Title
Land Cover – Nutrient Export Relationships in Space and Time

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Abstract
The relationship between watershed land-cover composition and nutrient export has been well established through several meta-analyses. The meta-analyses reveal that nutrient loads from watersheds dominated by natural vegetation tend to be lower than nutrient loads from watersheds dominated by anthropogenic uses (e.g., urban, agriculture). The meta-analyses suggest that land-cover change should have a detectable and sometimes pronounced effect on nutrient export. The same meta-analyses, however, also reveal considerable intra-site variability in watershed nutrient export. Nutrient export for a single watershed is variable from one year to the next due to a host of exogenous factors. Intra-site variability in watershed nutrient export complicates determination of the effect of land-cover change on nutrient export because it must be taken into account to determine if changes in nutrient export are significant. We incorporated intra-site variability into a statistical simulation model to determine the effect of land-cover change on nutrient export by treating exported loads as distributions, and testing for significant changes in the distributions. The distributions were compiled from over 1200 observations spread across 167 sites in the conterminous United States for total nitrogen (TN) and total phosphorus (TP). Land-cover changes were estimated from the National Land Cover Database (NLCD). Prior to implementing the model, we tested for spatial stationarity in the land cover - nutrient export relationship by testing for ecoregional effects. Ecoregions were not a significant factor, suggesting that the land cover – nutrient export relationship was relatively constant across the conterminous United States. We found a non-linear relationship between land-cover change and statistically significant differences in TN and TP distributions. Small amounts of land-cover change produced statistically significant differences in TN and TP distributions when a watershed was dominated by natural vegetation. As the amount of natural vegetation decreased, larger amounts of land-cover change were needed to produce statistically significant shifts in TN and TP distributions. These results suggest that nutrient yields from watersheds dominated by natural vegetation are sensitive to small changes in land cover, and that consistently meeting nutrient export management targets on an annual basis will be difficult in watersheds dominated by anthropogenic uses.