International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

Effect of Coal Mining in Water Quality of Prang River and Lynriang River, Jaintia Hills, Meghalaya, India

Lamsuk Nongtdu[1] Dr. Mimi Das Saikia [2]

[1]*M.tech student, Civil Engineering, Assam Downtown University, Guwahati, Assam, India*
[2]*Professor, Civil Engineering, Assam Downtown University, Guwahati, Assam, India*

---***---

Abstract - *The objectives of this study was to analyse and evaluate the water quality index seasonally of different water bodies in Meghalaya that are affected by coal mining. Meghalaya has a large deposit of coal and is also one of the most utilized minerals in the state. The water bodies of the state in the coal mining area have been greatly deteriorated due to this activity. The water samples from the coal mining area were collected on the month of September 2017, January 2018 and May 2018. Water quality index was analyse based on the various physicochemical parameters obtained after testing the samples. Pollution of the water can be clearly seen by the coloration of water in which most of the rivers and streams in that mining area their color varies from brownish to reddish orange. The samples were collected from two Rivers in the coal mining regions i.e., Prang River and Lynriang River in East Jaintia Hills district of Meghalaya. The analysis carried out to find the effect of the coal mining activities on the water quality of that area. The parameters that were determined for this purpose are temperature, pH, conductivity, TDS, turbidity, Total Hardness, Chloride and nitrate. The calculation was done using weighted arithmetic index method.*

Key Words- Meghalaya, Jaintia Hills, Water Quality Index, Physico-Chemical Parameters, Weighted Arithmetic Index Method

1. INTRODUCTION

Water is essentially important to every aspect of our lives. Studying the quality of surface water is necessary in order to protect our waterways from pollution. Coal mining is also one of the major causes of water pollution. Coal mining process such as preparation, combustion, waste storage, and transport cause various health effects to the people.

India has the fifth largest coal reserves in the world. India had 308.80 billion metric tons (340.39 billion short tons) of the resource. The estimated total reserves of lignite coal as on 31 March 2016 was 44.59 billion metric tons (49.15 billion short tons).

Meghalaya is one of the seven north-eastern states of India. Meghalaya has a rich base of natural resources include minerals like coal, limestone etc. The coal is found to be deposited along the Khasi hills, Jaintia hills and Garo hills.

The Jaintia Hills is one of the seven districts of Meghalaya that occupies the eastern part of the state. It covers an area of 3819 Km2 which is 17.03% of the total geographical area of the state. The Jaintia Hills District of Meghalaya is a major coal producing area with an estimated of about 40 million tones. These mining activities are controlled and managed by the individual who own the land. Mining operation has led to deterioration of environment. The quality of water is found to be very poor and not suitable for human use. In some rivers the colour of the water also has changed and many aquatic lives found dead.

Table 1- Location of Water sample

River	Latitude	Longitude
Lynriang (upstream)	25.365	92.315
Lynriang (midstream)	25.326	92.316
Lynriang (downstream)	25.239	92.235
Prang (upstream)	25.369	92.330
Prang (downstream)	25.346	92.344

2. MATERIALS AND METHODS

To classify the water quality of the selected river based on the water quality index, the water sample collected is tested is tested with different water quality parameters along the river in the month of September 2017 from their respective upstream and downstream site. Two rivers were selected (Prang River, Lynriang river). The surface water samples were collected in mid channel points between 07.00 and 12.00 hours from each of the sampling sites and placed in bottle for the laboratory investigations.

The calculation for weighted arithmetic water quality index (WQI) is given in the equations below:

$$WQI = (\sum WiQi)/(\sum Wi)$$

The quality rating scale (Qi) is calculated by using this expression below:

$$Qi = 100[(Vi - Vid)/(Si - Vid)]$$

Where,

Vi is the observed value of the parameters in the analysed water.

Vid is the ideal value of this parameter

$Vid = 0$ (Except pH=7.0 and DO=14.6mg/l)

For pH, we have the ideal value to be equal to 7 and a permissible value 8.5. Therefore, the equation for quality rating of pH is given below:

$$Q_{pH} = 100\left[\frac{(V_{pH}-7)}{(8.5-7)}\right]$$

Where V_{pH} is the observed value of pH.

Si is the standard value of the parameter

Table 2- Classification of water Quality based on Weighted Arithmetic WQI method

WQI	STATUS
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
Above 100	Unsuitable for Drinking

3. RESULTS AND DISCUSSIONS

The following are the value of each parameters of the water sample taken along Lynriang River:

Table 3- Parameters obtained from Lynriang River

Parameters	Upstream	Midstream	Downstream
pH	3.1	2.9	4.6
Conductivity (µmho/cm)	240	680	70
Total Dissolved Solids (mg/l)	166	469	50
Turbidity (NTU)	15	9	15
Chloride (mg/l)	11	9	6
Total Hardness (mg/l)	22	52	34
Nitrate-N (mg/l)	0.24	0.26	0.36

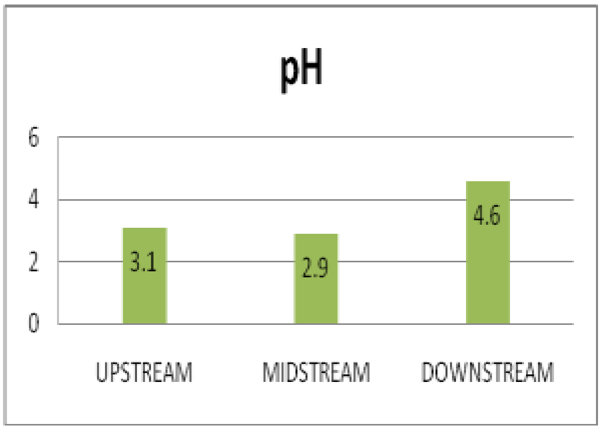

Figure 1- Variations of pH along Lynriang River

The river in coal mining areas has been found to be highly acidic. The pH of this river in their respective upstream, midstream and downstream is recorded to be 3.1, 2.9 and 4.6 respectively. The value recorded is not under the permissible limit. This shows in this area the river is in serious condition and the water is unsuitable for drinking. This type of water bodies cannot support any aquatic life in it such as fish, insects and amphibians. Downstream part of the river is mildly acidic as this part of the river is located away from the coal mining operations as compared to upstream and midstream part of the river and also vegetation and forest surround the area. Low pH of water bodies is cause due to the contamination of the Acid mine drainage (AMD) that leads to acidic behaviour of the water.

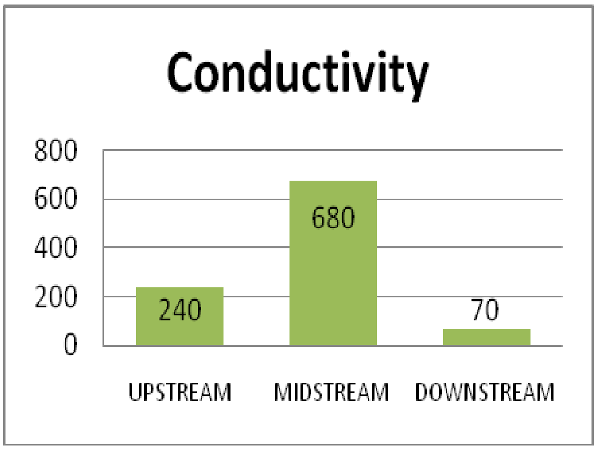

Figure 2-Variations of Conductivity along Lynriang River

Conductivity is the measure of the capacity of a solution to pass electrical flow. It measure the total dissolved solids present in ionic form. High conductivity of water indicates more ions present and low conductivity means fewer ions that are in the water. In this study, the conductivity is found to be 240µmho/cm, 680µmho/cm, and 70µmho in the upstream, midstream and downstream part of the river respectively. The highest value was recorded in the midstream of the river due to the inorganic dissolved solids such as nitrate, iron, and chloride. Significant increase in conductivity indicates that polluting discharge have entered the water.

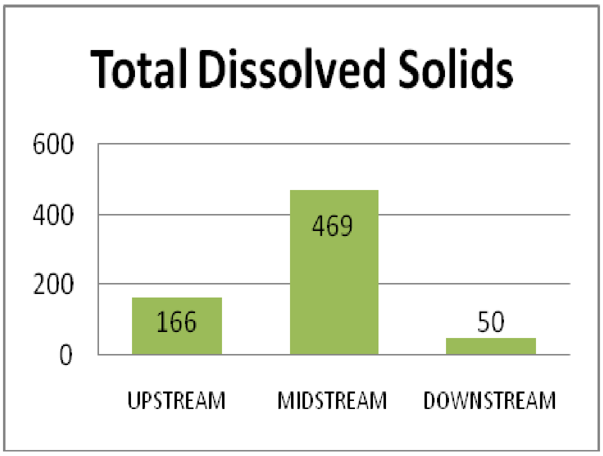

Figure 3-Variations of T.D.S along Lynriang River

Total dissolved solids (TDS) indicated the presence of different materials both in colloidal and dissolved solids like Na, K, Ca and Mg in natural. Total dissolved solids (TDS) were recorded as 166mg/l, 469mg/l, 50mg/l in the upstream, midstream, downstream respectively. The highest value recorded in the upstream and midstream. Dissolved solids can come from industrial waste, sewage, plankton and silt. Runoff from urban areas, road, fertilizers etc is also the sources of TDS. Downstream part of the river was found to have the lowest value (50mg/l) as it is located in forest cover area.

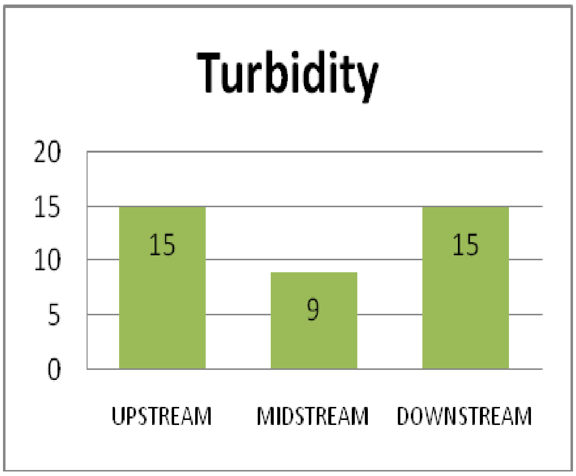

Figure 4-Variations of Turbidity along Lynriang River

Turbidity is a measure of the water's transparency, water with high turbidity is cloudy while water with low turbidity is clear. Turbidity of the river was recorded as 15NTU, 9NTU and 15.0NTU in upstream, midstream and downstream of Prang River respectively. This indicates that turbidity in this river is significantly high. The highest value was recorded at downstream (15.0NTU) of the river. This is due to high waste discharge, suspended and dissolved particles that get mixed up with water carry by runoff.

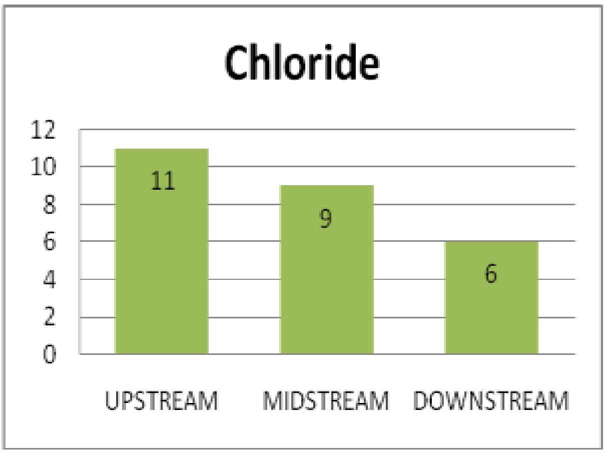

Figure 5-Variations of Chloride along Lynriang River

Chloride in the form of Cl^- ion is one of the major inorganic anions (negative ions) in saltwater and freshwater. The salty taste produced by chloride in drinking water depends on the concentration of the chloride ion. The chloride content from the study sites was found to be 11mg/l, 9mg/l and 6mg/l in the upstream, midstream and downstream respectively which is under the permissible limit. The highest chloride concentration observed in upstream and midstream and this might be due to higher accumulation of AMD in the areas that get contaminate with the water bodies.

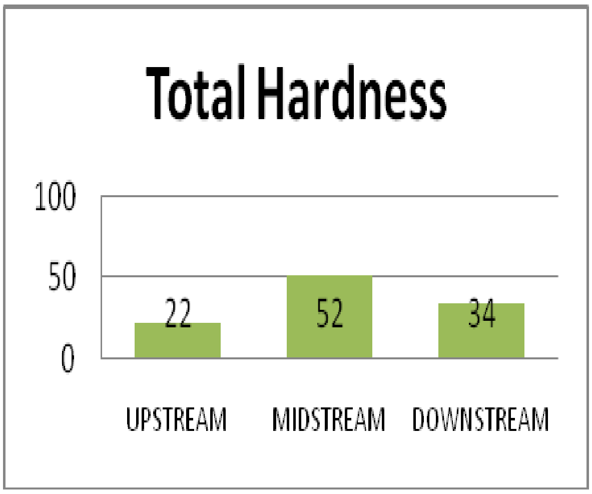

Figure 6-Variations of Total Hardness along Lynriang River

Water hardness is a measure of the amount of dissolved calcium and magnesium salts in water. The more calcium and magnesium content in the water, the harder the water will be. The total hardness was observed to be 22mg/l, 52mg/l, and 34mg/l in upstream, midstream and downstream respectively. It is caused due to the present of dissolved bicarbonate mineral like calcium bicarbonate and magnesium bicarbonate. Excess calcium and magnesium ions contribute to water hardness.

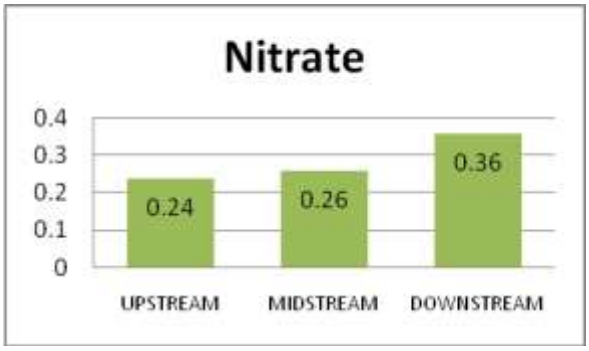

Figure 7-Variations of Nitrate along Lynriang River

Nitrate in the coal mines originated from the explosives used to blast the coal. About 85% of the total nitrogen released in mine drainage is from Nitrate. The nitrate values are 0.24mg/l, 0.26mg/l and 0.36mg/l in the upstream, midstream and downstream part respectively. All the value was found to be under the permissible value 4.5mg/l.

The Water Quality Index obtained using Weighted Arithmetic WQI method is shown below:

Table 4- Water Quality Index of Prang River

WATER QUALITY INDEX			
	∑Wiqi	∑Wi	∑Wiqi/∑Wi
UPSTREAM	34.641533	0.3909	88.6199369
MIDSTREAM	36.202311	0.3909	92.61271709
DOWNSTREAM	23.155	0.3909	59.23509849

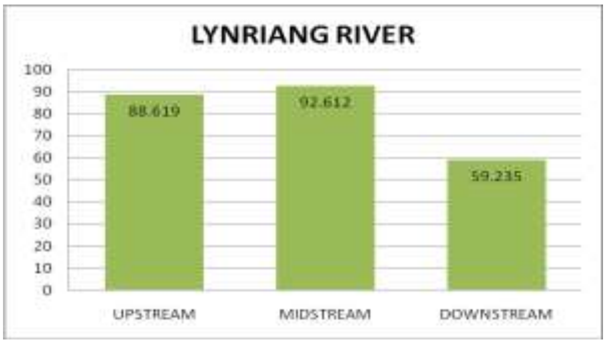

Figure 8-Variations of W.Q.I along Lynriang River

After analysis of different parameters and a series of calculation has been done by using Weighted Arithmetic Water Quality Index method, the value obtained are 88.61, 92.61 and 59.23 in the upstream, midstream and downstream respectively.

The upstream and midstream part have high value and falls in a category of very poor quality of water according to Table 2 that describe and classify the status of water quality. This shows that the water quality has been seriously deteriorated by coal mining activities. The colour of the water was observed to be brownish to orange colour. The colour of the water itself can describe that the water quality is not good. The downstream value was found to be almost under the permissible limit compared to the upstream and midstream. The coal mining activities in downstream area is found to be farther from the river as compared to upstream and midstream and also fewer operations are carried in this area. Also this area is surrounded by a dense forest.

Table 5- Parameters obtained from Prang River

Parameters	Upstream	Downstream
pH	3.4	3.1
Conductivity (µmho/cm)	690	560
Total Dissolved Solids (mg/l)	476	386
Turbidity (NTU)	8.8	4.5
Chloride (mg/l)	7	7
Total Hardness (mg/l)	64	42
Nitrate-N (mg/l)	0.41	0.34

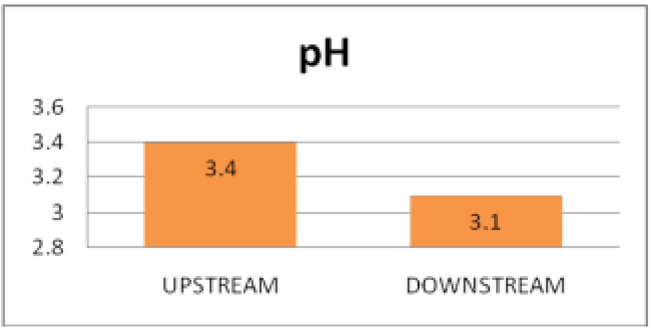

Figure 9- Variations of pH along Prang River

The pH of water was found to be 3.4 in upstream part and 3.1 towards downstream. The values obtained in this area were not under the permissible limit. This shows the water in this area is highly acidic .This indicates serious condition of the water bodies of the area and the water here can hardly support any aquatic life. Contamination of Acid mine drainage (AMD) leads to acidity or low pH of the affected water bodies. Acidic water or low pH also facilitates leaching of toxic metals into the water that could be injurious to aquatic life, directly or can disturb the habitat after precipitation.

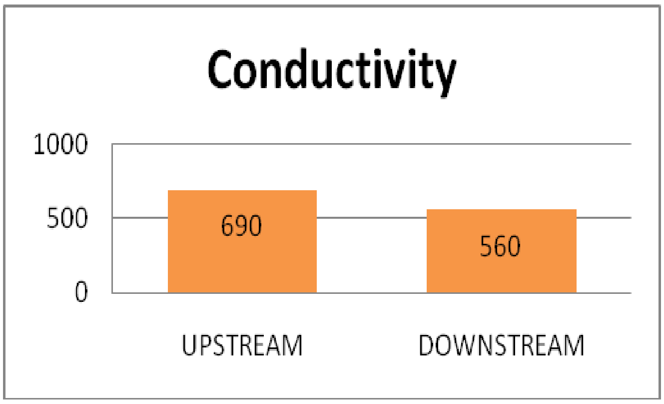

Figure 10-Variations of Conductivity along Prang River

In this study, the conductivity of this river was found to be 690µmho/cm and 560µmho in the upstream and downstream part of the river respectively. The highest value recorded at the upstream of the river due to the present of inorganic dissolved solids such as nitrate, iron chloride. Temperature also has a great effect on the conductivity of the water.

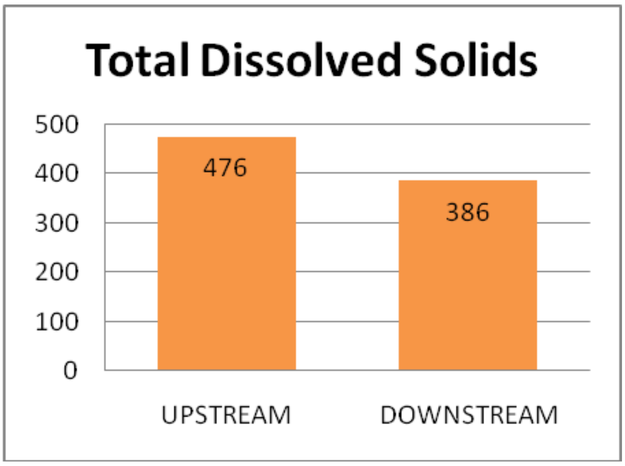

Figure 11-Variations of T.D.S along Prang River

Total dissolved solids (TDS) were recorded as 476mg/l and 386mg/l in the upstream and downstream respectively. The highest value was recorded in the upstream part of the river. AMD water was characterized by high concentration (>50 mg/l) of total dissolved metals. Dissolved solids can come from industrial waste, sewage, plankton and silt. Runoff from urban areas, road, fertilizers etc is also the other source of TDS.

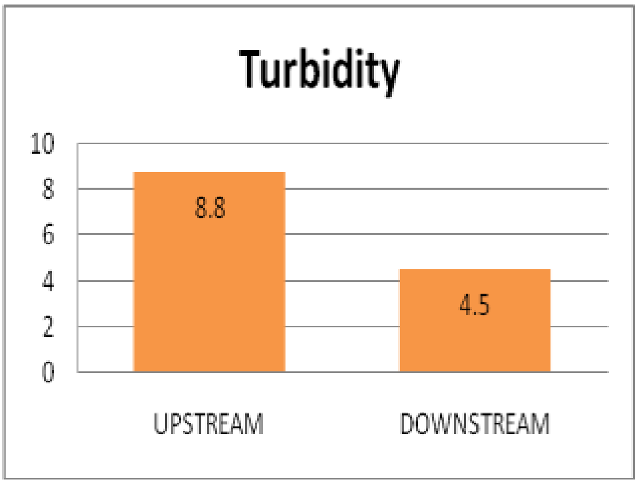

Figure 12-Variations of Turbidity along Prang River

Turbidity of the river was recorded as 8.8NTUand 4.5NTU in upstream and downstream of the river respectively. This indicates that turbidity is significantly high. The highest value of the river due to high waste discharge and sediments. Turbidity increased towards the river mouth due to high suspended particle.

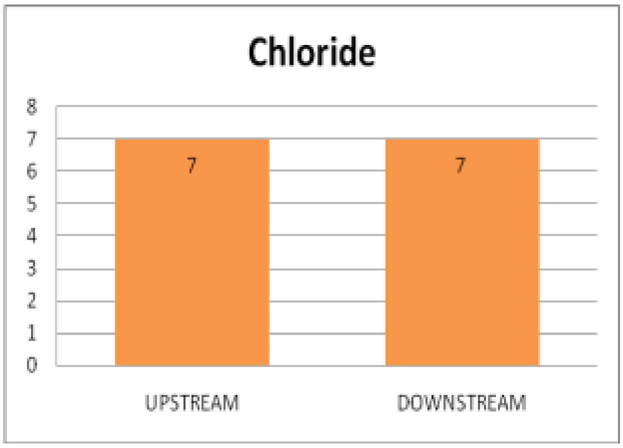

Figure 13-Variations of Chloride along Prang River

Chloride in the form of Cl^- ion is one of the major inorganic anions (negative ions) in saltwater and freshwater. The concentration of chloride ion affects the taste of the drinking water and produced a salty taste. The chloride content from the study sites was found to be 11mg/l and 9mg/l in the upstream and downstream respectively. The highest chloride concentration observed towards the upstream part of the river. It may be due to higher accumulation of AMD in the areas that get contaminate with the water bodies.

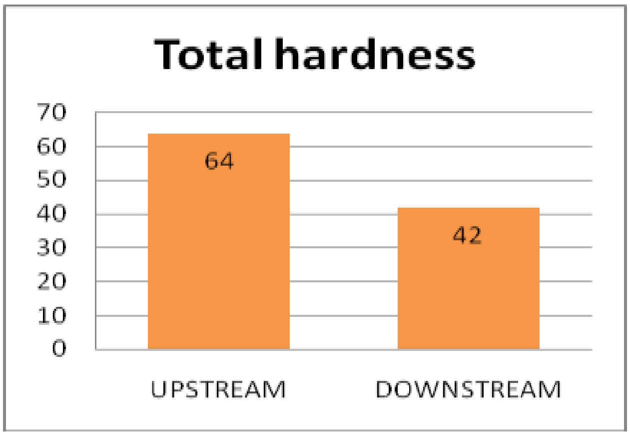

Figure 14-Variations of Total Hardness along Prang River

The more calcium and magnesium in water, the harder the water. The total hardness was observed to be 64mg/l and 42mg/l in upstream and downstream respectively. It is caused due to the present of dissolved bicarbonate mineral like calcium bicarbonate and magnesium bicarbonate.

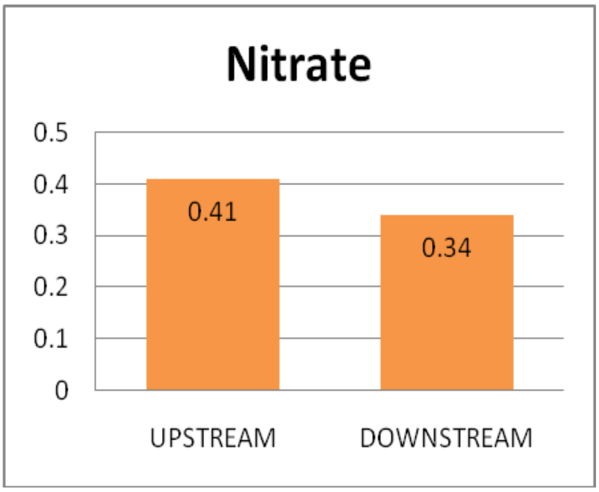

Figure 15-Variations of Nitrate along Prang River

Nitrate generally originated from the explosives used to blast the coal in the mines. It accounts for about 85% of the total nitrogen released in mine drainage. The nitrate values are 0.41mg/l and 0.34mg/l in the upstream and downstream part respectively. All the values were found to be under the permissible value 4.5mg/l.

Table 6- Water Quality Index of Prang River

Water Quality Index			
	∑Wiqi	∑Wi	∑Wiqi/∑Wi
UPSTREAM	33.012444	0.3909	84.4524033
DOWNSTREAM	34.066022	0.3909	87.1476649

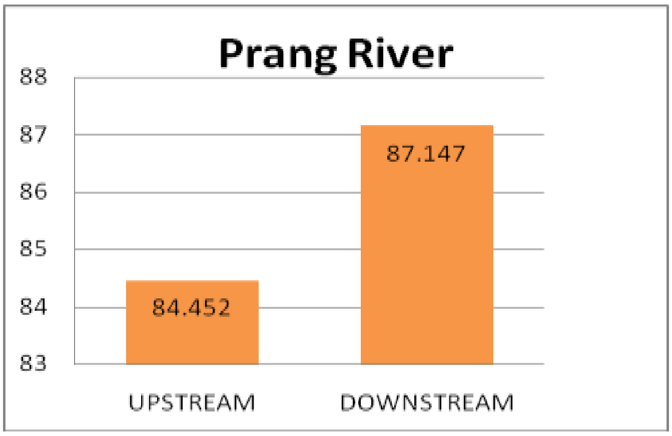

Figure 16- Variations of Water Quality Index along Prang River

The water quality index obtained after analysis of parameters and calculations are 84.452 in the upstream part and 87.147 towards downstream. This indicates that the water quality of both the upstream and downstream part was found to be very poor quality according to the Table 2 that classify and describe the status of water quality. The major causes of water pollution is due to the contamination of Acid mine drainage. The water is badly affected by contamination of Acid Mines Drainage (AMD) originating from mines, leaching of heavy toxic metals, organic enrichment and silting by sand and coal particles. The poor quality of water can also be due to the runoff from the sewage and waste disposal cause by villages nearby.

4. CONCLUSIONS

Two rivers of Jaintia hills district of Meghalaya has been considered for this study. In this study, it is found that all the rivers in all the part have low pH values showing their acidic nature i.e. their pH value is less than 5.5. TDS values are within the permissible limits (TDS > 500mg/l).Although in some area, TDS values are within the limit but they have higher value. High hardness values observed putting them in the hard water category. The conductivity readings (>250 mg/l) is also very high and may be because of the presence of chloride, nitrate and iron. The rest of the parameters all lies within the permissible limits and pose no threat to the environment. Coal mining operations have been banned for almost two years by the National Green Tribunal (NGT) in Meghalaya. By this almost all of the operations have been stop in the state; the water in this river could be more polluted if coal mining activity continues. Contamination of Acid Mine Drainage (AMD) originating from mines, leaching of heavy metals, silting by coal and sand particles are major causes of degradation of water quality in the area.

Pollution level of water has reached to the extent that it has become unfit for human consumption. The rivers or the water bodies in the area does not support any aquatic life. With this serious condition of water quality and aquatic life in rivers and streams of East Jaintia Hils, there should be a strong action taken against it for reducing the pollution and the coal mining. Practices like Filling of abandoned mines, extensive afforestation, neutralization of acidic seepage, conservation of top soil, scientific management of AMD and water resources can be done

ACKNOWLEDGEMENT

The authors are very grateful to the staff of the Directorate of Health Services Meghalaya, Shillong for helping in the laboratory works.

REFERENCES

1. Hota Manish 2015, “Assessment and Modelling of water quality near mines site”.

2. Kumar G. 2015, “Impact of coal mining in water quality”.

3. Lyngdoh Ibandarisuk and Kayang Highland 2012," Impact of Coal Mine Drainage on Water Quality and Microbial Ecology of Streams in Jaintia Hills, Meghalaya".

4. Raj Kumar Bronson Singh, Thounaojam Clinton Singh, Thounaojam Roshan Singh and Dr. Mimi Das Saikia (2016), "Assessment of Water quality Index of Nambul River, Imphal, Manipur, India".

5. Singh, G., 1997, “Environmental Impact Assessment of mining Projects”, The Indian Mining and Engineering Journal Volume 36 No.5

6. Roy Maitreyee 2017, “Advantages and challenges of banning rat hole mining in Jaintia Hills, Meghalaya

7. Tiwary, R.K. and Dhar, B.B., 1994, “Environmental Pollution from Coal Mining Activities in Damodar River Basin, India”, Mine Water and Environment. Volume 13, pp. 1-10.

8. Yogendra K. and Puttaiah E.T. 2008, Determination of water quality index and suitability of an urban waterbody in Shimoga Town, Karnataka