Understanding Water-Human interaction through an Intelligent Digital Watershed: Initial development and Implementation

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2011 International SWAT Conference
June 15-17, 2011
University of Castilla La Mancha
Toledo, Spain

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Introduction

Why CNH?

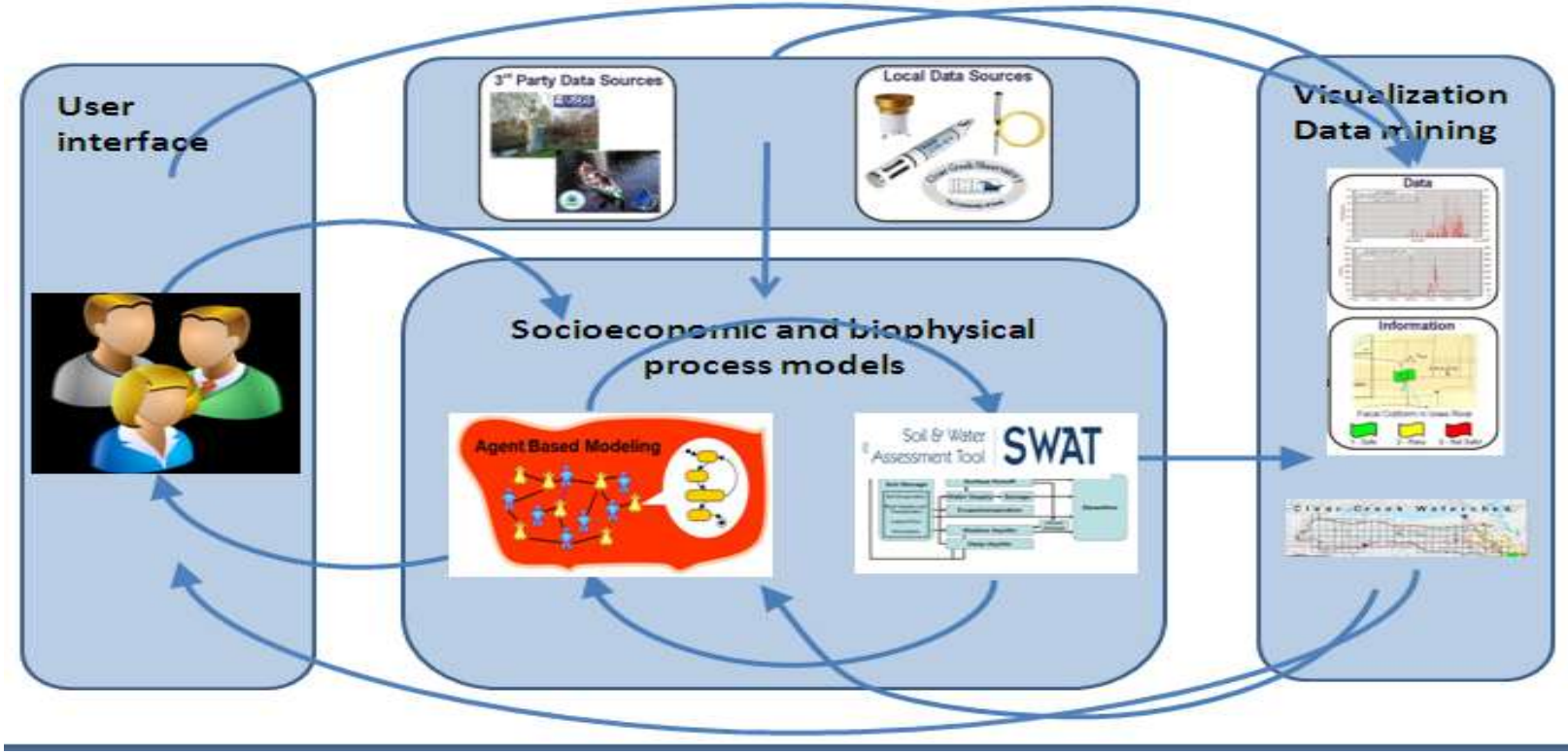
- Human activity is intricately linked to the quality and quantity of water resources. Although many studies have examined human-water dynamics, the complexity of such coupled systems is not well understood.
- Do decision-makers understand the tradeoffs among economic return and environmental impact given alternative assumptions about the application of nutrients? Does such understanding change the way farmers manage the landscape or regulators set policies?

Objectives: Built framework of linked socioeconomic and biophysical processes:

1. Understand the connections that exist between the expanding biofuel economy, land management, and water quality impacts
2. Develop CI-enabled technologies to assist:
   - researchers transform data into knowledge about interrelated socioeconomic and biophysical processes
   - stakeholders transform data into more informed decision-making through an understanding of these processes

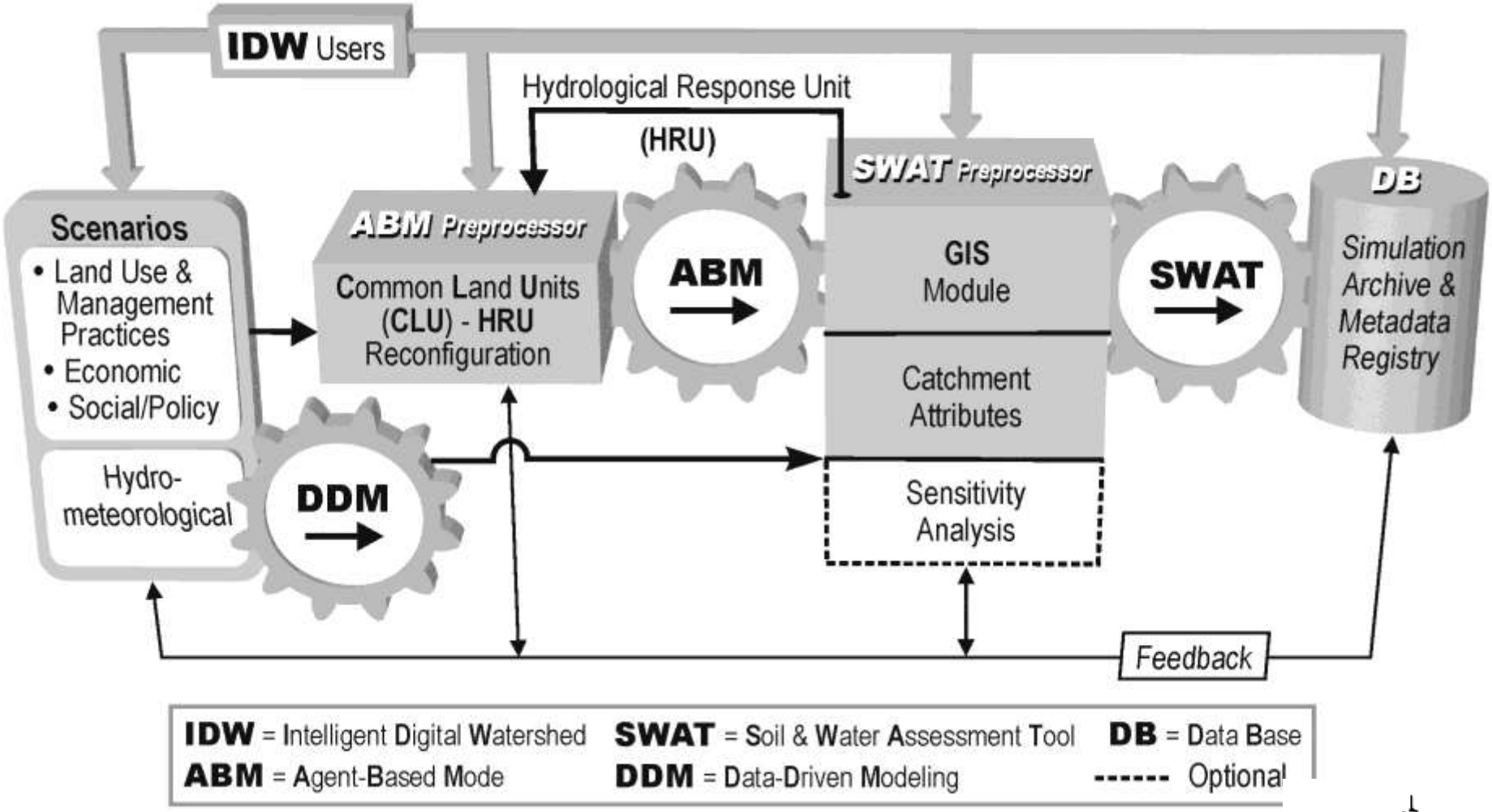
Approach:

Linking socioeconomic and biophysical processes: a "360°" modeling framework. Analyze scenarios based on alternative assumptions about policy, economics, climate

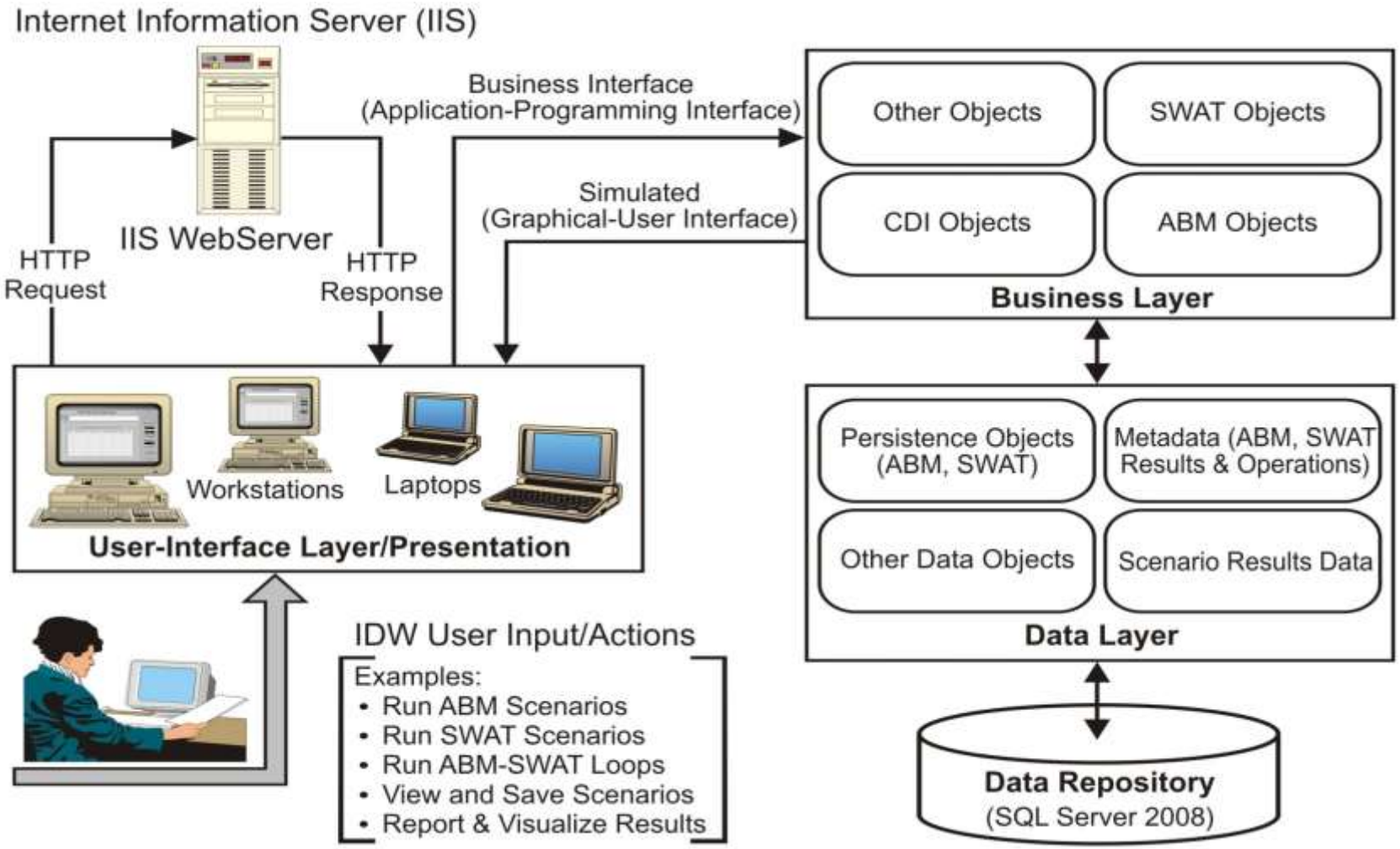


Modeled decisions are linked to an existing watershed simulation model to understand the impact these scenarios on indicators of water quality (nitrate, phosphate, dissolved oxygen)

IDW Framework:



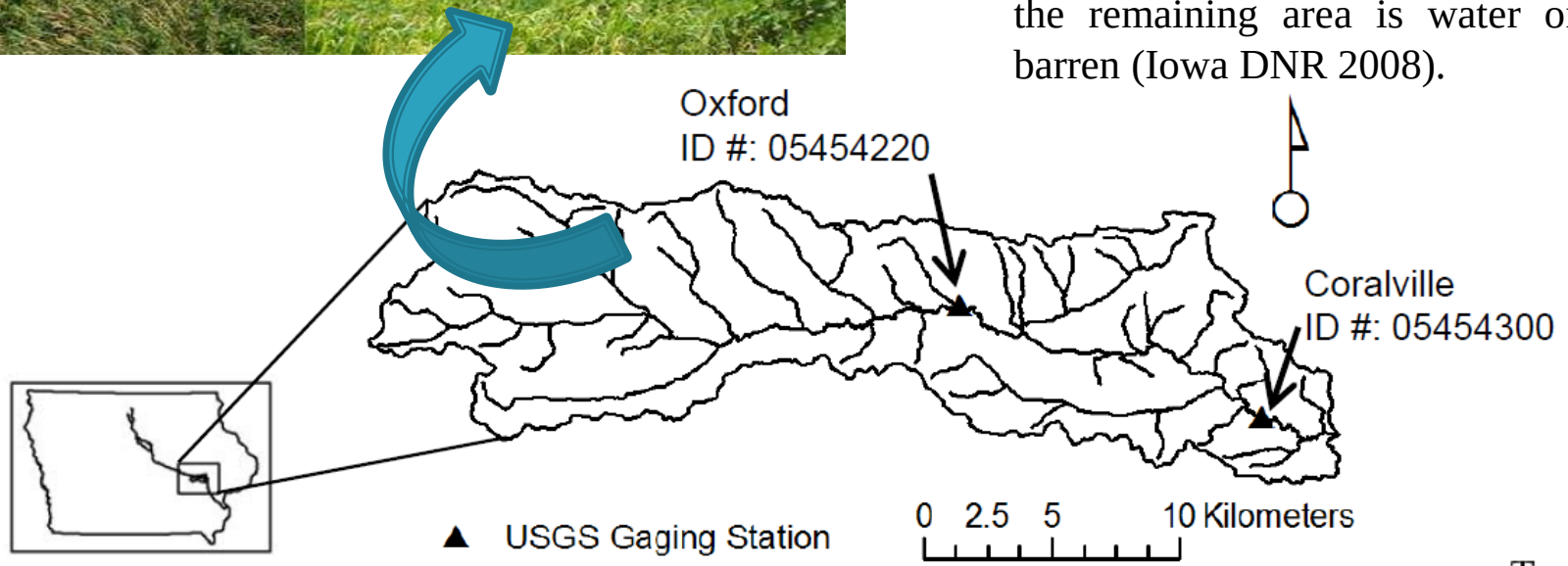
Model management and analysis



Implementation: Prototype Clear Creek IDW

Study area:

- The Clear Creek watershed is a **267 km^2** HUC (Hydrologic Unit Code) 10 units located in east-central Iowa.
- Approximately **85%** of the land cover in the watershed is **agricultural or grassland**, 8% is forest, 6% is roads or urban, and the remaining area is water or barren (Iowa DNR 2008).



Agent Based Model(ABM):

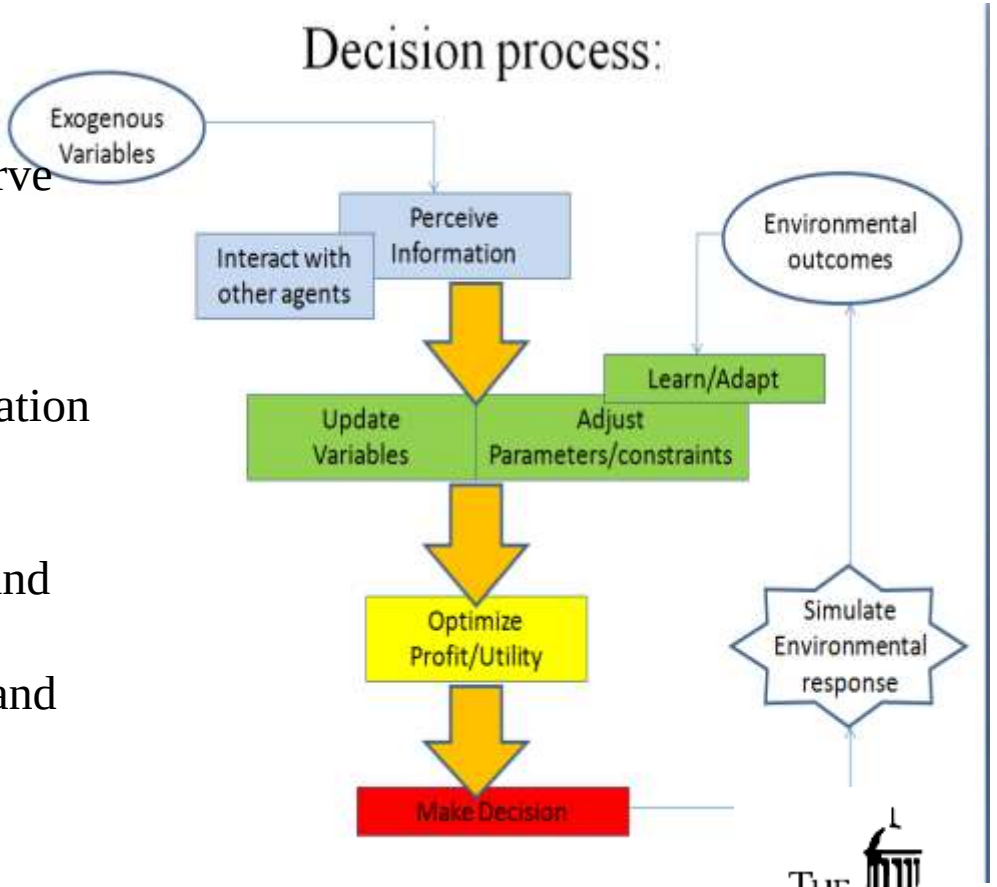
Agent-Based Model (ABM) is a cyber-enabled approach of simulating the actions and interactions of heterogeneous autonomous agents in complex adaptive systems (CAS) such as a land-use system (Bennett and McGinnis, 2008). Agents in the system make decisions and behave based on specific decision-making heuristic, learning and adaption rules.

ABM of farmers' decision on:

- Crop: corn, soybean, corn & stover, switchgrass, CRP (Conservation Reserve Program)
- Tillage: conventional, mulch, no
- Fertilizer application: N, P, K
- Decision rules: Profit/Utility maximization subject to environmental constraints

Exogenous variables:

- Market prices for commodities, fuel, and fertilizer
- Policies about conservation practices and biofuels
- Weather scenarios



To better define "agents" we surveyed rural residents of Clear Creek Watershed

6. How many more years do you plan to farm?

- ☐ _____ years
- ☐ I am already retired from farming
- ☐ I do not farm

7. Considering all sources of agricultural income (including government payments), what was the total gross value of your agricultural income in 2008?

- ☐ None
- ☐ $1-$ 24,999
- ☐ $ 25,000-$ 99,999
- ☐ $100,000-$249,999
- ☐ $250,000-$499,999
- ☐ $500,000-$999,999
- ☐ $1,000,000 and over

8. In the past five years, approximately what percent of your household income has come from farming?

- ☐ 0%
- ☐ 1-25%
- ☐ 26-50%
- ☐ 51-75%
- ☐ 76-100%

Questions on biofuel production

38. Do you sell any of your corn to an ethanol plant? ☐ Yes ☐ No

39. Have you ever invested in the ethanol industry? ☐ Yes ☐ No

40. How knowledgeable are you about the harvesting and marketing of

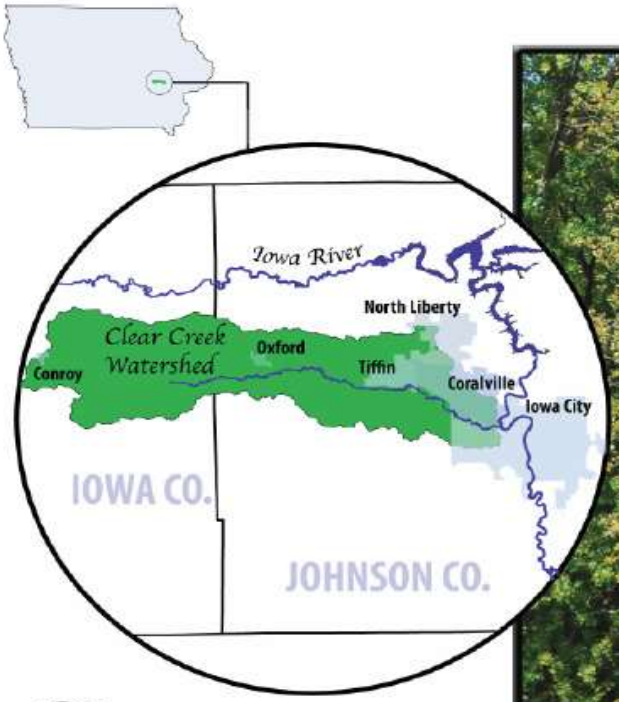
	1 (not at all knowledgeable)	2	3	4	5 (very knowledgeable)
Corn stover (stem residue)					
Switchgrass					

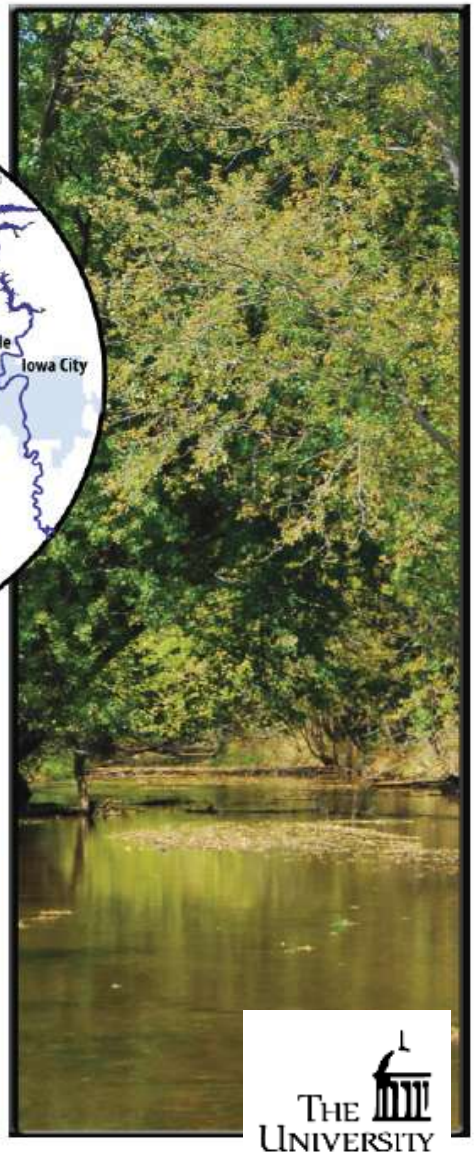
41. In 2009, did you harvest and sell any corn stover?

☐ Yes ☐ No

42. In the past 5 years, have you harvested or hired someone to harvest your hay?

☐ Yes ☐ No ☐ No hay harvested in past 5 years





Clear Creek Watershed

2010 Agricultural Land Survey

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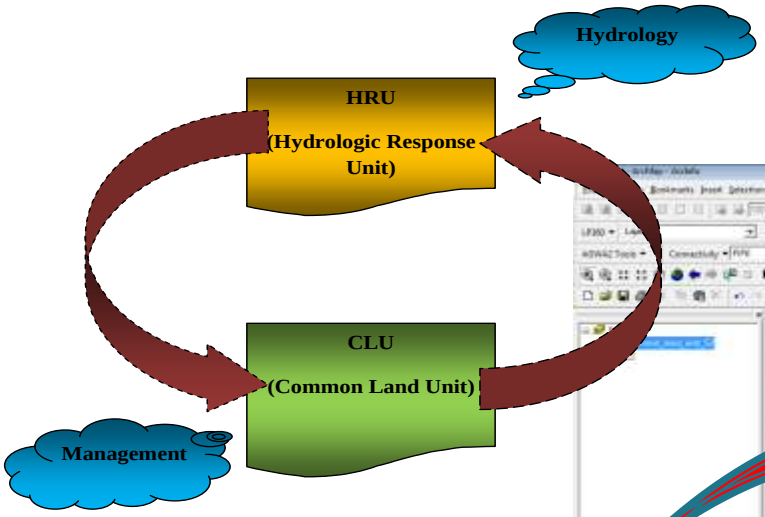
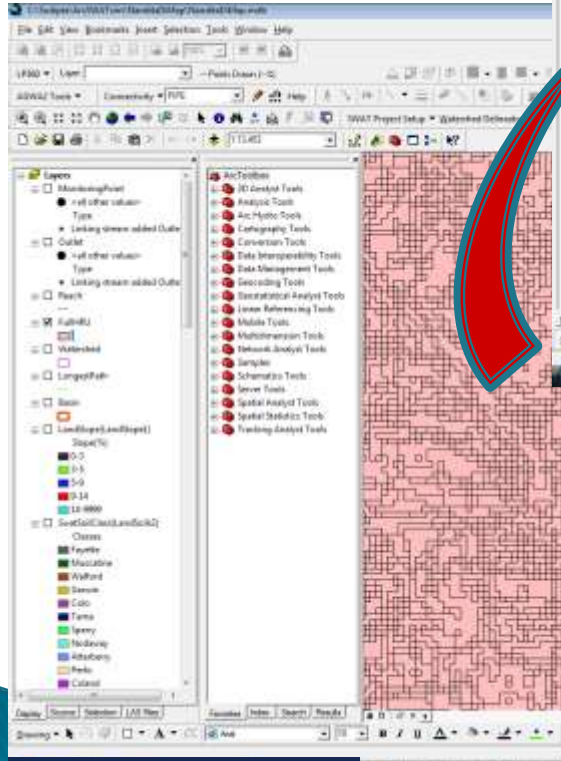
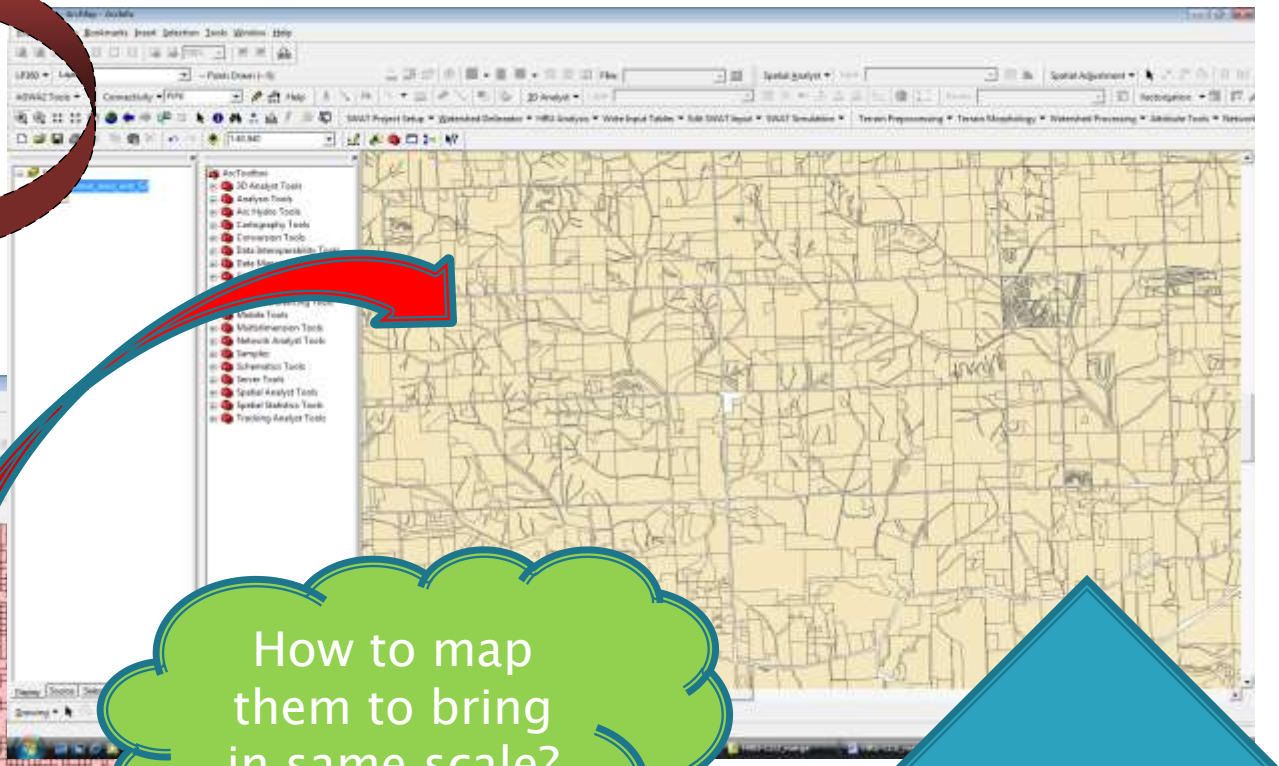
Issue of HRU and CLU scales:





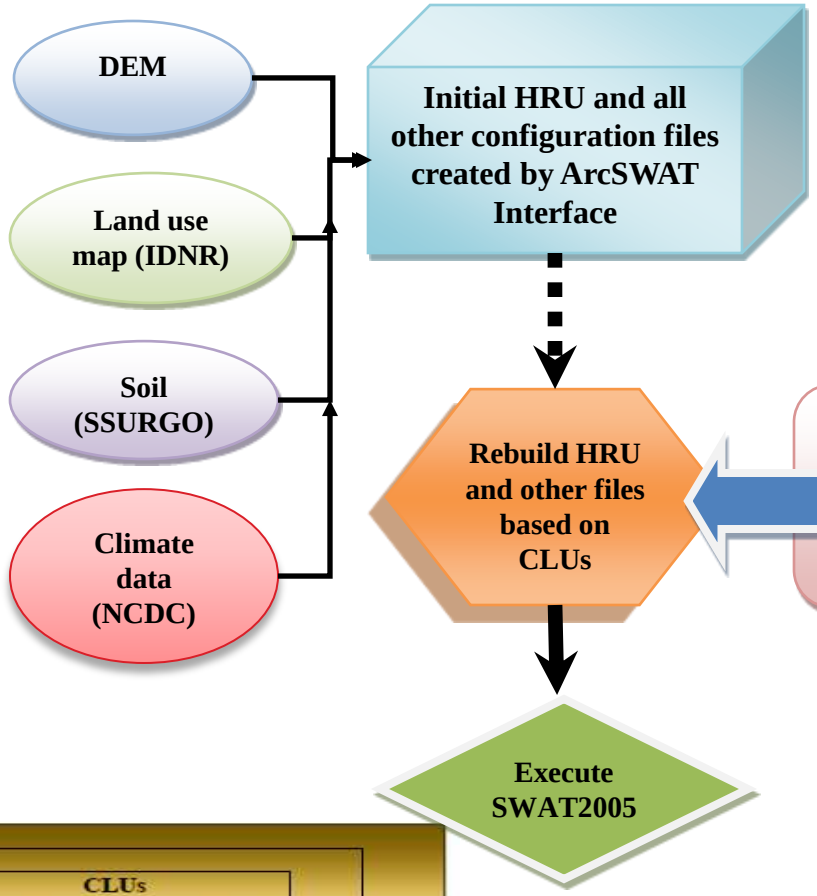


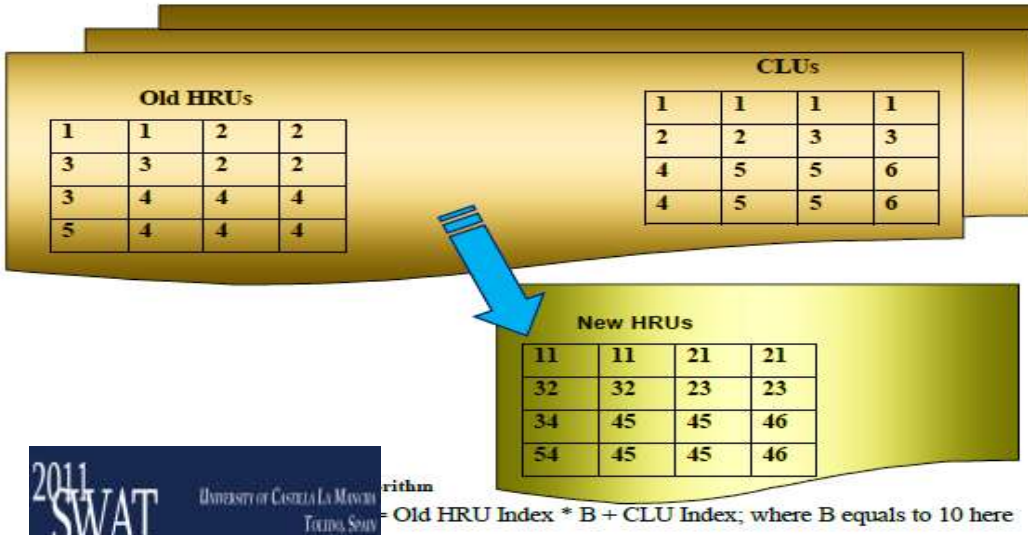
How to map them to bring in same scale?

ABM–CLU

SWAT–HRU

Building a CLU based modeling framework for ABM-SWAT multimodel simulation





HRU CLU conversion algorithm

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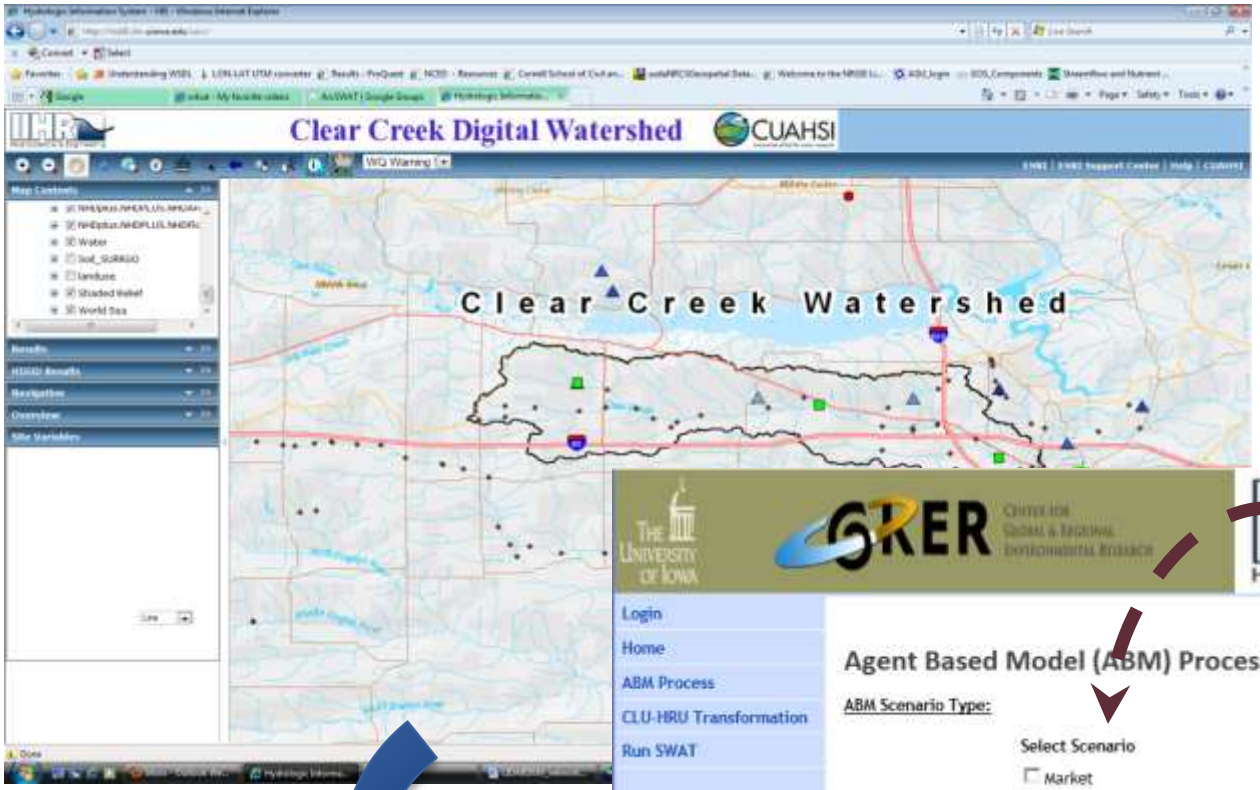
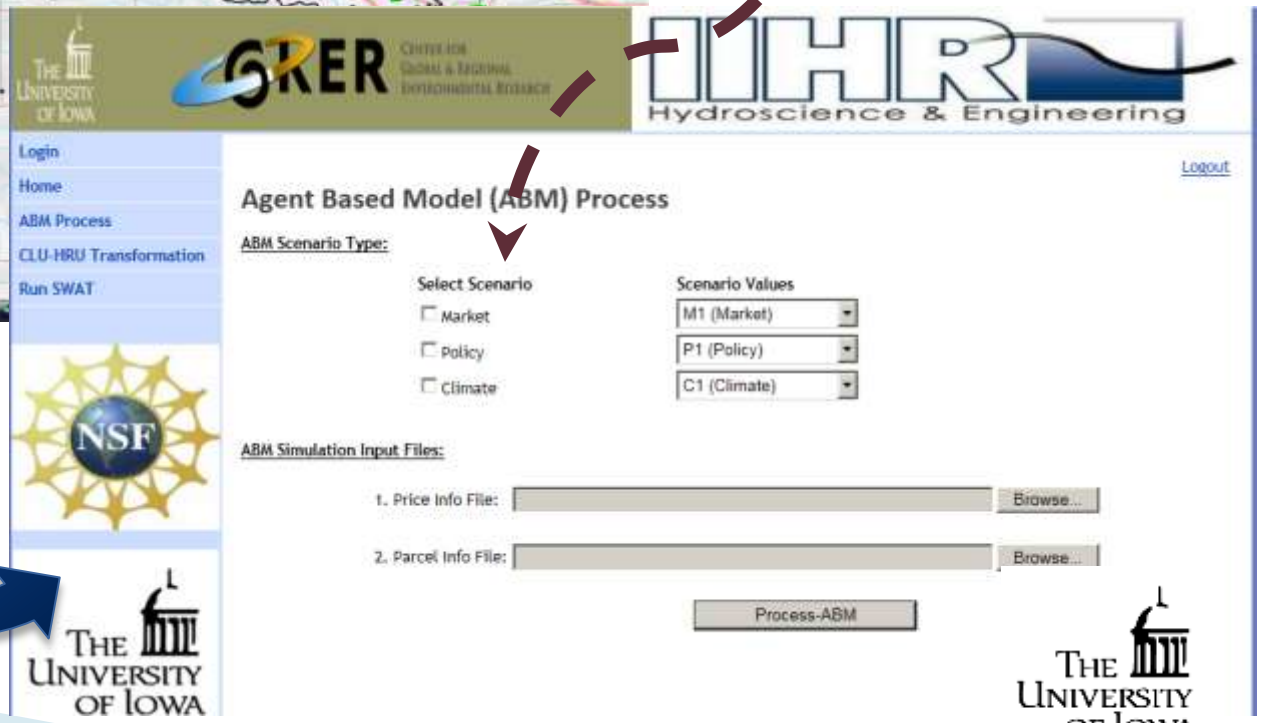
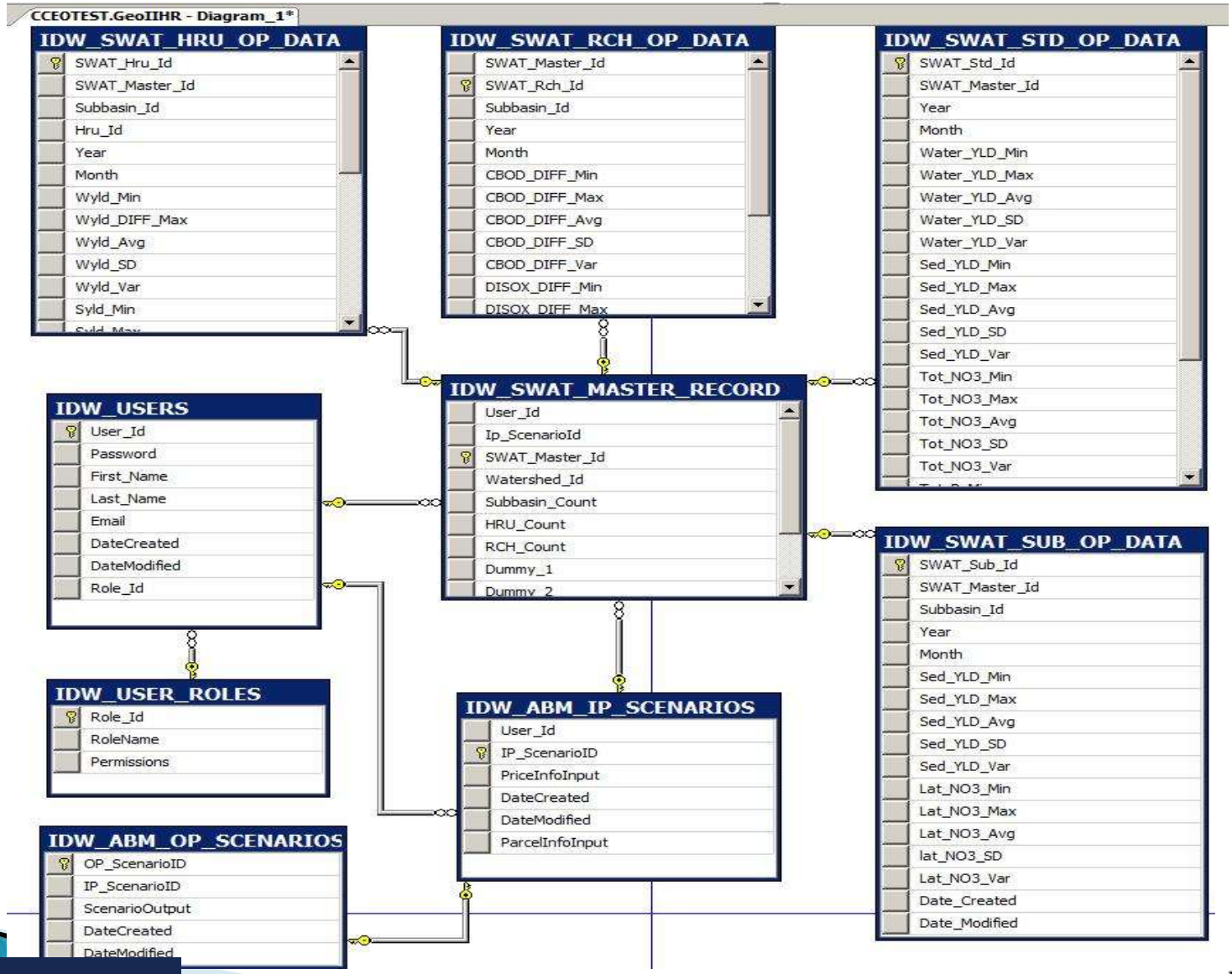
Prototype Clear Creek IDW



Scenario selection

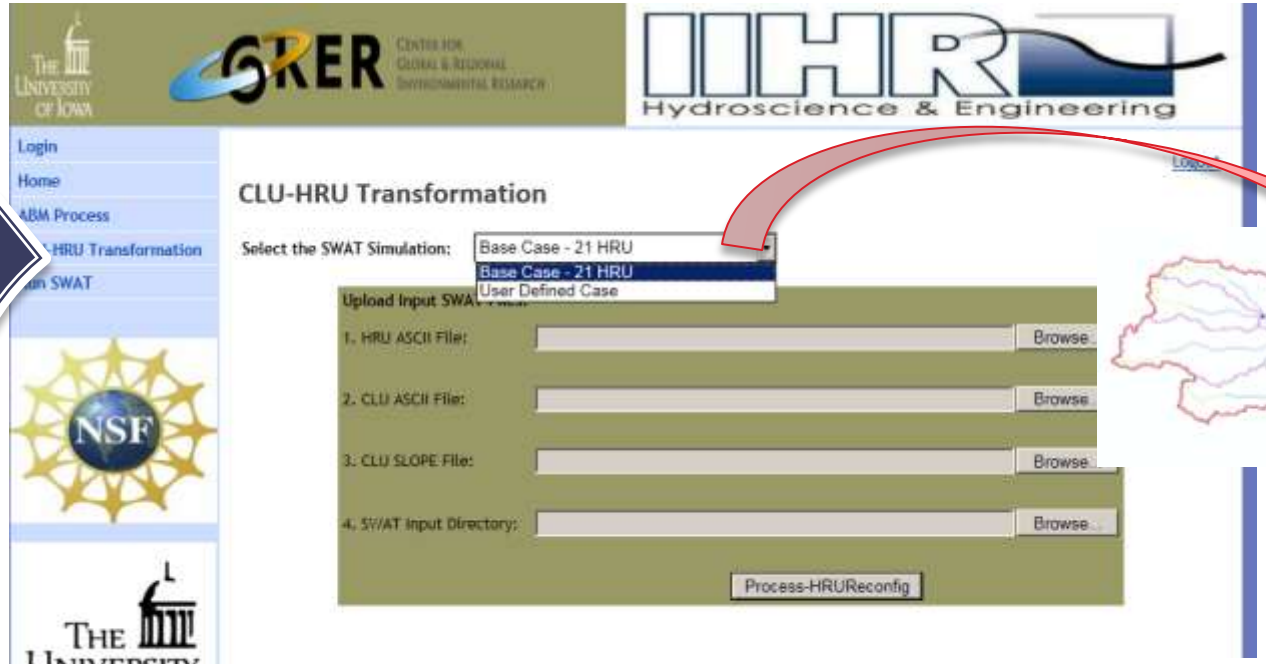


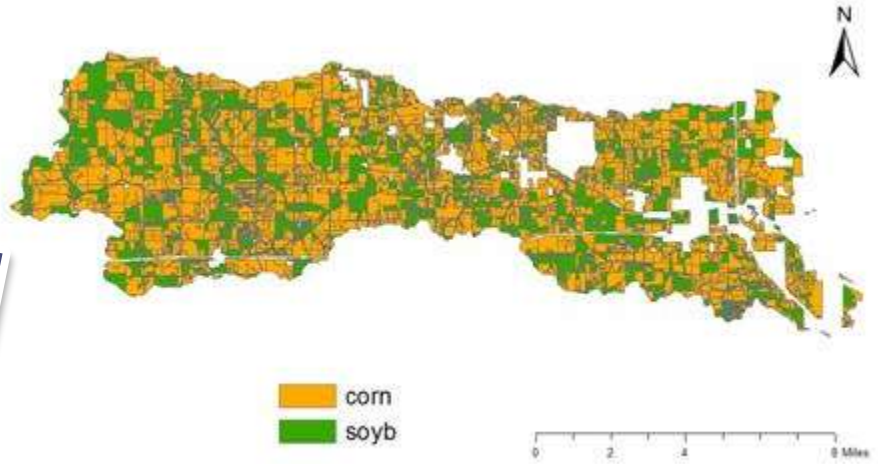
ModelBase schema:



Visualization in IDW: Market scenario

Multi model simulation steps:





Output from ABM run

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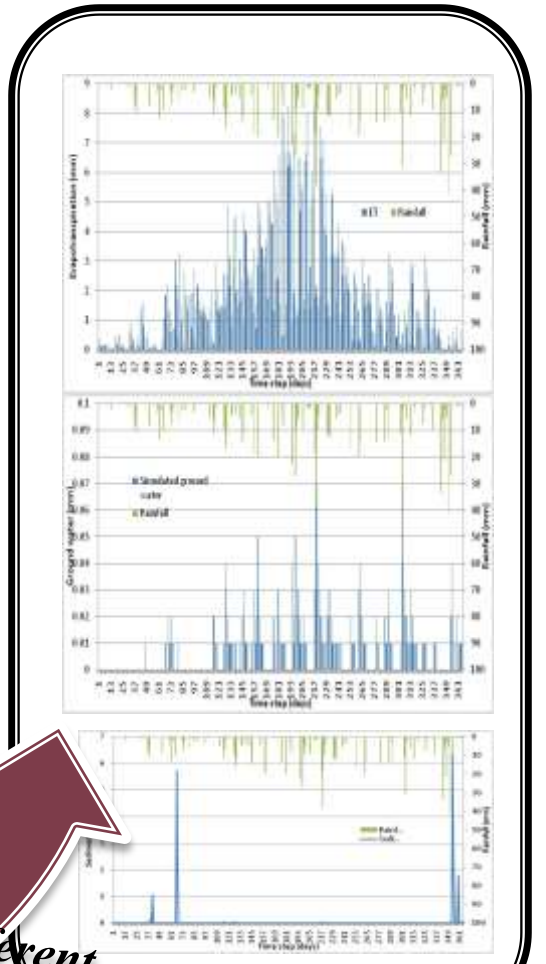
Multimodel simulation and Visualization:



Multimodel simulation visualization at different scales: Watershed, Subwatershed, Reach and CLU

Expected outcomes:

The IDW should also be able to:

- Find all scenarios that result in water quality that exceeds a user specified threshold level
- Find all scenarios that result in economic return exceeds a user specified threshold level

And help answer such questions as:

What characteristics do the scenarios that meet environmental and economic goals have in common?

Under alternative scenarios

- What agricultural land use patterns will emerge in the Clear Creek Watershed
- What is the likely impact of this land use pattern on water quality in the Clear Creek Watershed
- What is the likely impact of this land use pattern on economic return from grain and biofuel crops production in the Clear Creek Watershed

Thank You

For your kind attention
Have a question?

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