

Watershed Insights Report No. 13

Nutrient and Sediment Movement Influx and Efflux into Lake Greenwood, SC



Clemson University, under direction of the Saluda-Reedy Watershed Consortium (SRWC), conducted research from 2004 through 2006 to characterize the loadings of key contaminants into Lake Greenwood from the Reedy River and Saluda River basins and the export of these contaminants from Lake Greenwood. Reports and data from three years of research were summarized herein by Clemson University and North Wind Inc.

Part 1. Hydrologic Inputs

Methodology: Nutrient, sediment and selected metals influx was measured by sampling storm events and base flow from February 2004 to December 2006 at established sampling stations at the base of the Reedy and Saluda Rivers near the headwaters of Lake Greenwood. Samples were analyzed for total suspended solids (TSS), total dissolved nitrogen, dissolved organic carbon, chloride, nitrite, orthophosphate, bromide, nitrate, sulfate, total phosphate, total potassium, total calcium, total magnesium, total zinc, total copper, total manganese, total iron, total sulfur, total sodium, total boron and total aluminum using standard methods. Flow rates were measured and used to calculate annual loadings and annual mean concentrations for each variable. Daily loadings were calculated for each constituent using concentration and flow measurements.

Results and Discussion: Samples from the Reedy and Saluda Rivers were collected for 38 storm events from February 2004 to December 2006. Inputs from the Reedy and Saluda Rivers varied widely over this 3 year period. Basin size, land use, point source discharge and precipitation amount and intensity all affect loadings to Lake Greenwood from these two watersheds.

- Annual mean concentration (AMC) of chloride remained stable for all three years in the Saluda River but varied considerably in the Reedy River because of changes in total flow. Total loads were similar in 2004 but in 2005 the Reedy's load was almost 2 times the Saluda's load and in 2006 was more than 2 times the Saluda's load.
- Both basins exported roughly equivalent loads of nitrate in all three years, however, nitrate AMC was 2.5 times greater in the Reedy River compared to the Saluda River.
- The Saluda basin exported 5 times more TSS than the Reedy Basin in 2004 and 2006, and 10 times more TSS in 2005.
- In 2004 AMC of orthophosphate was equal for both rivers, however, the annual load in the Saluda River was more than 2 times that of the Reedy River. In 2005 and 2006 orthophosphate load was reduced by 360% in the Saluda River but remained relatively unchanged in the Reedy River.
- AMC of TSS in the Saluda River was more than 2 times that of the Reedy River for all three years. Saluda River TSS loading was 4 times greater in 2004 and 2005 and 5 times greater in 2006 than loading from the Reedy River.

These results reflect individual basin characteristics such as size, land use, and permitted point source discharges into the two rivers. Point source discharges in the Reedy basin contribute to elevated chloride, nitrate and orthophosphate annual mean concentration and

loads. The Saluda River basin is beginning to undergo land use change as a result of development. Without a change in current development practices these land use changes and their associated impacts will lead to increased sediment and nutrient inputs into local rivers and subsequently into Lake Greenwood.

Part 2. Nutrient Dynamics at the Sediment-Water Interface

Project Objectives and Methods: Most natural waters contain adequate supplies of all nutrients necessary for algal growth except phosphorus and/or nitrogen. Eutrophication can continue even after external anthropogenic sources have stopped due to internally regenerated phosphorus and nitrogen from sediments. Both phosphorus and nitrogen are co-limiting nutrients in Lake Greenwood. The objective of this project was to measure phosphorus and nitrogen levels in the pore water of sediment and water at the sediment-water interface in Lake Greenwood.

Methodology: Samples were collected from four points in Lake Greenwood (one lower, one mid, and two in the upper lake) on a regular basis from July 2005 to June 2006. Two laboratory sediment-water columns were used to measure the phosphorus flux at the sediment-water interface.

Part 3. Lake Greenwood Exports and Mass Balance

Nutrient, sediment and selected metals (the same analytes as previously listed for the Reedy and Saluda basins), were measured at a newly established sample station at the Lake Greenwood dam to obtain samples of water flowing past the dam. Bi-daily samples were taken from the Lake Greenwood dam station starting in February 2006. Daily loadings were calculated for each constituent using concentration and flow measurements. Mass balance analyses were run for orthophosphate, nitrate, total nitrogen, TSS and total phosphorus for March through September 2006.

Results and Discussion

Lake Greenwood functioned as a sink for TSS, nitrate, and total dissolved nitrogen for the entire sample period. The lake was also a sink for total phosphorus during this period with the exception of April. In April, the lake exported 168 kg of total phosphorus which represents only about 5% of the total load entering the lake. Orthophosphate was the most dynamic of all measured analytes. The lake was a sink for orthophosphate for March, April, May and September but exported during the months of June, July and August. This would be expected based on the general anaerobic condition of the sediments at this time of the year. As was expected, the concentration of phosphorus in the pore water of the sediment was significantly higher than lake water at the sediment interface. These data suggest significant phosphorus loading from the sediments into the water column during summer months.

Synopsis: As the Reedy and Saluda basins continue to undergo land cover change, sediment and nutrient loadings will continue to fluctuate and increase. These loadings will be affected by both rainfall and seasonal events. This research, along with additional ongoing research efforts, will aid in the characterization and understanding of sediment and nutrient loadings into Lake Greenwood. This research will increase our understanding of the impacts of urbanization and land cover change on the lake and aid in formulating appropriate management efforts and policies to allow for improved water quality in Lake Greenwood.

- This project was sponsored by the Saluda-Reedy Watershed Consortium and has involved technical work by North Wind Inc.
- Watershed Insights Report No. 13, authorized for release by SRWC on 08/17/2007.
- Key Contact: Steve Springs, ssprings@northwind-inc.com, 864.787.4504. SRWC is a broad-based group of universities, public agencies, private consultants, and non-profit organizations focused on assuring "Clean, Healthy and Abundant Water for a Sustainable Economy and Environment throughout the Saluda-Reedy Watershed".