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Sand mining and its impact on the river health: A case study of Kynshi River, Meghalaya

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Abstract:

The term 'river health' is a useful and widely understood concept. River sand mining has been practiced in the Kynshi River for many years and this has posed a great threat to the health of the river with reference to characteristics of the river, properties of the water, ecological conditions etc. The present research aims at assessing the river health by taking into consideration only one aspect i.e. bank erosion or change in the channel width of the river due to sand mining. Landsat Imagery has been used of two years span and Arc Gis software 9.1 versions for calculating and measuring the width of the river.

Keywords: Impact, River Health, Sand mining,

Introduction

Sand mining refers to the actual process of removal of sand or gravel from a place of their occurrence (Langer, 2003). As a resource, sand by definition is 'a loose, incoherent mass of mineral material which is a product of natural processes.' River sand is one of the world's most plentiful resources. The durability of river-borne coarser clastics (eg. sand and gravel) and their sorting by fluvial action make them best suitable raw materials/ingredients for building constructions (Kondolf et al., 2002), thus becoming a very important mineral for the expansion of society.

Rivers are the most important life supporting systems of nature. For centuries, humans have been enjoying the natural benefits provided by rivers without understanding much on how the river ecosystem functions and maintains its vitality. Indiscriminate sand mining poses a great threat to the river affecting the health of a

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

river because it leads to erosion of the river bank and damages Bio-diversity (Goenka, 2013). The Supreme Court in February 2011 ruled that "sand mining on either side of river in-stream or upstream is one side of the causes of environmental degradation and also a threat to biodiversity"

River Health

River health is taken to mean the degree of similarity to an un-impacted river of the same type, particularly in terms of physical characteristics, its biological diversity and ecological functioning.

Ecologically river health can be defined as *"The ability of the aquatic ecosystem to support and maintain key ecological processes and a community of organisms with a species composition, diversity and functional organization as comparable as possible to that of undisturbed habitats within the region". (Schofield and Davis, 1996 after Karr and Dudley 1981: 55-68).*

According to the Clean Water Act (CWA) of the United States in 1972, river health means physical, chemical and biological integrity, which refers to maintaining natural ecosystems' structures and functions. Schofield indicated that river health refers to the similarity to the undisturbed (original) river of the same type on the biological integrity and ecological function.

Statement of the Problem

River Health is the main problem faced for centuries especially for rivers flowing through urban areas. Environmentalists focus on the river health mainly in terms of disposal of pollutants in the form of solid waste and chemical substance. Few consider indiscriminate sand mining a factor in deterioration of river health in rural areas. In the past few decades, demand for construction grade sand is increasing in many parts of the world due to rapid economic development and subsequent growth of building activities. Given the urgent need for economic development, the long term impacts of indiscriminate sand mining affecting the river health are rarely raised

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

as an issue. The present study aims at exploring this aspect of river health by taking sand mining activities in Kynshi river of Meghalaya as a case study.

River sand mining has been practiced in the Kynshi River for many years and this has posed a great threat to the health of the river with reference to characteristics of the river, properties of the water, ecological conditions etc. The present research aims at assessing the river health by taking into consideration only one aspect i,e. bank erosion or change in the channel width of the river due to sand mining.

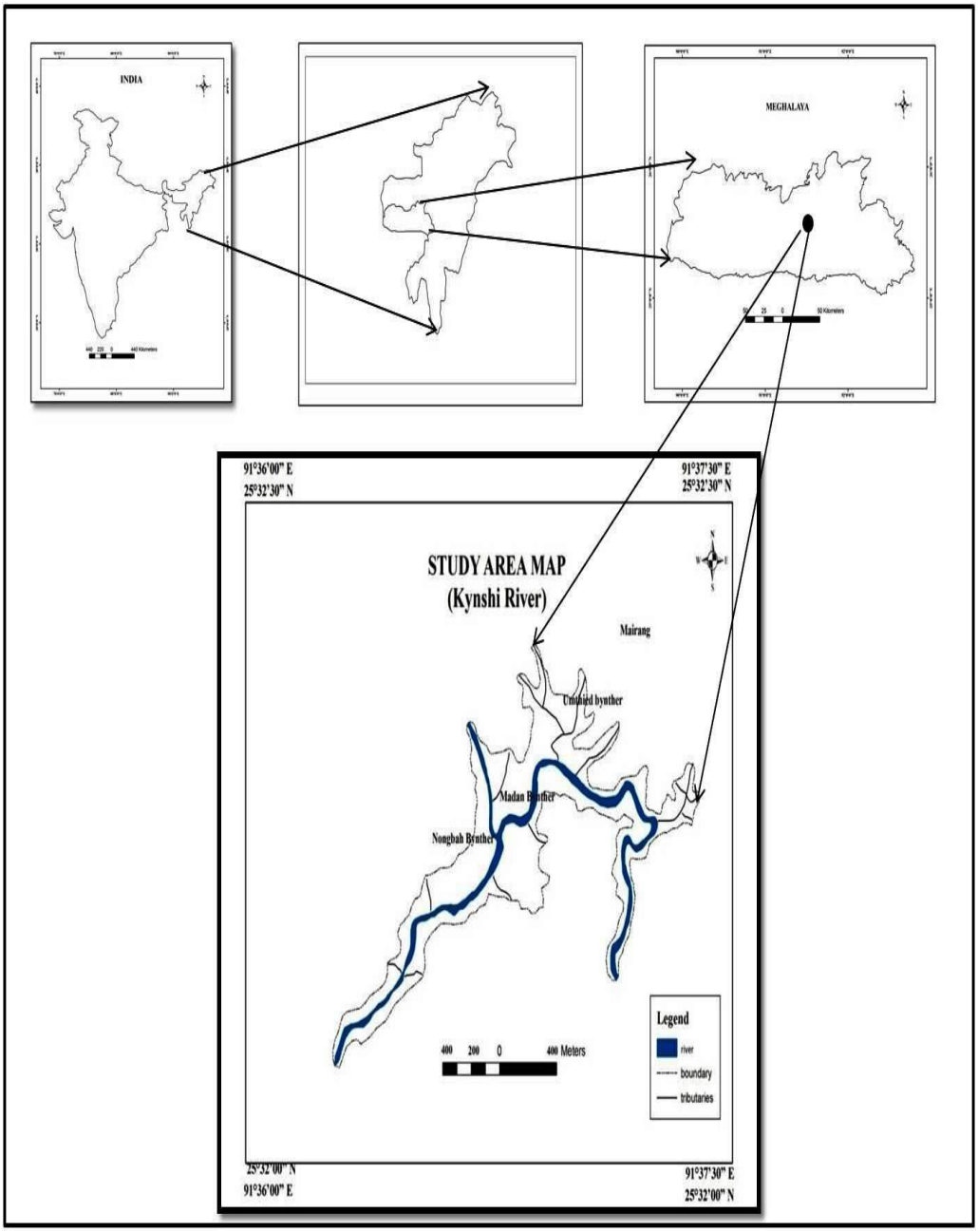
Study Area

River kynshi is one of the major rivers in West Khasi hills district of Meghalaya which flows from the east to the south western part of Meghalaya and enters into the Bay of Bengal. It is formed by many tributaries and streams of the central upland zone of Meghalaya in pre-Cambrian rocks mostly of gneiss and migmatites which are the results of intrusion by basic and ultrabasic intrusives and late tectonic granite plutons.

This river is most suitable to study the impact sand mining on the river health, because the river is subjected to sand mining for many years for its high grade sand that is exported to the city for building construction. This area is suitable for study in the perspective of sand mining because it is an area which consists of high grade crystal sand, deposited after erosion and transportation from the upstream of the Kynshi River. Sand mining has been practiced all along the river kynshi, though the focus of the present study is on the area where sand is mostly extracted from the river. The study area is confined to only a small area and an extension of 91° 35’ 57” E to 91 38’ 56”E longitude and 25° 32’ 26” N to 25 32’ 46” N latitude

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

Fig 1:



Showing Study area map

Objectives

To determine the channel plan form (width and shift) change due to sand mining.

Research Questions

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

The research primarily seeks answers to the issue of sand mining as affecting the health of the river. While it may be assumed that unbridled sand mining adversely affects the health of the river, the study intends to get an answer as to whether the river health has already been affected and if not, whether one can ensure such activity will not lead to decline in the health of the river in future.

Data Base

The data that has been used in this particular research are:

Landsat Imagery has been used of two years span I.e. of 2009 and 2014 respectively ,where the river (selected sites) have been digitized and then add the data into Arc Gis software 9.3 versions for calculating and measuring the width of the river .

Methodology

The study depends on extensive field survey in the study area where sand mining is mostly practiced and also by using Arc GIS Software 9.3. The widening of river bank or the channel change detection due to sand mining is analyzed by comparing the area represented in two years span Google Earth Imagery i.e. the year 2009 and 2015 respectively by dividing into two sections.

The River channel has been digitized directly in Google Earth Imagery by creating different data base or layers for different years and has been identified from different years by the colors of the line. After digitizing the data has been save as *.kmz* file and this data has been imported in ArcGIS software 9.3 versions for measuring the width of different years span and then compare it with one another and analyzed .

In Arc GIS software the channel change has been measured using the scale tool bar and it is measured in meters .The river channel has been divided into left bank and right bank. The red color line shows the bank of 2009 and the green color line shows the bank of 2015.When the green color line is moving beyond the red color line in the

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

right that means the bank has been eroded or shifted towards the right bank and if the green color line is moving beyond the left of the red color line that means the river channel has been eroded or shifted towards the left. The measurement taken which mentioned about the right and the left banks as well as the directions of the shift and how much the channel has been shifted (in meter) has been recorded in an excel work for further analyzing.

Results:

Types or methods of sand mining practiced:

River sand are mined extensively from the drainage networks of the Kynshi river, depending on the physiographic characteristics, river orders and ecological significance. However, the intensity of mining is high in the alluvial reaches of the main channels. In addition to mining of sand from active channels (in stream mining), a substantial amount of sand is also being extracted from the overbank areas (floodplain mining) of the river as well. Generally, two types of in stream mining are in practice in the study area— (i). Pit excavation and (ii). Bar skimming.

(i). Pit excavation is extraction of sand and gravel from the riverbed or floodplain areas by uncontrolled digging, in which draglines or dredges remove material from below the water table or directly from a stream channel. A long showel which has a curved tin tie with a long wooden stick for easy extraction of the sand from the river bed has been used.

(ii). Bar skimming, on the other hand, is the controlled extraction of sand from the exposed sand bars (in stream bars and point bars) in the channel environment. Usually, bar skimming would be done above the water table and within a minimum width buffer that separates the excavation site from the low flow channel and the adjacent active channel bank. Showel was used to extract the sand and carry it in a basket from the bank of the river to the road side for easy transport

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

Of the two types of sand mining, pit excavation is the widespread sand mining method adopted in the alluvial reaches of the rivers. *(Patmalal et,al)*

Plate 1: bar skimming method

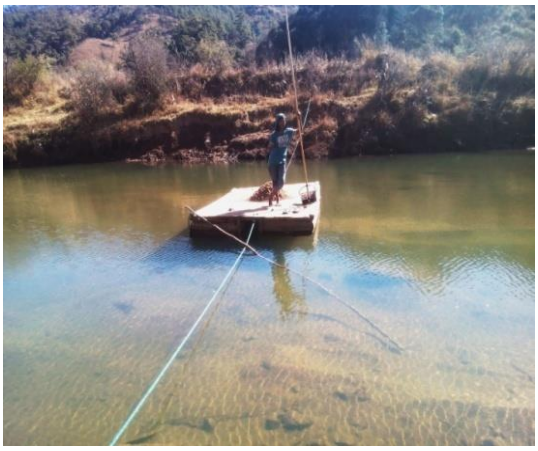


Plate 2: Showing wet pit mining.

Impact of sand mining on the River Health:

The health of the river in the study area has been affected physically, due to the sand mining taken place for so many years .The flow regime of the river has been changing , bank erosion is high in the mining sites , channel has been shifting etc. The sand mining activities has really affect the physical health of the river to a large extent.

Sand mining leading to increase in channel shifting*:*

The impact of sand mining on the physical health of the river has been assessed by comparing between two maps of two different years by detecting the change in the channel and also the increase and decrease of the width of the river.

In order to assess the physical health of the river, the study area has been divided into two section for clearly and deep analysis which are as follows:

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

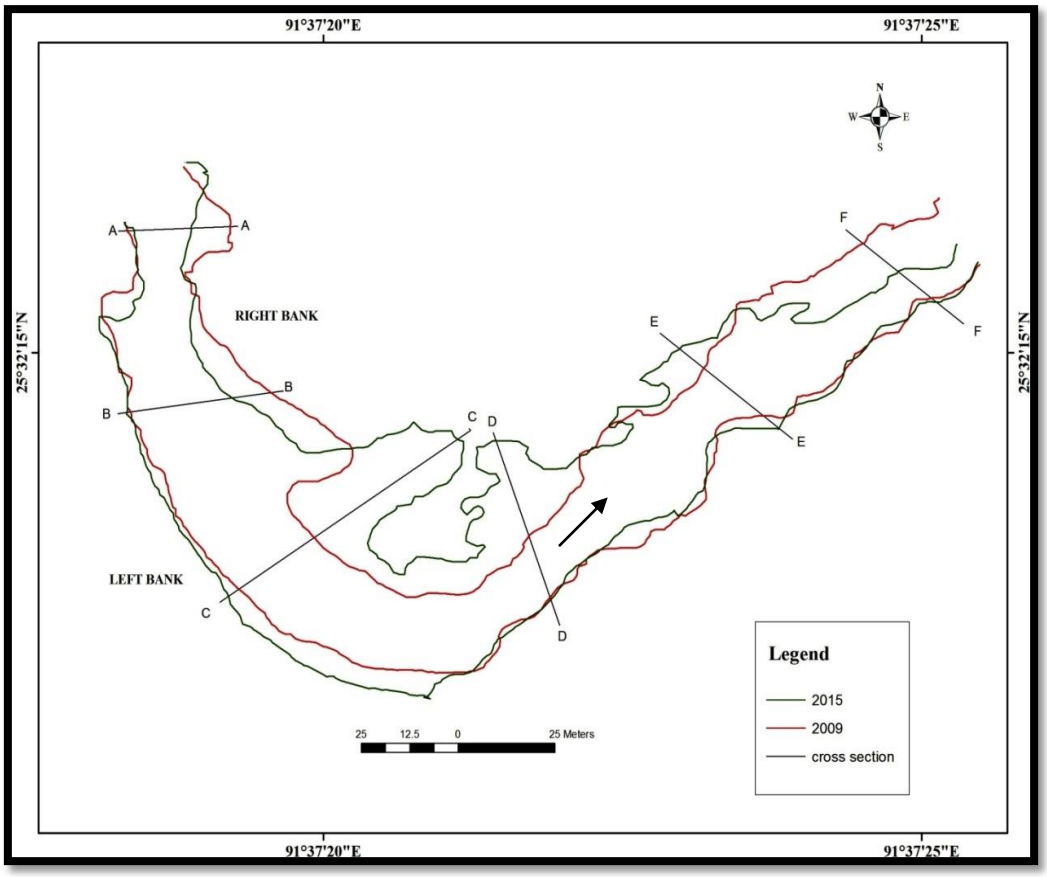


Fig 2: Kynshi River: Section 1 (South east of umthied bynther)

Table 1: Channel shifting and erosion of the bank in the 1st section (in metres)

Section	Left Bank (in metres)	Direction	Right Bank (in metres)	Direction	Change in river width
A	1.4	RIGHT	9	LEFT	7.6
B	0.7	RIGHT	9.1	LEFT	8.4
C	2.4	LEFT	26	RIGHT	23.6
D	1.4	LEFT	28.2	RIGHT	26.8
E	4.5	LEFT	7.5	RIGHT	3
F	1.1	LEFT	10.8	RIGHT	9.7

In the first section of the river which extends of 310 meters of the study area, where data has been highlighted in table 4.3 and fig 4.4 respectively, it is an area where

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

sand mining is abandoned since last two years by the people. Previous years in this particular section huge amount of sand has been extracted both bar skimming and pit excavation as well. Due to over exploitation of the sand from the river and the banks as well uneven shaped of the river takes place. In the year 2009 the river is still following the water regime which shows that the river is in a good health condition, whereas in the year 2015 due to over exploitation of sand especially from the banks it has affected the health of the river where most of the banks has been eroded.

In the cross section A the bank has been eroded only 1.4 meters of land and the river shifts towards the right ,whereas 9 meters of a river has been deposited by sediments, which shows that the river in this section is narrow . This happens because of the extensive wet pit mining where the sand has been extracted from the bed of the river which makes the river to become deeper and the volume of water occupy in these deep thalweg and thus river becomes narrower in this section.

In the section B 0.7 meters of the river bank has been eroded and the river shifted towards the right. Whereas 9.1 meters of the river is getting narrower in the left bank in the year 2015. This is also because of the over wet pit mining extracted from the sites which create deep thalweg .

In the cross section C, D and E 2.4, 1.4 and 4.5 meters of land respectively has been eroded from the left bank of the river ,whereas 26, 28.and 27.5 meters of the land has been eroded . Most of the sand located here has been eroded both by wet pit and bar skimming method as well. Bar skimming method is the main factors which leads to the high level of erosion in the right bank of the river. It is also in the sections 5 years before high grade of sand has been extracted with huge loads of trucks every day and at present these section is abandoned where only stones and pebbles are left in the sites.

In the cross section GF the river is getting narrower in the year 2015 as compared to that of the year 2009, the river gets narrower by 10.8 meters and the bank shifted to

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

the left. Access of wet pit mining takes place in this site which results in the deep thalweg of the river and the river gets narrower.

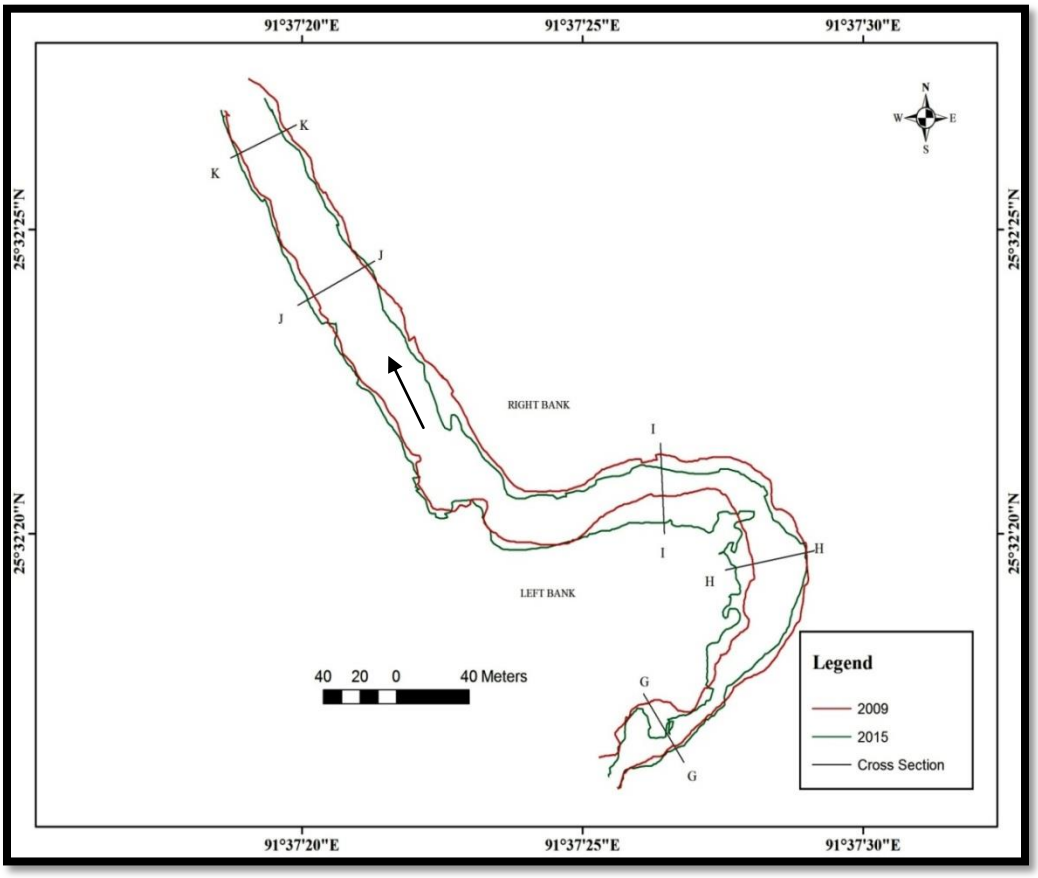


Fig 2: Kynshi River: section 2 (South east of umthied bynther)

Table 2: Channel shifting and erosion of the bank in the second section (in meters)

Section	Left Bank (in metres)	Direction	Right Bank (in metres)	Direction	Change in river width
G	1.9	LEFT	10	LEFT	8.1
H	3.2	LEFT	1.5	RIGHT	1.7
I	13.8	LEFT	7	LEFT	11.5
J	8.5	LEFT	0.2	LEFT	8.3
K	16.4	RIGHT	1.7	RIGHT	14.8

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

In the second section of the river which extends about 565 meters ,where data has been highlighted in fig 4.5 and table 4.4 ,there are five cross sections ,where in the cross section G the river gets narrower by 10 meters on the right bank and the bank shifted towards the left. Excessive wet pit mining takes place in this particular site which increase the river bed depth and results to narrowing of the river.

In the cross section H and I, the left bank of the river has been eroded or extracted about 3.2 and 13.8 respectively meters of the sand which leads in the widening of the river bank and uneven shape of the bank as well, whereas a few meters of the land i.e. only 1.5 and 7 meters of land have been eroded on the right bank of the river .This erosion is mainly because of the head cutting due to increase velocity in the meandering parts of the river.

In the cross section J and K the left bank of the river has been shifted about 8.5 and 16.5 meters respectively on the left and right direction of the river. This clearly shows a greater shift of the bank when comparing the year 2009 and 2015.

***Sand mining leading to increase in river width**:*

The uncontrolled extraction of sand from the river has haphazardly and increasingly affected the physical health of the river where erosion of the bank posed a great threat in the river either at a slow pace or rapidly pace.

Erosion on the bank of the river kynshi.

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

River width has been assessed by taking into consideration the bank erosion as follows:

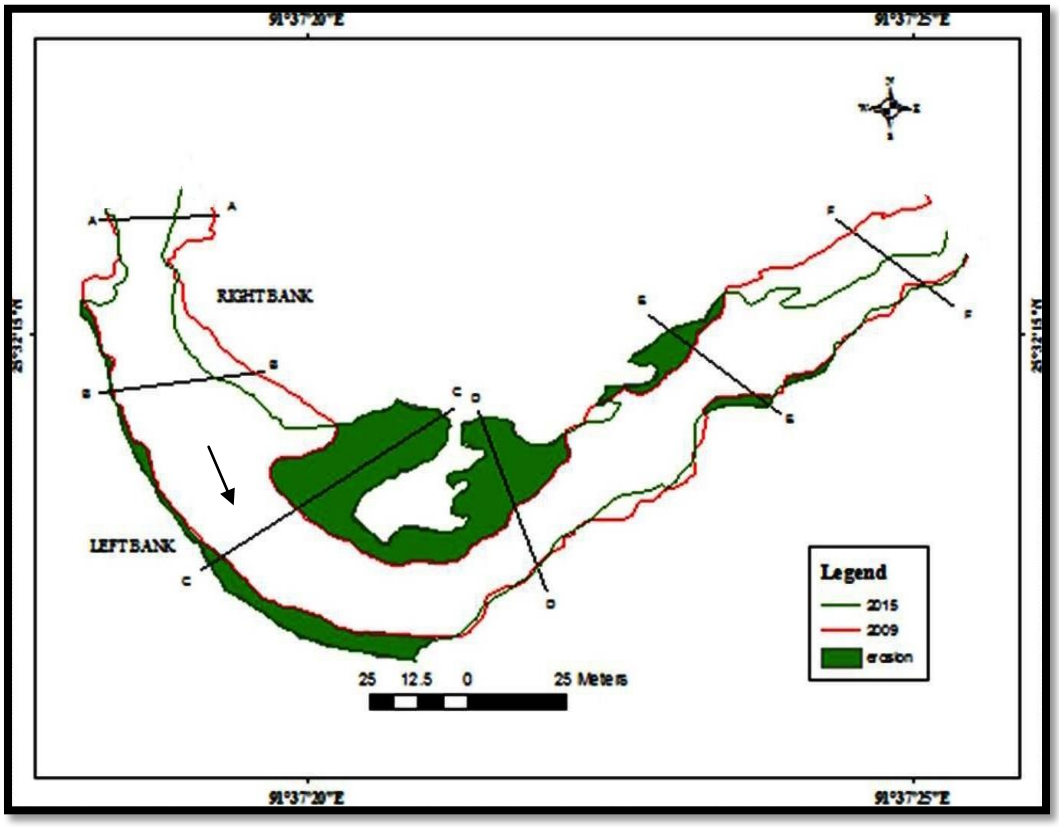


Fig 3: Showing Portion of land erosion in the first section of the study area

Sand mining in this particular section of the study area has pose a great threat to the physical health of the river .Comparing with the year 2009 the bank of the river has increase in its width during the year 2015 .Erosion either natural erosion and manmade erosion has really affected the health of the river where about 2127.83m2 of the land has been eroded during the past few years.

Erosion of the river bank takes place mostly at the sites where mining is taking place mostly at the meandering path of the river, the loosen of the sand due to sand mining along with the velocity of the water added results to the extensive erosion in the study area.

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

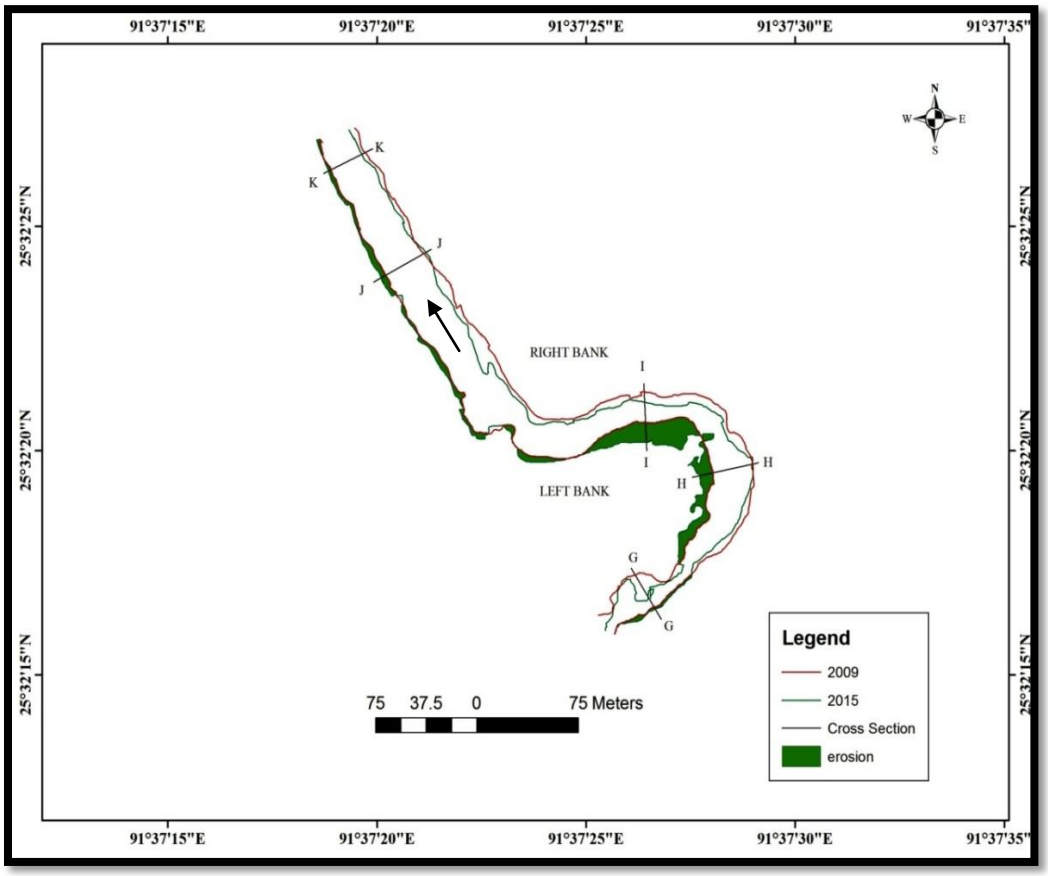


Fig 4: Showing Portion of land erosion in the Second section of the study area

In this particular section of the study area erosion or loss of land takes place mostly at the confluence of the river, where 2279.359m2 of the land has been eroded in these past few years where sand mining is in great demand and where the sand is available abundantly.

Table 3: Showing the total area eroded from the bank of the river kynshi

Section	Area
1	2127.83m2
2	2279.359m2
Total	**4407.189 m2 / 1.9 acres**

ISSN: 2277-2995
Vol-8-Issue-10-October-2019

Findings and Conclusion:

Sand mining in the river Kynshi ,both wet pit and bar skimming has really affect the physical health of the river especially in the mining sites where ,the flow regime has really change in the mining sites of the river . Erosion or increase in the channel width of the river also is high in the mining sections of the river where, due to bar skimming the banks of the channel has been eroded and the land resources have really been affected and about **4407.189 m2 / 1.9 acres** of the land has been eroded which really affected the owners and the farmers who practice agriculture near the river bank. Whereas, in some portion the river channel decrease in size which is due to the wet pit mining or the river bed mining, this happens because when waters flows it encounter bed load and it force over it and down cuts behind the bed load in a swirling eddies current and these current eroded the river bed creating depression in it which leads to the increase in the thalweg where the deepest thalweg found in the study area is 2metres and thus creating more rooms for water to store in the river bed and the river channel width got decreases.

Conclusion: Accepting the concept of river health is very useful for directing the aspects of our ecological research and inspiring public interest in our efforts, we move on to select the best indicators (symptoms). River sand mining has really had a great impact on the river health in the kynshi river especially on the physical health (indicators chose), but it also posed a great impact to the other indicators that have not been discussed in this particular research.

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