Global Scientific JOURNALS

GSJ: Volume 9, Issue 5, May 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Impacts of sand mining activities on Land Use Land Cover and Water Quality Parameters in Yamunanagar, Haryana, India

Rajan Dabral[1*], HAS Sandhu[1], Rajdeep Singh[1]

[1]Punjab Engineering College, Chandigarh, Punjab, India

***Corresponding Author: rajandabral27@gmail.com**

Abstract: Sand mining refers to process of removal of sand from rivers, streams and lake using various methods such as skimming, dry and wet pool mining, and scalping. These activities may cause serious environmental hazards (soil pollution, deforestation, water pollution etc.) as well as health issues (Lung infections, headache etc.). In the Present study, an attempt has been made to study impacts of sand mining by analyzing temporal variations of Land Use/Land Cover (LULC) of Gumthala Rao mine site in Yamunanagar district (Latitude: 29°57′29″ to 29°56′26″N and Longitude: 77°12′43″ to 77°12′48″E) of Haryana during the years 2000-2018 using geospatial technologies. The factors for choosing this study area were accessibility, availability of data, instances of large mining activities (legal/illegal) taking place in that site. Further, an attempt has also been made to study impacts of sand mining activities on the water quality parameters (pH, Electrical Conductivity, Turbidity, Total dissolved Solids, Total Suspended Solids, Total Hardness and DO) for surface and ground water using lab experiments during the months of Jan-April for the year 2019 for the study area. The LULC variations have been made for the buffer of 10 km around mine site was and it has been observed that sand reduces by the 84.61 %, open area increases by 102.67 % and build up area increases by 444.87 % during the study period. Further, reduction of 77.73 % in water body and 57.41 % green land area was also observed during the study period. The obtained results were validated and accuracy assessment has been done using image processing software with the average overall accuracy of 89.2 % and kappa value of 0.87. A significant change in turbidity, TSS and DO has been observed for surface water, while a significant change in turbidity, TSS and TDS has been observed for ground water. Also, no significant temporal variation has been observed in water quality parameters but there is spatial variation as water quality is affected near mine site.

Keywords: *GIS, LANDSAT, Remote sensing, LULC Sand mining, physico-chemical, water quality, Gumthala Rao.*

Introduction:

Sand and gravel are natural resources formed by the weathering of rocks over a long period of time by the action of wind and water. Sand is widely used constructional material throughout the world. It is a non-renewable resource as it takes very large time to form; its demand in the construction industry is extremely high. Almost 50 billion tons of sand is used for the construction purpose **(Koehnken, 2018).**To meet this huge demand of sand, the beach sand or the river sand or the fossil sand is used. In India, almost every major rivers like Ganga, Yamuna, Narmada, Satluj, Godavari, Krishna, Kaveri etc., is being used for the production of sand either legally or illegally. This has resulted in excess extraction of sand from these river banks, crossing the replenishing limits **(Rawat, 2016).** Sand also plays very important role in the protection of coastal environment as it reduces the impacts of the strong tidal waves before they reach the shoreline. Sand also acts as a habitat for many marine organisms **(Jonah *et al.*, 2015).**Sand mining refers to process of removal of sand from rivers, streams and lakes. Mining of sand includes various methods such as skimming, dry and wet pool mining, bar excavations and scalping **(Hill, 1999).**Due to increasing demand of sand for construction purposes a lot of legal and illegal sand mining is carried out creating an immense pressure on sand resources. Mining activities have resulted in many serious environmental hazards such as soil pollution, deforestation, water pollution, depletion of ground water table etc. **(Bindhusri and Arunachalam, 2015).** Many studies have been carried out to conserve land use land cover with the help of different satellite data. GIS can be used in demarcation, management and planning of sand mining zone. With the help of high resolution images like Cartosat and World view 2 legal and illegal sand mining can be demarcated accurately **(Mitra and Singh, 2015).**With the help of GIS one can also estimate the volume of sand that can be mined from the mining area **(Atejioye and Odeyemi, 2018)**.

Excess river sand mining has affected the biodiversity of river and had a huge impact on nearby environment - including air, water and soil contamination. In the process of mining, the minerals, chemicals or other contamination, present in the sand, enters the ground or surface water, resulting in the change of physico-chemical properties of water. Uncontrolled sand mining degrades the river and threatens its tropic structure. The situation tends to the loss of riparian and in stream vegetation, changes in the feeding, breeding and spawning grounds of aquatic organisms including fishes, not only impose stress in river ecology but also creates damages in the terrestrial near shore marine environments as well **(Padmalal *et al.*, 2008).** Water parameter like TSS, TDS and Turbidity are the parameters that are affected severely affected but the parameters like EC, Hardness, DO and pH are affected mildly **(River and Peck Yen, 2013; Bayram and Onsoy, 2015; Pillay *et al.*, 2017).** In this study, an attempt has been made to assess the temporal variation in LULC and study the water quality parameters for ground and surface water surrounding mining zone.

Study Area: Gumthala Rao village is located in Jagadhri Tehsil of Yamunanagar district in Haryana, India (Figure 1). It is situated 25km away from sub-district headquarter Jagadhri and 23km away from district headquarter Yamunanagar. As per 2009 stats, Gumthala is the gram panchayat of Gumthala Rao village. The total geographical area of village is 1391 hectares. As per 2019 stats, Gumthala Rao village comes under Radaur assembly & Kurukshetra parliamentary constituency. Yamuna Nagar is the nearest town to Gumthala Rao. The mining activity is located at Gumthala North Block/YNR B16 in riverbed in Tehsil-Radaur and District-Yamuna Nagar, Haryana. Mining area is located between Latitude: 29°57′29″ to 29°56′26″N and Longitude:77°12′43″ to 77°12′48″E . The mining area is a river bed with gentle slope from North-South. A buffer of 10km was taken around mine site **(EIA Report , 2016)**to estimate change in LULC.

During this study, 03 surface water sampling sites i.e. SW1 (near mine site),SW2 (Sandhali) and SW3 (Chandraon) and 05 ground water sampling sites GW1 (near mine site), GW2 (500 m from mine site), GW3 (village Gumthala Rao -1 km from mine site), GW4 (village Barheri -5km from mine site) and GW5 (village Chaugawan-3.5 Km from mine site) have been used for water quality testing and presented in Figure 3. The datasets used to achieve the objectives have been shown in Table 1. Further the methodology has been discussed in figure 4.

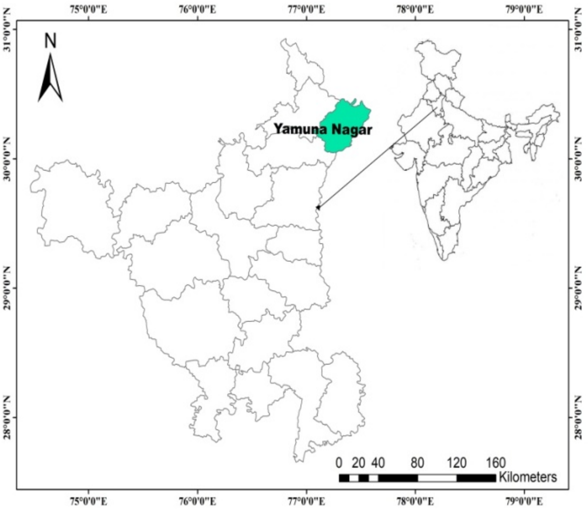

Figure 2: Map of Haryana (Yamunanagar)

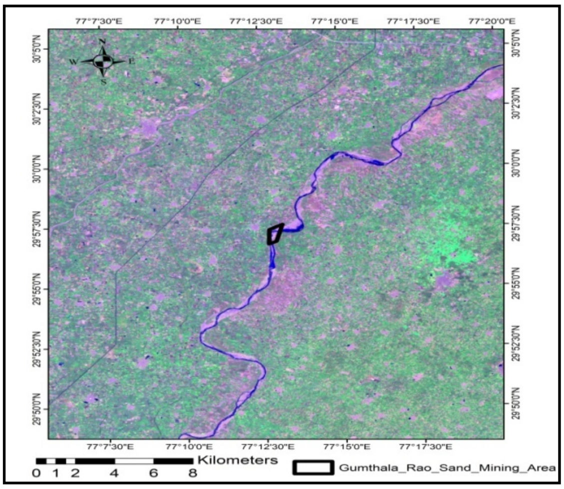

Figure 1: Satellite Image of Study Area (Gumthala Rao)

As Per the EIA report for this project, monitoring stations selected are shown in figure 3.

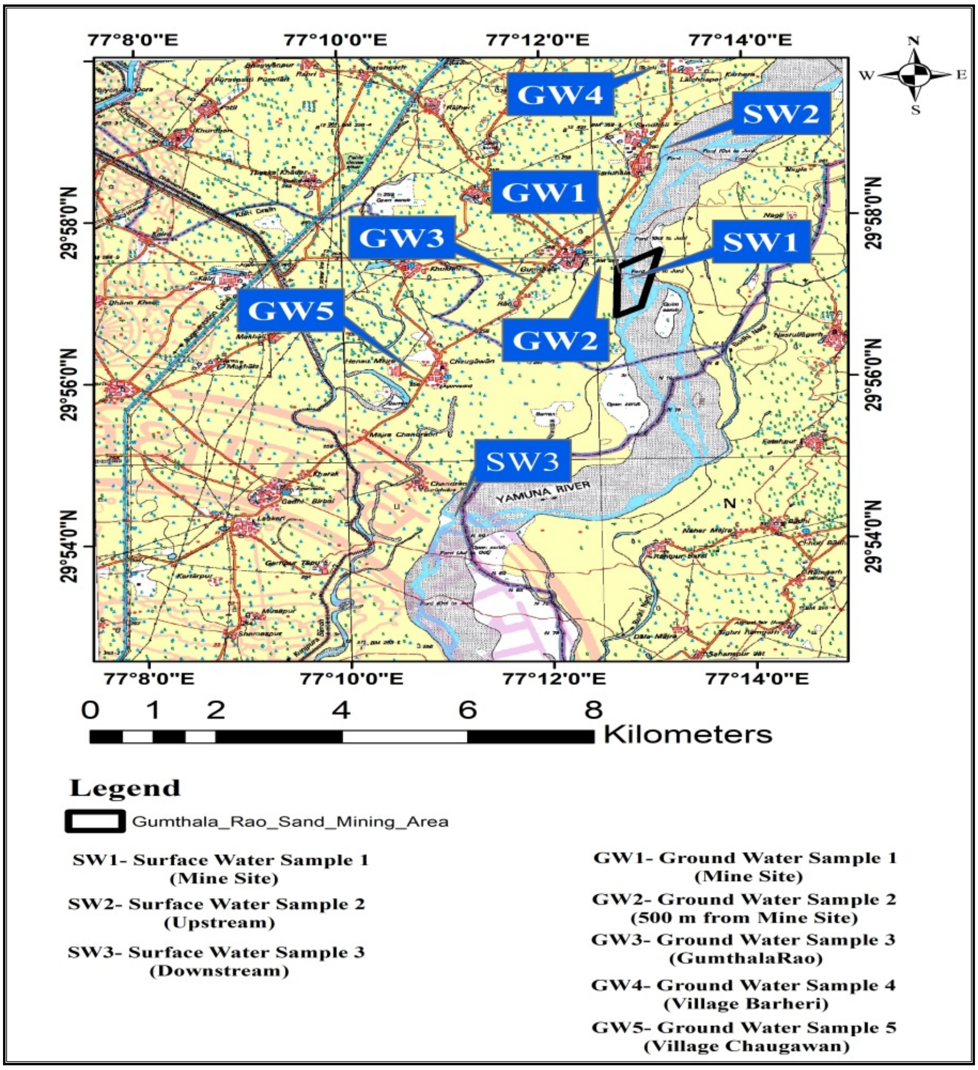

Figure 3: Sampling stations for Ground and Surface water

Data source: Data sets used are shown in table 1.

Table 1: Datasets used in the Study

DATA SETS	DETAILS	APPLICATIONS
Landsat 5 and Landsat 8	Date- 29/04/2000, 06/05/2008, 12/05/2010, 23/04/2015 and 07/04/2018, Resolution-30m, Source-https://earthexplorer.usgs.gov/	Land use land cover classification.
Software	ERDAS,ArcGIS and Google Earth.	Processing of image.

Methodology: The methodology that is followed in the research is shown below in figure 4.

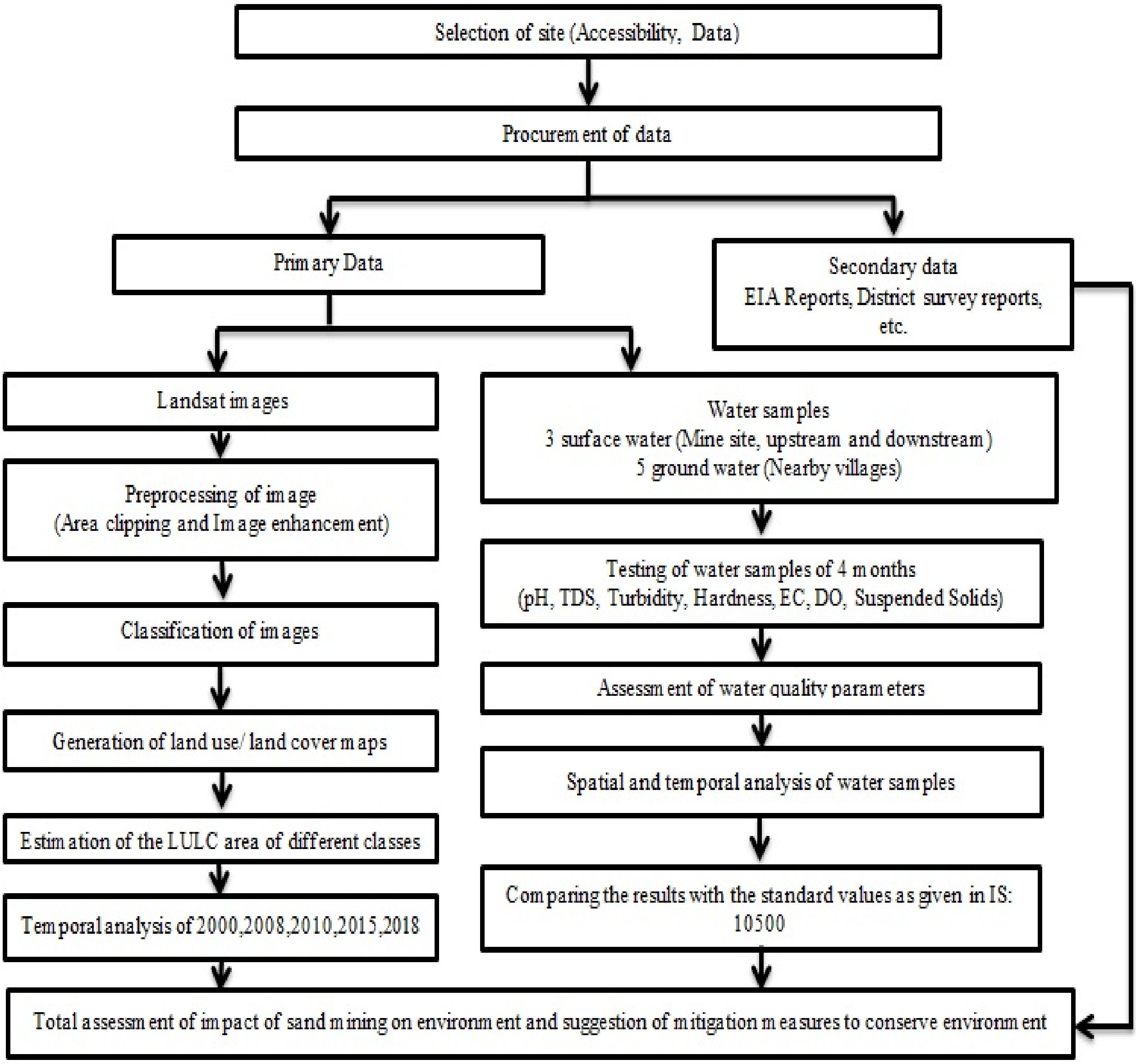

Figure 4: Methodology

The Landsat 8 image of 2015 and 2018 and Landsat 5 image of 2000, 2008 and 2010 was downloaded from the USGS Earth explorer for the analysis of land use and land cover. Layer stacking was done in software (ERDAS imagine 2014). Mining area and a buffer of 10km was clipped from the image to get the area of interest for the classification of Land use and land cover. The geographic information system (GIS) and image processing tools were applied to determine the land cover/land use pattern of the study area. A supervised classification was performed on images by taking the training sets. The land use was divided into six different classes i.e. Open land, sand, water body, Green land, Built up area and Agricultural land. Land use/land cover(LULC) maps were generated in ArcGIS 10.5 and with the help of LULC maps quantification of different classes and the change in their land use pattern was found out. Accuracy assessment was done with help of ground truth points for the year 2018 and with random points for rest of the years.

Water samples were collected four times, from January to April. The sampling procedure was followed as per the Standard guidelines of APHA and IS code guidelines. The bottles used for the sample collection was cleaned properly and were rinsed properly before taking the samples. The samples were taken from the depth of about 15-20 cm so that a true representative of the river sample may be taken. Proper preservation techniques were followed for the testing of samples and samples were tested within 36 hours of sampling. Methods used are shown in table below:

Table 2: Methods adopted for the testing of various water samples

S.NO.	Parameter	Test Method
1	pH	IS code 3025(Part 11)
2	Turbidity	IS 3025 part 10
3	Total Hardness	IS 3025 part 21
4	Total Dissolved Solids (TDS)	IS code 3025 part 16
5	Total Suspended Solids(TSS)	IS code 3025 part 17
6	Electrical Conductivity	Electrical Conductivity Meter
7	Dissolved Oxygen	APHA 20th Edition, 4500-O-B

Results and Discussions

LULC: The classified Landsat images of the selected years were evaluated to determine the land use/land cover pattern of the study area and are used to generate the LULC maps. Area of each different class was calculated to see the temporal variation of LULC during the study period. Different maps generated are shown in the figure 5. The figure clearly depicts that sand, water body and green land shows decreasing trend whereas open land, built up shows an increasing trend. Agricultural land is almost same. Due to very small area of deep lasses hav

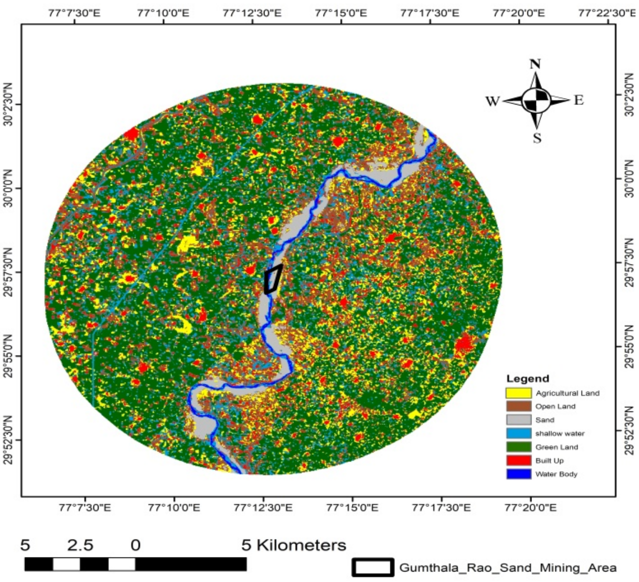

Figure 5a: Landuse pattern of Study Area-2000 (10 Km buffer from mine site)

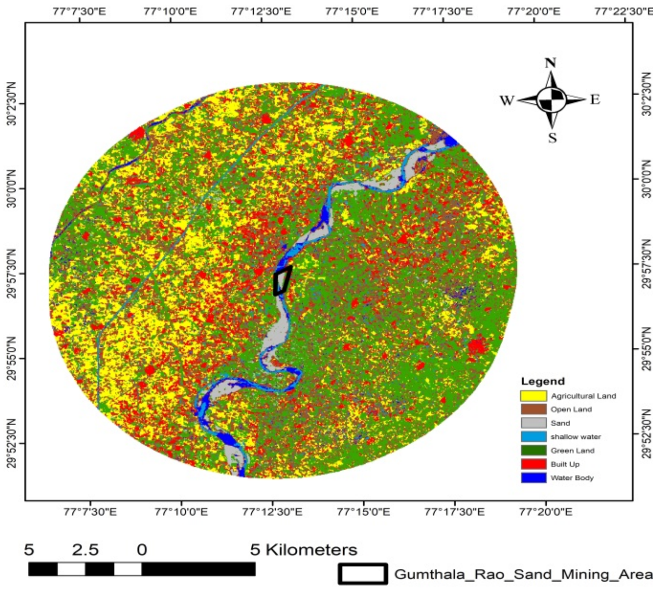

Figure 5b: Landuse pattern of Study Area-2008 (10 Km buffer from mine site)

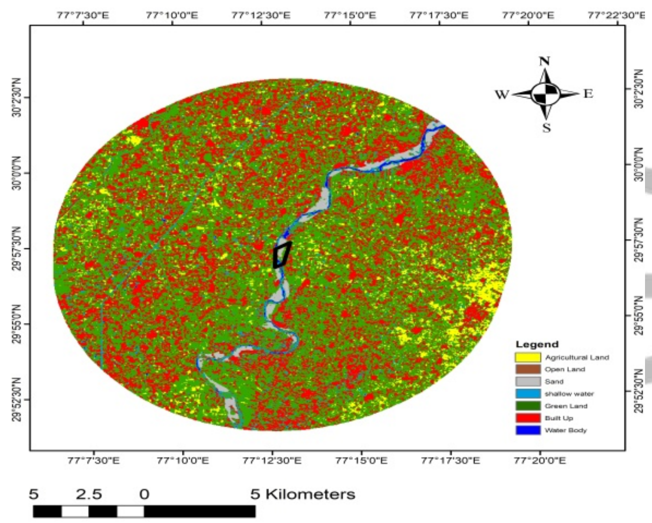

Figure 5c: Landuse pattern of Study Area-2010 (10 Km buffer from mine site)

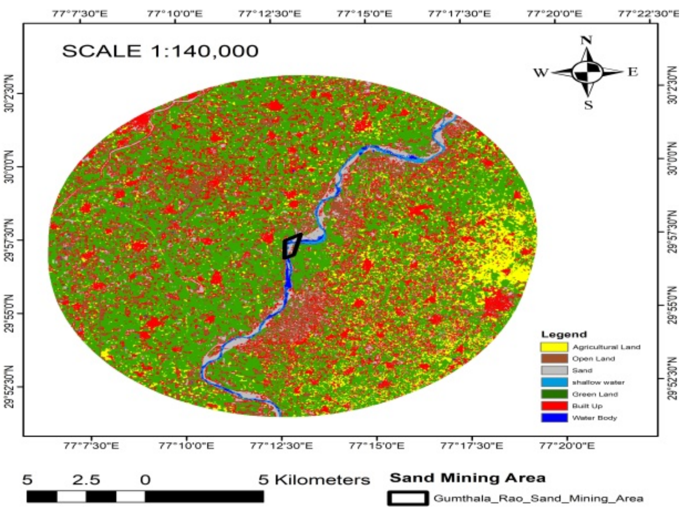

Figure 5d: Landuse pattern of Study Area-2015 (10 Km buffer from mine site)

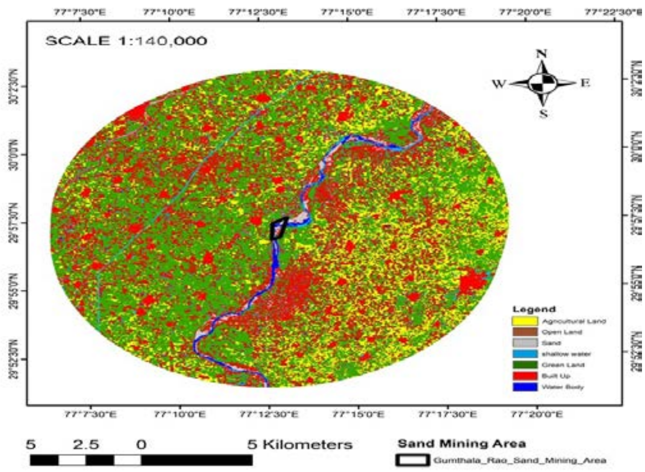

Figure 5e: Landuse pattern of Study Area-2018 (10 Km buffer from mine site)

Figure 5: Temporal Variation of LULC Classes

Results shows that sand area reduced from 2908.18 hectares to 447.35 hectares i.e. 84.69% decrease during the study period. Since, sand is a replensihable material and it may recover on its own. However results of this study shows drastic reduction in the sand area, which needs to be explored further. The investigations shows that sand may have been extracted beyond its replenishing limits, which also caused to increase in open area (102.67 %). This increase in open area may be due to creation of haul roads to provide transport facility to mining vehicles. There is a drastic decrease is water body (77.73%).The uncontrolled withdrawal of water along with sand due to mining activity resulted in shortage of surface water area. Due to urbanization in the study areaan increase in Built up area is observed around the mining site during the study period (444.87%). It has also been observed that there is reduction in Greenland (Forest and vegetation) in the study area due to increasing mining activities (57.41%).There is a slight increase in the agricultural area (14.54%). Accuracy assessment was done in ERDAS IMAGINE 2014, with the average overall accuracy of 89.2 % and kappa value of 0.87. These results are shown in the table 3.

Table 3: Area of different LULC classes

Land use	Area(In Hectares)					Percentage change in area
	2000	2008	2010	2015	2018	
Open Land	5402.92	6190.65	9363.27	10800.65	10950.39	102.67
Sand	**2908.18**	**1621.8**	**1761.09**	**951.44**	**447.35**	**-84.61**
Water Body	4855.65	2742.95	2806.4	1169.63	1080.95	-77.73
Green Land	15322.41	6598.72	6782.71	7953.88	6556.1	-57.41
BuiltUp	1967.04	7764.75	8508.18	9849.21	10717.92	444.87
Agricultural Land	4779.11	10312.5	5980.23	4530.41	5474.18	14.54

Water Quality Study: The samples taken from the mine site and various other points were analyzed in the laboratory as per the method listed earlier. The results of various tests performed are discussed below.

The sample of surface water shows that the variation of the physico-chemical parameters remains nearly same around the four months;i.e. there is insignificant change in temporal variation. The value of pH decreases from upstream to downstream whereas the EC values were high at mine site. The value of Total Hardness and Total Dissolved solids shows the sane trend as the EC values. These values coincide with EIA report and were under guidelines of EPA. The value of Turbidity and TSS were affected very largely, from upstream to downstream, these values shows the increasing trend. Same trend was shown by the study on Kelantan river, Harsit Stream and Okoro Nsit stream **(River and Peck Yen, 2013; Bayram and Onsoy, 2015; Akankali, Idongesit and Akpan, 2017).** There was a little change in the value of DO, similar to Lambodaro tributary of River Musi **(Juniah and Rahmi, 2017)** . These results are shown in table 4.

Table 4: Test results for various physico-chemical parameters for Surface Water

S. No	Parameter	SW1 (Mine Site)					SW2 (Upstream)					SW3 (Downstream)					EPA Guideline's
		Jan	Feb	Mar	Apr	EIA Report	Jan	Feb	Mar	Apr	EIA Report	Jan	Feb	Mar	Apr	EIA Report	
1	pH	8.38	8.39	8.42	8.44	8.08	8.11	8.2	8.26	8.3	7.81	7.69	7.78	7.85	7.88	7.9	5.5-8.5
2	EC (µS)	242	245	240	242	-	231	230	236	238	-	230	225	233	239	-	1000
3	TDS (ppm)	119	119	119	112	132	118	118	117	116	148	117	117	116	116	153	-
4	Total Hardness (mg/l)	142	142	142	143	104	141	141	140	141	144	140	140	140	142	148	-
5	Turbidity (NTU)	12	11	11	10	<1	1	2	4	5	<1	16	15	16	15	<1	<1
6	TSS (mg/l)	68	66	66	64	15	14.6	15.7	16.3	17.8	14.2	58	59	59	55	5.5	50
7	DO (mg/l)	6.3	6.6	6.2	6.2	6.8	7	6.8	6.7	6.7	6.5	6	5.8	5.8	5.6	5.6	>6

Similarly, in ground water, the variation of the physico-chemical parameters also remains nearly same around the four months. The value of pH is nearly neutral for all the ground water samples whereas the EC values were high at GW2 and GW3. The value of Total Dissolved solids shows the same trend as the EC values. Total Hardness shows no relation with the mining activities. These values coincide with EIA report and were under guidelines of EPA except the values for G2 and G3. The value of Turbidity and TSS were affected very largely in G1 and G2. The values for the ground water tests are shown in table 5 for the sampling site GW1, GW2 and GW3.

Table 5: Test results for various physico-chemical parameters for Ground Water from site 1, 2 and 3.

S. No.	Parameter	GW1 (Mine Site, Depth-20')					GW2 (500m from Mine Site , Depth-40')					GW3 (Village Gumthala Rao, Depth-40')					IS 10500 Specification
		Jan	Feb	Mar	Apr	EIA Report	Jan	Feb	Mar	Apr	EIA Report	Jan	Feb	Mar	Apr	EIA Report	
1	pH	7.8	7.8	7.73	7.7	7.6	7.2	7.2	7.15	7.17	7.8	7.07	7.07	7.13	7.1	7.82	6.5-8.5
2	EC (µS)	262	260	254	252	-	1540	1570	1579	1580	-	1330	1366	1327	1325	-	-
3	TDS (ppm)	127	127	127	127	237	725	732	736	739	447	655	665	660	660	122	500-2000
4	Total Hardness (mg/l)	155	155	155	154	160	181	181	181	180	186	424	424	423	424	65.7	200-600
5	Turbidity (NTU)	9	8	8	6	<1	12	14	13	17	<1	4	3	2	1	<1	1-5
6	TSS (mg/l)	6.3	5.8	5.2	5.2	-	2.9	2.46	2.14	2	-	2.8	2.6	2.4	1.3	-	-

For sampling site GW4 and GW5, the values obtain are shown in table 6.

Table 6: Test results for various physico-chemical parameters for Ground Water from site 4 and 5.

S. No.	Parameter	GW4 (Village Barheri, Depth-150')					GW5 (Village Chaugawan, Depth-180')					IS 10500 Specification
		Jan	Feb	Mar	Apr	EIA Report	Jan	Feb	Mar	Apr	EIA Report	
1	pH	7.45	7.45	7.85	7.83	7.85	7.34	7.34	7.74	7.78	7.64	6.5-8.5
2	EC (µS)	215	210	222	220	-	248	268	258	255	-	-
3	TDS (ppm)	194.4	191.5	192.4	195	193	350	350.2	346	355	356	500-2000
4	Total Hardness (mg/l)	1003	1003	1003	1002	93	1099	1101	1100	1101	240	200-600
5	Turbidity (NTU)	2	3	1	2	<1	1	2	2	1	<1	1-5
6	TSS (mg/l)	2.4	2.1	2	1.6	-	3.4	2.9	2.5	1.6	-	-

The physico chemical parameter shows specific trend for different parameters as discussed in the following paragraph (a) pH: The results have been shown in figure 6a. It varies from 7.07 to 8.44. This range is under the EPA guidelines (5.5-8.5) and IS 10500 specification (6.5-8.5). (b) EC: For surface water, the values of EC are under EPA guidelines but the value varies for the ground water sample. The EC value for GW2 and GW3 are higher than the prescribed value (EPA guidelines 1000 µS). The trend is shown in figure 6b. (c) TDS: The trend for TDS is same as that of EC and is shown in figure 6c. (d) Total Hardness: Total Hardness is more at the sampling points which are away from the mine site. Hence, no correlation is found for the total hardness and mining activity as shown in figure 6d. (e) Turbidity: Turbidity at mine site and at downstream end is very high for surface water. Also, the ground water sample GW2 and GW3 shows higher turbidity (>1 NTU). The trend is shown in figure 6e. (f) TSS: Similar to the turbidity, TSS also shows the same trends and it is shown in figure 6f. (g) DO: The DO for upstream and mine site are under guidelines (6 mg/l) but the values are slightly less for downstream. It may be due to mining activities.

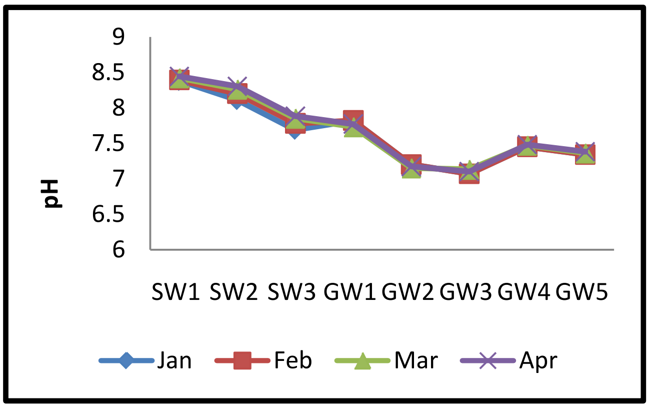

Figure 6a: pH Variations

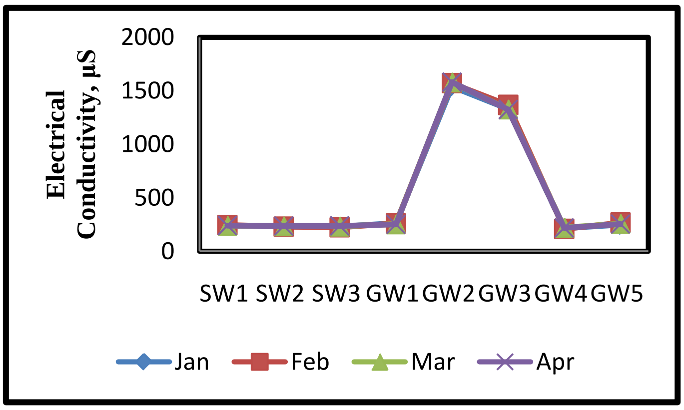

Figure 6b: EC Variations

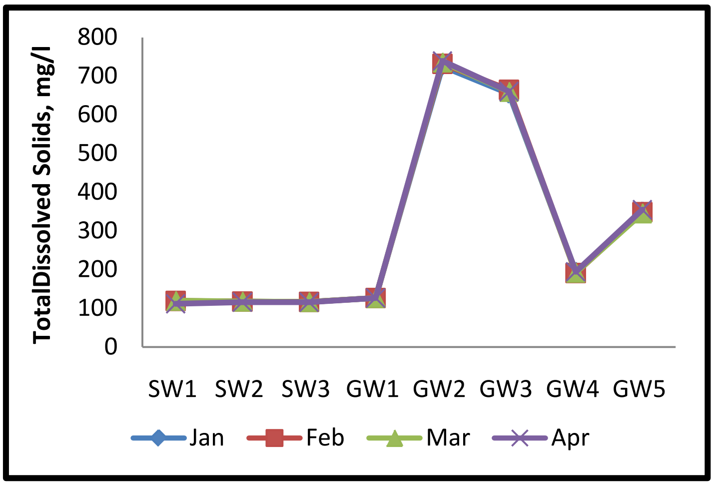

Figure 6c: Total Dissolved Solids variation

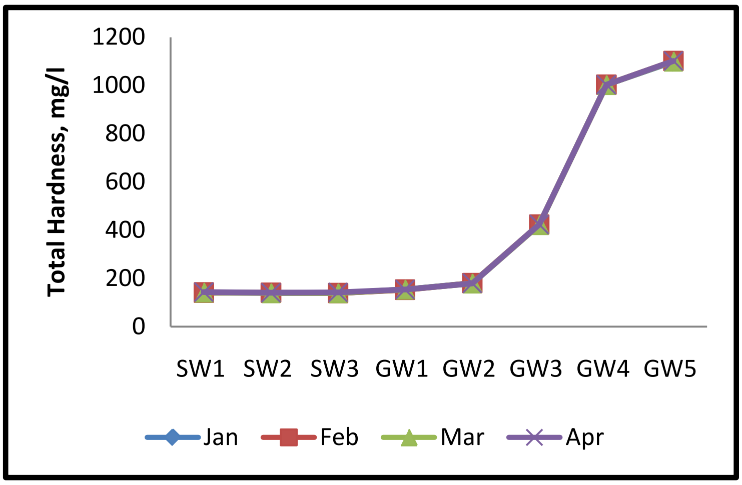

Figure 6d: Total Hardness variation

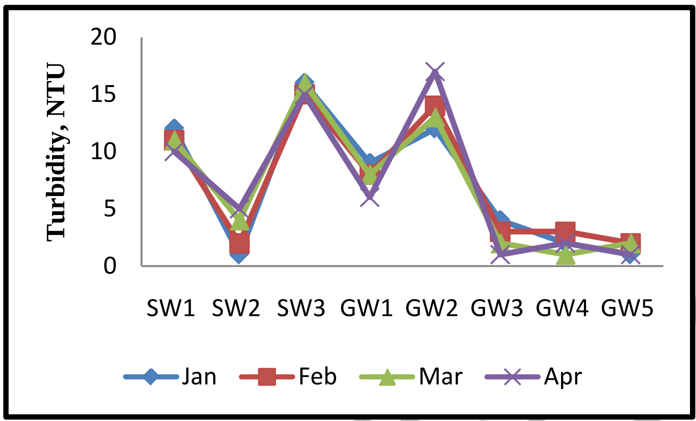

Figure 6e: Turbidity variation

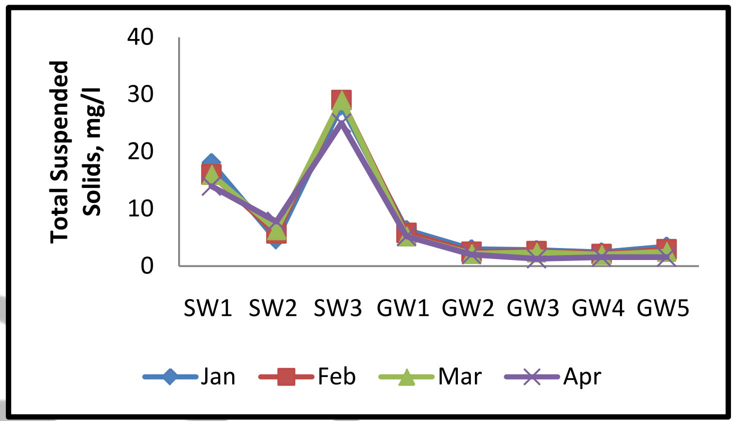

Figure 6f: Total Suspended Solids variation

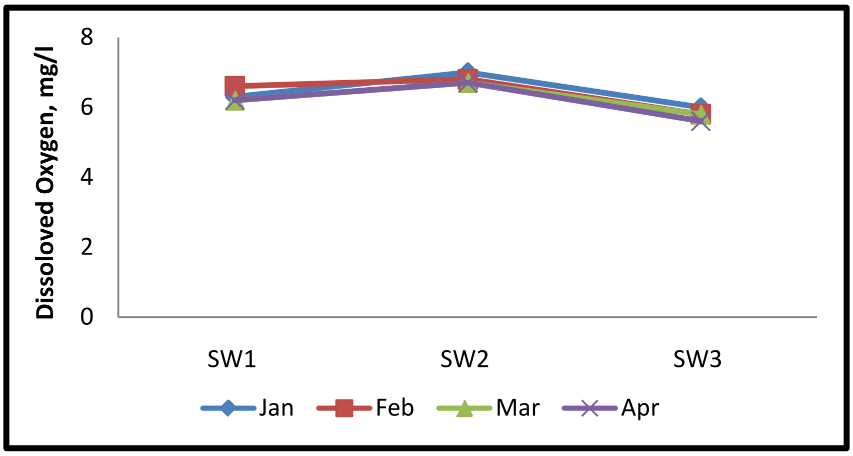

Figure 6g: Dissolved Oxygen variation

Figure 6: Variations of various Physico-Chemical Parameters

Conclusions and Recommendations: The study on impacts of sand mining reports that sand mining affects both land use/ land cover and water quality of the surrounding area. Following conclusions have been observed from the present study:

- **LULC-**Due to excess mining activities, there is substantial decrease in the sand cover in the study period. The sand cover in 2000 was 8.3% of the study area while in 2018 it is only 1.27% of sand is left i.e. 84.61 % decrease in sand cover on the river belt. If same scenario persists, there will be no sand in river belt in the upcoming years. Decrease in water bodies is 77.73 %. The surface water which is the important source for the mankind is depleting in the region. Although the surface water does not depend only on one issue but it has a major contribution in depleting. The mining causes damage to the vegetation and surface water etc. The excessive withdrawal of water due to mining activity resulted in shortage of surface water. Slight increase of 14.54 % agricultural area is observed .There is 102.67 % increase in open land .This increase in open area may be on account of no construction zone /parks gardens or cleaning of forest area/ vegetation/agriculture etc. Due to urbanization in the city 444.87 % increase in built up area is seen. Due to increase in built up area and open land 57.41 % decrease in green land is observed.

- **Surface water-** Due to sand mining, there is no significant effect on the parameters like pH, EC, TDS and Total Hardness for surface water. These values are similar to the values in EIA report and also these values are in range of the standards provided by EPA. For SW1, The value of Turbidity has been increased almost 10 times the EPA guidelines. TSS has been increased by 32% from the EPA guidelines. Similarly, for SW3, value of turbidity has been increased by almost 5.17 times the EPA guidelines. TSS has been increased by 15 %.DO is slightly decreased by 5% only at downstream. The values for SW1 and SW3 have been adversely affected by mining activities as the values in upstream (SW2) are under EPA guidelines.
- **Ground water-**In case of ground water, the values of, TDS, Turbidity and TSS has increased in GW1, GW2 and GW3. For GW1 major effect has been observed on turbidity i.e. almost 7 times the IS recommendations. For GW2 increase in TDS was observed as 46.6% while turbidity was almost 14 times and increase in TSS was about 238.5%. For GW3 increase in TDS was observed as 32% while turbidity was almost 2.5 times and increase in TSS was about 227.5%.Total hardness is more in the GW4 and GW5 and has no correlation with sand mining. Hence, we can conclude that to an extent, the ground water quality has also been affected due to the sand mining.

Recommendations: The results obtained have analyzed and presented in the above paragraphs. The authors wish to recommend some points which may minimize the impacts of sand mining: (a) An Environmental Monitoring program must be developed and should be necessary part of extraction of sand. (b) Alternatives to river sand must be encouraged and sand should be imported from areas where there is surplus availability. (c) Monitoring stations must be setup for the proper checking of sand mining impacts on water quality. (d) Evaluate control measures such as bank stabilization, revegetation of buffer strips, influences of connected floodplain pits etc. Restoration efforts should concentration techniques that will optimize water quality. (e) Various awareness campaigns should be conducted about river sand mining discussing impacts of mining on rivers and its mitigation measures.

References

Akankali, J. A., Idongesit, A. S. and Akpan, P. E. (2017) 'Effects of sand mining activities on water quality of Okoro Nsit stream , Nsit Atai local government area , Akwa Ibom state , Nigeria', 6(7), pp. 451–462.

Atejioye, A. A. and Odeyemi, C. A. (2018) 'Analysing Impact of Sand Mining in Ekiti State, Nigeria Using GIS for Sustainable Development', *World Journal of Research and Review*, 6(2), pp. 26–31.

Bayram, A. and Onsoy, H. (2015) 'Sand and gravel mining impact on the surface water quality: a case study from the city of Tirebolu (Giresun Province, NE Turkey)', *Environmental Earth Sciences*, 73(5), pp. 1997–2011. doi: 10.1007/s12665-014-3549-2.

Bindhusri, A. and Arunachalam, M. (2015) 'Environmental impact of sand mining in Tamiraparani River, south Tamilnadu', *International Conference on Engineering Trends an Science & Humanities ICETSH*, (August), pp. 123–132. Available at: http://www.internationaljournalssrg.org/IJECE/2015/Special-Issues/ICETSH/IJECE-ICETSH-P122.pdf.

Hill, L. (1999) 'Preliminary guidance document for authorisation and licensing of sand mining / gravel extraction in terms of impacts on instream and riparian habitats', pp. 1–14.

Jonah, F. E., Agbo, N. W., Agbeti, W., Adjei, D. and Shimba, M. J. (2015) 'The ecological effects of beach sand mining in ghana using ghost crabs (ocypode species) as biological indicators', *Ocean and Coastal Management*. Elsevier Ltd, 112, pp. 18–24. doi: 10.1016/j.ocecoaman.2015.05.001.

Juniah, R. and Rahmi, H. (2017) 'The influence of sand mining towards the sustainability of power support and capacity of Lambidaro River', *AIP Conference Proceedings*, 1903(November). doi: 10.1063/1.5011534.

Mitra, M. and Singh, S. (2015) 'GIS in Demarcation , Management and Planning of Sand Mining Zone', *International Journal of Scientific Engineering and Research*, 3(10), pp. 137–143.

Padmalal,D.,Maya, K., Sreebha, S. and 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), pp. 879–889. doi: 10.1007/s00254-007-0870-z.

Pillay, S., Naidoo, K.,Bissessur, A., Agjee, N., and Ballabh, H. (2017) 'Sand Mining Impacts on Heavy Metal Concentrations in Two Important River Systems of Northern Kwazulu-Natal, South Africa', *Journal of Human Ecology*, 47(2), pp. 155–162. doi: 10.1080/09709274.2014.11906748.

River, K. and Peck Yen, T. (2013) 'Status of Water Quality Subject to Sand Mining in the', *Tropical Life Sciences Research*, 24(1), pp. 19–34.

Singh, J. (2016) 'Environmental Impact Assessment report and for mining of sand (river bed mining) at yamuna river at mine lease period- 07 years Sh . Jogender Singh S / o Sh . Mahinder Singh '.