

Environmental Impacts of Hydrocarbon and Mineral Resources Exploration and Extraction from the Sea

Prof. Dr. Md. Sakawat Hossain



Introduction

Hydrocarbon and mineral resources are the main driving factors of the world's economy, which significantly impacts international geopolitical decisions, events, and the global environment. The industrialization of offshore and deep-sea hydrocarbon and mineral resources is expanding worldwide as easily accessible land-based energy resources have depleted, causing great concern for marine pollution. Environmental pollution of the sea may increasingly threaten a healthy marine ecosystem and human health. Direct environmental impacts of marine hydrocarbon industrialization include sediment re-suspension and burial by seafloor anchors and pipelines, oil-based low-toxicity drilling fluid discharges, and produced water. The ecological impacts of

the marine species at the population and community levels, specifically for its more

fragile ecosystems, are very significant and may prevail in the sea for many decades. On the other hand, the impacts of deep seabed (seabed depth greater than 200 m) mining of metals and minerals may be further aggravated by eliminating habitats for many marine species. These metallic minerals take millions of years to form, hence their burial or removal due to seabed mining constraining marine organism capacity to recolonize in the mined zones for decades.

Bangladesh is a developing country with a growing economy and spent billions of dollars importing liquefied natural gas (LNG), crude oil, petroleum products, and minerals. Offshore hydrocarbon

exploration in Bangladesh is relatively recent, which started in 1974 when the first production-sharing contracts (PSCs) were signed on the offshore areas in the Bay of Bengal. After discovering two natural gas reservoirs (Kutubdia and Sangu) in the Bay of Bengal, the exploration activities regrettably decelerated. The Government of Bangladesh now plans to extend the hydrocarbon and mineral resources exploration beyond the offshore area into the deep water. Therefore, considering the impacts on the marine environment from exploration and exploitation, and the need to minimize and control these impacts, appropriate national laws and regulations are vital in this exploration stage.

Effects of Routine Marine Hydrocarbon Activities

Routine hydrocarbon activities in the offshore and deep sea can have damaging impacts in each stage of exploration, production, and decommissioning of the facilities. During these stages, impacts on marine life can result from direct and indirect disturbances. Direct physical disturbance includes anchor chains, drill cuttings, drilling fluids, pipeline construction, and discharge of produced water, whereas indirect disturbance includes underwater sound, light, and traffic. During the exploration and production stage, positioning of hydrocarbon infrastructure on the seafloor will directly physically disturb the seabed and damage fragile benthic organisms (e.g., corals and sponges), which have very low resilience to external disturbance. Anchor and pipeline-related corrosion and leakage also risk exposing marine fauna to potentially harmful chemical pollution. Marine exploration and production-related drilling activities discharge different kinds of waste, which include drill cuttings, excess cement materials, drilling mud, chemical adhesive, and produced water. These discharge wastes cause chemical and physical damaging environmental effects to the sensitive marine ecosystem.

Therefore, all these hydrocarbon activity-related wastes must be treated following strict regulations before being discharged. When designing management strategies for offshore and deep-sea hydrocarbon activities, it is necessary to consider all of these potential environmental impacts of routine hydrocarbon activities.

Effects of Accidental Discharges of Hydrocarbon in the Sea

An uncontrolled release of hydrocarbons from the subsurface reservoir, which is known as a 'Blowout', causes the greatest risk to the marine environment and ecosystem. Marine hydrocarbon activities have the potential to result in accidental releases of oil or gas, either in the form of a blowout or accidental spill. This accidental release, specifically the possibility of a blowout, increases with the depth of the hydrocarbon operations in the sea. On a global scale, during offshore transport of hydrocarbon, one accidental spill of over 1000 barrels occurred every 2.5 months. In the Bay of Bengal, the accidental spill of hydrocarbon during the transportation is a common phenomenon. Several major offshore hydrocarbon blowouts have occurred, including the Macondo well blowout in the Gulf of Mexico in 2010, which discharged about 5 million barrels of oil; the IXTOC-1 well blowout in the Gulf of Campeche, Mexico, in 1979, where 3.5 million barrels of oil were released, and the Ekofisk blowout in the Norwegian sector of the North Sea in 1977 where 0.2 million barrels of oil were released. Although all these offshore blowout examples represent accidental discharges from the subsurface reservoir, the blowout occurrence frequency in the sea suggests that they can be expected during typical hydrocarbon production activities. However, fortunately, until now, blowout did not occur in the offshore or deep-sea areas of the Bay of Bengal

Effects of Deep Seabed Mining Activities



Figure 1: Mineral Exploration Map and Deep Seabed

There is an increasing interest in the mining of the deep seabed mineral deposits due to exhausting terrestrial mineral deposits of high-value metals such as cobalt, lithium, zinc, manganese, aluminium, nickel, and copper, which are very important to produce different electronic products like smartphones, wind turbines, solar panels, and batteries. The extraction and often excavation of mineral deposits from the deep seabed, where ocean water depths greater than 200 m, could severely harm marine biodiversity and ecosystems. As of May 2022, the International Seabed Authority (ISA) had issued 31 contracts to explore deep-sea mineral deposits, collectively covering the international seabed of more than 1.5 million km² (Figure 1). However, the ISA has only issued exploration contracts so far, but not the exploitation contract yet. The ISA's regulations for exploiting the sea minerals deposits are currently under development as some countries have already shown their strong intention to start deep-sea mining. Based on the available information, it is assumed that deep seabed mining could commence as soon as 2026 in international waters.

The disturbance of the seabed through digging and gauging by mining machines can alter or destroy deep-sea habitats. In addition, deep-sea mining activities will stir up fine sediments on the seafloor, generating large plumes of suspended fine

sediments (Figure 2), which may disperse for hundreds of kilometers, take a long time to resettle on the seafloor and affect marine ecosystems, specifically fragile species. To assess seabed mining impact and understand the ecosystem's recovery time, scientists at the National Oceanography Centre (NOC), UK, recently revisited a site that was used to simulate deep-sea mining activity nearly 30 years before. The study findings reveal that the impacts of large-scale commercial deep-seabed mining could potentially lead to irreversible damage to the key function of the marine ecosystem and requires efficient regulation of commercial deep-seabed mining activities.

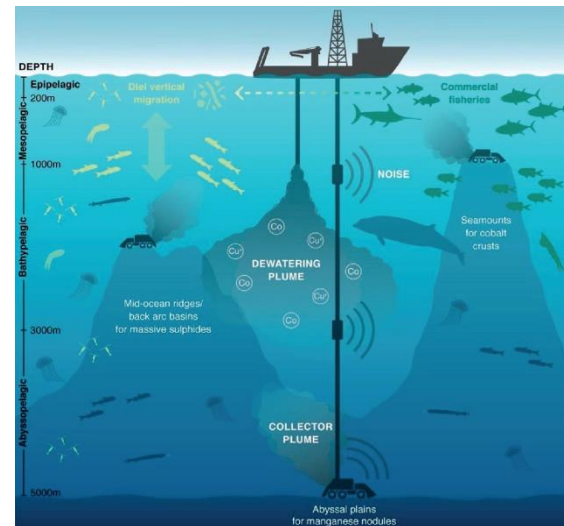


Figure 2: Possible Environmental impact of Deep Seabed Mineral Exploration

Recovery from the Impacts of Offshore Industrialization

Typical impacts from hydrocarbon exploration and production drilling may persist over the years to decades time scales in the marine environment. In general, the low-energy hydrodynamic regime in the deeper part of the sea may lead to the long-term perseverance of discharged toxic drilling material, whether deliberate or accidental. Seabed sediment contamination by drilling mud and hydrocarbon ingredients is of particular concern, as these toxic chemicals can persist for a long time, posing a significant

risk of prolonged eco-toxicological effects on the marine environment. As the low-energy hydrodynamic regime limits the dispersal of cuttings and chemicals, recovery of these highly sensitive benthic habitats may take longer. On the other hand, while deep-sea mining has not started in any part of the world, 31 contracts to explore seabed metals and minerals have been issued. The available scientific report suggests that commercial seabed mining would negatively impact ocean biodiversity, fisheries, and ecosystems and that this new frontier of mining requires a precautionary approach.

Conclusion and Way Forward

The Government of Bangladesh is now in the final stage of being updated the new Production Sharing Contracts (PSCs) 2023 with a proclaimed aim to make a breakthrough in gas exploration, specifically in offshore and deep-sea areas of the Bay of Bengal. This new upcoming PSC drew widespread attention prompting US-based ExxonMobil to offer to explore all 15 deep-sea hydrocarbon blocks of the country. In this context, it is assumed that any blowout occurring in offshore areas of Bangladesh, part of the Bay of Bengal, would also affect the coastal areas of neighbouring India and Myanmar. Therefore, paying solemn attention to the environmental issues in the Model PSC 2023, specifically related to the accidental blowout during the exploration or

production stage, is necessary. In particular, Article 10.27 of earlier Model PSC 2008 should be rewritten more specifically to include a loss of accidental discharge or blowout of the gas reserves. The environmental provision needs to be made by legal experts considering the Bangladesh Petroleum Act 2016, the Environment Conservation Act 1995, and the Environmental Conservation Rules 2023.

In addition, the Bangladesh government is now also prioritizing unleashing the full potential of ocean resources by making the Blue Economy the new frontier. In this connection, the government recently finalized Territorial Waters and Maritime Zones (Amendment) Act, 2021. The country now requires wholehearted support from the ISA for capacity building and knowledge transfer, particularly in the form of training and funding joint international research and studies. These collaborations from ISA will enable the Bangladesh government to make rules and regulations and exercise such powers and take such measures as it may consider necessary to regulate mining activities within its territorial sea, EEZ, continental shelf, and area in conformity with the guidelines of the ISA authority.

Writer: Dr. Md. Sakawat Hossain is the Chairman & Professor at the Department of Geological Sciences, Jahangirnagar University. Email: sakawat@juniv.ed