

# Understanding the Socio-ecological Drivers of Sand Mining and their Impact on Kulsi River, Assam, India

Samar Medhi

*Department of Geography, Gauhati University, Guwahati, Assam, India*

(Received 31 May, 2021; Accepted 30 June, 2021)

## ABSTRACTS

River in developing countries are tremendous pressure because of increasing dependence of human communities on sand, gravel, hydro electricity etc. River act as a basic source of livelihood and in many cases river has been exploited to such action that its replenishment is not possible. In terms of globalization and to achieve it development is the prior concern. That development ultimately exploit the natural resource base like river, forest etc and their various byproducts such as sand, gravel, timber and other raw materials. Such a noticeable example is Kulsi river originating from Meghalaya and finally merge with Brahmaputra as a southern most tributary. The main importance of the Kulsi river is that it is the shelter of endangered Gangetic Dolphin as well as rich source of pre-Cambrian quality sand. Under such circumstances this paper seeks to access the socio-economic life driving by the sand mining in the Kulsi river. It also identifies various ecological stress lead by sand mining in the river. The study also tries to pinnacle the future environmental problems related to the rampant sand mining with necessary suggestion.

*Key word: Gangetic Dolphin, Kulsi river, Pre-Cambrian, Sand mining, and socio-economic.*

## Introduction

River plays a vital role in the water cycle and endemism of aquatic ecosystem of the world. River is the source of various natural resources to support the mankind. Over time, the expansion of human population along with the development have altered the shape and direction of river by overexploiting natural resources such as sand, gravel etc. These overexploitation in return poses threat to existence of river as an aquatic ecosystem.

Sand is the result of fluvial process of weathering in the upper part of the hill or mountain. It primarily found in river bed, floodplain, ocean beach, hills etc. But in the process of construction, river made minor materials<sup>1</sup> are best suitable raw materials due to its durability and easily grouped by the geomorphic agents (Sreebha, 2014).

Sand as a mining activity has been carrying for centuries, predominantly for construction sector (Krumenacher, 2015). Today, the dynamics of emerging urbanization have altered extraction rate of river's aggregate material twice than its deposition rate by the same river (Peduzzi, 2014). That economic burden and uncontrolled sand mining from river beds leads towards the un-sustainability in the river morphology and existing bionetwork of the stream (Lu *et al.*, 2007; Padmalal *et al.*, 2008, 2014).

In India with implementation of national policy and economic development strategies made the construction based raw material as high priority. Thus the easily available river borne mineral becomes highly valued and ever increasing demand for human (Harison *et al.*, 2005). Today all the major rivers and their sub streams have been witnessing sand mining activity more or less in India. Over the time,

manual mining replaced to mechanical mining for optimum extraction that pushed some river to become vulnerable to adverse externalities of the nature. Most of the time emphasis is given on the income generate by river and other short term benefits. But little consideration is given on natural replenishment time of a river.

### Study area

The study area is located along the Kulsi river, a southern bank tributary of Brahmaputra river and one of the major sand mining site (Fig 1). Since 1989 sand mining was practiced in the study area though it was legalized by Assam government in 2013. The poor socio-economic status of the inhabitants and high demand of sand form adjacent growing city like Guwahati<sup>3</sup>, the study attained an immense significance within short span of time. Both manual mining with small and large nailed plank boat and suction machine are used to extract sand. Today the intensity of the extraction and its resultant effect has increased and threat to existing river ecosystem.

### Objectives

Attempt has been made to understand the socio-ecological condition drive by the sand mining and how it impacts them as well. On the basis of the findings

necessary suggestions has been made to control the rate of sand mining and to sustain the river ecology.

### Materials and Method

The study was carried out in the rural inhabitants near the bank of Kulsi river. The nature of the study is to find out the nature and intensity of involvement of Kulsi people with the river. The study was conducted in Kukurmara village, which is basically a sand miner village in Kamrup (R) district of Assam. Out of total 540 households, a total of 221 household are selected randomly for the study, which represent 41% households of the study area. The primary data are collected from the surveyed village and sand *mahals* (depot) by using purposively designed survey schedule and questionnaires. The researcher interviewed village heads, local environmentalist, NGOs and miners of the Kulsi basin. Other necessary secondary data have been collected from District Census report of 2011, official report from Kamrup (R) West Forest Division Office, Kukurmara Forest Range office along with reports of NGOs working in the area. An empirical and analytical method of study was followed to carry out the research work. For primary information, observation and interaction method was applied with the local people and the *Mahaldars* (sand mahal owners) of the sand mahals. Collected information are compiled and further represented through descriptive statistical method and finally reporting has been made.

### Results and Discussion

Kulsi river originating from the Khasi hills Meghalaya<sup>4</sup> is a reliable source of various natural resources. One of them is quality Pre-Cambrian as well as Quaternary sand. As the river sand has high demand in construction market in the adjacent emerging city of Guwahati and poor economic background of the study area pushes the inhabitants to engaged readily available sand mining as a source of livelihood. Study of the income structure of the inhabitants indicated that around 28 % of the households earn below Rs. 5000 in a month (Table 1). Regarding academic level 55.13% belongs to lower level of education, i.e. below HSLC as against only 4.86 % respondents are persuaded Bachelor degree (Table 2).

Sand is mainly mined from the upstream of

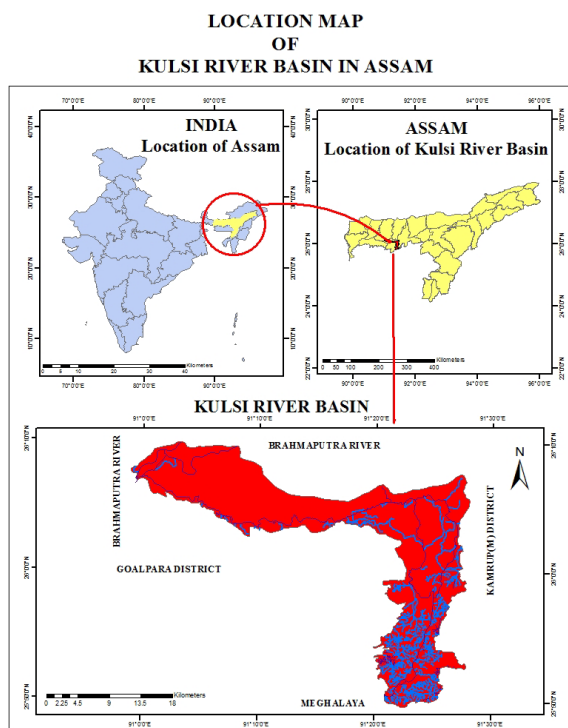


Fig. 1. Map of the study area

**Table 1.** Income level of local people in the study area, 2019

Income in Rs/month	Number of respondent	% of respondent
Below 5000	103	27.98
5000-10000	151	41.09
10000-15000	78	29.89
Above 15000	36	9.78
Total	368	100

Source: Primary survey, 2019

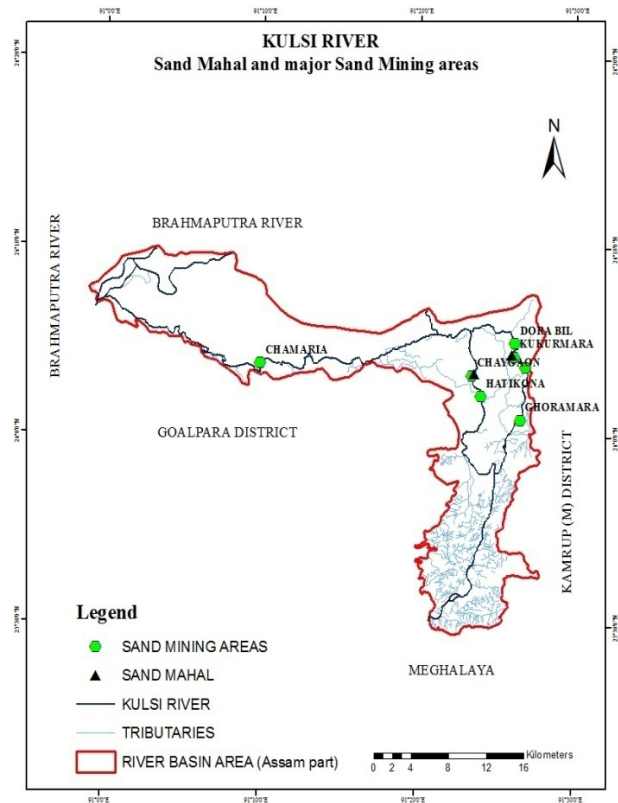
**Table 2.** Level of education of the respondents in the study area, 2019

Education status	Number of respondents	% of respondents
Below class V	70	12.61
Class V-HSLC	306	55.13
Class HSLC-HS	68	12.25
HS	72	12.97
Graduate	27	4.86
Post Graduate	12	2.16
Total	555	100

Source: Primary survey, 2019

Ghoramara, Satpakhli, Hatimukh and Kukurmara to confluence zone of Dora beel (Fig 2). In other parts of the Kulsi river like Samaria to confluence of Boko river, intensity of sand mining activity is low due to poor road connectivity and distance from Guwahati city. At present there are two governments approved Sand Mahal. The first one is kw/7/ Kukurmara, while the second one is kw/5/ Chaygaon no. 1. The first Sand Mahal has been licensed as mining contract<sup>5</sup> area from 2013 to 2020 and second one is from 2015 to 2022 under the Forest Department of Assam to extract sand from Kulsi river.

The high quality as well as demand of sands throughout the year never unemployed the river bank people. Be it an uneducated old man or an illiterate boy of fifteen, everybody has employment in Kulsi though the paid amount is comparatively meager than other profession. At least there are thousand boats engaged in mining activity in Kulsi River. A boat can hold average 1.5 cubic meter of sand. An aged man can extract at an average of two boats of sand in a day while a young one can maximize it up to four boats a day. The miners get Rs. 300 per boat from the *Thikadars* (contractor). The latter sell it to the supplier. The suppliers buy it from



**Fig. 2.** Sand mining areas of the study area

Mahal in one thousand rupees per tractor and sell it to the constructor in one thousand six hundred rupees per tractor (Table 3).

**Sand mining and contribution to state revenue**

Minerals and energy play important role in economic development of a state. Assam is rich in various mineral resources like coal, petroleum, iron, sand, gravel etc. Among them the minor mineral such as stone, gravel, clay, sand, etc are fall under department of Forest Government of Assam. In 2017-18 financial years the Assam Government received Rs.160 crore from the Forest Department of Assam (Table 4). Of which 90% is come from the minor minerals. In Kulsi river, according to the information of Kamrup West Divisional Forest office, Bamunigaon, the Assam Government has received approximately rupees 3 crore revenue from sand and it cleared that the amount of revenue is increasing over the years. It is due to the state’s emerging situation in urban housing and construction sector.

**Sand Mining and Ecological Issue**

The river sand plays a crucial part for the sustain-

able existence of river and its various functions. But the dependent on river for their livelihood and unaware of ecological balance led unscientific and uncontrolled extraction of sand without recourse to the environmental consequences and habitat ecology of the river. The following are the main effect of sand mining observed in the river ecology of Kulsi river.

### Influence on biodiversity

The Kulsi river is one of the last shelters of Gangetic Dolphin locally known as *Shihu*. Interestingly the study area, i.e. Kukurmara is one of the highest density zones of river dolphin in the Kulsi river. According to previous study and present field survey it is observed that the Kulsi River is under threat for aquatic fauna like Gangetic Dolphin, fish, tortoise, invertebrate, etc. Several factors are responsible for the havoc in the habitation of the aquatic animal. Where, sand mining and industrial pollution are more actively act as man-made stress factor on river ecology. Thus it needs immediate attention and forward steps to sustain the biological importance of the Kulsi.

In the study carried out in 1998 (Mohan *et al.* 1998), 24 Dolphin was recorded in the Kulsi River. While in 1993 to 1995 (three years continuous survey) it was declined from 17 to 12 respectively. Thus

it is estimated that the dolphin population is declined at a rate of 14.3% to 29%. High rate of sand mining was viewed as the major cause behind the scene of endangering Gangetic Dolphin in Kulsi and also predicted that if it will continue than it would not sustain in near future. However in 2005 and 2008, Aaranyak's Gangetic Dolphin Research and Conservation Division's (GDRCD) survey, estimated 27 and 29 dolphin populations in the Kulsi River with an increase of 25% from 1995 to 2005 (Table 5). The main reason behind the scene is the hard work and determination like constant monitoring and awareness camps for dolphin carried out by of the NGOs. The NGO Aaranyak has conducted 240 awareness campaigns in 30 monitoring sites till 2005. Besides media, traditional beliefs and government steps for the development of eco-tourism are also the factors of increasing dolphin population. According to the Aaranyak sand mining is one of the main threats for river dolphin but as well it maintains the depth of river as positive sign for dolphin habitation.

Unfortunately the member is that there are number official survey from 2008 to 2019 to estimate the number of dolphin population. We cannot underestimate the present demand of sand as well in near future, which will highly influence on river ecology

**Table 3.** On-site earning of different categories of people involved in sand mining, 2019

Type of Vehicle	Amount of sand (cum)/per vehicle	Earning of Miner (in Rs.)	Earning of Mahaldar (in Rs.)	Earning of Supplier in (Rs.)	Earning of Driver (in Rs.)	Earning of Labour (in Rs.)	Total price of sand in the market (in Rs.)
Tractor	2.5	500	500	350	100	150	1600
Truck	7	1400	1400	980	300	500	4580
Dumper	16	3200	3200	2300	700	900	10300

Source: Primary survey at KW/7/Kukurmara mahal

**Table 4.** The state's revenue from Sand Mahal under Kamrup west forest division, 2013-2017

Mahal Name with mining contract duration	Amount of sand extract(In cum)	Duration/year	Revenue generate (In Rs.)
KW/7/Kukurmara(2013-2017)	18381	2013-2014	4400908
	19079	2014-2015	4578000
	21845	2015-2016	5278000
	28087	2016-2017	6858718
	6803	2015-2016	4001442
KW/5/Chaygaon No. 1 (2015-2017)	19055	2016-2017	4572000
	177250		2,96,89,068.00

Source: Kamrup West Forest Division, Bamunigaon, 2019

and by that time the Gangetic Dolphin will be a story of the past.

Again, the Kulsi River is also connected by large number of wetlands (*Beel*). One of them is Chandubi (a tectonic lake). Prior 1973 the lake was the inhabitant of IUCN<sup>7</sup> red listed Gharial (*Gavialis gangeticus*) but due to poaching, collection of construction material from river had affected the wild Gharial population and become extinct (Saikia, 2012). During field study, the villagers informed that there was wild Gharial in Kulsi river four decades ago. They also said that their ancestor hunted down and narrowed them to zero because of the fear of being attacked by the Gharial when they were fishing and mining sand.

The Kulsi River and its adjoining wetlands are also rich in fish diversity. There are a total of 57 species of fish belonging to 16 families were found in Kulsi (Islam et al., 2013). However out of 57 species 51 number of fish species was recorded in Kukurmara region of Kulsi River (Phukan, 2016). Among them Cyprinidae family were the dominant with 24 species in Kulsi river and 21 species in the Kukurmara area of the river. But the abundance of fish species and its diversity are decreasing because of anthropogenic activities like over fishing in various months of the year and increasing river bed mining. In case of IUCN status of 2016 fish species are in between least concerned and near threatened in Kulsi. Due to in-stream mining activity, the various tributaries of Kulsi like Boko river, Kharkhari river etc and connected wetland like Dora beel, Salsala beel are also disturbed. During winter season these stream and wetland are become at drying condition and surrounding river ecosystem are threatened because of increasing depth of river as a continuous unscientific mining.

**Table 5.** Estimated Gangetic Dolphin in Kulsi river, 1992-2008.

Year	Number of Estimates of Dolphin	Survey by
1992	24	Mohan
1993	17	Mohan
1994	14	Mohan
1995	12	Mohan
2005	27	Waked, Aaranyak
2008	29	Waked, Aaranyak

Source: Mohan *et al.*, (1998) and Aaranyak survey (2005) and (2008)

The Kulsi river has good riparian zone in the form of herb, shrubs etc. This riparian vegetation is the connection between the aquatic and terrestrial ecosystem of the river. But the riparian vegetation in the study area is degrading and minimizing because of transport processes for carrying as well as stocking of sand and mining near the river. Human aggression in the form of habitation, industry and agriculture on vegetation zone also effects the riparian environment of the the Kulsi River.

### Water turbidity

In-stream mining process degrades the water quality as the fine particles of sand mixed up with water. In the study area over extraction of sand and construction of boundary wall as well as discharged of recently introduced industrial effluents of ITC Ltd industry in the Kulsi river worsen the water quality. The suspended material of sand and industrial wastes directly affect the photosynthesis process of aquatic fauna and also affect the aquatic mammals like Dolphin, fish, cormorant, etc through food chain. According to the local fisher men the fish population is depleting now days and they are bound to replaced their traditional livelihood of fishing to sand mining

The 'EASTMOJO' a new digital media technology along with IIT Guwahati studied the water turbidity of Kulsi river. They collected two water sample one from the non mining site and another from the industrial site (Kukurmara) of the river in 2019. The test result found that the turbid water is the mix of allege, sand suspended particle and the industrial waste material etc. The expert of the Department of Environment of IIT Guwahati reported that the sample collected from industrial site is within the safe zone in regards to the Government provide standard limit. But they alleged the standard safe limit of government and said that if the process continues then in one or two decade the river ecology will be badly affected and there would be no more Dolphins.

### Conclusion

The Kulsi river have high economic importance as it carries quality Pre-Cambrian sand and also have high ecological importance as it sustain the endangered Gangetic Dolphin. The backwardness of socio-economic status of the surroundings inhabitant is one of the noticeable aspects to the conservation is-

sues associated with riverine ecology. The study shows that at an average 1000 boats are engaged in sand mining activities per day in Kulsi river. The inhabitant also replaces their age-old fishing activities by sand mining as they view it more profitable one at present. Apart from it the unplanned industrial growth near the river and direct release of waste material to the Kulsi river intoxicated the river water and causing danger to dolphin and other aquatic species. Another important aspect is that the high in-stream mining in Kulsi river also affects the sub tributaries and connected wetlands as it become drying condition during winter season. That as a whole threatens the organic ecology of the river. Development is a part of society, but it should not be at the cause of destruction of nature. We all need to be aware to save our ecosystem of the earth for the future generation and try to evolve strategy to maintain a balance between economic development and environmental sustainability.

### Suggestions

We cannot stop extraction of sand from the river as it essential for modern day's construction. But we can move towards its sustainable use and other replacement. As there are lots of socio-economic and ecological stresses are reflecting in sand mining, it is necessary to adopt proper polices and sustainable method of mining to control the river biodiversity, water pollution and other associated issues. This may include some of the following suggestions:

- (a) Study to be encouraged to introduce and promote alternative construction materials for minimizing river bed degradation.
- (b) Strict law enforcement must be at the ground to prohibit over extraction of sand.
- (c) Proper policies for the welfare of miners along with encouragement of youth for alternative source of livelihood like Dolphin eco-tourism, household industry, fish farming, weaving industry, etc.

### Acknowledgements

This paper owes its gratitude to the people of Kulsi river specially Kukurmara village who has been very cooperative during the events of field survey. The collection of first hand information and the various interviews of Sand miner and mahaldar were conveniently conducted during the survey period.

We would like to acknowledge the Kukurmara range office and District west division forest office, Bamunigaon for granting us permits as well as data wherever required. Through this paper we would like to express our gratitude to the NGOs and local concerned bodies for their protection, conservation and awareness of the endangered species sheltered in Kulsi river.

### References

- Harison, D.J., Fidget, S., Scott, P.W., Macfarlane, M. and Weeks, J.M. 2005. Sustainable river mining of aggregate in developing countries. Geological society, London, Special publication, 250 : 35-45.
- Islam, M. R., Das, B., Baruah, D., Biswas, S. P. and Gupta, A. 2013. Fish Diversity and Fishing Gears used in the Kulsi River of Assam, India. *Annals of Biological Research*. 4 (1) : 289-293.
- Krausman, P.R., Naugle, D.E. and Frisina, M. 2009. Livestock grazing, wildlife habitat and Rangeland values. *Society of Range Management*. 31(5): 15-19.
- Lu, X.X., Zhang, S.R., Xie, S.P. and Ma, P.K. 2007. Rapid channel incision of the lower Pearl River (China) since the 1990's as a consequence of sediment depletion. *Hydrology Earth System Science*. 11 : 1897-1906.
- Mohan, R. S. L., Dey, S. C. and Bairagi, S. P. 1998. On a residential dolphin population of the Ganges river dolphin, *Platanista Gangetica* in the Kulsi river (Assam), a tributary of Brahmaputra. *Ibid*. 95(1): 1-7.
- Padmalal, D. and Maya, K. 2014. Sand Mining: Environmental impacts and selected case study. *Environmental Science and Engineering*, Springer.
- Padmalal, D., Sreebha, S. and Sreeja, R. 2008. Environmental effects of sand mining : a case from the river catchment of Vembanad lake, southwest coast of India. *Environmental Geology*. 54 (4) : 879-889.
- Peduzzi, P. 2014. Sand, Rear than one thinks. *Environmental Development*. 11 : 208-218.
- Phukan, T. 2016. *Diversity of fish fauna in Kulsi river tributary of Assam in relation to dolphin habitat zone*, an unpublished thesis submitted to Gauhati University, Guwahati, Assam.
- Saikia, P. 2012. Indian Gharial (*Gavialis Gangeticus*) status, ecology and conservation. *Rare Animals of India*. 42-58.
- Waked, A. 2005. *Conservation of Gangetic dolphin in Brahmaputra river system, India*. Final Technical report submitted to BP Conservation Programme and Rufford Small Grant, pp 80.
- Waked, A. and Braulik, G. 2009. *Protection of endangered Gangetic dolphin in Brahmaputra River, Assam, India*, Final technical report submitted to IUCN-sir Peter Scott Fund, p 44.