Use of CEEOT-SWAPP Modeling System for Targeting and Evaluating Environmental Pollutants

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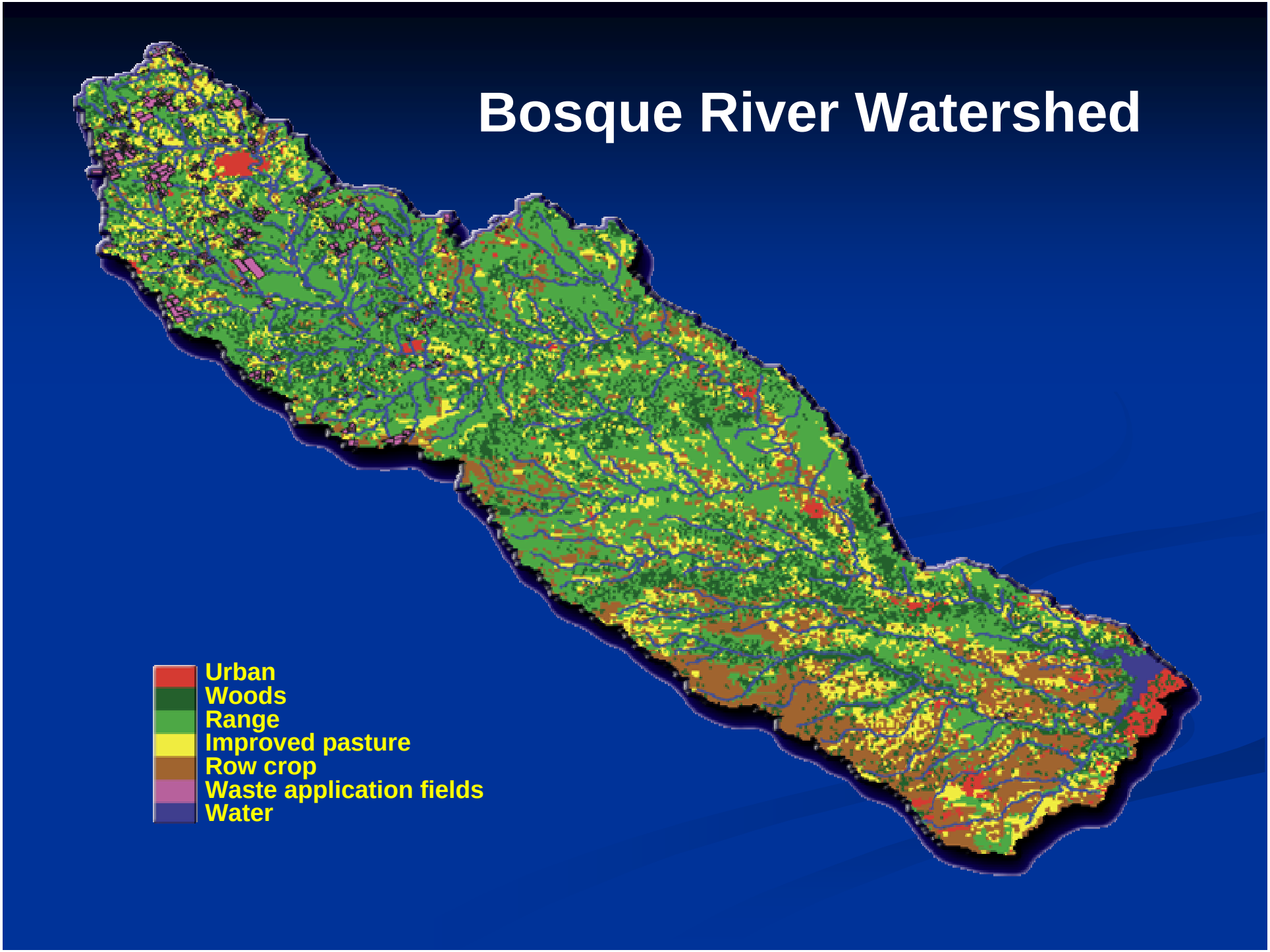
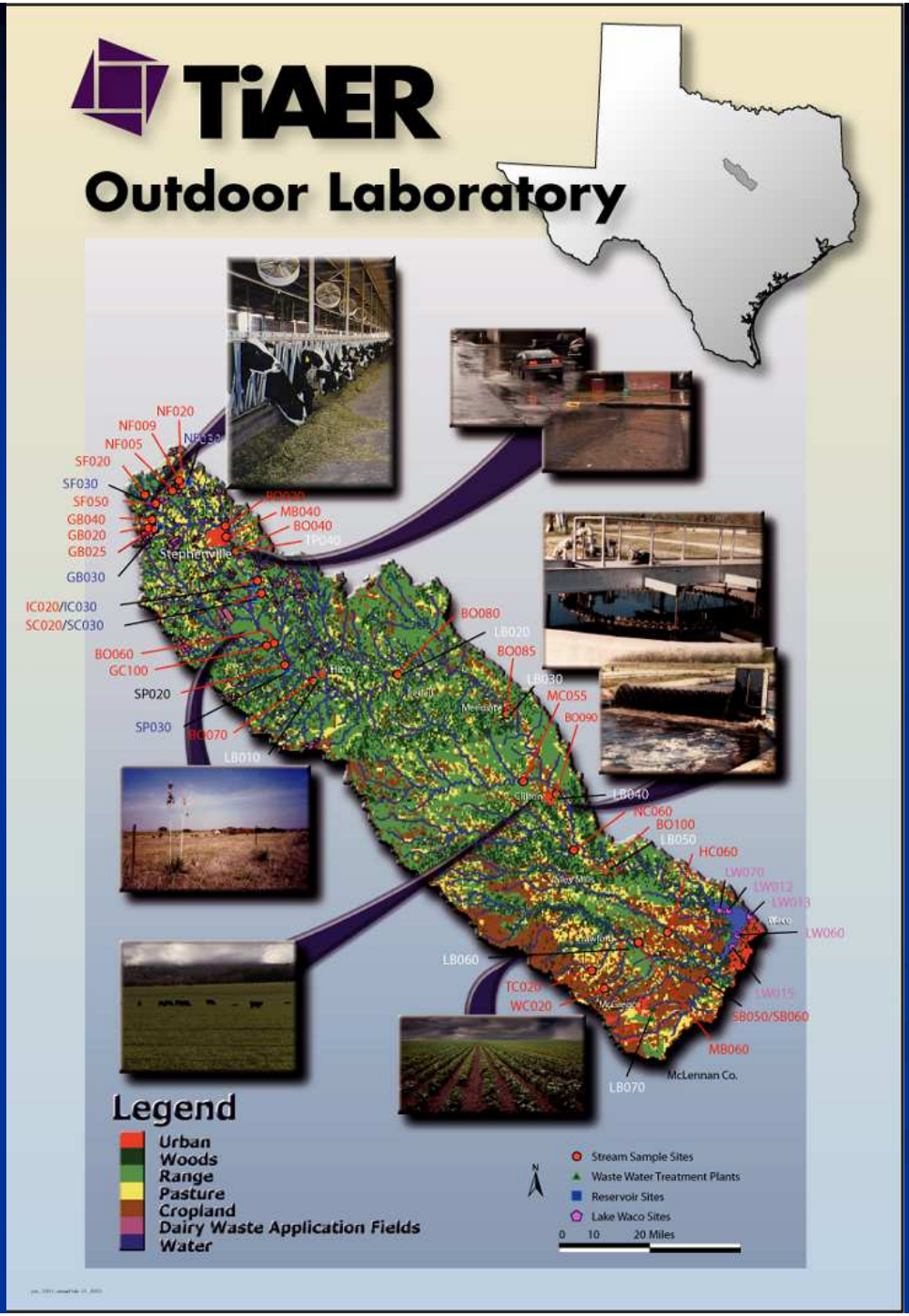
Targeting

- Identifies the level of contribution from each landuse within a watershed
  - Some portions of the landscape could contribute far more pollutants than the average
  - A small portion of a watershed could contribute the majority of pollutants.
- Identifies the optimal placement of selected BMPs within a watershed

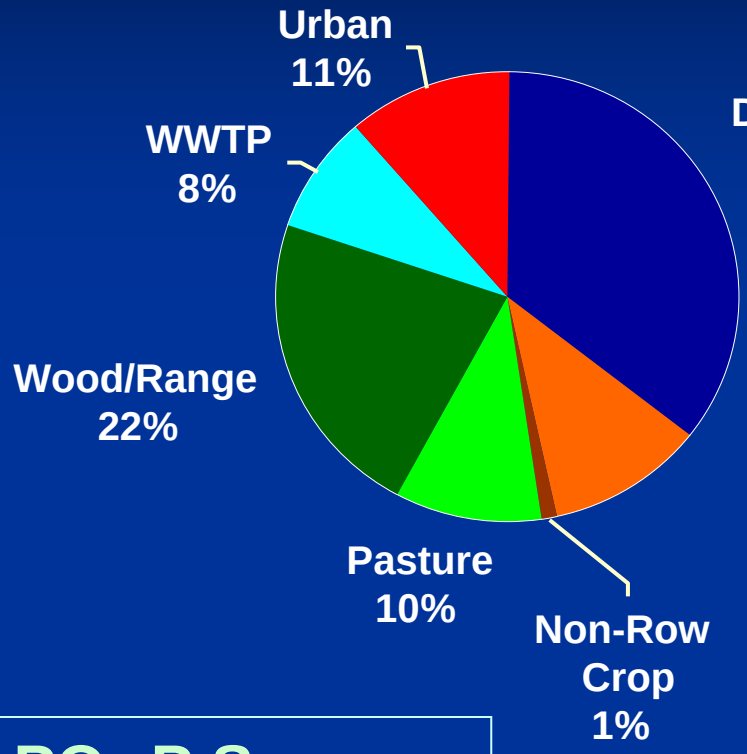
Bosque River Watershed




TiAER
Outdoor Laboratory
NF020
NF009
NF005
SF020
SF030
SF050
GB040
GB020
GB025
GB030
IC020/IC030
SC020/SC030
BO060
GC100
SP020
SP030
BO070
LB010
BO080
LB020
BO085
LB030
MC055
BO090
LB040
NC060
BO100
LB050
HC060
LW070
LW012
LW013
LW060
LB060
TC020
WC020
LW015
SB050/SB060
MB060
LB070
McLennan Co.
Stephenville
Hico
Meridian
Clifton
Waco
Legend
Urban
Woods
Range
Pasture
Cropland
Dairy Waste Application Fields
Water
Stream Sample Sites
Waste Water Treatment Plants
Reservoir Sites
Lake Waco Sites
0 10 20 Miles

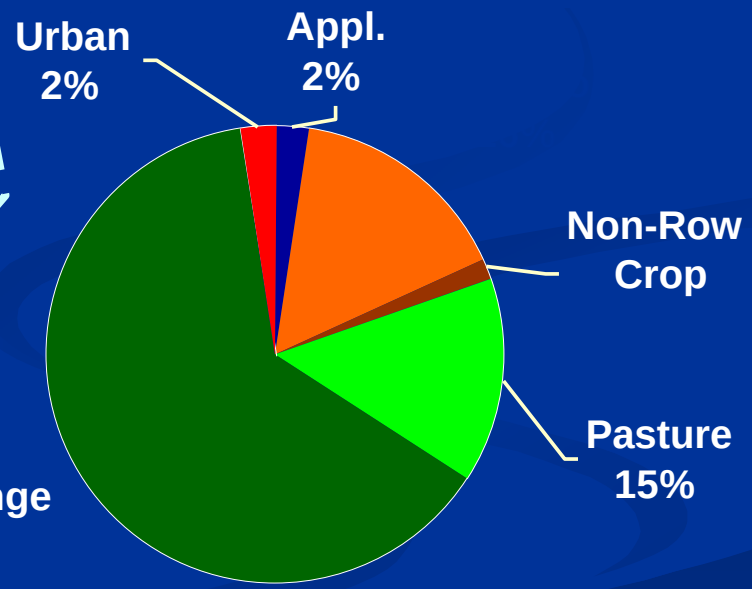
Bosque-Lake Waco Watershed

01 Nov 95 - 30 Mar 98



PO_4-P Source Contribution

Land Uses



Targeting Approaches

- Large Watershed
  - General and ambiguous
  - Easier approach
  - Does not provide the level of understanding necessary to address the inherent complexity within a watershed that is required for trading
- Smaller-watershed
  - Better understanding of the landuse contribution
- Field
  - Most precise method to understand the individual landuse contribution
  - Costly, more difficult, but required for trading

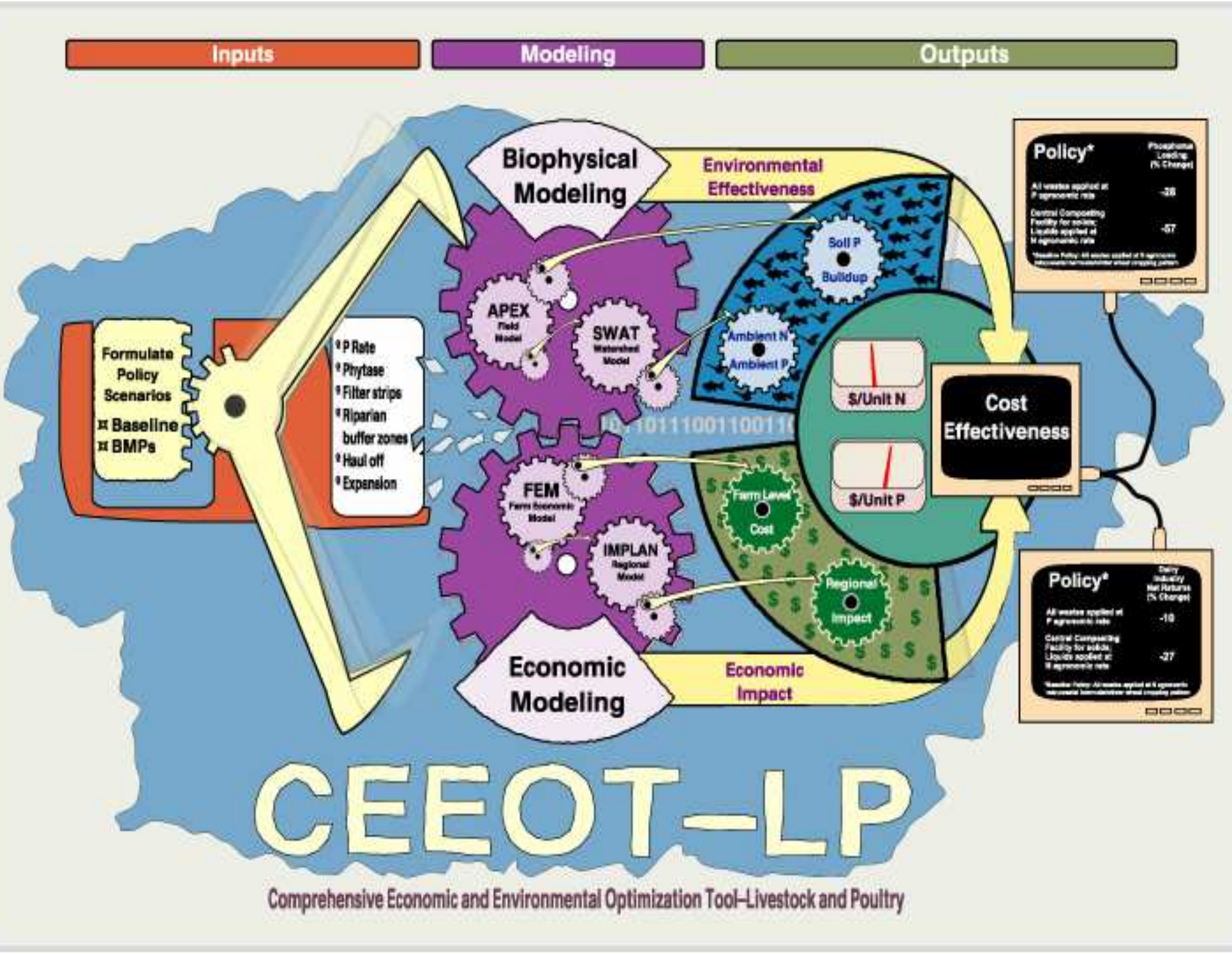
What are the Targeting Tools?

- Environmental Models
  - Field-scale model
  - Watershed-scale model
- Economic model
  - Provides cost/benefit evaluation of BMPs implementation

CEEOT Program

Modeling System

- **CEEOT**: Comprehensive Economic & Environmental Optimization Tool
  - **FEM** - Farm Economic Model
  - **APEX** – Agric. Policy/Environmental eXtender
  - **SWAT** – Soil & Water Assessment Tool


Inputs
Modeling
Outputs
Biophysical Modeling
Environmental Effectiveness
Soil P Buildup
Ambient N
Ambient P
APEX Field Model
SWAT Watershed Model
Formulate Policy Scenarios
Baseline
BMPs
P Rate
Phytase
Filter strips
Riparian buffer zones
Haul off
Expansion
$/Unit N
$/Unit P
Cost Effectiveness
FEM Farm Economic Model
Farm Level Cost
IMPLAN Regional Model
Regional Impact
Economic Modeling
Economic Impact
Policy*
Policy*
CEEOT–LP
Comprehensive Economic and Environmental Optimization Tool–Livestock and Poultry

Models (Economics) FEM
Farm-level Economic Model

- A whole-farm annual model that simulates the economic impacts of a wide range of scenarios on privately owned agricultural operations
- Model is calibrated with extensive data on farm practices, budgets and other watershed information
- Includes a number of simulation and optimization routines.

Advantages of SWAT

- Generates the required data bases using AVSWAT
- Stream routing function
- Input from other models and point sources, etc.

Watershed Scale Model (SWAT)

- SWAT is a daily-time step model
- SWAT was developed to predict the effect of different management scenarios on water quality, sediment yields, and pollutant loading in rural watersheds
- SWAT allows data input via Geographical Information System (GIS)

SWAT Weaknesses

- Lack of concentrated animal feeding operations and related manure application routines
- Lacks of spatially explicit hydrologic response units
- Lacks multiple cropping system
- Empirical approach to simulate filter strips
- Improved simulation of riparian zones and other conservation practices

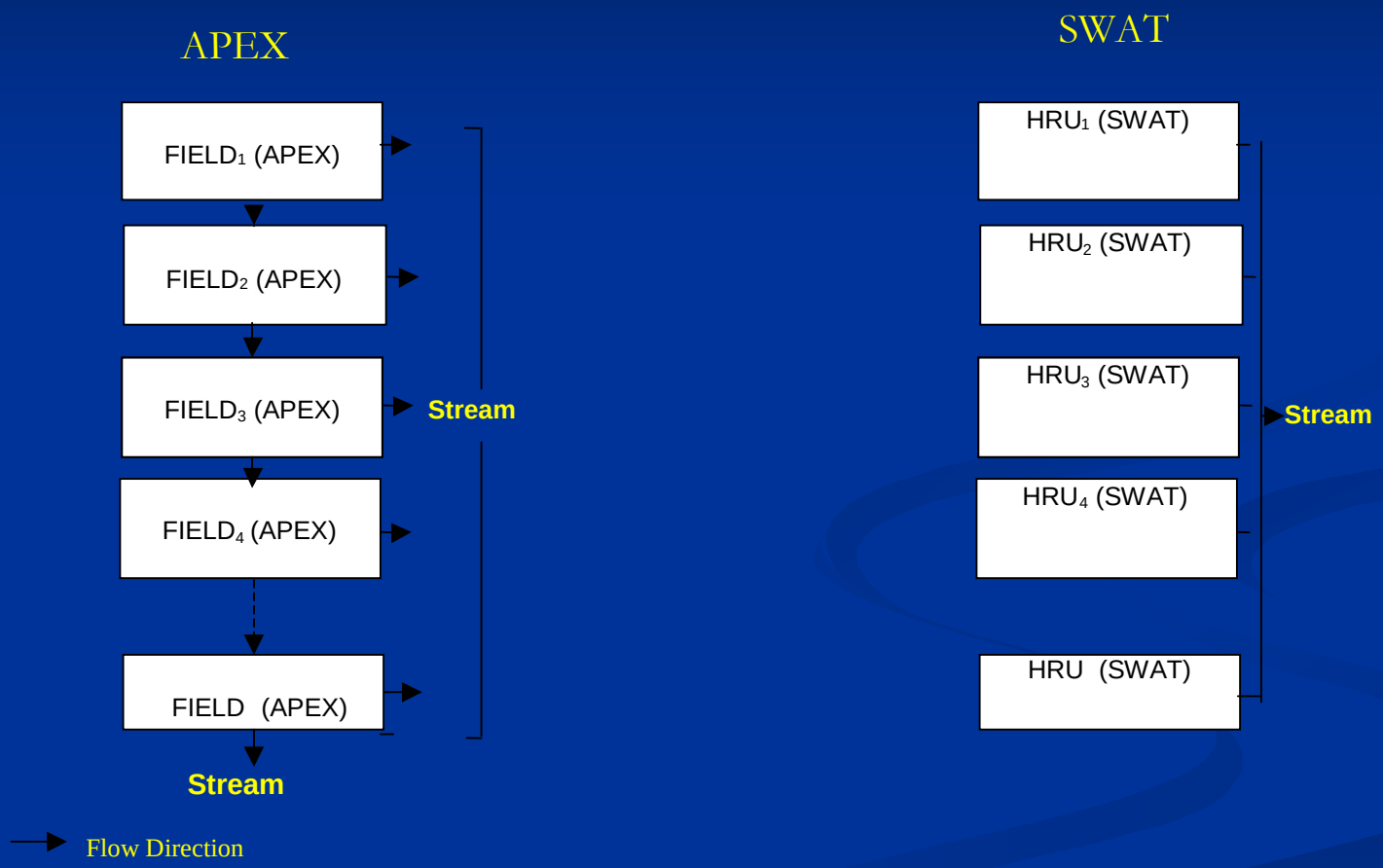
Field-scale Model (APEX)

- APEX was designed to simulate the edge-of-field runoff volume, nutrients and loadings of sediment and nutrients from crop and animal producing lands
- Output from APEX for each field can be input as a point source into the SWAT model

APEX Strengths and Weaknesses

- Strengths
  - Animal production
  - Multi-crop system
  - CO_2 simulation
  - Detailed filter strips simulation
  - Strong forestry component
- Weaknesses
  - Lack of GIS interface
  - Lack of secondary routing component

Flow Regimes



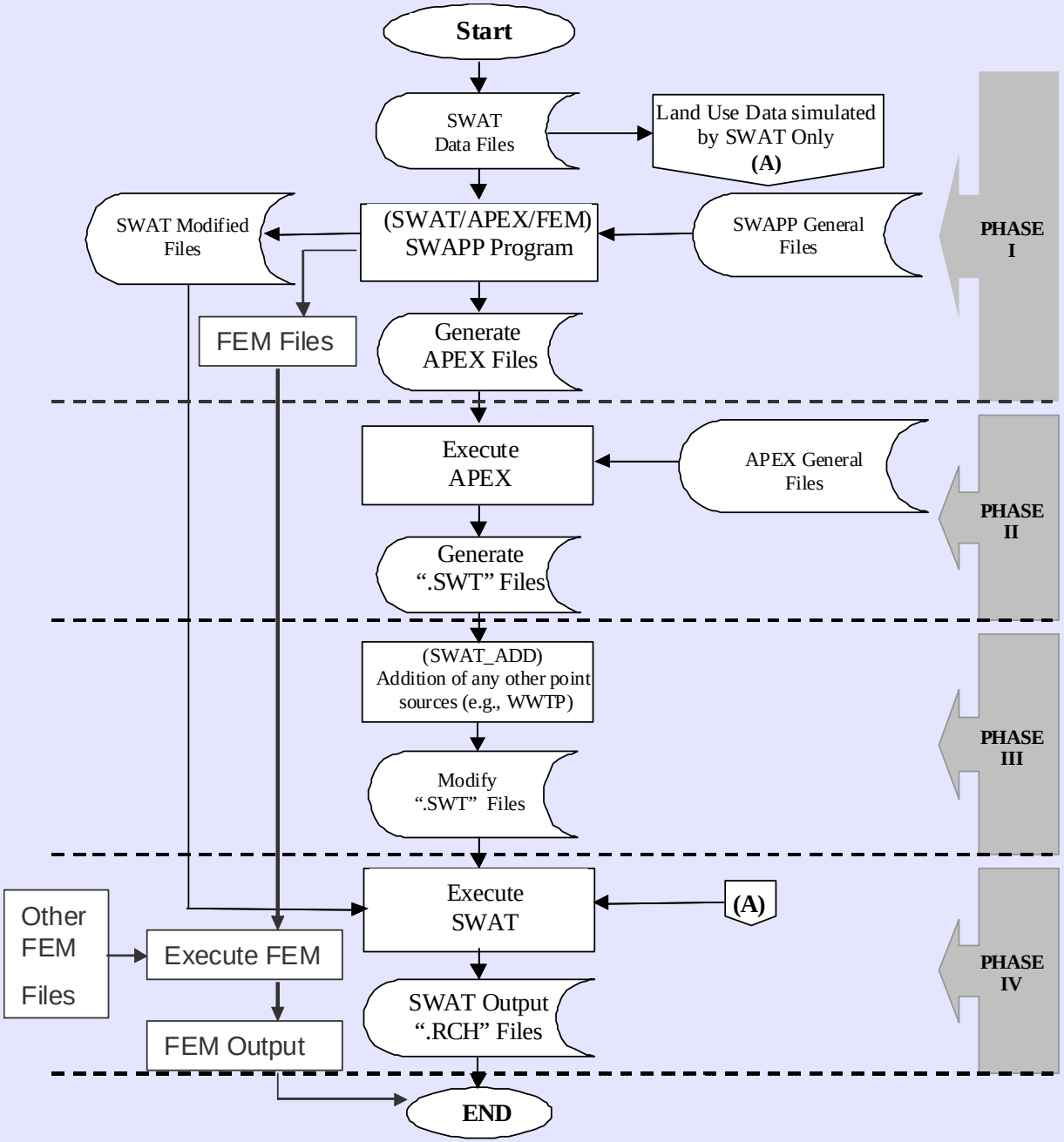
APEX-SWAT Linkage

- Simulated Landuse by APEX

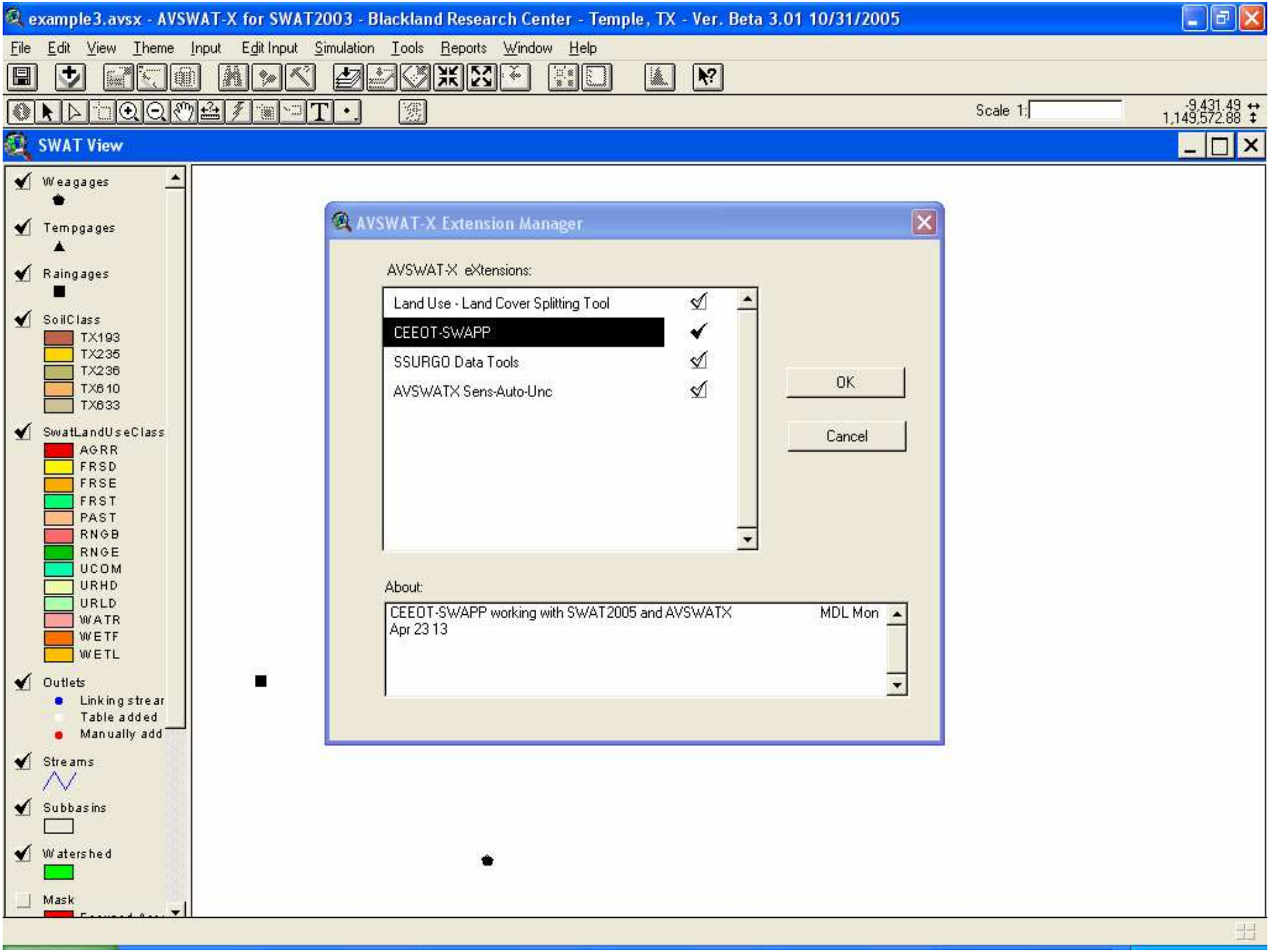
Input daily APEX edge-of-field flows, and sediment and nutrient loadings, at SWAT subbasin outlet

CEEOT-SWAPP Program (Automated CEEOT)

- Develop an automated program to facilitate the simultaneous use of environmental (SWAT and APEX) and economic (FEM) models


Start
SWAT
Data Files
Land Use Data simulated
by SWAT Only
(A)
SWAT Modified
Files
(SWAT/APEX/FEM)
SWAPP Program
SWAPP General
Files
PHASE
I
FEM Files
Generate
APEX Files
Execute
APEX
APEX General
Files
PHASE
II
Generate
".SWT" Files
(SWAT_ADD)
Addition of any other point
sources (e.g., WWTP)
PHASE
III
Modify
".SWT" Files
Other
FEM
Files
Execute
SWAT
(A)
Execute FEM
SWAT Output
".RCH" Files
PHASE
IV
FEM Output
END


APEX2110 & SWAT2005 *** Project *** --> TitfGA // *** Scenario *** --> Baseline
Projects
Subbasin and Land-Use Selection
APEX Files Creation
Execute Model
View Results
Database Management
Tools
Help
CEEOT-SWAPP
Comprehensive Economic and Environmental Optimization Tool
(SWAT/APEX/FEM Programs)
Version 5.7.1
Texas Institute for Applied
Environmental Research (TIAER)
Tarleton State University


example3.avsx - AVSWAT-X for SWAT2003 - Blackland Research Center - Temple, TX - Ver. Beta 3.01 10/31/2005
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SWAT View
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Tempgages
Raingages
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TX236
TX610
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SwatLandUseClass
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Manually add
Streams
Subbasins
Watershed
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AVSWAT-X Extension Manager
AVSWAT-X eXtensions:
Land Use - Land Cover Splitting Tool
CEEOT-SWAPP
SSURGO Data Tools
AVSWATX Sens-Auto-Unc
OK
Cancel
About:
CEEOT-SWAPP working with SWAT2005 and AVSWATX
Apr 23 13
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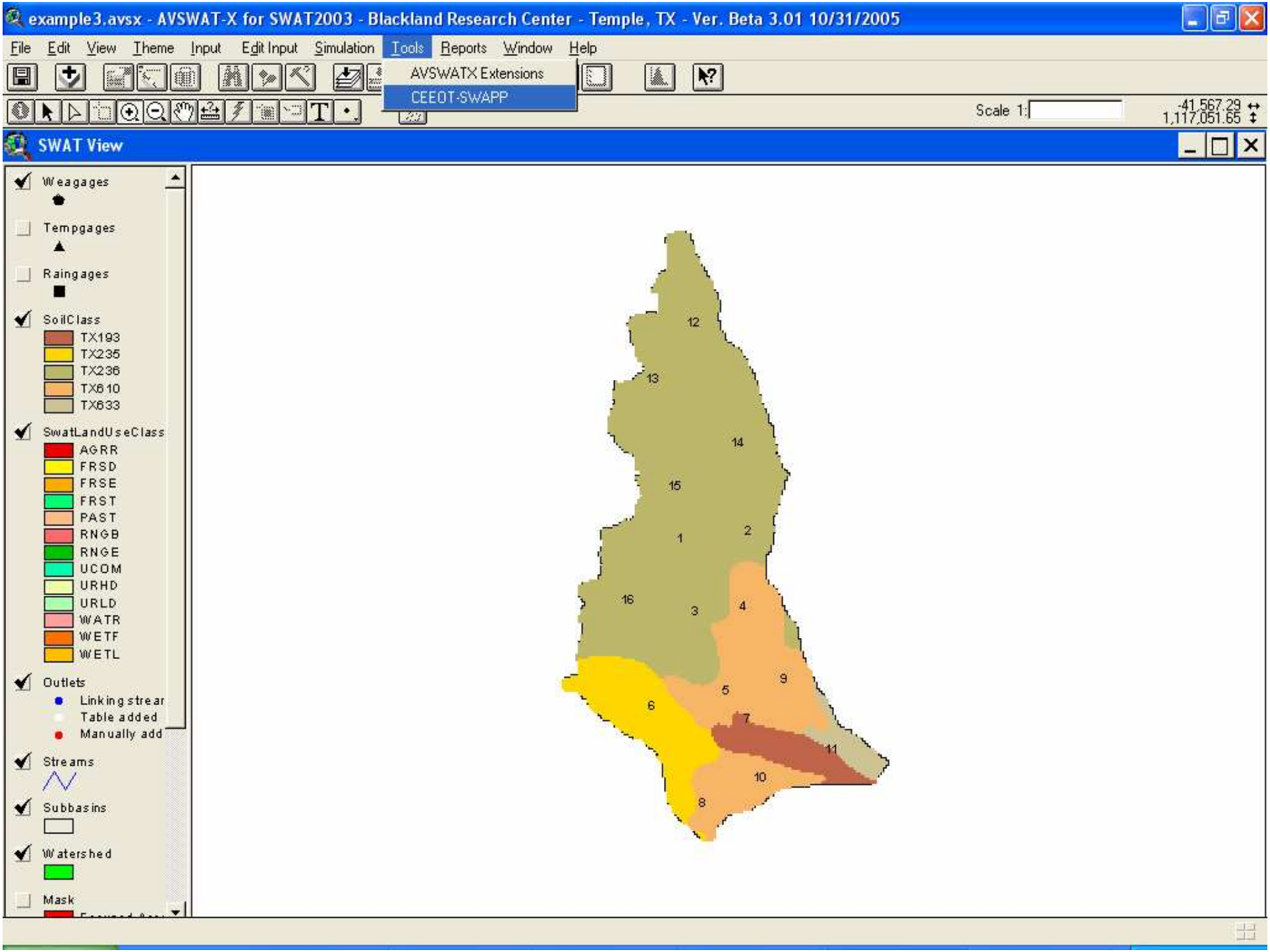
example3.avsx - AVSWAT-X for SWAT2003 - Blackland Research Center - Temple, TX - Ver. Beta 3.01 10/31/2005
File Edit View Theme Input Edit Input Simulation Tools Reports Window Help
AVSWATX Extensions
CEEOT-SWAPP
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Tempgages
Raingages
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Outlets
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Streams
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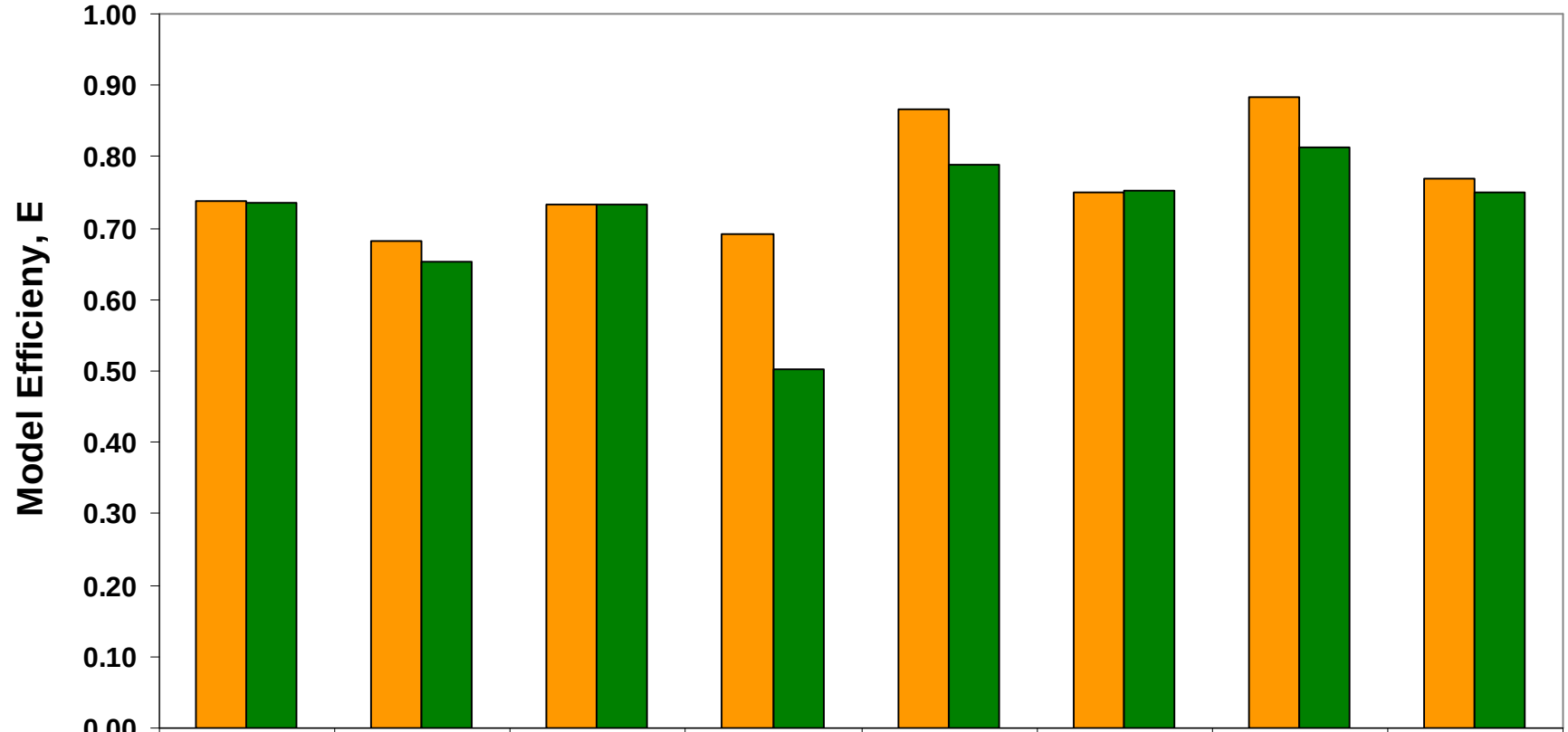
8

Better Evaluation by CEEOT-SWAPP

An example

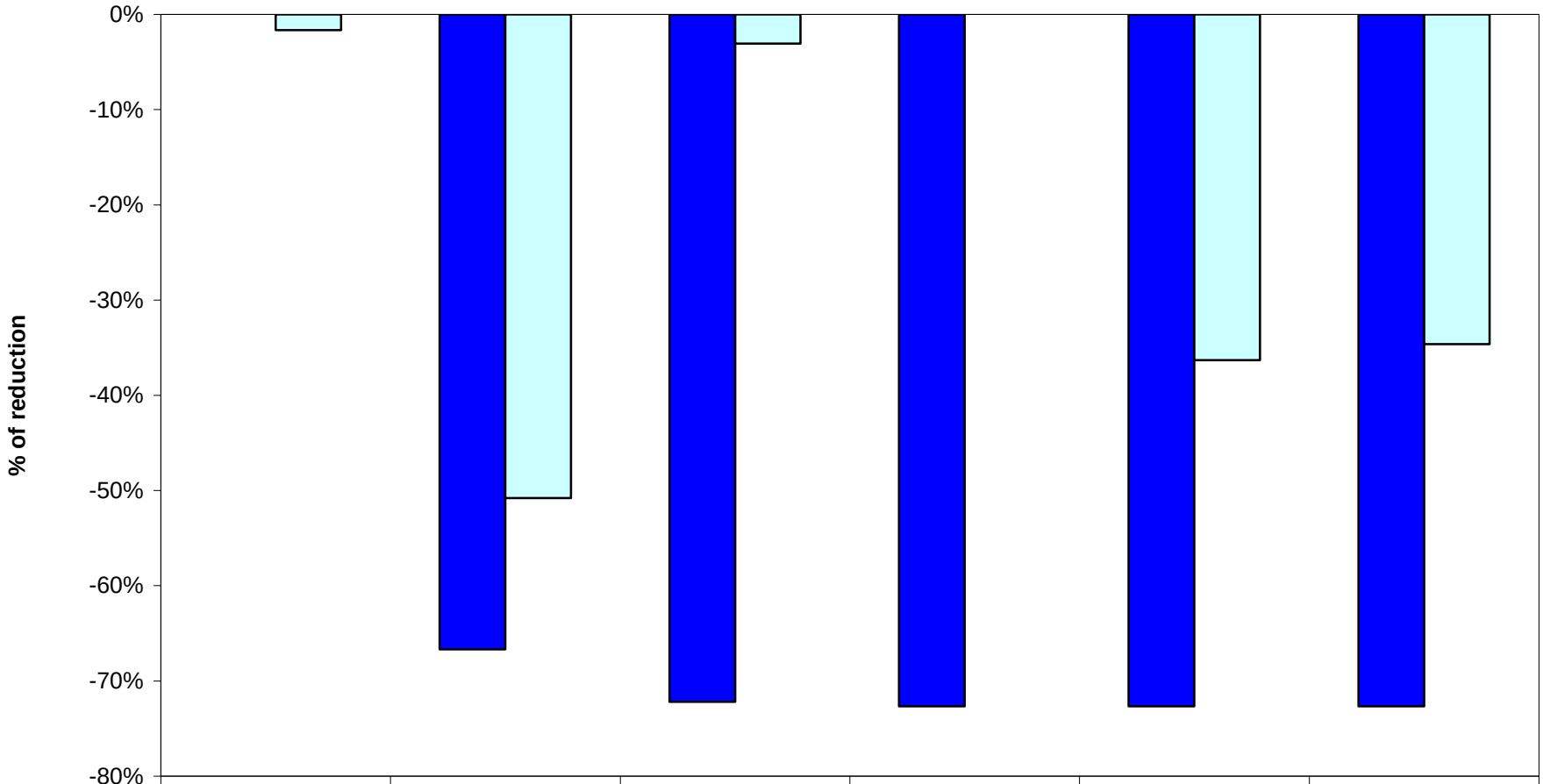
Model efficiency (E) for measured and predicted monthly flow, TSS, and nutrient loading at the outlet of UNBRW (BO070)



	Flow	TSS	NO_3-N + NO_2-N	PO_4	Organic-N	Particulate-P	Total-N	Total-P
SWAPP	0.74	0.68	0.73	0.69	0.87	0.75	0.88	0.77
SWAT-A	0.74	0.65	0.73	0.50	0.79	0.75	0.81	0.75

An Example of Filter Strip Simulation by CEEOT-SWAPP and SWAT alone

- Main Field
  - Continuous corn with area of 630 ha
- Filter Strip Characteristics
  - Efficiency = 0.73 (based on SWAT calculation)
  - Width = 10 m
  - Area = 2.5 ha
  - Crop = Switch grass



	Flow	TSS	NO3	PO4	Org N	Org P
SWAT	0.00%	-66.68%	-72.20%	-72.67%	-72.67%	-72.66%
SWAPP	-1.66%	-50.79%	-3.05%	0.00%	-36.31%	-34.62%

Essential Tool for BMP Evaluation

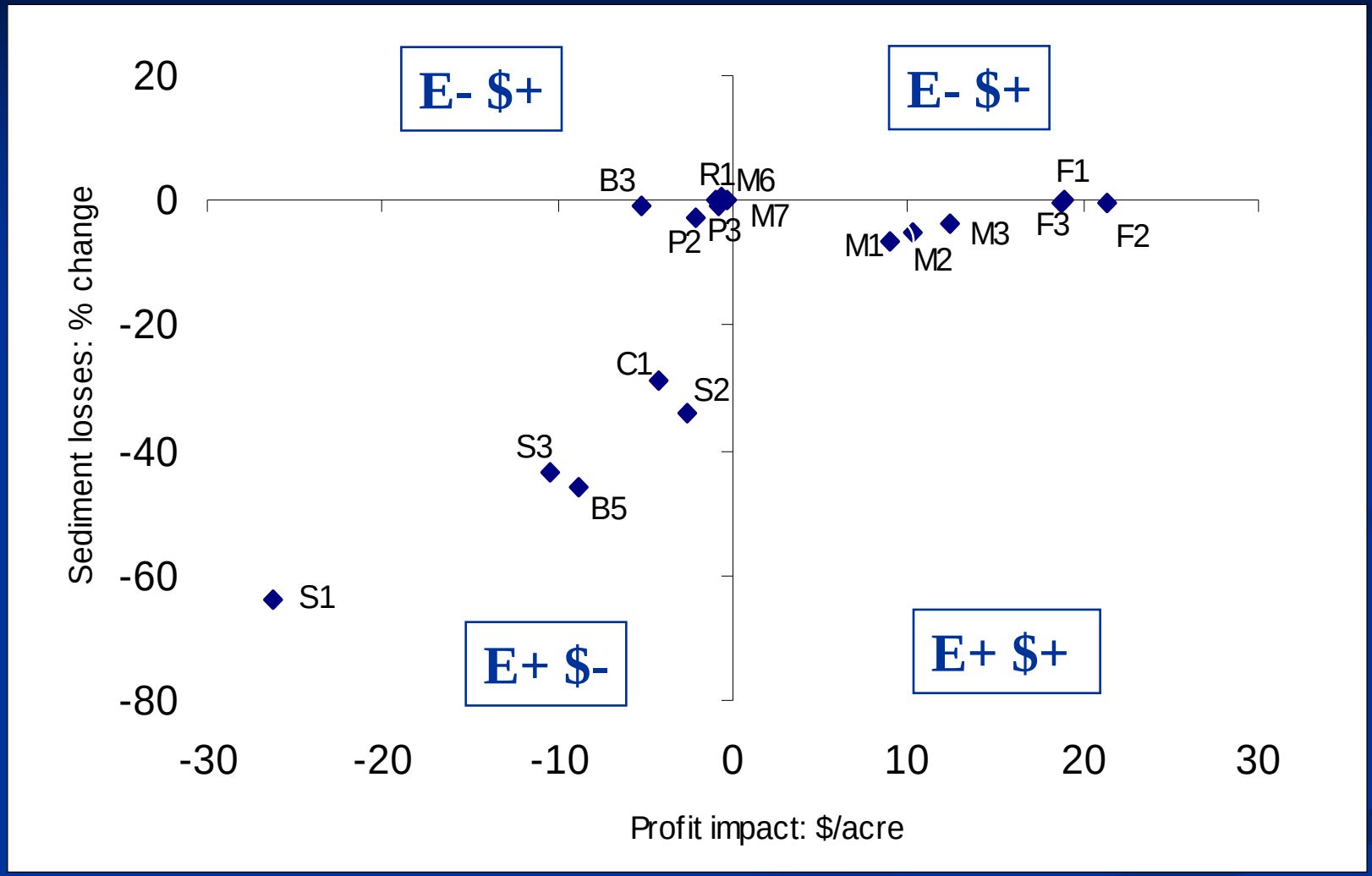
An Example

List of scenarios (1 of 2)

Scenario	Scenario Description
Manure Application (M)	
M1	Manure applied at the N rate and manure nutrient crediting
M2	Manure applied at the high P rate and manure nutrient crediting
M3	Manure applied at the low P rate and manure nutrient crediting
M6	Incorporation of solid manure
M7	Injection of liquid manure
Fertilizer Application (F)	
F1	Elimination of fall crop removal fertilizer applications on all cropland
F2	Reduced N application on all cropland
F3	Reduced and split N application on all cropland
Cropland tillage (c)	
C1	No-till on all cropland

List of scenarios (2 of 2)

Soil Management (S)	
S1	Terraces on cropland with slopes greater than 2 percent
S2	Contouring on cropland and pastureland with slopes greater than 2 percent
S3	Contour buffer strips on cropland with slopes greater than 2 percent
Ration Modifications (R)	
R1	Phytase-supplemented rations for swine farms
Structural BMPs (B)	
B3	Filter strips on manure application fields
B5	Enhancing and developing waterways for all cropland
Production System (P)	
P2	Hoop structures for all swine operations
P3	Hoop structures for open lot swine operations
Illustrative Combinations of Individual Practices	
Maquoketa 1	No-till and reduced N rate on all cropland b
Maquoketa 2	Contour buffer strips on cropland with slopes greater than 2 percent; reduced N on cropland b
Maquoketa 3	Contour crop and pastureland with slopes greater than 2 percent; reduced N on cropland b
Maquoketa 4	No-till on solid manure fields and injection of liquid manure


E- $+
E- $+
E+ $-
E+ $+
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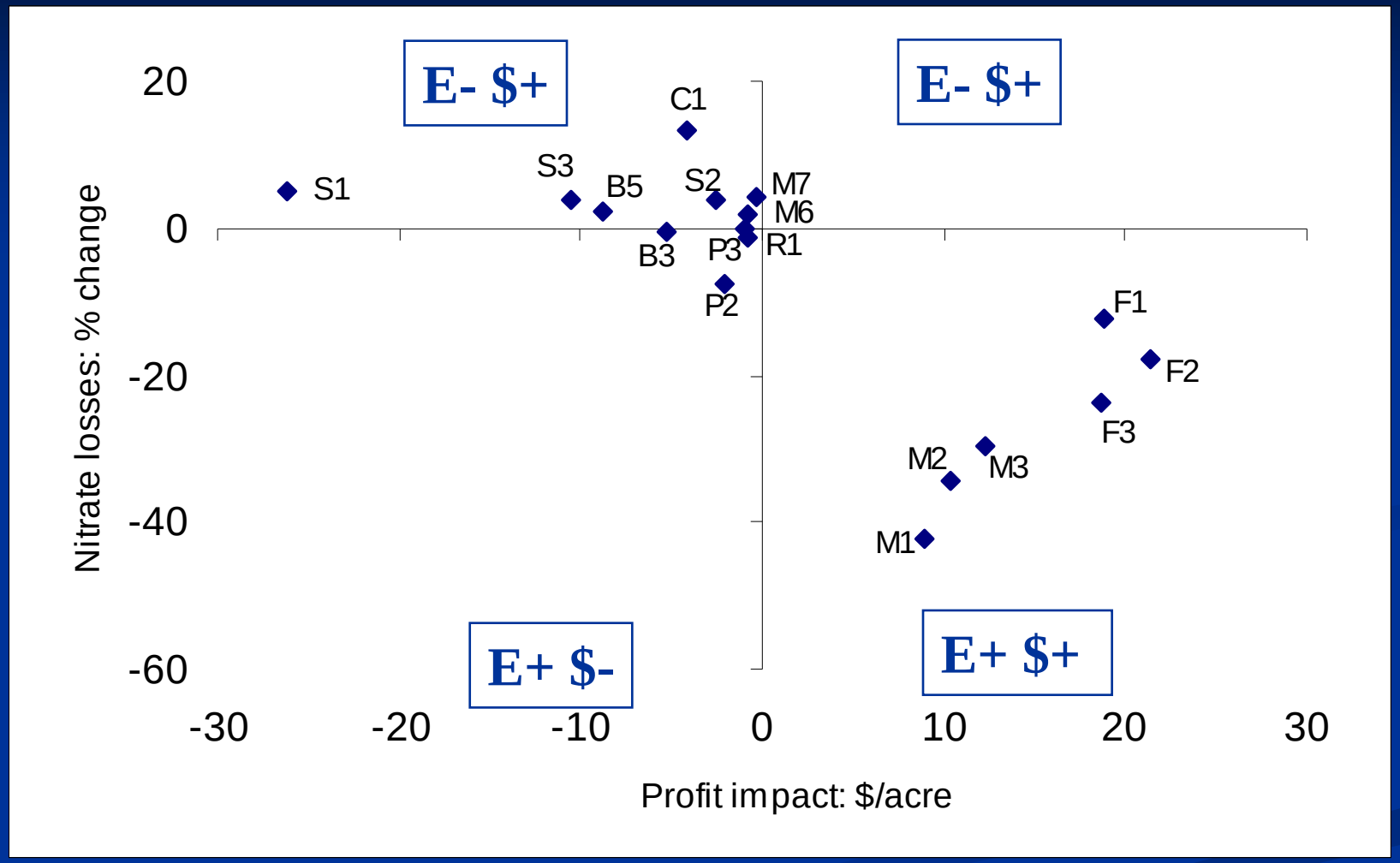
-20
-40
-60
-80
-30
-20
-10
0
10
20
30
Sediment losses: % change
Profit impact: $/acre
B3
R1
M6
M7
P2
P3
M1
M2
M3
F1
F3
F2
C1
S2
S3
B5
S1


E- $+
E- $+
E+ $-
E+ $+
20
0
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-40
-60
-30
-20
-10
0
10
20
30
Nitrate losses: % change
Profit impact: $/acre
C1
S1
S3
B5
S2
M7
M6
R1
B3
P3
P2
F1
F2
F3
M2
M3
M1

Conclusion

- The CEEOT-SWAPP program transfers SWAT data files generated by the AVSWAT program to APEX data files rapidly and automatically
- The CEEOT-SWAPP program is
  - an valuable tool to evaluate the environmental contribution of targeted landuses (fields) within the watershed
  - an valuable tool to evaluate the economic factors related to trading and water quality implementation

Acknowledgement

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