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Review paper

Impacts of Sand Mining on Riverine Ecosystems: A Short Review

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ABSTRACT

Sand mining (aggregates regardless of particle size) from riverine ecosystems, leads to significant environmental impacts and is thus receiving increasing attention globally. The present paper summarizes the results of literature review addressing the impacts of sand mining on riverine ecosystems including river morphology, water quality, biodiversity, soil and landscape. The rapid rise in urbanization and construction of large-scale infrastructure projects are driving increasing demands for construction materials worldwide. The increasing demand of riverine resources (sand, gravel and boulder) is one of the main reasons for illegal mining that effects the health, physical process and different function of rivers, degradation of the riparian zone, degradation of aquatic and terrestrial biodiversity. The aim of the present paper was to provide an understanding of the impacts sand mining activities on riverine ecosystems and to guide future research directions.

1. Introduction

Soil is a cheap natural resource made up of gravel, sand, clay, loam which constitutes the different types. According to Mwangi (2007), soil has many uses, it is needed for agriculture, as a habitat and in construction but the genesis of cash economy brought many profit driven companies to be involved in its mining both legally and illegally with some having no regard for the environment. Soil mining and harvesting has both positive and negative environmental impacts. Human activities along with natural environmental changes greatly impact on fluvial regime of rivers. On mountain and semi-mountain territories these processes are developed in the most complicated manner due to man-made activities diversity throughout river basins As the construction demands increase worldwide because of increase in urbanization, the extraction of sand from riverine ecosystems also increases that lead to devastating effects on morphology and ecology of these water bodies United Nations Environment

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Programme (UNEP, 2014) estimated that between 32 and 50 billion tonnes of river bed material (sand, gravel, cobbles and boulder) are extracted globally (Schandl et al., 2016).

Further, Kuttipuran (2006) reviewed soil mining in many communities (Indian) and reported that when urbanization grows demand for sand increases that leading to mining of this precious resource. Increasingly, there are media reports (Maharashtra and Goa) where illegal extraction of sand is considered as an environmental (Pereira, 2012). Moreover, Saviour (2012) observed impacts of mining (direct and indirect) in the River Bharathapuzha and concluded the decrease of water table and reduced rice harvest.

Observation of Bagchi (2010) based on how the communities view sand mining and gravel extraction indicates that they expressed dissatisfaction with the indiscriminate illegal mining. The miners created deep tunnels across their farmland as well as creating deep pits through crop fields. According to villagers' reports, approximately eighty trucks were seen passing through villages on daily basis. Their reports to authorities seemed not to be heard. Lawal (2011) highlighted that sand mining is rapidly becoming an ecological problem as demand increases in many states of Nigeria's industry and construction sectors. The mining is done both legally and illegally leading to environmental devaluation (Fig. 1).

Fig. 1 Extensive Sand mining from Jhelum River at Anantnag, Kashmir (*captured by author* Gowhar Rashid)

This paper summarizes the results of a literature review into the impacts of riverine sand mining on freshwater ecosystems. The aim of the review was to provide an understanding of the range of observed impacts related to sand mining activities and to guide future research directions.

2. Sand Mining on Riverine Ecosystems

Sand mining activities are one of many recognized pressures affecting riverine ecosystems (Koehnken et al., 2020). Increasing reports about the negative environmental of sand mining, calls grow for stronger regulation of mining (Schandl et al., 2016). Impacts of sand mining on rivers may be direct or indirect. Direct impacts are those in which the extraction of material is directly responsible for the ecosystem impact, such as due to the removal of floodplains habitat. Indirect impacts are related to ecosystem changes that are propagated through the system due to physical changes in the river system resulting from sand extraction. Thus the riverine morphology is affected in many ways:

1. Indiscriminate river sand mining often results in many indirect and cumulative effects on the physical characteristics of a river. When sand is extracted from the riverbed, to compensate for the supply deficiency, the sand-supply balance tends to migrate upstream (Knighton, 1989) responsible for the erosion of the riverbed (Fig. 2). The transport capacity of flowing water is mainly determined by the volume of water, the flow velocity and sediment load. In general, the more sediment the river is carrying, the less energy is left for erosion. However, in the case of sand mining, the sediment is deposited in the pits and the water will erode downstream (Padmalal and Maya, 2014).
2. Sand mining activities, dumping of waste materials will cause reduced water quality for downstream population and also increased cost for water treatment plants. The extraction of sand induces formation of fine inorganic and organic particles (Barman et al., 2019). By extracting sand from the river, the stirred up sand particles are deposited on downstream sand bars that lead into the formation of floodplain as happened in case of river Periyar in India (Babu and Sreebha, 2004; Padmalal et al., 2008). There are also reports (Kim et al., 2020) that river sands contain finer contaminants and can accumulate with many toxic elements like Cd.
3. In general, a stable riverbed ensures the survival of many species (both fauna & flora). Removal of the sand from riverbed means instability that leads to that leads to the loss of habitat (Zou et al., 2019). In riverine ecosystems vegetation and animal spp. play an important role in maintaining the

ecological balance and when the balance in this ecosystem is affected, it can be pushed to a tipping point (Padmalal and Maya, 2014). Further the extraction of sand causes turbidity which causes blockage of sunlight and reduces both photosynthesis and respiration (Padmalal and Maya, 2014). The widening of the riverbed as noticed in river Jhelum hinders the movement of fish species between flows and pools (Lawal, 2011). Thus the changes in riverine ecology can have detrimental consequences for the entire food web as reported by Zou et al. (2019). Apart from the fauna, the mining, effects of sand mining also extend to riverine vegetation. A direct effect is lowering groundwater table, responsible for killing vegetation along the riverine zones and in the wetlands (Sreebha and Padmalal, 2011).

4. As reported by Bagchi (2010) stream mining on Indian rivers causes environmental surface and land degradation which causes damage to river banks and associated ecosystems. Soil erosion (Fig. 2) because of unrestricted mining causes disturbance of groundwater and riverine ecology. Further, if the disturbance process continues for a long period the velocity of flowing water will lead to erosion of beds and banks. Earlier, Kondolf (2007) reported the impact of velocity on erosion and found that river beds can propagate both upstream and downstream results lowering of water tables. Moreover, Stebbins (2006) observed that sand mining in streams leads to destruction of both aquatic and riparian habitat by changing riverine morphology, decreasing water table (Fig. 3)

Fig. 2 Signs of erosion on riparian zone (Vaishav stream Kulgam) (*captured by author* Gowhar Rashid)

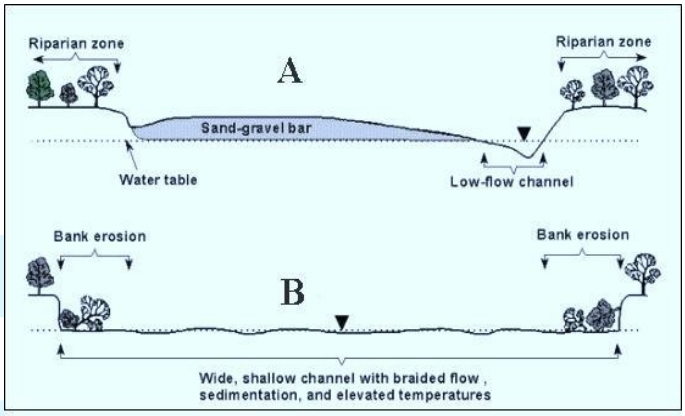

Fig. 3 Impacts of mining on active channel (Stebbins, 2006)

3. Cases Related to Sand Mining in NGT (2021)

The cases related to sand mining in National Green Tribunal (NGT) India in 2021 are summarized in Table 1.

Table 1 Cases related to sand mining in 2021 (NGT, 2021)

Date of NGT order	Location	Description
15/4/2021	Jeypore, Orissa	Related to illegal sand mining in Kharsrota river, Jeypore, Odisha. Illegal mining damaged the river bed and environment.
16/4/2021	Paschim Bardhaman, West Bengal	Related to illegal sand mining carried out on the river bed of river Ajay within blocks Jamuria and Barbani.
23/6/2021	Jaipur, Rajasthan	Minerals mined in villages of Jaipur district. At least 15 mines do informal and destructive mining around the villages. Such activity impacts houses, agricultural fields and health of the people.
14/07/2021	Sonipat, Haryana	Action was taken by the NGT against illegal mining. DSP Associates, Sonipat, had diverted the natural flow of river by digging a man-made pit 20 foot deep and made a bund to stop the natural river flow.
10/8/2021	Paschim Bardhaman, West Bengal	The NGT had directed the district magistrate of Paschim Bardhaman to file affidavit providing information regarding the details of mining area, extent of illegal sand mining, quantity, duration of mining, name of the persons carrying out the mining activity and the loss of revenue due to illegal sand mining. The NGT directed the committee to compute environmental compensation and restore the environment.
16/8/2021	Jaipur, Orissa	Mechanical excavators to mine sand used during monsoon in violation of Sustainable Sand Mining Management Guidelines, 2016 and Enforcement and Monitoring Guidelines for Sand Mining, 2020.

4. Conclusion & Recommendations

Sand and gravel represent the highest volume of raw material used on earth after water. Human community depends on soil for agriculture, construction and even as a habitat for various organisms (Mwangi, 2007). Moreover, the amount being mined is increasing exponentially, mainly as a result of rapid economic growth. To sustain the economic growth in future, it becomes important that the resource is used judiciously. There is worldwide concern about the environment which prompted the researcher to carry out this study on the environment. Riverine experts are also worried about the methods used for mining. For example, when we exract sand using excavator machines the results can be destructive causing huge and irreparable damage to riverine ecology. Large in-stream sand mining causes degradation of rivers, therefore, there has to be periodic assessment of how much sand can be ecofriendly mined, as the quantity can vary from a river to river and within a river from stretch to stretch.

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Declaration of Conflict

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Babu, K. N., & Sreebha, S. (2004). Evaluation of nutrient budget of the rivers and adjoining back water–near shore systems of Kerala (unpublished report). Centre for Earth Science Studies, Thiruvananthapuram, India, p. 118.
2. Bagchi, P. (2010). Unregulated sand mining threatens Indian rivers. *The Journal India Together*, *21*, 7-9.
3. Barman, B., Kumar, B., & Sarma, A. K. (2019). Impact of sand mining on alluvial channel flow characteristics. *Ecological Engineering*, *135*, 36-44.
4. Kim, S., Yang, D. S., & Kim, Y. S. (2020). Distribution of metal contamination and grain size in the sediments of Nakdong River, Korea. *Environmental Monitoring and Assessment*, *192*(8), 1-15.
5. Knighton, A. D. (1989). River adjustment to changes in sediment load: the effects of tin mining on the Ringarooma River, Tasmania, 1875–1984. *Earth Surface Processes and Landforms*, *14*(4), 333-359.
6. Koehnken, L., Rintoul, M. S., Goichot, M., Tickner, D., Loftus, A. C., & Acreman, M. C. (2020). Impacts of riverine sand mining on freshwater ecosystems: A review of the scientific evidence and guidance for future research. *River Research and Applications*, *36*(3), 362-370.
7. Kondolf, G. M. (1994). Geomorphic and environmental effects of instream gravel mining. *Landscape and Urban planning*, *28*(2-3), 225-243.
8. Kuttipuran, M. (2006). RIVERS: Physical Modifications. Donnelley, Singapore.
9. Lawal, P.O. (2011). Effects of sand/gravel mining in Minna Emirate area of Nigeria on stakeholders. Journal of Sustainable Development, 4(1), 193.
10. Mwangi, S. (2007). Management of river systems in East Africa. *Nairobi: Macmillan*.
11. NGT (2021). Why unlawful sand mining in India needs good governance: NGT (2021). https://www.downtoearth.org.in/blog/mining/why-unlawful-sand-mining-in-india-needs-good-governance-78773; Accessed on 15 September 2022
12. Padmalal, D., & Maya, K. (2014). Impacts of river sand mining. In *Sand Mining* (pp. 31-56). Springer, Dordrecht.
13. Padmalal, D., & Maya, K. (2014). Impacts of river sand mining. In: Sand Mining (pp. 31-56). Springer, Dordrecht.
14. Padmalal, D., Maya, K., Sreebha, S., & Sreeja, R. (2008). Environmental effects of river sand mining: a case from the river catchments of Vembanad lake, Southwest coast of India. *Environmental geology*, *54*(4), 879-889.
15. Pereira, K. (2012). Illegal Sand Mining: The Unexamined Threat to Water Security in India.
16. Saviour, N. M. (2012). Environmental impact of soil and sand mining. *International Journal of Science, Environment and Technology*, *3*, 221-216.
17. Schandl, H., Hatfield-Dodds, S., Wiedmann, T., Geschke, A., Cai, Y., West, J., ... & Owen, A. (2016). Decoupling global environmental pressure and economic growth: scenarios for energy use, materials use and carbon emissions. *Journal of cleaner production*, *132*, 45-56.
18. Stebbins, M. (2006). Can gravel mining and water supply wells coexist. *Maine: University of Maine*, 109.
19. UNEP (United Nations Environment Programme) (2014). UNEP 2014 Annual Report. https://www.unep.org/resources/annual-report/unep-2014-annual-report; Accessed on 12 September 2022
20. Zou, W., Tolonen, K. T., Zhu, G., Qin, B., Zhang, Y., Cao, Z., ... & Gong, Z. (2019). Catastrophic effects of sand mining on macroinvertebrates in a large shallow lake with implications for management. *Science of the Total Environment*, *695*, 133706.