LUU_CHECKER:
A Tool for Dynamically Incorporating New Land Uses in SWAT

Gurdeep Singh
Ph.D. Candidate
University of Arkansas

Dharmendra Saraswat
Associate Professor
Purdue University

Dr. Naresh Pai, former Ph.D. Student and Post-Doc Scholar (for developing the initial desktop version)

Mouli Koppolu, former GRA, and
Ben Hancock, Staff Member, Geospatial group (for helping with the cloud version)

Financial Support Agency

# Develop cloud-based tools to dynamically account for temporal evolution of complex landscape

Temporal land use land cover (LULC) changes have direct impact on evapotranspiration, surface runoff, and groundwater.*

Model's ability to simulate water quality impacts of temporal LULC changes can be limited by the usage of a single LULC data layer over the modeling period.**

*Pai and Saraswat, 2011
**Chiang et al., 2010
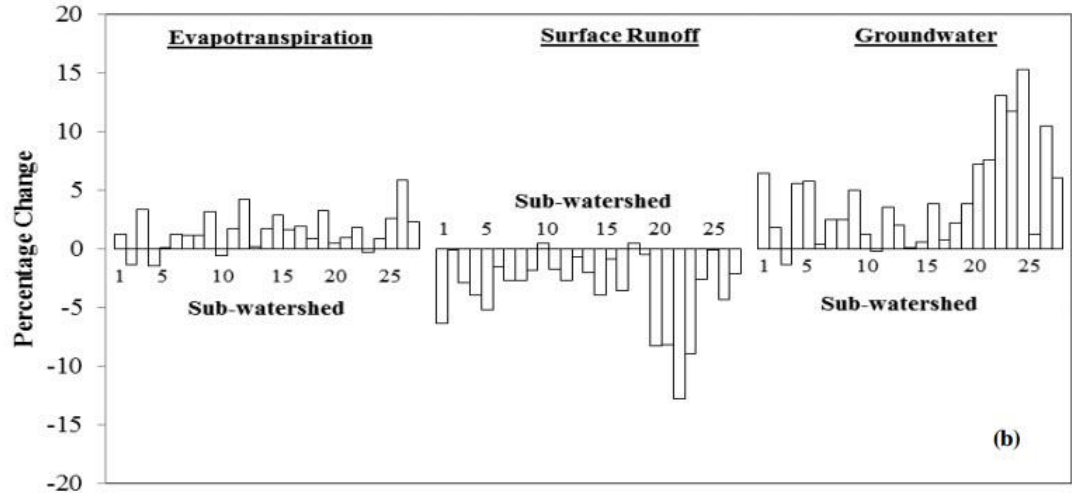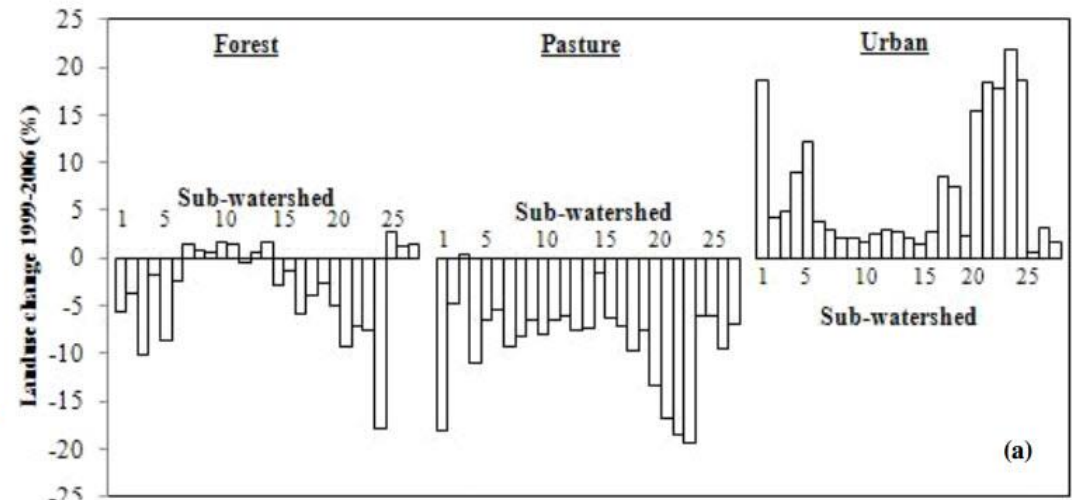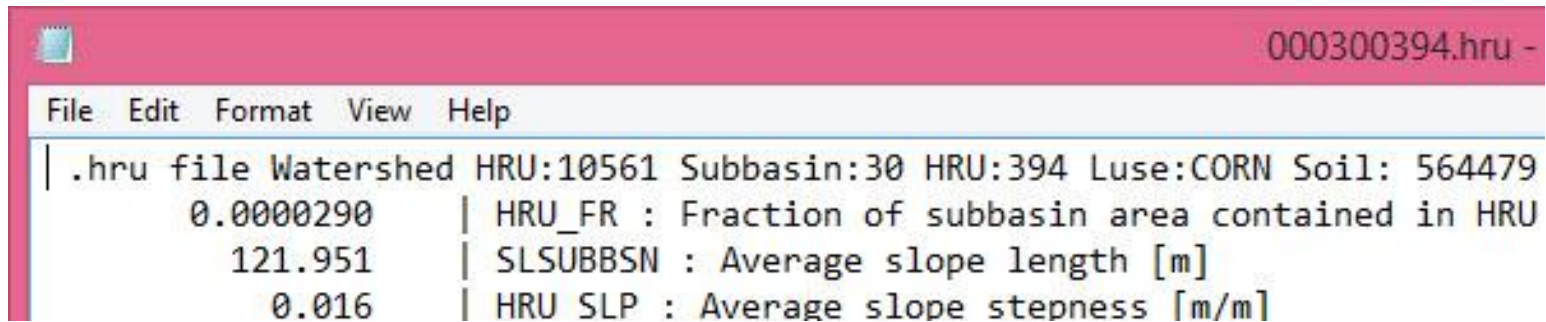
In watersheds where land-use has changed during study period, it is important to incorporate that information within the SWAT model before simulating various processes.

- Land-use update (LUU) module has been part of SWAT model since SWAT2009 release*.

- HRU_FR variable gets updated as per the number of temporal land use data layers that are input in the model.
- HRUs cannot be added or deleted.
- Sum of HRU_FR for each subbasin = 1.
- Base map data is needed for initiation

*Pai and Saraswat, 2011

.dat files

lup.dat - Notepad

No.	Month	Day	Year	FileName
1	1	1	1999	file1.dat
2	1	1	2004	file2.dat
3	1	1	2006	file3.dat

FILE1.DAT - Notepad

file1.dat file for hru fraction reset

1	0.03
2	0.21
3	0.47
4	0.23
5	0.05

$$\sum_{HRU\_ID=1}^{n} HRU\_FR = 1$$

SWAT 2015

INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

PURDUE UNIVERSITY

Land-use layer1		Land-use layer2	
(6 land uses and 3 soils)		**(6 land uses and 3 soils)**	
Subbasin 1	Subbasin 2	Subbasin 1	Subbasin 2
HRUs	HRUs	HRUs	HRUs
1 lu 1 – soil 1	1 lu 4 – soil 1	1 lu 1 – soil 1	1 lu 4 – soil 1
2 lu 2 – soil 2	2 lu 5 – soil 2	2 lu 2 – soil 2	2 lu 5 – soil 2
3 lu 3 – soil 3	3 lu 6 – soil 3	3 lu 3 – soil 3	3 lu 6 – soil 3
4 lu 4 – soil 1	**4 lu 1 – soil 3**	4 lu 4 – soil 1	
		5 lu 5 – soil 2	
		6 lu 6 – soil 3	
Subbasin 3	Subbasin 4	Subbasin 3	Subbasin 4
HRUs	HRUs	HRUs	HRUs
1 lu 1 – soil 3	1 lu 4 – soil 3	1 lu 1 – soil 3	1 lu 4 – soil 3
2 lu 2 – soil 2	2 lu 5 – soil 2	2 lu 2 – soil 2	2 lu 5 – soil 2
3 lu 3 – soil 1	**3 lu 6 – soil 1**	3 lu 3 – soil 1	

- Land-use layer 1 - base layer for HRU delineation
- Land-use layer 2 - updating HRU fractions
- New land-uses 5 and 6 in subbasin 1 will not get simulated

- Land-use 2 - base layer for HRU delineation
- Land-use 1 - updating HRU fractions
- Land-use 1 in subbasin 2 and landuse 6 in subbasin 4 will not get simulated.

Numbers represent index in array. Colors represent lulc.

Base LULC (Subbasin1)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Base LULCs

New LULC (Subbasin1)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

New LULCs

Compare LULCs

Identify new LULCs

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SWAT 2015
INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

PURDUE
UNIVERSITY

CONCEPT

Numbers represent index in array. Colors represent lulc.

New LULCs

Reclassify

Base LULC (Subbasin1)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Shuffle indices →

Copy of Base LULC (Subbasin1)

16	22	19	25	10
14	13	17	8	23
4	7	20	5	2
24	15	1	11	3
12	18	21	6	9

Reorder indices →

Composite LULC

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Calculate number of cells to be reclassified to the new LULC

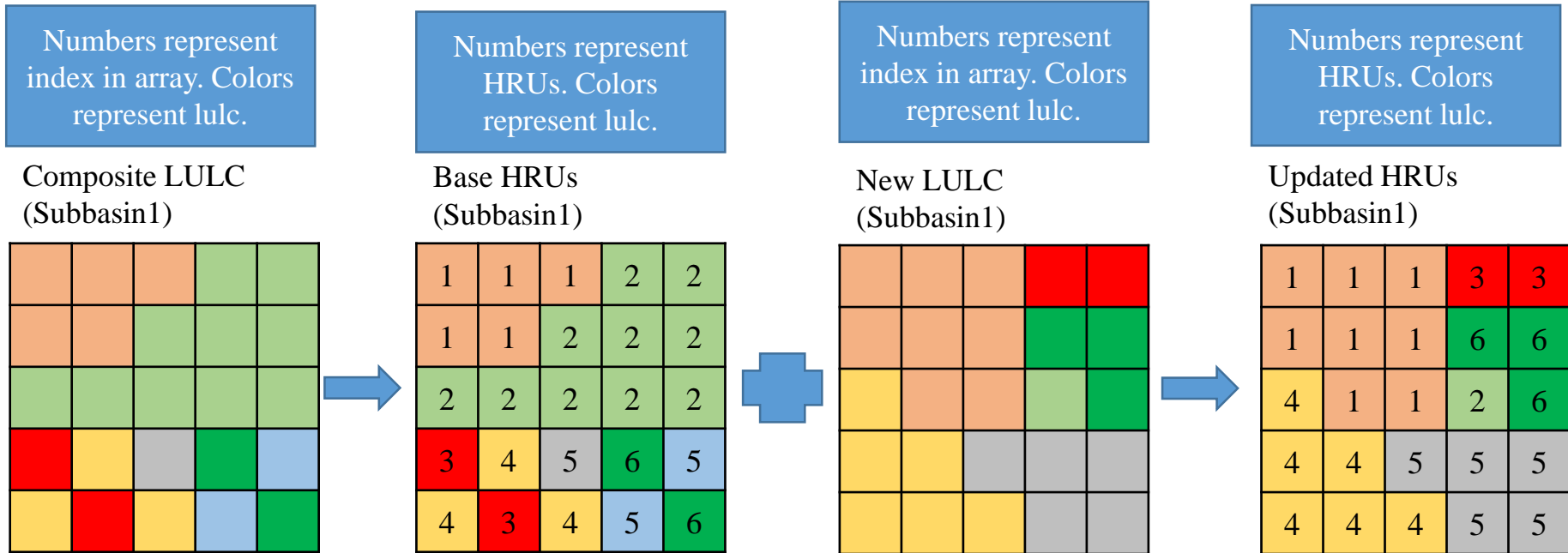| User Provided Percentage	✕	Subbasin Size	=	Number of cells to reclassify as new LULC

Repeat for each new lulc

8%	✕	25	=	2

U of A — DIVISION OF AGRICULTURE — RESEARCH & EXTENSION — University of Arkansas System

PURDUE UNIVERSITY

Emerging LULC Report

- LULC 1977 (12 landuses) and LULC 2005 (13 landuses)

```
/srv/SWAT/ALLFOLDERS/gsindia.singh@gmail.com/LUCCHECKER

Subbasin 1
[ 6 13]

Subbasin 2
[6]

Subbasin 3
[ 6 11]

Subbasin 4
[ 8 10 11]

Subbasin 5
[ 6  8 13]

Subbasin 6
[ 1 10]

Subbasin 7
[4 6]

Subbasin 8
[]

Subbasin 9
[6]

Subbasin 10
[6]
```
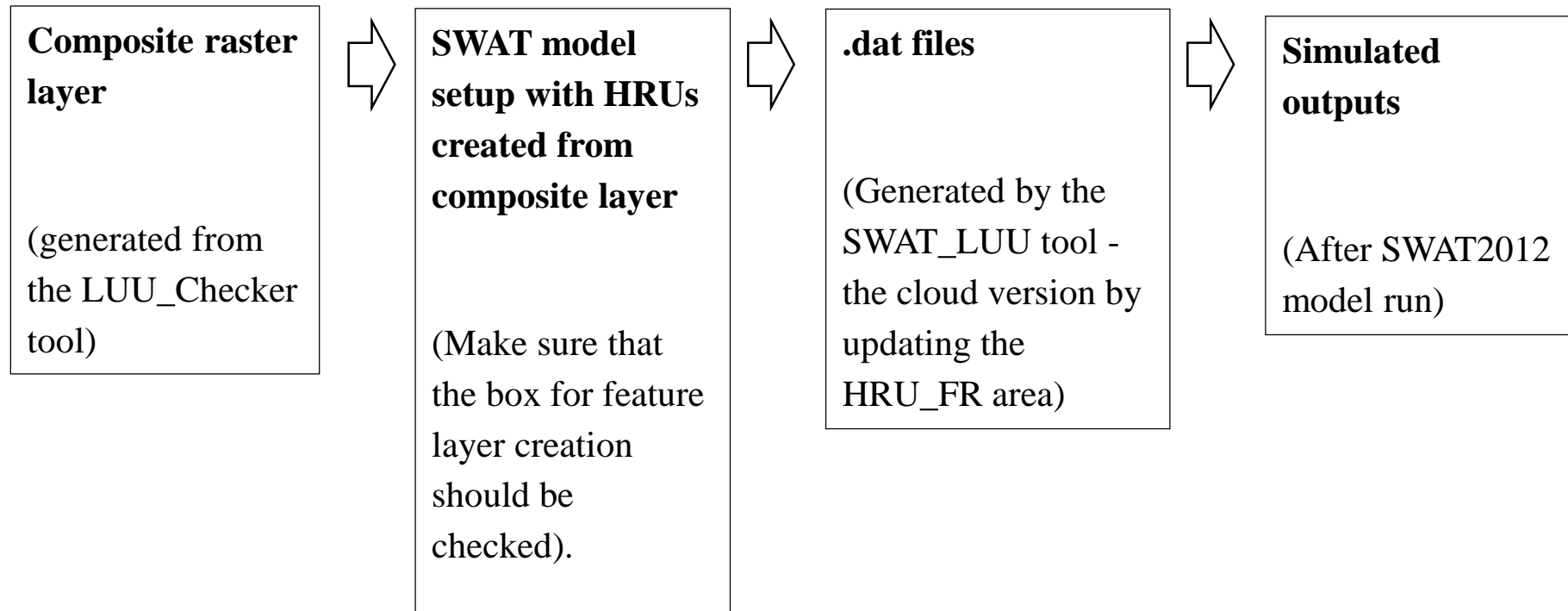
- This report gives the information of the emerging land uses in each subbasin in land use layers.

- Land uses 6 and 13 emerged in subbasin 1 of composite land use layer.

- Both the land uses would not have been simulated with the traditional approach.

- Interesting insight is that the land use 6 was also not present in subbasin 1 of the land use layer 1.

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SWAT 2015
INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

PURDUE
UNIVERSITY

In order to use the LUU Checker tool, the SWAT model setup workflow needs to be revised as follows:

Composite raster layer

(generated from the LUU_Checker tool)

⇨

SWAT model setup with HRUs created from composite layer

(Make sure that the box for feature layer creation should be checked).

⇨

.dat files

(Generated by the SWAT_LUU tool - the cloud version by updating the HRU_FR area)

⇨

Simulated outputs

(After SWAT2012 model run)

SWAT 2015
INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE
PURDUE UNIVERSITY
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

DEMO

Step-1:

Subbasins Shapes Folder:

- Compress the folder containing a subbasin shapefile into a zip format.
- The name of the zip file and shapefile should be same.
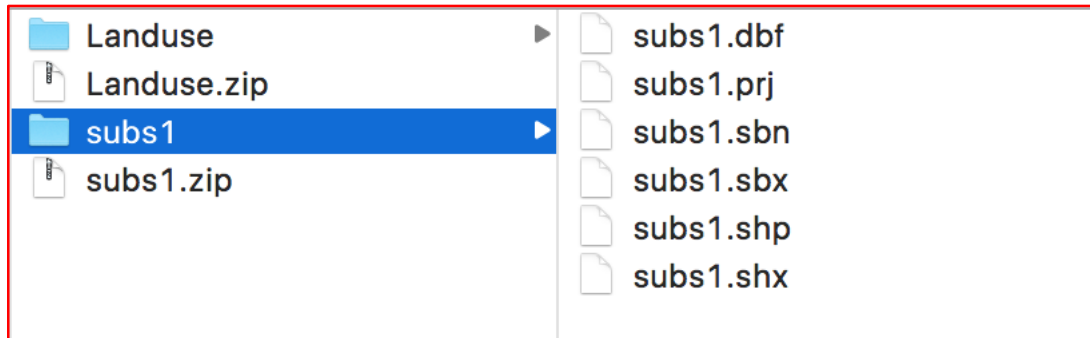
Step-2:

Landuse Folder:

• Compress the landuse folder that contains all the land use files into a zip format and upload.
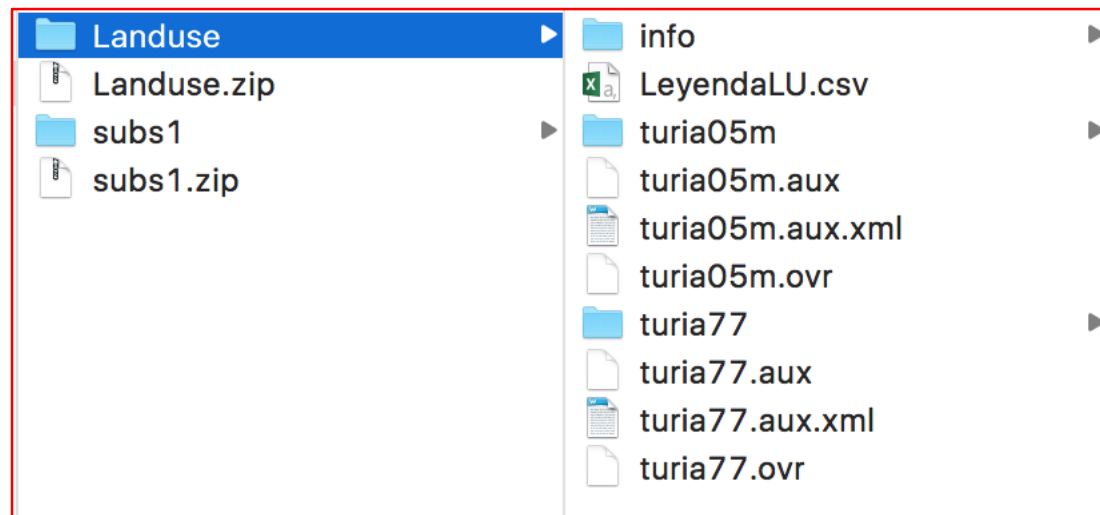
Step-3:

Base Landuse Raster File:
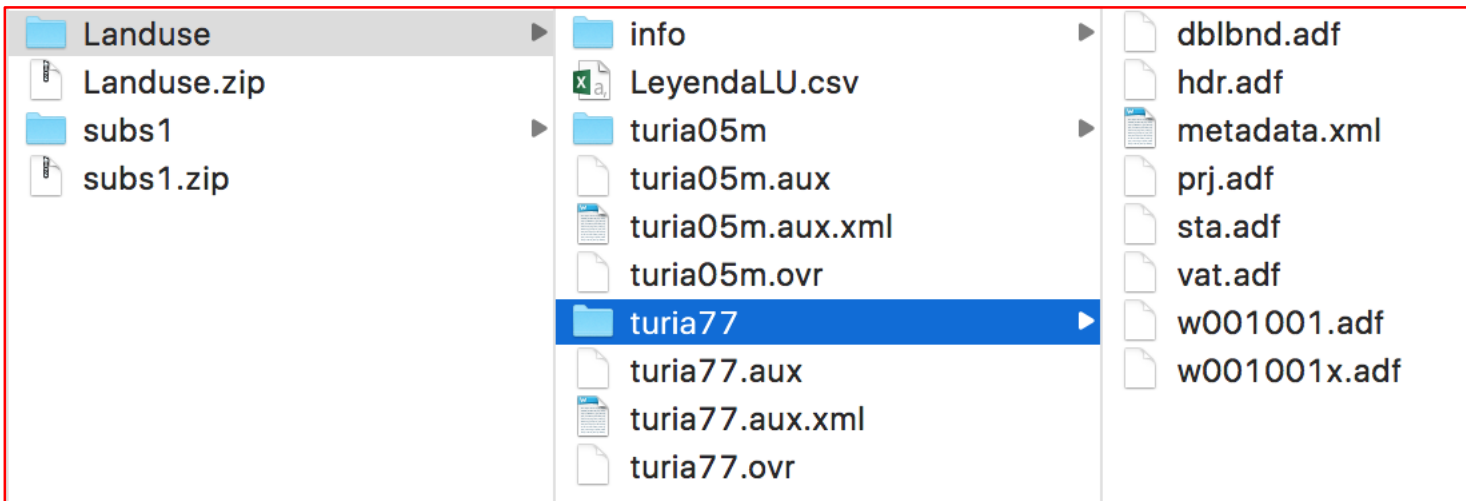
- User can select either the first year (1977) or the latest layer (2005) as the base.

Step-4:

Number of New Landuse Layers:

- Select the number of landuse layers other than the base layer.

- If 2 landuse layers are available and one layer is selected as base layer, then the user should input 1.

Step-5:
New Landuse layers:

- On selecting the number of new landuse layers, a hidden select option will appear depending on the number of new landuse layers provided in the previous step.

- Select the remaining landuse layers.

Step-6:

LULC New Percentage

- Provide the percentage value for new landuses that needs to be updated.

LULC New Percentage:
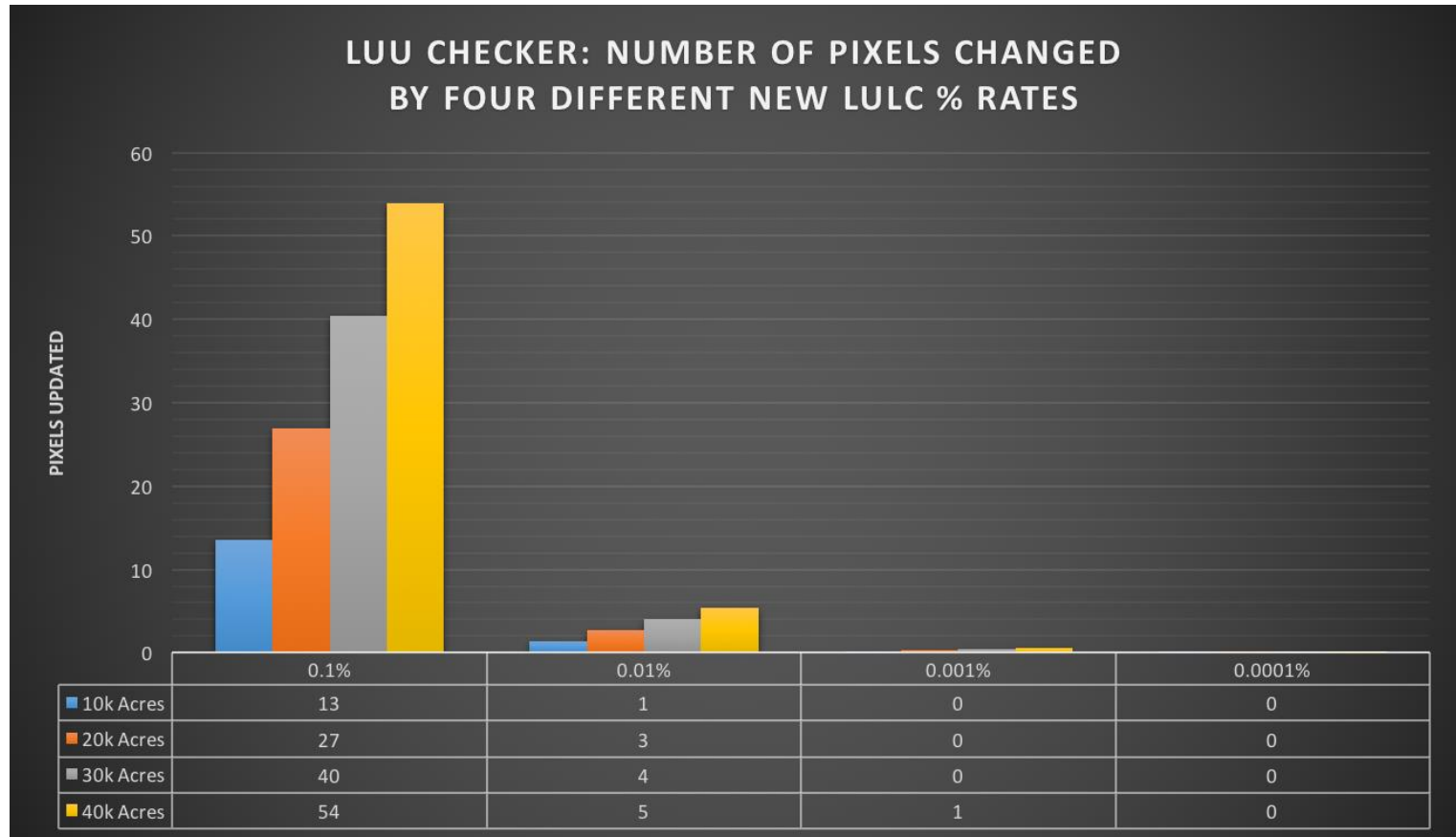
`0.001` **OK** **?**

Warning: Be careful while selecting a percentage threshold value lower than 0.01. In smaller subbasins (<10,000 acres), a threshold value percentage of less than 0.01 may result in 0 pixels being designated to account for emerging landuse/landcover in the composite landuse raster.

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SWAT 2015
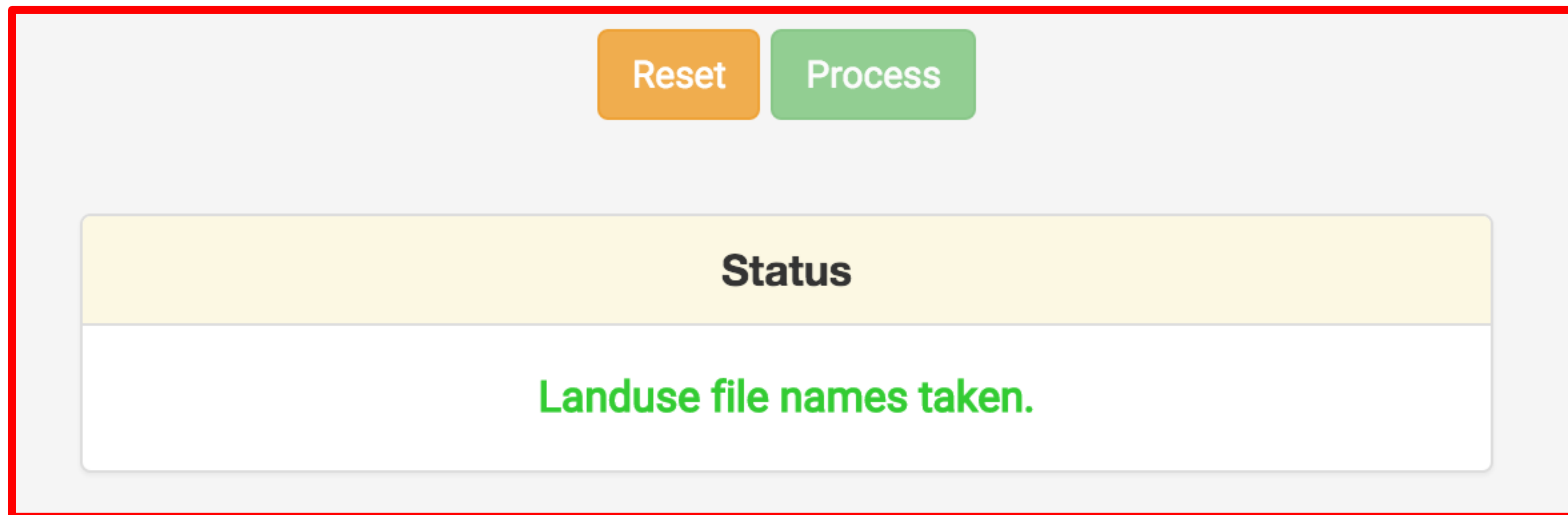INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

PURDUE
UNIVERSITY

Step-6:
LULC New Percentage- a Scenario

Step-7:

Process:

- After uploading all the required files, the tool is ready to process the files.

- The program runs on the server and creates a new composite raster in GeoTiff format.

- LUU_Checker, a cloud based tool, to dynamically account for temporal evolution of complex landscape has been developed.

- The composite raster data layer, generated by the LUU_Checker tool, creates HRUs with all the possible land uses present in different temporal land use layers.

- Eventually, the SWAT model and temporal land uses are input in the SWAT_LUU tool to update the HRU area corresponding to temporal land use layers.

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

SWAT 2015
INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

PURDUE
UNIVERSITY

LUU_Checker

http://130.184.161.242:17777/tool_selection

Email: saraswat@purdue.edu