



# BAY OF BENGAL LITERACY

Essential Principles and Fundamental Concepts  
Version 1 : January 2019







## WHAT IS BAY OF BENGAL LITERACY?

Essential principles and fundamental concepts of the Bay of Bengal literacy have been developed locally, and it is based on internationally-recognized principles and concepts of Ocean literacy.

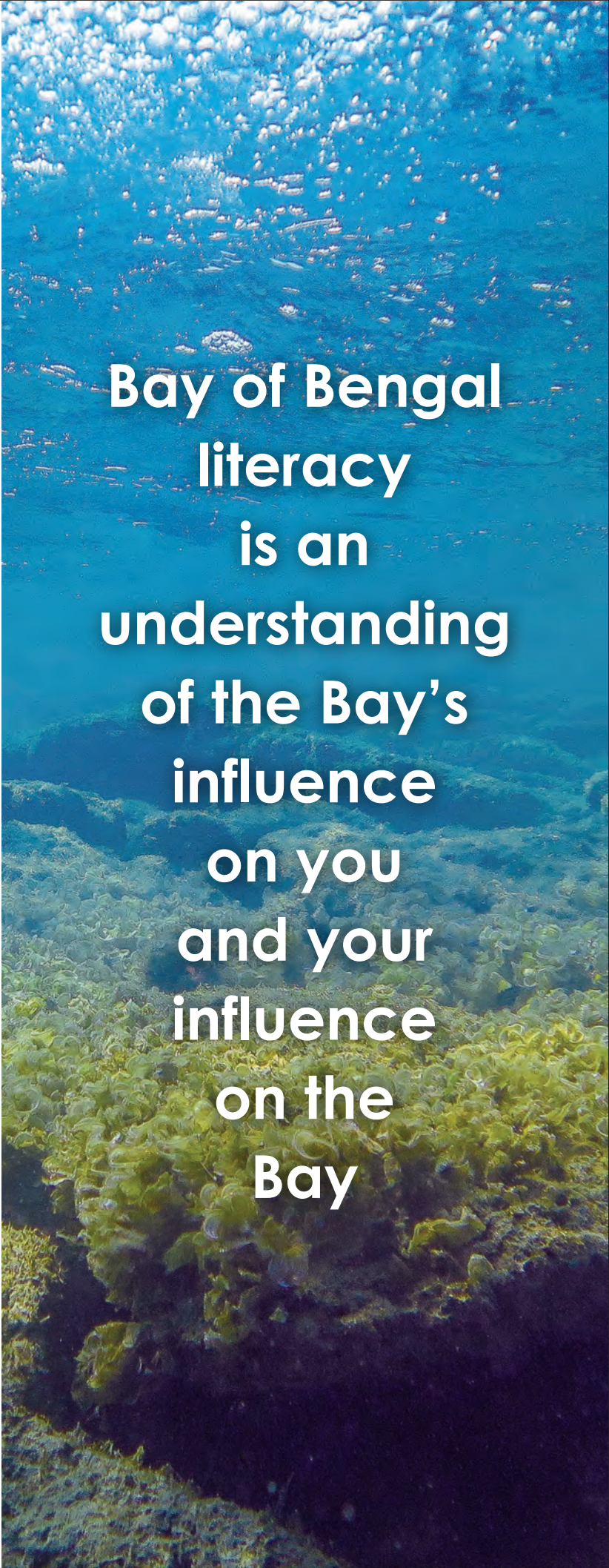
Bay of Bengal literacy is an understanding of the Bay of Bengal's influence on you and your influence on the Bay of Bengal.

A Bay of Bengal-literate person:

- Understands essential principles and fundamental concepts about the Bay of Bengal's nature, characteristics, processes, and values;
- Capable of communicating with others in a meaningful way about the Bay of Bengal and its basin areas; and
- Is able to make informed and responsible decisions regarding the Bay of Bengal and its basin areas.

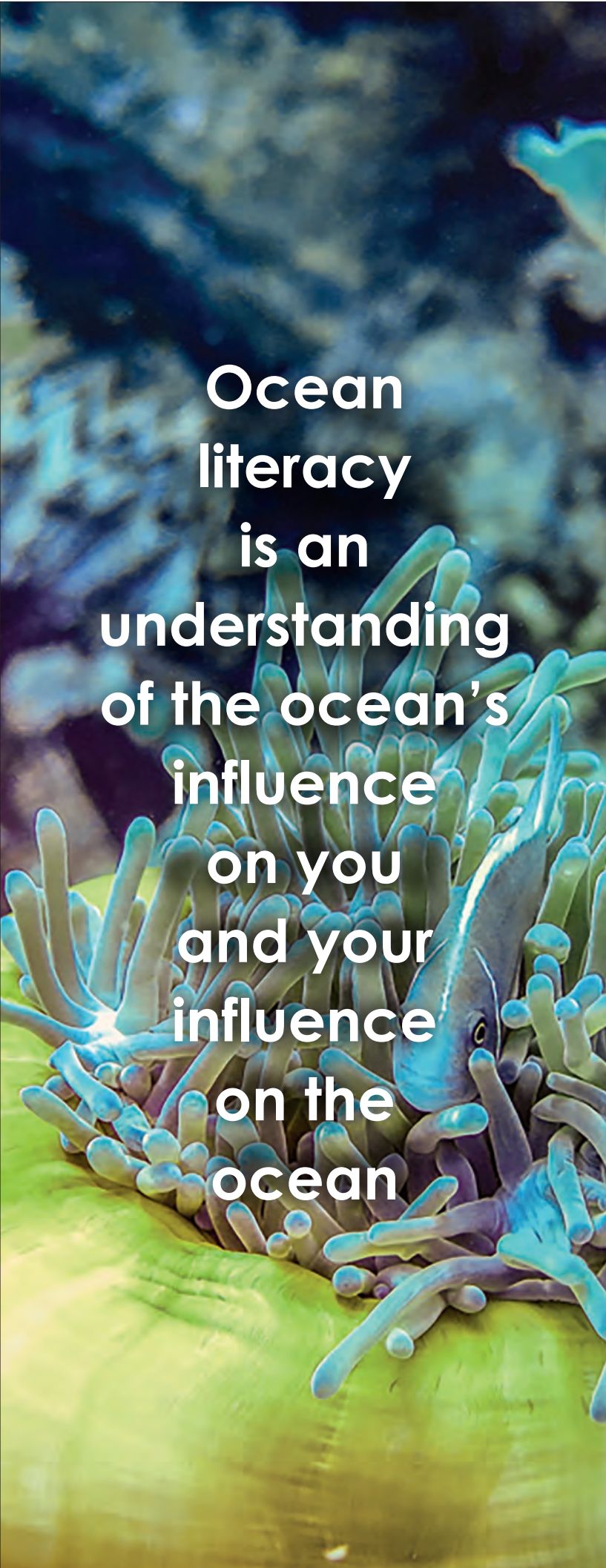
Since different disciplines of science are interrelated to understand the ocean, the idea of ocean literacy, essential principles and fundamental concepts of the Bay of Bengal literacy are not limited to any particular discipline. Therefore, one fundamental concept can be used to explain multiple essential principles. These essential principles and fundamental concepts will contribute to bring coordination, compatibility, and consistency among different disciplines under ocean sciences and mass communication on the Bay of Bengal

This guidebook presents a vision of ocean-literate and Bay of Bengal-literate societies in the littoral countries; Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand.



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**Ocean literacy is an understanding of the ocean's influence on you and your influence on the ocean**

## OCEAN LITERACY

As per the Ocean Literacy Network ([www.oceanliteracy.net](http://www.oceanliteracy.net)), Ocean literacy is an understanding of the ocean's influence on you and your influence on the ocean. An ocean-literate person understands essential principles and fundamental concepts about the ocean; can communicate in a meaningful way about the ocean, and is able to make informed and responsible decisions regarding the ocean and its resources.

### 7 Principles of Ocean Literacy

- The Earth has one big ocean with many features
- The ocean and life in the ocean shape the features of Earth
- The ocean is a major influence on weather and climate
- The ocean made Earth habitable
- The ocean supports a great diversity of life and ecosystems
- The ocean and humans are inextricably interconnected
- The ocean is largely unexplored

Our ocean defines the blue planet we live in. Five great, interconnected ocean basins, the Atlantic, Pacific, Indian, Arctic and Southern, make up the only ocean in our solar system and contain 97 percent of Earth's water. The vapor released into the atmosphere returns as rain, sleet, and snow, ever replenishing the planet with freshwater. All life, including our own, exists because of the ocean. Our lives depend, now and forever, on the health of the ocean. Understanding the ocean is essential to comprehending and protecting this planet on which we live.



## DEVELOPMENT OF BAY OF BENGAL LITERACY

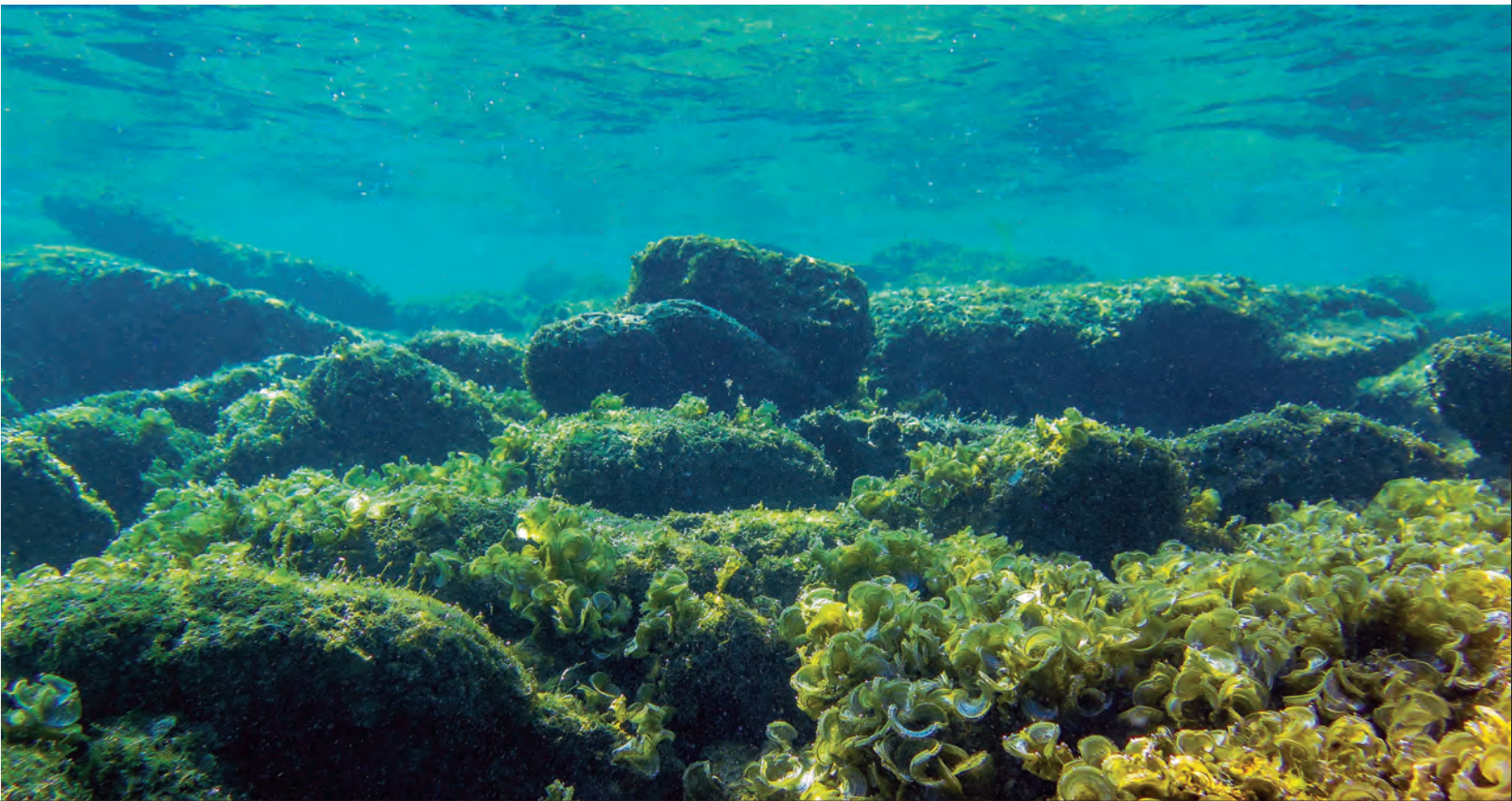
'Bay of Bengal Literacy: Essential Principles and Fundamental Concepts' intends to present the very first instructions to build local frameworks for Ocean Literacy in the littoral countries; Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand. This document can be used as a practical resource to create contents on Bay of Bengal literacy by educators, journalists and policymakers throughout formal and informal learning environments including schools, colleges, madrasa, libraries, museums, aquariums, parks, and science and knowledge centers.

Based on Essential Principles and Fundamental Concept of Ocean Literacy developed by Ocean Literacy Network in the United States, and following the Great Lakes Literacy framework as a model, a group of scientists, experts, communicators, and educators in Bangladesh worked to prepare this first version of Bay of Bengal Literacy. The development of this version was facilitated under a project run by VOICE with support from Earth Journalism Network's Bay of Bengal Organizational Grant. The grant is funded by the Climate Justice Resilience Fund.

Again, essentials principles and fundamental concepts of the Bay of Bengal literacy have been developed and presented in this guidebook for more deliberations and consultation among concerned scientists, communicators, and educators of Bay of Bengal countries. This guide should be updated before introducing and using it in formal and informal education, mass communication, journalism, outreach activities and campaigns. Collective effort and consensus from stakeholders are necessary to achieve Ocean Literacy goals in the littoral countries of the Bay of Bengal.

The following people have led the research and drafting process for this version; Md Kutub Uddin, VOICE; Nazia Naoreen Mumu, Bay of Bengal Stewardship; Dr. Kazi Ahsan Habib, Sher-e-Bangla Agricultural University; Mahatub Khan Badhon, Dhaka University; S M Rezaul Karim, VOICE; Enamul Mazid Khan Siddique, Bay of Bengal Stewardship; Sheikh Rokon, Riverine People; and Fahmida Khalique Nitu, National University. Volunteers facilitators of Bay of Bengal Stewardship, and academicians from Sher-e-Bangla Agricultural University have reviewed the guide, we are grateful to them.

This version is now open for general comment and expert inputs. National workshops will be organized to publish a new and improved version of this guide.







## THE OCEAN AS TOOL OF TEACHING AND COMMUNICATION

The ocean covers most of the planet Earth, and most of the species originated in the ocean. Ocean affects the weather and climate and provides food for most of the human population on earth. Ocean health is now facing unprecedented threats from pollution, habitat destruction, overfishing, and climate change and acidification continued for decades after decades. Understanding Ocean or an ocean-literate society is an important part to solve these complicated and critical issues. Public understanding of the ocean is now limited. The more people know about the ocean, the more they will support policies for a healthy ocean. It is difficult to comprehend the complicated and unpredictable ocean ecosystem. But computer simulation, model, hands-on experience make it easier to understand and teach as well. If interested people are given the opportunity to have practical experience, then people will be able to connect themselves with ocean, bays, rivers, and wetlands. This will eventually encourage them to support and work for an ocean-literate society.]

Curriculum content, instruction, and assessment in formal education derive from accepted standards. Making ocean sciences concepts prominent at national science education requires instructions and inclusion of ocean sciences in the curriculum contents, training for teachers of primary, secondary and higher secondary levels.

In this regards, this guide can help to develop the outlines. It can also be easily used to develop contents for informal education, textbooks, models, simulation, hands-on experience, and to run campaigns. Those who are concerned about science education and about the future health of our ocean planet must actively promote the implementation of high-quality science standards in schools, colleges, and madrasa at national and local levels, professional societies and associations, and non-government organizations. In order to be effective, we must agree upon and codify the disciplinary core ideas and practices of science related to the ocean, bays, coasts, rivers, and wetlands.



# Bay of Bengal Literacy

Essential Principles and Fundamental Concepts

[www.bayofbengalliteracy.net](http://www.bayofbengalliteracy.net)





## 7 PRINCIPLES OF BAY OF BENGAL LITERACY



1. The Bay of Bengal is the shallow embayment in the northeastern Indian Ocean basin and connected to the global Ocean



2. Natural forces formed the Bay of Bengal; the bay continues to shape the features of its basin



3. The Bay of Bengal influences local and regional weather and climate



4. The Bay of Bengal is part of the global Ocean that makes our planet habitable



5. The Bay of Bengal supports a broad diversity of life and ecosystems



6. The Bay of Bengal and humans are inextricably interconnected



7. Much remains to be learned about the Bay of Bengal



## 1. The Bay of Bengal is the shallow embayment in the northeastern Indian Ocean basin and connected to the global Ocean

**A.** The Bay of Bengal is a major physical feature in South Asia. Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, and Thailand are littoral countries of the Bay.

**B.** The Large Marine Ecosystem (LME) of the Bay of Bengal covers an area of about 3,585,440 km<sup>2</sup> and includes Bay of Bengal, Andaman Sea, Straits of Malacca, along with river estuaries, and smaller bays and gulfs.

**C.** Freshwater from the rivers largely influences the characteristics of the Bay; it is influenced by the Ganges-Brahmaputra-Meghna river basin, the second largest hydrologic region in the world. The basin areas drain the single largest load of river sediment to any sea in the world. Sediment and freshwater from the rivers have reduced the salinity of surface waters along the shore.

**D.** The Bay of Bengal Large Marine Ecosystem, its river basins, and river systems, and the global Ocean are all connected. Rivers transport sediments, dissolved gases, nutrients, minerals, and pollutants from basin areas into the Bay.

**E.** The Bay of Bengal is an integral part of the water cycle and are connected to the region's river basins and water systems. Changes in water systems affect the quality, quantity, and movement of water, including retention time.

**F.** Water currents circulate within the Bay of Bengal's Large Marine Ecosystem are powered by wind, waves, energy from the sun, and water density differences. The concave coastline shapes continental slope and seabed. Its geographic orientation close to the equator and the direction of the prevailing winds such as monsoon, and the shores, and structures on the shores influence the path of circulation.

**G.** Sea level is the average height of the Bay of Bengal relative to the land, taking into account the differences caused by tides. Variations in precipitation, evaporation, runoff, as well as wind and waves result in changed sea level. Due to the influence of water density and wind, the seasonal changes of the sea level in the Bay are remarkable and one of the highest in the world.

**H.** An important vertical circulation process in the Bay of Bengal is upwelling and downwelling. In this process, sub-surface water is brought toward the surface, and conversely, a downward displacement happens. Upwelling and downwelling are seasonal, being created by monsoon winds. This circulation process is key to mix the oxygen and nutrient-poor water in the deeper areas of the bay with the oxygen and nutrient-rich surface water.

**I.** Although the Bay of Bengal is the largest bay in the world, it is finite, susceptible and its resources are limited.





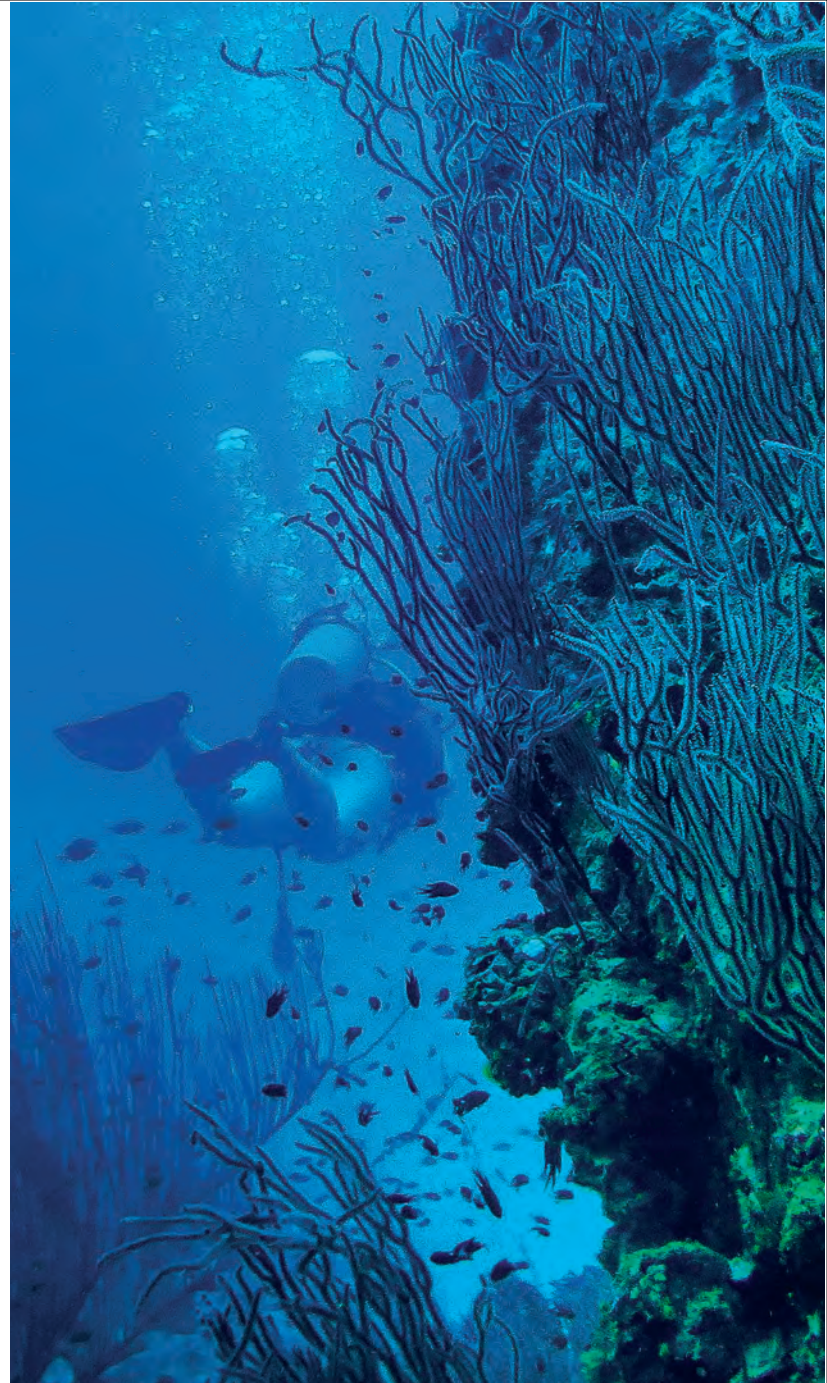
## 2. Natural forces formed the Bay of Bengal; the bay continues to shape the features of its basin

**A.** The formation of the Bay of Bengal and its sedimentary basins was started in the early Cretaceous period, during the seafloor spreading between Antarctica and India. The seafloor spreading occurred about 118 million years ago along a line that now joins Rajmahal and Sylhet volcanic provinces. During Paleocene epoch greater India's tectonic plate collided with Eurasian plate and later it continued its northward drift, resulting in the Himalayan uplift. Unlike most of the boundaries between Oceanic and Continental crust on the planet, the Bay of Bengal's one is unusual in that it is located on shore, several hundred kilometers inshore beneath present-day northern Bangladesh, because the large volume of sediments shed following the uplift of the Himalayas.

**B.** The Bengal delta, also known as Ganges delta is still active today, sedimentation through Ganges-Brahmaputra-Meghna river system continues to date, extending into the offshore and the deeper waters of the bay. In the present day, a thick uniform abyssal plain occupies almost the entire Bay of Bengal, in many places underwater valleys dissect this plain mass. The seabed is characterized by a broad U-shaped basin gently sloping southward with its opening to the Indian Ocean.

**C.** The sea level change, waves and various weather phenomena are reshaping the coastal areas.

**D.** Rapid erosion, influenced by wind, waves, and currents, results into redistribution of rock, soil and other earth materials of coastal wetlands in the Bay of Bengal.



**E.** Sediments, composed of fragments of animals, plants, rocks and minerals, are a product of erosion. Sedimentation in the Bay of Bengal is dominated by deposits from the rivers, derived mainly from the Himalayas and other lower plain and mountain ranges.

**F.** The Bay of Bengal is the largest bay in the world. On the boundary of the Bay of Bengal's oceanic crust and continental crust, sits the world's largest delta—the Bengal delta. The largest submarine fan in the world, the Bengal fan, lies under the surface of the bay.





### 3. The Bay of Bengal influences local and regional weather and climate

**A.** The Bay of Bengal affects both weather and climate of this region by impacting the basin's energy and water cycles. Differences in the circulation and temperatures of waters in the bay can produce changes in weather patterns.

**B.** Absorption of solar radiation influences the temperature of the Bay of Bengal. Inflowing river waters also affect the temperature. The bay loses heat by evaporation and warming the overlying air when the atmosphere is cool. After water vapor is released into the atmosphere, it condenses and forms precipitation, some of which falls within the basin areas of the Bay of Bengal.

**C.** The Bay of Bengal modifies the local weather and climate. Because water temperatures change more slowly than land temperatures, sea waters gain heat in summer and release heat during cooler months. This asymmetric heating between the bay and the landmasses of its littoral countries lead to wind pattern associated with precipitation—that is the monsoon. Monsoon winds bring drier winter and wetter summer in South Asia.

**D.** The Bay of Bengal has a significant influence on the regional climate by absorbing, storing, and moving heat and water. During the summers, the southwesterly winds pick moisture from the bay and make rainfall in basin areas. The winter winds blow from the northeast regions of the Asian continent and subsequently travel towards the bay and extend to the greater Indian Ocean.

**E.** The Bay of Bengal is influenced by larger climate change patterns affecting the Indian Ocean region and the world. Climate patterns in the Bay of Bengal's Large Marine Ecosystem are changing with rising sea level, along with irregular monsoon, more intense and frequent storms, and warmer and drier conditions are predicted.





#### **4. The Bay of Bengal is part of the global Ocean that makes our planet habitable**

- A.** The first life is thought to have started in the ocean. The earliest evidence of life is found in the Ocean.
- B.** The Ocean provided and continues to provide water, oxygen, and nutrients, and moderates the climate needed for life to exist on Earth.
- C.** Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean. This accumulation of oxygen in Earth's atmosphere was necessary for life to develop and sustain on land.







## 5. The Bay of Bengal supports a broad diversity of life and ecosystems

**A.** The bay supports life in water and on land; from microbes to whales, crocodiles and Bengal tigers. The presence of different water masses in coastal areas has produced sub-systems along the coast that differ in their environmental characteristics, ecology, and biodiversity.

**B.** Most life in the Bay of Bengal exists as microorganisms. Microorganisms such as phytoplankton and cyanobacteria are the most important primary producers in the bay.

**C.** The Bay of Bengal and its basin areas are very nutrient rich and support organisms from every kingdom on our planet.

**D.** The Bay of Bengal provides many examples of life cycles, adaptations and important relationships among organisms, such as symbiosis, predator-prey dynamics and energy transfers.

**E.** The Bay of Bengal provides habitats for both terrestrial and aquatic species. The bay's large marine ecosystem is three-dimensional, offering vast living space and diverse habitats from the shoreline and surface down through the water column to the seafloor.

**F.** Habitats in the bay are defined by environmental factors. As a result of interactions involving abiotic factors such as temperature, clarity, depth, oxygen, pH, light, nutrients, pressure, substrate type and circulation; life in the Bay Bengal is not evenly distributed spatially or temporally. Abiotic factors within the bay's large marine ecosystem can change daily, seasonally or annually because of natural and human influences.

**G.** Ecosystem processes influence the distribution and diversity of organisms from the surface to bottom and nearshore to offshore in the bay.

**H.** Having a diverse range of ecosystems (wetland, seagrass beds, mangroves, salt marsh, coral reefs), the Bay of Bengal provides productive nursery areas for many aquatic and terrestrial species which rely on these habitats for protective structure, hunting grounds, migration stops, and raising offspring.

**I.** The introduction of invasive alien species causes degradation of ecosystems, causing major challenges to the conservation of marine biodiversity in the Bay of Bengal.





## 6. The Bay of Bengal and humans are inextricably interconnected

**A.** The Bay of Bengal affects many human lives. It is considered as a highly productive ecosystem (Class 1) largely due to nutrient inputs from rivers. It supports millions of people by providing their subsistence and livelihoods.

**B.** The total population of the Bay of Bengal countries is around 2,000 million which makes it home to about one-quarter of the world's population. This region is also home to one of the largest concentrations of economically-disadvantaged communities with wages less than 2 USD per day.

**C.** The Bay of Bengal is affected directly by the decisions and actions of people of Bangladesh, India, Indonesia, Malaysia, Myanmar, Maldives, Sri Lanka, Thailand.

**D.** Local and national laws, regulations and resource management affect what is put into and taken out of the Bay of Bengal. Shoreline development and industrial or commercial activities lead to point and non-point source pollution. Humans have altered the biology of the lakes and the viability of species through harvesting, species introduction, and nutrient loading.

**E.** Coastal regions along the Bay of Bengal are impacted by land use decisions and natural hazards. Physical modifications (changes to beaches, shores, and rivers) can exacerbate the effects of erosion, storm surges and sea level changes.

**F.** Individual and collective actions are needed to effectively conserve and manage the Bay of Bengal's resources for the benefit of all.







## 7. Much remains to be learned about the Bay of Bengal

- A.** The extent of exploration and understanding of the Bay of Bengal interactions and links among diverse ecosystems and people is extremely low. There are research gaps in certain sectors; fulfilling these gaps may help to understand more about the Bay of Bengal.
- B.** Understanding the Bay of Bengal is more than a matter of curiosity. Exploration, inquiry, and monitoring will promote better understanding and protection of the Bay of Bengal's ecosystems, processes, and resources.

**C.** Over time, the pattern of resource-use in the bay has changed significantly. The future sustainability of the resources in the Bay of Bengal depends on our understanding of the available resources and its potential and limitations.

**D.** Technologies and methods can be used to expand our ability to explore the Bay of Bengal that will provide information to policymakers and leaders in coastal communities.

**E.** Models can help us understand the complexity of the social-ecological systems of the Bay of Bengal. Models process observations, describe interactions among systems, expose information gaps and forecast change.

**F.** Exploring, understanding and communicating about the Bay of Bengal ecosystem are interdisciplinary efforts. Cross-sectoral coordination is required among institutions working for biodiversity conservation and coastal communities along with professionals in science, technology, engineering, and math, as well as public outreach and education.

### THE GUIDEBOOK WAS GREATLY BENEFITTED FROM THE FOLLOWING WORKS;

Ocean Literacy Essential Principles and Fundamental Concepts (Ocean Literacy Network, 2013) • Great Lakes Literacy (Ohio Sea Grant, 2013) • The UNEP Large Marine Ecosystems Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas (United Nations Environment Programme, Nairobi, 2008) • Talwani, M., Desa, M. A., Ismaiel, M., & Krishna, K. S. The Tectonic origin of the Bay of Bengal and Bangladesh. *Journal of Geophysical Research: Solid Earth*, 121, 4836–4851 (2016) • Varkey, M. J., Murthy, V. N., & Suryanarayana, A. Physical Oceanography of the Bay of Bengal. *Oceanography and Marine Biology: An Annual Review*, 34, 1–70, (1996) • Kay, S., Caesar, J., & Janes, T. Marine Dynamics and Productivity in the Bay of Bengal. In R. J. Nicholls, C. W. Hutton, S. E. Hanson, W. Neil Adger, M. M. Rahman, & M. Salehin (Eds.), *Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis*, 263–275 (2018) • Milliman, J. D., & Meade, R. H. World-Wide Delivery of River Sediment to the Oceans. *The Journal of Geology*, 91(1), 1–21 (1983) • Bay of Bengal (Sea Around Us, 2007) • Antony, C., Unnikrishnan, A. S., & Woodworth, P. L. Evolution of extreme high waters along the east coast of India and at the head of the Bay of Bengal. *Global and Planetary Change*, 140, 59–67 (2016) • Balakrishna, S., Morgan, J. R., & Verlaan, P. A. Bay of Bengal. *Encyclopædia Britannica* (2009, [www.britannica.com/place/Bay-of-Bengal](http://www.britannica.com/place/Bay-of-Bengal)) • Curray, J. R., Emmel, F. J., & Moore, D. G. The Bengal Fan: morphology, geometry, stratigraphy, history and processes. *Marine and Petroleum Geology*, 19(10), 1191–1223 (2002) • Chaturvedi, S., & Sakhuja, V. Climate Change and the Bay of Bengal: Evolving Geographies of Fear and Hope (ISEAS – Yusof Ishak Institute, Singapore City, 2015) • Unnikrishnan, A. S., & Shankar, D. Are sea-level-rise trends along the coasts of the north Indian Ocean consistent with global estimates? *Global and Planetary Change*, 57 (3–4), 301–307 (2007) • Brammer, H. Bangladesh's dynamic coastal regions and sea-level rise. *Climate Risk Management*, 1, 51–62 (2014) • Townsley, P. Review of Coastal and Marine Livelihoods and Food Security in the Bay of Bengal Large Marine Ecosystem Region (Bay of Bengal Large Marine Ecosystem Program, Phuket, 2004)

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