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Impact of Coastal Urbanization on Marine Diversity

Ratnamala S. Jawale [a++*]

[a] Department of Zoology, Veer Wajekar Arts, Science and Commerce College, Mahalan Vibhag, Phunde, Raigad, Navi Mumbai – 400 702, Maharashtra, India.

Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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Review Article

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ABSTRACT

Worldwide coastal urbanization is major issues of concern due to its negative impact on the health of the marine and coastal ecosystem. Construction of aquaculture facilities, oil and gas platforms, submarine cables/pipes, wind farms, artificial shore defences, and port activity can cause coastal pollution and physical disturbances to the coastal margins. Coastal urbanisation cause drastic changes in land use, destruction of natural ecosystems, and increase in the demand for natural resources. Most of the world's largest cities are located along coasts and cause changes in the size, composition, and distribution of human populations affecting coastal regions. Fishing or harvesting, the destruction of mangroves, and pollution and sedimentation from human activities all can affect the coastal environment. This study provides an illustrative and recent scientific account on the current status, major drivers, and impacts of coastal urbanization on marine diversity, sensitive coastal habitats, and severity of coastal pollution. For present review, bibliographic study was conducted using published literatures with the help of Internet search engines like Google, Google Scholar, PubMed, ScienceDirect, and ResearchGate. Results of the present study revealed that, construction of offshore infrastructure, coastal infrastructure, and facilities associated with

[++] *Assistant Professor;*
**Corresponding author: Email: rsjawalechaudhari@gmail.com;*

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ports, docks and marinas is responsible for overexploitation of both living and non-living resources, coastal pollution, and the wholesale conversion of natural habitats into a different state such as breakwaters, bridges, jetties, marinas, piers, port and harbour, reclaimed land, and seawalls. The study recommends the strict vigilance over the urban planning, civil and municipal engineering, and the design of coastal cities. Further, during coastal construction guidelines of Coastal Regulatory Zones should be properly followed for the protection and conservation of the most productive coastal ecosystem.

Keywords: Biodiversity; coastal infrastructure; habitat loss; marine pollution; urbanization.

1. INTRODUCTION

Lecerf et al., 2021 described that “coastal and marine ecosystem provide various services such as: cultural services (i.e., tourism, recreational, aesthetic, and spiritual benefits); provisioning services (e.g., fisheries, building materials); regulating services (e.g., carbon sequestration and storage, erosion prevention, waste-water treatment, moderation of extreme events); and supporting services (e.g., life-cycle maintenance for both fauna and local communities, element and nutrient cycling)”. Therefore, it is essential to maintain the health of marine life, the climate regulating functions and ecosystem services provided by the ocean (Jouffray et al., 2021).

UNU-IHDP,2015 reported that “most major cities of the world are located in ocean coastal zones since coastal zones typically offer ready access to water and fertile soil. In recent years, urban expansion along the coastal zones has become quite rapid and the rising skyscrapers of coastal cities are facing serious risks”. “Due to the lack of awareness and scientific understanding on urban development and planning practices, the coastal environment is facing a tremendous threat to its natural health, homogeneity, and coastal and marine life” (Pelling, 2013).

Rajashekariah and WWF,2011 India pointed that “the term “urban” includes an area with the population of more than 5,000; density exceeding 400 persons per sq. km., and where 75% of the male workers are engaged in non-agricultural professions. Urbanisation refers to the general demographic processes, by which cities are expanding”. Rapid urbanisation of many coastal cities has led to drastic changes in land use, destruction of natural ecosystems, and increase in the demand for natural resources (Dey, 2009).

McEvoy et al., 2013 recorded that “urbanization is the growth of cities and towns relative to the population of rural areas. Along with the economic drivers, urban areas attract people due to facility of hospitals, ports and port-related activity, robust infrastructure of schools, stores, tourism centred on coastal attractions, and other services that contribute to human well-being”. Elevation, land use, population density, sea/land breezes, and topography make the coastal cities more vulnerable to flooding and other hazards (UNU-IHDP., 2015).

Celliers and Ntombela, 2015 stated that “urbanisation refers to the social and political changes that may occur when people live in large, nucleated settlements. Urbanisation is a complex phenomenon and has direct effects on biodiversity and the state of the coastal environment”. Further, coastal organization (CU) can cause introduction of non-synthetic substances and compounds, urban and industrial wastewaters, atmospheric deposition and run-off from metal contaminated sites constitute major sources of toxic metals (WME, 2013).

Creel, 2003 reported that “many of the world’s coasts are becoming increasingly urban, because 14 of the world’s 17 largest cities are located along coasts. Changes in the size, composition, and distribution of human populations affect coastal regions by changing land use and land cover. Fishing or harvesting, the destruction of mangroves, and pollution and sedimentation from human activities all can affect the coastal environment”. Therefore, CU and associated human activities have caused numerous changes to marine environments, including the loss of natural habitats and replacement with artificial structures (Kyosuke, 2021).

Urbanization is the increase over time of urban population in proportion to the region's rural population (WME, 2013). “CU exerts huge pressure on the health of marine ecosystems due to emergence of various environmental issues and conflicts. Worldwide, urbanization is increasing in coastal areas and affects the

ecologically most vital ecosystem due to its transaction with the land and the sea. CU cause a sharp decline in ecosystem service provided by the coastal regions and results in coastal hazards such as: climate change, coastline erosion, land inundation, sea level rise, seawater intrusion, and storm surge" (Xuezhong et al., 2022).

Sempere-Valverde et al.,2023 reported that "coastal ecosystems provide resources such as: aquaculture, fisheries, industrial and trade opportunities, and tourism and leisure activities. As a result, about half of the world's big cities and half of the world's population live within 200 km of a coastline. Further, population density in coastal areas is three times higher than the global average. Such a growing population at the coastal line demands more land for the construction of coastal infrastructure". Construction materials such as plastics, concrete, rubber, chemicals, and other associated materials affect the coastal and marine diversity (Becker et al., 2020).

Huijibers et al., 2015 stated that "CU alters the composition of scavengers at the land-ocean interface, replace raptors as scavengers by invasive mammals, and remove marine carrion from rural beaches. It also causes depletion of many coastal species, loss and fragmentation of habitats, overexploitation of fish stocks, and pollution. CU may also impact the suitability of salt-marsh ecosystems for maintaining and regulating estuarine faunal communities". It alters the patterns of faunal distribution and abundance of benthic communities in the salt-marsh landscapes due to the habitat fragmentation and its loss (Michael., 2014).

According to Magana et al., 2020 "CU is a major contributor to the degradation of intertidal ecosystems. It includes the marine built infrastructure such as aquaculture facilities, artificial reefs and marinas, artificial shorelines, commercial ports and marinas, etc". CU is associated with increased land reclamation and cause negative environmental impacts on marine species connectivity, coastal biodiversity, ecosystem functioning and sustainability (Li, 2020).

Chou et al., 2015 noted that "CU has resulted in the modification of natural shores for port operations, marinas and coves, and marine recreation, which impact the original coastal biodiversity". "The coastal shoreline including mangroves, coral reefs, and seagrasses provides ecosystem services, drives the economy, and serves as a buffer to climate change" (Burak et al., 2004). "The coastal ecosystem is threatened by degradation, overfishing, erosion, and the effects of climate change. Therefore it's an urgent need to address challenges such as coastal erosion, biodiversity loss, pollution, and overfishing to conserve and protect the coastal ecosystem and biodiversity" (World Bank Group, 2022).

Concepcion et al.,2015 revealed that "CU has an important impact on biodiversity; particularly on the composition, species assemblages and mobility of the biological communities. It causes biotic homogenisation through the replacement of non-urban specialist species with urban adapted, typically generalist species". "Expanding urban development, tourism, aquaculture and related activities along with destructive fishing, shipping, coastal development and discharge of untreated effluent from industries have caused damage and pose a severe threat to coastal and marine biodiversity" (Saravanan et al., 2013).

United Nations, 2022 commented that "healthy, resilient marine and coastal ecosystems are a source of food, energy, minerals and transport. Coastal and open ocean ecosystems also play an important role in climate regulation. CU results in loss of biodiversity and the erosion of ecosystem functions threaten economic, social and cultural life". "Physical alterations derived from urbanization affects the feeding ecology, field metabolic rates, habitat and thermal occupancy, and reproduction in fishes like black-spot shiner (*Notropis atrocaudalis*), sabine shiner (N. *sabinae*), and urban guppies (*Poecilia reticulata*)" (Rosso et al., 2023).

Xu and Zhang., 2022 reported that; it is of great significance to explore the relationship between urbanization and marine pollution in coastal areas for the sustainable development of coastal cities. The rapid economic growth and urbanization of coastal cities destroys the environment of the city itself, and also brings pollution beyond the self-purification capacity to the coastal waters around the city. It is known that the rapid development of CU has brought about various disasters, such as climate change, land loss, and excessive consumption of natural resources (Liu et al.,2020).

Rajashekariah and WWF India observed that; due to increased urbanisation, natural resources are under extreme pressure. Hence, to

understand the impact of CU on biodiversity becomes imperative for the conservation and also for planning sustainable cities. CU also involves establishment of fishing and allied activities (e.g. seafood processing, marketing and export), industrial activities (e.g. nuclear and thermal power plants, refineries, fertiliser and chemical plants, desalination plants, sand mining etc.), and maritime trade can exert significant pressure on coastal ecosystems and the services they provide (Sanyal et al., 2007).

Todd et al., 2019 demonstrated that "resource exploitation, pollution pathways and ocean sprawl are the main drivers of CU which affects the coastal ecosystems. Loss of foundation species; changes in biodiversity and productivity; and the establishment of ruderal species, synanthropes and novel assemblages are the major impact of CU. CU also cause conversions of coastal and agricultural land for human use, especially to accommodate increasing needs for housing, factories, commercial buildings, transport infrastructure, and recreational developments" (Philip et al.,2022).

Vargas-Fonseca et al., 2016 concluded that; the degree of CU is strongly correlated with the spatial distribution of fish species richness and abundance. The vulnerable and iconic fish species are affected by the presence of coastal cities. Coastal and marine ecosystems act as store houses of biological diversity, and also home to a large human population. However, due to industrialisation and urbanization, these ecosystems are under pressure (Bhatt and Vivekanandan., 2013).

2. MATERIALS AND METHODS

For present review the searched literature contains research papers, reviews, reports, and conference papers with the help of Internet search engines like Google, Google Scholar, PubMed, ScienceDirect, and ResearchGate. According to the content relevancy, 12 papers were eliminated, and 37 papers remained. The purpose of this review is to summarize Impact of Coastal Urbanization on Marine Diversity with reference to major drivers of marine urbanization and impacts of coastal urbanization on marine habitats and biodiversity.

3. MAJOR DRIVERS OF MARINE URBANIZATION

Todd et al.,2019 stated that; the primary drivers of marine urbanization include: resource exploitation, pollution, and ocean sprawl. Resource exploitation involves the exploitation of both living and non-living resources and includes dredging and mining for minerals, recreational, and subsistence and commercial fishing.

"Pollution includes animal/slaughterhouse waste, domestic wastewater, fecal matter, industrial and municipal waste, oil from automobiles, sediments, street dust, and other contaminant sources such as pharmaceuticals, light pollution, and noise pollution" (Wellset al., 2019).

Ocean sprawl is the wholesale conversion of natural habitats into a different state. Breakwaters, bridges, groynes, infrastructure, jetties, marinas, piers, port and harbour, reclaimed land, and seawalls are collectively termed as 'ocean sprawl' (Firth et al., 2016).

4. IMPACTS OF COASTAL URBANIZATION ON MARINE HABITATS AND BIODIVERSITY

"Population growth, economic development, climate adaptation, and tourism lead to CU, which has serious impact on living marine resources. Climate change and ocean acidification, habitat loss, overfishing and resource depletion, and pollution are the major impacts caused by the CU on marine life" (Todd et al., 2019).

Gao et al.,2017 described that compounds from oil of motor vehicles, shipping, and industries; heavy metals from industrial and vehicle emissions, leaching from landfills, urban runoff, and sewage; nitrogen and phosphorus from industrial discharge, human and animal waste, detergents, mariculture; PCBs and PBDEs, pharmaceuticals, and tributyltin from antifouling paint, industrial effluents, and sewage; plastics from resin pellets, discarded end-user products, and fishing activities; and sediments from construction sites cause potential effects on marine life Fewtrell and McCauley, 2012.

4.1 Impacts on Marine Life

"Acute gastrointestinal illnesses, e.g. salmonellosis; change in behavior and physiology of marine life; death of fish and planktons during intake and processing; disrupts behavior: ability to find food, mates or avoid predators); internal blockages/injuries due to ingestion and/or entanglement in plastic debris; mortality: bycatch species; mortality or injury

from boat collisions; negative impacts from cyanide or dynamite fishing; reduces growth and fecundity; removal of target fish and shellfish; smothering of benthic fauna due to build-up of organic material; starvation due to false 'stomach filling'; suffocation, lacerations, infections, and reduced ability to swim; transmission of disease and parasites among native species; and viral diseases such as hepatitis and respiratory infections" (Wang et al.,2023).

4.2 Damage/ Degradation of Sensitive Habitats

"Changes to the composition of the sediment/substrate; changing bathymetry and sediment transport patterns; damage of sensitive habitats from contact fishing gears; degradation of habitats from the launching/recovery of boats; habitat loss, and fragmentation; lowering/loss of beach leading to erosion; physical disturbance to coastal habitats; and removal of the substrate and associated benthic biota" (Lecerf et al.,2021).

4.3 Negative Impacts of Coastal Pollution

Eutrophication due to addition of nutrients; lost and abandoned fishing gear issues; noise pollution; reduced light and enhanced turbidity due to sediment suspension, release of toxicants; thermal pollution due to brine and heated water; noise and light pollution during construction phase. Construction of offshore infrastructure (aquaculture facilities, oil and gas platforms, submarine cables/pipes, wind farms) and coastal infrastructure (artificial shore defences) and facilities associated with ports, docks and marinas cause coastal pollution (Xuezhong et al.,2022).

5. CONCLUSION

Results of the present study reveal that; to minimize the negative effects of coastal urbanization on the marine environment, the architecture, urban planning, civil and municipal engineering, and the design of coastal cities should be properly checked before the construction. Coastal construction should be made by strictly following the guidelines of Coastal Regulatory Zones. Further, utmost care should be taken for proper treatment of municipal and industrial wastes before its release in the coastal ecosystem.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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