution. The key areas of policy action to manage the diversity of opportunities and risks are summarized in Box 12. The first steps recommended in this report of measuring, modeling, and setting targets for a blue economy scenario would help indicate the potential benefits to the country from such actions and identify country-specific priorities.

In recognition of the challenge of coordinating a policy planning process across so many agencies, a "Blue Economy Cell" was established at the Ministry of Power, Energy and Mineral Resources in 2017. While a good first step, this cell will likely need to be supported by a stronger coordination mechanism linked to the Planning Commission. That would facilitate the carrying out of the recommendations of measuring the

Box 12: Key elements of a Blue Economy Policy Direction: D.I.R.E.C.T. + MAX

Develop and/or strengthen national policies to better integrate blue economy considerations into national and sub-national policy and governance frameworks. This would begin by continuing the ongoing design of the Integrated Coastal and Ocean Management Policy, as well as the various ocean economy sectoral policies under review or design. These policies should be informed by the measures suggested previously, with clear targets set for the blue economy.

Implement policies for a healthy, resilient, and productive ocean spaces because without it, citizens, and particularly the poor will feel the pinch. Within the overarching Integrated Coastal and Ocean Management Policy and the mix of related sectoral policies, this report has emphasized the importance of factoring in the role of natural capital in the ocean economy, and active measures and management of these capital stocks to ensure the three dimensions of sustainable development: social, environmental, and economic.

Raise Awareness (including building a common virtual education platform) to better educate stakeholders on what the blue economy is and why it matters. This includes a focus on removing informational barriers that are often created at least partially by a sectoral focus, through educating public, private, and civil society, and youth in sectors that forecasts suggest will provide the next generation of new jobs (i.e. blue clusters). Because some of these emerging sectors may require skills and training that have not previously been in demand, educational and training systems will need to respond.

Ensure ocean wealth is kept national and local. Stop IUU fishing; promote effective monitoring, control, and surveillance using enabling technology as it becomes available. The country has placed a priority on ensuring that fish resources are well-managed and not lost to IUU activity as happens in many regions of the world.

Construct infrastructure (soft/hard, blue/green) to support a transition to a blue economy. Vulnerability to coastal flooding poses grave risks to the national economy and certainly the blue economy, and will likely require combinations of three adaptation strategies: building barriers against the water, changing structures to reduce damages, and relocating structures to areas with lower flood risks. Marine and coastal construction will likely change from having an ancillary role in the ocean economy to taking on a much more central role in the blue economy. Moreover, Bangladesh's broad experience and its need to innovate and expand in addressing flooding have given it a body of expertise that could aid other countries as climate change brings threats similar to what Bangladesh has long confronted.

Transform R&D and national knowledge/know-how centers via institutional links with emerging global experience and platforms. As other countries are embarking on similar processes, there may be opportunities for exchange and collaboration that could build skills and enhance research and development of blue economy industries.

MAXimize Finance for Development to unlock private capital. Deploy scarce public finance to reduce impediments for private sector investment and secure innovative and sustainable finance for blue clusters. Blue economy principles are being developed that could help support flow of private capital to investments that are consistent with the broad objectives. Such principles could be applied across different public agencies to guide projects and inform developers.

ocean economy and modeling its future potential, and subsequently setting clear and realistic targets for the benefits that a blue economy could generate. The effectiveness of an institutional mechanism to coordinate a policy planning and implementation process will help lower transaction costs and ultimately enhance the investment climate.

In sum, the challenges are substantial, but the blue economy stands to bring the people of Bangladesh substantial benefits of development and general wellbeing in the years and decades ahead. Now is the time to marshal the data, political will, and financial resources to put the country on this path. With proper management, the country's oceans can generate livelihoods for the current generation and for futures ones, without harm to the subsea natural capital that makes this contribution possible.

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Annexes

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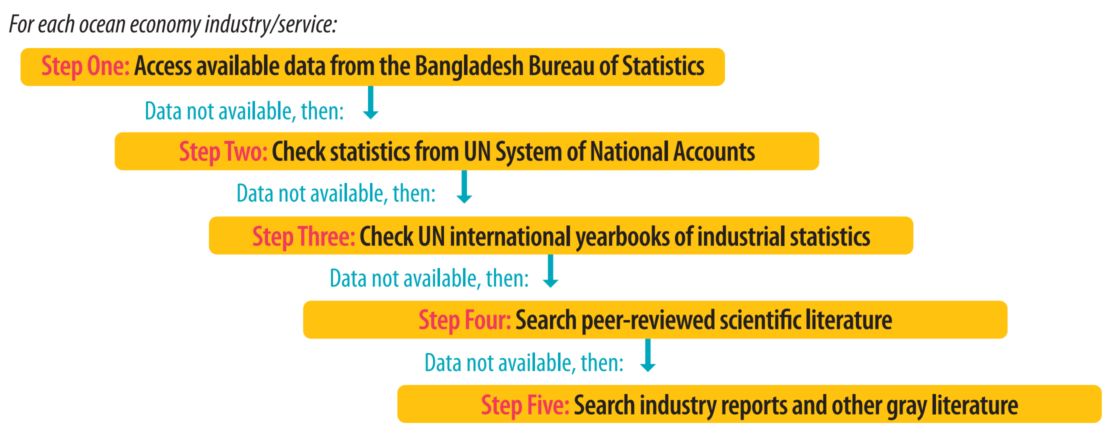
Annex 1. Methods used

The report describes the concept of the ocean economy as a discrete segment of a country's broader economy, based on a review of the scientific literature, foundational research such as the 2016 report of the Organisation for Economic Co-operation and Development (OECD), and past work by the Center for the Blue Economy in developing the National Ocean Economics Program in the United States. The report also provides an overview of the blue economy concept, based on a literature review conducted using Web of Science and Google Scholar search engines for the topic term "Blue Economy," as well as foundational research such as World Bank and UN DESA (2017), Voyer et al. (2017), and Patil et al. (2016). Countries identified as having blue economy policies were researched to identify the overarching policy documents, as the basis for synthesizing a number of cases where the concept has been applied.

The report provides an initial assessment of Bangladesh's ocean economy by synthesizing available data for various measures indicating economic output at a given point in time. Official government data on the contribution of specific industries to gross value added (GVA) were accessed from the Bangladesh Bureau of Statistics (BBS), and supplemented as needed with (in sequential order) (i) United Nations national accounts statistics, (ii) United Nations international yearbooks of industrial statistics, (iii) peer reviewed literature published before August 2017, and (iv) industry reports and other gray literature.

Figure A1.1: Process for Generating Estimates of the Output from Bangladesh's Ocean Economy

For each ocean economy industry/service:



Source: Authors' analysis.

Official government data on the contribution of ocean economy industries to GDP are maintained at the BBS and available in aggregated form on the website.[17] Data were provided by BBS in disaggregated form where available, as value added by industry. Where data were not available, the UN System of National

17 . This characterization is emphasized here not in order to exclude the intrinsic values ocean ecosystems may have or to suggest that other values are of greater priority, but rather to emphasize the connection between the ocean's ecosystems and economic activity (Patil et al. 2016).

Accounts was also checked. However, analysis of main aggregates[18] contained useful data for the "fisheries" sector only. In addition, the United Nations International Yearbook of Industrial Statistics[19] was reviewed, with relevant data on number of establishments, employees, and wages for three industries: "fish processing," "ship and boat building," and "ship building." However, the most recent data available were from 2006, and as such were not utilized for this analysis. Subsequently, for remaining gaps the peer-reviewed literature was searched (for publications prior to August 2017) using the terms "Bangladesh" + "ocean"+ "economy"+ "GDP" generally, as well as searches for each ocean economy and related industry and service using the following format: "Bangladesh" + "[name of ocean economy industry/service]"+ "[GDP/income/value added]". These searches did not yield additional data beyond government statistics referenced previously.

A number of gray literature sources proved useful, notably an economic valuation of the marine and coastal ecosystem services in the Bay of Bengal (Emerton 2014), produced as part of the Bay of Bengal Large Marine Ecosystem (BOBLME) project. Similarly, industry reports and other gray literature sources provided data on fisheries, aquaculture, ship building, ship breaking, tourism, and recreational fisheries.

For carbon sequestration, a 20-year economic value of the carbon sequestered and stored in the Sundarbans region mangroves was calculated using location-specific carbon densities and extent (Fatoyinbo et al., in review), under the assumptions of no net loss of mangrove area of 435,861 ha under the treatment scenario, global average loss rates of 0.7 percent per year (Pendleton et al. 2012) under the business as usual scenario, carbon emission half-life of 20 years, ecosystem (above-ground, below-ground, and top meter of soil) carbon density of 239.31 Mg/ha (Fatoyinbo et al., in review), and carbon value of $5/Mg CO2eq. The total discounted (r=0.08) value of carbon in 2013 USD was estimated at US$122.8 million.

The third chapter of the report describes the coastal ecosystems of Bangladesh and drivers of change. A literature review was conducted using the Web of Science and Google Scholar search engines to locate peer-reviewed journal articles relevant to Bangladesh. Web of science topic search terms always included "Bangladesh" and the following additional terms (number of hits in parentheses): "Coast* Environment* Chang*" (129), "Coast* Ecosystem Health* (20), "Ecosystem Health" (60), "Coast* Health" (122), "Coastal Erosion" (48), "Marine Fisher*" (51), "Coastal Pollution" (46), and "Coastal Waste" (21). Google Scholar searches used the same terms but only the first two pages of hits (n=20) were reviewed. Information from this literature review was synthesized in order to provide an overview of the status of the country's marine ecosystems.

18 . Fishing effort is defined as the amount of fishing gear of a specific type used on the fishing grounds over a given unit of time—for example, hours trawled per day, number of hooks set per day, or number of hauls of a beach seine per day. When two or more kinds of gear are used, the respective efforts must be adjusted to some standard type before being added (FAO 1997, in FAO Fishery Glossary 2009). Fishing effort is frequently used as a surrogate relating to a given combination of inputs into the fishing activity (OECD 1998).

19 . NOW Grenada. Grenada's blue economy poised for rapid growth.

Annex II. Brief summary of the status of the ecosystems underpinning the ocean economy

in economic terms, ocean ecosystems provide services to society and hence can be characterized as natural capital, forming part of a portfolio of capital assets that underpin growth in the ocean economy.[20] Using this characterization, the global ocean economy's natural capital asset base has already undergone significant changes over the last few centuries in the structure and function of ocean ecosystems—even prior to any expansion of the ocean economy or the projected impacts of climate change. These changes were occurring before the last few centuries, but have since accelerated in magnitude and rates, towards ecological collapse in some cases (Jackson et al. 2001). By 2015, the G7 Science Academies issued a statement warning that human activities were causing changes to the ocean's ecosystems that would profoundly affect human well-being (G7 Science Academies 2015). In 2016 the UN Secretary-General wrote that the findings of the first world ocean assessment "indicate that the oceans' carrying capacity is near or at its limit," and that "urgent action on a global scale is needed to protect the world's oceans from the many pressures they face" (United Nations 2016).

The human drivers of changes in modern ocean ecosystems began at least 40,000 years ago with harvests of marine animals using nets, intensifying in the twentieth century with the advent of industrial fishing and the rapid expansion of coastal populations (McCauley et al. 2015 and Lackey 2005). Overfishing as a result of the expansion of fishing effort has fundamentally altered many coastal and marine ecosystems, often serving as a precursor to other ecosystem changes such as eutrophication, outbreaks of disease, and introductions of exotic species, as shown below (Jackson et al. 2001).

The global fishing effort[21] **turned industrial in the 1800s with the advent of steam-powered ships, mechanized fishing techniques, and refrigeration (Lackey 2005).** By the turn of the twentieth century another steady expansion of fishing effort was underway worldwide, increasing estimated global ocean production from roughly 2 million tons in 1850 to 14 million tons by the end of World War Two in 1945 (Sanchirico and Wilen 2007 and WHAT 2000). In the 1950s a post-war boom in ship-building expanded the global fishing fleet several times over, typically in the absence of coastal state regulation of fishing activities in waters farther than three nautical miles from the coast. The fleet increasingly became diesel-powered and equipped with newly commercialized communication and navigation technologies. "Factory freezer trawlers" took to the seas, able to process fish on the vessel, freeze it into blocks, and store the processed

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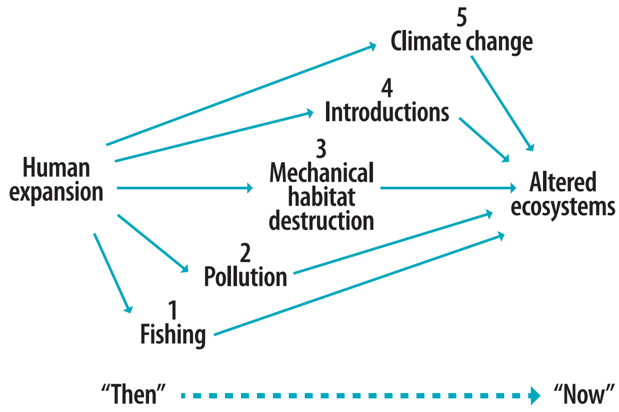
21

Figure A2.1: Historical Sequence of Human Disturbances Affecting Coastal Ecosystems



Source: Jackson et al. 2001.
Note: The figure illustrates a historical sequence of human disturbances affecting coastal ecosystems, beginning with fishing (step 1), with steps 2-5 likely varying in order in different cases.

product over long periods until the ship returned to port (FAO 2014, Sanchirico and Wilen 2007, Lackey 2005, and Wang 1992). Between 1965 and 1995 global fishing power increased by an estimated 270 percent (Garcia and Newton 1995). As fishing effort and investment grew, global ocean fish catch expanded roughly 6 percent per year between 1945 and 1970, from some 14 million tons to 60 million tons (FAO 2014c). Only with the conclusion of the United Nations Convention on the Law of the Sea in 1982 did coastal states begin to systematically declare jurisdiction over fishing activities in the waters up to 200 nautical miles from their coasts and by 1996 the "peak catch" of 87.7 million tons was recorded. Catch levels have stagnated since then (FAO 2014c).

Though overfishing became one of the first human drivers of change in ocean ecosystems, assessments of it have only been aggregated at the global level by FAO since 1973 (Ye and Cochrane 2011). Since that time, the percentage of marine fisheries assessed as biologically overfished has increased from 10 percent to 31 percent (FAO 2016).

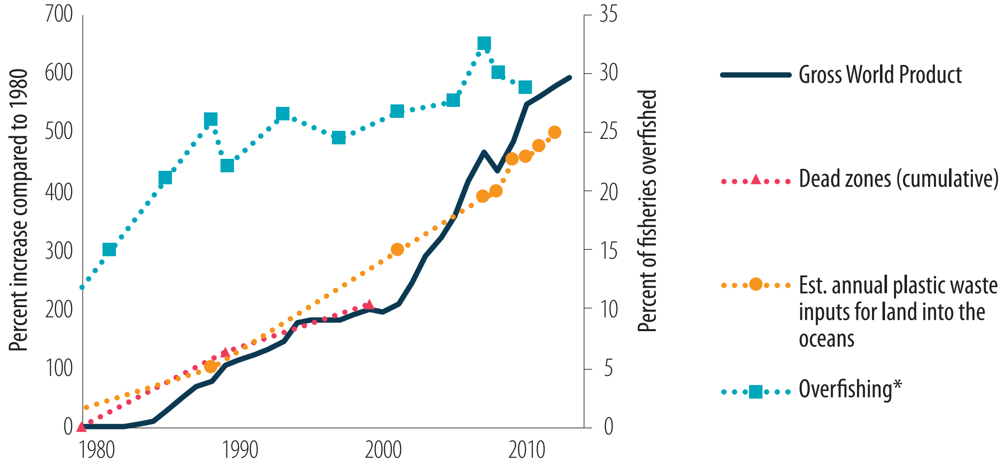
Following the same general sequence described above, pollution from land-based sources into the ocean has increased significantly from pre-industrial levels. Human inputs of nitrogen and phosphorus into estuarine and coastal ecosystems more than doubled in the twentieth century, notably after industrially-produced fertilizer was introduced in the 1940s (UN 2016 and UNEP 2012). The influx of these nutrients contributes to processes that reduce the dissolved oxygen in the seawater, in some cases driving it below levels that can support animals and creating "dead zones" in coastal waters near major population centers and watersheds (UN 2016 and Diaz et al. 2008). Between the 1960s and 2008, the number of these scientifically-reported low-oxygen zones in coastal waters increased exponentially to over 400 systems covering an area of some 245,000 square kilometers—almost the size of New Zealand (Diaz et al. 2008). More recently, the volume of plastic entering the ocean has grown to an estimated 4.8 to 12.7 million tons per year (Jambeck et al. 2015), leading to projections that total volume will exceed the volume of fish by 2050 (WEF 2016).

In this same general time frame, much of the world's population migrated towards the ocean in the twentieth century, with the coastal zone gaining a higher density of population and cities and mega-cities—it is now home to an estimated 38 percent of the global population (UNEP 2016, Neumann et al. 2015, and McCauley et al. 2015). As a result, wetlands were increasingly filled, coastlines hardened for construction, and natural habitats altered or destroyed (UNEP 2016 and McCauley et al. 2015). Between 20 to 35 percent of mangroves have been lost since 1980, estimates show (Polidoro et al. 2010 and FAO 2007), and 29 percent of the known areal extent of seagrass beds has disappeared since they were initially recorded in 1879 (Waycott et al. 2009). Similarly, the last global assessment of the status of coral reefs in 2008 estimated that the world has lost 19 percent of the original area of the reefs (Wilkinson 2008). Cumulatively, these changes in ecosystems have had an impact on marine biodiversity, leading McCauley et al. (2015) to suggest that while current marine extinction rates may be relatively low compared to recent terrestrial rates, they may also be analogous to the period on land just prior to the industrial revolution—after which extinction rates increased dramatically.

On top of these human drivers of change in ocean ecosystems, climate change is projected to further alter ecosystem functions and services (Gattuso et al. 2015). For example, ocean warming is expected to significantly reduce dissolved oxygen levels and hence raise the number and size of dead zones (Schmidtko et al. 2017, Long et al. 2016, and Keeling et al. 2010). Projections from the IPCC's fifth assessment suggest that as a result of warming, coral reefs will be functionally extinct by 2050 (UN 2016).

If these trends in human-driven changes to ocean ecosystems continue, potential growth in the ocean economy could be reduced.

Figure A2.2: Decoupling Economic Growth and Degradation of the Global Ocean Environment



Source: Golden et al. 2017.
Note: * Percentage of assessed fish stocks that are fished at biologically unsustainable levels according to FAO.

Annex III. Examples of countries'efforts to pursue a blue economy

The concept of the blue economy has entered into widespread use around the world (Colgan 2017b), albeit defined and applied differently in a range of policies (Colgan 2017a). However, it may be instructive for Bangladesh to see how this concept has taken shape in various countries' policies, though relatively few directly address questions of what specific strategies would best apply in Bangladesh (Colgan 2017a). This annex does not provide an exhaustive list of countries embracing some form of the concept in policies, but aims to indicate the directions and types of policies pursued elsewhere.

Australia. The Australian Government has stated: "A blue economy is one in which our ocean ecosystems bring economic and social benefits that are efficient, equitable and sustainable" (Voyer et al. 2017). The country's policy related to the blue economy is reflected in the 2015 National Marine Science Plan, focused on growth of the ocean economy to AU$100 billion by 2025 through addressing seven key challenges:

- ***Maintaining marine sovereignty and security and safety;***
- ***Achieving energy security;***
- ***Ensuring food security;***
- ***Conserving biodiversity and ecosystem health;***
- ***Creating sustainable urban coastal development;***
- ***Understanding and adapting to climate variability and change; and***
- ***Developing equitable and balanced resource allocation (Voyer et al. 2017).***

The plan articulates a strategy focused on research and development activities to address each challenge, without a central role for CMSP or a focus on developing innovation hubs and maritime clusters (Voyer et al. 2017).

China. Starting with the 11th Five-Year Plan (2006-2010), which launched an accounting system to measure the ocean economy, the Government of China has prioritized the blue economy concept as a development strategy (Conathan and Moore 2015). Based on these measurements, growth was shown to be impressive, averaging 13.5 percent annually and quickly winning recognition as a key component of the national economy (Conathan and Moore 2015 and Zhao et al. 2014). As a result, in 2011 the 12th Five-Year Plan prioritized the blue economy, focusing on economic growth targets of 9 percent annually in GVA to contribute 10 percent of GDP by 2015, and research and development expenditure growth to 2 percent of ocean economy output value (Conathan and Moore 2015). With its focus on economic growth from the ocean, China's blue economy policies have also been guided by a National Marine Functional Zoning

Plan originally issued by the State Council in 2002, and subsequently including industrial development zones as well as conservation zones (Voyer et al. 2017 and Conathan and Moore 2015). Indeed, in 2011 the State Council established a "blue economic zone" in Shandong Province, which was subsequently credited with generating significant economic growth for the coastal city of Qingdao (Conathan and Moore 2015). In sum, China's blue economy policies have focused on growth of the ocean economy, through a cross-sectoral and spatial planning process for economic development (Conathan and Moore 2015).

Conathan and Moore (2015) suggest that China's experiences with blue economy policies offer several lessons for other countries:

1. "The formulation of integrated resource use and development plans across disparate economic sectors—including fisheries, energy and tourism—has the potential to highlight common-sense and win-win policy options to enhance economic development and protect the marine environment; [and]
2. "Specific policy support given to innovative, high-growth potential industries, such as marine bioprospecting, may underpin regional economic development in coastal regions and help sustain vibrant entrepreneurial ecosystems centered on marine and oceanic resources."

European Union. Beginning with a 2006 Green Paper and subsequent 2007 Council approval of an integrated maritime policy (Suris-Reguerio et al. 2013), the EU developed perhaps the earliest and most well-known blue economy policy in 2012 (Voyer et al. 2017). At the time, the EU was still dealing with a difficult post-financial crisis situation and a fragile economic outlook, yet saw the ocean economy as a potential driver of the entire region's economy, with a potential of 5.4 million jobs and a GVA of just under €500 billion annually (European Commission 2017). In this context, the "blue growth opportunities for marine and maritime sustainable growth" or "Blue Growth Strategy" aimed to take advantage of new technologies for ocean use, diversify from limited terrestrial resources, and expand production of renewable energy, by focusing on five sectors of the ocean economy considered as high potential: "blue energy," aquaculture, coastal and maritime tourism, marine biotechnology, and seabed mining (European Commission 2012).

The EU Blue Growth strategy envisaged establishment of a competitive advantage in the global ocean economy, and in 2017 a report to the European Commission declared significant progress. "A way for tidal and wave energy to achieve their potential has been agreed," the report said, "regulatory barriers to aquaculture are being tackled, employment in maritime tourism is growing, products from marine biotechnology research are reaching the market and technologies for monitoring the environmental impact of deep sea mining have been developed" (European Commission 2017a). The strategy was focused on significant investment in research (through its 2014-2020 research program allocating more than €800 million), a European Maritime and Fisheries Fund to help encourage investment (though a lack of public and private risk funding for emerging industries was cited as a continuing challenge), and CMSP to help ensure that "we do not repeat the same mistakes on sea as we did on land" (European Commission 2017a and Voyer et al. 2017). In 2017, the EU launched a focused initiative to promote the blue economy in the western Mediterranean, following a similar approach (European Commission 2017b).

India. The government has prioritized the blue economy concept since 2014/2015, with the Prime Minister stating subsequently that the "blue economy must act as a catalyst in improving India's progress" (ANI 2017). While the concept is not articulated in a formal policy document, the National Maritime Foundation has established the Blue Economy Strategic Thought Forum India, and defined the blue economy as "marine-based economic development that leads to improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities" (Sreenivisan 2016). Moreover, the private sector via the Federation of Indian Chambers of Commerce and Industry (FICCI) has charted out a path on how different industries could contribute to the government's plans through the "Blue Economy Vision 2025: Harnessing Business Potential for India Inc. and International Partners."

Indonesia. Not long after taking office in 2014 to lead the world's largest archipelagic nation, President Widodo outlined a development strategy and foreign policy for the country as a "global maritime axis" at the crossroads of the Indian and Pacific Oceans (Santikajaya 2014). The policy was focused on growth in the ocean economy to lift Indonesia into the upper middle-income bracket, based on four main objectives:

I. strengthening sovereignty over the country's waters and resolving maritime border disputes;

II. sustainably managing the natural resources and protecting the marine environment, notably by stepping up efforts to both combat illegal capture fishing and to expand aquaculture development, exponentially growing public revenues from the sector by 2019;

III. increasing tourism (doubling visitors by 2019) by building marinas along yacht routes, for example; and

IV. building science and research capacity for a blue economy, for example, through construction of three marine science-techno parks by 2019 (Salim 2014).

To achieve these objectives, the emerging policy framework focuses on an integrated sea use management plan with marine spatial planning as a central feature. It seeks to develop blue economy zones (with current pilot projects in Lombok Island, Nusa Penida, and Bali) and promote blue economy investment models (Sunoto 2014), with support from a 20-year engagement by the World Bank and partners, and the Coral Reef Rehabilitation and Management Program (COREMAP). The blue economic zone projects aim to promote the sustainable use of tuna fisheries, aquacultures, marine tourism, and the salt and pearl industries (Sunoto 2014). The Ministry of Marine Affairs and Fisheries (MMAF) translated this framework into a sector-specific policy (2015-2019) focused on "sovereignty-sustainability-prosperity," i.e. reducing illegal fishing, enhancing sustainability of fishing, and improving livelihoods (MMAF 2015). While these policies were developed as a priority for the country in 2014-2015, early reviews of implementation progress and lessons learned are not yet available.

Small Island States. Small Island States have been in the forefront of advancing the blue economy concept. As part of the 2014 UN summit on development of small island states, the group put forward a blue economy position paper conceptualizing the oceans as "development spaces" where spatial planning integrates conservation, sustainable use, oil and mineral wealth extraction, bio-prospecting, sustainable energy production, and marine transport (SIDS 2014). The paper notes that a blue economy model should break with the "business as usual 'brown'" development model where the oceans are perceived as a means of free resource extraction and waste dumping, with "costs externalized from economic calculations" (SIDS 2014).

Mauritius was at the vanguard of this effort when its government launched a "national dialogue on the ocean economy" in 2013, developing a new growth strategy based on its ocean space and resources entitled "The Ocean Economy: A Roadmap for Mauritius" (Cervigni and Scandizzo 2017). The policy set a target of doubling the ocean economy's share of GDP over a 12-year time horizon (2013-2025). In 2015 the government created a new Ministry of Ocean Economy, Fisheries, Marine Resources and Outer Islands to consolidate various organizations, together with a National Ocean Council acting as an advisory body (Cervigni and Scandizzo 2017). A 2017 World Bank report (Cervigni and Scandizzo 2017) that modeled the potential for the country to achieve this target, suggested a number of key messages, including:

- Meeting the target of doubling the contribution of the country's ocean economy to GDP was possible, but would take time (likely 15 years) and significant investment (on the order of US$580 million annually for 10 years).
- Return on investment would likely be 20 percent, depending upon key enabling conditions such as stable macroeconomic and exchange rate policies (to encourage investment inflows), investment in human capital (to avoid mismatch between demand and supply of skilled and semi-skilled labor), and conservation of the ocean's natural capital.
- Investments were recommended on a cluster approach, in key sectors, starting with fisheries and aquaculture where the focus would be on reducing overfishing and environmental stresses in the lagoons and coastal fisheries, careful management of the development of underused resources such as the Banks fisheries, and an enhanced investment climate for expansion of aquaculture and the seafood hub.

- Investment in ports is expected to play a key role in the future of its ocean economy, based on expansion of the country's role as a hub of global trade flows, including container transshipment, re-export of petroleum products, and transshipment of fish.
- Expansion of marine renewable energy is possible, with deep ocean water cooling having the most potential, as well as offshore wind (depending on financing options)—with mutually reinforcing benefits for the ICT sector.
- All of this growth would require a CMSP process to ensure that it does not come at the expanse of ocean ecosystems, as well as addressing the risks of large shocks to the ocean economy from climate change.

Nearby, the Seychelles also embraced the blue economy concept in 2014, with a focus on (i) designating 30 percent of the coastal zone as marine protected areas by 2020 (based on a CMSP process), (ii) leveraging funds for marine conservation via a "debt-for-nature swap," (iii) issuing one of the world's first "blue bonds" for fisheries management investment, based on guarantees from the World Bank and Global Environment Facility, and (iv) transitioning from open access to managed small-scale fisheries (GLISPA 2014). The country has designated the Ministry of Finance, Trade and the Blue Economy to lead this effort. In 2015 the University of Seychelles established a blue economy research institute (University of Seychelles 2017).

In the Caribbean, the Government of Grenada announced in 2014 its intention to undertake a number of activities to protect its "blue space" and grow the island's blue economy.[22] Focusing on perceived emerging opportunities in aquaculture, marine renewable energy, marine biotechnology, and ocean-related tourism, the country has also committed to conserve at least 25 percent of its near-shore marine area by 2020 (Patil et al. 2016). To guide its blue economy efforts, the country established the National Ocean Governance Committee, comprised of officials from a range of government agencies, and completed an integrated coastal zone policy in 2015 (Patil et al. 2016). The policy shift has been most clearly articulated in the country's 2015 Blue Growth Coastal Master Plan, which identified specific blue development zones along the coast and a number of potential projects and initiatives (Patil et al. 2016). In 2016, the country organized the Blue Week conference to promote ocean-related investment in the country. Grenada is aiming to conduct a CMSP process to underpin blue development projects, as well as establish a Blue Growth Innovation Institute (Patil et al. 2016).

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Annex IV. Summary of concepts for incorporating natural capital into an ocean account

The measurement of ocean economies is a rapidly evolving field of research. In the last decade, many countries around the world have begun to develop some form of specialized adaptation of their national income and product accounts to identify and track the contributions of the ocean economy to national and regional economies as gross output over a defined period of time (Colgan 2017a and Colgan, 2017b).

In terms of measuring underlying natural capital, the limitation of such national accounts has been recognized for some time (World Bank 2006). Measurements of national economies have largely been standardized through the UN System of National Accounts, as in Bangladesh. Now, the relatively recent standards added for a System of Environmental and Economic Accounts (SEEA) and an Experimental System of Ecosystem Service Accounts (ESESA) can help add measures of natural capital to national accounts (Colgan, 2017a).

The SEEA sets standards and procedures for creation of natural resource stock accounts with a focus on extractive resources, which for the ocean economy applies to fisheries and minerals. These stock accounts measure both the physical size of the resource (e.g. biomass of fisheries) and its value measured at market prices. The stock is measured at the beginning of the year, and then the flows are added over the course of the year so that the change in the value of the stock over the year is measured. Flows include increases in both physical size and in value (e.g. fish recruitment) and reductions in physical size and in value (e.g. fish catch plus natural mortality). In the case of a renewable stock such as fish, these measurements should show whether annual economic activity is staying within sustainable limits (Colgan, 2017a).

In addition, the SEEA measures spending on environmental and resource management as a distinct category, including public sector expenditures (on both policy instrument design and delivery) as well as private sector spending (both capital and operating) on regulatory compliance. Such a measure could also include climate-related expenditures, such as incremental expenditures on infrastructure or buildings that minimize damage from coastal flooding. The rationale for this measure is to track the level of economic resources committed to maintaining or cleaning the environment, although in practice this is a somewhat ambiguous measure of the status of ecosystems (or the impact of expenditures). For this reason, the ESESA focuses on measuring the value of ecosystem services, as classified by the Common International Classification of Ecosystem Services (CICES) (Colgan, 2017a).

The difference between the values estimated in the SEEA and the ESESA can be illustrated with the case of fisheries: while the SEEA estimates a natural capital value associated with the fish stock, the ESESA estimates a natural capital value associated with non-market ecosystem services such as wetlands that serve as habitat or clean water, and create the conditions that fish need to propagate. Of course, wetlands provide a range of ecosystem services beyond providing nursery areas for fish stocks, such as coastal flooding and recreation.

By using the SEEA and ESESA, a country can create a snapshot of the ocean economy's contribution to its national economy measured on a value-added basis—the "gross ocean product"—and could also provide the "net ocean product" reflecting the gain (or loss) in physical and natural capital for any given period (Colgan, 2017a). Such an expanded ocean account, to include "net ocean product," provides a much more complete picture of the withdrawals of natural capital in the output from the ocean economy, as compared to investments. Table A4.1 below provides an indicative template for such an account.

Table A4.1: Indicative Net Ocean Product Account Matrix

Investment Capital (System of National Accounts)						
		Opening stock	+ Additions	- Withdrawals	- Depreciation	Net Product
Nonresidential	Structures					
	Equipment					
	Intellectual property products					
	Inventories					
Residential						
Natural Capital: Renewable and Non-Renewable Ocean Resources (System of Environmental and Economic Accounts)						
	Physical account	Economic account				
		Opening stock	+ Additions	- Withdrawals	-Depletion	Net Product
Minerals						
Fisheries						
Natural Capital: Other Ecosystem Services (System of Experimental Ecosystem Services Accounts						
	Physical model	Economic values				
		Opening stock	+ Additions	- Withdrawals	-Depletion	Net Product
E.g. mangroves:						
Blue carbon						
Coastal protection						

Source: Colgan 2017a.

The measurement of net ocean product also requires extensive biophysical information to be joined to economic information. This is a complex and time-consuming process, but it need not be done all at once. The biophysical measures of ecosystem components are needed for the effective management of the ocean and coastal resources in any event, so development of this information is critical under any circumstances. Biophysical information can be combined into tracking indexes that can provide useful information as more complete natural capital accounts are being developed. An example is the Ocean Health Index, which ranks Bangladesh number 100 out of 221 EEZ's measured.

Another important step in developing the needed accounting systems is for the Government to set specific data standards for all of the blue economy development projects that it participates in or funds. Many different projects will be needed to shape Bangladesh's blue economy and each should play a role in developing its overall data and information needs. By developing a plan to move towards full ocean economy and natural capital accounting on a phased basis, and in ways that allow the continual improvement of economic and biophysical information, both short- and long-term information needs can be addressed.

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