Biodiversity and Sand Mining: Key Ecological Impacts

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Introduction

Sand mining takes place in flood plains, dunes, freshwater systems, rivers, and in coastal and marine ecosystems (Torres et al, 2021). The mining process can take place through dredging, sand bar scalping, and dry pit digging and can involve pumping, shoveling, or more large-scale extractive equipment (Torres et al, 2021; Ahmed et al, 2020).

Sand mining has numerous impacts across many sectors, including social, economic, and political fields, but the focus of this paper is to examine the ways that sand mining contributes to biodiversity loss. Sand mining has a significant impact on biodiversity, but considering the variety of ecosystems and mining mechanisms possible in mining sand, it is important to note that the impacts are not homogenous and vary depending on the circumstances of mining and local ecosystem response. River channels may widen or narrow, water and sediment flow may increase or decrease, and changes may happen gradually or suddenly, depending on the ecosystem (Koehnken et al, 2020).

A mining operation to extract sand along the highway BR-364 in Rondônia, Brazil.
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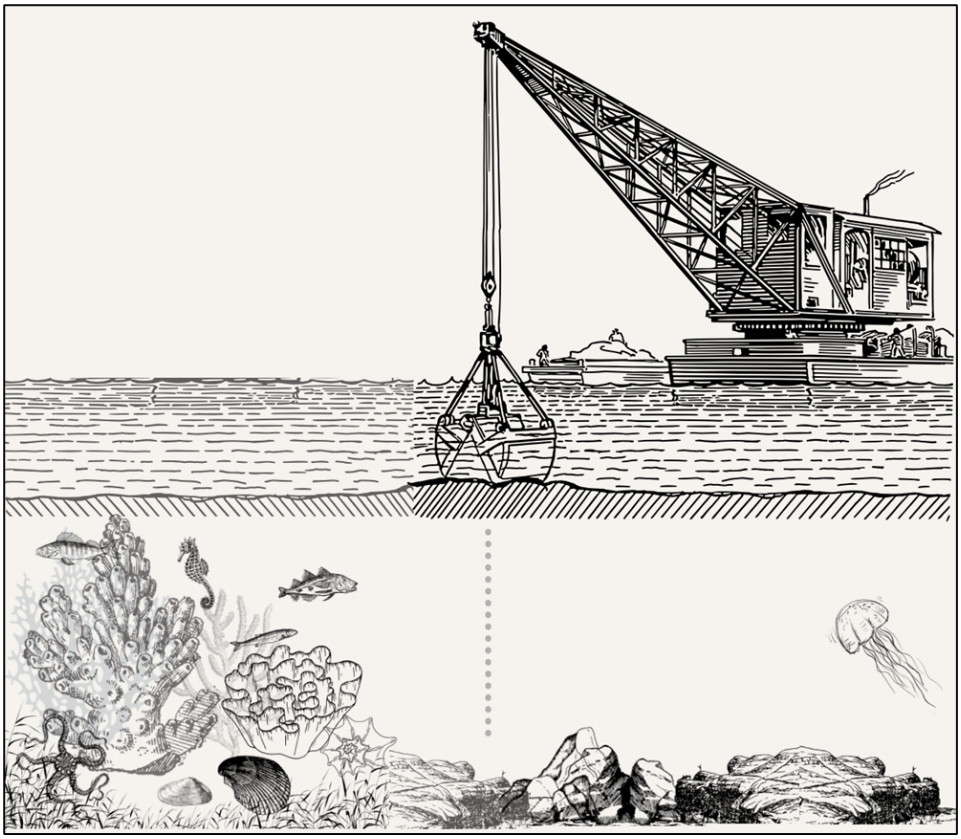
Change in Topography

One of the most noticeable impacts of sand mining is the drastic change to topography and its subsequent impact on habitat. Habitat loss often begins before mining starts, when deforestation occurs to make space for mining equipment and facilities (Koehnken et al, 2020).

Once mining begins, some of the most immediate habitat impacts come from the direct removal of flora and fauna during sand extraction, particularly dredging (Torres et al, 2017; Koehnken et al, 2020). Invertebrates, coral reefs, seaweeds and other aquatic plants, and fish species can be dragged out of their environment by mining equipment (Torres et al, 2017; Koehnken et al, 2020). Nonliving entities, such as tree trunks and rocks, can also be removed, reducing the complexity of the riverbed and destroying hiding places and thermal refuges of aquatic species (Ahmed et al, 2020).

The destruction of riverine, marine, and coastal habitats both exterminates and displaces species from their biomes, diminishing biodiversity and ecosystem function (Ahmed et al, 2020). Mining can put substantial stress on already endangered species, as sand mining has done to the Ganges River Dolphin in India (Torres et al, 2017; Larson, 2018). As native species are destroyed or displaced, invasive species take over, further preventing the recovery of the damaged ecosystems (Ahmed et al, 2020; Koehnken et al, 2020).



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Change in Water Flow

Water flow is affected in rivers, lakes, and deltas when mining activities change the shape or depth of a channel through dredging, scalping and riverbed incision, all of which have impacts on water quality, temperature, and turbidity (Koehnken et al, 2020).

Not only is the quality of the water surrounding the mining area affected, but research shows that the impacts are felt downstream, where a reduction in water flow causes lakes to shrink (Xin NG and Park, 2021). Besides the loss of aquatic life in a shrinking ecosystem, the diminishing of freshwater lakes can limit access to sufficient food and shelter for shoreline animals, including migratory species such as the highly endangered Siberian Crane in China (Koehnken et al, 2020; Larson, 2018).

Riverbed incision has been linked to a reduction in the regional water table, which can lead to salinization of groundwater and soil, as well as a loss of tributaries and water sources around the mining site (Xin NG and Park, 2021). Salinization and water loss can generate areas of infertile soil and make it difficult for plants and crops to grow (Gavriletea, 2017).

Sand mining can also take place in river adjacent areas, such as flood plains. This affects vital wetlands and can cause a reduction in or disconnection from inundation areas, leading to severe flooding and loss of seasonal irrigation in local communities (Xin NG and Park, 2021).

Sand mining in the Ayeyarwady River in Myanmar.
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A pile of sand extracted from the Ayeyarwady River in Myanmar.
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Change in Sediment Flow

The disruption of riverbeds and benthic ecosystems causes sediments to become suspended in the water, reducing water clarity and quality (Torres et al, 2017; Kim and Yoo, 2020). Sedimentation limits the photosynthesis capability of aquatic and marine life, starving light feeding organisms and deteriorating the diversity of the local food web (Torres et al, 2017).

In marine ecosystems, sedimentation reduces the growth of phytoplankton, threatening fisheries and other marine life (Kim and Yoo, 2020). Sedimentation in river ecosystems reduces the survival of invertebrates and plants, throwing ecosystems out of balance (Koehnken et al, 2020).

The removal of sand in rivers can also lead to a deficiency of sediment in local and downstream ecosystems, or sediment starvation. The loss of sediment causes bank instability and increases erosion, changing the topography of waterbodies beyond the mining area (Xin NG and Park, 2021). The loss of shoreline sand impacts dunes, banks, and shoreline vegetation and leaves coastal communities and ecosystems vulnerable to flooding, storm surges, and other coastal events (Torres et al, 2017; Koehnken et al, 2020).

Bank removal also causes the destruction of nests and nesting grounds and has been directly linked to the decline in both the southern and northern terrapin in South and Southeast Asia (Larson, 2018). Loss of sediment can cause deltas to sink and diminish (Torres, et al 2021; Xin NG and Park, 2021), destroying vital feeding and breeding grounds for multitudes of migratory and local species (Ahmed et al, 2020).

Chemical and Elemental Composition

Sand mining can change the chemical composition of an ecosystem in a number of ways. Pollutants released during the mining process can contaminate water, air, and soil, presenting serious health concerns for ecological and human communities.

The potency of heavy metals and other substances emitted from the mining process are magnified by the change in water temperature associated with channel widening and the loss of plant species that normally filter out toxins (Koehnken et al, 2020).

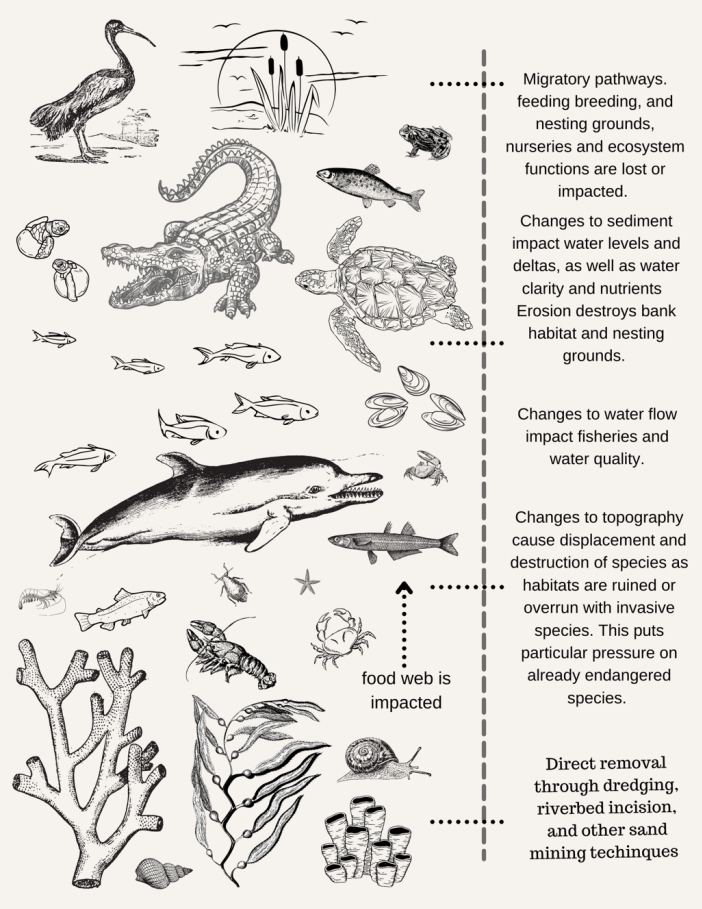
The loss of filtration is also a part of sand mining's impact on ecological cycles such as the nitrogen cycle and carbon sequestration (Koehnken et al, 2020). Runoff and vegetation loss can lead to eutrophication and skew pH and toxicity levels (Ahmed et al, 2020). Dredging, particularly in marine environments, can also release previously stored substances. In benthic areas, dredging has been linked to the release of toxins and sequestered carbon (Dawson, 2021).

Conclusion

Through changes in topography, hydrology, sedimentation and chemical composition, sand mining has significant and negative impacts on a multitude of ecosystem types and the species reliant on their healthy function, including humans. The impacts to ecosystems discussed above have repercussions for migratory species (affecting migratory stopovers and food sources), the spawning regions and habits of species, essential nurseries, complexities of food webs, and crucial ecosystem services (Torres et al, 2017).

Biodiversity is clearly impacted by sand mining, but there are still many questions left unanswered. Much of the data for this paper came from cost-benefit analyses or studies considering the social, economic, and environmental impacts of sand mining. There were few studies which examined the sand crisis through a lens of biodiversity loss or investigated the response of a particular species to sand mining. There is also no consensus of the overall impact sand mining has on biodiversity regionally or globally. Though it happens around the world at many scales, the total impact on biodiversity has not been quantified. Finally, the ways which climate change may worsen these impacts has not been deeply explored.

While the impacts of sand mining on biodiversity are unique, complicated, and intersecting, the evidence shows that sand mining without strict regulation has extremely deleterious consequences for the local and regional environment. Without regulation and without a reduction in sand consumption, sand exploitation will lead to ecological and social loss in many ecosystems.



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