Decision Support Tool for Evaluating Watershed Best Management Practices

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1. INTRODUCTION

- Lake Decatur is the major source of public water supply for the City of Decatur, Illinois. Its drainage area (i.e., 925 sq. mi.) is mainly cropland (~90%) with extensive network of tile drains.
- Agricultural runoff has been the main cause of the lake's water quality impairment, affecting its provision of a crucial life-supporting ecosystem service—public water supply.
- The lake was listed in the 2004 Section 303(d) for nitrate-N and total phosphorus impairment, and TMDL was completed in 2007.
- Two subwatersheds (i.e., Big Ditch and Big/Long Creek watersheds) were selected for developing TMDL implementation plan (see Figure 1).
- Decision support models (DSMs) were developed for generating optimal alternative scenarios (see Figure 3) of watershed best management practices (BMPs) (Bekele, et al., 2014).
- A Decision Support Tool (DST) is further developed for evaluating different BMP implementation scenarios in the study watersheds (see Figure 2).

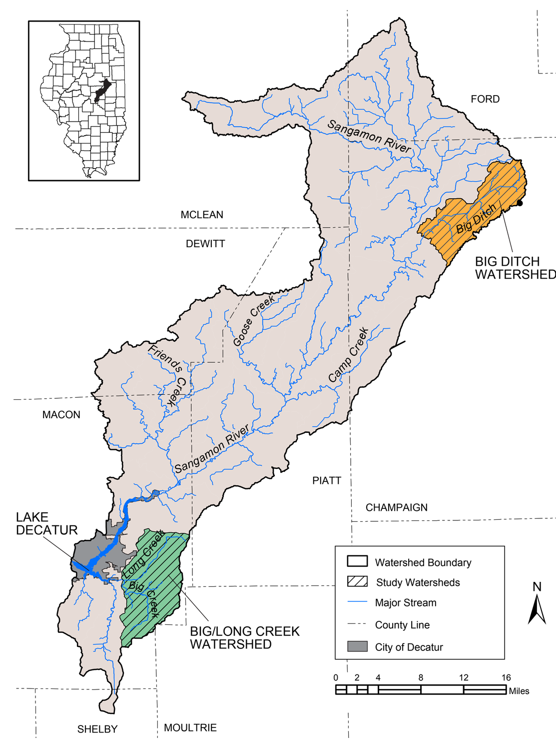

Figure 1. Lake Decatur Watershed

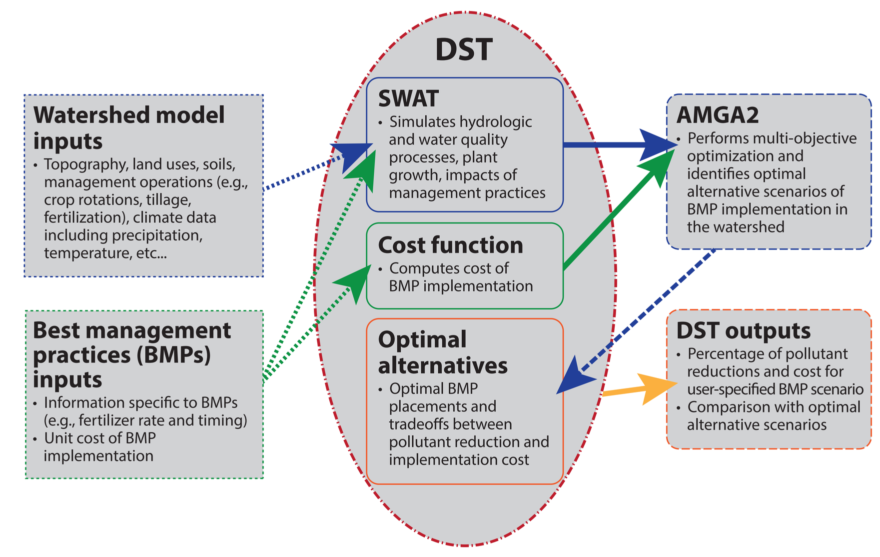

Figure 2. Components of the Decision Support Tool (DST)

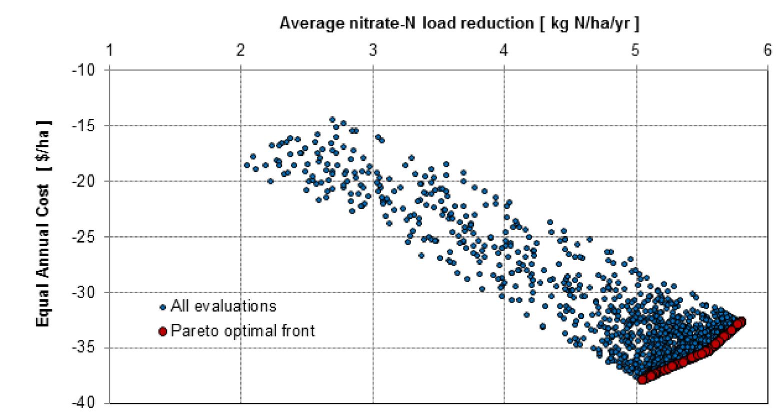

Figure 3. Multi-objective optimization of nutrient management scenarios using AMGA2: Evolving towards optimal tradeoffs

2. OBJECTIVE

- To develop a tool for evaluating different, user-specified implementation scenarios of selected BMPs (i.e., their placements in the watershed and implementation costs).
- To assist in making informed decision through comparison of different implementation scenarios with optimal alternatives provided by the tool and/or with each other.

3. DECISION SUPPORT TOOL (DST)

- The DST runs (i) Soil and Water Assessment Tool (SWAT) for simulating watershed responses including flow, sediment, and nutrients; (ii) evaluates impacts of selected BMPs and their implementation costs; and (iii) compares simulated BMP scenarios with optimal ones.
- SWAT is designed to predict the long-term impacts of land management practices on water, sediment, and agricultural chemical yields in watersheds. Data-driven routines were incorporated for evaluating those BMPs that were not included in SWAT.
- SWAT models of Big Ditch and Big/Long Creek watershed were calibrated and validated for flow, sediment, nitrate-N, and TP (Bekele et al., 2014); They were incorporated into the DST.

4. DST APPLICATION: IMPLEMENTATION OF CONSTRUCTED WETLANDS

- **Constructed wetlands (CWs)** can provide water quality benefits by removing sediment and nutrients from surface and subsurface agricultural runoffs.
  - In SWAT, CWs are modeled as water bodies in a hydrologic response unit (HRU). CW treatment area to HRU area is set at 50% with a minimum CW drainage area of at least 5 hectares. Ratio of CW surface area to its drainage area equals 0.05. $2,700 per acre of wetland surface area and a maintenance cost of $0.11 per acre of CW treatment area, and revenue loss were used to estimate implementation cost.
  - SWAT is modified to allow CWs to receive HRU tile flows.

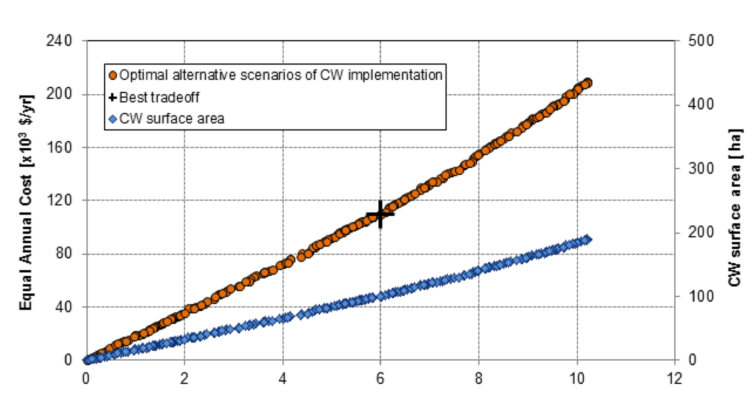

Figure 4a. Optimal alternative scenarios of CW implementation in BDW

- **Optimal implementation alternatives for Big Ditch Watershed (BDW)**
  - The most cost-effective implementation scenario is considered as the best tradeoff alternative (see Table 1, Figures 4a and 4b).

Table 1. Load reductions and implementation cost for the best tradeoff alternative

BMP treament area [% of watershed area]		Pollutant load Reduction						Equal annual cost (EAC)
		Nitrate-N		Total phosphorus		Sediment		
Priority	Total	[kg/ha/yr]	[%]	[kg/ha/yr]	[%]	[t/ha/yr]	[%]	[$/yr]
area 1 = 2.2	18.6	5.987	17.1	0.043	7.2	0.014	5.0	109,426
area 2 = 7.5		EAC [$/kg/ha]		EAC [$/kg/ha]		EAC [$/t/ha]		$/ha/yr
area 3 = 8.9		9.18		1,279		3,997		55

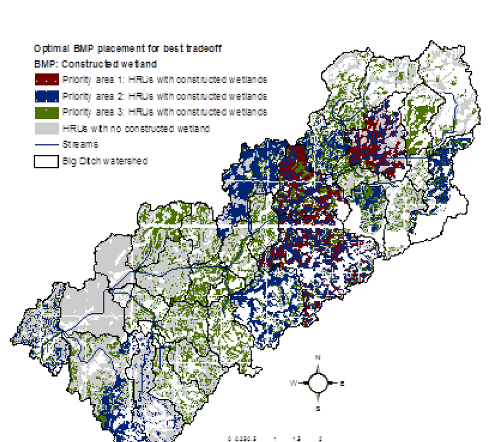

Figure 4b. Optimal placements of CWs in BDW for the best tradeoff alternative

- **Evaluating a user-specified implementation scenario of constructed wetlands in BDW using DST** (see Figures 5a and 5b).
  - Select a watershed and a subbasin, and visualize its land use, soil, slope; Select BMP type and its placement from a list of suitable HRUs; Evaluate the BMP scenario and obtain figure and table showing the simulated scenario using default and user specified costs.

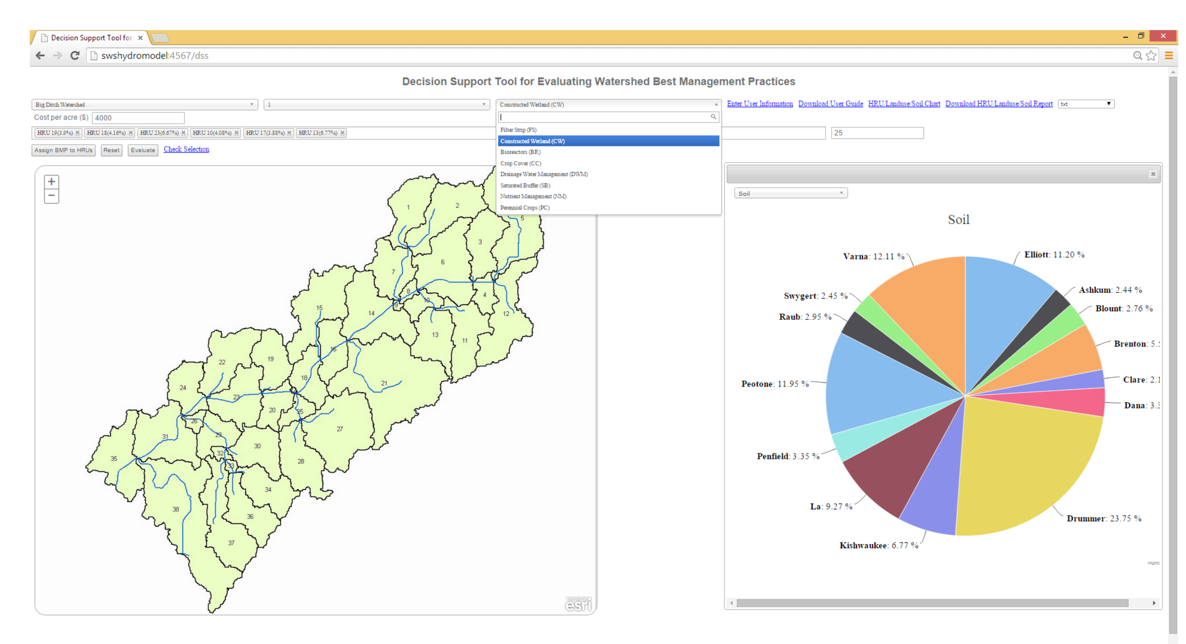

Figure 5a. DST features showing watershed, soils, BMP selection and placement

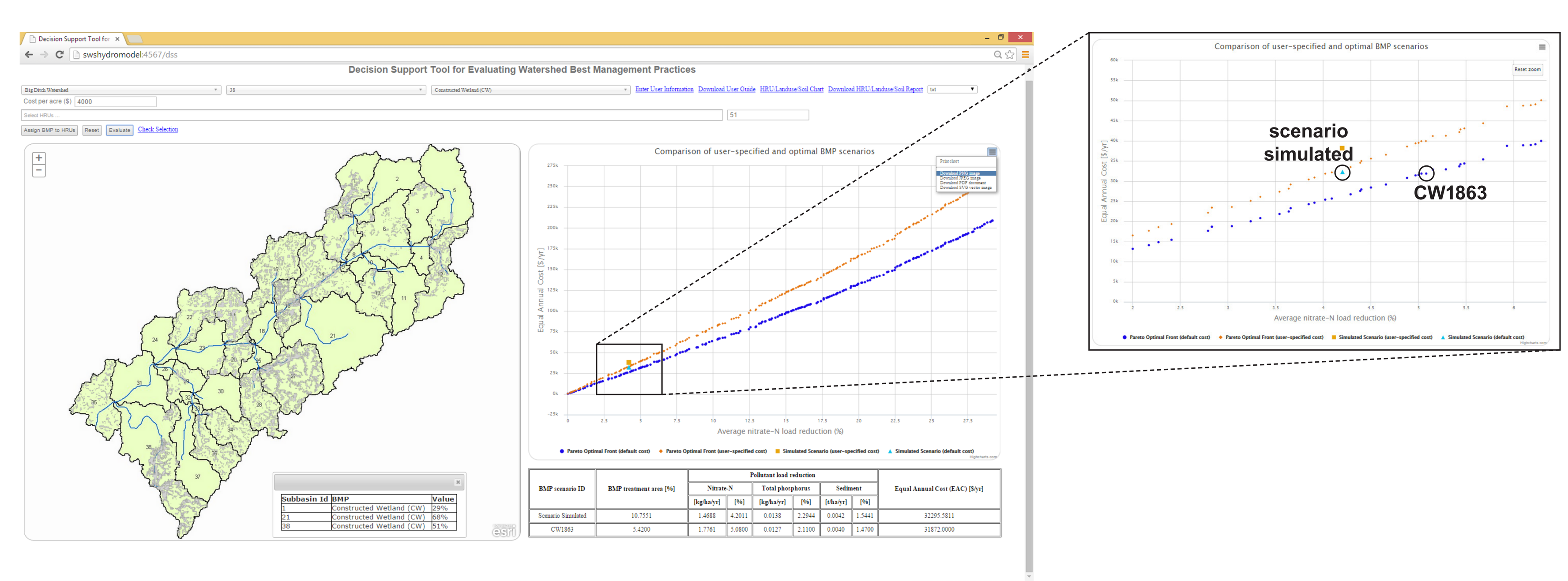

Figure 5b. DST showing simulation outputs for Big Ditch watershed

5. CONCLUSION

- The DST is designed to develop user-specified scenarios of selected BMPs and evaluate their water quality benefits, assessing the level of ecosystem service provision (i.e., clean water supply).
- The DST can provide guidance to make informed decision through comparisons of different BMP implementation scenarios with each other and/or with optimal alternatives.
- Developing DST for the entire Lake Decatur watershed will increase the practical utility of this tool (e.g., screening of TMDL implementation projects, assessing nutrient trading potential in the watershed, etc…).

Reference: Bekele, E.G., L. Keefer, and S. Chandrasekaran (2014). Decision Support Model for Generating Optimal Alternative Scenarios of Watershed Best Management Practices. ISWS CR 2014-02. Illinois State Water Survey, Champaign, IL. 104 p. http://www.isws.illinois.edu/pubdoc/CR/ISWSCR2014-02.pdf

Acknowledgment: Major contributions towards the development of the DST application were provided by Santhosh Gajendran and Bharat Thatavarti, who were research assistants, pursuing MS in computer science. Sara Olson prepared the poster design and layout.

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