Precautions when using a light scattering turbidity meter for measuring the load of suspended solids in mining districts waterways of Guyana.

By

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CONTEXT

Turbidity is the measurement of the effect that suspended solids and molecules on the transmission of light through an aqueous solution such as water. This is a qualitative measurement. Suspended Solids measurement is a quantitative analysis of a solution. In a lab this is usually accomplished by drying a known volume of the solution and then weighing the remaining particles =0,45 µm in mg/l.

Water quality is defined by a variety of variable, suspended solids and turbidity being basic indicators. Most regulatory bodies use suspended solids to set environmental guidelines for discharge in the aquatic system, others use turbidity to set limits for discharge. Livan and Couture (2000), have reviewed limits used by Guyana's neighbouring countries and by Canada. This review shows that the weight of total suspended solids is more commonly use as an indicator of water quality than turbidity measurements.

The central and northern part of the Guyana interior is rich in minerals and small scale gold and diamond mining activities is important for the local economy. Striping the land and ore with monitors is a common practice due to the limited investment required. This activity leads to the formation of significant turbidity plumes in the waterways also used for domestic purposes by the Hinterland. The Government of Guyana wants to introduce environmental guidelines in the mining practice but lacks base line data and the revenues for collecting the information.

In a manner to satisfy the upcoming guidelines in an economical way, GGMC wishes to setup monitoring stations within their existing mining stations. Since turbidity measurements is not as labour intensive as is total suspended solids, it is proposed to provide mines inspectors with turbidity meters and require monitoring downstream mining sites on a regular basis.

Samaroo (2000) provided the first insight on the use of turbidity measurements as a water quality indicator in the Imbaimadai area. =10-20 NTUs was indicative of an undisturbed environment; between 25 and 40 NTUs, miners were advised to correct the situation; and =50-70 NTUs, mining activities were interrupted.

Mack (1986) found that Turbidity measurements can only be correlated to Total Suspended Solids for very localized areas and for identical seasonal conditions. Barbera (2000) found no significant correlations between these two variables when doing his measurements immediately downstream from a mining camp in Guyana.

Livan *et al.* (2001) obtained a significant correlation between TSS and NTU but the associated error created overlap for the intervals proposed by Samaroo (2000).

Since the coming environmental guidelines aim at containing mining related turbidity and provide Hinterlands with adequate water usage downstream from mining camps, any limits set by GGMC to regulate the mining industry must be defendable in Court.

The following discussion provides decision makers with the limitations of using turbidity measurements as an indicator for regulating mining activities without dry mining recovery practices or without adequate settling pounds.

OBJECTIVE

The objective of the study is to investigate the potential of using turbidity measurements in place of the more cumbersome TSS measurements for evaluating water quality in turbidity plumes.

METHODOLOGY

During March of 2002, the water quality of the Potaro River was monitorede between Amatuk Falls and Tumatumari settlement. Water samples were taken at different depths and at intervals on that section of the River. For Total Suspended Solids, water was filtered on pre-weighted Nuclepore 0,45µm pore size of 47 mm diameter filters. After drying the filters at 65°C for 12 hours, filters were weighted to calculate the weight of TSS. Turbidity measurements were done in the filed using a Hach 2100 turbidity meter.

RESULTS

Figures 1a and 1b provide the results of two studies performed respectively in 2001 (Livan *et al*, 2001) and this study in the same segment of the Potaro River but during different hydrological conditions.

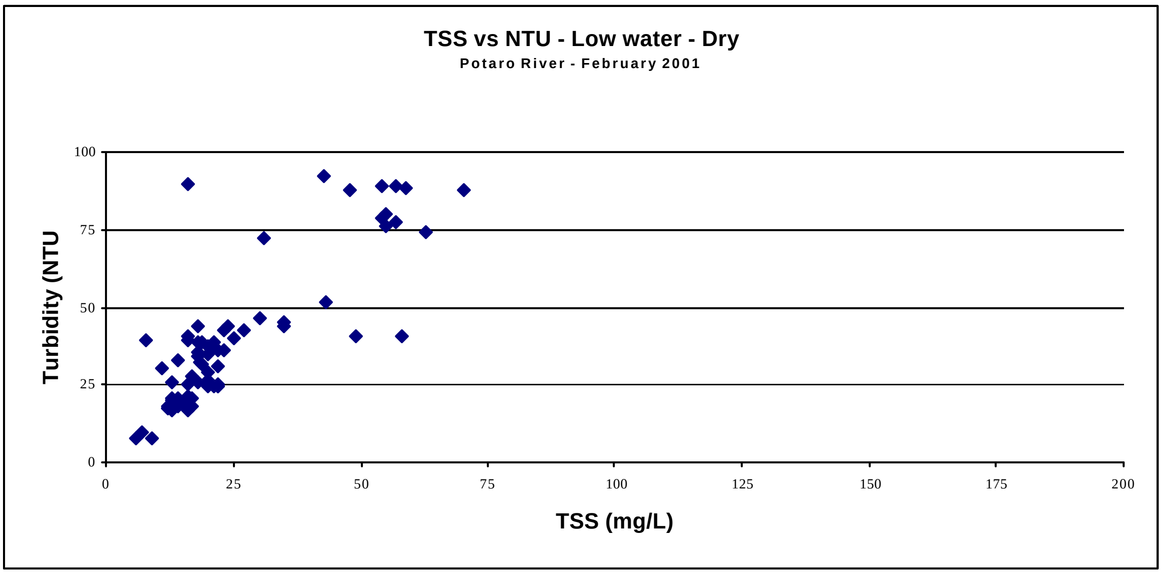

Figure 1a: ***Relationship between Total Suspended Solids and Turbidity during low water and dry conditions in the Potaro River during February 2001.***

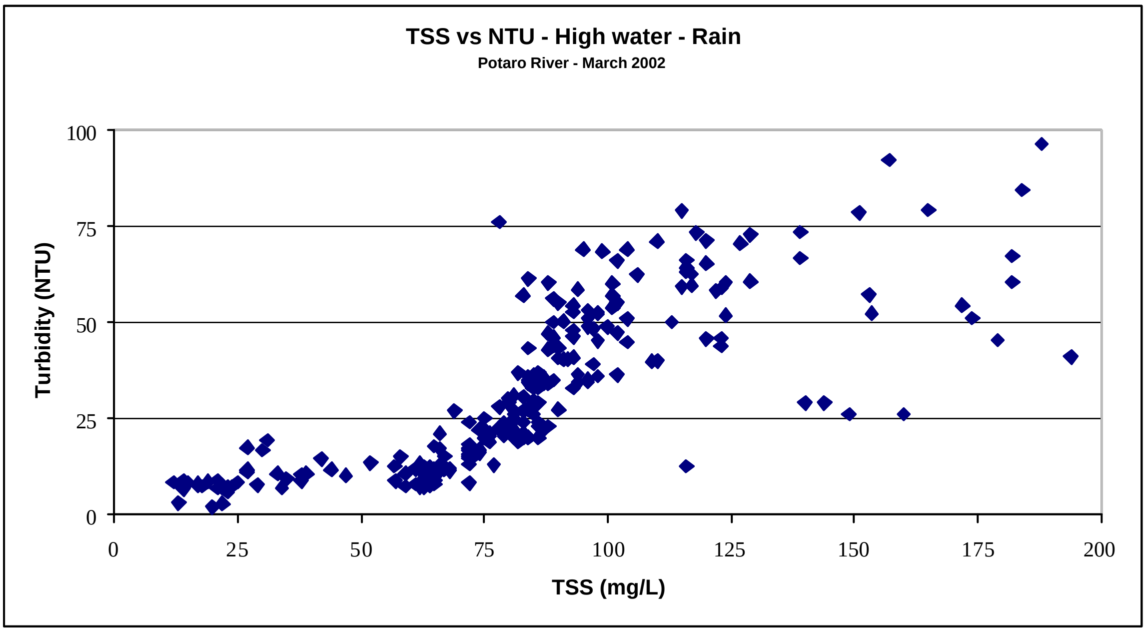

Figure 1b: ***Relationship between Total Suspended Solids and Turbidity during high water and rainy conditions in the Potaro River during March 2002..***

In Figures 1a and 1b we can find similarities, e.g. no hydrology dependence:

- Above 50 NTUs, there is no relationship between Turbidity and TSS;
- Below 50 NTUs, there is a trend in the relationships;
- There is a linear relationship in both situations but only when high water TSS values are between 65 and 100 mg/L

In Figures 1a and 1b we can find dissimilarities, e.g. with hydrology dependence:

- During low water (Figure 1a), the relationship between TSS vs NTU is linear with a regression coefficient of R^2 = 0,75while during high water the trend is more of a power curve with an R^2 = 0,67;
- During high water, TSS does not affect Turbidity until it reaches 65 mg/L while at low water, the slope for the linear regression is 1,25;
- During high water, colour is a dominant component of turbidity and masks TSS variability until it reaches 65 mg/L;

We also looked at trends for both variables by taking the water column and transect average for each station and plotting it in a downstream fashion for the Potaro River section comprised between Amatuk Falls and Tumatumari. Figure 2 shows this downstream representation for TSS and Turbidity.

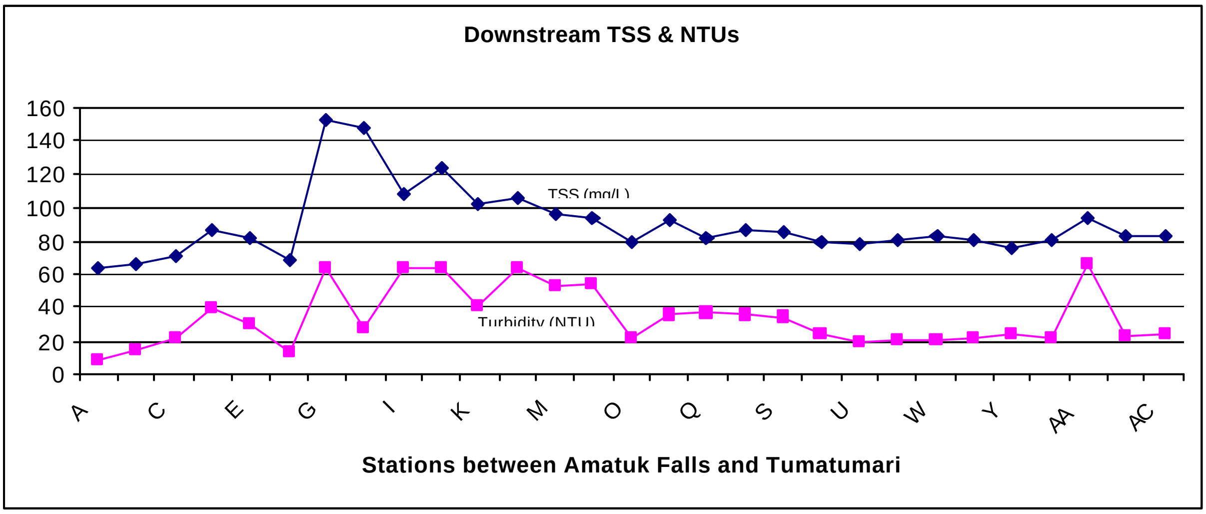

Figure 2: ***Downstream distribution of average TSS and Turbidity values on the Potaro River during March 2002.***

Figure 2 suggest a good concordance in trends between both variables. The sub-section between Mahdia creek and Kurubrung River is an exception to this concordance. In the presence of a high input of suspended solids (station H: Mahdia creek) in the Potaro river, turbidity measurements do not reflect the settling of particles as is shown by the decreasing TSS values between stations H and P (downstream Kurubrung river).

Base level NTUs (assumed background values) were arbitrarily taken from creeks and rivers in the studied section of the Potaro River where visual inspection suggested no mining activity upstream. Table 1 provides the location with NTU and TSS results for those stations.

STATION	TURBIDITY (NTU)	TSS (mg/L)
Ekuneparu creek	2	20
Little Uenang creek	3	22
Maniparu creek	3	13
Amatuk Falls	8	
Kuribrung (300m up)	8	20

Table 1: ***Individual and average TSS and Turbidity for presumed background levels.***

From these stations, it is presumed that background levels of turbidity for the Potaro River are = 10 NTUs. Corresponding TSS values are = 20 mg/L.

CONCLUSION:

The use of turbidity measurements for predicting TSS values is not an accurate method. As shown, correlation between TSS and turbidity changes with different hydrological conditions. For high water conditions, TSS values ranging between 20 and 65 mg/L are not significantly reflected in Turbidity readings.

When average values are taken for each station and transect, there exists a good correspondence in the trend of the 2 variables. Only at high values does this correspondence disappear.

Background levels for turbidity and TSS in this section of the Potaro River are presumed to be respectively = 10 NTUs and = 20 mg/L.

Using Samaroo (2001) suggestion for regulating mining operations based on NTU intervals, a warning (=30 NTU) should have been given to the mining operation who's effluent flows in Hoit creek and mining operations should have been closed (= 60 NTU) for those who's effluents flow in the Mahdia creek.

Livan and Couture (2001) suggestion for regulating mining operations based on TSS were established for low water hydrology (25 mg/L). The TSS values obtained during the 2002 Potaro River study suggest that ambient TSS values are more in the range of 60-80 mg/L during high water hydrology. Again, Hoit creek is slightly above this range while Mahdia creek exceeds it largely.

RECOMMENDATION:

- The data suggest that colour from humic acids and the presence of sub-µm particles in the samples, influence Turbidity readings independently of the concentration of TSS; this is apparent for TSS values between 20 and 65 mg/L. It is recommended to sample a minimum of 5 liters of water from three stations: 1-in the Potaro River upstream Mahdia creek, 2- in the Potaro River downstream Mahdia creek and 3- within (=300m from the mouth) Kuribrung River. Water should be filtered through 0,45 µm filters and the filtrate available for standard dilution before reading Turbidity values;
- Turbidity meters used in Guyana are light scattered meters that are influenced by the shape, nature and surface area of particles. This would be responsible for the lack of correlation found between TSS and Turbidity. Light attenuation turbidity meters are not affected by the particle's features. Recently, a new generation of instruments has been introduced and makes it possible to obtain readings at low TSS concentrations. It is recommended that a light attenuation turbidity meter be purchased by GENCAPD to test its ability to predict TSS values.