ELUCID Decision Support System and Field-Scale Analysis Training

May 7, 2014

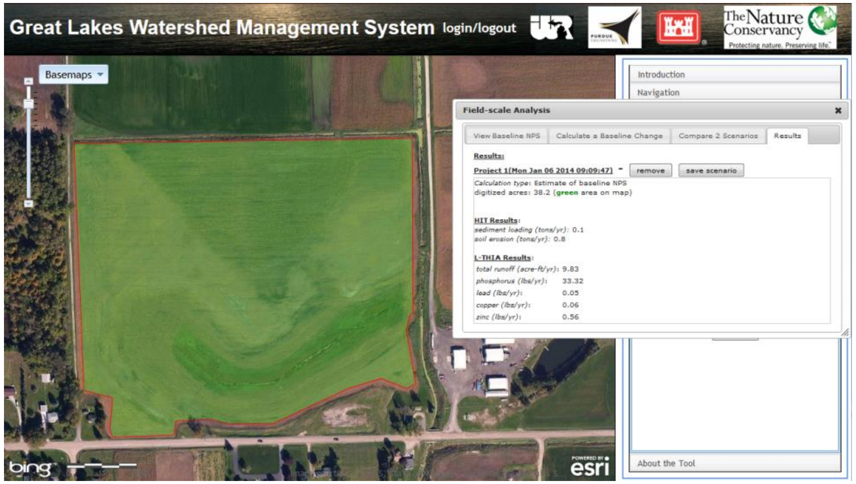
Mott Community College, Flint, MI

Prepared by the Michigan State University Institute of Water Research

Overview

Field-scale Analysis Calculators allow users to:

- Evaluate non-point source (NPS) pollution model estimates at field scales
- Conduct field-scale scenario evaluations of land cover changes or best management practices (BMPs)
- HIT and L-THIA models



History of Support and Development

- HIT Data jointly developed by
  - MSU Institute of Water Research
  - US Army Corps of Engineers
- Dynamic Nutrient Calculations and Tools jointly developed by
  - Department of Agricultural and Biological Engineering at Purdue University (L-THIA)
  - US Army Corps of Engineers
  - MSU Institute of Water Research
- Dynamic Field Scale Sediment Calculator jointly developed by
  - The Nature Conservancy (Paw Paw River Watershed and Saginaw Bay Watershed)
  - MSU Institute of Water Research

Background | Models

High Impact Targeting (HIT)

HIT estimates sediment loading from agricultural lands to nearby streams

Long-Term Hydrologic Impact Analysis (L-THIA)

L-THIA estimates run-off volumes and pollutant loads

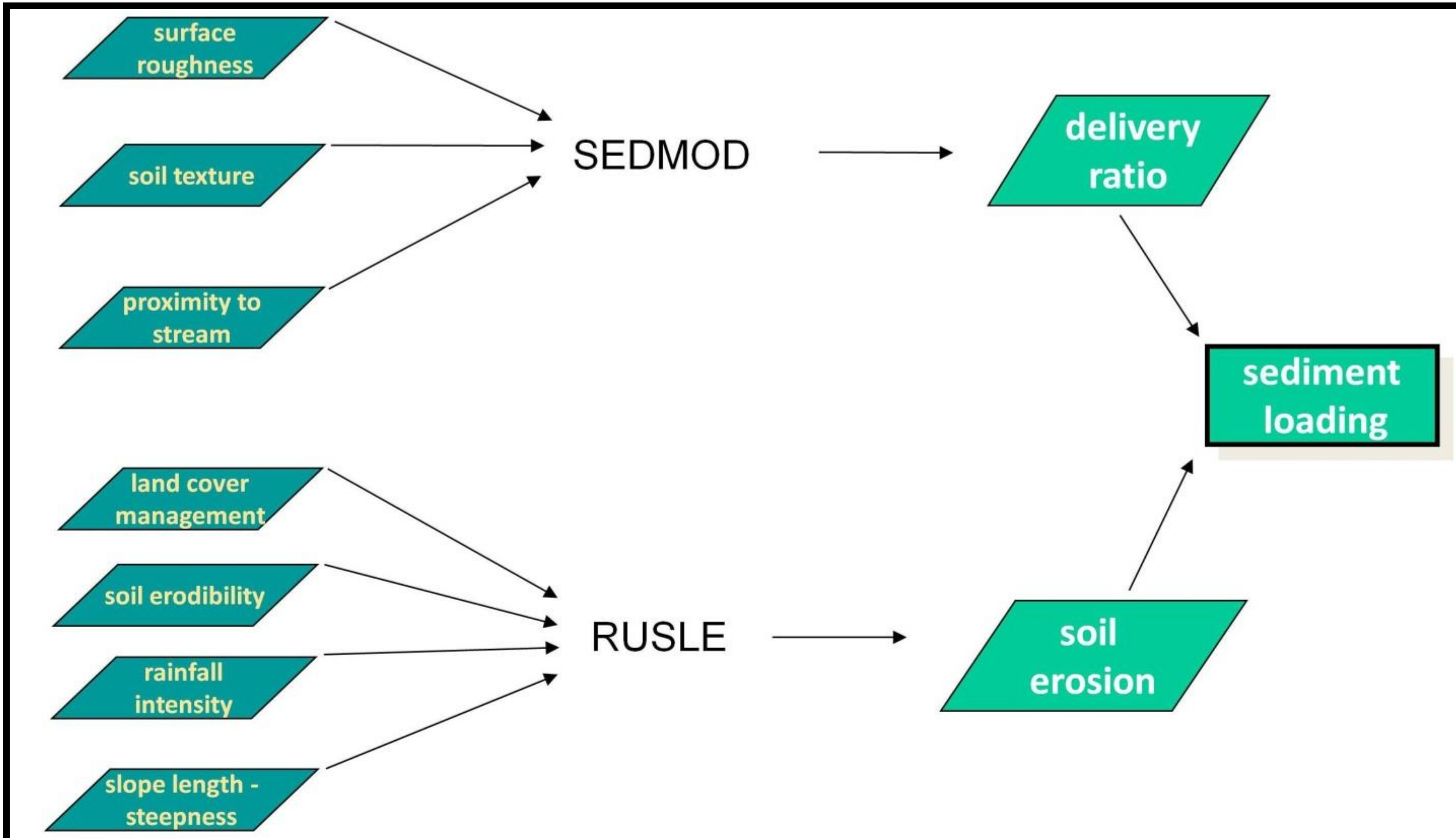
Background | Models

High Impact Targeting (HIT)

HIT estimates sediment loading from agricultural lands to nearby streams

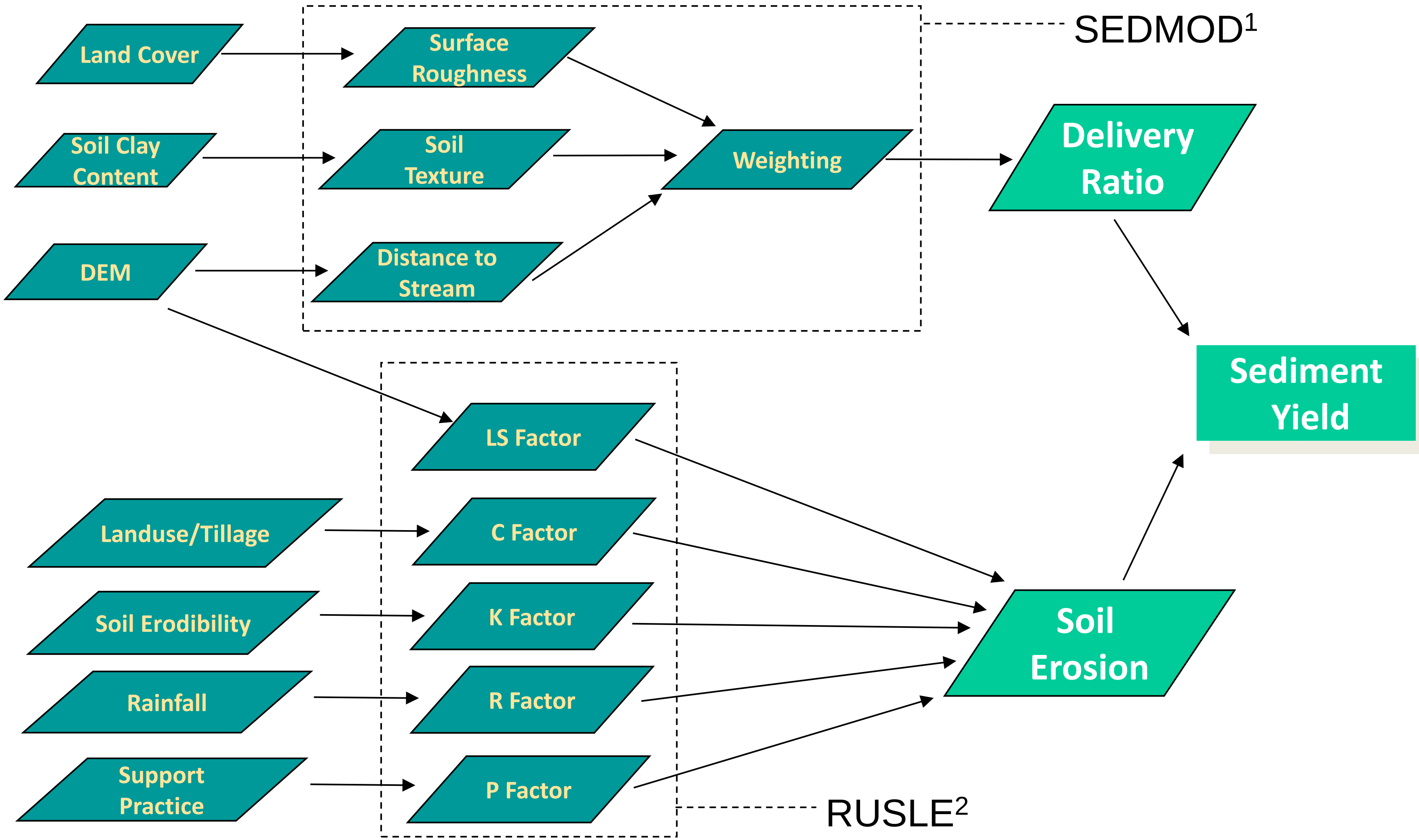
Based on RUSLE and SEDMOD models

HIT Model



surface roughness
soil texture
proximity to stream
SEDMOD
delivery ratio
sediment loading
land cover management
soil erodibility
rainfall intensity
slope length - steepness
RUSLE
soil erosion

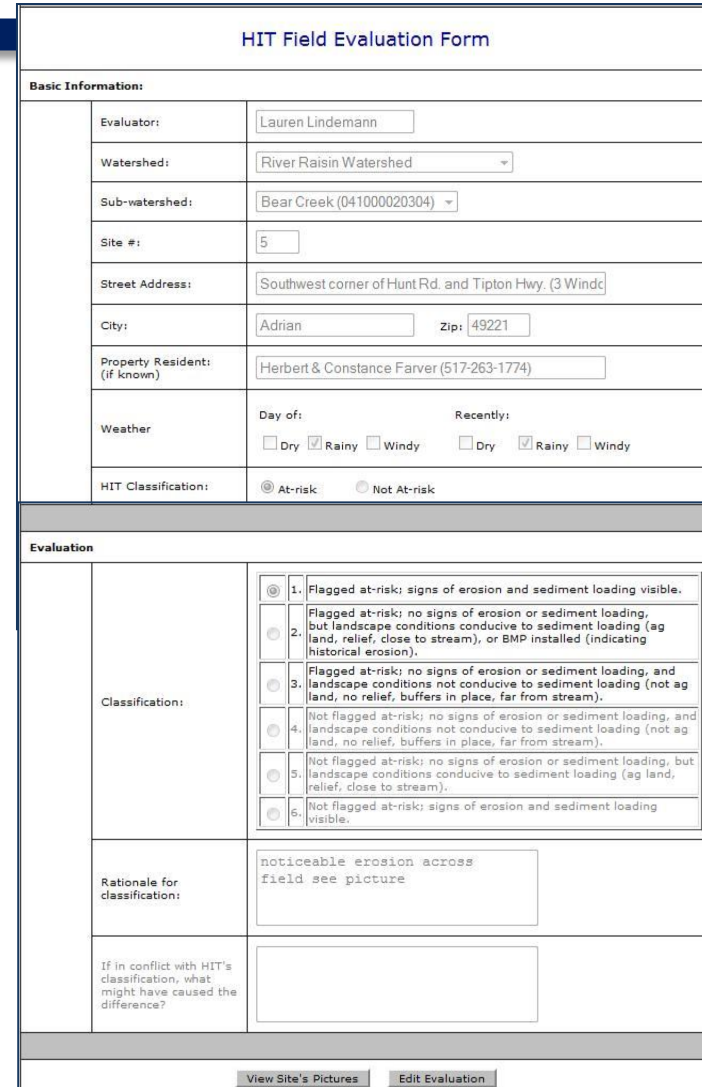
HIT Model



1. Fraser. May 1999
2. Renard, Foster, Weesies, McCool, Yoder. 1996.

HIT: Field Evaluations

C.D. technicians visited over 200 fields in the pilot watersheds and evaluated the accuracy of the high-risk maps.



HIT Field Evaluation Form

Basic Information:

Evaluator:	Lauren Lindemann
Watershed:	River Raisin Watershed
Sub-watershed:	Bear Creek (041000020304)
Site #:	5
Street Address:	Southwest corner of Hunt Rd. and Tipton Hwy. (3 Windc
City:	Adrian Zip: 49221
Property Resident: (if known)	Herbert & Constance Farver (517-263-1774)
Weather	Day of: Dry, Rainy (checked), Windy; Recently: Dry, Rainy (checked), Windy
HIT Classification:	At-risk (selected), Not At-risk

Evaluation

Classification:

1. Flagged at-risk; signs of erosion and sediment loading visible. (selected)
2. Flagged at-risk; no signs of erosion or sediment loading, but landscape conditions conducive to sediment loading (ag land, relief, close to stream), or BMP installed (indicating historical erosion).
3. Flagged at-risk; no signs of erosion or sediment loading, and landscape conditions not conducive to sediment loading (not ag land, no relief, buffers in place, far from stream).
4. Not flagged at-risk; no signs of erosion or sediment loading, and landscape conditions not conducive to sediment loading (not ag land, no relief, buffers in place, far from stream).
5. Not flagged at-risk; no signs of erosion or sediment loading, but landscape conditions conducive to sediment loading (ag land, relief, close to stream).
6. Not flagged at-risk; signs of erosion and sediment loading visible.

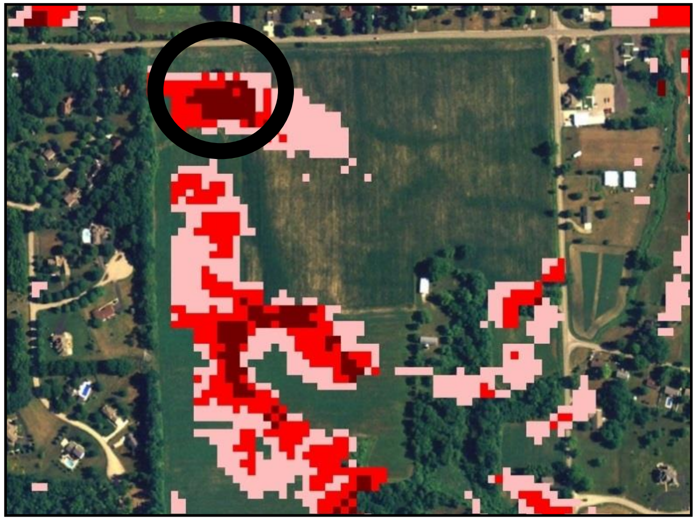
Rationale for classification: noticeable erosion across field see picture

If in conflict with HIT's classification, what might have caused the difference?

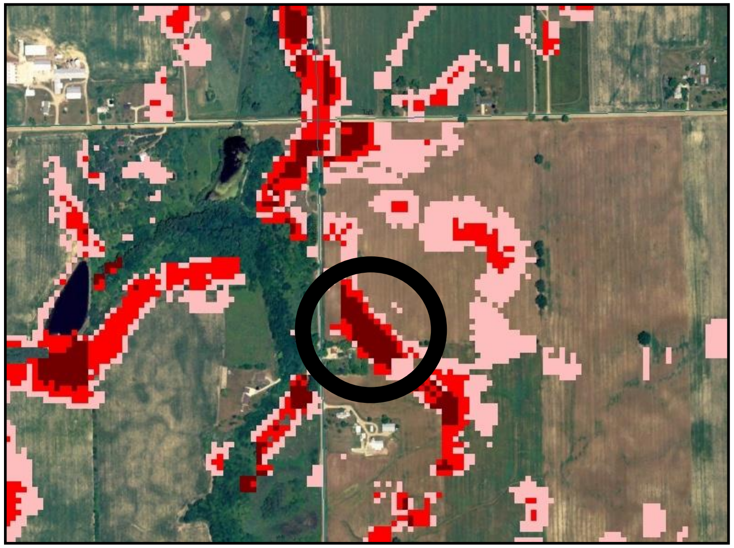
View Site's Pictures | Edit Evaluation

HIT: Field Evaluations

Results: 70% of the time HIT maps correctly characterized the landscape.



HIT: Field Evaluations



Primary causes of errors at other 30%:

- Coarse land cover input (30-meter resolution)
- DEM unable to accurately characterize flow-direction

HIT: Limitations

- Focused primarily on agricultural lands, not suitable for urban analysis.
- Focused on sheet erosion (RUSLE), not gully, bank, or wind.
- Comparisons to stream monitoring data have been inconclusive.
- Estimates of erosion and sediment loadings are for relative comparisons, not intended for precision.

Background | Models

Long-Term Hydrologic Impact Analysis (L-THIA)

L-THIA estimates water run-off volumes and pollutant loads

An overview/screening model

Does not require detailed data input

Basic L-THIA Model Components

Hydrologic component estimates average annual direct runoff based on the Curve Number method with daily rainfall data

Water quality component estimates pollutant loadings using estimated direct runoff and coefficients associated with land uses

Basic L-THIA Model

Hydrologic component estimates direct runoff using Curve Numbers (CN) and rainfall data

CN analysis used to estimate runoff based on the relationship between rainfall, land uses, and hydrologic soil group.

Originally described in the Soil Conservation Service publication "TR-55" (NRCS, 1986) and several modifications have since been proposed.

The relationship between rainfall, runoff and CN value is non-linear, meaning that small changes in land use or rainfall can produce large changes in runoff.

Basic L-THIA Model

Hydrologic component estimates direct runoff using Curve Numbers (CN) and rainfall data

Curve Number determined by:

- Hydrologic Soil Group
- Land Use
- Antecedent Moisture Condition

30 year rainfall database for each county

Example Curve Numbers

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80

NRCS TR-55

Curve Numbers

Photo Credit: Dean Curtis

Photo Credit: Karen Mayes

Basic L-THIA Model

Water quality component estimates nonpoint source pollutant masses using Event Mean Concentration (EMC) coefficients

EMCs compiled by the Texas Natural Resource Conservation Commission (Baird and Jennings, 1996) from numerous literature and water quality data

NPS pollutant masses computed by multiplying runoff depth for a land use by area of that land use and appropriate EMC value and converting units.

Nonpoint Source Pollution

L-THIA produces Average Annual Pollutant Results for sediment, nutrients, a series of metals, and bacterial indicators

(e.g. lbs of Nitrogen per year)

Available L-THIA NPS Outputs in GLWMS:
Total Runoff
Nitrogen
Phosphorous
Total Suspended Solids
Lead
Copper
Zinc

Nonpoint Source Calculations

Table 1. Event Mean Concentration by land use classifications from Baird and Jennings (1996)

NPS Pollutant	Land use classification						
	Residential	Com-mercial	Indus-try	Transi-tion	Mixed	Agricu-ltural	Range
Total Nitrogen (mg/L)	1.82	1.34	1.26	1.86	1.57	4.4	0.7
Total Kjeldahl Nitrogen (mg/L as N)	1.5	1.1	1.0	1.5	1.25	1.7	0.2
Nitrate+Nitrite (mg/L)	0.23	0.26	0.3	0.56	0.34	1.6	0.4
Total Phosphorus (mg/L)	0.57	0.32	0.28	0.22	0.35	1.3	0.01
Dissolved Phosphorus (mg/L)	0.48	0.11	0.22	0.1	0.23	---	---
Suspended Solids (mg/L)	41	55.5	60.5	73.5	57.9	107	1
Dissolved Solids (mg/L)	134	185	116	194	157	1225	245
Total Lead (µg/L)	9	13	15	11	12	1.5	5.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EMC values for calculation of NPS contaminants from each land use

Assumptions

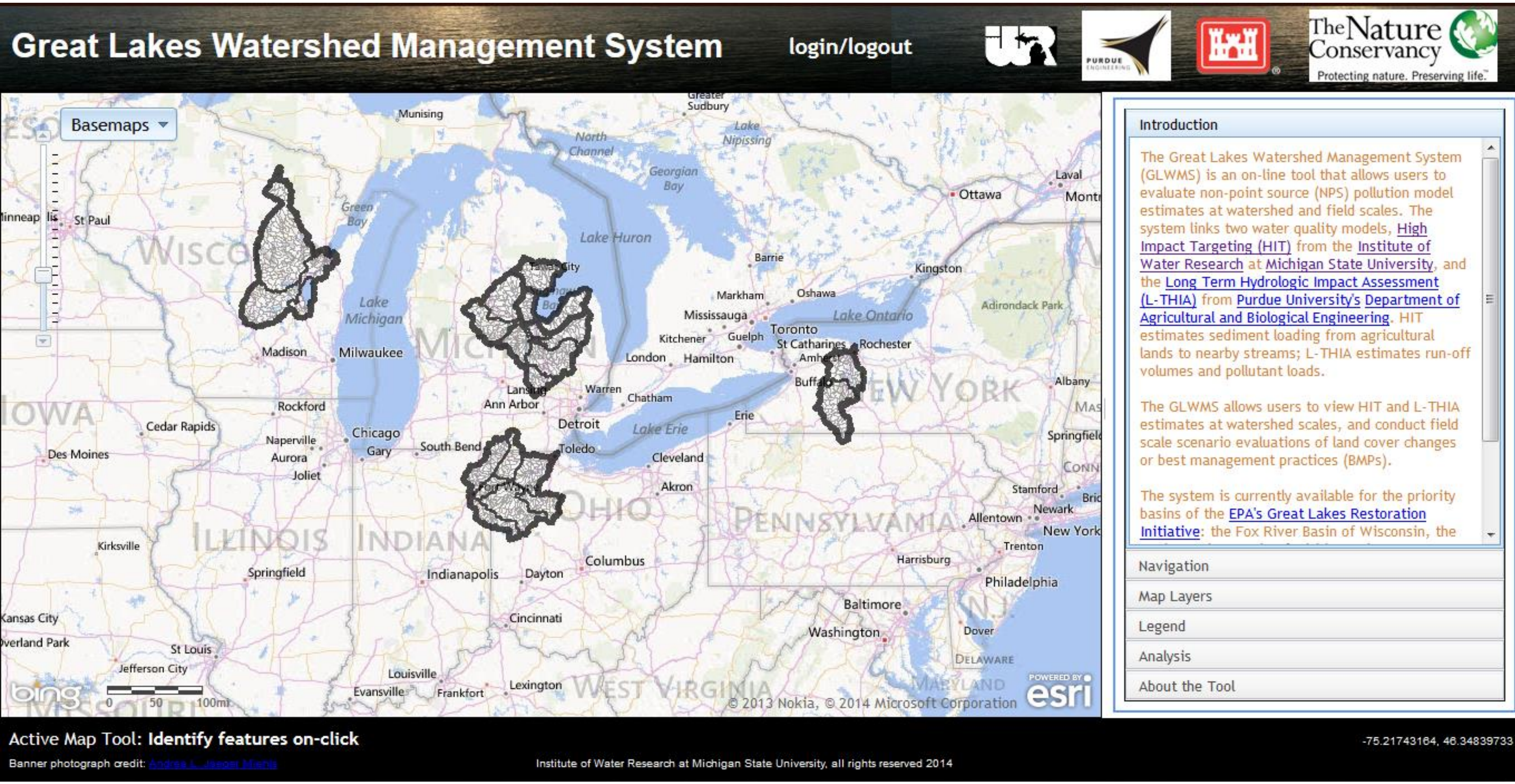
- Water flows across the surface to form watershed
  - Storm drains or tiles are not considered
- Water equally spread across landscape
  - No routing of runoff
- Average antecedent moisture
  - Soil is not saturated or frozen
- Rainfall is evenly spread in local area

Limitations

- Accuracy of land use and soil data
- Accuracy of runoff curve number (CN)
  - Depends on land use and soil data
- Accuracy of published NPS relationship
  - Lead in runoff based on 1990's models

SETTING UP YOUR ANALYSIS

Default Map


Great Lakes Watershed Management System
login/logout
The Nature Conservancy
Protecting nature. Preserving life.
Basemaps
Introduction
The Great Lakes Watershed Management System (GLWMS) is an on-line tool that allows users to evaluate non-point source (NPS) pollution model estimates at watershed and field scales. The system links two water quality models, High Impact Targeting (HIT) from the Institute of Water Research at Michigan State University, and the Long Term Hydrologic Impact Assessment (L-THIA) from Purdue University's Department of Agricultural and Biological Engineering. HIT estimates sediment loading from agricultural lands to nearby streams; L-THIA estimates run-off volumes and pollutant loads.
The GLWMS allows users to view HIT and L-THIA estimates at watershed scales, and conduct field scale scenario evaluations of land cover changes or best management practices (BMPs).
The system is currently available for the priority basins of the EPA's Great Lakes Restoration Initiative: the Fox River Basin of Wisconsin, the
Navigation
Map Layers
Legend
Analysis
About the Tool
© 2013 Nokia, © 2014 Microsoft Corporation
POWERED BY esri
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0 50 100mi
Active Map Tool: Identify features on-click
-75.21743164, 46.34839733
Banner photograph credit:
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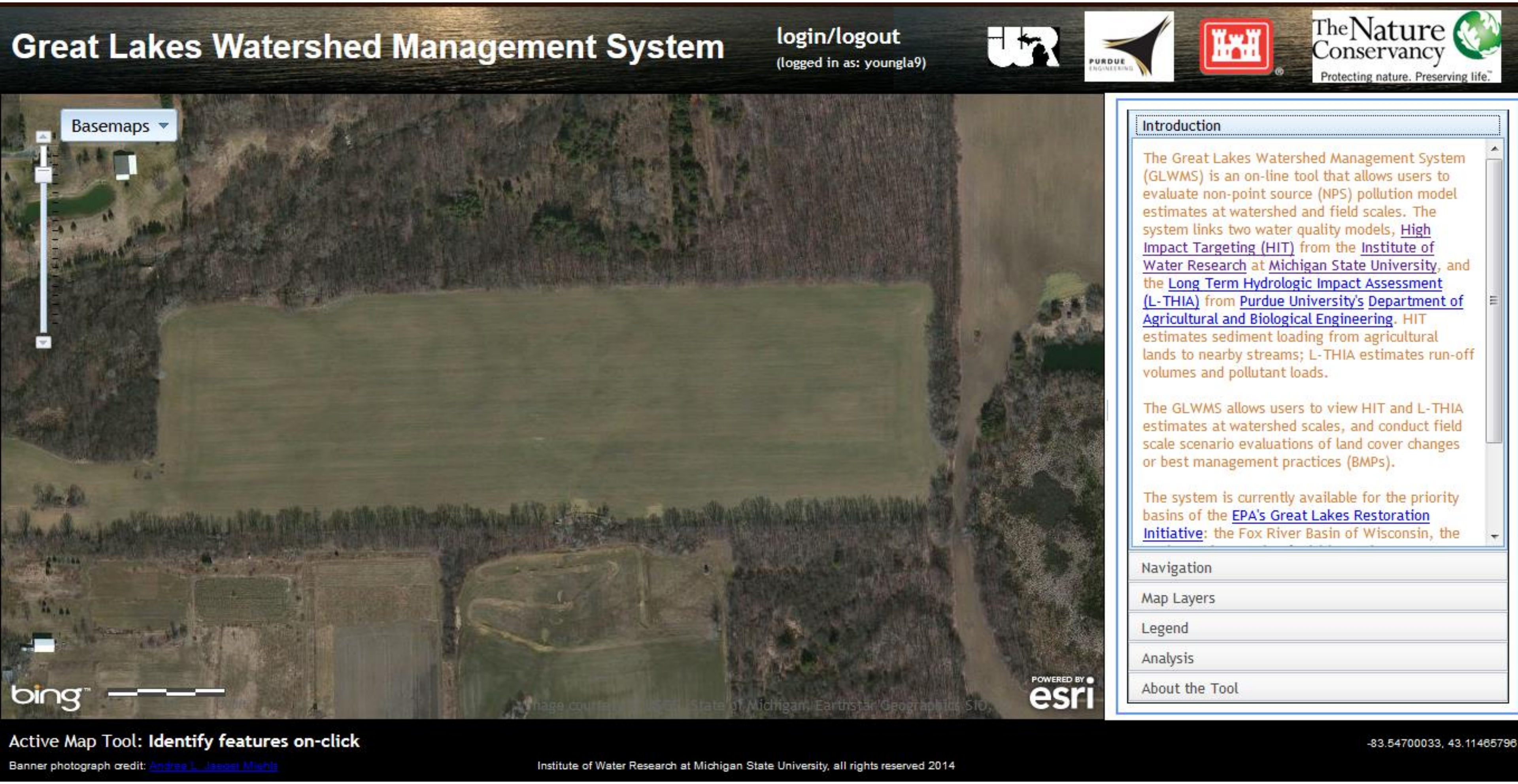
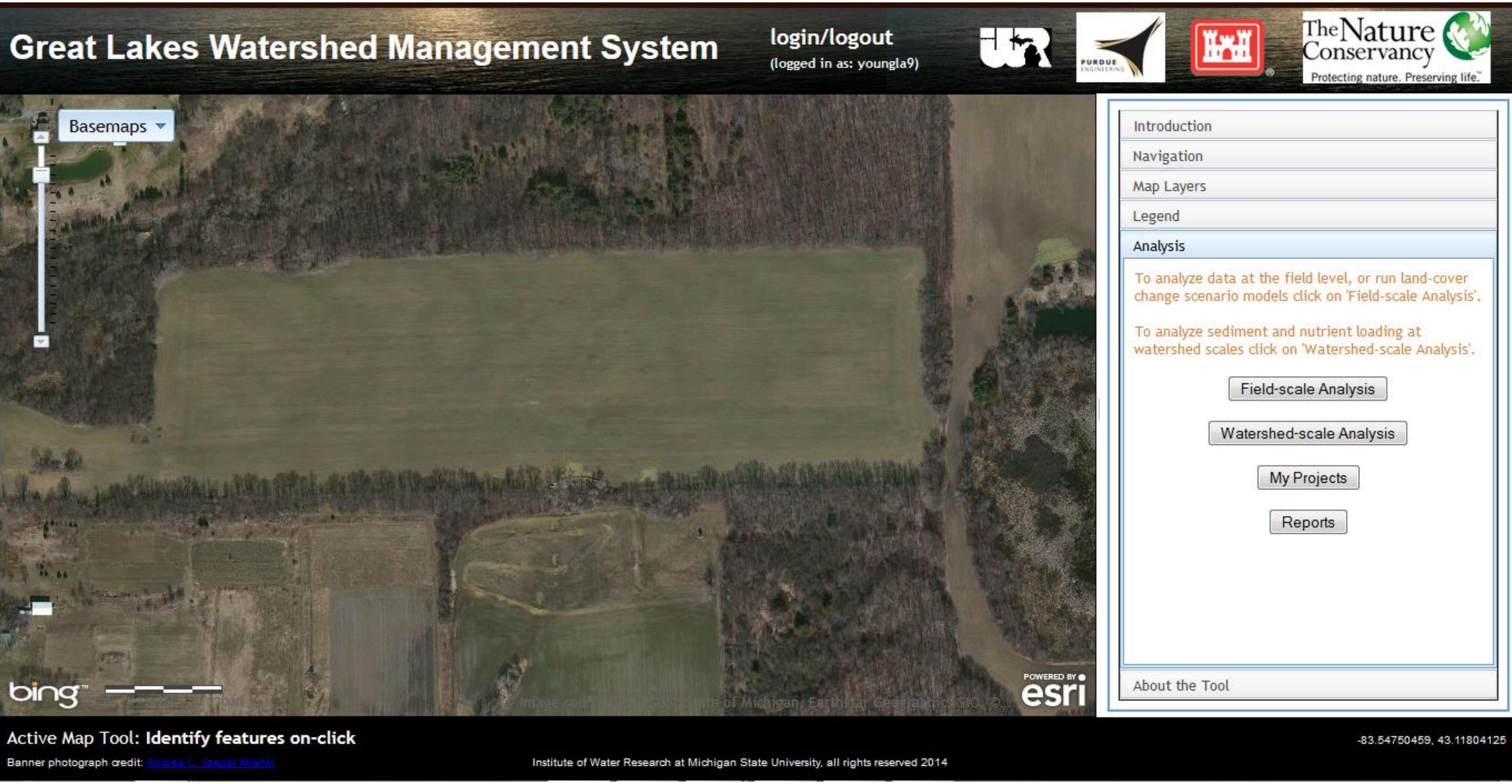
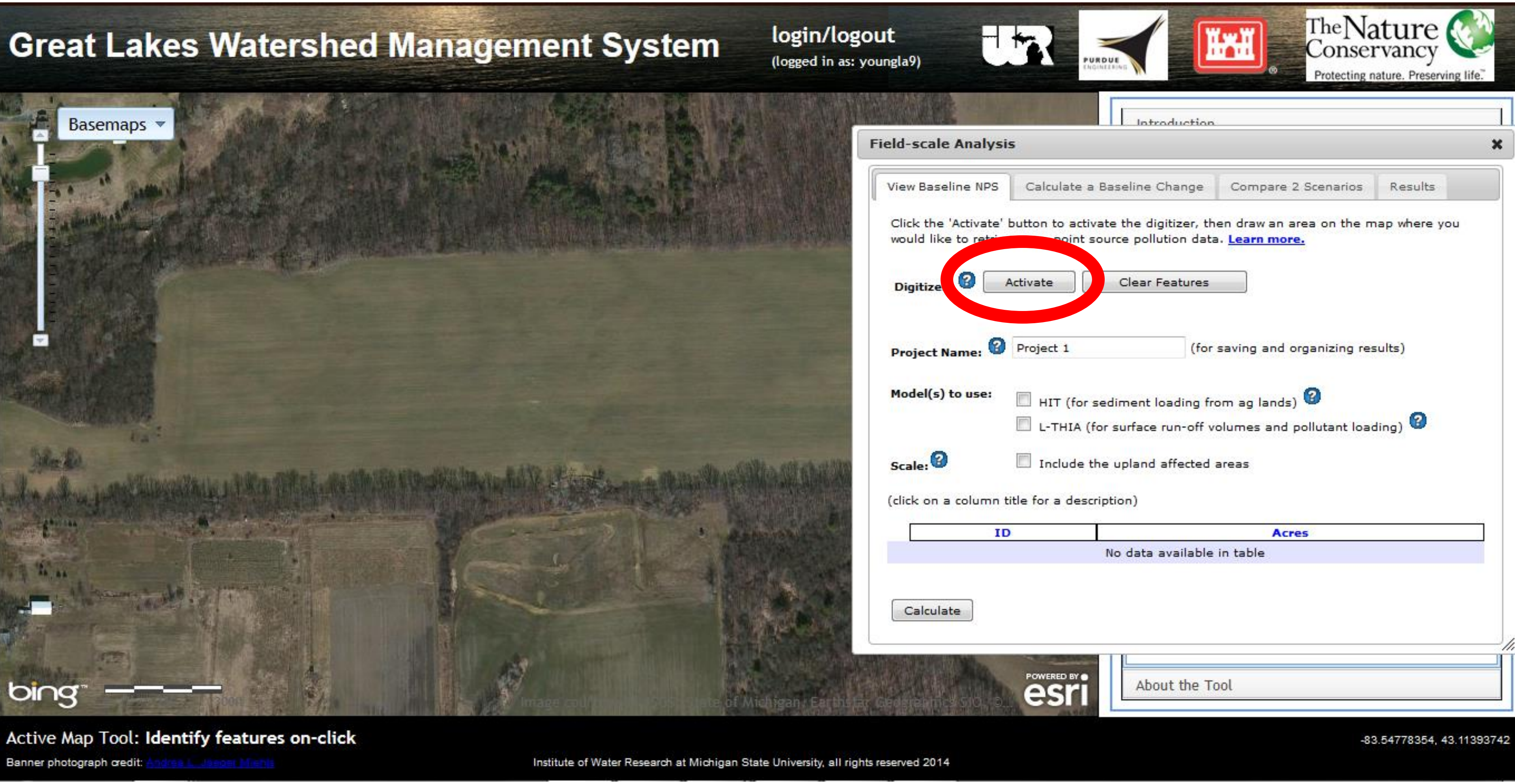
Located Site



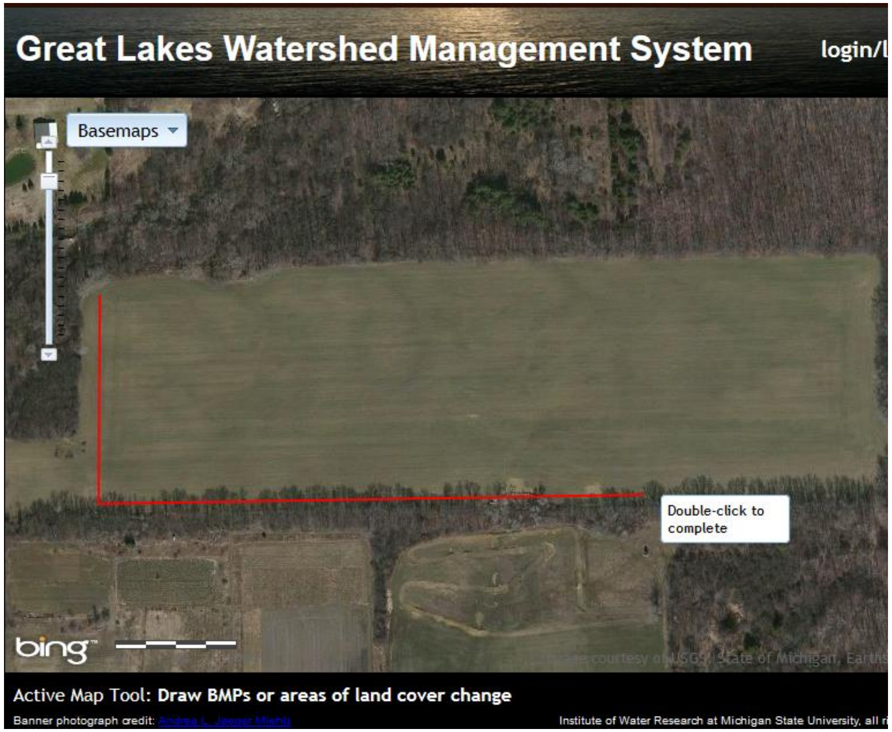
Analysis Tab



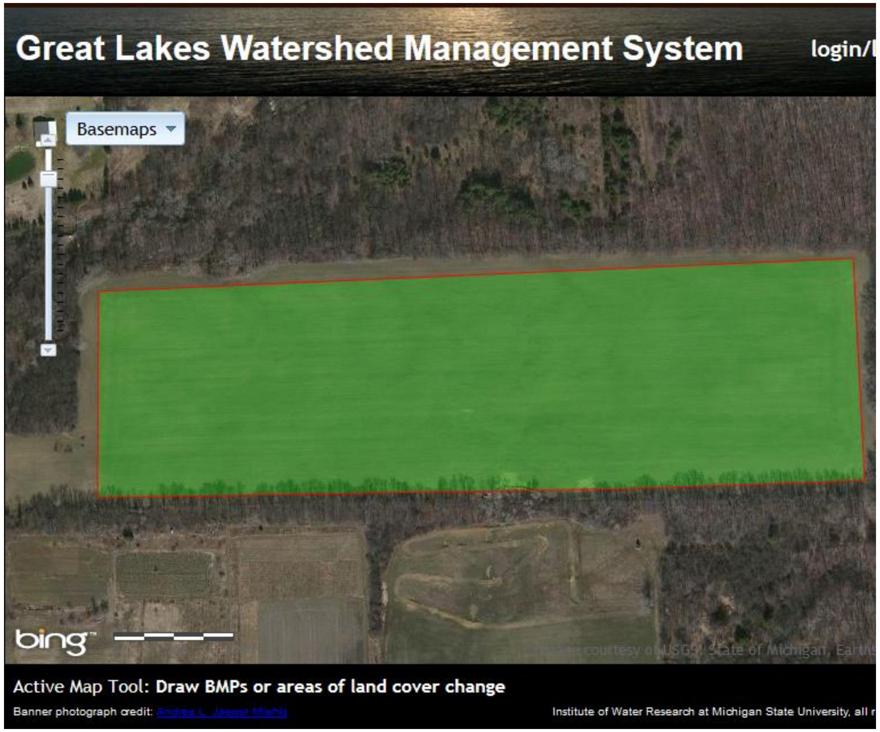
Field-scale Analysis Window



Digitize



Great Lakes Watershed Management System
Basemaps
Double-click to complete
Active Map Tool: Draw BMPs or areas of land cover change
Banner photograph credit:
Institute of Water Research at Michigan State University, all r



Great Lakes Watershed Management System
Basemaps
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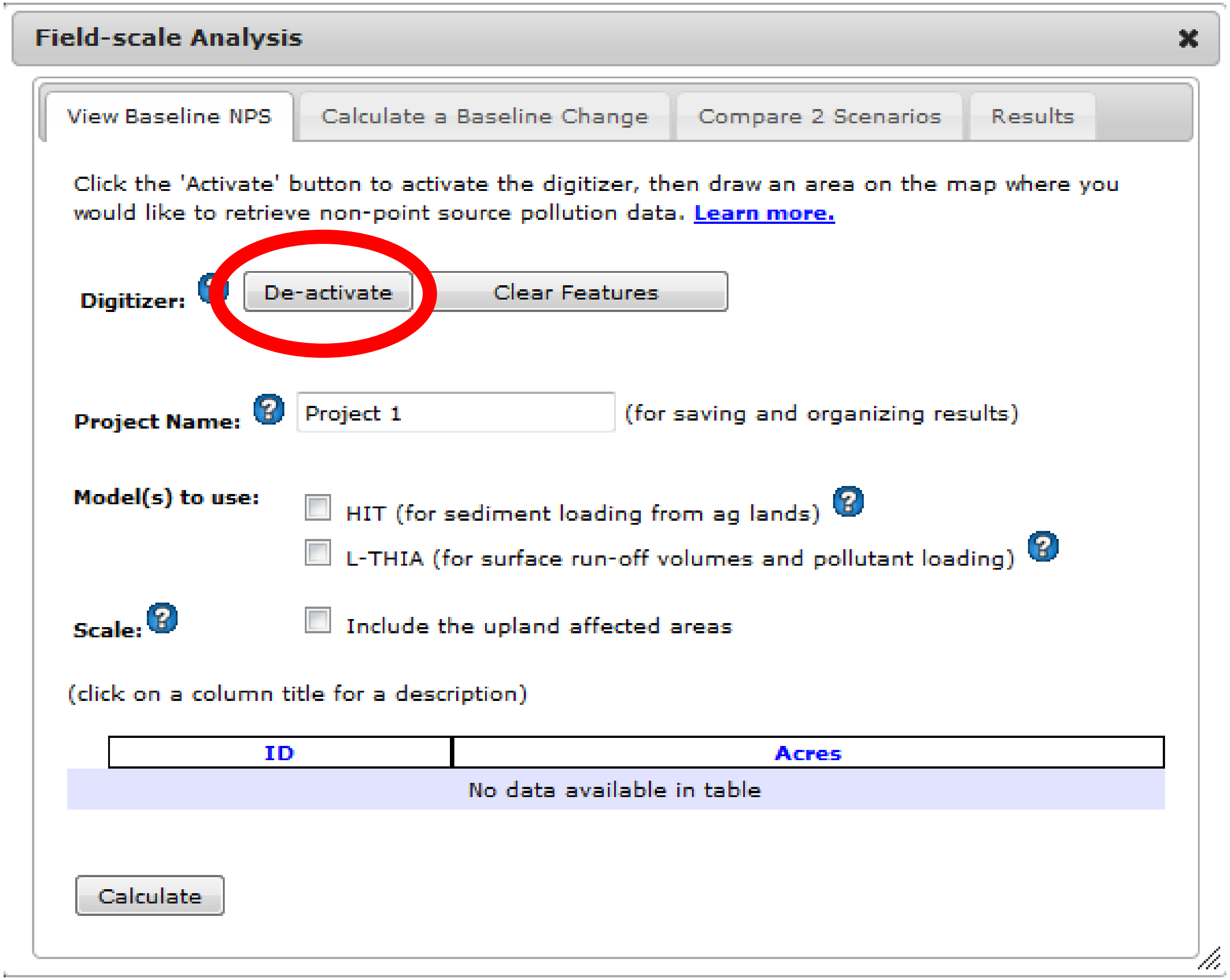
Deactivate Digitizer



View Baseline NPS

- Estimates the baseline nonpoint source pollutant loads
- During a rain event, how much NPS pollution is running off given current land conditions

Calculate a Baseline Change

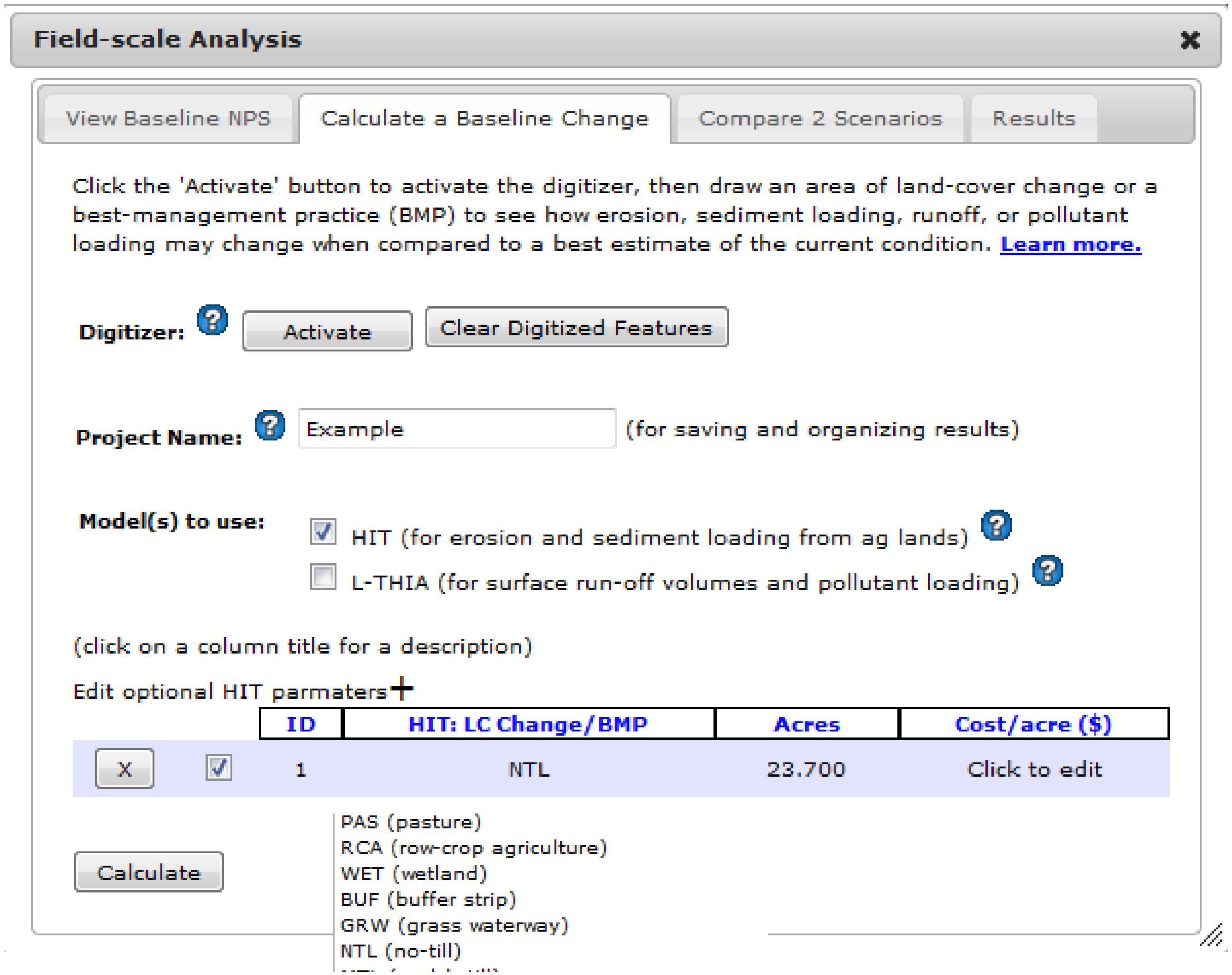
- Estimates the change in runoff and NPS pollutants based on a land cover change or best management practice

Compare 2 Scenarios

- Pits two different land covers or best management practices against each other
- Determines which BMP will have the greater impact on NPS loadings
- Allows you to set your own baseline for HIT

http://www.ars.usda.gov/pandp/docs.htm?docid=9372 Photo courtesy of USDA

Filling out the Field-scale Analysis Window



Results

Field-scale Analysis

View Baseline NPS | Calculate a Baseline Change | Compare 2 Scenarios | Results

Results:

Example - Baseline (Wed Mar 05 2014 13:31:23) + remove

Example(Wed Mar 05 2014 14:47:21) - remove save scenario

Calculation type: Change from baseline NPS
digitized acres: 23.7 (**green** area on map)
total acres (including affected upland): 24.4 (**blue** area on map)
HIT land cover change / BMP: NTL

HIT Results:
Job ID: j1894814a346944709338898d6362c71e

Initial erosion in affected areas (tons/yr):	16.83
Calculated erosion (tons/yr):	9.16
*Erosion **DECREASE** (tons/yr):*	7.67
Initial sediment loading in affected areas (tons/yr):	1.88
Calculated sediment loading (tons/yr):	0.94
*Sediment load **DECREASE** (tons/yr):*	0.94

DEMO

http://tinyurl.com/May2014ELUCID