TOTAL SUSPENDED SOLIDS DATA FOR USE IN SEDIMENT STUDIES

G. Douglas Glysson, U.S. Geological Survey, 412 National Center, Reston, VA 20192; (703) 648-5019; FAX (703) 648-5722; email ggglysson@usgs.gov,
John, R. Gray, U.S. Geological Survey, 415 National Center, Reston, VA 20192; PH (603) 648-5318; FAX (703) 648-5277; email jrgray@usgs.gov;

ABSTRACT:

The U.S. Environmental Protection Agency identifies fluvial sediment as the single most widespread pollutant in the Nation's rivers and streams, affecting aquatic habitat, drinking water treatment processes, and recreational uses of rivers, lakes, and estuaries. A significant amount of suspended-sediment data has been produced using the total suspended solids (TSS) laboratory analysis method. An evaluation of data collected and analyzed by the U.S. Geological Survey and others has shown that the variation in TSS analytical results is considerably larger than that for traditional suspended-sediment concentration analyses (SSC) and that the TSS data show a negative bias when compared to SSC data. This presentation presents the results of a continuing investigation into the differences between TSS and SSC results. It explores possible relations between these differences and other hydrologic data collected at the same stations. A general equation was developed to relate TSS data to SSC data. However, this general equation is not applicable for data from individual stations. It also compares estimates of annual suspended-sediment loads that were made using regression equations developed from paired TSS and SSC samples with annual loads computed by the USGS using traditional techniques and SSC data. Load estimates were compared for 10 sites where sufficient TSS and SSC paired data were available to develop sediment-transport curves for the same time period for which daily suspended-sediment records were available. Results of these analyses indicated that as the time frame over which the estimates were made increases, the overall error associated with the estimates decreases. Using SSC data to compute loads tends to produce estimates with smaller errors than those computed from TSS data. Loads computed from TSS data tend to be negatively biased as compared to those computed from traditional techniques. There does not appear to be a simple way to examine SSC and TSS paired data sets to determine if the TSS data will give as good as or better estimate of the suspended-sediment load than the estimates obtained using the SSC data.

Differences Between the SSC and TSS Analytical Methods. The fundamental difference between SSC (ASTM, 1999) and TSS (APHA and others, 1995) analytical methods arises during the preparation of the sample for subsequent filtering, drying, and weighing. A TSS analysis generally entails withdrawal of an aliquot of the original sample for subsequent analysis, although as determined in a previous study, there may be a lack of consistency in methods used in the sample preparation phase of the TSS analyses (Gray, Glysson, and Conge, 2000). The SSC analytical method uses the entire water-sediment mixture to calculate SSC values.

Data: A total of 14,466 sample pairs analyzed using the SSC (USGS parameter code 80154) and TSS (USGS parameter code 00530) methods were retrieved from the electronic files of the USGS (U.S. Geological Survey, 2000a). Data were available from 48 States and Puerto Rico. Samples were collected sequentially in-stream using methods described in Edwards and Glysson (1999). Daily suspended-sediment records, obtained from the USGS Daily Suspended-Sediment Load database (U.S. Geological Survey, 2000b), were computed using the standard USGS methods described by Porterfield (1972) and normally have 200 to 300 samples per year available for the computation and are referred to hereafter as loads produced by "traditional techniques."

Findings:

1. An analysis of 14,466 paired SSC and TSS environmental samples from 48 states showed that the TSS tended to be smaller than SSC throughout the observed range of suspended-sediment concentrations encountered in this study. This is consistent with the assumption that most of the subsamples used to produce the TSS data were obtained by pipette, or by pouring from an open container. Subsampling by pipette or by pouring will tend to produce a sand-deficient subsample. (Glysson, Gray, and Conge, 2000)

2. No consistent relation between either the percent sand or percent difference between TSS and SSC, and water discharge or sediment concentration was identified for the stations used in this investigation. (Glysson, Gray, and Conge, 2000)

3. Although TSS and concentration of fines from SSC samples are generally in better agreement than TSS and SSC whole-sample concentrations, the degree of agreement can vary appreciably between stations (even stations with low sediment concentrations and low sand content.) (Glysson, Gray, and Conge, 2000)

4. The relation between SSC and TSS at a station will give a better estimate of the conversion factor needed to correct TSS data at that station than simply using the general equation of SSC = 126 + 1.0857(TSS)that was developed using the entire data set. Caution should be exercised before relating SSC and TSS using this general equation because of the potentially large errors involved. (Glysson, Gray, and Conge, 2000)

5. Using regression analysis in the estimation of suspended-sediment loads will have errors that can be substantial. The absolute value of errors in this study ranges from as large as 4000% for the estimation of a daily load to 2% for the estimation of the sum of the loads for the period of record. In all cases, the differences found between the actual suspended-sediment loads computed by the traditional methods used by the USGS and the estimated loads decreased as the time period over which the loads were estimated increased. (Glysson, Gray, Schwarz, 2001)

6. Using SSC data tends to produce load estimates with smaller errors than those for which TSS data were used. Six of the 10 sites included in the analysis had errors in the sum of the loads larger than 40% when the TSS data were used, compared to only one when the SSC data were used. No stations had the errors in the sum of loads using TSS data significantly smaller than those using SSC data. (Glysson, Gray, Schwarz, 2001)

7. There does not appear to be a simple, straightforward way to compare the SSC and TSS paired data sets to determine if the TSS data will give as good or better estimate of the suspended-sediment load. (Glysson, Gray, Schwarz, 2001)

Conclusions: The differences between TSS and SSC analyses of paired samples can be significant. If TSS and SSC paired samples exist or can be collected, it might be possible to develop a relation between SSC and TSS. It appears from the results of this study so far, that in order to attempt to adjust TSS data, one would have to have a significant number of paired data sets from the station of interest. Even then, this method may not be a guaranteed way to adjust the TSS data accurately. There appears to be no simple, straightforward way to adjust TSS data to estimate suspended-sediment concentrations if paired samples are not available. Additional work needs to be done before any definite procedure can be recommended to adjust TSS data to better estimate SSC values. Using SSC data tends to produce load estimates with smaller errors than those for which TSS data were used.

The TSS Method, which was originally designed for analyses of wastewater samples, has been showed to be fundamentally unreliable for the analysis of natural-water samples. In contrast, the SSC method produces relatively reliable results for samples of natural water, regardless of the amount or percentage of sand-size material in the samples. SSC and TSS data collected form natural water are not comparable and should not be used interchangeably. The accuracy and comparability of suspended solid-phase concentrations of the Nation's natural water would be greatly enhanced if all these data were produce by the SSC analytical method.

REFERENCES

American Public Health Association, American Water Works Association, and Water Pollution and Control Federation, 1995, Standard Methods for the Examination of Water and Wastewater, 1995, Total Suspended Solids Dried at 103°-105° C, Washington, D.C., American Public Health Association, Method 2540D, p. 2-56.

ASTM, 1999, Standard Test Method for Determining Sediment Concentration in Water Samples: American Society of Testing and Materials, D 3977-97, Vol. 11.02, pp. 389-394.

Edwards, T.K., and Glysson, G.D., 1999, Field Methods for Measurement of Fluvial Sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter C2, 89 p.

Glysson, G.D., Gray, J.R., and Conge, L.M., 2000, Adjustment of total suspended solids data for use in sediment studies: Proceedings, ASCE's 2000 Joint Conference on Water Resources Engineering and Water resources Planning and Management, July 31 – August 2, 2000, Minneapolis, Minn., 10 p. (http://water.usgs.gov/osw/pubs/ASCEGlysson.pdf)

Gray, John R., Glysson, G. Douglas, Turcios, Lisa M., and Schwarz, Gregory E., 2000, Comparability of suspended-Sediment Concentration and Total Suspended Solids Data, U.S. Geological Survey Water-Resources Investigations Report 00-4191, 14 p. (http://water.usgs.gov/osw/pubs/WRIR00-4191.pdf)

Glysson G.D., Gray, J.R., and Schwarz, G.E., 2001, A Comparison of Load-Estimate Errors Using Total Suspended Solids and Suspended-Sediment Concentration Data, Proceedings of the World Water and Environmental Congress, May 20-24, 2001, Orlando, FL, 10 p. (http://water.usgs.gov/osw/pubs/TSS_Orlando.pdf)

Porterfield, George, 1972, Computation of Fluvial-Sediment Discharge, Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter C3, Book 3, 66 p.

U.S. Geological Survey, 2000a, Water Resources Data for USA, accessed September 15, 2000, at http://water.usgs.gov/nwis/.

U.S. Geological Survey 2000b, Suspended Sediment Database: daily values of suspended sediment and ancillary data, accessed September 15, 2000, at http://webserver.cr.usgs.gov/sediment/.