

Impacts of Sand Mining on Environment – A Review

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Abstract – Illegal and indiscriminate sand mining will become threat to the worldwide environments. It leads to changes in river channel form, physical habitats and food webs. It also increases the velocity of flow in river which destroy flow-regime eventually erodes the river banks. Removal of vegetation and destruction of the soil profile destroys habitat above and below the ground and faunal population decrease. Sand dunes are part of the beach system, when destroyed coastal lands are vulnerable to flooding. Sand dunes play an important role in barriers against like heavy storms, erosion through waves or floods. They serve as habitat for many small animals and plants that are part of the marine and coastal food web and whose loss implies a threat to other species as well. Sand aquifer helps in recharging the water table and sand mining causes sinking of water tables in the nearby areas, , drops leaving the drinking water wells on the embankments of these rivers dry. Turbidity increases at the mining site. Saline water intrusion takes along the coastal aquifers. Sand mined areas loose scenic beauty, cause radiation based on the component minerals, dust pollution, creates noise and vibration and spoils roads and other structures. This paper reviewed the sand mining impacts on river, dune, marine, hydrological, biological and sociological environments with some worldwide case studies.

Keywords: Sand mining, river, dune, beach, hydrological, biological, sociological

I INTRODUCTION

‘Sand mining’ is a practice that is used to extract sand, from various environments, such as beaches, inland dunes and dredged from ocean beds, and river beds of deltaic regions. The mining is in operation in all the continents of the Globe. Environmental problems occur when the rate of extraction of sand, gravel and other materials exceeds the rate of deposition.

Sand budget of a particular environment shall be observed before sand mining. Specific hydrologic and hydraulic information are necessary. To mine the sand without causing undue

erosion or degradation at the site. Sand mining various environments is presented below.

River Environment

Impact of Sand mining

Sand is vital for sustenance of rivers. The sand mining has several impacts on the river environment. Sand mining disturbs and completely remove the habitat from the mined zones.

It leads to changes in its channel form, physical habitats and food webs – the river’s ecosystem. It also increases the velocity of flow in river which destroy flow-regime eventually erodes the river banks.

- Channel widening causes shallowing of the streambed, producing braided flow or subsurface inter-gravel flow in riffle areas, hindering movement of fishes between pools.
- Riverbed becomes dry due to exposure to solar radiation decrease the surface and groundwater.
- Depletion of sand in the streambed causes the deepening of rivers and estuaries, and the enlargement of river mouths and coastal inlets. It leads to saline-water intrusion.
- Removal of vegetation and destruction of the soil profile destroys habitat above and below the ground and faunal population decrease.

CASE STUDIES

Amaravathi River, Tamil Nadu, India

At Amaravathi River, high altitudes denudation occurred where tea gardens are plentiful. As the vegetation removed and replaced by tea plantations the function of recharge of ground water during rainy season and discharge to surface water during dry season is lost. This will augment the surface flow during rainy days and there will be no storage of ground water resulting in virtual drying of small streams[1].

Pampa River, Kerala, India

‘Ithipalliyar’, tributary of Pampa River, water flow through it is blocked much of the time following

the fall in the main riverbed level due to continuous sand mining. The riverbed which had a sand carpet of 15 – 20 feet thickness and spreading across the full width of Pampa has already disappeared. Fall in riverbed and removal of sand from beneath top soil at the river embankment resulted caving into the river in many places[2].

Coastal Environment

Beach formation begins with erosion continental material. It forms sand, gravel, and cobble fragments, which transport to sea by rivers. Mine sediment is suspended in sea water and transported along the coast by the long shore current.

Sand dunes are present on shorelines where fine sand is transported landward by a combination of wind and waves and stabilized with vegetation. Dunes can help protect coastal property from the destructive forces of storm surges and tsunamis. However manmade had severe impacts on coastal sand dunes[3][4].

Impacts of sand mining

- If the sand is mineral within 30m depth or less than 3km from shore, beaches and dunes suffer (Photo-1).
- Sand dunes are part of the beach system and provide reservoirs of sand that feed the beach during tropical storms and hurricanes. If they destroyed, coastal lands are vulnerable to flooding.
- Sand dunes play an important role as barriers against like heavy storms, erosion through waves or floods.
- Destruction of picturesque beaches causes tourism to dissipate.
- They serve as habitat for many small animals and plants that are part of the marine and coastal food web and whose loss implies a threat to other species as well.
- Beach erosion takes place because of sand mining and effect homes and livelihoods (Photo-2).



Photo- 1. Illegal sand mining in a beach, source: <http://www.frontline.in>



Photo-2. Sand mining threatens homes, Source: <http://www.irinnews.org>

Some case studies

Morocco Coast (South Africa)

Moroccan coast has a very large coastal sand body resupplied by regular erosion of cliffs and episodic injections from rivers in flood. Sand mining completely damaged the coastal environment[5].

Kerala coast (India)

Because of sand mining, low lying areas, water logged during monsoon and mostly inundated by seawater. These are mostly mono cropped lands with rice as the main crop. Water bodies, mostly brackish, cover considerable area. Two RAMSAR sites that adjoin the Kayamkulam kayal namely Ashtamudi kayal and Vembanad kayal are well connected through various channels and canals. Most of this large contiguous marshland is about 1.5 meters below the sea level. Once the small strip of coastline that protects this region from the seawater is mined off, seawater intrusion would inundate the land and saline incursion will affect ground water also. Negative chain reaction is observed along the districts of Kollam, Alappuzha, Pathanamthitta, Kottayam and Ernakulam[6].

Kwale Coast (Kenya): Due to sand mining near the Indian Ocean coast, people suffered from health risks with titanium mining[7]. The endangered colobus monkey, marlins, tiger sharks, stable antelopes, mangroves and coral reefs lost their habitat.

Quandamooka, Moreton and Stradbroke Island, (Queensland) – A significant proportion of Minjerriba land has affected by sand mining[8]. The environmental infringements cited by the Government are categorized as infringements on land, water, flora and fauna and air. The government is concerned about the noise pollution and also the rehabilitation of the local community[9].

Waikato Beaches, (New Zealand) – Sand dunes are damaged by vegetation clearance for sand mining around waijkato Beaches”[10].

Santa Barbara Beach, São Miguel (Azores) – Sediment starvation noticed along Santa Barbara Beach where beach was destroyed. The coastline used to have towering dunes made of white-pink sand that visitors had to scramble over just to get a glimpse of the expansive Ocean. But now, there are no sand dunes and the beach, once thick and full, has been whittled down to a thin strip that gets smaller and smaller by the day[11].

Anguillian Beach (Caribbean Islands)

The unregulated removal of the sand had an enormous impact on the north-east side of the island between Savannah Bay and the tip of windward Point. Sand dunes that once loomed over the beach and protected the inland shoreline and vegetation have been reduced to a three-foot mound that is being eroded by wave action and a continued sand mining. Large trucks and heavy equipment have been chipping away at the sand-based land and this has created an unprotected and unstable cliff.

Sile Bay used to have large sand dunes. After significant sand mining and Hurricane Luis, the beach is gone and a breakwater is being used to stop further coastal land erosion. While the breakwater may help with the erosion, it also stops beach rehabilitation because the waves are not able to deposit any sand[12].

Ghana Coast

The construction sector in the coastal areas of Ghana relies heavily on coastal sand and pebbles in the building of houses, bridges and roads[13]. The process of sand mining has accelerated coastal environmental degradation to an alarming rate.

Biological Environment

Sand mining is one of the main threats to the rich biodiversity alongside our perennial rivers and ephemeral water courses. It can destroy riverine vegetation, cause erosion, pollute water sources and reduce the diversity of animals. The beach and dune system habitat along the coastal zones also victims. Off-shore sand mining pumping biota with sand and damaging coastal ecosystem.

Impacts of sand mining

Some of the impacts of sand mining on biological environment are presented here;

- Many species of trees and shrubs in dry riverbeds are supported by groundwater retained by the river sand at varying depths will disappear.

- The extraction of sand from the riverbed may affect their survival and recruitment ability[14].
- Dust caused by trucks can impede the photosynthesis of plants[15][16].
- Affect burrowing animals and insects, as well as plants, and to a lesser extent larger mammals and reptiles because they can easily migrate to uninterrupted places[15][16].
- As sand mining destabilises soil structure, river banks and often leaves isolated islands of trees, subsequent flow will erode the banks and islands.
- Mined areas that show decreased depth of surface flow could result in migration blockages for fish during low flows. When water does not cover much of the streambed, the amount of viable substrate for aquatic organisms is limited. In high-gradient streams, riffles and cobble substrate are exposed; in low gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat[17].
- Operation of heavy equipment in the channel bed can directly destroy spawning habitat for fish and macro invertebrate habitat, and produce increased turbidity and suspended sediment downstream.
- Stockpiles and overburden left in the floodplain can alter channel hydraulics during high flows[18].
- The most likely effects of suspended sediments on fish include: reduction in light penetration and of photosynthesis in micro and macrophytes, resulting in reduced food availability and plant biomass; reduced visibility of pelagic food; reduced availability of benthic food due to smothering; clogging of gillrakers and gill filaments[19].
- Destabilising river banks and increased sediment inputs disturb rich sea bank and organic matter in the overburden.

Marine Habitat

Some of the impacts of sand mining from sea bed on marine ecology should be considered from the following points (*citation needed*)

- Increase turbidity will influence the water quality and habitats to where the mining water flows.
- Benthic fisheries such as mollusk, shrimp and crab catch will have direct impact
- Many benthic breeding organisms who have eggs adhesive to bottom objects, such as squids, will be greatly disturbed.

- The sediment in the mining site, if contains toxic material due to long time accumulation, will cause a second time pollution.
- Skimming the surface of the sea bottom, spreading its impact over a large area. Kill the marine organisms that have settled.
- Physical disturbance of the habitat caused by dredging activities includes noise, which can interrupt nesting/breeding activities.

Kitts and Nevis (West Indies)

The biodiversity of St Kitts and Nevis, including the sea turtle population, is under threat to the increase in illegal sand- mining that is taking place[20].

North Sea

In North Korea, the benthic community structure is severely disrupted and recovery to resemble similar age composition and community structure could take more than 2 years[21].

Hydrological Environment

On the river bed the sand acts as a spongy, natural carpet and as a good aquifer. The interstices of sand harbouring rich biodiversity.

Impacts of sand mining

Water table depletion

Sand aquifer helps in recharging the water table and sand mining causes sinking of water tables in the nearby areas. Apart from threatening bridges, sand mining transforms the riverbeds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry.

Water Quality

Turbidity increase at the mining site due to resuspension of sediment, sedimentation due to stockpiling, organic particulate matter, oil spills or leakage from excavation machinery and transportation vehicles.

Salinisation

Saline water intrusion takes along the coastal aquifers.

Acid Mine Drainage

Acid mine drainage also dissolves toxic metals, such as copper, gold, silver, molybdenum, aluminum, cadmium, arsenic, lead and mercury,

from the surrounding rock. Even in very small amounts, metals can be toxic to humans and wildlife. If uncontrolled, the acid mine drainage may runoff into streams or rivers or leach into ground water. Plants, animals, and fish are unlikely to survive in such streams.

Maharashtra (India)

Godavari River, has been mined so badly for its sands in the Marathwada region of Maharashtra State. So it is almost dried up and villagers depending on tanker water. Wells have dried up and farmers have to have water piped in over long distances. As per the rules, sand can be excavated only up to a depth of one metre but dig up to as much as seven metres[22].

Kerala (India)

Water tables have dropped dramatically, and a land once known for its plentiful rice harvest now faces scarcity of water in the Bharathapuzza River basin. In the villages and towns ground water levels have fallen drastically. A free-flowing river Bharathappuzha had no water due to sand mining. As the sand cover gone, shrubs and acacia groves have cropped up in the middle of the river. Similar has been the fate of the Pamba River, Kerala's third longest river. Sand mining has reduced the water-holding capacity of the rivers in the state[22].

Water resources damaged in river basins included those of the Palar and its tributaries Cheyyar, Araniyar and Kosathalaiyar the Cauvery, the Bhavani, the Vellar, the Vaigai, and the Thamiraparani[23].

Papagiri Catchment, Karnataka

Illegal and excessive sand mining in the riverbed of the Papagani catchment area in Karnataka has led to the depletion of groundwater levels and environmental degradation in the villages[24].

Sand mining has caused the draining of and damage to several perched lakes and wetlands. The miners make no attempt to replicate the original geomorphology in their post mining rehabilitation. Instead they reinstate a homogenous landform which has very different hydrological characteristics[25].

Sociological Aspects

Sand mining has many negative impacts on the society. It affects livelihood of the people, health, science beauty, climate and damage infrastructure. These effects are elaborated here.

Impacts of sand mining

Scenic beauty

The beaches and backwaters of coastal areas are famous for their scenic beauty. Beach and backwater tourism is one of the main areas for economic development. There are pockets along the coast with harbours and commercial centers. We can't see the beauty in near future.

Coastal Erosion

People live in the coastal areas are under the constant threat and fury of nature wherever the sand mining carried. Coastal erosion causes damage to the properties leading to social discontent²⁶. Extraction of beach sand exposes coastal areas to the ravages of erosion.

Radiation

The residue of the radioactive mineral such as monazite and zircon, detrimental to local biota.

Cancer

Fracking process may cause cancer in silica sand mining areas.

Dust Pollution

Large quantities of dust enters into the atmosphere during sand mining cause respiratory disorders.

Noise and vibration

Noise is an issue in the mining areas because mines normally operate 24 hrs day and sound levels fluctuate widely. The noises pollute the environment and disturb sleep.

Roads and other structures

Movement of heavy vehicles cause damage to roads and bridges and sometimes cause traffic hazards.

Case Studies

Alappuzha (Kerala, India)

The coastline of Alappuzha is densely populated with fisherman community. At present the area is under threat due to sand mining. The area is identified as one of world's most potential and productive fishing grounds.

Sand Mining affects the coir and coir products depended population of the area. Coir extraction process from the husk is complicated and requires brackish water to treat and soften it. The physico-chemical condition of the water is crucial for this process, as its variation might affect the quality of the coir strands. Once mined, the backwaters of the

area will get more exposed to the sea, thereby changing the physico-chemical parameters of the water. Many families lost their lively hood or additional income[26].

CONCLUSION

Minerals are part of a nation's natural wealth. The nation is to advance industrially and economically by the proper development and exploitation of these resources. It has to be remembered that the sand once removed cannot be replaced in the next generation. It will take centuries for replacement.

Sand sustains the rivers and the percolation of water to far off distances both for the growth of trees to sustain drinking water and raise cultivation. It is almost a lifeline to the human existence. Without considering the precise gift provided by nature, commercial exploitation for short term gains by pumping out the sand indiscriminately from the rivers, dunes and beaches will destroy whole environment. People employ huge machineries like cranes and other pumping mechanism causing untold natural calamities and loss to the society. In order to maintain the balance between the environment and sand mining, the Governments should regulate the mining.

REFERENCES

- [1] <http://www.aredsindia.org>
- [2] <http://www.thehindubusinessline.com>
- [3] <http://geography.howstuffworks.com>
- [4] <http://www.crd.bc.ca>
- [5] <http://coastalcare.org>
- [6] <http://www.kerennis.nic.in>
- [7] Toward Freedom Magazine, 2001
- [8] Quandamooka Lands Council, 2003
- [9] <http://en.wikipedia.org>
- [10] <http://www.waikatoregion.govt.nz>
- [11] Borges, P., Andrade C. and M. C. Freitas (2002) Dune, Bluff and Beach Erosion due to Exhaustive Sand Mining – the Case of Santa Barbara Beach, São Miguel (Azores, Portugal), Journal of Coastal Research, SI 36 pp.89-95 (ICS 2002 Proceedings), Northern Ireland.
- [12] <http://www.anguillalife.com>
- [13] John Victor Mensah, (1997) Causes and Effect Of Coastal Sand Mining in Ghana, Singapore Journal of Tropical Geography, V. 18, pp. 69–88.
- [14] Nair, 2005 in <http://earth.esa.int/cgi-bin>.
- [15] <http://earth.esa.int/cgi-bin>
- [16] Muller, 2005 in <http://earth.esa.int/cgi-bin>.
- [17] Silvanus Kweenda Uunona, <http://earth.esa.int/cgi-bin>
- [18] NMFS. (1998) National Marine Fisheries Service (NMFS) National Gravel Extraction Policy. Internet document: <http://swr.ucsd.edu/hcd/gravelsw.htm>.
- [19] Bruton, M.N. (1985) The effects of suspensoids on fish. Hydrobiologia, V. 125, pp. 221-241.114, pp.349–367.
- [20] <http://www.carribeannesnow.com>
- [21] <http://www2.fc.up.pt/peleas>
- [22] <http://english.ohmynews.com>
- [23] <http://www.Frontline.In>
- [24] Chandrasekhara Rao M. (2006) Sand Mining: Groundwater Depletion in Papagani Catchment Economic and Political WeeklyV. XLI No. 07.
- [25] <http://savestraddie.com>

[26] Sekhar, L.K and Jayadev S.K (2003) “Karimanal (Mineral Beach-Sand) Mining In The Alappuzha Coast Of Kerala – A People’s Perspective” in Martin J. Bunch, V. Madha Suresh and T. Vasantha Kumaran, eds., Proceedings of the Third International Conference on Environment and Health, Chennai, India, 15-17 December, 2003. Chennai: Department of Geography, University of Madras and Faculty of Environmental Studies, York University, pp. 470 – 488