Landscape features

Impact: Nutrient leaching and run-off

Reference 3

Shen, W; Li, S; Mi, M; Zhuang, Y; Zhang, L 2021 What makes ditches and ponds more efficient in nitrogen control? AGRICULTURE, ECOSYSTEMS AND ENVIRONMENT, 314, 107409. 10.1016/j.agee.2021.107409

Background and objective

Ditches and ponds are widely used ecological engineering measures to control agricultural non-point source pollution. Numerous site-level studies have examined the removal rate of total nitrogen (TN) in ditches and ponds, but these results vary greatly. This study aimed to summarize global studies on the nitrogen removal of ditches and ponds. Through statistical analysis, the authors answered the following questions: 1) What is the general removal rate of ditches and ponds across climatic and geographic regions? 2) When will ditches and ponds become pollution sources rather than sinks? 3) What are the key factors that affect the removal rate of ditches and ponds? 4) What kind of enhancement measure (e.g., selected vegetation) is statistically effective in improving the nitrogen retention of ditches and ponds?

Search strategy and selection criteria

The authors used the Web of Science, Scopus, Science Direct and CNKI databases to search articles between 1960 and 2019 that include the following search strings: (“nitrogen” or “nutrient*" or "diffuse pollut*” or “non point source pollut*" or "NPS pollut*”) AND (“ditch*" or "channel*” or "pond**"). 1) The study was conducted in the fields, and simulated ditches or ponds in the laboratory were not included; 2) the sources of pollution were agricultural non-point source (ANPS) pollution; 3) the nitrogen index was total nitrogen (TN) of a single ditch or pond, and ditch-pond systems are not included.

Data and analysis

In this study, meta-analysis was used to illustrate the overall removal effect of ditches and ponds. A random model was chosen to combine estimates across studies. The calculation was performed in the R packages “metafor”. To facilitate understanding and display, the lnR values were back-transformed as removal rate of ditches and ponds. The Kruskal-Wallis test was conducted to compare the removal rate between different groups. Correlation analysis was used to show the relationship between different factors and the TN removal rate. Spearman’s correlation coefficient was computed to exhibit the correlation, as the data is non-normal. A 5% significance level was applied in all statistical analyses. All statistical analyses were performed in R 3.6 and Origin 2021.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
92	Croplands	Effluent concentration	Influent concentration	Metric: Total nitrogen (TN); Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	69%

Results

- The summarized effect of ditches and ponds was a 38.7% reduction in TN (95% confidence intervals = 34.1 - 43.0%), confirming that the nitrogen retention effect of ditches and ponds is significant in general as the 95% confidence intervals did not overlap with zero.
- The removal rate between vegetated and unvegetated ditches and ponds showed a significant difference ($P < 0.01$). However, in the ditches and ponds with vegetation, the selected vegetation did not show better effectiveness than natural vegetation ($P = 0.421$).
- Different temperature groups showed a significant difference in removal rates of ditches and ponds ($P < 0.01$). The removal rate was the highest in the 20 - 30 °C group and the lowest in the 0 - 10°C group. There was a significant and positive relationship between temperature and removal rate ($P < 0.01$).
- The removal rate between non-concrete ditches and part-concrete ditches did not show a significant difference ($P = 0.422$), however, the removal rate of full-concrete ditches was significantly lower than that of non-concrete and part-concrete ditches ($P = 0.011$).
- The influent concentration and the removal rate also showed a significant positive correlation ($P < 0.01$).

Factors influencing effect sizes

- Temperature : Higher removal rate when temperature increases.
- Vegetation presence in ditch : Higher removal rate in vegetated ditches and ponds.
- Construction material : The removal rate of full-concrete ditches was significantly lower than that of non-concrete and part-concrete ditches.

Conclusion

Based on this statistical analysis, ditches and ponds effectively reduce total nitrogen, and the general removal rate is 38.7%.