IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Impact Factor 8.066 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 11, Issue 3, March 2024
DOI: 10.17148/IARJSET.2024.11349

Environmental Impacts of Sand Mining: A Comprehensive Review

Khyati Poonia[1], Pragya Kansara[2], Prem Choudhary[3]

Student, College of Technology and Engineering[1, 2]

DGM, Bharat Electronics Limited[3]

Abstract: Sand mining is a prevalent activity worldwide, driven primarily by the demand for construction materials. However, the environmental consequences of sand extraction are extensive and multifaceted, affecting various ecosystems and communities. This review paper synthesizes the current understanding of the environmental effects of sand mining, encompassing diverse aspects such as land degradation, habitat destruction, water pollution, and socio-economic repercussions. By examining the interplay of geological, hydrological, biological, and societal factors, this paper aims to provide a comprehensive overview of the challenges posed by sand mining and potential strategies for sustainable management.

Keyword: Sand mining, Environmental Impact, land degradation, Socio-economic implication

I. INTRODUCTION

Sand, as a critical natural resource, plays a pivotal role in various industries, particularly construction and infrastructure development. The exponential growth in urbanization and industrialization has led to a surge in demand for sand, driving extensive extraction activities across rivers, beaches, and floodplains. While sand is often perceived as an abundant resource, the scale and intensity of extraction have raised concerns regarding its long-term environmental impacts. This section provides an overview of the global significance of sand mining and introduces the key environmental issues associated with this practice. Sand mining is a globally pervasive activity, propelled predominantly by the escalating demand for construction materials essential for infrastructure development, urban expansion, and industrial projects. However, the ramifications of sand extraction on the environment are profound and multifaceted, exerting extensive pressures on diverse ecosystems and local communities. This comprehensive review paper endeavours to consolidate the current understanding of the environmental repercussions of sand mining, encompassing a broad spectrum of impacts ranging from land degradation and habitat destruction to water pollution and socio-economic ramifications(Ojha & Choudhary, 2017). The deleterious effects of sand mining transcend geographical boundaries, affecting various ecosystems including rivers, lakes, coastal areas, and adjacent terrestrial habitats(Choudhary, Chaudhary, et al., 2023; Choudhary & Choudhary, 2020). One of the primary environmental concerns associated with sand extraction is land degradation, which manifests through the alteration of landforms, erosion of riverbanks and floodplains, and depletion of natural resources(Choudhary, 2020). The removal of sand disrupts the delicate balance of sediment transport processes, leading to accelerated erosion, loss of fertile soil, and diminished agricultural productivity in surrounding areas. Habitat destruction represents another critical consequence of sand mining, particularly in riparian zones and coastal regions characterized by high biodiversity and ecological significance. The extraction of sand disrupts the natural habitat of numerous species, including fish, birds, and aquatic vegetation, leading to population declines, habitat fragmentation, and loss of ecological resilience.

Moreover, the destruction of coastal dunes and mangrove forests for sand extraction exacerbates the vulnerability of coastal ecosystems to erosion, storm surges, and sea-level rise, amplifying the risks of coastal inundation and loss of shoreline habitats. Water pollution emerges as a pervasive and insidious consequence of sand mining operations, stemming from the discharge of sediment-laden water and chemical contaminants into rivers, lakes, and groundwater aquifers. Sedimentation and turbidity resulting from mining activities impair water quality, reducing light penetration and oxygen levels, thereby disrupting aquatic ecosystems and compromising water supply for human consumption and irrigation. Furthermore, the use of heavy machinery and chemicals in sand extraction introduces pollutants such as heavy metals and hydrocarbons into the environment, posing risks to human health and ecosystem integrity. In addition to its ecological ramifications, sand mining engenders a myriad of socio-economic challenges, particularly for communities dependent on riverine resources for livelihoods and cultural practices. The displacement of indigenous populations, loss of agricultural land, and conflicts over resource allocation are common consequences of unsustainable sand mining practices, exacerbating social disparities and undermining sustainable development goals. Moreover, the socio-economic benefits derived from sand extraction are often inequitably distributed, perpetuating cycles of poverty and marginalization

DOI: 10.17148/IARJSET.2024.11349

in affected communities. To address the multifaceted challenges posed by sand mining, it is imperative to adopt a holistic and integrated approach that acknowledges the interplay of geological, hydrological, biological, and societal factors. Sustainable management strategies should prioritize the conservation of natural ecosystems, promotion of responsible governance, and equitable distribution of benefits among stakeholders. By fostering interdisciplinary collaboration, stakeholder engagement, and participatory decision-making processes, it is possible to mitigate the adverse environmental and socio-economic impacts of sand mining while promoting the long-term sustainability of natural resources and human well-being.

II. GEOLOGICAL AND HYDROLOGICAL IMPACTS

Sand mining alters the geomorphology and hydrology of river systems, leading to erosion, sedimentation, and changes in riverbed morphology. The removal of sand disrupts natural sediment transport processes, exacerbating erosion downstream and altering the equilibrium of river channels. Moreover, excessive extraction can lower water tables, degrade groundwater quality, and exacerbate drought conditions in surrounding areas. This section explores the geological and hydrological consequences of sand mining, highlighting the complex interactions between natural processes and anthropogenic activities(Choudhary, Jain, et al., 2020; Choudhary, Prajapat, et al., 2020).

III. ECOLOGICAL EFFECTS

The ecological impacts of sand mining extend beyond the aquatic environment, affecting diverse ecosystems such as wetlands, coastal dunes, and riparian habitats. Habitat destruction, loss of biodiversity, and disruption of ecological processes are among the primary concerns associated with sand extraction. In particular, the removal of sand can destabilize riverbanks, leading to erosion and loss of vegetation, which, in turn, impacts the habitat suitability for flora and fauna. Furthermore, sand mining can disrupt the breeding and feeding patterns of aquatic species, contributing to declines in fish populations and ecosystem resilience.

IV. WATER QUALITY AND POLLUTION

Sand mining operations often entail the discharge of sediment-laden water and pollutants into rivers and adjacent water bodies. Sedimentation and turbidity resulting from mining activities can impair water quality, reducing light penetration and oxygen levels, which in turn affects aquatic ecosystems and compromises water supply for human consumption and irrigation. Moreover, the use of heavy machinery and chemicals in sand extraction can introduce contaminants such as heavy metals and hydrocarbons into the environment, posing risks to human health and ecosystem integrity. Sand mining operations involve the extraction of sand from rivers, beaches, and floodplains to meet the demand for construction materials. During this process, sediment-laden water is often discharged back into rivers and adjacent water bodies. This discharge contributes to sedimentation and turbidity, which can have detrimental effects on water quality (Lodha et al., 2023) and aquatic ecosystems. Sedimentation occurs when suspended particles settle out of the water column and accumulate on the riverbed or lake bottom. This process can smother benthic habitats, disrupt aquatic vegetation, and alter the physical structure of the water body. Additionally, sedimentation reduces light penetration into the water column, inhibiting photosynthesis in aquatic plants and algae. As a result, primary productivity decreases, impacting the entire aquatic food web(Kumar et al., 2023). Turbidity refers to the cloudiness or haziness of water caused by suspended particles such as sediment, organic matter, and plankton. High turbidity levels can interfere with fish feeding and navigation, as well as disrupt spawning and egg development. Moreover, sediment-laden water can clog the gills of fish and other aquatic organisms, impairing their respiratory functions and overall health. The reduction of light penetration and oxygen levels in water bodies due to sedimentation and turbidity can have cascading effects on aquatic ecosystems. Decreased oxygen levels lead to hypoxia or even anoxia, creating dead zones where aquatic life cannot survive. This can result in mass fish kills and declines in biodiversity. Furthermore, sand mining operations often involve the use of heavy machinery and chemicals to extract and process sand. Heavy machinery such as dredgers and excavators disturb the riverbed or shoreline, releasing sediment into the water and causing additional turbidity. Chemicals such as flocculants may be used to settle suspended particles, but they can introduce contaminants into the environment. These contaminants may include heavy metals from equipment corrosion and hydrocarbons from fuel spills or leaks. The introduction of contaminants into water bodies poses risks to both human health and ecosystem integrity. Heavy metals such as lead, mercury, and arsenic can accumulate in aquatic organisms and bio magnify through the food chain, potentially reaching harmful levels for human consumption. Hydrocarbons can have toxic effects on aquatic life, impairing growth, reproduction, and immune functions. In summary, the discharge of sediment-laden water and pollutants from sand mining operations can have significant environmental impacts on rivers, lakes, and coastal ecosystems. These impacts include reduced water quality, habitat degradation, biodiversity loss, and risks to human health. Therefore, sustainable management practices and regulatory measures are essential to mitigate these adverse effects and ensure the long-term health and integrity of aquatic environments.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 11, Issue 3, March 2024

DOI: 10.17148/IARJSET.2024.11349

V. SOCIO-ECONOMIC IMPLICATIONS

The socio-economic impacts of sand mining are complex and multifaceted, affecting communities dependent on riverine resources for livelihoods and cultural practices. Displacement of indigenous populations, loss of agricultural land, and conflicts over resource allocation are common consequences of unsustainable sand mining practices. Furthermore, the socio-economic benefits derived from sand extraction are often inequitably distributed, exacerbating social disparities and undermining sustainable development goals(Choudhary et al., 2019; Choudhary et al., 2022). This section examines the socio-economic dimensions of sand mining, emphasizing the importance of stakeholder engagement and participatory decision-making processes.

VI. REGULATORY FRAMEWORKS AND MANAGEMENT STRATEGIES

Effective regulation and management of sand mining require a holistic approach that integrates environmental, social, and economic considerations(Choudhary, Jangeed, et al., 2023). This section discusses existing regulatory frameworks and management strategies aimed at mitigating the environmental impacts of sand mining(Poonia et al.). Sustainable alternatives such as recycled aggregates, dredged materials, and artificial sand offer promising solutions to alleviate the pressure on natural sand resources while minimizing ecological harm.

VII. CONCLUSION

In conclusion, sand mining poses significant environmental challenges that necessitate urgent action at local, national, and global levels. Addressing the complex interplay of geological, hydrological, ecological, and socio-economic factors requires a concerted effort involving policymakers, industry stakeholders, and local communities. By adopting sustainable practices, promoting responsible governance, and fostering collaborative partnerships, it is possible to mitigate the adverse impacts of sand mining while ensuring the long-term integrity of our natural ecosystems and the well-being of future generations.

REFERENCES

[1]. Choudhary, S. (2020). FACTORS AFFECTING FLOOD MANAGEMENT IN BIHAR, INDIA. *International Journal on Environmental Sciences*, *11*(1), 72-76.

[2]. Choudhary, S., Chaudhary, M., Surecha, O. P., Trivedi, A., & Hiren, C. (2023). Assessment of Drinking Water Quality and Efficiency of Water Treatment Plants in Udaipur, Rajasthan. *European Chemical Bulletin*, *12*(3), 1175-1182.

[3]. Choudhary, S., & Choudhary, P. (2020). Sediment Yield and Sand Erosion Model through Arc SWAT and SPSS-14 Software for Sand Mine Site in Rajasthan. *International Journal of Engineering and Advanced Technology (IJEAT)*, *8*(6S), 138-141.

[4]. Choudhary, S., Chouhan, S., Jain, M., Panchal, K., & Bhardwaj, Y. (2019). Development of Rain Water Harvesting System through National Highway Profiles by Using GIS and Field Survey. *Available at SSRN 3348303*.

[5]. Choudhary, S., Hasan, M., Suthar, M., Saraswat, A., & Lashkar, H. (2022). Design Features of Eco-Friendly Home for Sustainable Development. *International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering*, *10*(1), 88-93.

[6]. Choudhary, S., Jain, K., Choudhary, P., Dangi, K., & Kalal, K. (2020). Requirements of Solid Waste Management System in Savina Vegetable Market at Smart City Udaipur in Rajasthan. *International Journal of Engineering and Advanced Technology (IJEAT)*, *9*(3S), 26-29.

[7]. Choudhary, S., Prajapat, O., Suthar, B., Kumar, S., & Kumar, M. (2020). Requirements and Planning of Badliya Village for converting it into Smart Village Category in Banswara, Rajasthan. *International Journal of Engineering and Advanced Technology (IJEAT)*, *9*(3S), 40-44.

[8]. Kumar, S., Meena, S., Gupta, P., Sharma, S., & Choudhary, S. (2023). Scope and Impact of River Sand Mining in Ajmer, Rajasthan. *International Advanced Research Journal in Science, Engineering and Technology*, *10*(7), 283-287.

[9]. Lodha, R., Yash, S., Surecha, O. P., Trivedi, Anirudh, Chaplot, H., Chaudhary, M., & Choudhary, S. (2023). Scaling Potential and Corrosion Assessment through Langelier Saturation Index and Ryznar Stability Index of Under Ground Water in Udaipur, Rajasthan. *International Advanced Research Journal in Science, Engineering and Technology*, *10*(7), 254-260.

[10]. Ojha, S., & Choudhary, S. (2017). QUALITATIVE ANALYSIS OF SOCIO-ENVIRONMENTAL FACTORS OF SAND MINING ON MITHRI TRIBUTARY OF LUNI RIVER AT KOSANA, PIPAR JODHPUR DISTRICT OF RAJASTHAN. *International Research Journal of Environmental Sciences*, *6*(10), 22-31.

[11]. Poonia, K., Kansara, P., & Choudhary, S. Use of GIS Mapping for Environmental Protection in Rajasthan–A Review.