The MANAGE Water Quality Database: Development of a new drainage nutrient concentration component

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INTRODUCTION

Agricultural intensification and crop specialization continues to be driven by an ever increasing demand for food. It is now imperative to understand the consequences of modern agricultural practices such as the increase in the frequency and severity of nutrient–related water impairments. This in-progress study builds on the momentum of the previously established "Measured Annual Nutrient loads from AGricultural Environments" (MANAGE) database to better answer questions about how and why nutrients are transported in subsurface drainage.

OBJECTIVES

- Compile nitrogen (N) and phosphorus (P) concentration data from agricultural tile drainage studies done in the United States and Canada into new MANAGE Drain Concentration database.
- Identify contributing factors to nutrient loss from agricultural tile drainage through meta-analysis and other statistical analyses.

MATERIALS AND METHODS

- Peer-reviewed literature were reviewed for drainage P and N concentration data between May and December 2016.
- Literature were subjected to the same criteria as used for the MANAGE "Drain Load" table.
  - The study was conducted in the United States or Canada
  - The study has a drainage area of at least 0.09 ha.
  - The study is considered "free drainage".
  - The study has at least one year of data.
  - The study is a peer-reviewed publication.
  - The study is of homogeneous land use.
  - The study is not a rainfall simulation or lysimeter study.
- Data Thief® software will be used to pull data from figures.
- Upon compilation, the MANAGE "Drain Concentration" database will be subjected to statistical analyses, including meta-analytical procedures.

ACKNOWLEDGMENTS

- Funding for this work was provided by the Illinois Nutrient Research and Education Council.
- MANAGE Drain Load development was previously funded by the 4R Research Fund.

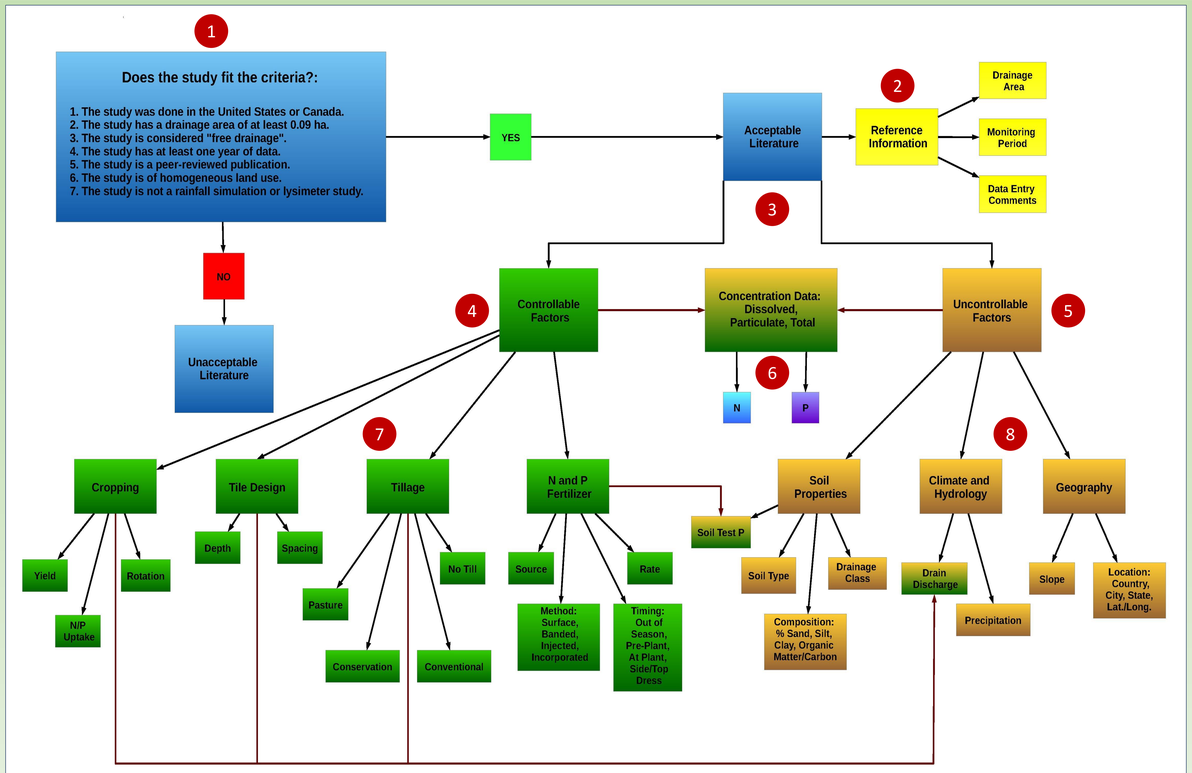

Figure 1. The MANAGE Drain Concentration database architecture allows for informative statistical analysis of common agricultural practices coupled with soil properties, climate, and geography.

RESULTS TO DATE

- 103 peer-reviewed studies have been reviewed.
- 60 of the 91 (65%) MANAGE Drain Load database studies were acceptable for the Drain Concentration database.
- 7 studies previously rejected for "Drain Load" were acceptable for "Drain Concentration".
- 28 new studies have been reviewed to date.
  - 7/28 (25%) were acceptable for "Drain Concentration".
  - 10/28 (36%) were acceptable for further addition to "Drain Load".
- 74 total studies have been accepted for "Drain Concentration".
  - 59/74 (80%) contain N data
  - 28/74 (38%) contain P data
  - 12/74 (16%) contain N and P data
- 98 Data Thief® files and tables have been created.
- Currently, 17 U.S. states and Canadian provinces are represented.

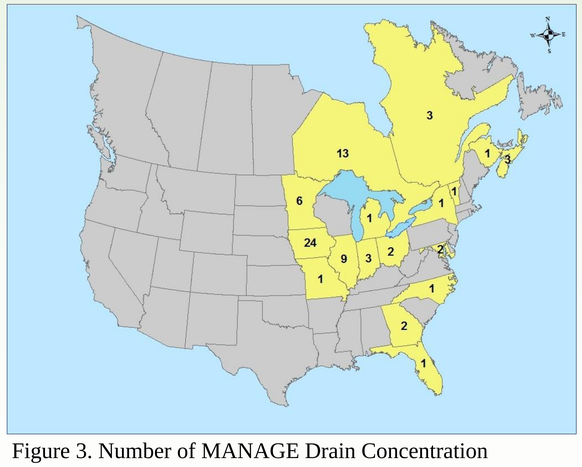

Figure 3. Number of MANAGE Drain Concentration database studies by state or province as of August 2016. Information sourcing will continue until December 2016.

1. The database is formed from data extracted from peer-reviewed literature meeting the criteria set by the creators of the MANAGE Drain Load database.
2. Once deemed acceptable, study specific details such as monitoring period, drainage area, and other reference information is recorded.
3. Further study information is split into two categories, controllable and uncontrollable factors relating to nutrient concentrations in tile drainage.
4. Controllable factors are choices made by the land manager than can promote or limit nutrient losses.
5. Uncontrollable factors such as soil properties, climate, and geography affect land management decisions and contain forces that promote or limit nutrient losses.
6. The N and P concentration data will be a function of both controllable and uncontrollable factors. All dissolved, particulate, and total N and P concentrations will be used in determining which single or combination of factors are best to limit nutrient losses in agricultural tile drainage through meta-analysis and other statistical analyses.
7.
   - Cropping – The choice in crop type and the yield will determine how much soil N and P is used by the plant and not allowed to be lost.
   - Tile design – The depth and spacing of tiles determines how much drainage discharge there will be creating a difference in N and P concentrations.
   - Tillage – Water infiltration, water holding capacity, and mineralization rates are affected by the use of (or non-use) tillage and impact N and P abundance and movement.
   - Fertilizer – The rate, timing, method, and source of fertilization determine the rate at which the soil N and P is replenished, transformed, taken up by plants, and lost.
8.
   - Soil Properties – The composition of the soil (% sand, silt, clay, and organic matter/carbon) will determine soil type and drainage class (very poorly drained to excessively drained). Along with land use and management, soil properties will yield varying soil P amounts.
   - Climate and Hydrology – Precipitation aids the movement of N and P throughout the soil. Large amounts of precipitation will cause a high amount of drain discharge allowing more nutrients to exit the field. Drain discharge is also affected by soil properties and land management decisions.
   - Geography – Changes in land topography and slope have an effect on water movement and therefore nutrient movement. The location in which the field lies will determine the climate and topography.

CONCLUSION

Eventually, the MANAGE "Drain Concentration" database will inform agricultural operations about controllable and uncontrollable factors impacting drainage nutrient concentrations along with yield penalties associated with in-field practices that impact nutrient losses. This work aims to bolster the efforts to implement appropriate nutrient loss reduction practices to ultimately improve water quality across the Mississippi River Basin.