

# Impact of Industrial Activities on River Mahanadi Near Jagatpur Industrial Estate: A Case Study

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*Received August 28, 2010, revised and accepted May 15, 2012*

**Abstract:** A study has been taken to evaluate the impact of industrial waste generated from different industries existing in Jagatpur Industrial Estate on river Mahanadi. Samples were collected from final discharge point to river Mahanadi of different industries as well as upstream and downstream of river Mahanadi to Jagatpur Industrial Estate. Samples were collected in three seasons. The results obtained at U/S and D/S points on river Mahanadi in different seasons (winter, summer and rainy) has been compared graphically. From the seasonal variation it was observed that almost all parameters are in increasing trend. In the rainy season, yearly average value at the D/S point is quite high as compared to yearly value at U/S point. The high values in rainy season is due to washing of waste dumping near Mahanadi bed. Quality Ratings for different parameters has been calculated from that water quality index was found out and compared. From the results it is concluded that, due to industrial waste discharge, water quality of river Mahanadi is deteriorated at the D/S point on river Mahanadi and the results are not meeting the prescribed standard for drinking water under Class A.

**Key words:** Industrial activity, River Mahanadi.

## Introduction

Water is the universal solvent, the elixir of life and also the medium of the activity. Water is indispensable in our daily life as we use it for various purposes like cooking, bathing, cleaning, drinking, washing clothes. But through various human activities, organic and inorganic substances are introduced into freshwater and as a result water becomes polluted (Abdulmonem, 2008). Use of polluted water is hazardous to health and life of living organisms (Trivedy and Goel, 1984; Garcier, 2009). Mahanadi is the largest river in Orissa which originates from Chhatisgarh and finally falls in Bay of Bengal near Paradeep (Figure 1). Before that it receives an immense amount of domestic and industrial effluents. Due to rapid industrialization and urbanization of the Cuttack city, the



Figure 1: Map of Orissa in India.

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Mahanadi river is contaminated with the discharge of effluents (Rajaram and Das, 2008). Accordingly, the stretch of Mahanadi near Jagatpur Industrial Estate has been chosen before and after the discharge of effluent from the Jagatpur Industrial Estate in order to ascertain the quality and physico-chemical characteristics of Mahanadi river water (Wang et al., 2008).

### Location of Sampling Points

In order to assess the water quality and physico-chemical characteristics of river Mahanadi, two sampling points upstream and downstream to Jagatpur Industrial Estate such as Tripty Drinks, Cos-board, Prithwiraj Diary, Health Food Products and Ori-drinks were selected. Upstream point is near Mahanadi Barage and downstream point is half kilometre farther from the discharge point of the effluent to the river Mahanadi (Srivastava and Singh, 1995). Detail sample points are given in Figure 2.

### Materials and Methods

Grab samples were collected from discharge points of different industries adjacent to river Mahanadi near Jagatpur Industrial Estate and composite samples were collected from U/S and D/S points of river Mahanadi as per specification; precaution and preservation are added as per requirements. Samples were collected once in a month for a period of one year (2008-09). The samples were collected in clean sampler bottles to study the parameters like pH, BOD, COD, TSS, alkalinity and Total Hardness. While DO samples were collected in DO bottles and have been fixed immediately on the spot. Similarly samples were collected separately in bacteriological bottles for Total and Fecal Coliform. The samples were analyzed immediately after collection following the standard methods for examination of water and waste water (APHA, 1989).

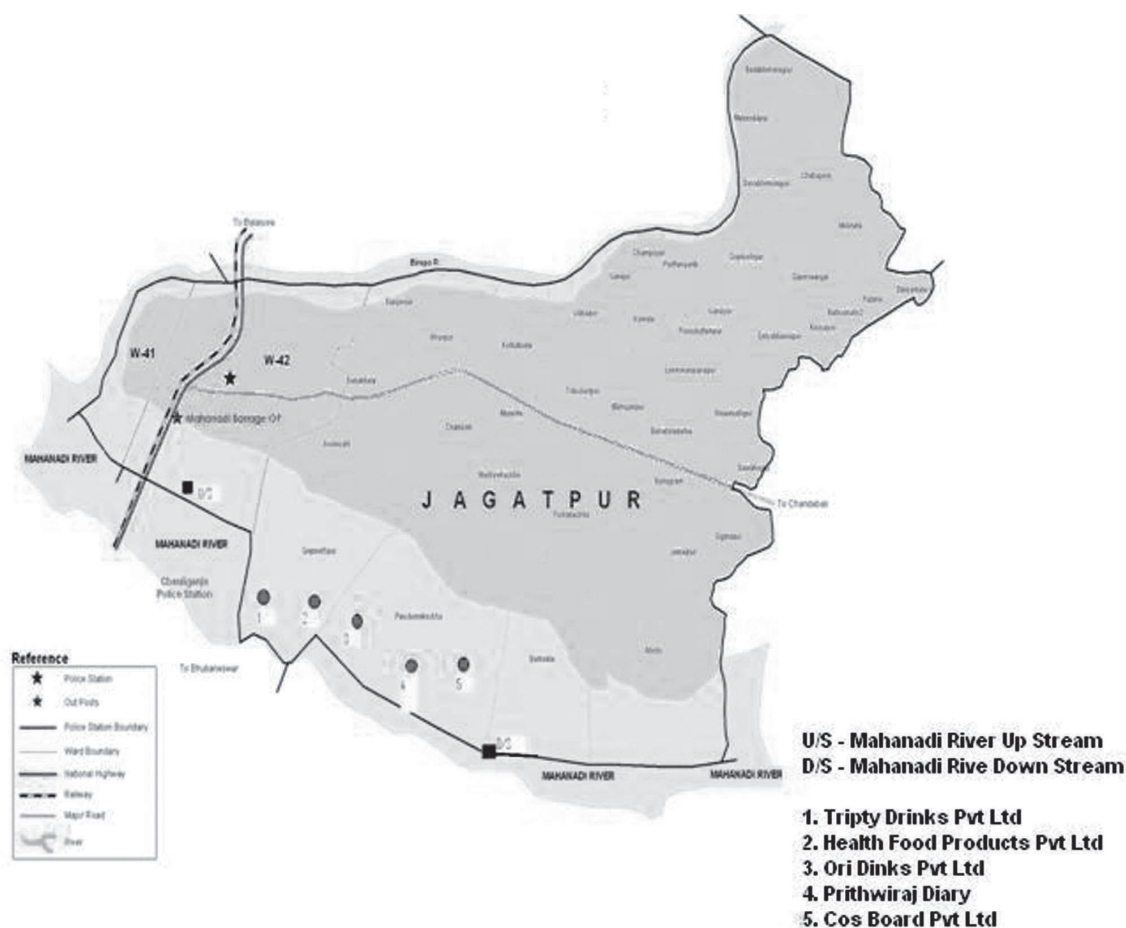
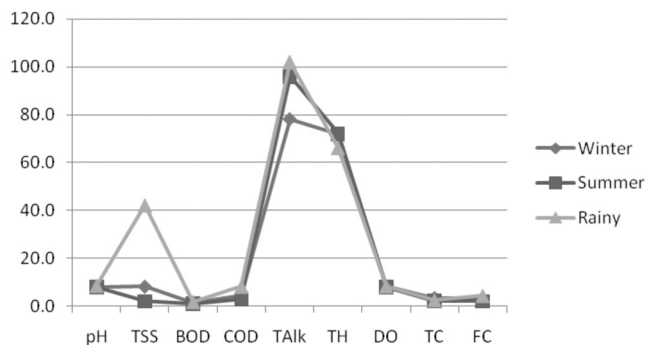
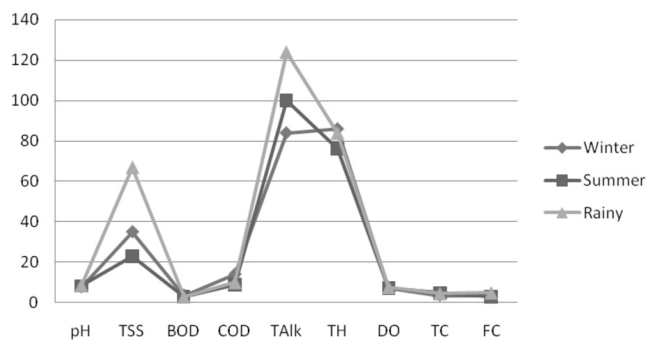


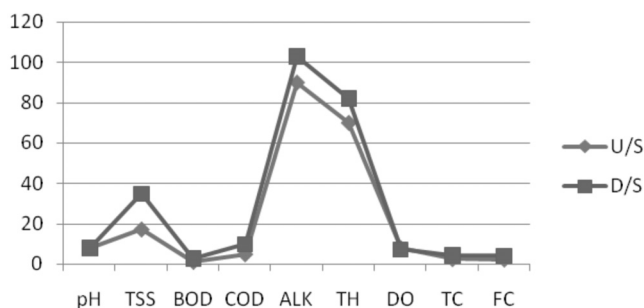
Figure 2: Map of Jagatpur Industrial Estate locating different sampling points.



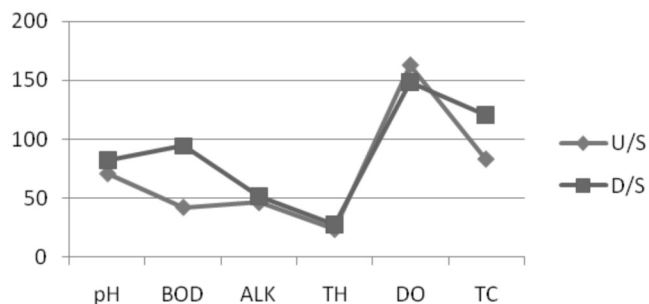
**Figure 3: Seasonal variation in parameters of Mahanadi River at U/S point.**



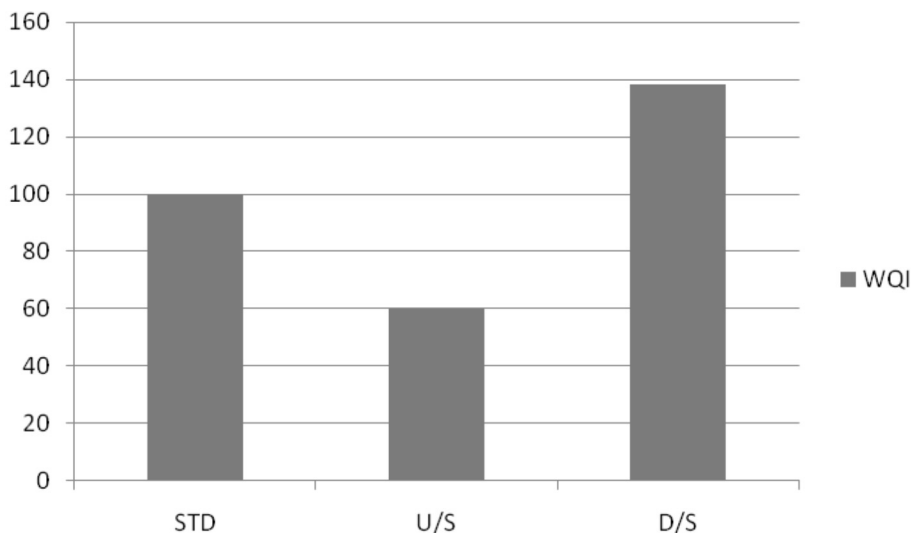
**Figure 4: Seasonal variation in parameters of Mahanadi River water at D/S point.**



**Figure 5: Comparison of annual average value of River Mahanadi.**



**Figure 6: Comparison of quality rating of upstream and downstream.**



**Figure 6: Water quality index of River Mahanadi.**

## Results and Discussion

The results are presented in Tables 1 and 2 (Seasonal data at U/S and D/S).

### pH

The pH of the Mahanadi river water at U/S ranged from 7.7 to 8.4 and at D/S it is 7.8-8.6. It indicates that, both

the points are in increasing trend and it always remained in alkaline range. From the annual mean it is observed that pH value increased from 8.0 to 8.2 at D/S. This increased value is due to the impact of alkaline waste from Jagatpur Industrial Estate.

### TSS (Total Suspended Solid)

TSS of river water at U/S point ranged from 2.0 to 42.0

and D/S point it is 23.0-67.0. In both the points TSS mean value is low in summer while it is maximum in rainy season. TSS value at D/S point is 35.0 while it is 17.3 at U/S point (Table 5).

### BOD (Biological Oxygen Demand)

BOD of river water ranged from 1.0 mg/l to 1.6 mg/l at U/S point and at D/S point it is 2.9 mg/l to 3.6 mg/l. At D/S point it is higher than permissible limit. From annual mean value at U/S point BOD value is 1.2 mg/l and at D/S it is 2.8 mg/l. It clearly indicates that BOD value at D/S is doubled than U/S point (Young et al., 1981).

### COD (Chemical Oxygen Demand)

COD of river water at U/S point ranged from 3.0 to 8.0 mg/l and at D/S it is 9.0-14.0 mg/l. It is also in increasing trend. From annual mean value it is observed that COD

value has increased from 5.0 to 10.0 mg/l. This indicates that COD value at D/S is more than U/S point.

### ALK (Alkalinity)

At U/S point it ranged from 78.0 to 102.0 mg/l and at D/S it is 84.0-124.0 mg/l. At both the points alkalinity value is also in increasing trend. Alkalinity value at D/S is 103.0 mg/l while it is 90.0 mg/l at U/S as per mean average value (Table 5).

### TH (Total Hardness)

TH value at U/S is ranged from 66.0 to 72.0 mg/l and at D/S it is 76.0-86.0 mg/l. At both the points it is in increasing trend. At D/S, TH value is 82.0 mg/l whereas at U/S it is 70.0 mg/l from annual mean value (Table 5). Thus it indicates that it is maximum in D/S than U/S (Goetz and Smith, 1959).

**Table 1: Seasonal data of Mahanadi River at upstream point**

Location of sampling points	Parameter	Season		
		Winter	Summer	Rainy
Mahanadi River upstream to Jagatpur Industrial Estate, near Mahanadi Barage	pH	7.7	8.1	8.4
	TSS	8.0	2.0	42.0
	BOD	1.2	1.0	1.6
	COD	4.1	3.0	8.0
	TALK	78.0	96.0	102.0
	TH	72.0	72.0	66.0
	DO	8.2	8.0	8.2
	TC	3.3	2.2	2.3
	FC	3.1	2.0	4.2

*N.B.:* TSS, BOD, COD, ALK, TH and DO are expressed in mg/l, TC and FC are in MPN/100 ml in logarithmic form.

*Remarks:* TSS—Total Suspended Solids, BOD—Biochemical Oxygen Demand, COD—Chemical Oxygen Demand, TALK—Total Alkalinity, TH—Total Hardness, DO—Dissolved Oxygen, TC—Total Coliform, FC—Fecal Coliform.

**Table 2: Seasonal data of Mahanadi River at downstream point**

Location of sampling points	Parameter	Season		
		Winter	Summer	Rainy
Mahanadi River downstream to Jagatpur Industrial Estate	pH	7.8	8.3	8.6
	TSS	35.0	23.0	67.0
	BOD	3.6	3.0	2.9
	COD	14.0	9.0	10.0
	TALK	84.0	100.0	124.0
	TH	86.0	76.0	84.0
	DO	7.5	7.2	7.6
	TC	3.6	4.9	4.6
	FC	3.5	2.9	4.9

**DO (Dissolved Oxygen)**

DO value is ranged from 8.0 to 8.2 mg/l at U/S and at D/S it is 7.2-7.6 mg/l. DO value is slightly lower at D/S. From annual mean value it is 8.1 mg/l at U/S while it is 7.4 mg/l at D/S. It clearly indicates that DO value is in decreasing trend at D/S.

**TC (Total Coliform, MPN/100 mm)**

TC value at U/S is ranged from 2.2 to 3.3 whereas it is 3.6-4.9 at D/S. It is observed that TC value is higher at D/S than U/S. From comparative mean value it is 2.6 at U/S and 4.4 at D/S. It indicates that TC value is doubled at D/S than U/S (Singh and Singh, 1994).

**Table 3: Monthly and yearly average data of Mahanadi River at upstream point**

Location of sample point	Month	Parameter								
		pH	TSS	BOD	COD	ALK	TH	DO	TC	FC
Mahanadi River upstream to Jagatpur Industrial Estate	March	8.1	1.8	1.0	2.9	95	72	7.9	2.2	2.0
	April	8.0	2.1	1.1	3.2	97	70	8.2	2.2	2.0
	May	8.1	2.0	1.0	3.0	96	72	8.0	2.2	2.0
	June	8.2	2.1	0.9	2.9	96	74	7.9	2.2	2.0
	July	8.3	41.0	1.7	8.2	99	68	8.2	2.3	2.1
	August	8.5	40.0	1.8	8.1	103	65	8.0	2.3	2.2
	September	8.4	42.0	1.6	8.0	102	66	8.2	2.3	2.2
	October	8.0	45.0	1.3	7.7	104	65	8.4	2.3	2.2
	November	7.6	7.8	1.2	4.2	79	72	8.0	3.3	3.1
	December	7.7	8.3	1.1	3.9	80	73	8.2	3.3	3.1
	January	7.8	7.9	1.3	4.2	75	71	8.4	3.3	3.1
	February	7.7	8.0	1.2	4.1	78	72	8.2	3.3	3.1
	<b>Avrg</b>	<b>8.0</b>	<b>17.3</b>	<b>1.2</b>	<b>5.0</b>	<b>92</b>	<b>70</b>	<b>8.1</b>	<b>2.6</b>	<b>2.4</b>

**Table 4: Monthly and yearly average data of Mahanadi River at downstream point**

Location of sample point	Month	Parameter								
		pH	TSS	BOD	COD	ALK	TH	DO	TC	FC
Mahanadi River downstream	March	8.0	3.0	1.7	5.7	95	75	7.0	4.9	4.9
	April	8.4	2.8	2.1	6.1	101	77	7.1	4.9	4.9
	May	8.3	3.0	2.0	6.0	100	76	7.2	4.9	4.9
	June	8.5	3.2	2.2	6.2	104	76	7.5	4.9	4.9
	July	8.8	69.0	3.0	9.8	123	81	7.4	4.6	4.3
	August	8.7	68.0	2.6	10.1	125	85	7.5	4.6	4.3
	September	8.6	67.0	2.9	10.0	124	84	7.6	4.6	4.3
	October	8.3	64.0	3.1	10.1	124	86	7.9	4.6	4.3
	November	7.5	38.0	3.7	14.0	86	89	7.5	3.6	3.4
	December	7.9	37.0	3.5	15.0	85	87	7.6	3.6	3.5
	January	8.0	30.0	3.6	13.0	81	82	7.4	3.6	3.5
	February	7.8	35.0	3.6	14.0	84	86	7.5	3.6	3.5
	<b>Avrg</b>	<b>8.2</b>	<b>35</b>	<b>2.8</b>	<b>10</b>	<b>103</b>	<b>82</b>	<b>7.4</b>	<b>4.4</b>	<b>4.2</b>
<b>ISI (10,500-91)</b>		<b>6.5-8.5</b>	<b>500-2000</b>	<b>2.0</b>	<b>20.0</b>	<b>200-600</b>	<b>300-600</b>	<b>5.0</b>	<b>10</b>	<b>NIL</b>

**Table 5: Comparison of annual mean value of River Mahanadi for different parameters**

Location of sampling points	Parameter								
	pH	TSS	BOD	COD	ALK	TH	DO	TC	FC
Mahanadi River upstream	8.0	17.3	1.2	5.0	90	70	8.1	2.6	2.4
Mahanadi River downstream	8.2	35	2.8	10	103	82	7.4	4.4	4.2

**Table 6: Waste water quality of different industries at Jagatpur Industrial Estate**

<i>Industries</i>	<i>Parameter</i>							
	<i>pH</i> (mg/l)	<i>TSS</i> (mg/l)	<i>BOD</i> (mg/l)	<i>COD</i> (mg/l)	<i>TH</i> (mg/l)	<i>TDDS</i> (mg/l)	<i>TFe</i> (mg/l)	<i>Turb</i> (NTU)
Health Food Product	6.5	104	144	314	-	-	-	-
Tripty Drinks	7.8	68	45	132	-	-	-	-
Oridrinks	7.1	-	-	-	112	1624	0.129	0.5
Prithwiraj Diary	7.5	106	43	104	-	-	-	-
Cos Board	7.1	68	50	220	-	855	-	-

**Table 7: Water quality index of River Mahanadi at Jagatapur Industrial Estate**

<i>Parameter</i>	<i>Quality rating</i> (qi)		<i>Unit weight</i> (wi)		<i>WQI</i>	
	<i>U/S</i>	<i>D/S</i>	<i>U/S</i>	<i>D/S</i>	<i>U/S</i>	<i>D/S</i>
pH	70.6	82	0.1	0.1	7.6	15.3
BOD	42	94.3	0.2	0.4	10.5	41.1
ALK	46	51.3	0.0	0.0	0.1	0.3
TH	23.3	27.3	0.0	0.0	0.05	0.1
DO	162.6	148.6	0.1	0.2	24.6	38.6
TC	82.9	120.6	0.2	0.3	16.9	42.7
Weighted Arithmetic Index (Eqiwi)					60.0	138.3

**FC (Fecal Coliform, MPN/100 mm)**

FC value at U/S ranged from 2.0 to 4.2 and at D/S it is 2.9-4.9. It is observed that FC value at both the points is maximum in rainy season. From Table 5, FC value at U/S is 2.4 and D/S it is 4.2. It is clearly observed that, FC value at D/S is doubled than that of U/S.

**Conclusion**

From the annual mean value, both for U/S and D/S points in river Mahanadi, it was observed that all the parameters are in increasing trend at D/S point as compared to U/S point except for DO parameter. DO is decreased from 8.1 to 7.4 mg/l. From the trend it is clearly indicated that the water quality of river Mahanadi is deteriorated further at D/S point as compared to U/S point. Decrease in DO value indicates the increase in pollution load at D/S (Jameson and Rana, 1996). From the above study it is revealed that the water quality at D/S point is deteriorated due to discharge of industrial waste from Jagatpur Industrial Estate to river Mahanadi. The present status shows that the water quality at D/S is not meeting the prescribed standard for drinking water quality (Table 4) for Class A classification of river (Singh and Singh, 1997). Water quality index of 60 at U/S indicates the water quality within the standard values (Jin Zhu et al., 2009). The water quality index of 138 at D/S indicates

that, water quality is not meeting the standard of 100 (ICMR, 1975). It is high time to take necessary steps to curtail pollution load in river Mahanadi from Jagatpur Industrial Estate, so that water quality of river Mahanadi will remain within the limit (Bhargava, 1985; Mohanty, 2001) reducing safety for the users.

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## Calendar of Events

### **The 7th Conference on Sustainable Development of Energy, Water and Environment Systems? SDEWES Conference Ohrid 2012**

1st to 6th July 2012

Ohrid, Macedonia

Website: <http://www.ohrid2012.sdewes.org/>

Contact person: Zvonimir Guzovic

Organized by: University of Zagreb, Instituto Superior TTenico, MANU-ICEIM

### **Singapore International Water Week 2012**

1st to 5th July 2012

Singapore,

Website: <http://www.siww.com.sg>

Contact person: Lau Ping Ping

Organized by: Singapore International Water Week Pte Ltd

### **Groundwater Vulnerability? Emerging Issues and New Approaches**

9th to 12th July 2012

Paris, France

Website: <http://www.sisyphe.upmc.fr/imvul/>

Contact person: Pierre Adler

Organized by: UPMC- Sisyphe, France and IMVUL - Marie Curie Initial Training Network

### **12th International Conference on Modelling, Monitoring and Management of Water Pollution**

10th to 12th July 2012

New Forest, Hampshire, Spain

Website: <http://www.wessex.ac.uk/12-conferences/water-pollution-2012.html>

Contact person: Alice Jones

Organized by: Wessex Institute of Technology, UK

### **4th International Conference on Water Supply Management System and Social Capital**

16th to 17th July 2012

Makassar, South Sulawesi, Indonesia

Website: <http://icwsmsc.wordpress.com/>

Contact person: M. Asad

Organized by: Civil Engineering Department, Hasanuddin University

### **2012 International SWAT Conference & Workshops, New Delhi, India**

16th to 20th July 2012

New Delhi, India

Website: <http://swatmodel.tamu.edu/conferences/2012>

Contact person: Uttam Aswal, FITT, IIT Delhi

Organized by: Indian Institute of Technology Delhi

### **Water Management in Mining 2012**

31st July to 1st August 2012

Brisbane, Queensland, Australia

Website: <http://www.watermgmtmining.com.au>

Contact person: Judy Hizon

Organized by: Mining IQ

### **Water Resources and Wetlands**

14th to 16th September 2012

Tulcea, Romania

Website: <http://www.limnology.ro/water2012/Committees.html>

Contact person: Petre Bretcan

Organized by: Romanian Limnogeographical Association

### **2nd International Conference on Energy and Environmental Science (ICEES 2012)**

28th to 29th September 2012

Phnom Penh, Cambodia

Website: <http://www.icees.org/>

Contact person: ICEES 2012 Secretary

Organized by: IACSIT