

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

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*The Group:*

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# Introduction

## Why CNH?

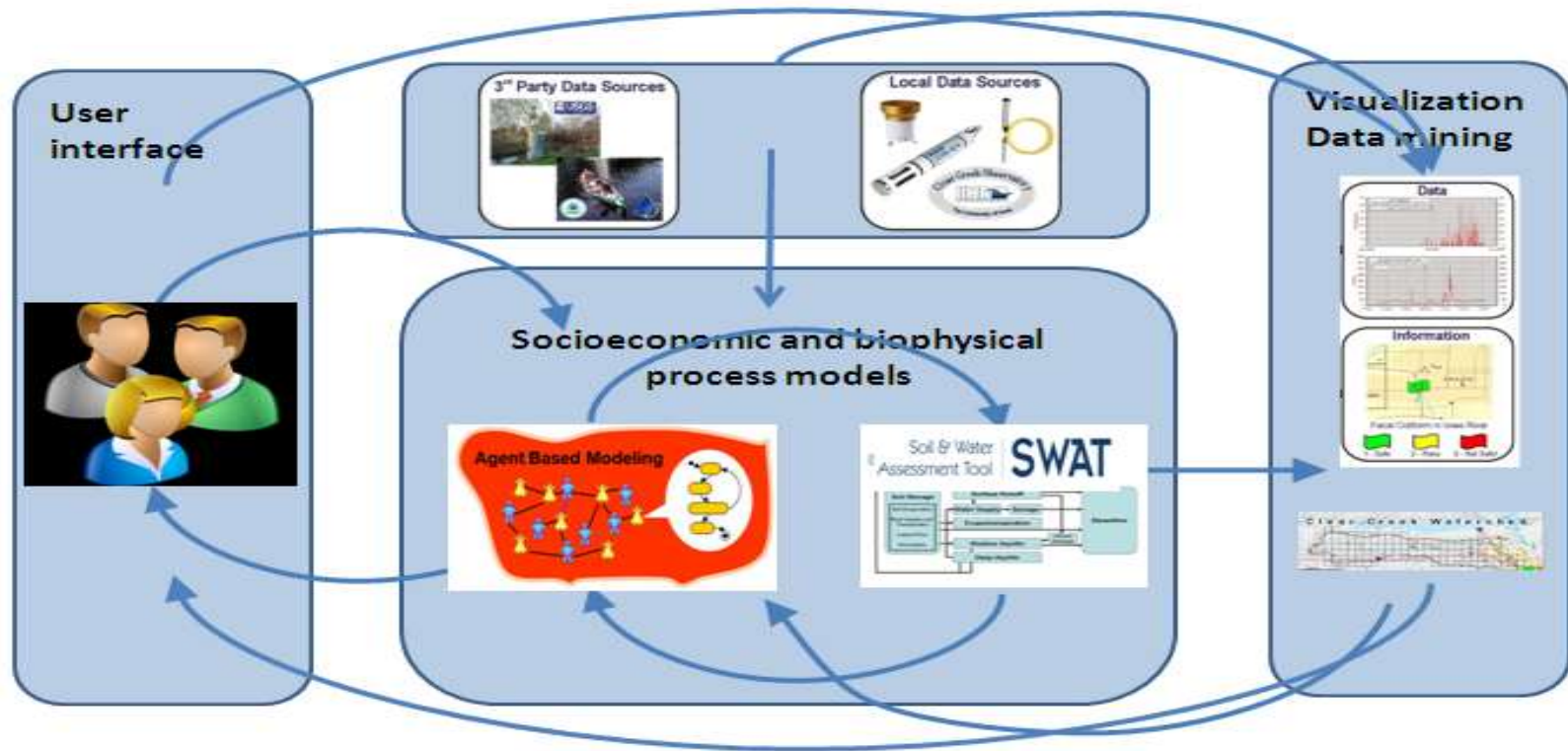
- Human activity is intricately linked to the quality and quantity of water resources. Although many studies have examined human-water dynamics, the complexity of such coupled systems is not well understood.
- Do decision-makers understand the tradeoffs among economic return and environmental impact 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

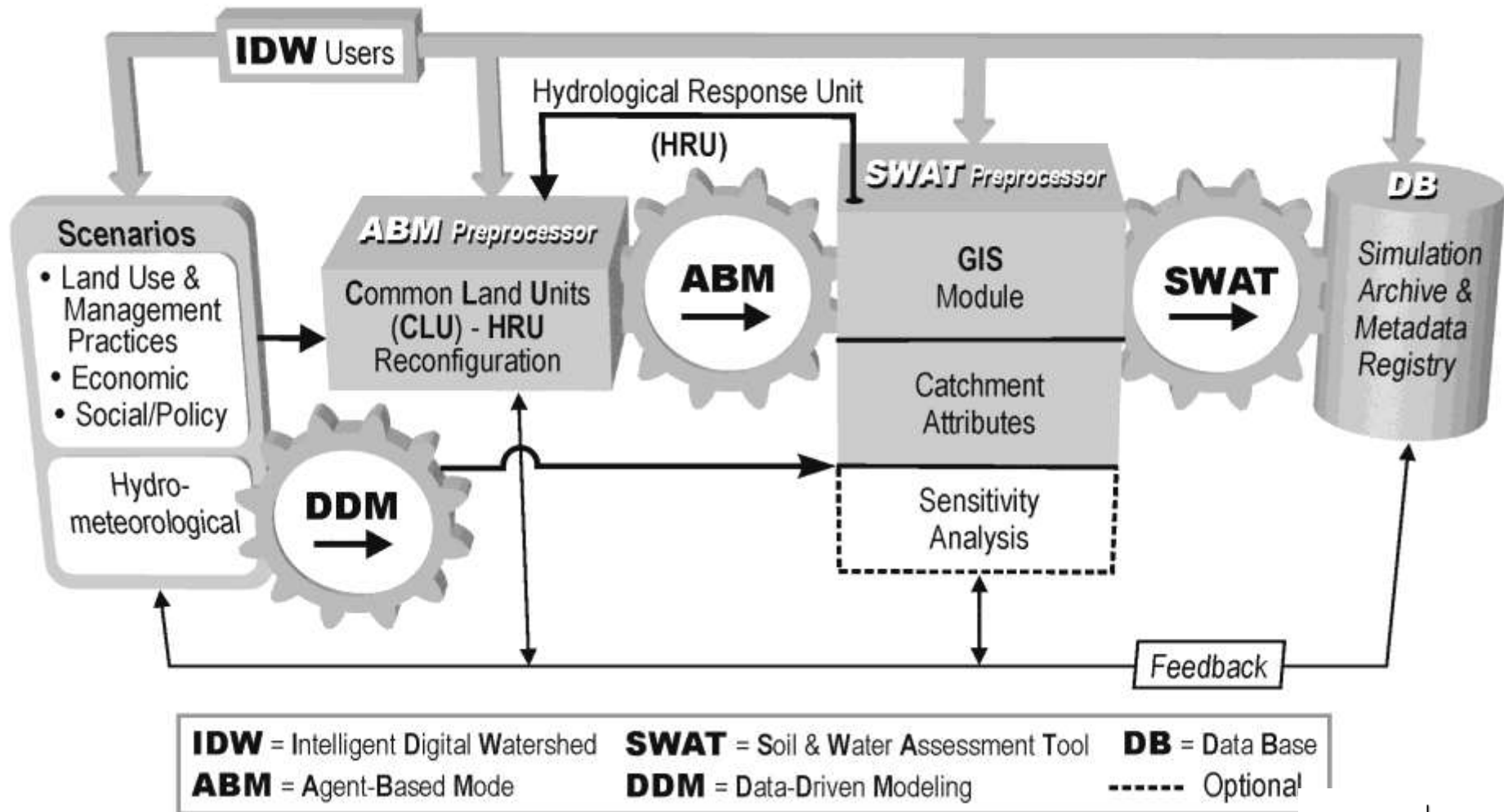
## Approach:

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



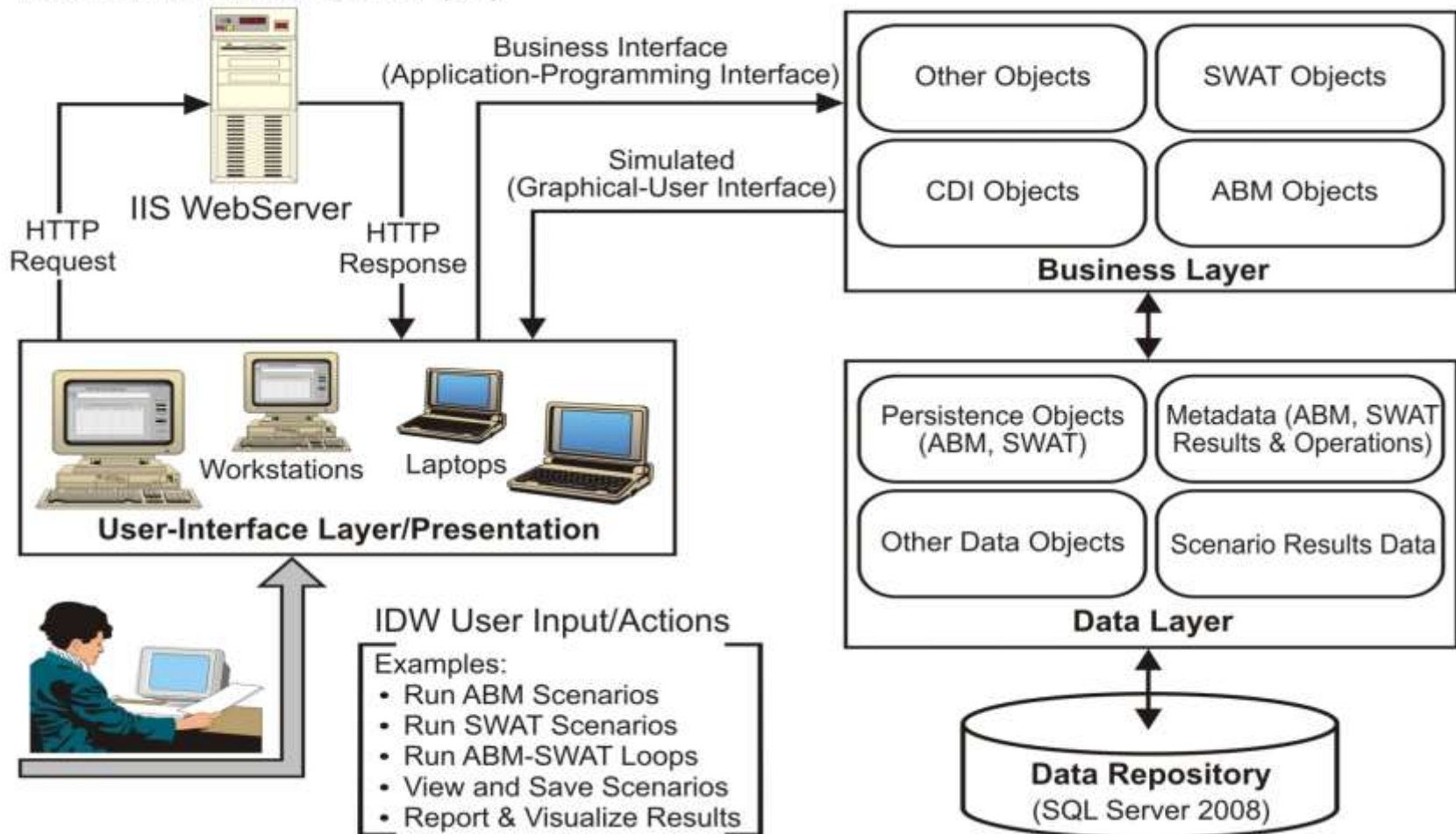
Modeled decisions are linked to an existing watershed simulation model to understand the impact these scenarios on indicators of water quality (nitrate, phosphate, dissolved oxygen)

# IDW Framework:



# Model management and analysis

Internet Information Server (IIS)



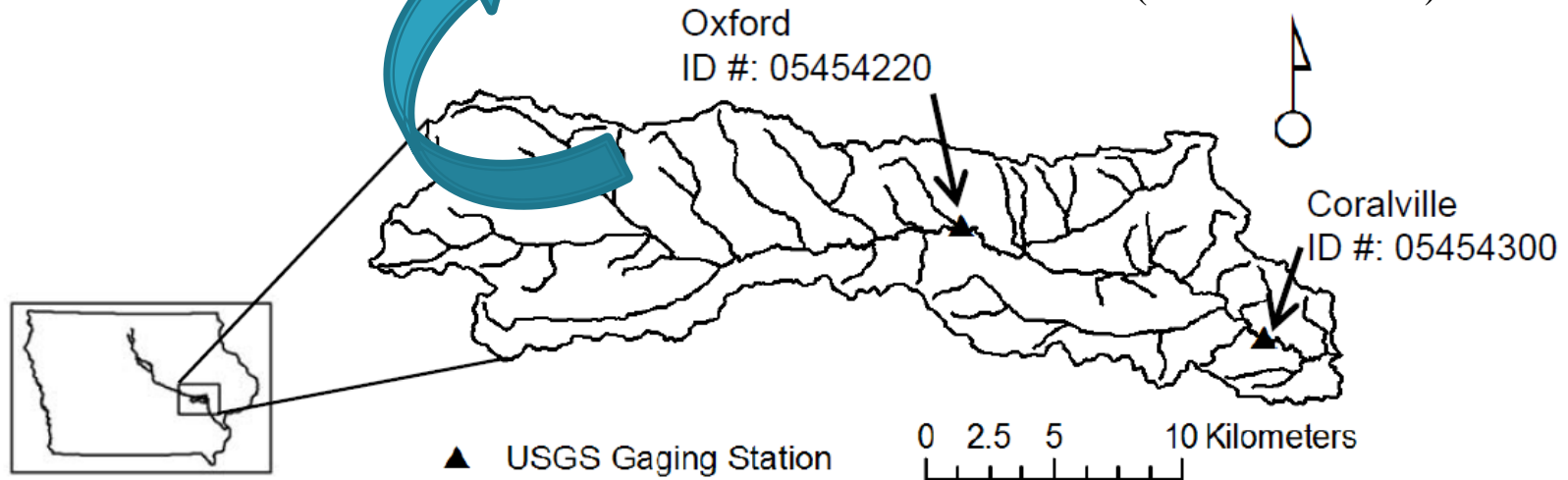


# Implementation: Prototype Clear Creek IDW



## Study area:

- The Clear Creek watershed is a **267 km<sup>2</sup>** 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

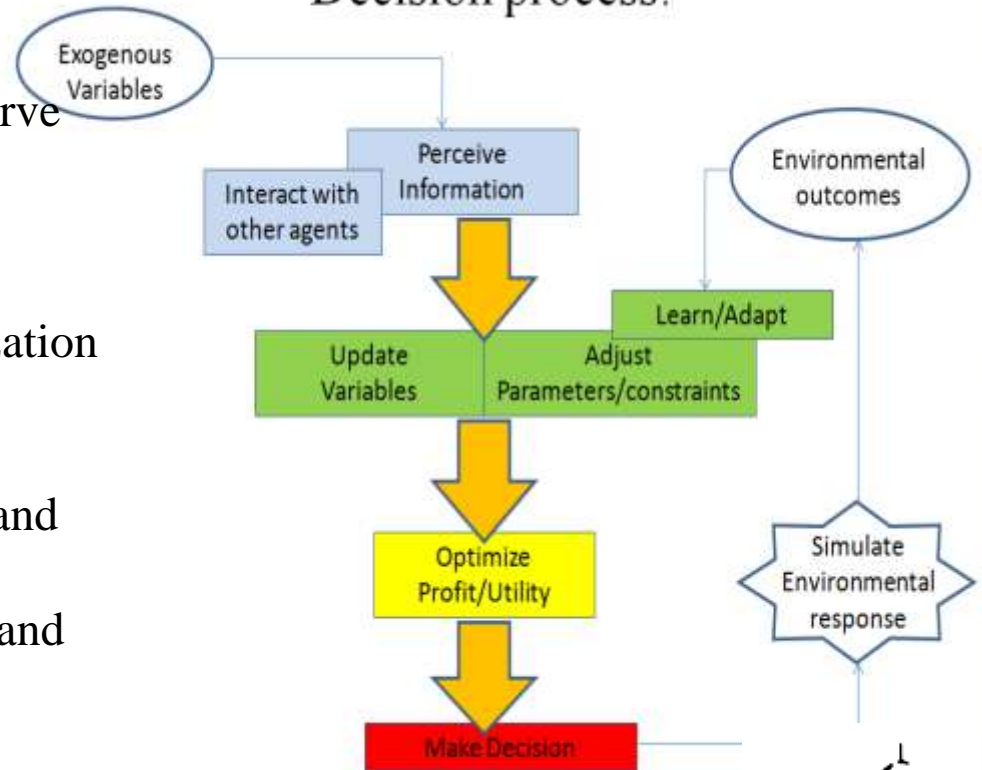
## Exogenous variables:

Market prices for commodities, fuel, and fertilizer

Policies about conservation practices and biofuels

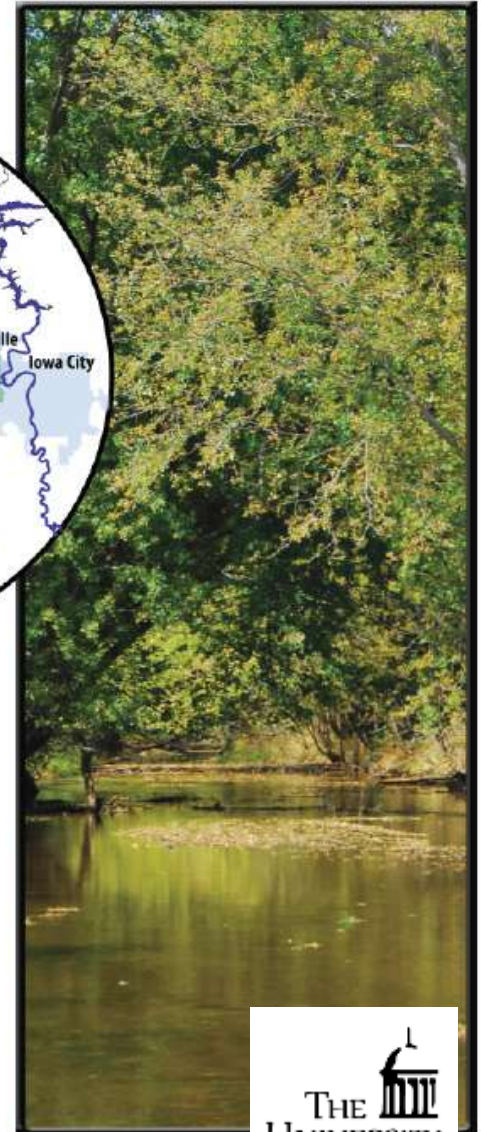
Weather scenarios

## Decision process:



# 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  \$250,000-\$499,999
- \$ 1-\$ 24,999  \$500,000-\$999,999
- \$ 25,000-\$ 98,999  \$1,000,000 and over
- \$100,000-\$249,999
8. In the past five years, approximately what percent of your household income has come from farming?
- 0%  51-75%
- 1-25%  76-100%
- 26-50%



## 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

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

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

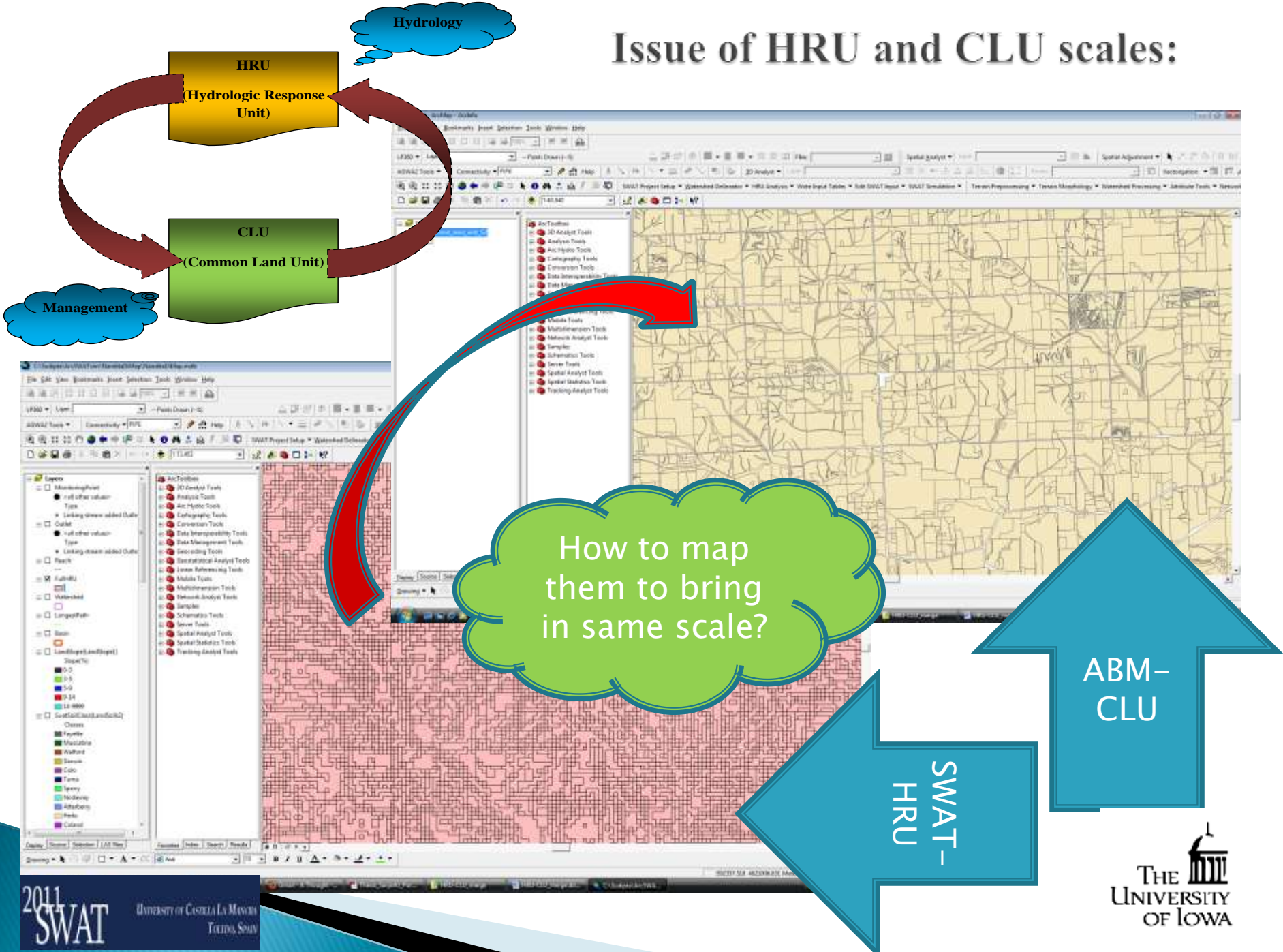
C. Subsidy sources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Special insurance to lower the risk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Crop insurance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Using a co-op to handle delivery arrangements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# Clear Creek Watershed

## 2010 Agricultural Land Survey



# Issue of HRU and CLU scales:



Hydrology

HRU  
(Hydrologic Response Unit)

CLU  
(Common Land Unit)

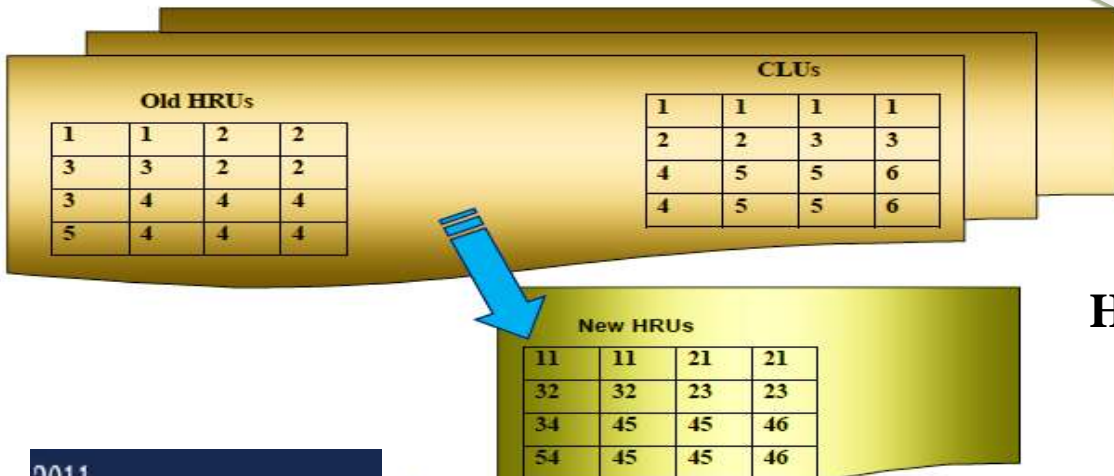
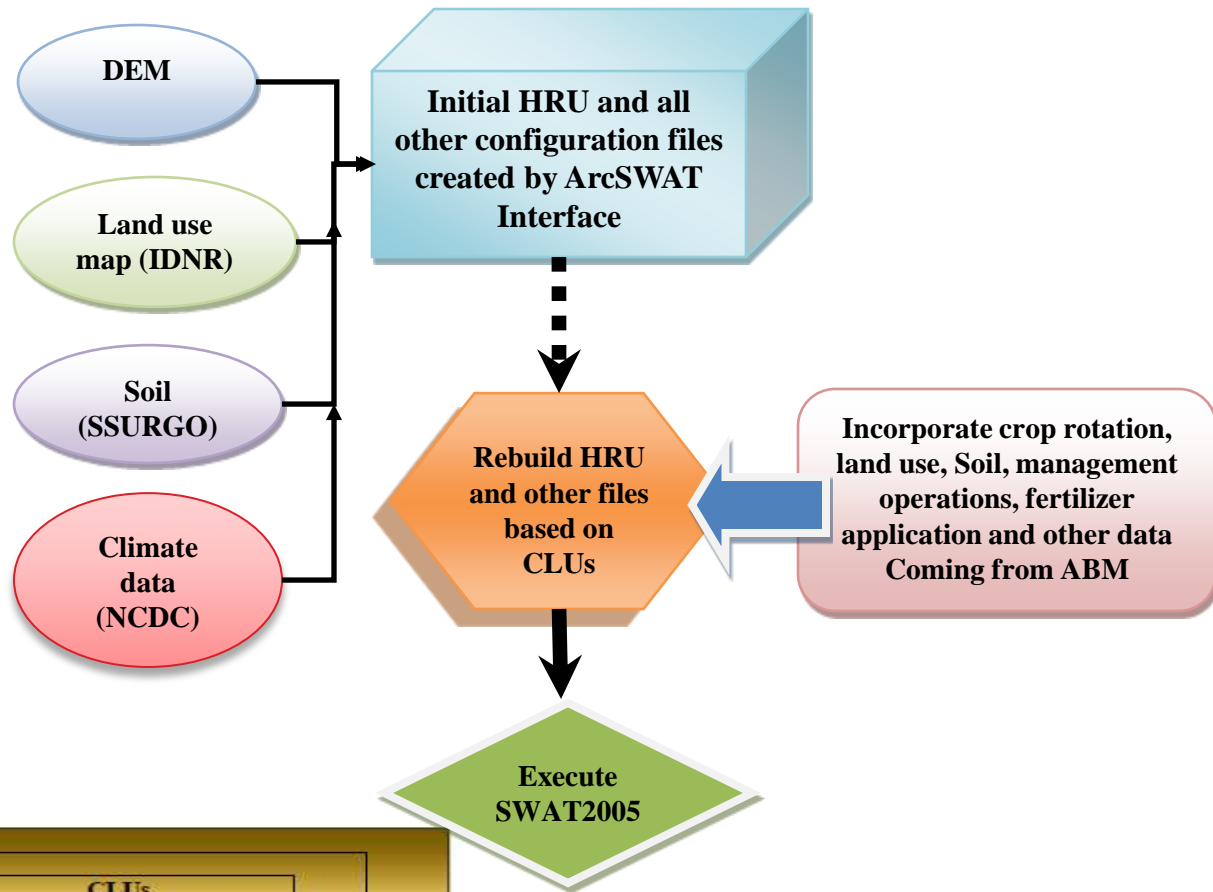
Management

How to map them to bring in same scale?

SWAT-  
HRU

ABM-  
CLU

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



**HRU CLU conversion algorithm**

Algorithm  
 $\text{New HRU Index} = \text{Old HRU Index} * B + \text{CLU Index}$ ; where B equals to 10 here

# Prototype Clear Creek IDW

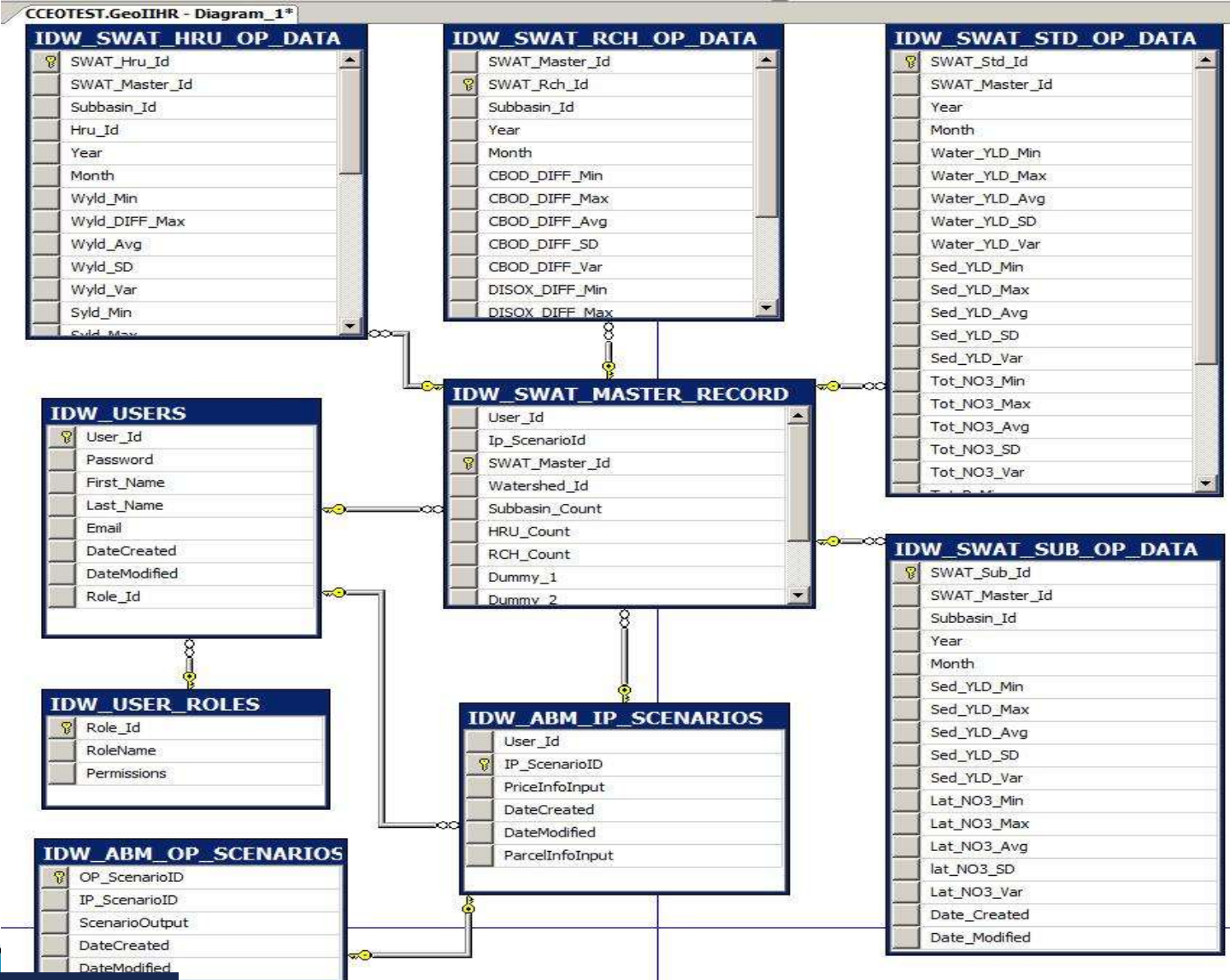
The screenshot displays the 'Clear Creek Digital Watershed' web application. The top navigation bar includes the IHR logo, the title 'Clear Creek Digital Watershed', and the CUAHSI logo. Below the navigation bar is a map of the 'Clear Creek Watershed' with various geographical features and markers. A green box labeled 'Scenario selection' is positioned above the map. Below the map is a navigation menu with options: Login, Home, ABM Process, CLU-HRU Transformation, and Run SWAT. The 'ABM Process' section is highlighted, showing the 'Agent Based Model (ABM) Process' interface. This interface includes a 'Select Scenario' section with radio buttons for Market, Policy, and Climate. The 'Policy' option is selected. To the right, the 'Scenario Values' section has dropdown menus for 'M1 (Market)', 'P1 (Policy)', and 'C1 (Climate)'. Below this is the 'ABM Simulation Input Files' section with two file input fields: '1. Price Info File:' and '2. Parcel Info File:', each with a 'Browse...' button. A 'Process-ABM' button is located at the bottom of the form. A large blue arrow points from the 'ABM Process' section back to the map. The bottom of the page features logos for NSF, The University of Iowa, and the 2011 SWAT logo.

Scenario selection





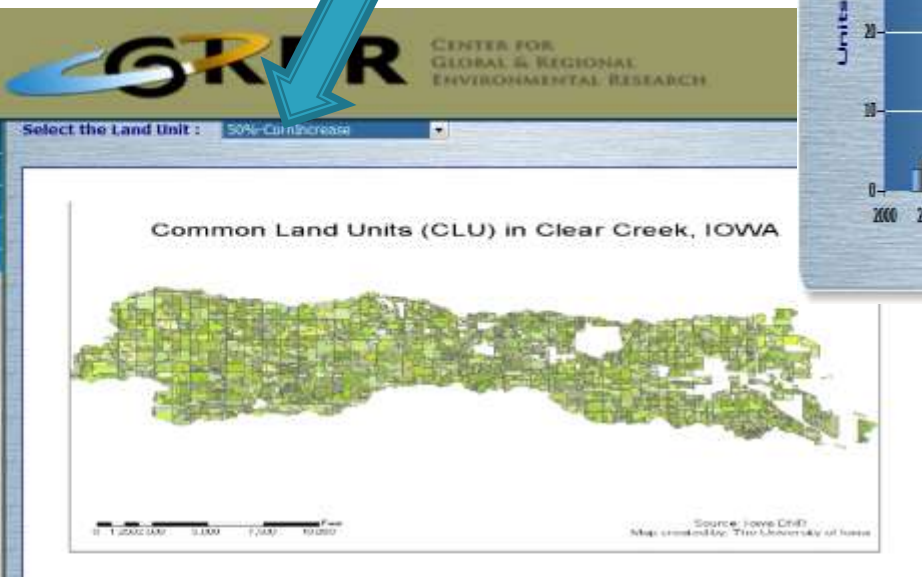
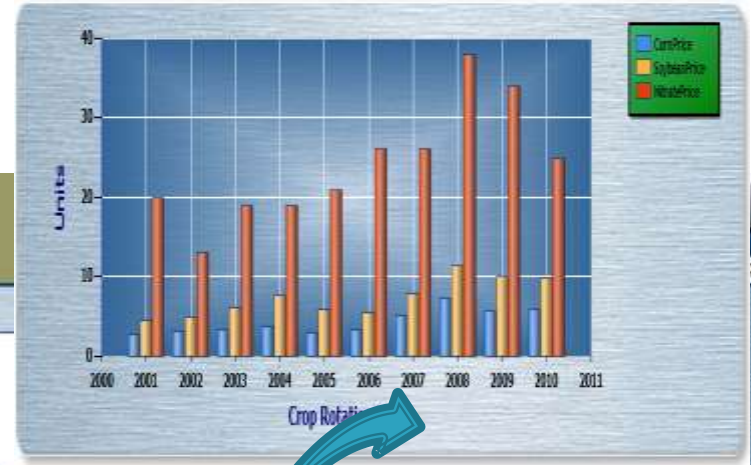
# ModelBase schema:





# Visualization in IDW: Market scenario

Choose price year



- Login
- Agent Based Process
- CLU-HRUTransformation
- Run-SWAT
- Results



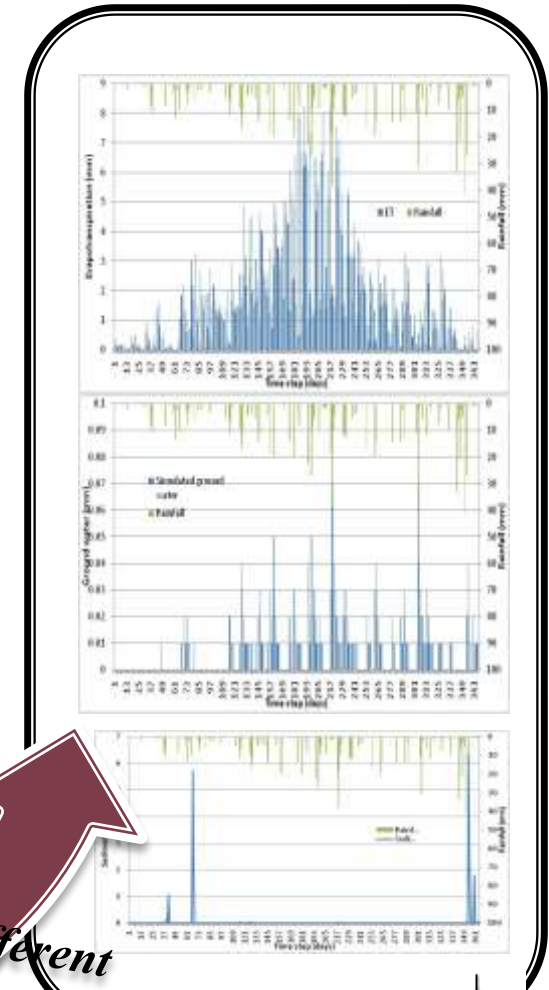
# Multi model simulation steps:

The image displays the 'CLU-HRU Transformation' web interface. The interface includes a navigation menu on the left with options like 'Login', 'Home', 'ABM Process', 'CLU-HRU Transformation', and 'Run SWAT'. The main content area is titled 'CLU-HRU Transformation' and features a dropdown menu for 'Select the SWAT Simulation:' with options 'Base Case - 21 HRU', 'Base Case - 21 HRU', and 'User Defined Case'. Below this are four 'Upload Input SWA' sections: '1. HRU ASCII File:', '2. CLU ASCII File:', '3. CLU SLOPE File:', and '4. SWAT Input Directory:', each with a 'Browse...' button. A 'Process-HRUReconfig' button is at the bottom. A red arrow points from the dropdown menu to a map of a watershed. A blue arrow points from the 'Output from ABM run' text to a map of the same watershed showing land use with a legend for 'corn' (orange) and 'soy' (green). The map includes a north arrow and a scale bar from 0 to 8 miles. Logos for The University of Iowa, GKER, and IIHR are visible at the top.

Output from  
ABM run

# Multimodel simulation and Visualization:

UserID	ScenarioType	Scenarios in Waiting Queue	Select Scenario
ID1/00001	ScenarioType	0995cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00002	ScenarioType	0775cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00003	ScenarioType	0995cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00004	ScenarioType	0775cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00005	ScenarioType	0995cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00006	ScenarioType	0775cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00007	ScenarioType	0995cf-444b5d-000aaa-03488f	<input type="checkbox"/>
ID1/00008	Climate	0775cf-444b5d-000aaa-03488f	<input type="checkbox"/>



*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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