LiDAR Processing Tool

Developed for Maryland NRCS Through ESRGC

by Eric Flint

Salisbury
UNIVERSITY

Problem Statement

- NRCS is tasked with numerous landscape planning projects like wetlands restoration, flood prevention, and watershed planning.
  - Due to the nature of these projects, LiDAR derived datasets are ideal to reduce unnecessary field work.
- Manually processing LiDAR in NRCS field offices is problematic:
  - Extremely Large Datasets
  - Varied specializations of potential users
  - Raw LiDAR datasets do not provide the context required for land planning and design.

SALISBURY
UNIVERSITY

Solution

- NRCS commissioned ESRGC to develop a tool that can automate the functions required to process ground-based LiDAR into standardized outputs for all of NRCS's field offices.

ESRGC — Eastern Shore Regional GIS Cooperative
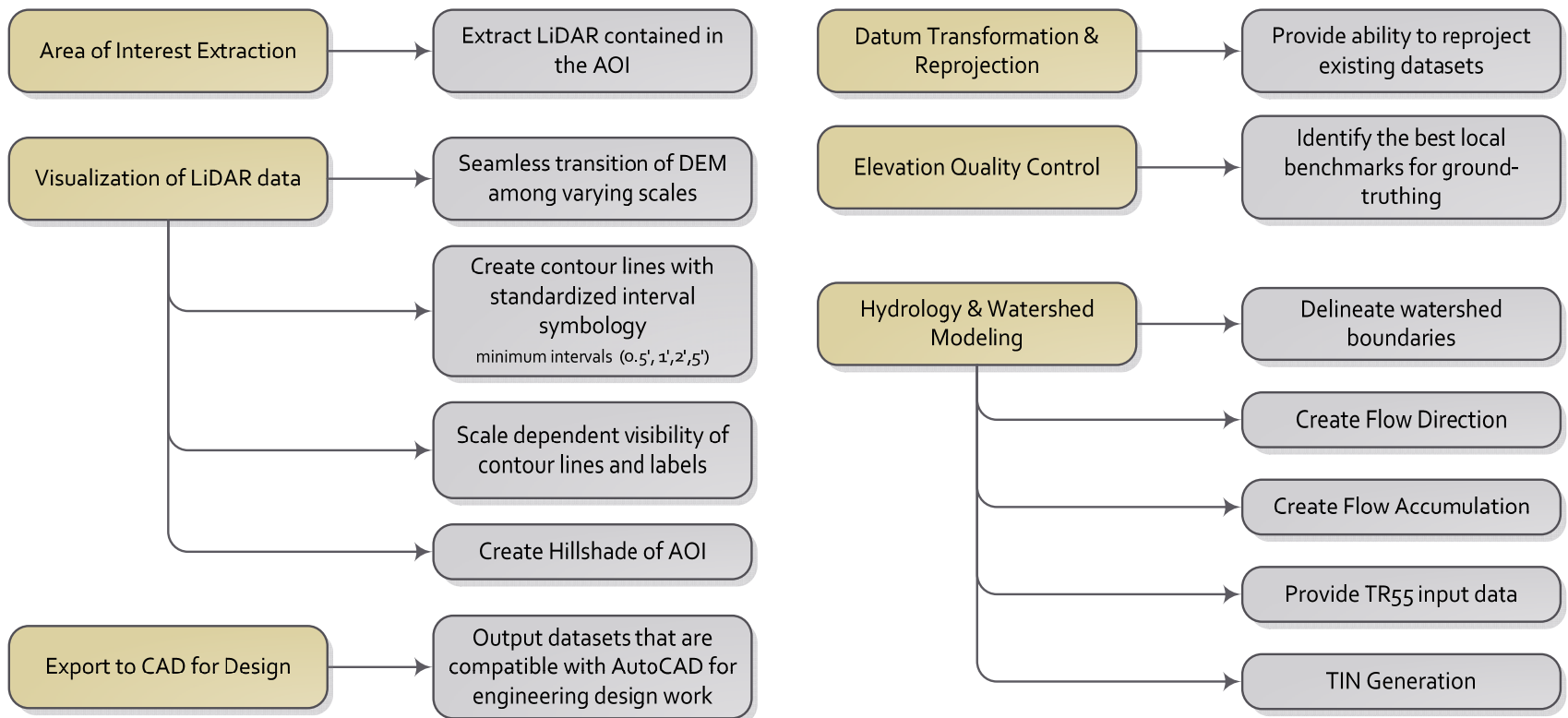
© Salisbury University

Disclaimer

- This tool is mission specific based the requirements developed by NRCS and may require personalization for use at other organizations.

- This tool utilizes only **existing functions** built in to ArcMap 9.2-10.0 software.

- Purpose is to provide standardized project datasets at remote field offices.

SALISBURY
UNIVERSITY

General Tool Requirements

- Must operate on any State of Maryland ground-based LiDAR Dataset
  - Project location independent
- Must not require additional licensing
- Must be ArcMap 9.2-10.0 compatible
- Must allow implementation at all MD field offices

Salisbury
UNIVERSITY

Desired Automations

REQUIREMENTS DEVELOPED BY MARYLAND NATURAL RESOURCE CONSERVATION SERVICES

Area of Interest Extraction	→	Extract LiDAR contained in the AOI

Visualization of LiDAR data	→	Seamless transition of DEM among varying scales
	→	Create contour lines with standardized interval symbology minimum intervals (0.5', 1',2',5')
	→	Scale dependent visibility of contour lines and labels
	→	Create Hillshade of AOI

Export to CAD for Design	→	Output datasets that are compatible with AutoCAD for engineering design work

Datum Transformation & Reprojection	→	Provide ability to reproject existing datasets

Elevation Quality Control	→	Identify the best local benchmarks for ground-truthing

Hydrology & Watershed Modeling	→	Delineate watershed boundaries
	→	Create Flow Direction
	→	Create Flow Accumulation
	→	Provide TR55 input data
	→	TIN Generation

© Salisbury University

Salisbury UNIVERSITY

Automation Goals

- Provide a user-friendly interface for users with varying GIS backgrounds and skill levels.

- Provide standardized project datasets at remote field offices.

- Decrease required user input (time & data) to process LiDAR datasets.

- Increase efficiency in data processing for the use of planning and visualization.

Salisbury
UNIVERSITY

Why Not Arc Hydro?

- This tool:
  - Leverages existing functionality of Arc with minimal user input.
  - Automatically applies user input to disparate processes in addition to hydrology. (contouring, benchmarking, .dwg export,..)
  - Provides only the hydrology tools needed by NRCS.
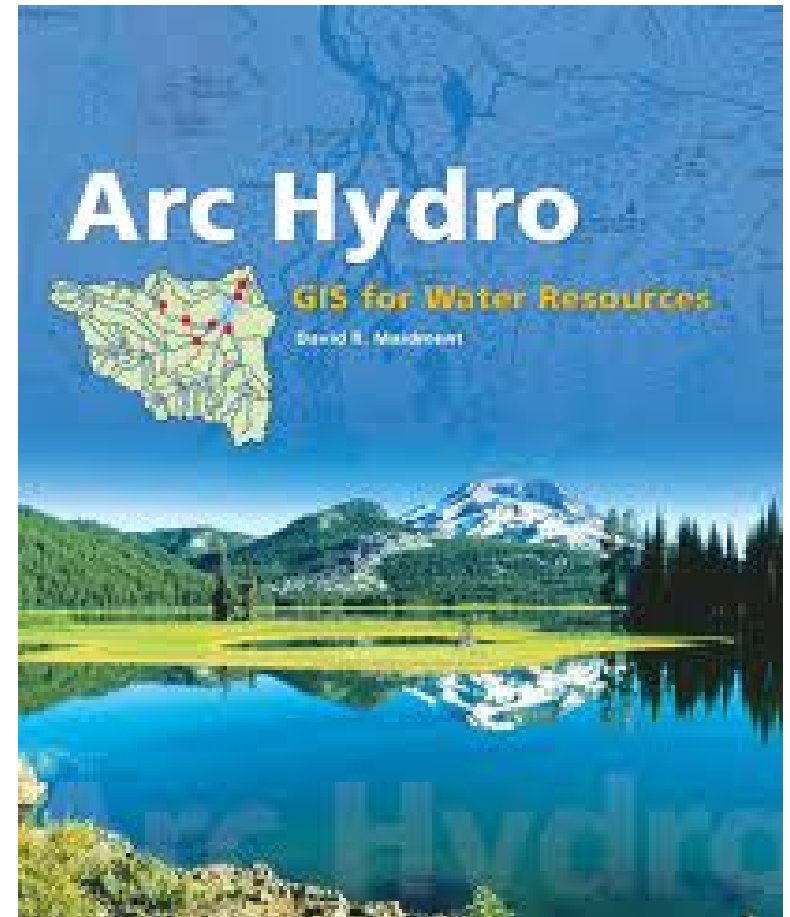
Photo from Esri Press: *Arc Hydro*

© Salisbury University

Conceptual Design

- Compile a list of ArcMap tools that will accomplish the established requirements.
- Compartmentalize functions based on output models of tools.
  - Data Management
  - **Contouring**
  - Hydrology

Contour Function

Intervals

Create Interval Representation Rules

Create Contours

Contours Layer

Thin Contours to Reduce Pixilation

Add CAD Properties & Export To AutoCAD

Apply Representation Rule

Select Contour Lines By Interval

Smoothing Algorithm

Salisbury
UNIVERSITY
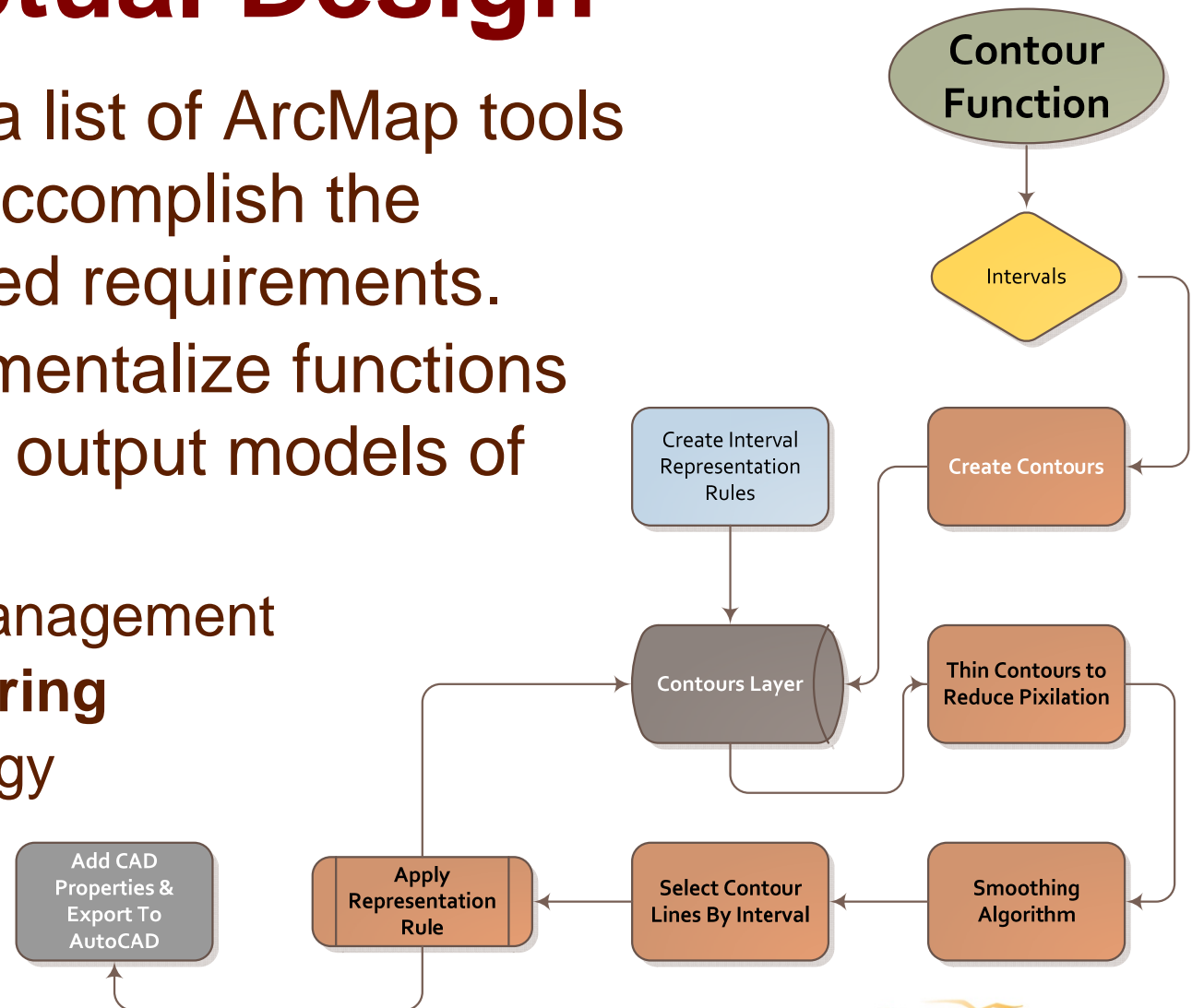
Testing Conceptual Design

- ## Model Builder

  - Create loosely coupled models to test logical progression

  - Compile loosely coupled models into a tool

© Salisbury University
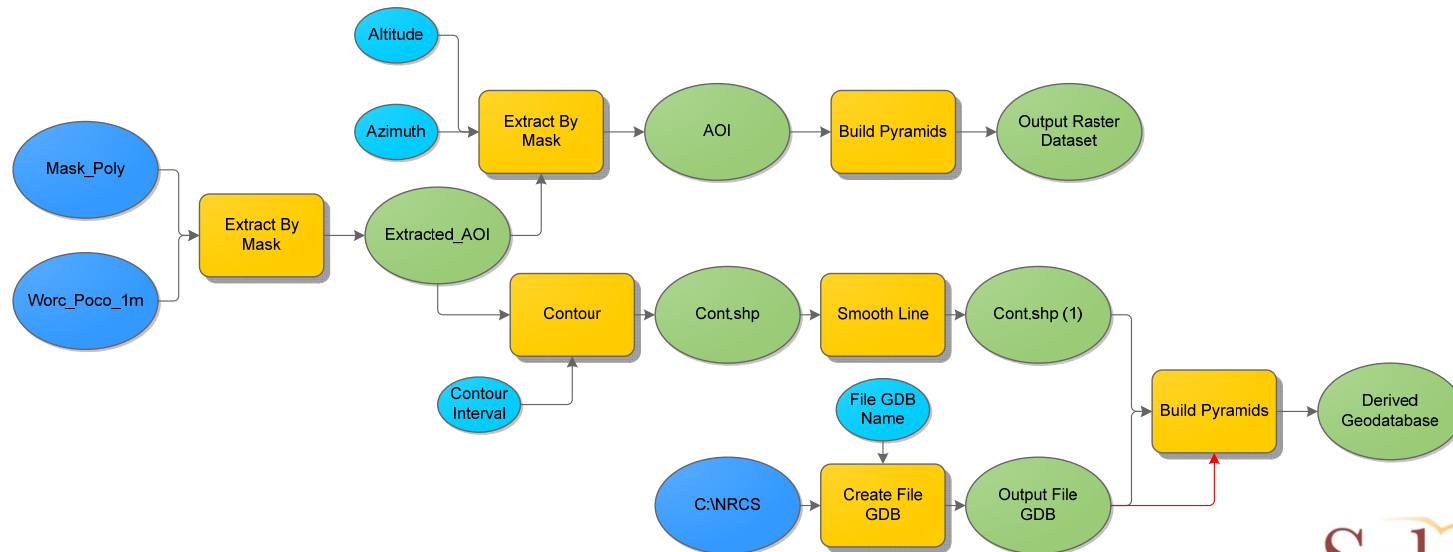
Development of Modeling Processes

Data Management
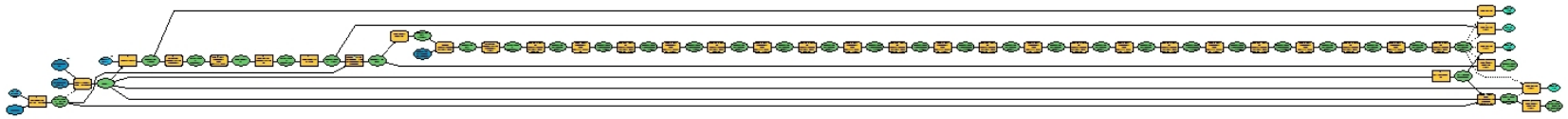
Contouring & Representation
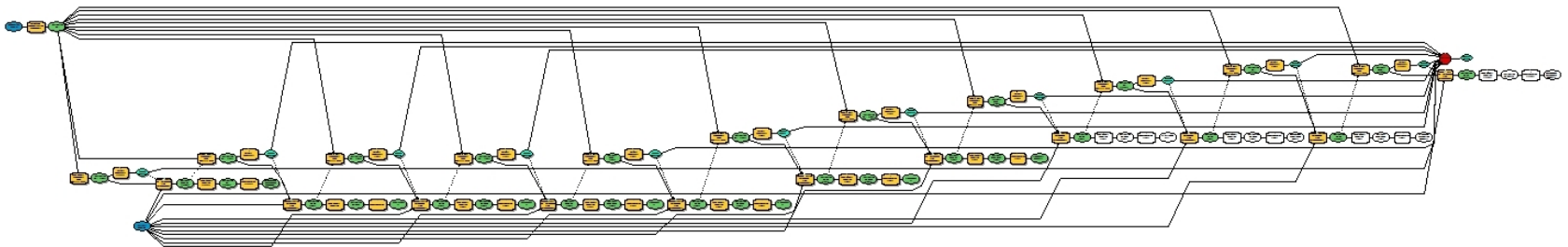
Drainage Visualization
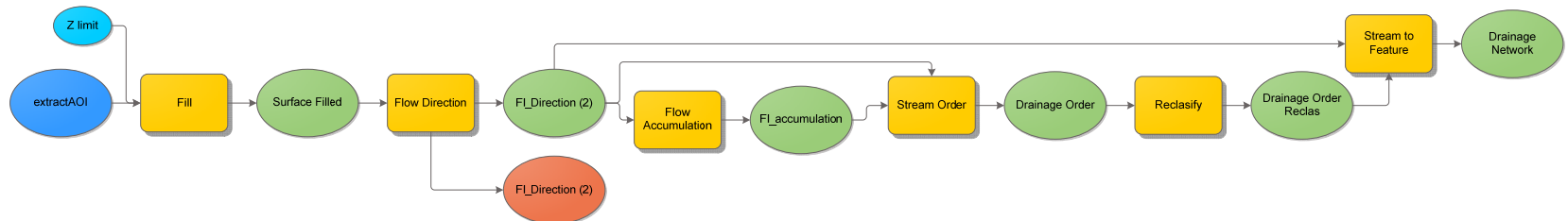
Model Builder Benefits and Limitations (In reference to this project)

- Model builder is a user friendly interface that allows for the rapid generation of automated tools.

- It is a useful tool to visualize the steps required to achieve desired outputs.
  - Graphic workflow of tool

- Model builder becomes less user friendly as complexity increases.
  - Validation (good and bad)
  - Interators are not intuitive

Salisbury
UNIVERSITY

Transition to ArcPy

- Due to the nature of this project, we transitioned to ArcPy in an effort to reduce redundancy in the models, and increase the ability to customize the final user interface.
  - Needed the ability to logically link disparate processes through a single interface without validation conflicts.
  - Novice to Python, and the Arc Object Model
    - Exported models to ArcPY for template

Application

AOI Polygon

AOI Polygon

NRCS Lidar Processing Tool (ArcPy Script)

User Input

Output:

File Geodatabase (Created on the fly)

AOI DEM (Raster)

AOI Hillshade (Raster)

AOI Slope (Raster)

Drainage Basins (Raster)

Benchmarks (Point)

Contours (Line)

Drainage Network (Linear Net)

Flow Direction (Raster)

Flow Accumulation (Raster)

© Salisbury University

Salisbury
UNIVERSITY
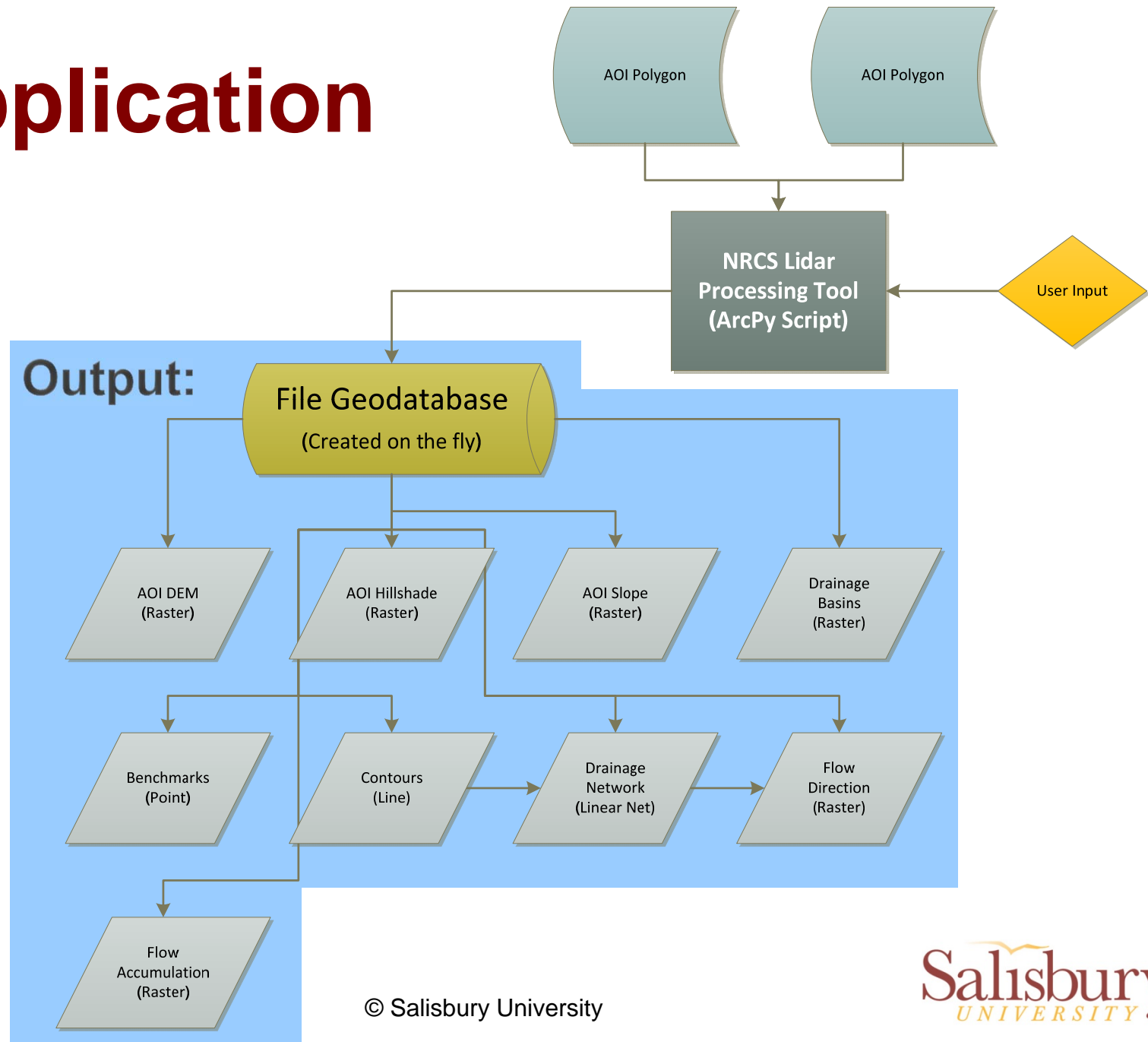
Tool Testing Runtimes

NRCS Lidar Processing Tool

$y = 2E\text{-}06x + 0.0004$
$R^2 = 0.9823$

Time (Minutes)

Area of Interest (Acres)

Time

Linear (Time)

NRCS Lidar Processing Tool

MetaData:

- The tool, and all required files must be installed in C:\ArcPy_NRCS directory.
- It can be run directly from ArcMap

Salisbury
UNIVERSITY
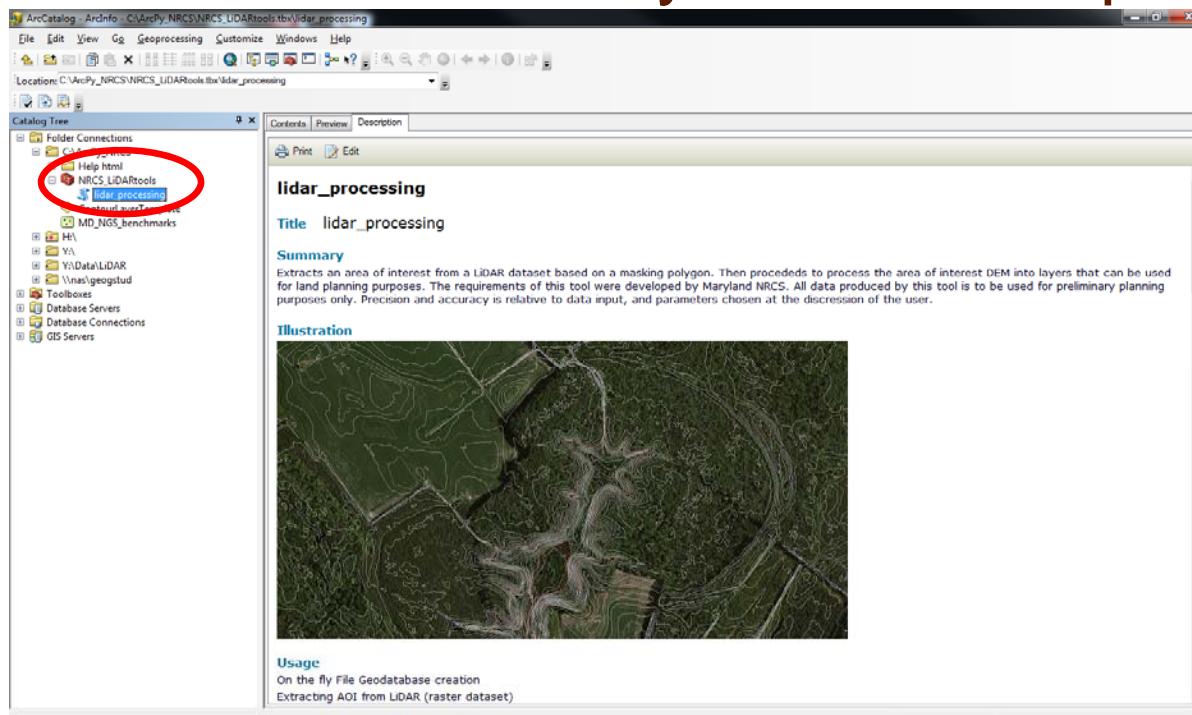
NRCS Lidar Processing Tool
Interface:

Customized Validation
User Input Constraints:

© Salisbury University

Masking Polygon and NGS Benchmarks
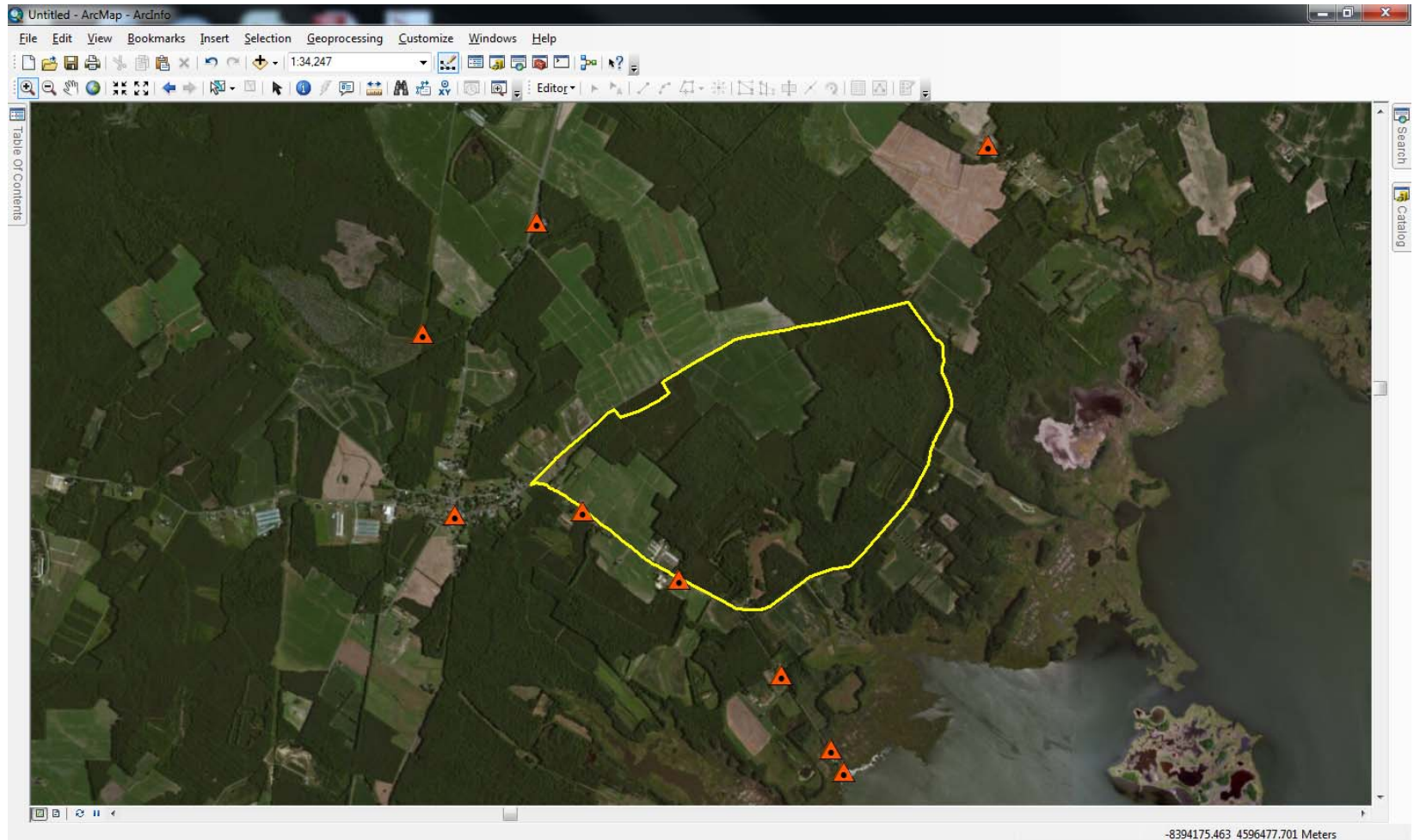
Extracted AOI
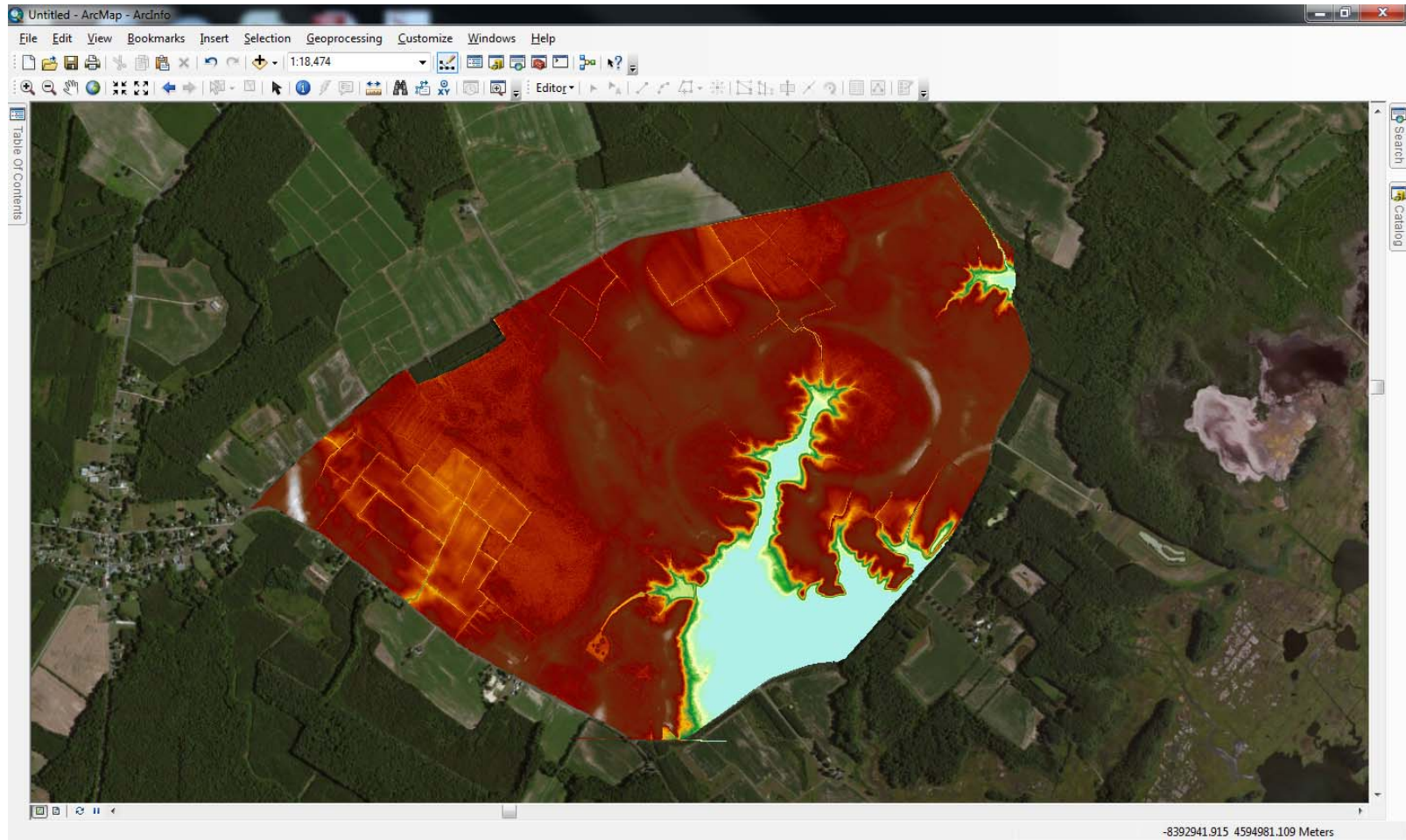
LiDAR Visualization
LiDAR and Translucent Hillshade

Salisbury
UNIVERSITY
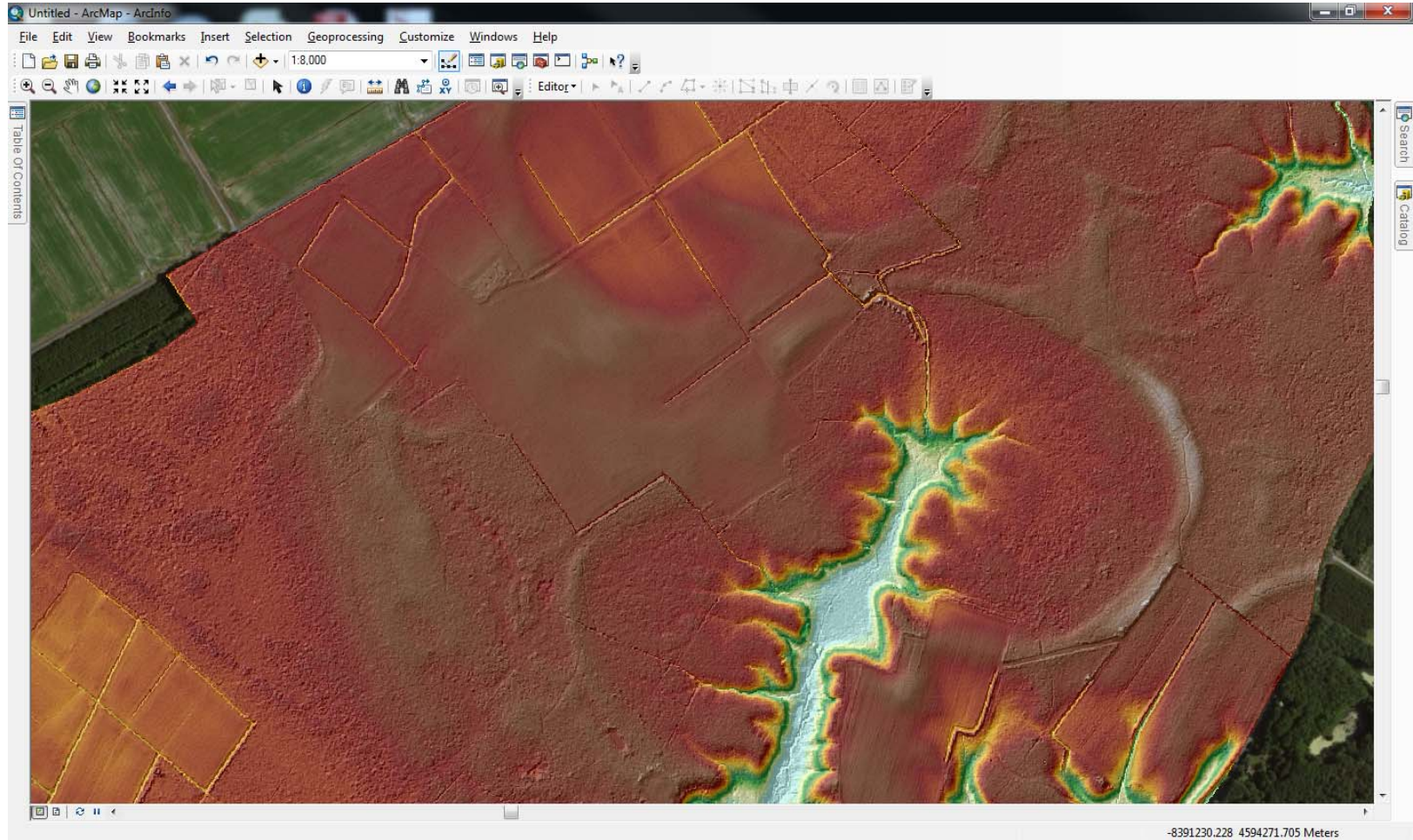
Contours With Standardized Symbology
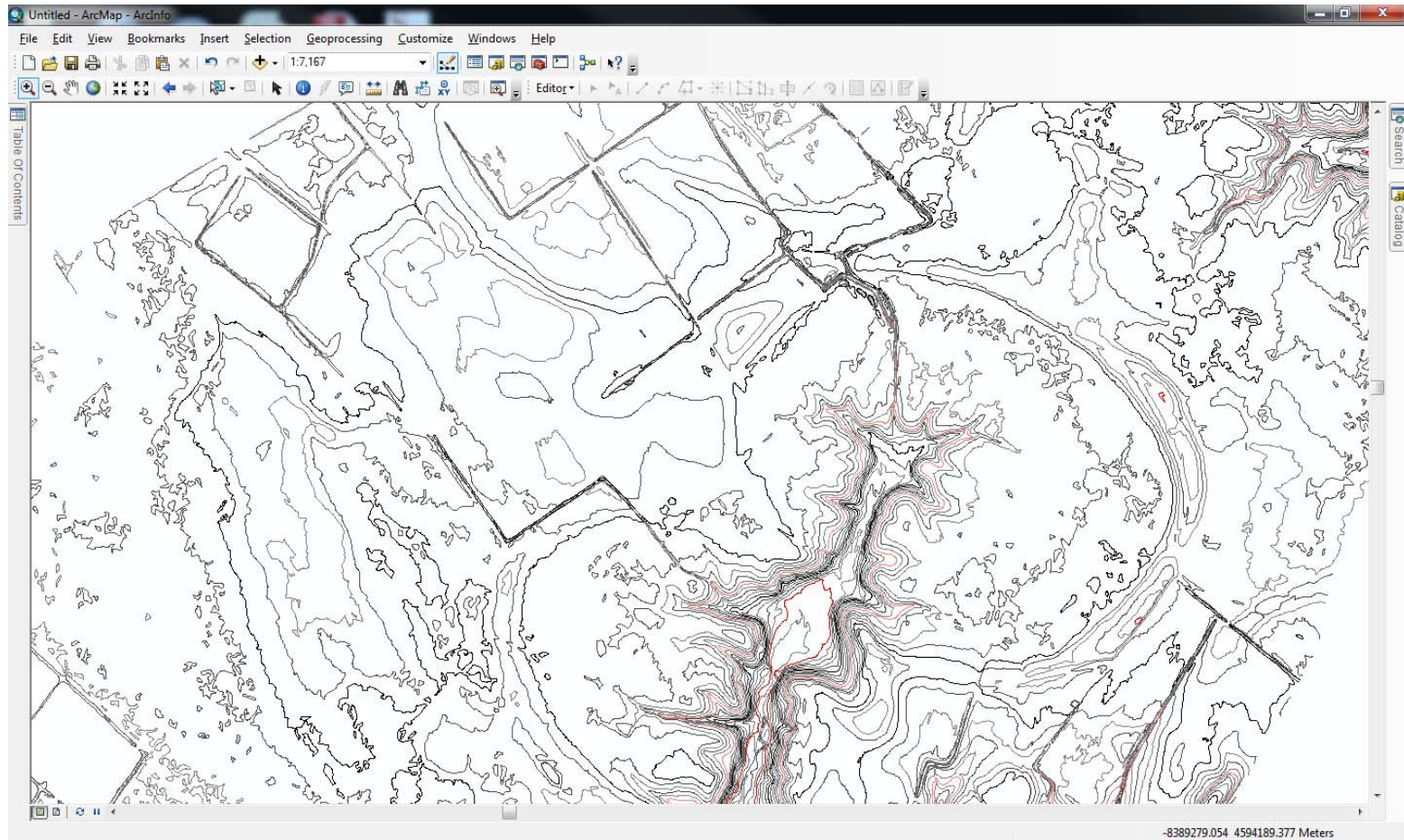
Drainage Network
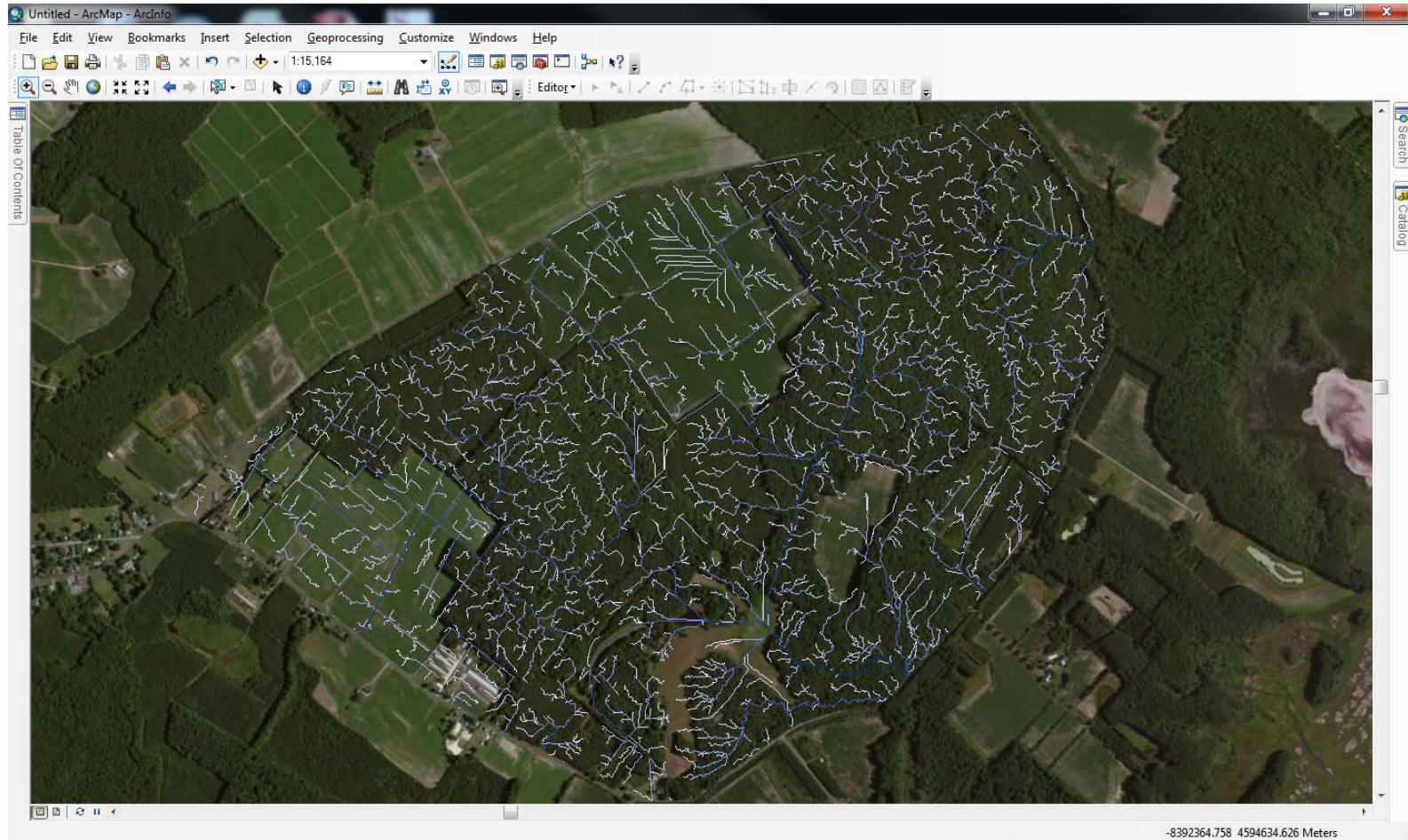
Drainage Basins
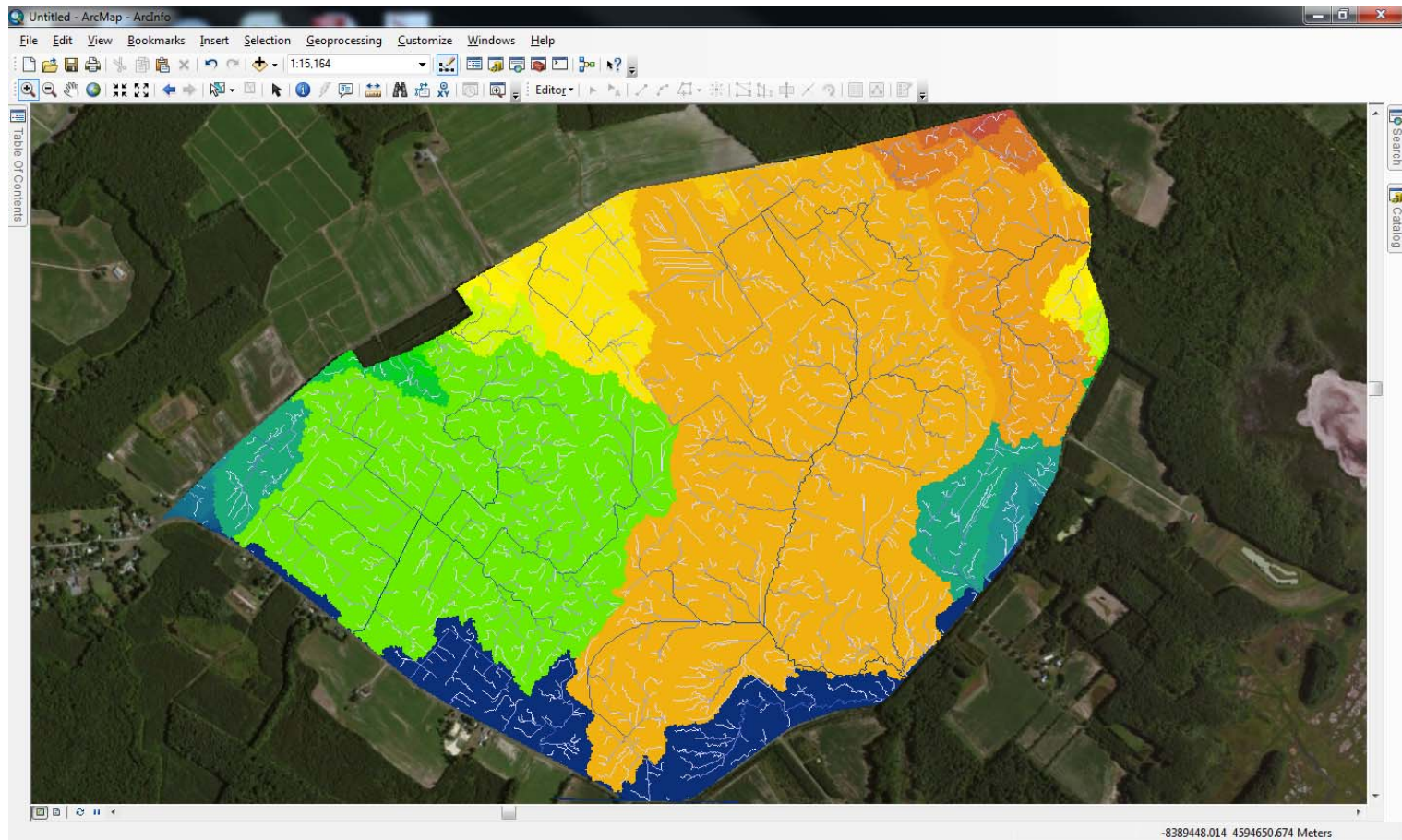
Area of Interest Slope

© Salisbury University

Challenges

- Constrained to ArcMap version 10.0 functionality
  - 10.1 has increased scripting capability
    - Allowed access to label properties
    - Allowed access to scale dependencies
- Project exceeded the intended typical use of Model builder and required transitioning to ArcPy.

Salisbury
UNIVERSITY

Considerations

User Input Required: 11

- Datasets: 2
- Settings: 9 (including Units)

Processes Automated: 58

- User interacts with 1 interface

Automated Parameters: 222

- User input reduced by 211 parameters.

Accomplishments

- Successfully developed a multi-faceted, user-friendly tool using Model Builder and Arcpy scripting that automates otherwise repetitive and time consuming data processing.

Salisbury
UNIVERSITY

Potential Modifications

- This tool is being tested by NRCS and is likely to be subject to modification.

- This tool could be published to Salisbury University's Server and linked to a web based application for remote use.

- This tool could read LiDAR datasets directly from ESRGC's State LiDAR data servers.
  - Users will not need locally stored copy of tool or LiDAR datasets.

Salisbury
UNIVERSITY

Additional Information

- This tool was released to MD NRCS for testing, and will be released publicly when finalized
  - Follow ESRGC on twitter for release information or check website at: www.esrgc.org

Salisbury
UNIVERSITY

Questions?