Measuring Nutrient Losses via Runoff from an Established Golf Course

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Objectives:

1. Compare nutrient loading via surface water runoff from a new golf course versus the site's previous native prairie condition.
2. Investigate the new golf course's impact on surface water quality during construction and during golf course operations.

Start Date: 1998
Project Duration: nine years
Total Funding: $218,155

Kansas State University in cooperation with Jim Colbert, PGA TOUR, GCSAA, and various alumni has built a 27-hole championship golf course, Colbert Hills Golf Course, near Manhattan, Kansas. The golf course was built on land that has a prairie-woodland mix that is typical of the Flint Hills Region. The only previous land use was occasional grazing for beef cattle.

We have set up four monitoring stations on Little Kitten Creek (the major stream) and its tributaries to collect water samples, measure runoff discharges, and collect precipitation data. Water samples were tested for total nitrogen, total phosphorus, and sediment concentrations. Surface water runoff amounts were studied so that mass transport of nutrients and sediment can be analyzed.

In the past year, we continued our previous nutrient runoff research by collecting more samples and analyzing data. A below average amount of precipitation resulted in the collection of 27 total samples from inlet and outlet sites this year. We divided the data set into three subsets, namely pre-construction (native conditions), during construction, and during operation. At the main stream leaving the golf course, 28, 138, and 282 surface water samples were collected for the three periods, respectively.

Data analysis showed that golf course construction has the greatest impacts on surface water quality with average concentrations of 3.88 mg/L, 0.93 mg/L, and 2,754 mg/L for total N (TN), total P (TP), and sediment (TSS) respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period. During operation, sediment content was brought down significantly to an average of 594 mg/L, slightly higher than that of the native prairie condition. The average concentrations of TN and TP were 2.10 mg/L and 0.53 mg/L, much lower than those in the construction period, but still over 40 and 25 percent higher than those in the native prairie condition, respectively.

Sources of nutrients in streams under native prairie condition and during construction are thought to be from the input of rainfall and sediment eroded from fertile topsoils. During golf course operation, fertilizer application is another source of nutrients in streams, in addition to those mentioned above. Further analysis shows that there are direct connections between fertilizer application and concentration of TN and TP in streams. Although these connections are not so obvious in most cases, there are cases that clearly indicate the amount and timing of fertilizer application are to be blamed.

Analysies showed that there are cases that clearly indicate the amount and timing of fertilizer application are to be blamed for increased nutrients in the sampled streams.

Less sediment in streams during operation is a contribution of golf courses to the environment. Higher concentration of TN and TP than that under native prairie condition is expectable. However, only a few samples have TN greater than 10 mg/L, a drinking water standard.

We were able to determine the surface water runoff amounts and the mass amounts of nutrient transported offsite. The determined rates of nutrient transport for native conditions were similar with those in the adjacent Konza Prairie Research Area. The rate of nutrient transport during construction was 3 to 4 times that under native conditions, which was consistent with the estimation of sediment yields.

We will continue to collect surface water samples for another year in order to have a better understanding of the impacts of golf course operation on surface water quality. With more data, we will be able to develop an Artificial Neural Network (ANN) model to simulate the impacts of construction and operation of a golf course on surface water quality.

Summary Points

- Golf course construction has the greatest impacts on surface water quality with average concentrations of 3.88 mg/L, 0.93 mg/L, and 2,754 mg/L for total N (TN), total P (TP), and sediment (TSS) respectively, compared with 1.18 mg/L, 0.39 mg/L, and 477 mg/L for the pre-construction period.
- During operation, sediment content was brought down significantly to an average of 594 mg/L, slightly higher than that of the native prairie condition.
- The average concentrations of TN and TP were 2.10 mg/L and 0.53 mg/L, much lower than those in the construction period, but still over 40 and 25 percent higher than those in the native prairie condition, respectively.
- There are cases that clearly indicate the amount and timing of fertilizer application are to be blamed.