DAILY SEDIMENT LOADS IN THE NORTH OCONEE RIVER

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Abstract. We present 65 years of daily turbidity data from the North Oconee River obtained from the Athens drinking water treatment facility. We use these data to characterize short- and long-term water quality changes from nonpoint sources. The turbidity data have been coupled with daily USGS discharge data for the Middle Oconee River to provide an estimate of the distribution of daily sediment loads for the period of record.

BACKGROUND

As widespread concern for public health and environmental quality continues to grow, and as limited agency budgets are increasingly taxed by expanding environmental issues, we look for effective and efficient ways to improve our understanding and management of water quality.

The focus of many water quality protection efforts has shifted to nonpoint source pollution prevention (EPA, 1998; Rasmussen et al., 1998). The major source of nonpoint source pollution is sediment. Soil erosion causes sediment to be deposited into water bodies. Increased sediment loads harm aquatic life and elevate the cost of drinking water treatment. Many water quality parameters are directly tied to sediment. Fecal coliform, herbicides and pesticides, metals, and nutrients are sorbed to soils and are transported into and through waterways by erosion. Heightened nutrient levels have been linked to pfisteria outbreaks. Fecal contamination leaves the public exposed to waterborne pathogens such as hepatitis and meningitis.

A major investment has been made in this country to improve public health and environmental integrity. While we often express a need for additional data, this data often comes at a cost. The purpose of this presentation is to demonstrate how existing unreported data can be utilized to improve our understanding of water quality dynamics.

METHODS

We recently discovered that turbidity data for the North Oconee River have been collected daily at the Athens Drinking Water Facility since August 20, 1932. This data, comprising 24,024 observations over 66 years, is available on ledger sheets, which we transcribed to machine readable format. Only one percent of the data are missing, primarily during the early period. The data were collected from a stationary pipe feeding from the North Oconee River, and were measured using Jackson Turbidity Units prior to approximately 1970, and Nephelometric Turbidity Units afterward. Because of differences between turbidity units, this analysis focuses primarily on the post-1970 data.

It is clear from previous studies (see, e.g., Holmbeck-Pelham and Rasmussen, 1997) that turbidity varies with discharge. Historical USGS discharge data for the North Oconee River at Athens (Station 02217900) are available only for a four-year period, from June 24, 1944, to December 31, 1949. To obtain a more complete discharge record, we also obtained USGS discharge data for the nearby Middle Oconee River at Athens (Station 02217500), which are available from May 1, 1937, to September 30, 1996. We developed a relationship between the same-day flows of the Middle and North Oconee Rivers using a power trend line regression:

$$Q = 1.0718\ M^{0.9373} \qquad R^2 = 0.954$$

where M is the observed Middle Oconee River discharge, Q is the predicted North Oconee River discharge, and r is the simple correlation coefficient. We consider the observed fit to be good. No statistically significant (5%) lag was found between either day-ahead or day-behind discharges.

RESULTS

Figures 1 and 2 present annual and daily averages of North Oconee River discharges from the 1930s to the 1990s. Figures 3 and 4 present annual and daily averages of turbidities for the same period. No clear long-term trend is apparent in either discharge or turbidity, although we find a moderate correlation, $r = 0.60$, between the two. Both discharge and turbidity display seasonal patterns.

Note that mean daily discharges peak at approximately 600 cfs during the spring, and reach their lowest values of approximately 150 cfs during the early fall. Peak turbidities of about 40 NTU occur dur- ing the summer months, while lowest turbidities of approximately 15 NTU occur during the late fall.

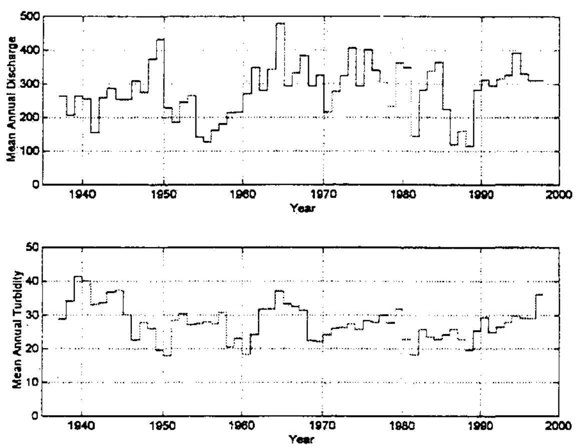

Figure 1. Mean annual discharge and turbidity.

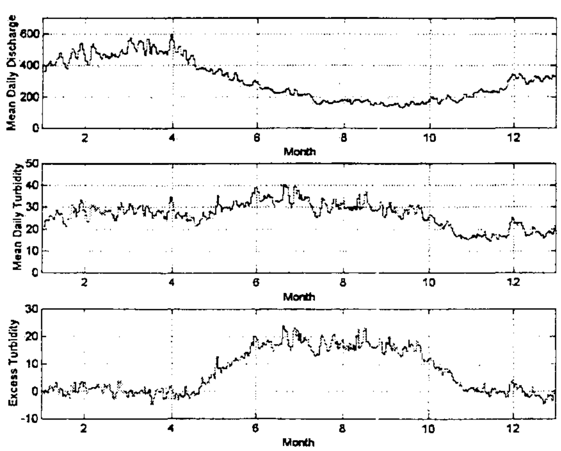

Figure 2. Mean daily discharge, turbidity and excess turbidity.

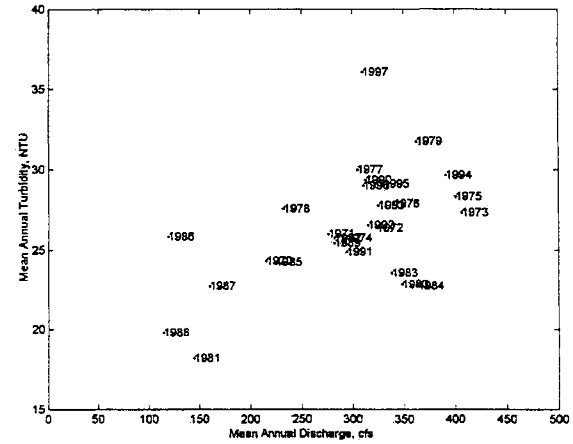

Figure 3. Mean annual discharge versus turbidity.

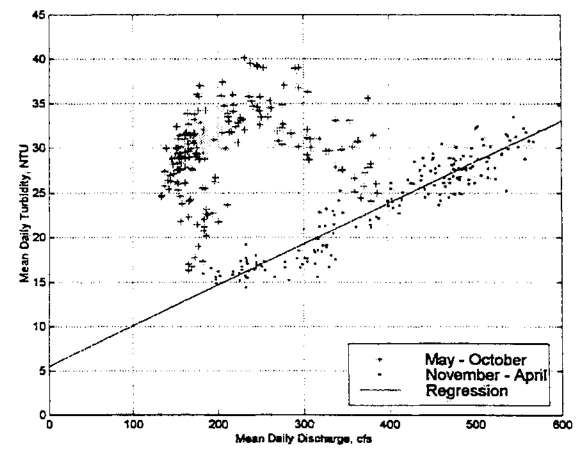

Figure 4. Relationship between discharge and turbidity.

Also note that individual daily turbidity peaks appear to be correlated with daily increases in discharge. We can examine this correlation by plotting mean daily discharge against mean daily turbidity, shown as Figure 4. Note that an excellent linear agreement is found between the months of November and April:

$$C = 5.7057 + 0.0446\,Q \qquad R^2 = 0.946$$

where C is the mean daily turbidity, NTU, and Q is mean daily discharge, cfs. Only a very weak relationship, $r = -0.307$, exists between daily turbidity and discharge for the months of May to October.

We reveal an excess turbidity in Figure 2 by removing the discharge-turbidity relationship from the daily means. The excess turbidity rises starting in May to a maximum of about 20 NTU, is steady during the summer, and disappears in the autumn. We hypothesize that the excess turbidity corresponds to organic components of turbidity, such as phytoplankton, that correlate with solar intensity and stream temperature. Additional measurements of organic matter are required to evaluate our theory.

Daily sediment loads are found by multiplying the observed turbidity by the observed discharge, and converting to units of tonnes per day. Table 1 provides a statistical summary of the data. Note that: a) the sediment loads include both the mineral and presumed organic loads; b) the four order-of-magnitude range in observed daily loads; c) the maximum total daily load constitutes approximately one third of the total annual load of 18,250 tonnes; and d) the mean daily turbidity exceeds the recommended action limit of 25 NTU (Kundell and Rasmussen, 1995).

SUMMARY AND CONCLUSIONS

We present an unused data source for daily turbidity. These data are available from the local drinking water facility, and date back to the 1930s. Other communities that rely on surface water as their drink-ing water source may also have this type of data ar-chived.

We relate the observed daily data to daily discharges obtained from a nearby USGS discharge station. We show that mean daily turbidities are strongly correlated with mean daily discharges during the months from November to April. Turbidities are higher from May to October by about 20 NTU, apparently due to an increase in phytoplankton during these months. We also found that extreme discharges account for most of the sediment load. The average turbidity exceeds the recommended action level of 25 NTU proposed by the Board of Regents' Scientific Panel on Erosion (Dirt 1).

Table 1. North Oconee River Daily Observations

	Discharge (cfs)	Turbidity (NTU)	Sediment Load (tonnes/day)
Average	380	33	50
Median	280	25	15
Minimum	8	2	0.30
Maximum	7,500	325	5,500

LITERATURE CITED

EPA, 1997, "State Source Water Assessment and Protection Programs Guidance", *EPA 816-R-97-009*.

Holmbeck-Pelham, S.A. and T.C. Rasmussen, 1997, "Characterization of Temporal and Spatial Variability of Turbidity in the Upper Chattahoochee River", *1997 Georgia Water Resources Conference*, Athens, Georgia, p. 144-147.

Kundell, J.E. and T.C. Rasmussen, 1995, "Recommendations of the Georgia Board of Regents' Scientific Panel on Evaluating the Erosion Measurement Standard Defined by the Georgia Erosion and Sedimentation Act", *1995 Georgia Water Resources Conference*, Athens, Georgia, p. 211-217.

Rasmussen, T.C., J. Reed, J. Bollinger, 1998, "A Decision Tree Methodology for Source Water Assessment and Protection", *Source Water and Protection 98*, Dallas, TX, p. 39-45.