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Environmental Impact of Coal Mining on Water Resources: An Overview

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Abstract: This study is focused on of impact of coal mining on water resources. Subsurface water level subsidence and water contamination due to wash off, mine water discharge, acid mine drainage, and coal washing operations in the Raniganj coalfield area are all concerns caused by mining activities. Pumping operations release water from mines, and decline subsurface water levels. Water pollution occurs in mining areas by physically, which results from silting in water bodies and chemically by containing trace elements. The main oobjectives of this research paper are to detect the problems related to impacts of mining on water resources. And, to find out the remedies of those problems with the help of primary and secondary data and their analysis with using proper methodology and technique.

Keywords: Subsurface water table, Mine water, Acid mine drainage, Trace elements and Overburden dumps.

I. INTRODUCTION

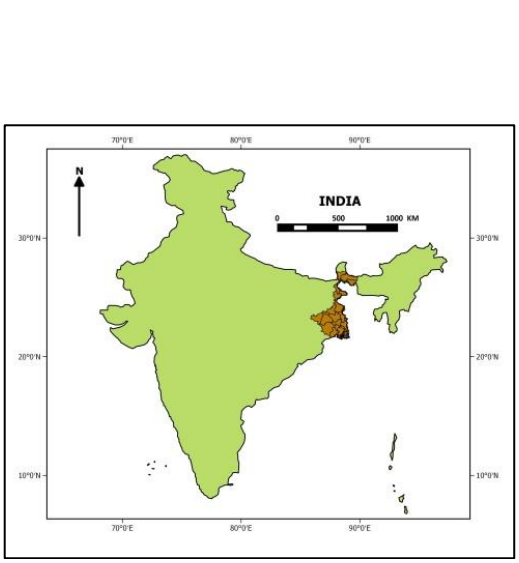
Coal mining is an extractive industry. The coal mining area of Raniganj is one of India's oldest. In the Damodar Valley, it is the richest coal mining zone, and it plays an important role in Indian national economy. Mining takes place in the Raniganj region using both open cast and underground methods. Nimcha, Jemari, Satgram, Mangalpur, Dhosur, Bashra, Damulia, and Barabani are some of the prominent collieries in the Raniganj coal field. (Figure no.-4). At about 90 per cent collieries are belonging to underground extraction and only 10 per cent from open cast mining process [1]. Coal extraction has the potential to harm the environment. Mining has the major environment impact on water resources. Subsurface water level subsidence and contamination attributed to wash off, mine water discharge, acid mine drainage, and coal washing operations in the Raniganj coalfield area are all concerns caused by mining activities. Pumping operations release water from mines, lowering subsurface water levels. As a result, the focus of this research is on the impact of coal mining on water resources.

II. OBJECTIVES

The main objectives of this study are to detect the problems related to impacts of mining on water resources and to find out the remedies of those problems.

III. STUDY AREA

The Raniganj coalfield is the most important coalfield in West Bardhaman district of West Bengal in India. The region lies in the Damodar valley region, surrounded by the Durgapur- Asansol industrial belt, and is bounded by latitudes 23˚35´ N to 23˚55´and longitudes 86˚ 45´ E to 87˚ 20´ E (Figure No.- 1&2). It extends for 75 kilometres between Mugma and Durgapur in the west and north-south direction. It is 35 kilometres long and is bordered on the south by the river Damodar and on the north by the river Ajoy. The Andal-Sainthia railway line may act as the eastern boundary.



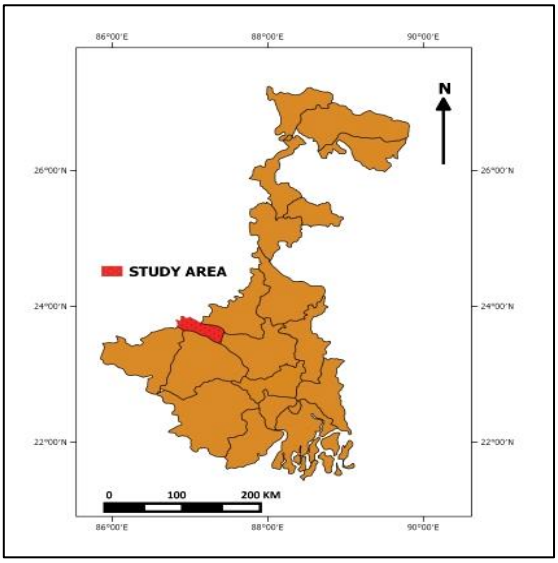


Figure- 1: West Bengal in India, Figure-2: Raniganj Coal Belt area in West Bengal

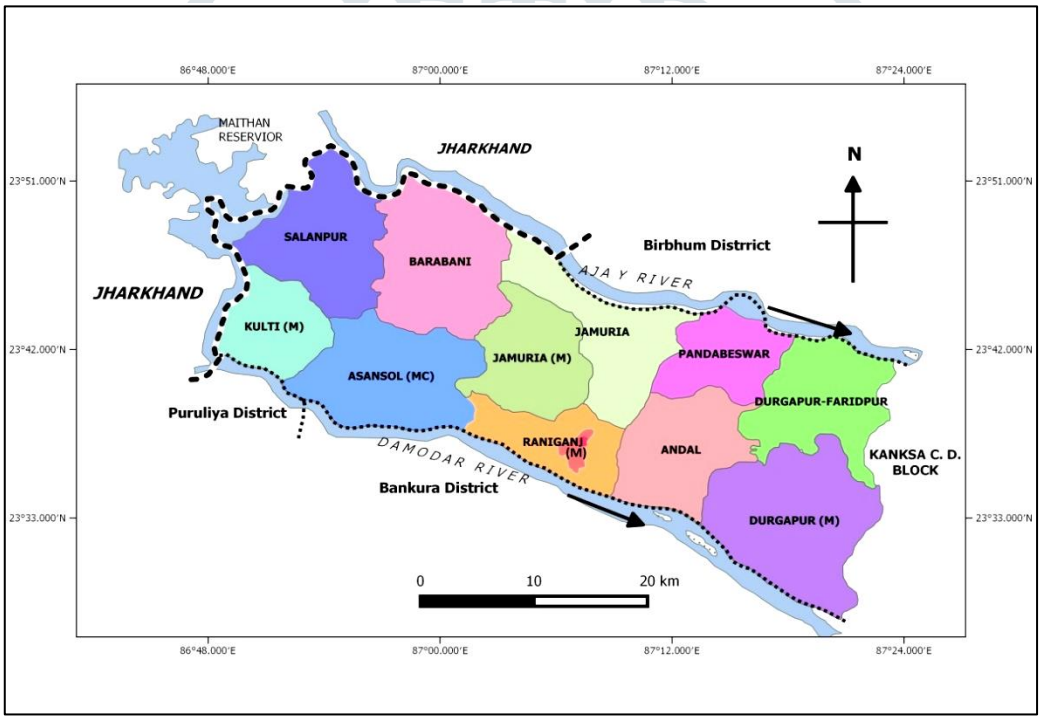


Figure-3: Study Area – Raniganj Coal Belt in West Bardhaman District

Source of Figure: 1, 2 & 3 - India and West Bengal Administrative Atlas (2011), Asansol Durgapur Development Authority (ADDA)

IV.MATERIALS AND METHODS

The methodology of the study includes reviewed of different articles, collection of research data over the field study and observation methods. Primary data have been collected from field study and personal interview at different collieries with the officers, workers and local people of Raniganj coal field area. Secondary data have been collected from Central Mining Planning and Design Institute Limited (CMPDIL) office, Environmental Impact Assessment (EIA) reports, journals and books and research paper related to coal mines. QGIS software (Version -2.8.3) is used for making suitable maps.

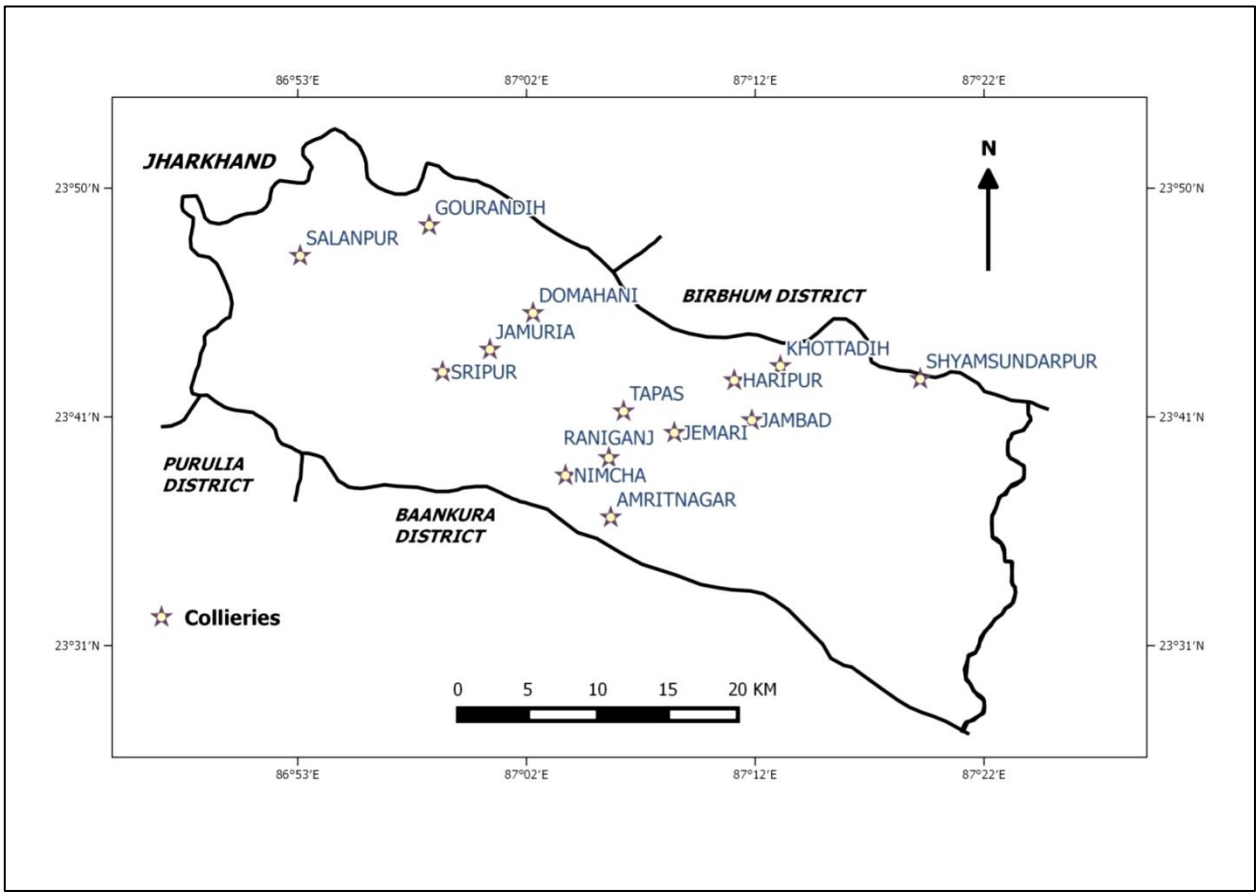


Figure-4: Some important Collieries of Raniganj Coal Belt Area , West Bardhaman District, West Bengal
Source of Figure: 4-Asansol Durgapur Development Authority (ADDA), CMPDIL

V. RESULT AND DISCUSSION

Coal is in high demand as a primary source of energy production. The country's coal production has been dramatically increased to fulfil that need. Coal is normally extracted using one of two methods: opencast or underground, however both processes damage the ecosystem. The mining industry causes environmental damage in a number of different ways, but it has the greatest impact on water resources. Water level goes down to expel excess water from the mine. Furthermore, toxic and hazardous compounds in the mineral area make the water highly toxic when it comes into contact with it, making it unfit for use and detrimental to health. This paper describes water resources in the coal mining region being affected in two ways, both quantitatively and qualitatively.

1. **Depletion of water Level**

The spatial fluctuation of under water level is caused by various factors. Surface relief, lithology, rainfall, hydrological features, and anthropogenic activity are some of the factors [2]. Water levels in the Raniganj coal belt area are dropping due to huge water releases from mines through pumping activities (Table no.-1). Coal seams are voids and cracks created by the excavation of coal from underground mines. Water from the upper layers can sometimes seep into the lower layers and leads to lowering the subsurface water level.

Table No.-1: Daily Mine Water Discharge from some mines of Raniganj Coal belt area

Sl. No.	Name of the Mine	Average Mine Pumping (m^3/day)	Domestic consumption from mine water (m^3/day)	Industrial consumption from mine water (m^3/day)	Excess mine water (m^3/day)
1	Satgram UG	1100	475	1100	0
2	Chapukikhas UG &OC	870	366	156	348
3	Amritnagar UG	1390	897	205	288
4	Nimcha UG	2150	1292	817	41
5	Jemehari UG	780	245	42	493
6	North Searsol UG	1500	800	500	200
7	Kunustoria	3250	750	800	1700
8	Bansra UG	2000	733	770	497
9	Jambad UG	800	600	100	100

10	Pandaveswar UG	1000	790	180	30
11	Kendra UG	1000	807	70	123
12	Sonepur Bazari OPC	5000	1000	4000	0
13	Jhanjra UG	2250	1936	1530	220
14	Shyamsundarpur UG	1500	700	730	70
15	Bankola UG	1400	1000	380	20

Source: CMPDL Office, Asansol

Some CMPDIL monitoring stations recorded historical groundwater levels in the Raniganj coalfield from 2013 to 2020 (table no. 2). Pre-monsoon water levels range from 1.70 to 10.55 metres below ground level (bgl), with an average of 4.57 to 7.59 metres. Water levels in the post-monsoon range from 1.55m to 9.58m. The annual change in water level ranges from 0.54m to 6.60m bgl, with an average of 0.89m to 3.87m. Pre-monsoon water levels have been seen to be decreasing. However, a rising tendency in the amount of fluctuation between pre- and post-monsoon levels strongly suggests that mining has a negative impact on groundwater levels in the Raniganj coalfield area.

Table No.- 2: Historical Ground water level of Raniganj Coalfield area, 2013-2020

Period	Water level in Metre below ground level								
	Pre- monsoon (Aril/May)			Post monsoon (Nov/Dec)			Fluctuation		
	From	To	Average	From	To	Average	From	To	Average
2013	5.02	10.5	7.59	2.85	4.9	3.71	1.82	6.6	3.87
2014	2.2	8.85	4.74	2.78	9.58	4.63	0.68	1.1	0.89
2015	3.57	8.02	4.98	2.5	6.21	3.75	0.55	1.9	1.23
2016	3.1	7.34	4.59	1.55	7	3.66	0.05	2.78	0.94
2017	1.7	9.87	6.54	2.9	8.85	4.71	1.02	5.54	2.84
2018	3.27	6.48	4.57	2.13	3.03	2.63	0.54	3.45	1.94
2019	3.38	9.52	5.33	2.68	8.2	5.11	1.06	1.32	1.81
2020	3.61	10.65	6.24	0.9	6.5	3.18	1.63	4.4	3.06

Source: CMPDL Office, Asansol

2. Lowering of water quality

Coal mining releases a lot of oil and grease from the machinery required to extract and transport coal, which mixes with water bodies and makes them vulnerable [3]. Large overburden dumps are built along the mine area in the event of open cast mining. These dams are contaminated with pyrites, nitrous oxide, and hazardous metals. Rainwater washes them away, and they end up in surrounding rivers, streams, and reservoirs. As a result, it causes contamination of the water and becomes not usable for domestically. According to Central Mining Planning and Design Institution Limited (CMPDIL) report 2014[4], the nitrate concentration in opencast mine water is extremely high in the Raniganj Coal mining area due to the usage of high nitrate

explosives. The water quality that has been evaluated by CMPDIL samples of groundwater discharge from various underground mining projects is shown in Table no.- 3. The findings are compared to the Ministry of Environment and Forests (MoEF), Government of India Schedule-VI mine discharge norms. The analysis findings are found to be broadly consistent with the stipulated stands. Only the nitrogen concentration and pH level are high in this area.

3. Acid mine drainage

When a substance or material is injected to water in excess of the amount specified, it becomes unusable for use, which declines the water quality Acid mine drainage occurs when water drained from a mine comprises excessive levels of heavy metals, sulphate, pyrite, and other minerals, and it pollutes water resources unless adequately treated [5]. The fertility of organisms living in these contaminated waters decreases, as the aquatic food chain is collapsed. As a result, ecosystems are permanently damaged [6].

Table No.3: Mine water quality data

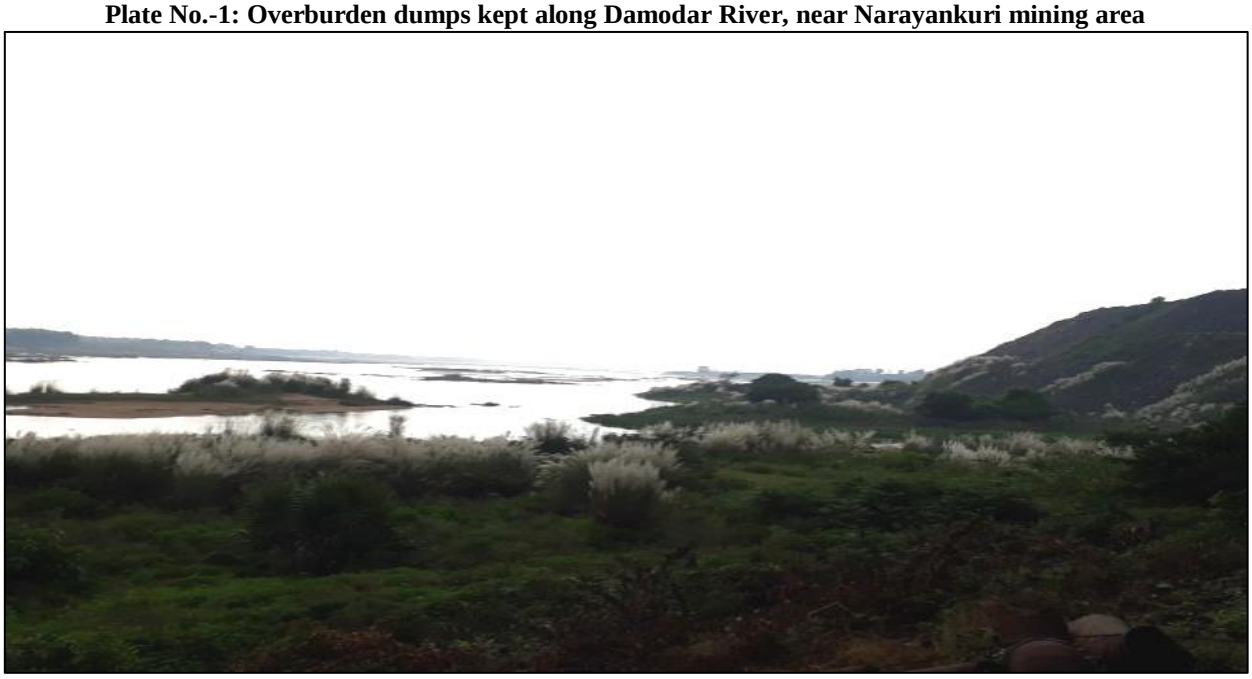
Sl. No.	Parameters (mg/l except Temperature)	Name of the Coal Mines (Result of Discharge water)						MoEF Scheduled - VI
		Sodepur	Narsamuda	Patmohona	Chinakuri I	Chinakuri III	Sheetalpur	
1	Suspended Solids	26	30	30	34	32	30	100
2	Oil & Grese	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10
3	Arsenic (as As)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2
4	Lead (as Pb)	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	0.1
5	Copper (as Cu)	0.02	0.03	0.02	0.02	0.02	0.02	3
6	Zinc (as Zn)	0.04	0.02	0.03	0.02	0.02	0.02	5
7	Dissolved phosphates (as PO4)	0.88	1.4	1.1	1	0.8	1.1	5
8	Sulphides (as S)	0.03	0.02	0.02	0.03	0.02	0.02	2
9	Nitrate Nitrogen (as N)	7.8	7.4	6.2	6.8	6.4	7.2	10
10	p H	8.2	8	8.2	8.2	8.3	8.1	5.5-9.0

Source: CMPDIL Office, Asansol

4. Impact on river morphology

Overburden and waste materials from open cast mines and quarries are frequently washed into nalas or local water drainages, clogging their flow. As a result, the nalas are subjected to water logged conditions. The overburden dumps are made up of loose, unconsolidated materials from quarries [7]. Rain water washes away these loose sediments, causing erosion on overburden dumps [8] [9]. As a result, these dumps serve as sources of silt and deposit in the drainage system adjacent to them [10]. Coal mining overburden dumps are frequently kept on river banks, obstructing the river's flow (Plate No. 1). Various pollutants in it pollute the river water at the same time.

Plate No.-1: Overburden dumps kept along Damodar River, near Narayankuri mining area



Source: Field Survey by the author (September 2021), Raniganj Coal Belt Area

5. Water Resources Management

To effectively maintain the quality and quantity of water resources in the coal mine area, certain techniques and procedures are required. Some of the associated water resource management practises explored are listed below.

i) Mine water discharges from pumping operations must be kept to a safe level and used properly.
ii) The multipurpose use of mine water must take into account water shortage in the surrounding area.
iii) The lands and pits that have sunk can be turned into ponds for water gathering and conservation, as well as fisheries.
iv) Plantation in the mining region to improve vegetation cover, which will minimize runoff and increase ground water recharge.
v) The water quality of mine water discharged into the local river, nala, and domestic water supply shall be monitored.

VI. CONCLUSION

The above discussion shows that coal extraction and its related activities are having a very detrimental effect on the environment as well as water resources. Land erosion, forest degradation, soil contamination, air pollution, and natural drainage deterioration are all negative effects of coal mining. Mine discharge water contaminates the surface and groundwater which adversely effect on environment as well as on human health. Ground water levels are lowered as a result of overexploitation through pumping operations. The Government, mining authorities and local people have to be taken some remedial measure with proper care for minimizing the problems.

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