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SWAT TOOLS- AN INNOVATIVE INFRASTRUCTURE FOR WATERSHED MODELERS

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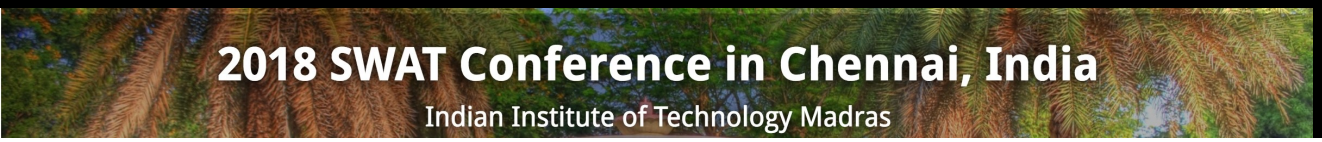

January 12, 2018

QUIZ

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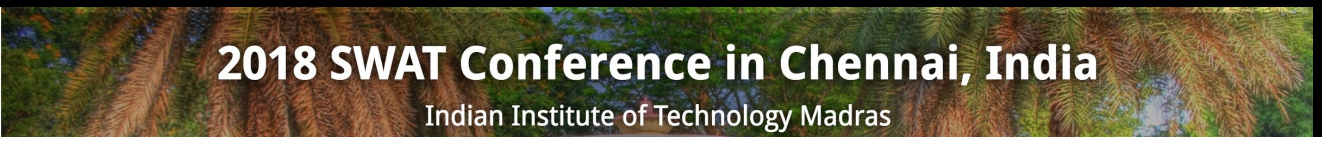
Ownership to SWAT ???
USDA_ARS

Texas A & M University

SARA (COMPLETE) SWAT



January 12, 2018

TAR Principle- A Guide

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Team Work:

GRA: Dr. (s) Naresh Pai and Gurdeep Singh, Mr. Eeshan Kumar and Mr. Mouli Koppolu

Research Staff: Ben Hancock

Acknowledgment: SWAT Tools

2017 ASABE Blue Ribbon Educational Aids Award

Funding- ANRC

Reaching Out: Live User Statistics Availability

https://saraswat-swat.rcac.purdue.edu/infographic

OUTLINE

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How to Access

Background

- Land Use Checker module

- Land Use Update module with a case study

Smart Interface

Conclusion

ACCESS

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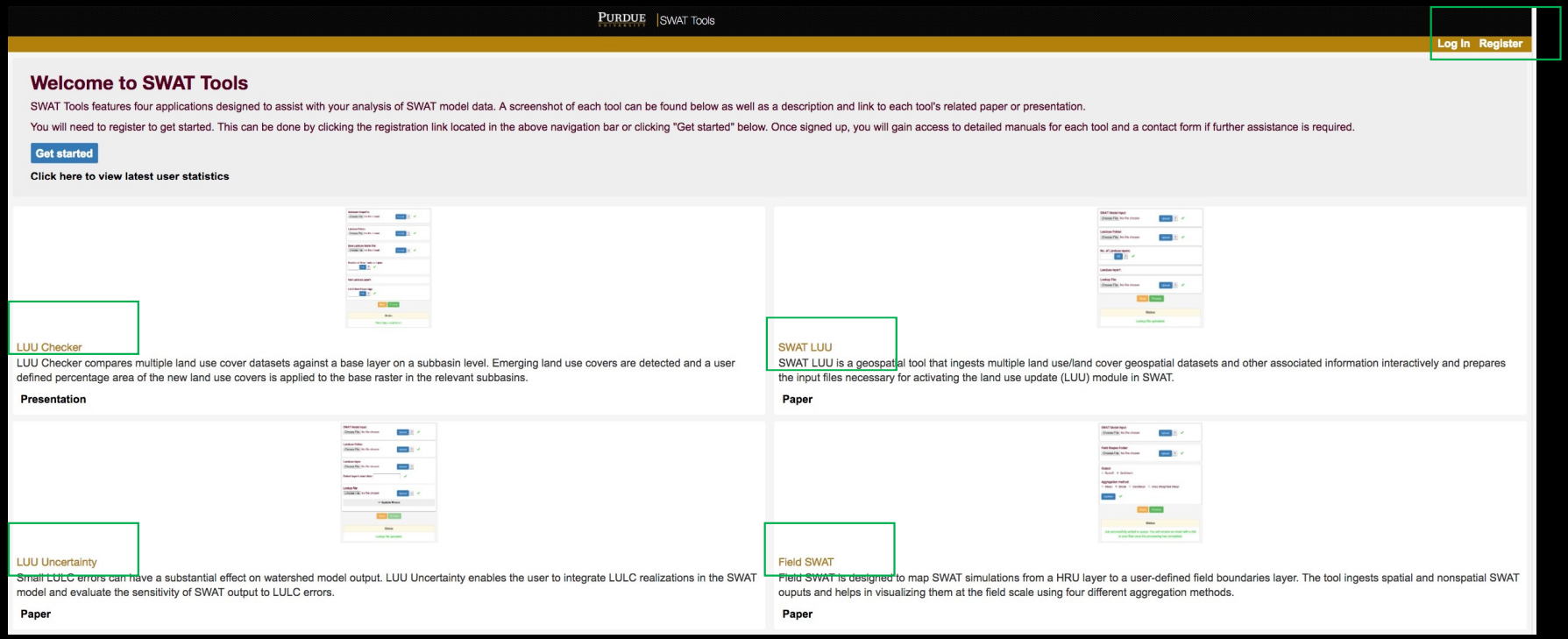
url: https://saraswat-swat.rcac.purdue.edu
Search term: swat tools purdue



BACKGROUND

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- SWAT 2009: released January 2010
- New module inclusion: land use change (LUU)*
- Input files required: lup.dat, file1.dat, file2.dat,….

*Arnold et al. (2010)

LUU USE CONDITIONS

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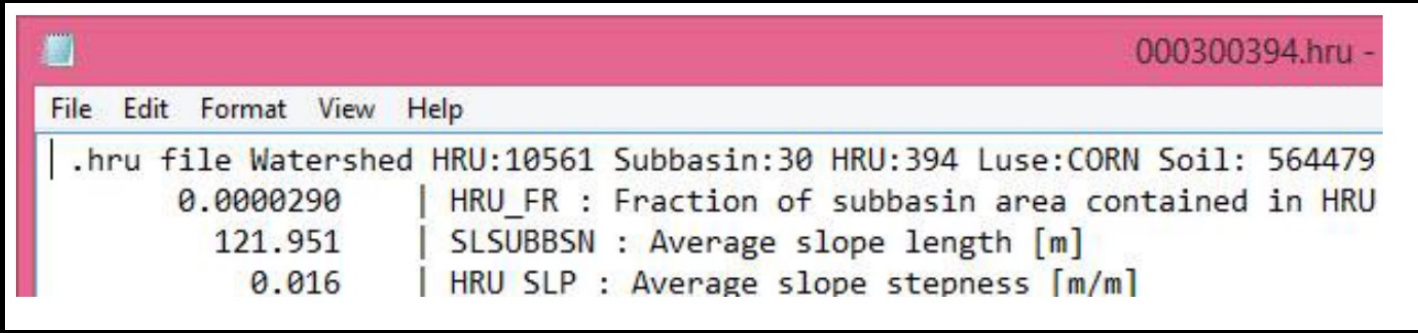

- HRU_FR is updated
- HRUs can't be added or deleted
- Sum of HRU_FR – 1
- Base LULC data is needed for initiation

FILE STRUCTURE

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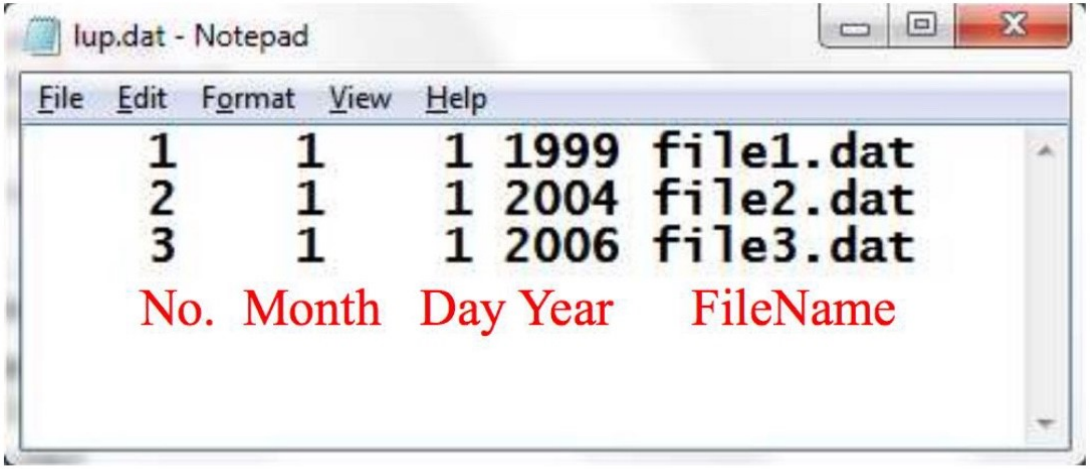
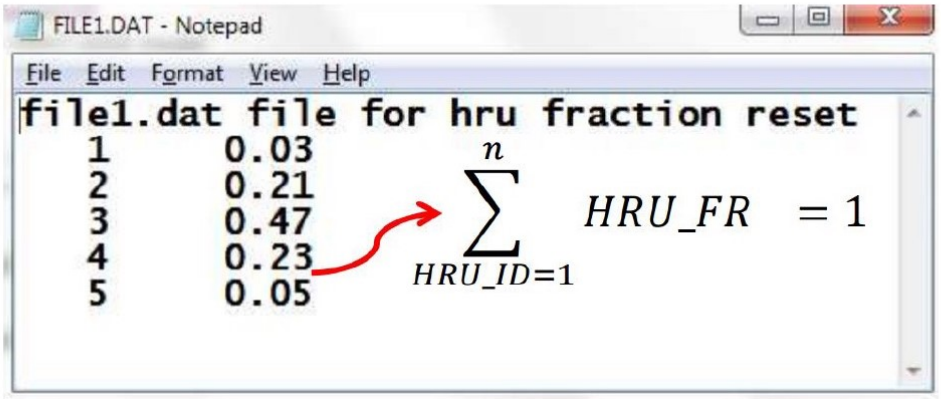
.dat files





BACKGROUND

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SWAT Model's ability to simulate water quality impacts of LULC changes are limited if only one LULC image is used as base layer for long-term modeling*

*Chiang et al. (2010)

HRU Modeling Challenges 1

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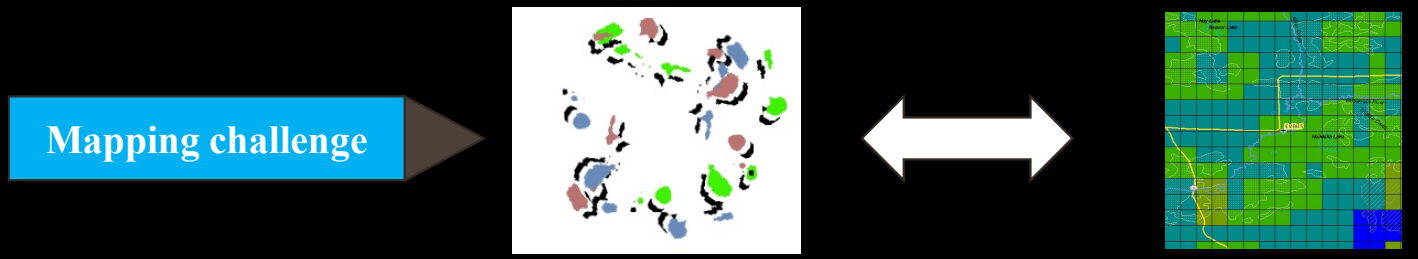
- LUC module needs updated area of HRUs each time new LULC data is input but there are challenges…

1. Numerous HRUs: few 100's to 1000's
2. Fragmented HRUs:



Fragmented HRU

Regular LULC raster grid

HRU Modeling Challenges 2

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

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

- 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.

SOLUTIONS

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- Map hrus to a regular raster layer

Pai, N. and D. Saraswat. 2011. SWAT2009-LUC: A tool to activate the land use change module in SWAT 2009. Trans. ASABE, 54(5):1649-1658

- Develop a new raster dataset for accommodating emerging LULC for long term simulation (LUU_Checker)

LUU Checker

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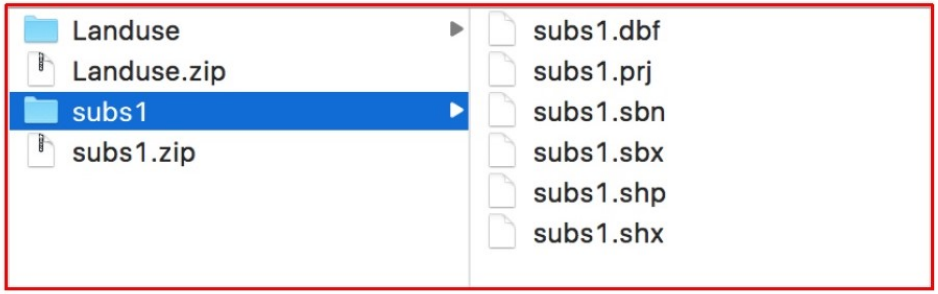
Step 1

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.



LUU Checker

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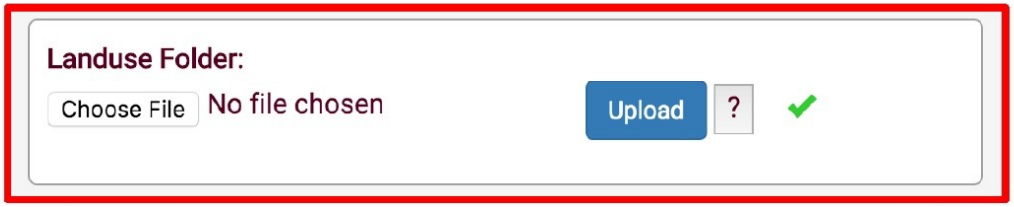
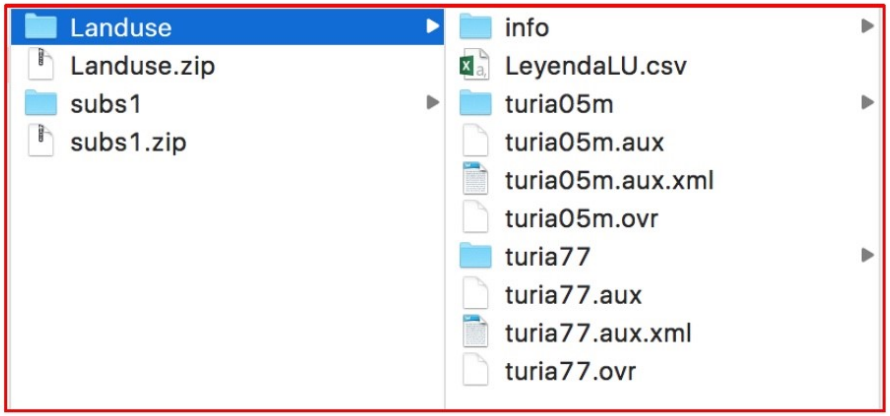
Step 2

Landuse Folder:

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





LUU Checker

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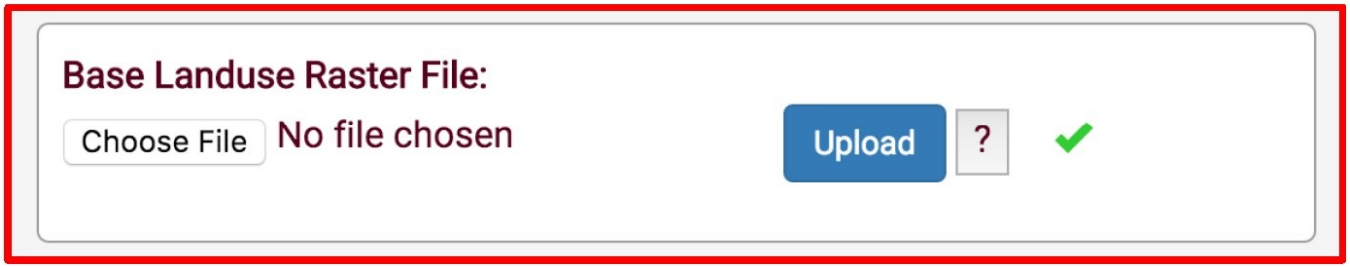
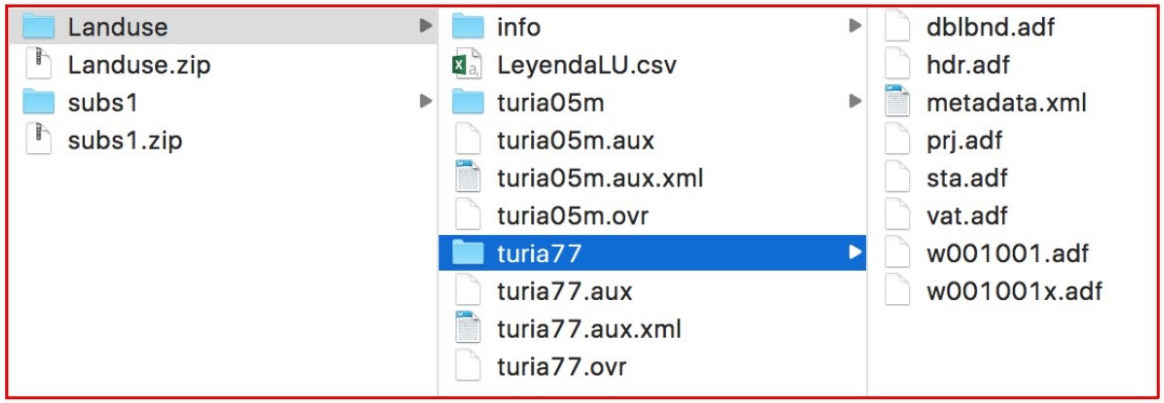
Step 3

Base Landuse Raster File:

- User can select either the first year (1977) or the latest layer (2005) as the base.





LUU Checker

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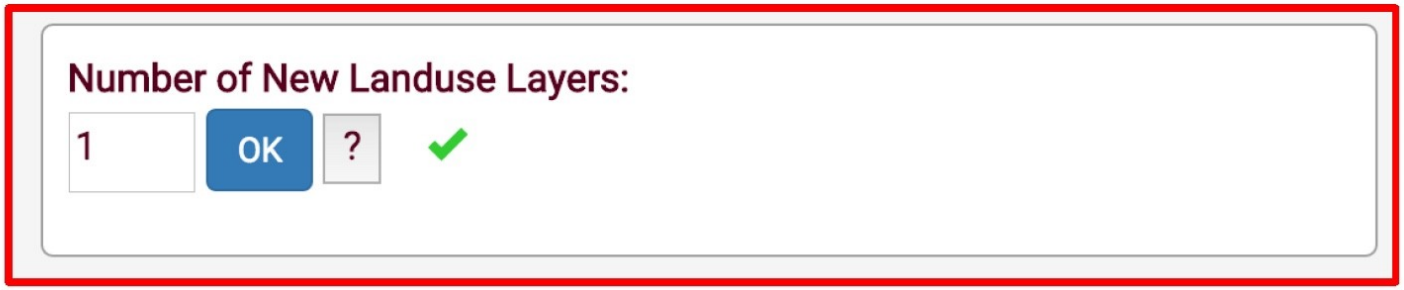
Step 4

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.



LUU Checker

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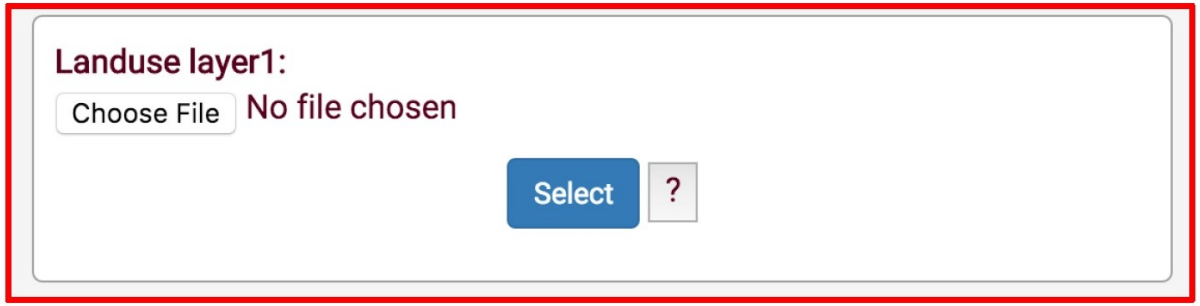
Step 5

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.



LUU Checker

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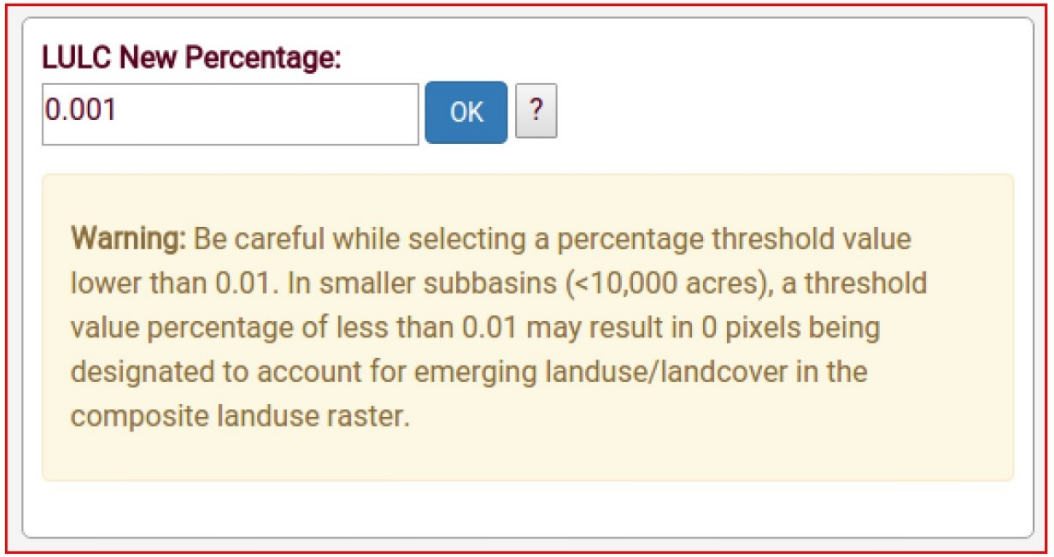
Step 6

LULC New Percentage

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



LUU Checker

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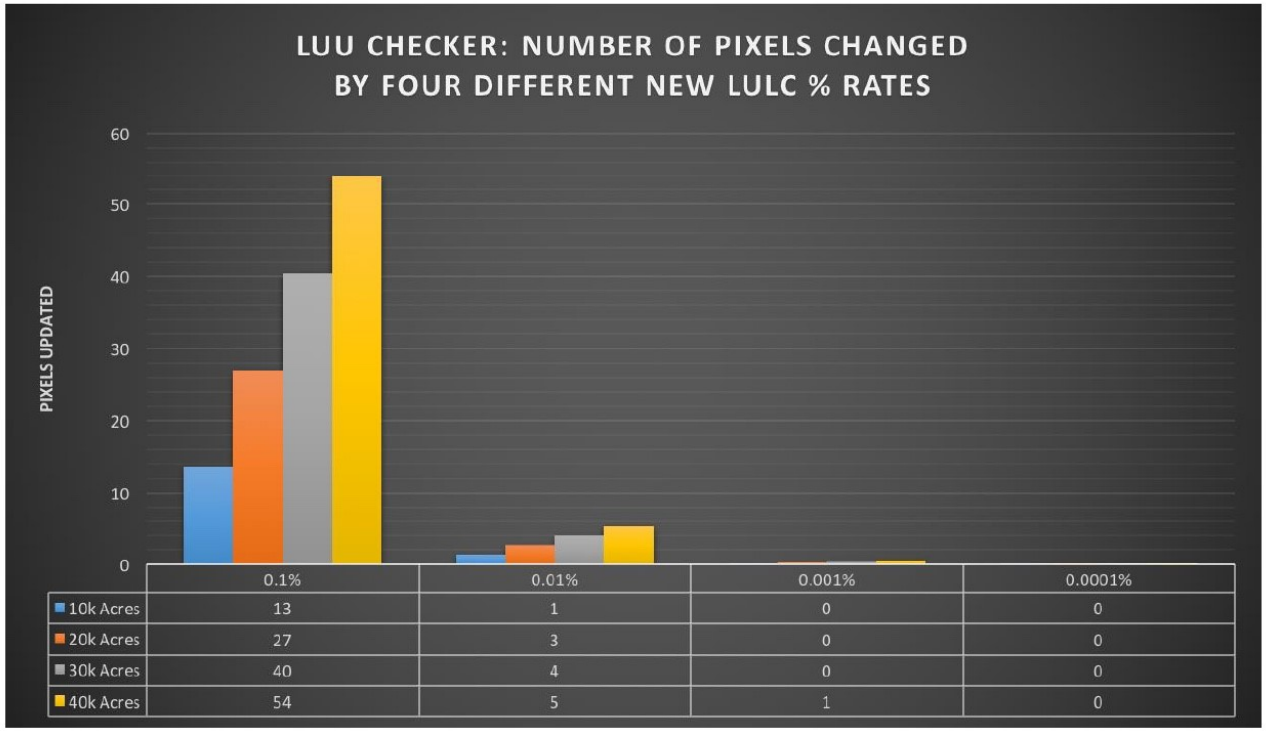
Step 6- continue

LULC New Percentage- a Scenario



	0.1%	0.01%	0.001%	0.0001%
10k Acres	13	1	0	0
20k Acres	27	3	0	0
30k Acres	40	4	0	0
40k Acres	54	5	1	0

LUU Checker

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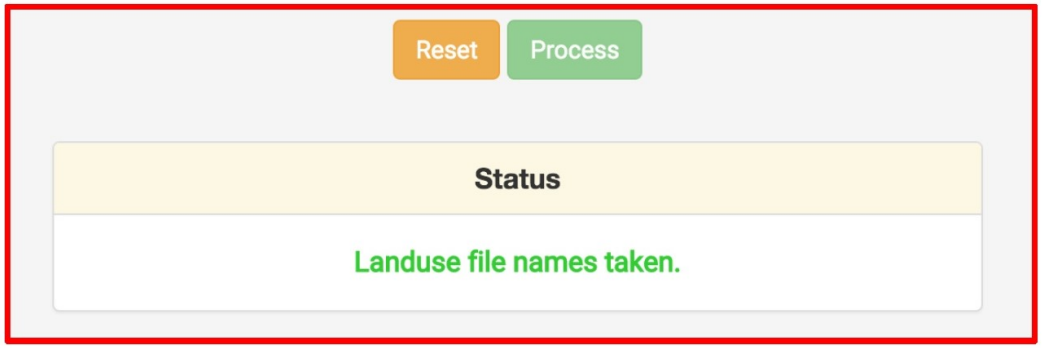
Step 7

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.



Land Use Update Modeling Workflow

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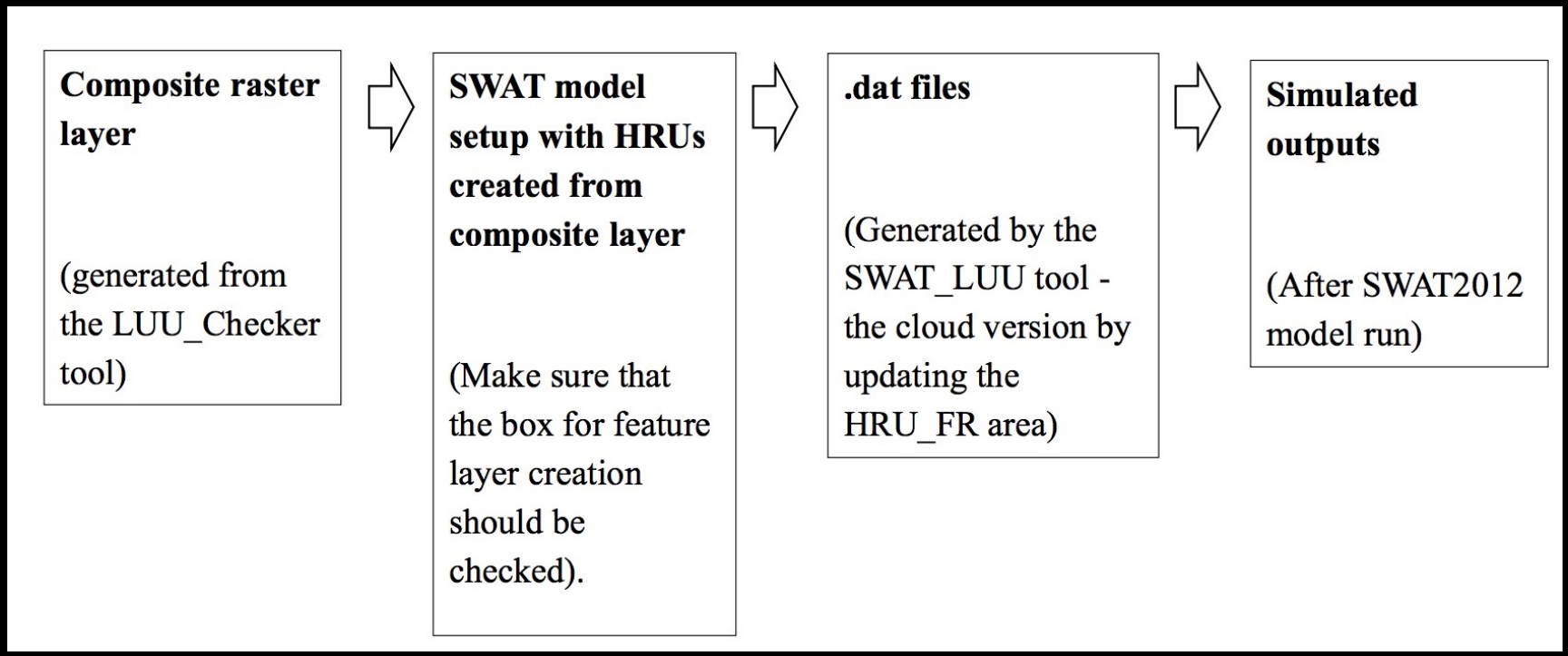

Composite raster layer contains HRU level LULC data in different temporal land use data layers that is subsequently used for SWAT_LUU tool

Case Study: Cache River Watershed

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Drainage area: 5,066 km^2

Subbasins: 27

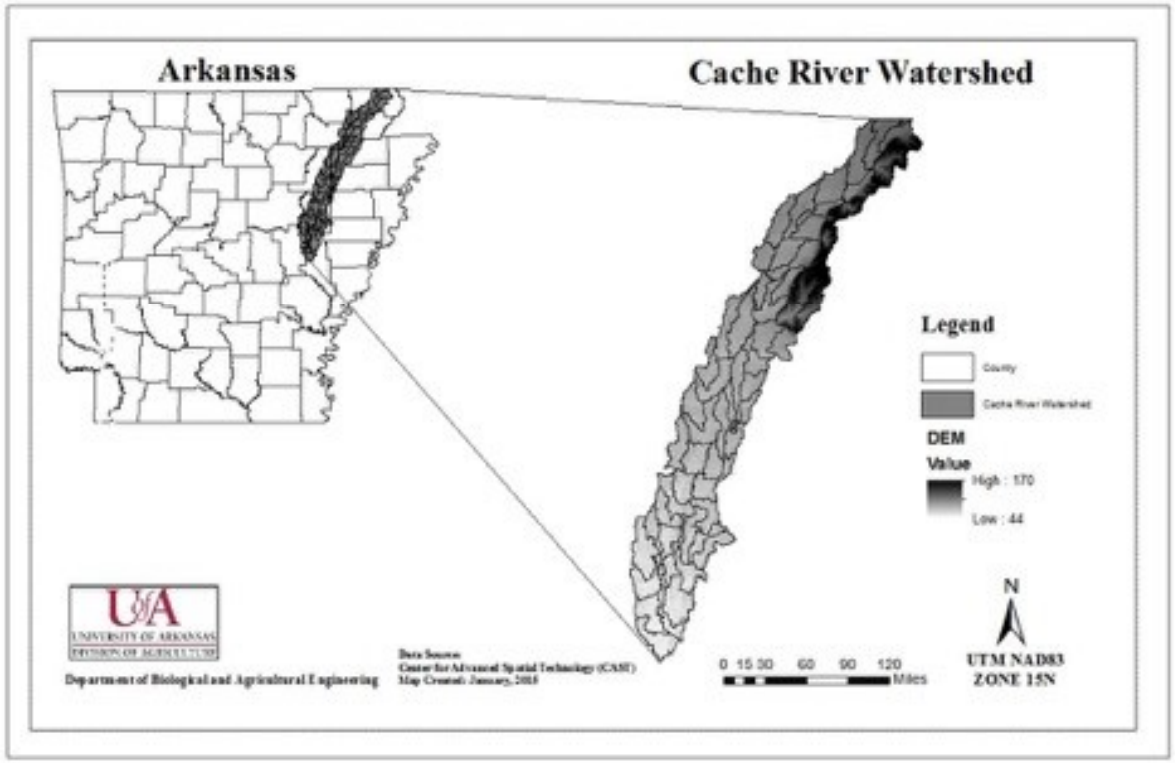
LULC: 2006

Soil: SSURGO

Slope: 4 classes

HRUs: 12,321 (14,053)
(Thresholds: 0%, 0%, 0%)

Study period: 1999 - 2006



Marginal crop land (soil health and land capability - 3.3 to 11.3%

RESULTS – COMPARATIVE PERFORMANCE

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- SWAT model with dynamic and targeted LULC*- i.e. one with realistic land use land cover was found to result in:
  - Sediment (< 1.8% for Switchgrass; <1.6% for Miscanthus),
  - total phosphorus (< 2.3% for Switchgrass; < 2% for Miscanthus) and
  - total nitrogen (< 2.1 percent for Switchgrass; < 2.5% for Miscanthus)

Compared to single land use layer model

*Singh, G. and D. Saraswat. 2016. Development and evaluation of targeted marginal land mapping approach in SWAT model for simulating water quality impacts of selected second generation biofeedstock. Environmental Modeling and Software, 81(c): 26-39

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SMART USER INTERACTION

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ISSUE #1- FILE EXTENSION

Problem

- User had issue with SWAT LUU NOT recognizing their landuse layers

Cause

- Landuse data was missing the **.aux** files
- Instead only the **.aux.xml** ones were present
- SWAT LUU uses these files to get the landuse layer names, due to the double extension, it incorrectly thought the layer names ended with **.aux**

Solution

- Fixed by copying the **.aux.xml** files and removing the **.xml** from the copy
- Alt fix would be using the actual **.aux** files
- Content of the files is not important which is why the first fix works

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ISSUE #2- HRU ID MISMATCH

Problem

- Execution of SWAT LUU was halting after the TxtInOut folder was processed

Cause

- Caused by the number of HRU ids discovered in the TxtInOut directory not matching the number of HRU ids found in hrus1.shp

Solution

- Added method to compare the number of HRU ids found in the TxtInOut against the number of HRU ids found in hrus1.shp
- If they match, continue the process.
- If they don't match, halt the process and alert the user

ISSUE #3- FRACTIONAL AREA CALCULATION

Problem

- User's SWAT LUU process was failing
- Pinpoint error to occurring in the **calculate_new_fractional_areas** method

```
# get indexes for the parts of the current landuse layer inside the watershed
landuse_layer_values_inside_watershed = landuse_layer_raster[self.inside_watershed_indexes]
```

- The goal is to extract landuse values at the hru locations

Cause

- Analysis of the hrus1 and landuse raster revealed mismatching resolutions
  - Hrus1: 16 bit signed integer with 25m^2 resolution (4416 x 6455)
    landuse: 8 bit unsigned integer with 30m^2 resolution (4315 x 5840)
  - Problem #1 – grids do not match. Problem #2 – individual cells in grids do not represent the same area

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ISSUE #4- COMPRESSED FILE TYPE

Problem

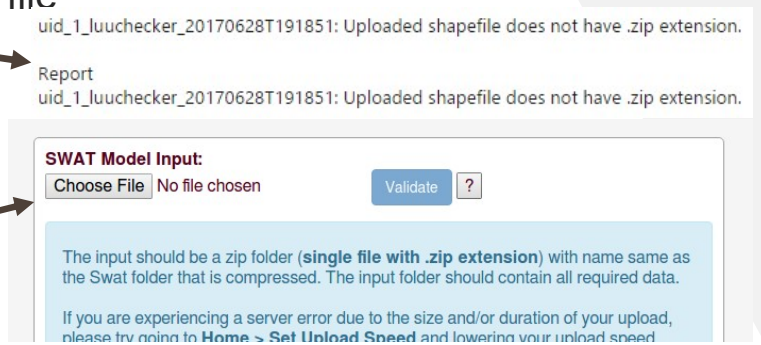
- Error occurring when user attempted to upload compressed SWAT model

Cause

- SWAT Model folder compressed, but not as a Zip file
- User's SWAT Model was a RAR file

Solution

- Improved error and help messages to provide even more details making it explicit that the compressed folder needs to be **.zip**



ISSUE #5: INTERNET SPEED AND FILE SIZE

Problem

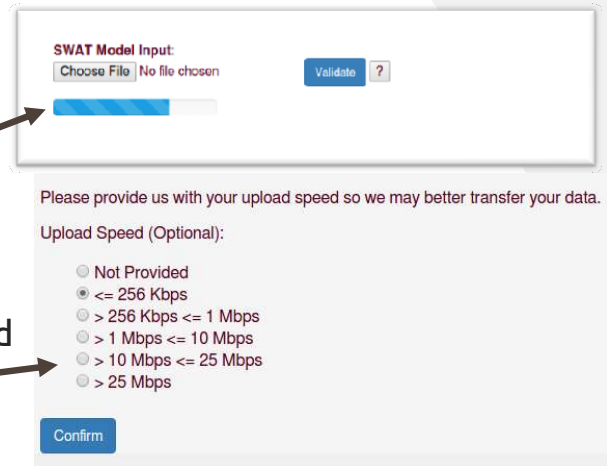
- Upload timing out

Cause

- User attempting to upload file larger than supported by nginx's settings
- ITAP unable to increase nginx max file size

Solution

- Detect large file uploads and upload directly to a S3 bucket
- Bypasses the nginx server
- Decision to use S3 based on file size and user's internet speed
  - Internet speed collected from a new form



CONCLUSION

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

CONCLUSION- continue

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- Potential for class room teaching
- Several measures are taken to guide users

SAVE THE DATE PLEASE

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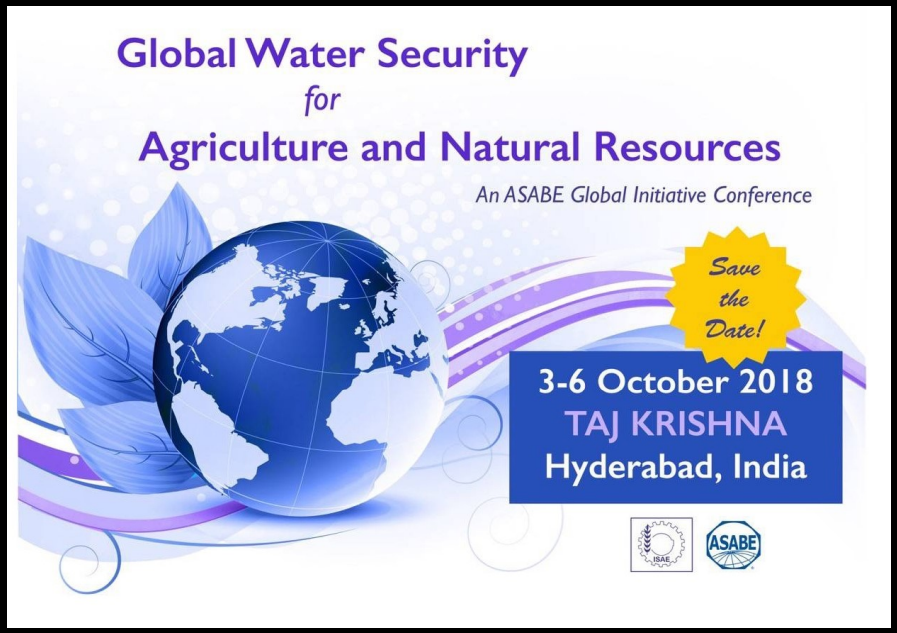

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THANK YOU

QUESTIONS