World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:17, No:09, 2023

Multivariate Ecoregion Analysis of Nutrient Runoff From Agricultural Land Uses in North America

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Abstract : Field-scale runoff and water quality data are critical to understanding the fate and transport of nutrients applied to agricultural lands and minimizing their off-site transport because it is at that scale that agricultural management decisions are typically made based on hydrologic, soil, and land use factors. However, regional influences such as precipitation, temperature, and prevailing cropping systems and land use patterns also impact nutrient runoff. In the present study, the recently-updated MANAGE (Measured Annual Nutrient loads from Agricultural Environments) database was used to conduct an ecoregion-level analysis of nitrogen and phosphorus runoff from agricultural lands in the North America. Specifically, annual N and P runoff loads for cropland and grasslands in North American Level II EPA ecoregions were presented, and the impact of factors such as land use, tillage, and fertilizer timing and placement on N and P runoff were analyzed. Specifically we compiled annual N and P runoff load data (i.e., dissolved, particulate, and total N and P, kg/ha/yr) for each Level 2 EPA ecoregion and for various agricultural management practices (i.e., land use, tillage, fertilizer timing, fertilizer placement) within each ecoregion to showcase the analyses possible with the data in MANAGE. Potential differences in N and P runoff loads were evaluated between and within ecoregions with statistical and graphical approaches. Non-parametric analyses, mainly Mann-Whitney tests were conducted on median values weighted by the site years of data utilizing R because the data were not normally distributed, and we used Dunn tests and box and whisker plots to visually and statistically evaluate significant differences. Out of the 50 total North American Ecoregions, 11 were found that had significant data and site years to be utilized in the analysis. When examining ecoregions alone, it was observed that ER 9.2 temperate prairies had a significantly higher total N at 11.7 kg/ha/yr than ER 9.4 South Central Semi Arid Prairies with a total N of 2.4. When examining total P it was observed that ER 8.5 Mississippi Alluvial and Southeast USA Coastal Plains had a higher load at 3.0 kg/ha/yr than ER 8.2 Southeastern USA Plains with a load of 0.25 kg/ha/yr. Tillage and Land Use had severe impacts on nutrient loads. In ER 9.2 Temperate Prairies, conventional tillage had a total N load of 36.0 kg/ha/yr while conservation tillage had a total N load of 4.8 kg/ha/yr. In all relevant ecoregions, when corn was the predominant land use, total N levels significantly increased compared to grassland or other grains. In ER 8.4 Ozark-Ouachita, Corn had a total N of 22.1 kg/ha/yr while grazed grassland had a total N of 2.9 kg/ha/yr. There are further intricacies of the interactions that agricultural management practices have on one another combined with ecological conditions and their impacts on the continental aquatic nutrient loads that still need to be explored. This research provides a stepping stone to further understanding of land and resource stewardship and best management practices.

Keywords : water quality, ecoregions, nitrogen, phosphorus, agriculture, best management practices, land use
Conference Title : ICBDA 2023 : International Conference on Big Data in Agriculture
Conference Location : Paris, France
Conference Dates : September 18-19, 2023