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WATER QUALITY LIMITATION FOR TURBIDITY BASED SEDIMENT MEASUREMENT IN RIVERS

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Abstract: The concentration and size of sediment particles are mainly affected flow and climate conditions, soil properties, topography, and plant cover properties. The direct water sampling method has many difficulties to represent continuous monitoring of sediment transport, especially during extreme flow conditions. Turbidity based estimating of suspended sediment is widely used for river studies due to its simply and cheap using. The strong relationship between turbidity and suspended sediment concentrations has led to the use of turbidimetry to estimate sediment concentration. The use of turbidity values for SSC is an indirect method and based on to determine the statistical relationship between these values; the relationship could be linear, non-linear or polynomial. But this relation is affected by water pollution, colloids and plankton units, air bubbles and other suspended materials in the water sample rather than mineral suspended particles. In this study, Seapoint Turbidity Meter sensor was used to provide accurate, reliable, automated and continuous time series of suspended-sediment concentrations under different water quality conditions in river. The study was conducted at river conditions, and two different water qualities were considered depend on electrical conductivity and turbidity values. The first sampling point was chosen close the source of river for obtaining clear water and second one was chosen at polluted point by waste water of city. The regression analyses were applied between the sediment concentrations with the turbidity values to observe of different water quality effects and were evaluated using determination coefficient (R^2) and regression equation. Sediment concentration values were varied between 0.02 and 1.12 g/l during sampling season depend on rainfall and river discharge but these values and water quality parameters were found extremely high and unstable due to pollution of waste water pollution of city. Fairly high R^2 value (0.971) was obtained for first station water which has relatively clear, but week relationship (0.273) was obtained of between the sediment concentrations and the turbidity values for second station due to water pollution. This problem is important limitation for turbidity based sediment measurement, and it should be considered to more accurately estimate sediment concentration with turbidity values

Keywords: Suspended sediment, turbidity, water pollution, environmental

Introduction

Suspended sediment concentration (SSC) in water is the main quality parameter for environmental and natural science practices. The measurement of SSC has some difficulties in river condition. The direct water sampling method is generally used as traditionally. But this method is restrictive to represent continuous monitoring of SSC, especially during exchangeable and high discharge conditions (Thorne and Hanes, 2002; Guerrero et al., 2016). Because sediment concentration very variable parameter depends on basin, flow and climate conditions (Gray et al., 2002). The concentration and size of sediment particles are mainly affected by precipitation,

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soil texture and erodibility, topography, and land cover properties (Melesse, 2011). In addition the sampling and filtering processes are required more time and labor with (Wren *et al.*, 2000; Schoellhamer and Wright, 2000). Therefore continuous sediment measurements with sampling are expensive and impossible of adequately frequency with the spatiotemporal coverage (Tfwala and Wang, 2016). These limitations have led to new devices with the technological advances for continuous and precision sediment monitoring. Especially in terms of using light and sound scattering or attenuation by particles in water has used to estimate sediment concentration. This new techniques have gained importance within the researcher, and its validation has been tested in many laboratory and field studies (Pedocchi and Garcia, 2012).

Turbidity based sediment estimation are increasingly used due to its simply and cheap using. Turbidity is defined as an optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample (APHA 2012). Scattering and absorption of light occurs on mineral suspended particles, colloids and plankton units, air bubbles and other suspended materials in the water sample (Lewis *et al.*, 2002). The possibility of simultaneous observations of turbidity and its relationship between suspended sediment concentrations (SSC) has led to the use of turbidimetry to monitor sediment transportation (Uncles and Stephens, 2010). The use of turbidity values for SSC is an indirect method and based on to determine the statistical relationship between these values; the relationship could be linear, non-linear or polynomial (Sun *et al.*, 2001). In addition the Regression equation should be considered individually for each stream condition with variations following the change of hydrological seasons (Williamson and Crawford, 2011). Changes in sediment size, mineral composition and water quality properties are the main limitations of this method. These effects should be considered and defined for different conditions to more accurately estimate sediment concentration with turbidity values (Ziegler, 2002). Tananaev and Debolskiy (2014) reported that the effecting factors of turbidity and sediment grain size should be considered in multivariate models, to minimize errors and acquire an understanding of its response. Mitchell *et al.* (2003) conducted a turbidity study using river conditions, and they reported that water quality and sediment properties were strongly affected, leading to errors in turbidity measurements, especially in spring season conditions. Chanson *et al.* (2008) conducted a laboratory study and produced a strong relationship ($R^2=0.992$) between sediment concentration and turbidity (Nephelometric Turbidity Units, NTU) at low concentrations (0.8 g/L) for silt and sand sediment materials. Slaets *et al.* (2014) were used the cumulative rainfall values as additional input parameter to estimate sediment concentration with turbidity measurement. Pearson's correlation coefficient was improved with Multiple linear regression analyses up to 0.87 compared with single (turbidity) parameter.

In this study, the possible use of the Seapoint Turbidity Meter sensor to provide accurate, reliable, automated and continuous time series of suspended-sediment concentrations was investigated under different water quality conditions in river.

Methods

Field measurements were made at two different points of Aksu river, in Kahramanmaraş, Mediterranean region of Turkey at 36° 55' E, 37° 36' N and altitude of 840 m. Aksu river is 115 km long, about 0.20 to 2.00 m deep mid-stream, and about 20-30 m wide. However, the water depth changed between 0.25 and 0.58 m during the experiment. The catchment area is about 646 km² and, it represents the heterogonous characteristics of the Mediterranean regions consisting of the wide variety of agricultural systems, forest ecosystems, rangelands, bare rocks and wetland.

Water samples (500 ml) were collected from the midpoint of total water depth through from two sampling stations. Station 1 was near the source of river and more clear than Station 2. Sediment concentrations of the collected samples were determined by the filtration method in the laboratory. At the same samples, two water quality properties were determined; electrical conductivity by EC meter and turbidity by Turbidity Meter. Simultaneously, The Seapoint Turbidity Meter was used to measures turbidity at the same sampling points, by detecting light scattered from suspended particles in water (Figure 1). It is small, consumes very little power, is highly sensitive and has a wide dynamic range. It is also has a very low temperature coefficient. (Smerdon, 2006). This sensor was connected to Aquascat data logger devices manufactured by Aquatec Group, UK. Sensor readings were stored during 90 second period and resulting in an average of 90 readings for every concentration.



Figure 1. The AQUAscat-L (Aquatec Group) device and seapoint turbidity meter sensor

The regression analyses were applied to obtain the relationship between the sediment concentrations with the turbidity values to observe of different water quality effects. These relationships were evaluated using determination coefficient (R^2) and regression equation.

Results and Findings

The water analyzes results; turbidity and electrical conductivity are presented in Figure 2 for each station.

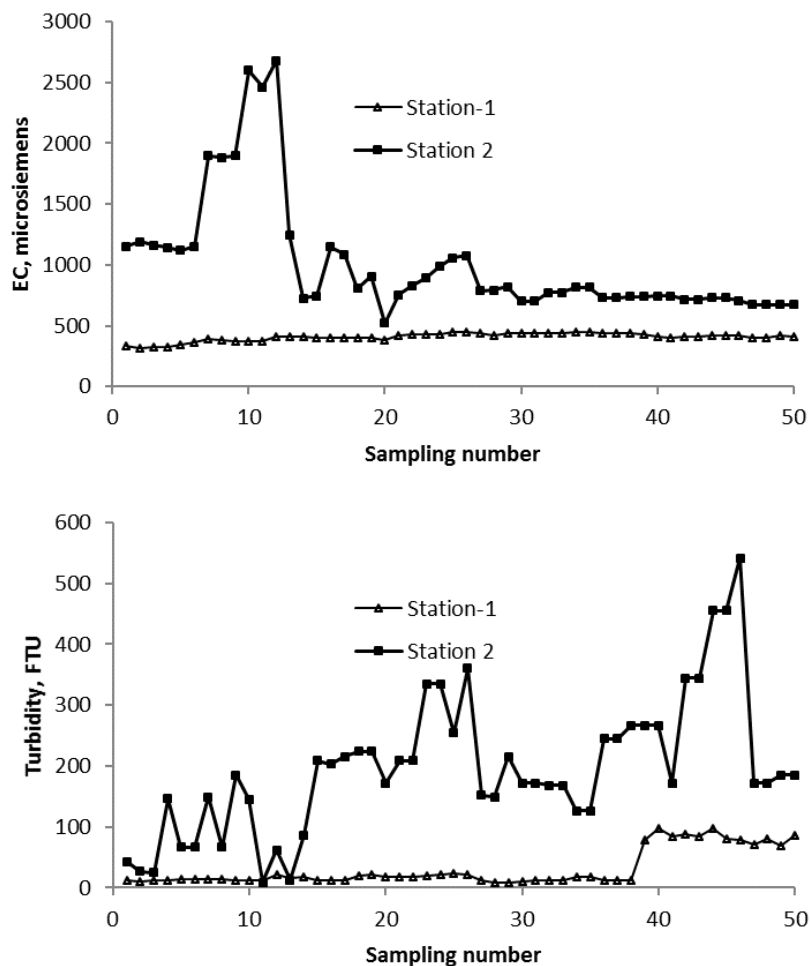


Figure 2. The water analyzes results

For station 2, EC and turbidity values were found extremely high and unstable due to pollution of waste water pollution of city. Relatively low and stable values were observed at Station 1. This station is suitable for to compare effect of water quality on estimate turbidity based sediment estimation.

Sediment concentration results of the collected samples by the filtration method in the laboratory were presented Figure 3.

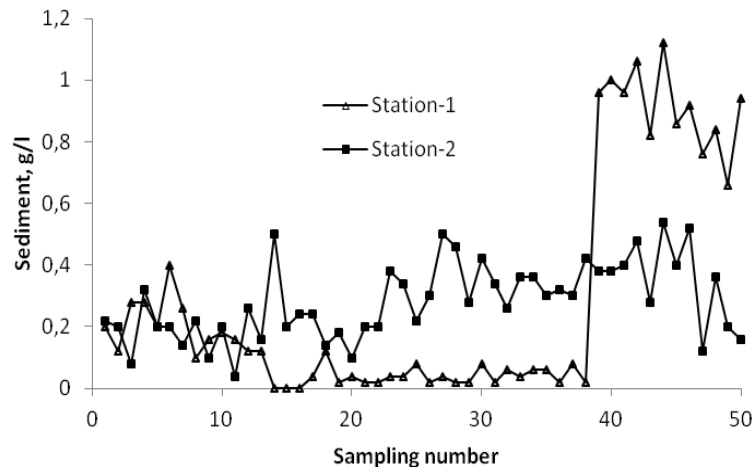


Figure 3. Sediment concentration values by the filtration method

Sediment concentration values were varied between 0.02 and 1.12 g/l during sampling season depend on rainfall and river discharge.

The regression analyses results of between the sediment concentrations and the turbidity values were given Figure 4 with regression equation and determination coefficient (R^2).

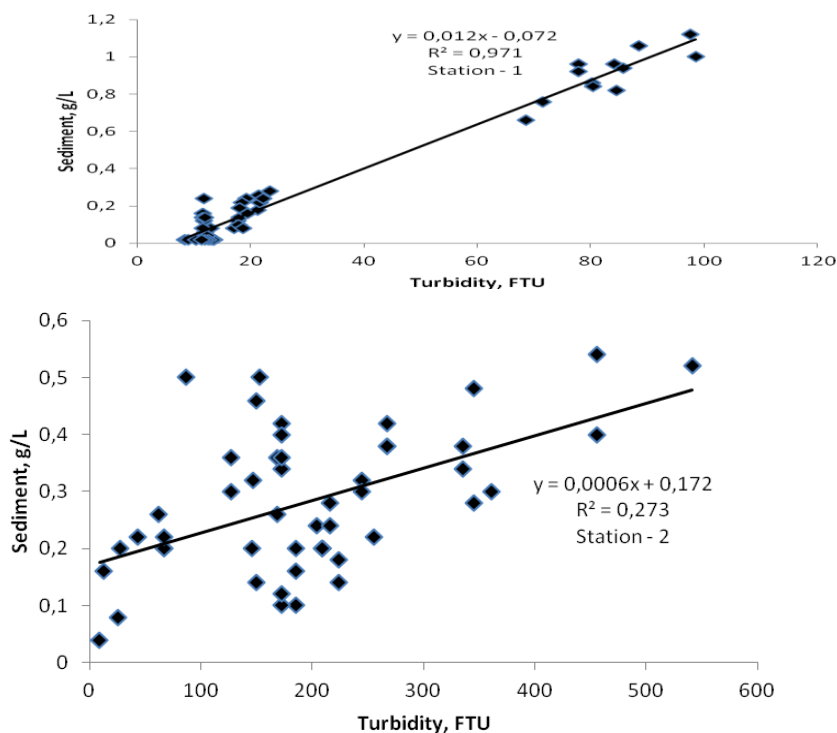


Figure 4. The regression analyses results of between the sediment concentrations and the turbidity

Fairly high R^2 value (0.971) was obtained for station water which has relatively clear water. But turbidity values can be divide two separate group. Because it can be give error due to repetition of FTU for the different small sediment contentions (especially for $FTU < 20$)

Station - 2 had effected by urban and industrial waste and it has high turbidity values as independent of sediment concentration changing. That's why week relationship was obtained of between the sediment concentrations and the turbidity values. This problem is important limitation for turbidity based sediment measurement. These effects should be considered and defined for different conditions to more accurately estimate sediment

concentration with turbidity values (Yao et al., 2014). Consequently the effective factor on turbidity values should be minimized and sediment concentration factor should be alone as main factor.

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