SWAT2009_LUC: A TOOL TO ACTIVATE LAND USE CHANGE MODULE IN SWAT 2009

Naresh Pai

Dharmendra Saraswat

Department of Biological & Agricultural Engineering

Presented at:

2011 SWAT

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

UofA UNIVERSITY OF ARKANSAS DIVISION OF AGRICULTURE

Cooperative Extension Service

BACKGROUND

- Simulate impact of soil, land use, and management activities on water quantity and quality[1]
- Past studies mostly relied on "snapshot" approach for characterizing **land use in watersheds** for the entire study period
- Temporal land use changes have direct impact on hydrology, sedimentation, and nutrient losses[2]

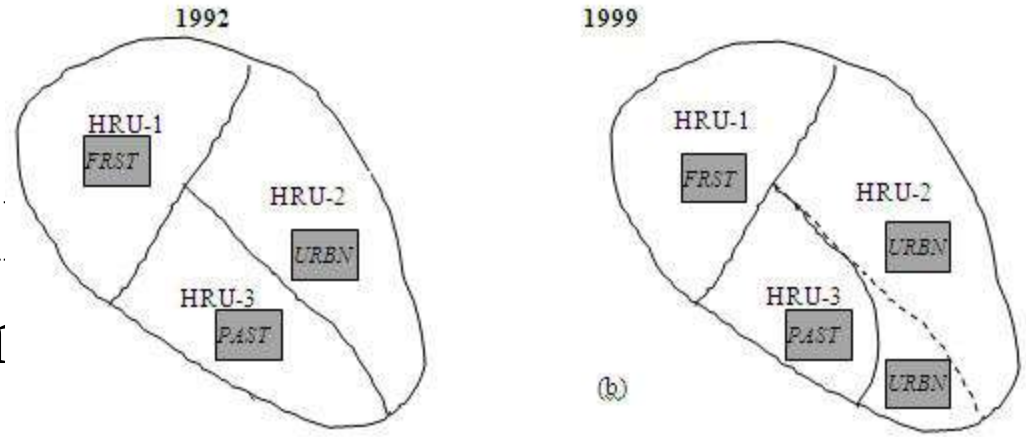
- A **single land use dataset is therefore not a** reasonable representation of watershed processes

[1]Frankenberger (2011)

[2]Miller et al. (2002), Ahearn et al. (2005), Ouyang et al. (2010)

BACKGROUND……..

- SWAT 2009: released January 2010
- New module: land use change (LUC)*{LUU}
- Distribution of existing land use could be varied AT ANY TIME DURING the model run
- Manua ion is time consun



*Arnold et al. (2010)

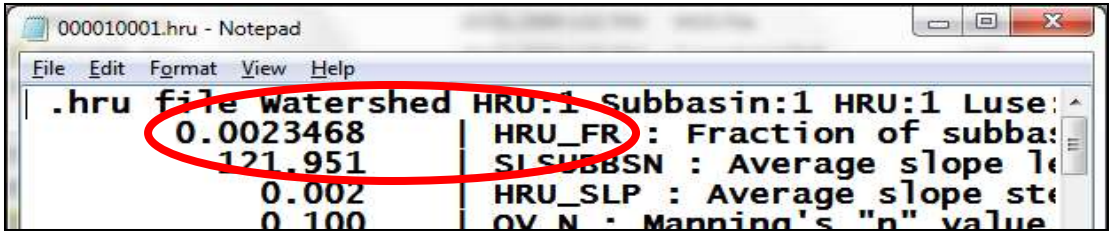
OBJECTIVES

1. Develop a Graphical User Interface (GUI) for a desktop based, stand-alone tool to activate LUC (LUU) module in SWAT 2009

2. Assess the performance by comparing LUC tool's output with input land use data

LUC MODULE CONCEPT

- **Assumption**: SWAT model for the project area has been created
- **HRU**: unique combination of land use, soil, and slope within a subbasin
- Fractional area of an existing HRU is represented by HRU_FR variable in *.hru files



- LUC module operates by updating HRU_FR variable as many times as the number of temporal land use data layers are input in the model
- Constraints: 1) HRUs can't be added or deleted
  2) Sum of HRU_FR for each subbasin = 1

LUC MODULE: CHALLENGE

- Depending on watershed size, threshold decision, and heterogeneity

1. Numerous HRUs: few 100's to 1000's
   LS (4) * ST (10) * SC (4) = 160 – computational time

2. Fragmented HRUs: Single HRU could consist of multiple islands[#]

Mapping challenge

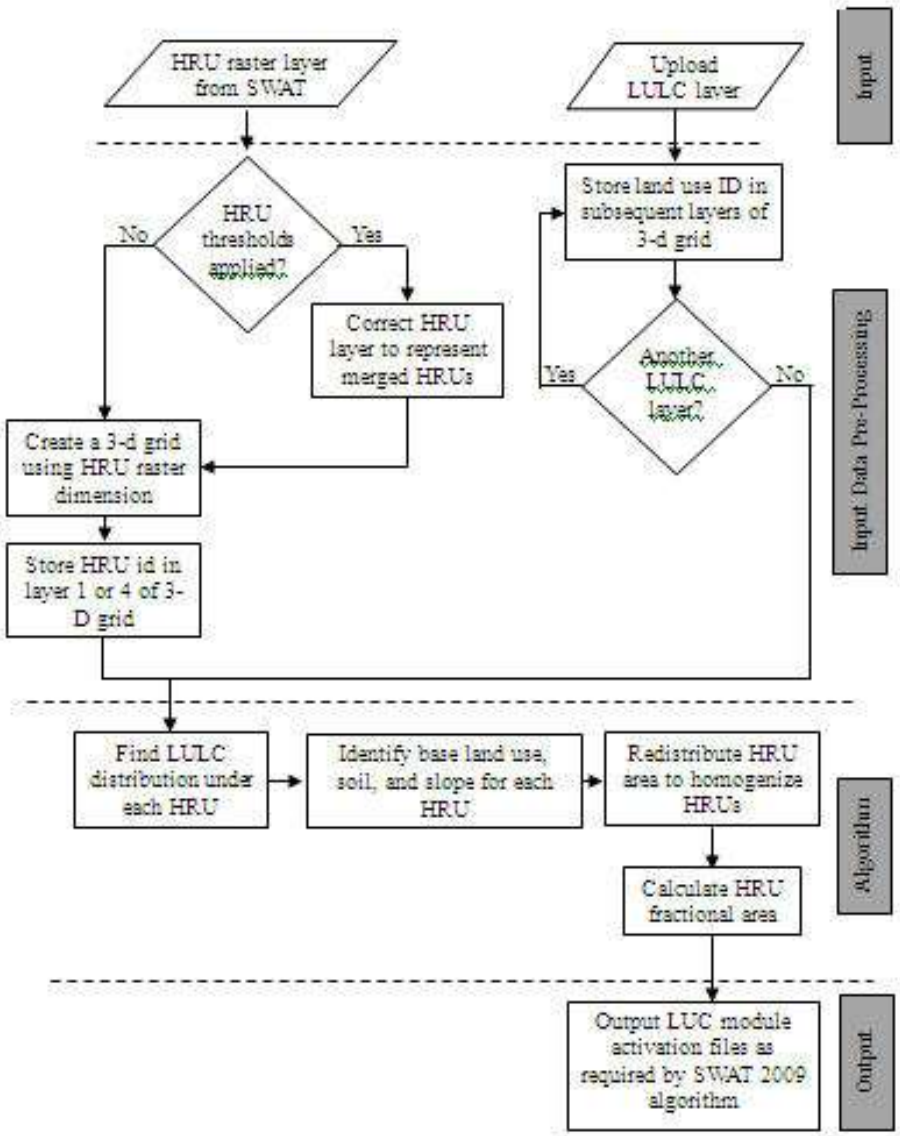
Fragmented HRU

Regular LULC raster grid

3. Area under all HRUs require- labor and time (hrus1.rrd)

[#]Pai et al. (2011; in review)

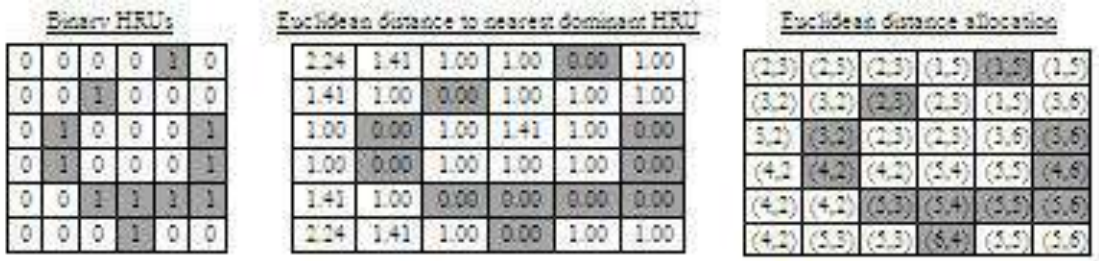
LUC MODULE: FLOW CHART



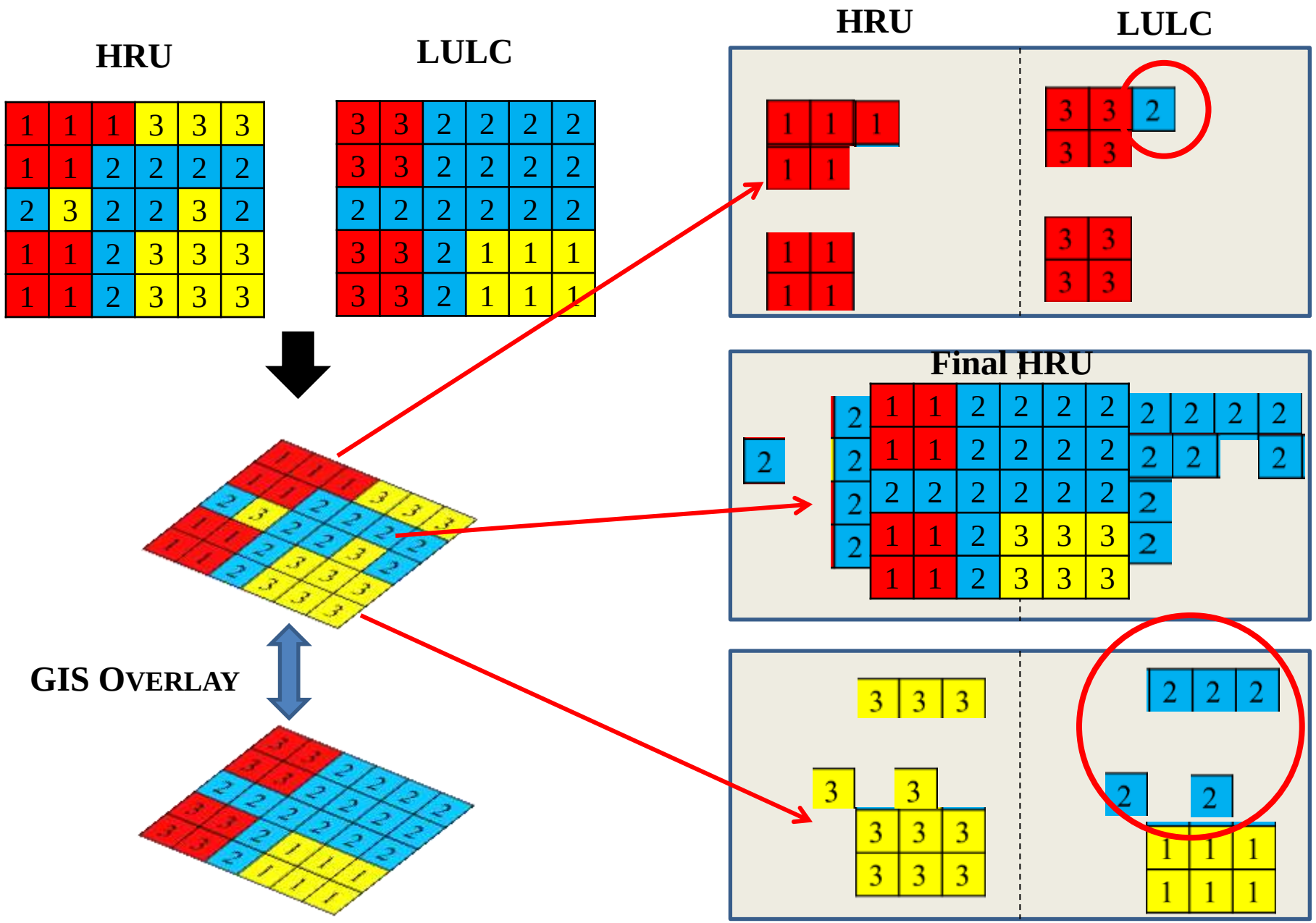
HRU - LULC Mapping

Input Processing

- For ***non-threshold SWAT models***: use 0-0-0 HRU raster that includes all unique combinations of land use, soil, and slope (hrus1.rrd)
- For ***SWAT models created using threshold***: post process non-dominant **(ND)** HRUs with nearest dominant **(D)** HRUs in 0-0-0 raster using Euclidean distance allocation method*

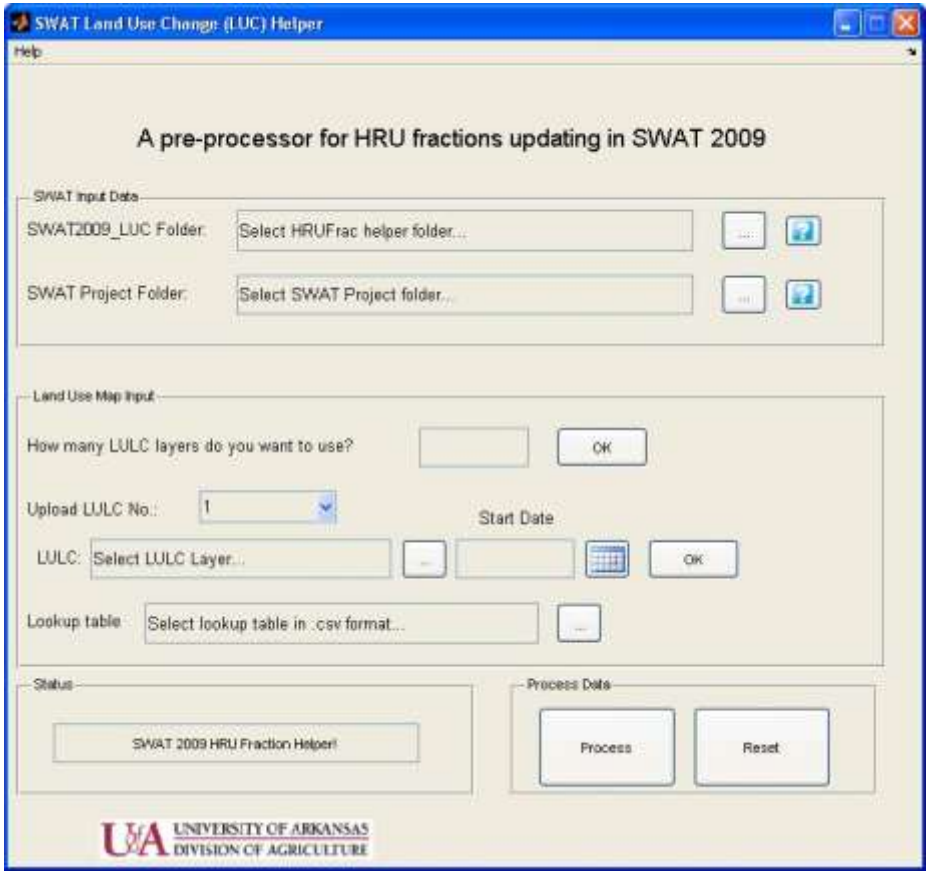


HRU – LULC Mapping



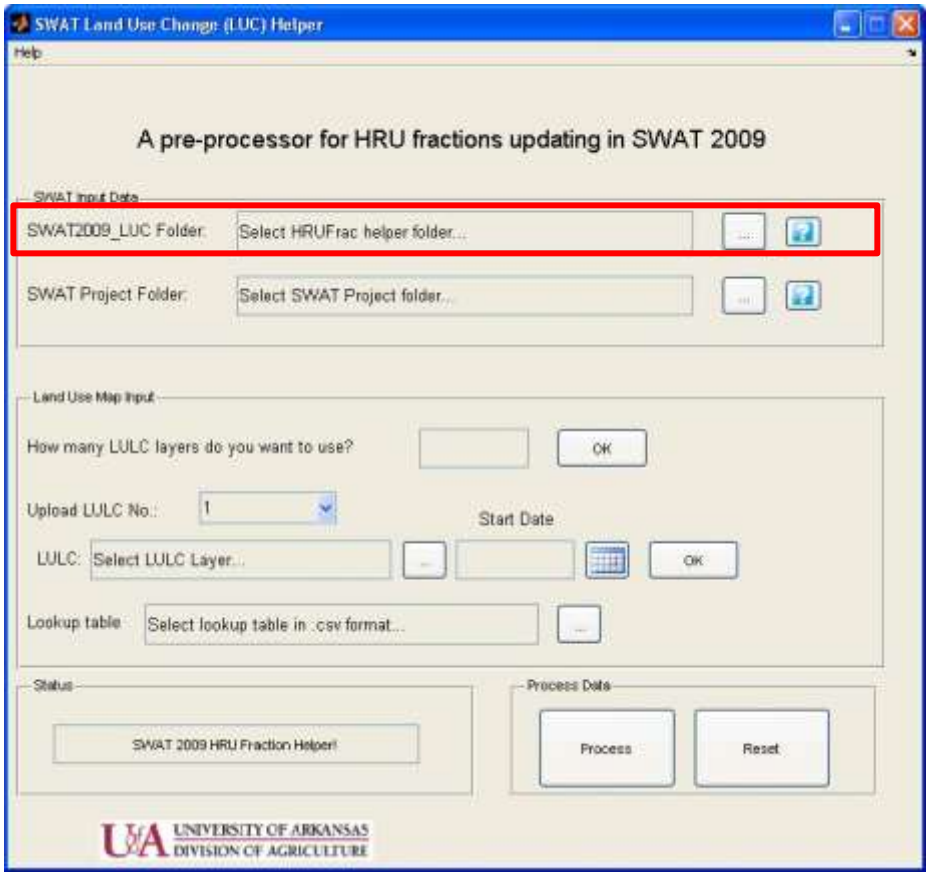
SWAT2009_LUC TOOL

- GUI for activating LUC module developed
- Ingests multiple land use layers interactively
- Interacts with SWAT project folder
- Output: lup.dat, file1.dat, file2.dat,….
- Projection is **important**



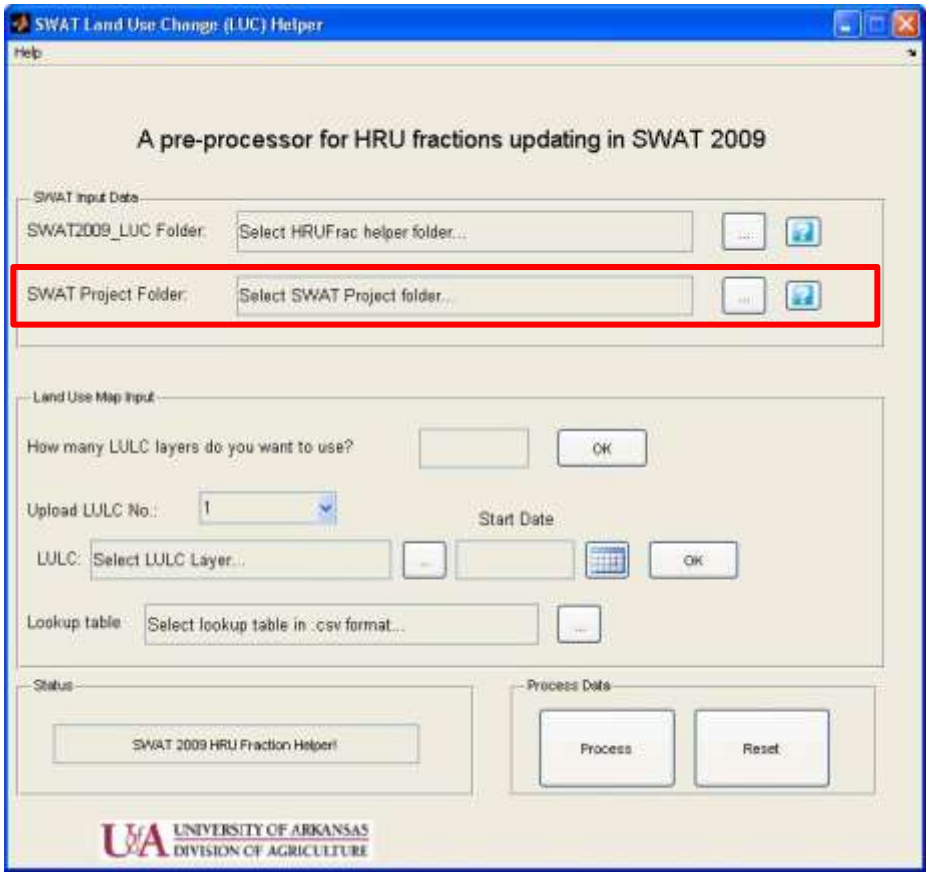
SWAT2009_LUC TOOL

- **Step 1**: Identify SWAT2009_LUC folder
- Note: buttons sequentially enabled
- Create sub-folders:
  - Shape
  - Raster
  - Output
- Store:
  - hru1.shp
  - hrus1.rrd
  - lup.dat, fileX.dat



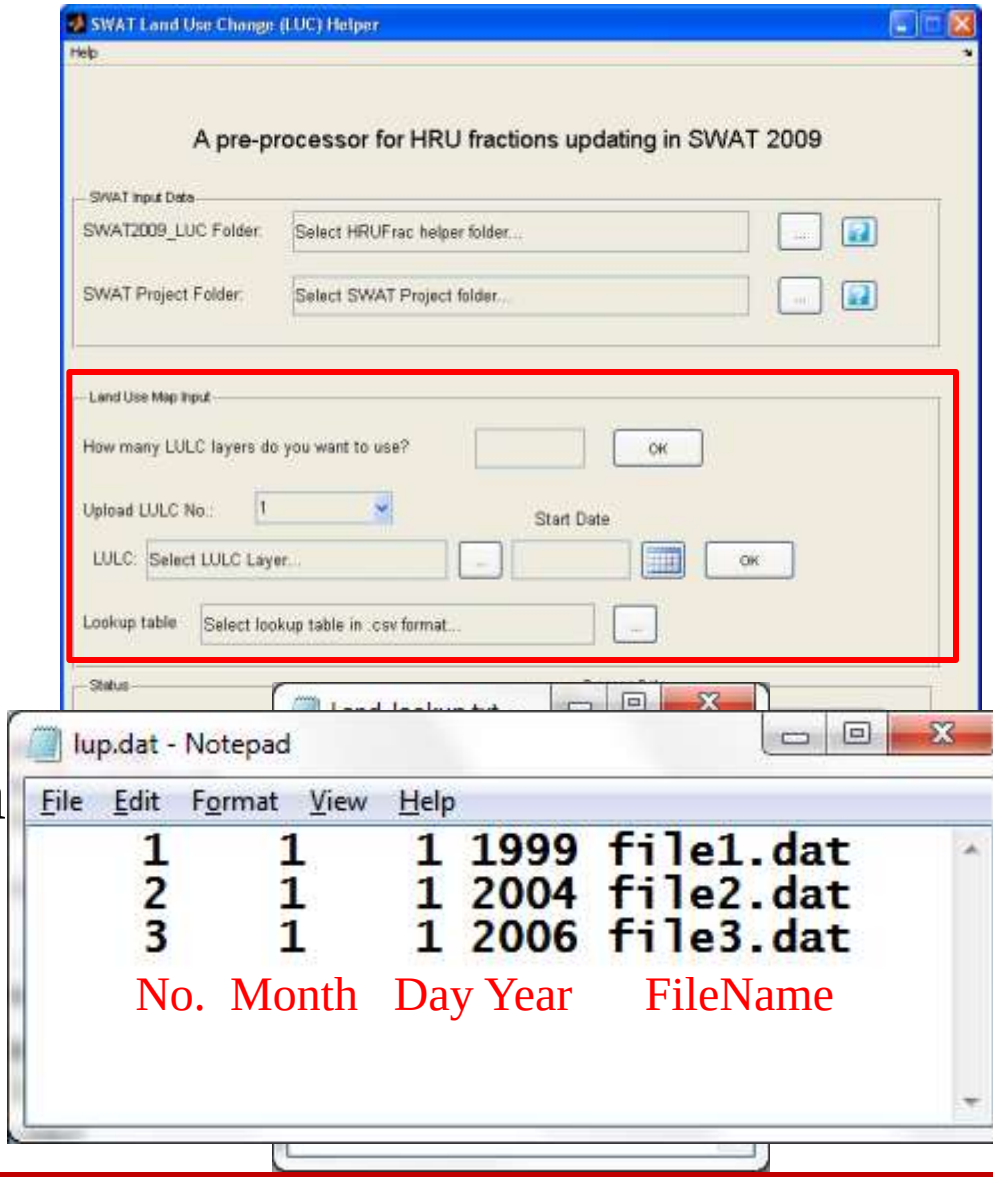
SWAT2009_LUC TOOL

- **Step 2**: Identify SWAT project folder
- Copy hrus1.rrd (from Watershed/Grid folder) in Raster folder
- Copy hru1.shp (from Watershed/Shapes folder) in Shape folder *(to identify HRUs that passed the threshold)*
- Post-process hrus1.rrd *(for thresholded projects only using Euclidean Allocation method)*



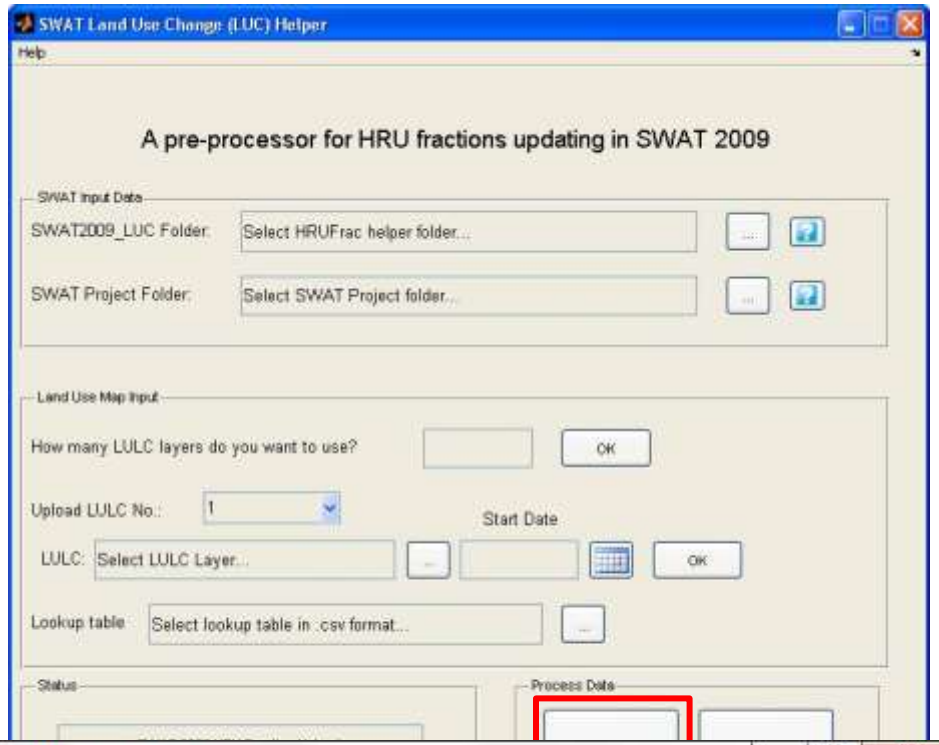
SWAT2009_LUC TOOL

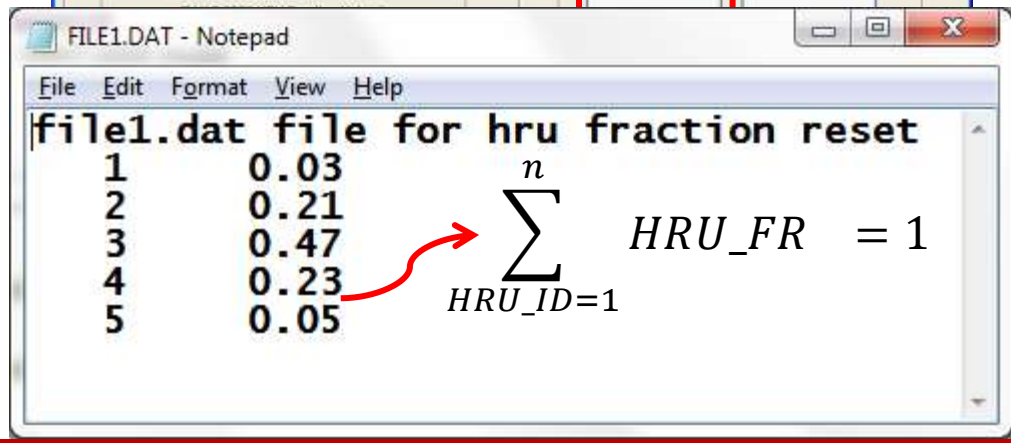
- **Step 3**: Upload LULC data and starting dates
- Use starting dates to create **lup.dat** and store in Output folder
- Upload lookup table to connect land use map with SWAT four-alphabet code



SWAT2009_LUC TOOL

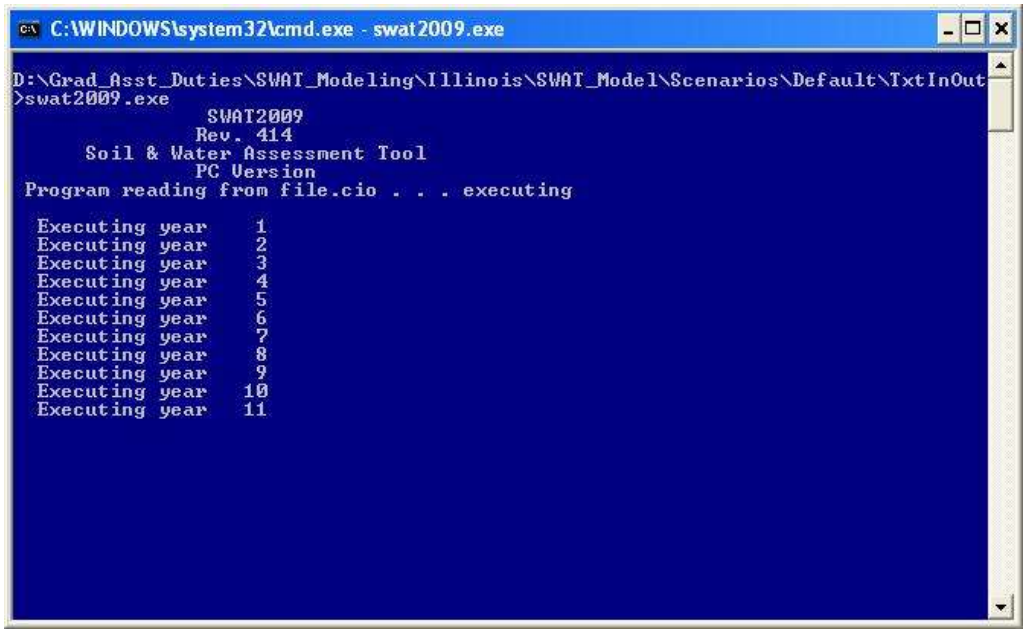
- **Step 4**: Hit **Process** button
- Identify base LULC for each HRU using *.hru files
- Re-classify HRU ids based on LULCs that are not part of base HRU definition
- Re-calculate HRU_FR and output in fileX.dat in Output folder
- Copy lup.dat, file1.dat, file2.dat, … to TxtInOut to **activate LUC module**

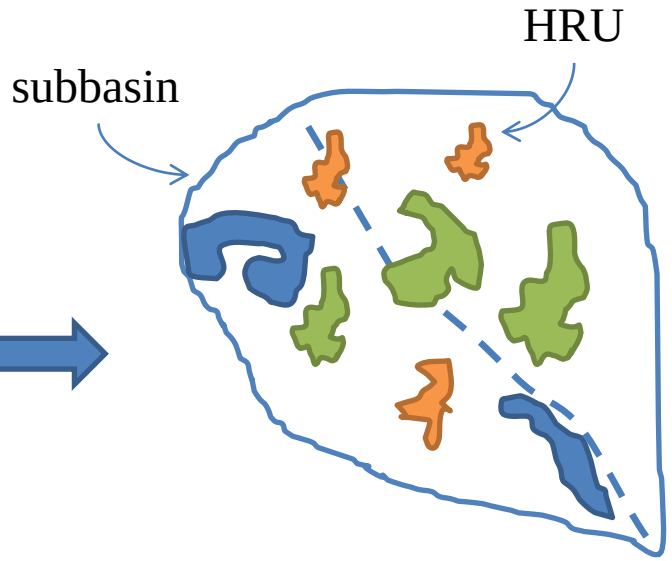




LUC Module Working

SWAT2009
Model run 1998 - 2008





Case Study: Illinois River Watershed

Drainage area: 1,963 km^2

Subbasins: 27

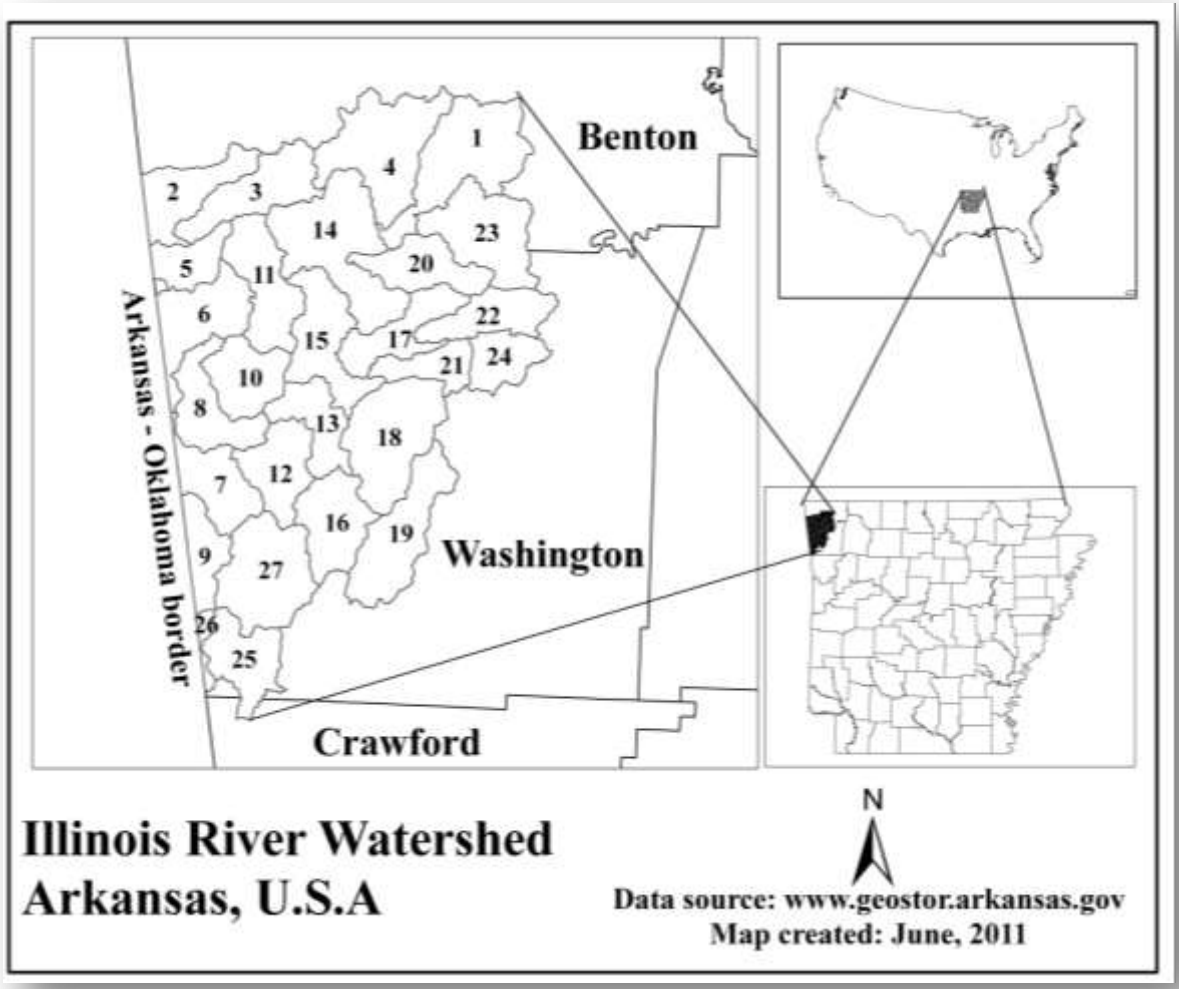
LULC: 2006

Soil: SSURGO

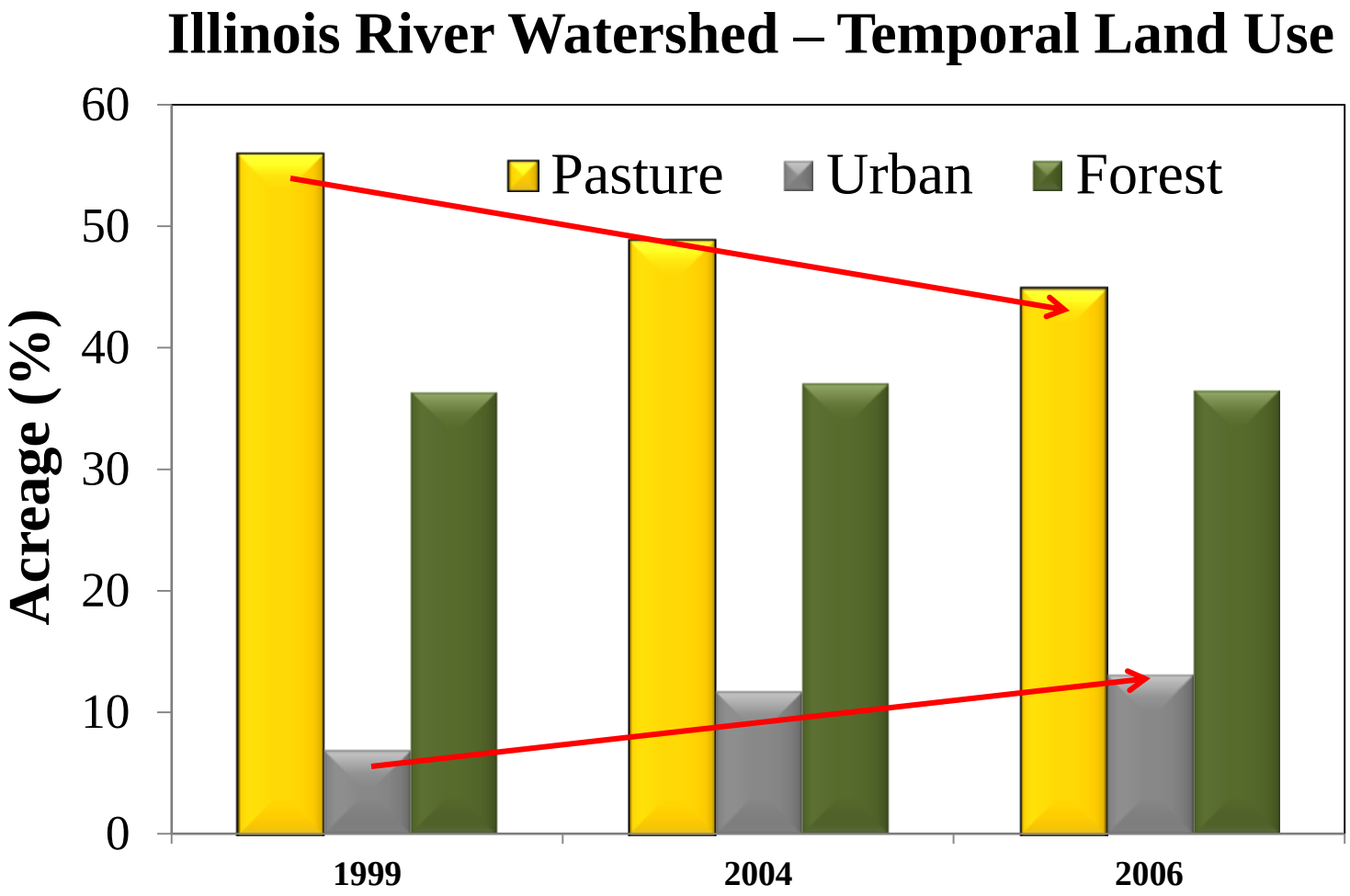
Slope: 4 classes

HRUs: 1,126
(Thresholds: 5%, 10%, 0%)

Study period: 1999 - 2006

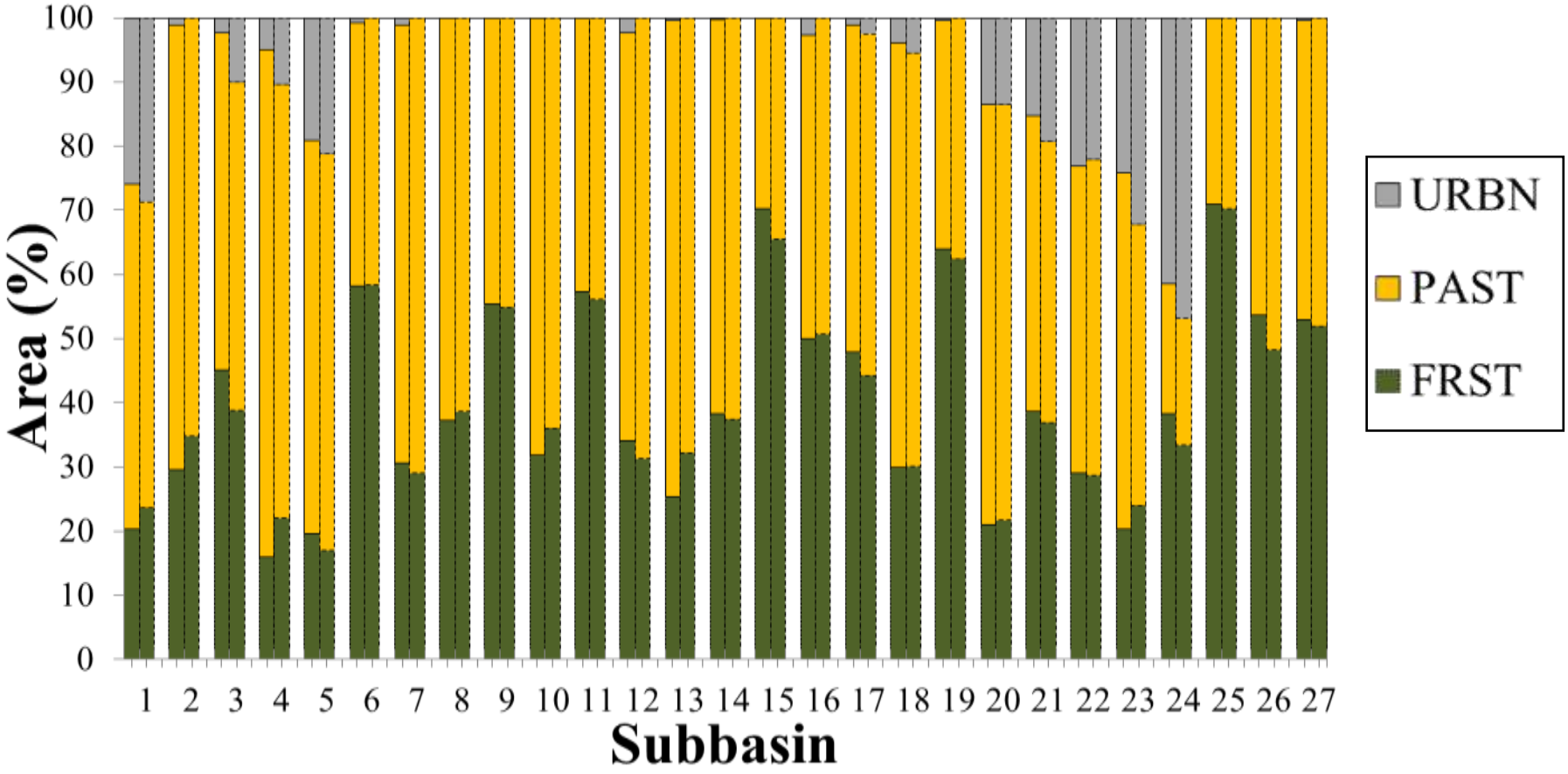


Land Use Change



RESULTS – TOOL PERFORMANCE

- ✓ Land use calculated by SWAT2009_LUC closely matched LULC layer for all years



CONCLUSIONS

- ✓ Objective 1: SWAT2009_LUC, a GUI driven, desktop-based tool was developed to activate the LUC module in SWAT 2009
- ✓ Objective 2: LUC module output was comparable to actual LULC data
- ✓ Tool useful for modelers wanting to evaluate impact of land use change (LUU)

ACKNOWLEDGEMENTS

Financial support: Arkansas Natural Resources Commission (ANRC)

Purdue: Dr. Indrajeet Chaubey and his team, Purdue University

ArcSWAT technical support: Dr. Raghavan Srinivasan, Texas A & M University

SWAT Team: Jeff Arnold, Mike White and Nancy Simons at USDA-ARS, Temple, TX

QUESTIONS

Dr. Dharmendra Saraswat

Assistant Professor - GeoSpatial
Department of Biological & Agricultural Engineering
University of Arkansas

Email: dsaraswat@uaex.edu

Website: http://baegrisk.ddns.uark.edu/geospatial