Eco. Env. & Cons. 29 (January Suppl. Issue) : 2023; pp. (S517-S523)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i01s.079

Effects of Sand Mining on Riverine Ecosystem and Otter Habitat in Kudli, Tungabhadra River

R. Dhananjaya[1] and Vijaya Kumara[2]

Department of P.G. Studies and Research in Wildlife and Management, Kuvempu University, Jnana Sahyadri, Shankaraghatta, Shivamogga 577 451, Karnataka, India

(Received 24 May, 2022; Accepted 14 July, 2022)

ABSTRACT

The Tungabhadra River in Karnataka has a significant amount of sand mining activity. With a growing demand for sand reflecting rapid urbanization and population growth, regulation has proven difficult leading to exploitation with serious environmental implications. Sand mining is a generic term referring to the process of extraction of sand from rivers, streams, lakes, and oceans. Illegal and unregulated sand mining would threaten the biodiversity of the river, and such alarming events were seen in almost all parts of the river Tungabhadra. The Tungabhadra River hosts India's only otter conservation reserve, to conserve vulnerable species of smooth-coated otter. Furthermore, the TB River has significant habitat for a viable otter population along the entire length of the river. A study was conducted from June 2017 to January 2020 in 10 randomly selected stations with 31 sites. During the survey, we came across many threats to the otters, viz., pollution conflicts with fishermen, habitat deterioration by human activity, and so on. Among these factors, sand mining stands out to be the most disastrous to the survival of otter's habitat. Among the 31 sampled sites, only 1 site was chosen called Kudli, which is examined, studied, and discussed in this paper.

Key words: *Tungabhadra river (TBR), Smooth-coated otter,* Lutrogale perspicillata, *Impact ofSand mining, and establishment of Conservation reserve.*

Introduction

Freshwater ecosystems are treated as a natural resource by humans and not as an ecosystem service provider. This attitude has led to the exploitation by diversion of these river waters for agriculture, generating hydroelectricity, industries, fishing, waste disposal, sand mining, and other fundamental requirements of man without an understanding of river hydrology and floodplains (Hosetti, 2005). Most of the time these river environments with human modifications are a vital niche and habitat for diverse flora and, fauna; and the lack of scientific knowledge about river functions is perhaps the cause for major concern (Harvey and Lisle, 1998).

Rivers are the most important life-supporting system of nature. Since time immemorial, humans have settled adjacent to the river basins (Padmalal *et al.,* 2007; Naiman, 1992; Naiman and Bilby, 1998). But in recent times, industrialization and rapid growth in the population are causing damage to the riverine ecosystems including the flora-fauna dependent on these water chemistry and topography (Nitin Bassi *et al.,* 2014). Because of the dominance and dependency of man over these ecosystems, the administrative authorities prioritize human re-

([1]Research scholar, *Professor)

quirements over the various species that make their habitat in this ecosystem. This, in addition to many factors, pose multiple challenges to the very survival of the fore-mentioned flora and fauna, especially the riverine variety. There are not a lot of conservation efforts that are being spent on the riverine ecosystem in contrast to the focus that the terrestrial ecosystem receives (Hussain *et al*., 2020; Linke *et al*., 2007; Saunders *et al.,* 2002). Considering the importance of rivers for agriculture and settlements, native freshwater animals will be forced to share and adapt to human changes.

Among the major freshwater mammals, otters are top carnivores and are considered ambassadors of the wetlands, belonging to the Mustelidae family (Nawab and Gautam, 2008). The fossil records of freshwater otters date back to the Miocene period (5 to 23 million years ago). They are habitat specialists of freshwater ecosystems (Hussain, 1993). Being carnivores that rely on small mammals, birds, reptiles, and invertebrates, and are predominantly piscivores (Anoop and Hussain, 2005). Due to being semi-aquatic carnivorous predators of the freshwater ecosystem, otters play a vital ecological role as the apex predators of the riverine ecosystem by occupying the top position in the food web. This carnivorous mammal has ecological importance because there are very few other carnivorous predators living in the riparian ecosystems and these can create direct and indirect impacts on the food web and the ecological community, ultimately impacting the entire riparian ecosystem and its functioning. Ironically, its effects are not recognized, hence many species of otters are facing a massive decline in their population (Chackravarthy *et al.*, 2019).

According to IUCN, out of 13 species of otters reported on the earth, 5 species are endangered, 2 species are vulnerable, 5 species are near threatened and 1 species (North American river otter) is least concerned, respectively (Duplaix and Savage, 2018). India is home to 3 species; viz., Smooth-coated Otter (*Lutrogale perspicillata*), a Small-clawed otter (*Aonyx cinereus*), and Eurasian otter (*Lutra lutra*) (Suthar *et al.,* 2017). The Smooth-coated Otter which is one of the vulnerable species mentioned above is the focus of this study.

The Smooth-coated Otter is distributed throughout the country. They are protected by the Government of India under Schedule II Part II of the Indian Wildlife (Protection) Act, 1972. IUCN rates it as 'Vulnerable' and CITES has placed this species of otter in Schedule I. Their populations have been reduced by over 50% during the last 10 years (Hussain, 2013; IUCN).

Though smooth-coated otters are extremely resilient and adaptable, thriving even in human-dominated riverine environments (Khoo and Sivasothi, 2017; Khoo and Lee, 2020). Otter populations are now dwindling throughout the species range, due to prey depletion, poaching for pelt, retaliatory killing, pollution, and habitat loss (Nicole Duplaix and Melissa Savage, 2018). The goal is to recognize and document specific local threats so that resource and habitat protection strategies can be formed. The increase in the number of newer threats, a major one being sand-mining, has made it difficult for otters to adapt further and it has received minimal to no attention from systematic studies and research.

Study area and Methods

Among the 31 sampled stations, one of the most important and interesting habitats/hot spots for these otters was Kudli (14° 00'30.7" N 75° 40' 29.8 "E), located in Shimoga District, Karnataka State, India. We recorded a romp (group) with a maximum number of 7 otters in a single sighting, of which 4 adults and 3 cubs in a span of 2 years. The population of otters in this study area ranged from 3–7 at different times of the month, but a survey of local fishermen gave a number as high as 15. Kudli means summation, union, or joining in Kannada because it's the confluence point of rivers Tunga and Bhadra, the rivulets after traveling a distance of 147 and 171 km respectively, to form the river Tungabhadra at an elevation of 610 meters (2001 ft) at the village named Kudli. Kudli has a particularly human-modified river stretch with a good riverine ecosystem for flora, avifauna, and reptiles and has good numbers of otters. Here, great fluctuations in otter population density have been witnessed due to disturbance by anthropological activities such as sand mining and intensive fishing. We also get to see the highest rate of fisherman and otter conflicts, leading to the retaliatory killing of otters.

The main objective of this paper is to outline the direct and indirect threats to the otters from sand-mining, by evaluating the before and after effects of sand-mining in Kudli on otter ecology and availability, this was done through visiting areas of sand extraction and information on otter ecology was collected during field visits by direct observations, Sur-

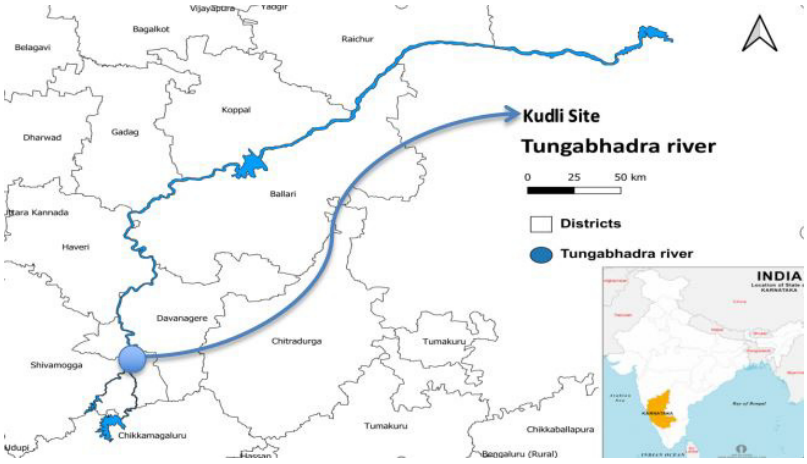


Fig. 1. The river Tungabhadra's map and Kudli site.

veying local fishermen and stakeholders, Secondary data was collected from analysis of case studies and includes a review of the available scientific literature on effects of sand mining on freshwater ecosystems.

Results

Out of 31 sampled sites 10 sampled areas showed the presence of otters through direct sightings and positive with indirect signs. These areas had abundant perennial water. In direct sightings the number of otters ranged from solitary to a romp of 8 otters in a single sampling area, highest being in Kudli. The indirect signs ranged from 1 to 14; highest being in Mudlapura. These found to feed mainly on fishes, birds, reptiles and other invertebrates based on availability in the riverine habitat conditions.

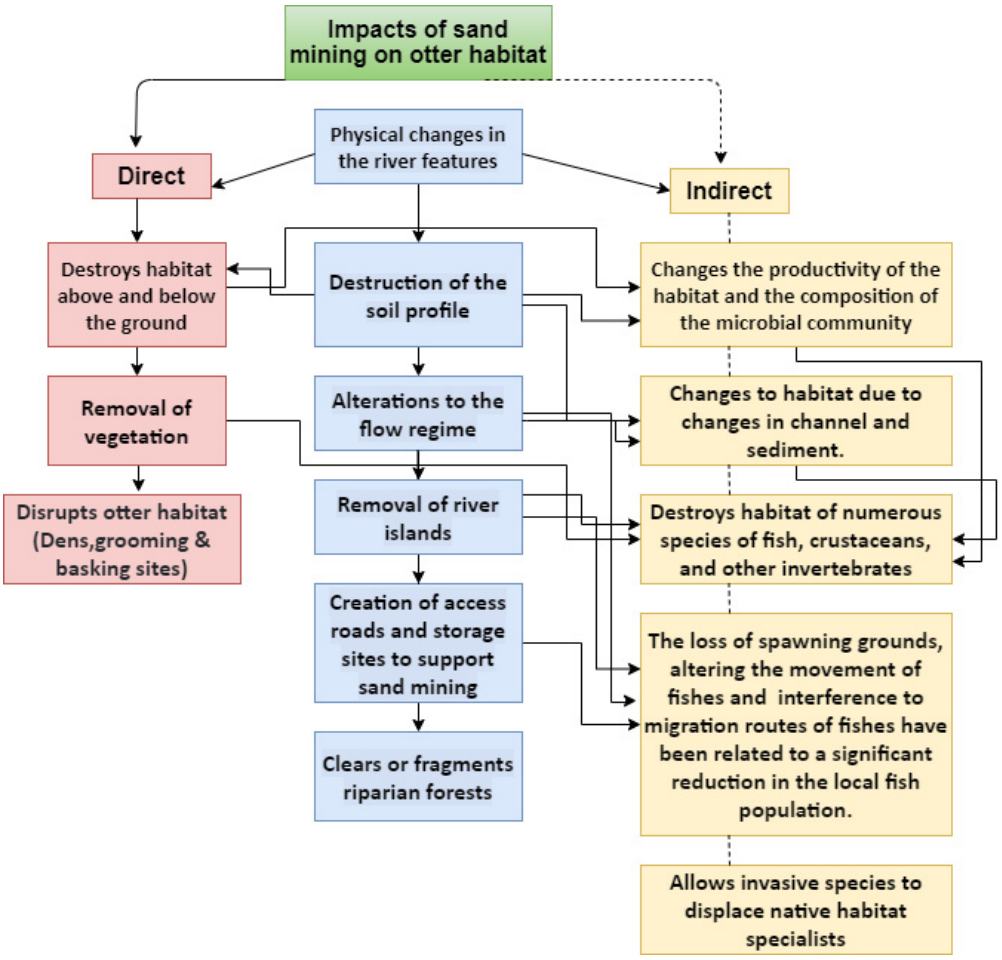
In the hitherto study it was realized, that three major ecological components of the otter's habitat that are directly and indirectly negatively affected by the sand-mining operation are "cover" (riverine banks with forest and vegetation), "food" (fishes, crustaceans and other invertebrates) and "water" (altering flow regime). The disturbance from mining and removal of islands inside the riverine ecosystem which has active dens of otters and increased water levels has resulted in otters becoming a rare sighting. Before the sand mining, through direct observation up to 8 otters were recorded in kudli in multiple field visits. This observation revealed that sand min-

Table 1. Disturbance by sand mining in kudli area on riverine ecosystem before and after sand mining

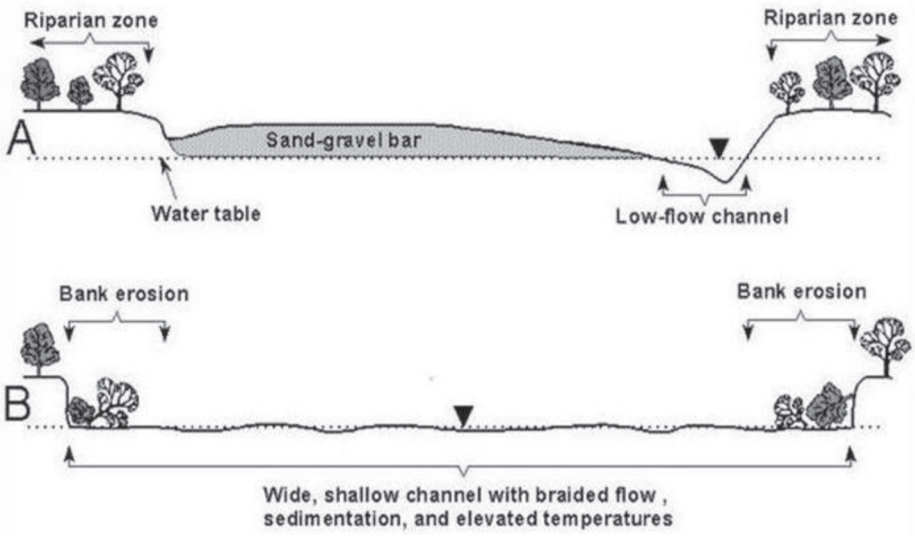
Disturbance by sand-mining in kudli	Pre sand-mining	Post sand-mining
Average number of peoples in the banks	6	22
Number of small vehicles	2	10
Number of industrial vehicles	0	12
Roads	1	3
River widening in meters	162	178
Number of islands	7	2

Table 2. Otter abundance before and after sand mining

Surveyed results for otter in kudli sampled site	Pre sand-mining	Post sand-mining
Direct sightings	10	2
Indirect sightings (spraints and footprints)	8	3
Number of dens found	5	0
From local fishermen	15	10
Retaliatory killing	0	1



Pic. 1. Schematic conceptual model used to describe direct and indirect impacts of sand mining on the otter habitat.



Pic. 2. A cross-sectional diagram of a channel showing (A) a typical sand gravel bar in relation to riparian zone and water table. (B) the wide shallow channel that results from unrestricted mining and that is characterized by bank erosion, vegetation loss, sedimentation and braided flow.

Pic. 2. Kudli 2017

Pic. 3. Kudli 2020

ing proved to be lethal to the survival of otters in Kudli. Similarly, the biodiversity of the river namely, crocodiles, turtles, and birds were damaged by the sand mining activity in the Chambal River in Gwalior (Tiager and Roa, 2008).

Discussion

Impacts on cover (riverine vegetation): According to Hussain and Choudhury, 1995 in Chambal River; Anoop and Hussain in Kerala, 2004; and many scientific literatures on otter's habitat, the functions of river bank vegetation are very clear and its vital to otter habitat. In this study we found all the otter dens in kudli site were covered by thick vegetation (Pic-3). Otters while traveling, form tunnels of vegetation (Pic-3) (thick grasses and dense shrubs) along the river bank. This acts as an escape cover and provides refuge from predators and humans on land. Clearing and fragmenting the riparian vegetation interferes with otter movements in the banks. In 2017, and 2018 the river stretch at kudli was undisturbed with a large amount of vegetation, sand, and dens covered by vegetation (Pic-6). In a span of two years by the end of 2019, the area was changed due to sand mining and become unsuitable to otters (Pic-2). Exposure to otter dens makes otters more vulnerable to poaching and retaliatory killing. Mining of sand banks is destructive for otter population as sand banks are essential for nesting, basking, grooming and socializing.

Impact on food: Physical changes to river and habitat degradation by the destruction of soil profile and alteration in flow regime of the river is considered to have a detrimental effect on macroinvertebrate and benthic organism. This activity also has an adverse effect on benthic fish populations, which rely on other benthic organisms as primary food sources. The loss of spawning grounds and interference with fish movements by mining have been related to a significant decline in local fish populations (Mingist and Gebremedhin, 2016). Subsequently, species abundance and community structures, and food web dynamics of the ecosystem are affected. The loss of species such as crustaceans, macro-invertebrate, amphibians, reptiles, and fishes adversely affects the otter's prey abundance. As carnivorous animals, otters are directly related to their prey availability. A decrease in the diversity and abundance of fish is also a result of an everyday conflict between fishermen and otters.

Impacts on water: The quality of the river's water

Pic. 4. Otter's sightings in Kudli before sand-mining.

Pic. 5. Indirect sightings of otters in Kudli (Sparints, Dens, Footprints)

will be impacted by instream sand mining activities. Increased short-term turbidity at the mining site as a result of sediment resuspension, sedimentation as a result of stockpiling and dumping of excess mining materials and organic particulate matter, and oil spills or leakage from excavation machinery and transportation vehicles are all consequences.

Increased riverbed and bank erosion raise the concentration of suspended solids in the water near the excavation site and downstream. Suspended solids can have a negative impact on water users and aquatic ecosystems. The effect is amplified if water users downstream of the site extract water for domestic use. Suspended solids can significantly raise the cost of water treatment.

Pic. 6. Active dens of otters in the Kudli area covered by vegetation.

Pic. 7. Large-scale mining activity for sand in otter's habitat on either side of the river in the kudli area.

This study warns modern human society to protect the river biodiversity specifically otters, the associated species (both flora and fauna), and the food web from sand mining.

Acknowledgement

The authors wish to thank Chairman, Department of Wildlife management, Kuvempu University Shankaraghatta, for providing facilities and to Kuvempu University Shankaraghatta for awarding a fellowship to Mr. R. Dhananjaya. The authors wish to thank late Professor Dr.B.B. Hosetti for the guidance for the study planning and Fishermen who helped us during surveys and for the accommodation and hospitality.

Conflict of Interest: All authors declare that they have no conflicts of interest.

References

Anoop, K. R. and Hussain, S. A. 2004. Factors affecting habitat selection by Smooth-coated otters (*Lutra perspicillata*) in Kerala, India. *J. Zool., Lond.* 263 : 417–423DOI:10.1017/S0952836904005461.

Anoop, K.R. and Hussain, S.A. 2005. Food and feeding habits of smoothcoated otters (*Lutra perspicillata*) and their significance to the fish population of Kerala, India. *J. Zool*. 266 : 15-23.

Akshit, R., Suthar, Jagruti, Y., Rathod, Ishani, B. Patel, Deepa J. Gavali and Jayendra Lakhmapurkar, 2017. Historical and Current Distribution of Smooth Coated Otter *Lutrogale perspicillata* in Gujarat, India. *IUCN Otter Spec. Group Bull.* 34 (2): 95–103.

Hosetti, B.B. 2005. *Concepts in Wildlife Management.* ISBN 9788170352976, 8170352975 Daya Publishing House page no: 221

Chackaravarthy, S.D., Kamalakannan, B. and Lakshminarayanan, N. 2019. The Necessity of monitoring and conservation of smooth-coated otters (*Lutrogale perspicillata*) in non-perennial rivers of South India. *IUCN Otter Spec. Group Bull*. 36 (2) : 83–87.

Harvey, B. and Lisle, T. 1998. Effects of suction dredging on streams: A review and an evaluation strategy. *Fisheries Habitat.* 23(8): 8–17.

Hussain, S.A. 1993. *Aspects of the ecology of smooth-coated Indian otter Lutra perspicillata in National Chambal Sanctuary*. Ph.D. thesis, Aligarh Muslim University.

Hussain, S.A. and Choudhury, B.C. 1997. Status and distribution of Smooth-coated Otter Lutra perspicillata in National Chambal Sanctuary. *Biol. Conserv.* 80: 199-206

Hussain, S.A. 2013. Activity Pattern, Behavioural Activity and Interspecific Interaction of Smooth-Coated Otter (*Lutrogale perspicillata*) in National Chambal Sanctuary, India *IUCN Otter Spec. Group Bull.* 30 (1): 5 - 17

Hussain Syed Ainul, Irengbam Michelle, Barthwal Shivani, Dasgupta Niladri and Badola Ruchi, 2020. Conservation planning for the Ganga River: a policy conundrum VL - 45 *Landscape Research.* 10.1080/01426397.2020.1808959

IUCN Red List of Threatened Species: *Lutrogale perspicillata*: *https://www.iucnredlist.org/species/12427/21934884*. (Accessed: 2020- August- 15).

Khoo, M.D.Y. and Sivasothi, N. 2017. The population status of smooth coated otters (*Lutrogale perspicillata*) in Singapore. Undergraduate thesis, National University of Singapore, Singapore.

Khoo, M.D.Y. and Lee, B.P.Y.H. 2020. The urban Smooth-coated otters *Lutrogale perspicillata* of Singapore: a review of the reasons for success. *Int. Zoo Yb.* 54: 1–12 DOI:10.1111/izy.12262

Linke, S., Pressey, R. L., Bailey, R. C. and Norris, R. H. 2007. Management options for river conservation planning: Condition and conservation re-visited. *Freshwater Biology*. 52(5): 918–938 https://doi.org/10.1111/j.1365-2427.2006.01690.x

Mingist, M. and Gebremedhin, S. 2016. Could sand mining be a major threat for the declining endemic *Labeobarbus* species of Lake Tana, Ethiopia?. *Singapore Journal of Tropical Geography*. 37 : 195– 208. doi: 10.1111/sjtg.12150.

Nawab, A. and Gautam, P. 2008. Living on the edge: Otters in developing India. In Wetlands – The Heart of Asia. *Proc. Asian Wetland Symp., Hanoi, Vietnam.*

Naiman, R.J. 1992. *Watershed Management*. Springer, New York

Naiman, R.J. and Bilby, R.E. 1998. *River Ecology And Management In The Pacific Coastal Ecoregion*. In: Naiman RJ, Bilby RE (eds), Springer, New York, pp 1–22

Nitin Bassi, M. Dinesh Kumar, Anuradha Sharma and P. Pardha-Saradhi, 2014. Status of wetlands in India: A review of extent, ecosystem benefits, threats and management strategies. *Journal of Hydrology: Regional Studies*. 2 : 1-19, ISSN 2214-5818, https://doi.org/10.1016/j.ejrh.2014.07.001.

Nicole Duplaix and Melissa Savage, 2018. The Global Otter Conservation Strategy. IUCN/SSC Otter Specialist Group, Salem, Oregon, USA

Padmalal, D. Maya, K.K., Sreebha, S. and Sreeja, R. 2007 Environmental effects of river sand mining: A case from the river catchments of Vembanad lake, Southwest coast of India. *Environmental Geology.* 54: 10.1007/s00254-007-0870-z

Saunders, D. L., Meeuwig, J. J. and Vincent, A. C. J. 2002. Freshwater protected areas: Strategies for conservation. *Conservation Biology.* 16(1): 30–41. https://doi.org/10.1046/j.1523-1739.2002.99562.x.