MIDDLE TENNESSEE STATE UNIVERSITY

Watershed modeling for Evaluating the Effectiveness of Conservation Practices in Agricultural Watersheds in Tennessee: Pilot Study

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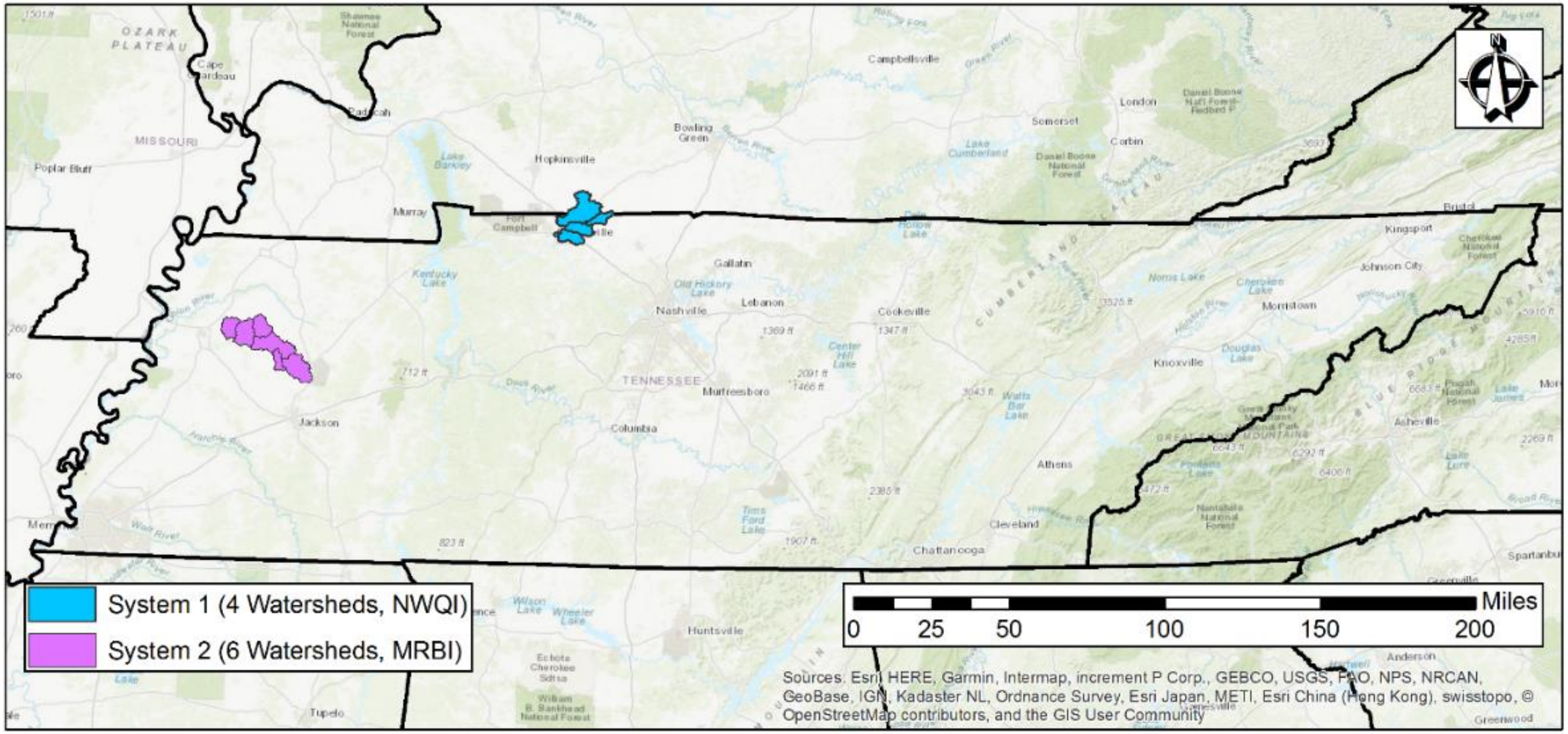
USDA NRCS U.S. Department of Agriculture Natural Resources Conservation Service

USDA ars Agricultural Research Service

MT MIDDLE TENNESSEE STATE UNIVERSITY Department of Geosciences

Study Area

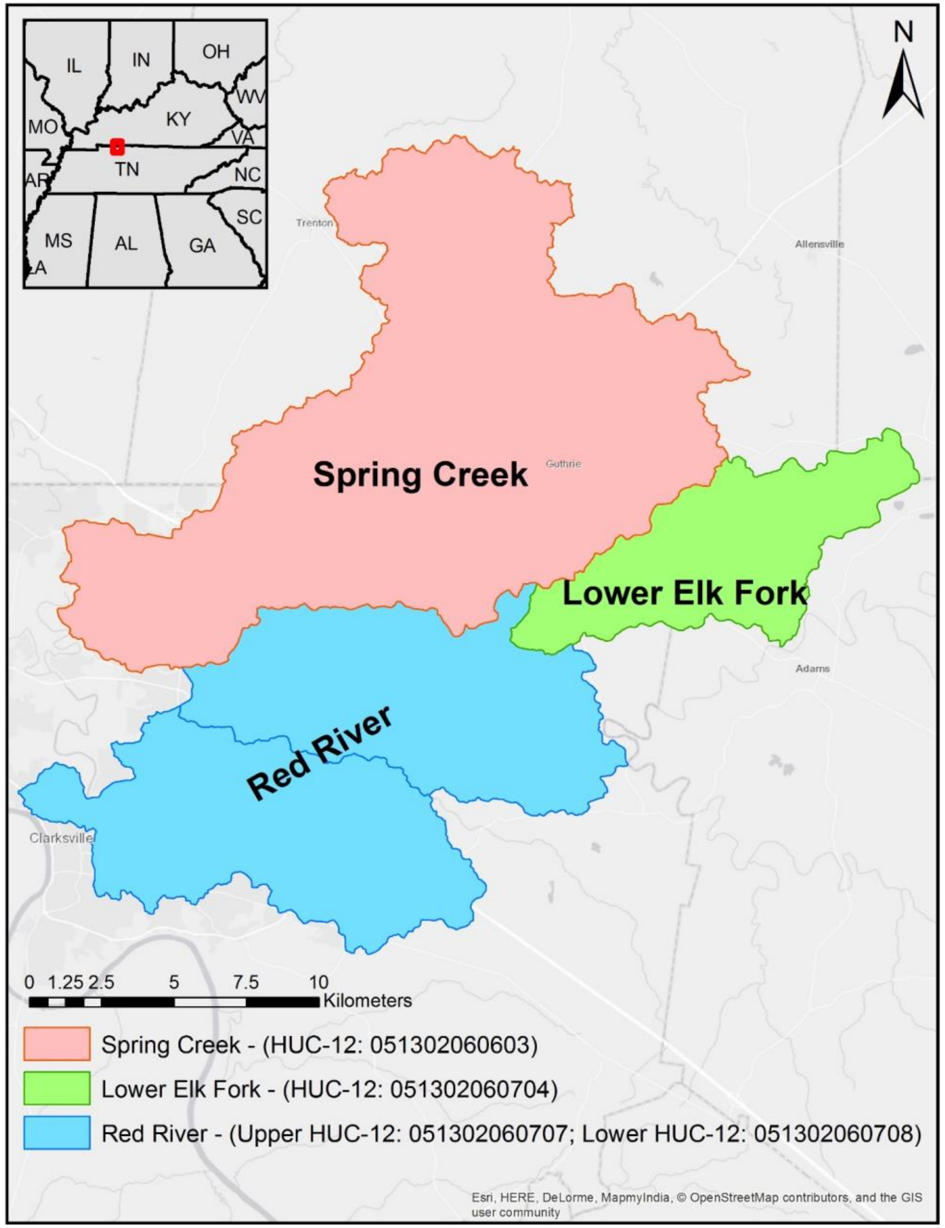
Two watershed systems are investigated to understand and evaluate the effectiveness of conservation practices in Tennessee. System 1 includes four watersheds in Northern Middle Tennessee and are all part of the 2019 National Water Quality Initiative (NWQI). System 2 includes six watersheds in West Tennessee and are all part of the Mississippi River Basin Initiative (MRBI).

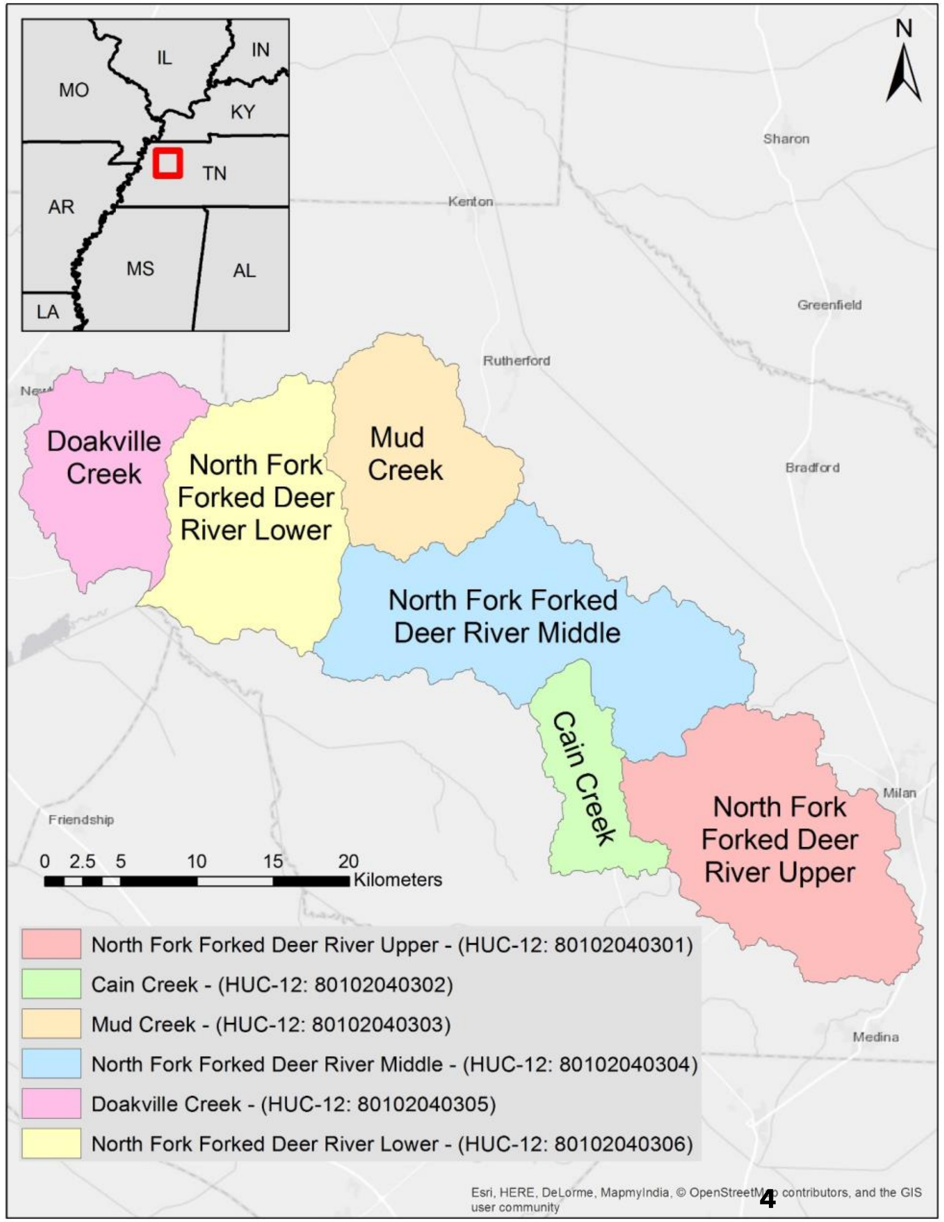


Study Area

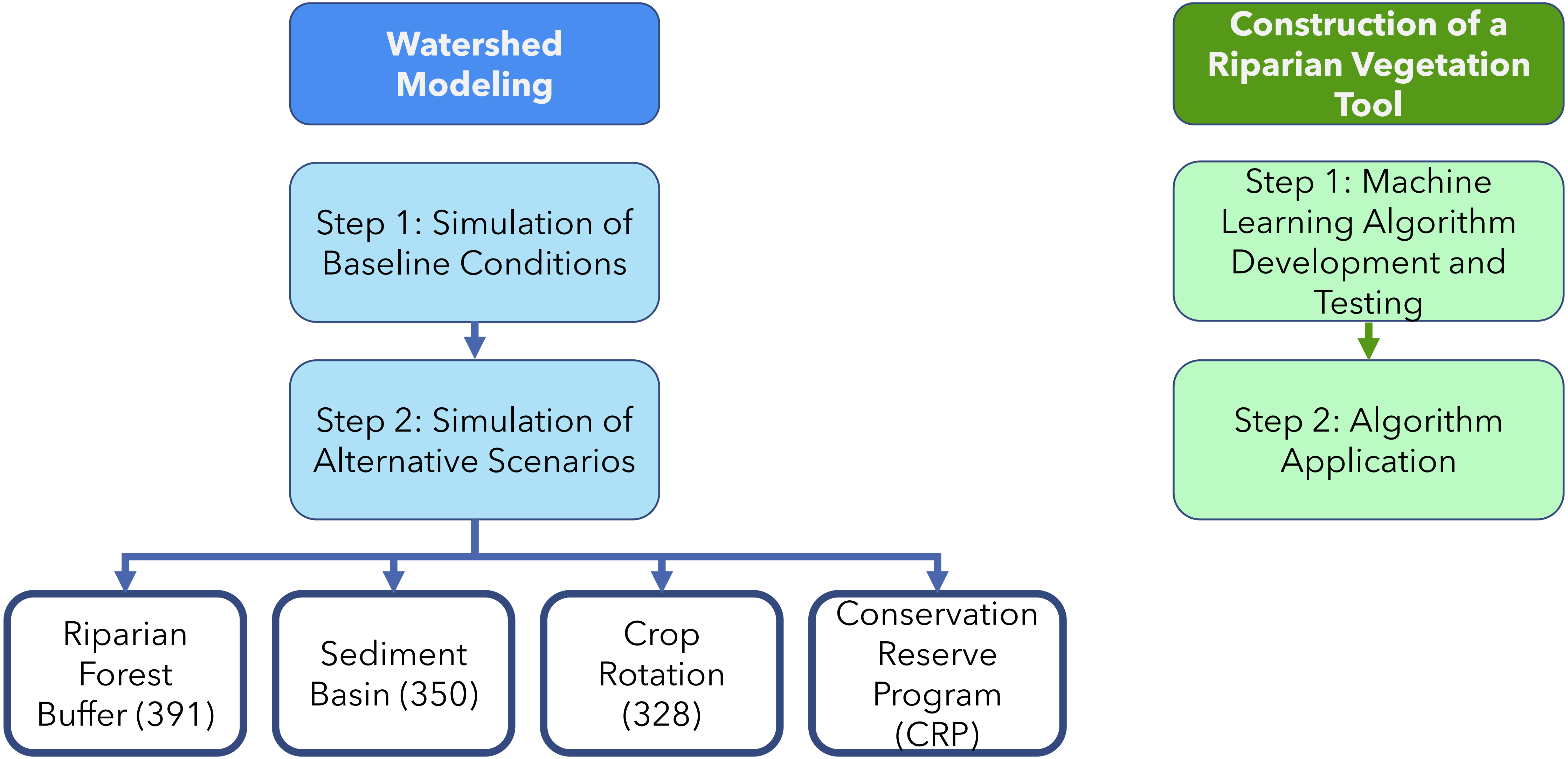
- System 1 is located in Robertson and Montgomery counties in Tennessee and Logan and Todd Counties in Kentucky. It consists of three subsystems: the Lower Elk Fork, the Spring Creek (both of which have single HUC 12 subdivisions), and the Red River (which is divided into two HUC 12 subdivisions).

- System 2 is located in Gibson and Dyer Counties in West Tennessee and consists of six HUC-12. The total area is 156,000 acres and it drains to the Forked Deer River.





Project Structure



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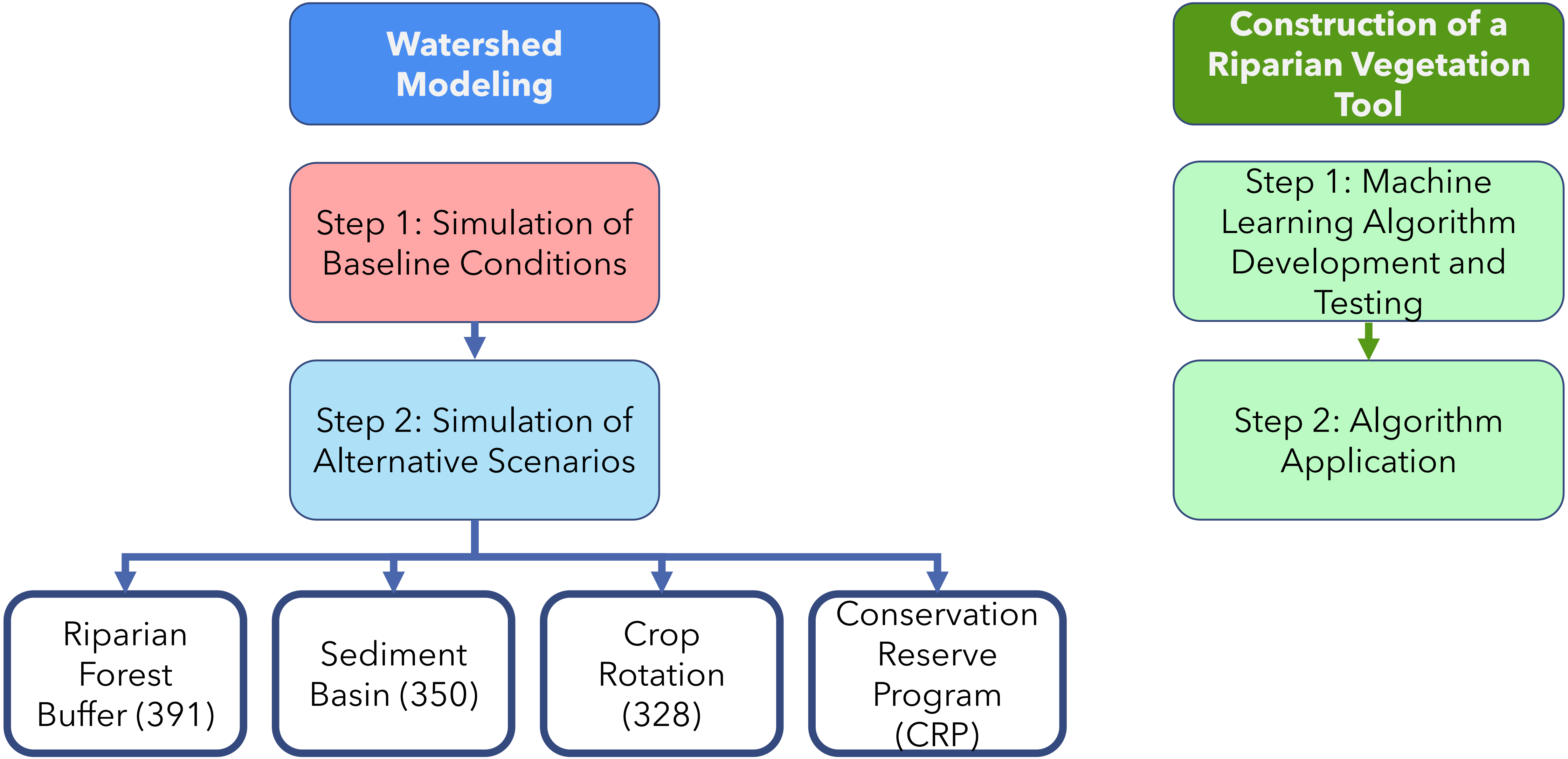
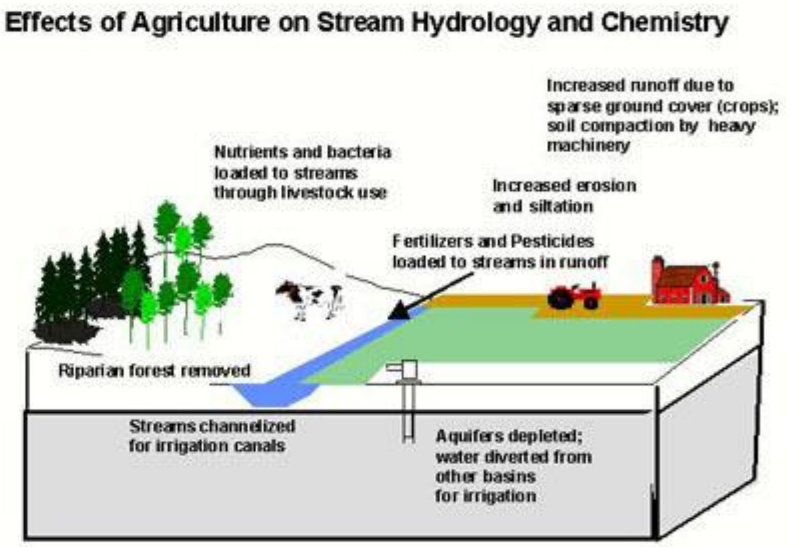


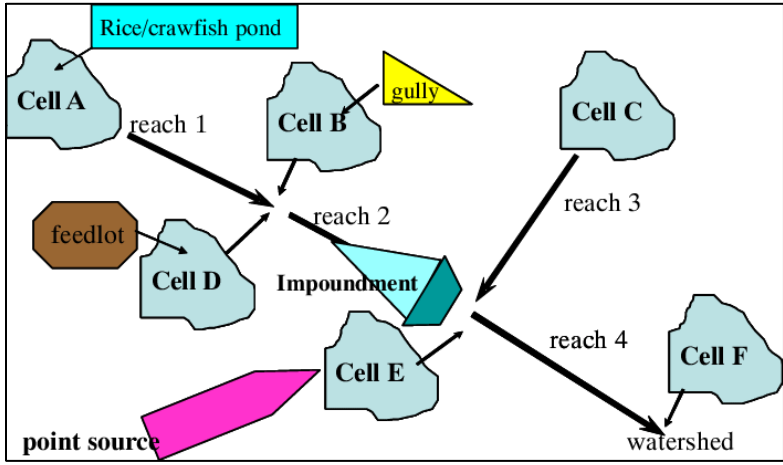
Watershed Modeling: AnnAGNPS

- The AnnAGNPS watershed pollution model is the result of a partnership between two branches of the U.S. Department of Agriculture (USDA), the Agricultural Research Service (research branch) and the Natural Resource Conservation Service (action branch).

- The AnnAGNPS model performs long-term continuous simulations of mixed-land use watersheds on a daily time step to model farming management practice impacts on runoff and sediment/nutrient/pesticide detachment, transportation, and deposition. The hydrology of the watershed is based on a daily water balance considering surface runoff, evapotranspiration (ET), and percolation of water through the soil profile. Detachment, transportation, and deposition of sediment and attached and dissolved chemicals are determined using an integrated approach. Landscape erosion processes are calculated using the Revised Universal Soil Loss Equation (RUSLE) for estimation of sheet and rill erosion while accounting for land cover and farming management practices. The delivery of multiple particle sizes of eroded sediments to concentrated flow is calculated using the Hydro-geomorphic Universal Soil Loss Equation (HUSLE).

- The watershed is represented by two basic modeling units: concentrated surface flow paths (referred to as reaches) and sub-catchments (referred to as AnnAGNPS cells). AnnAGNPS cells are hierarchically connected by reaches depicting how surface and shallow subsurface flow throughout the watershed.





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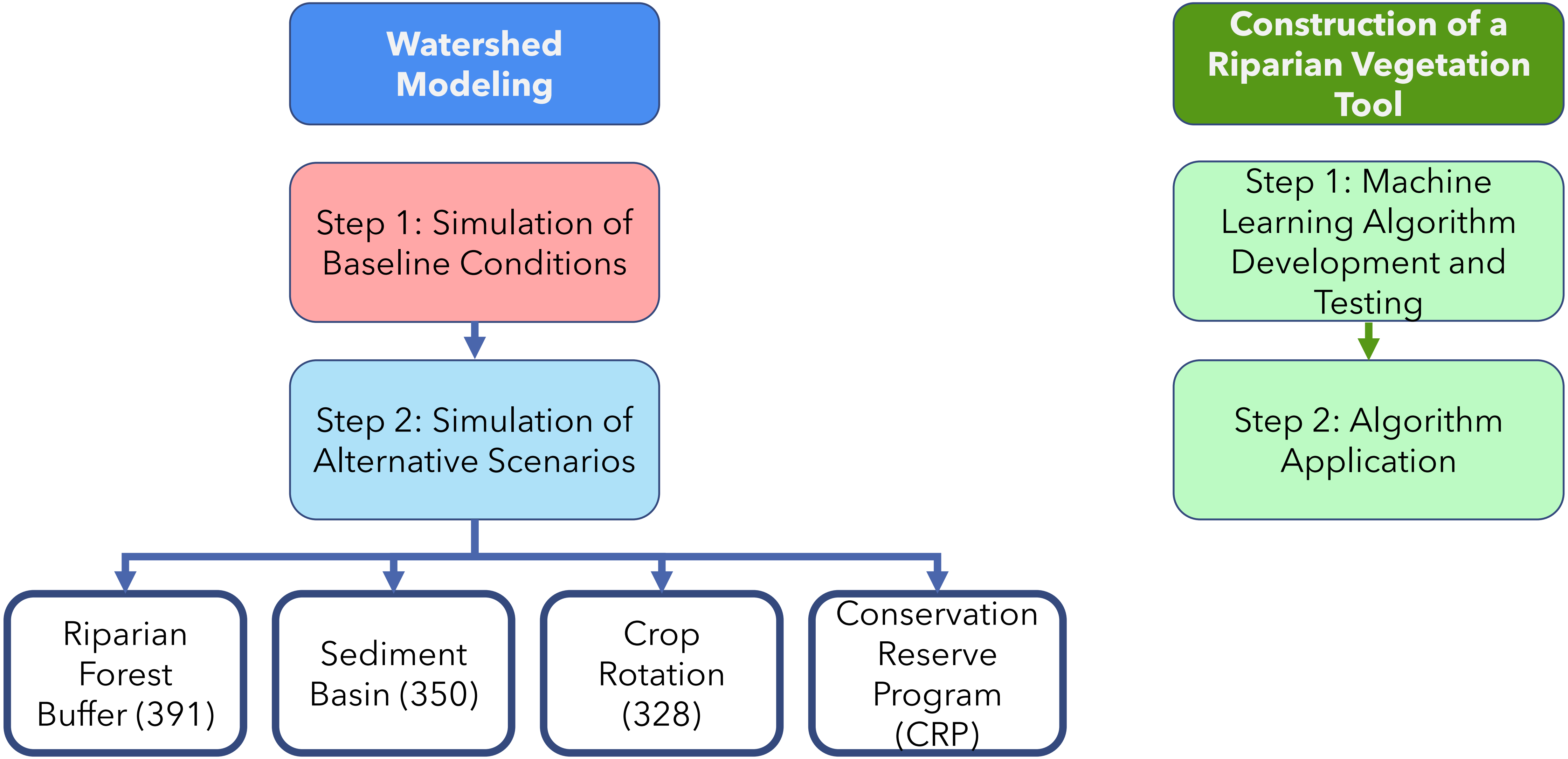

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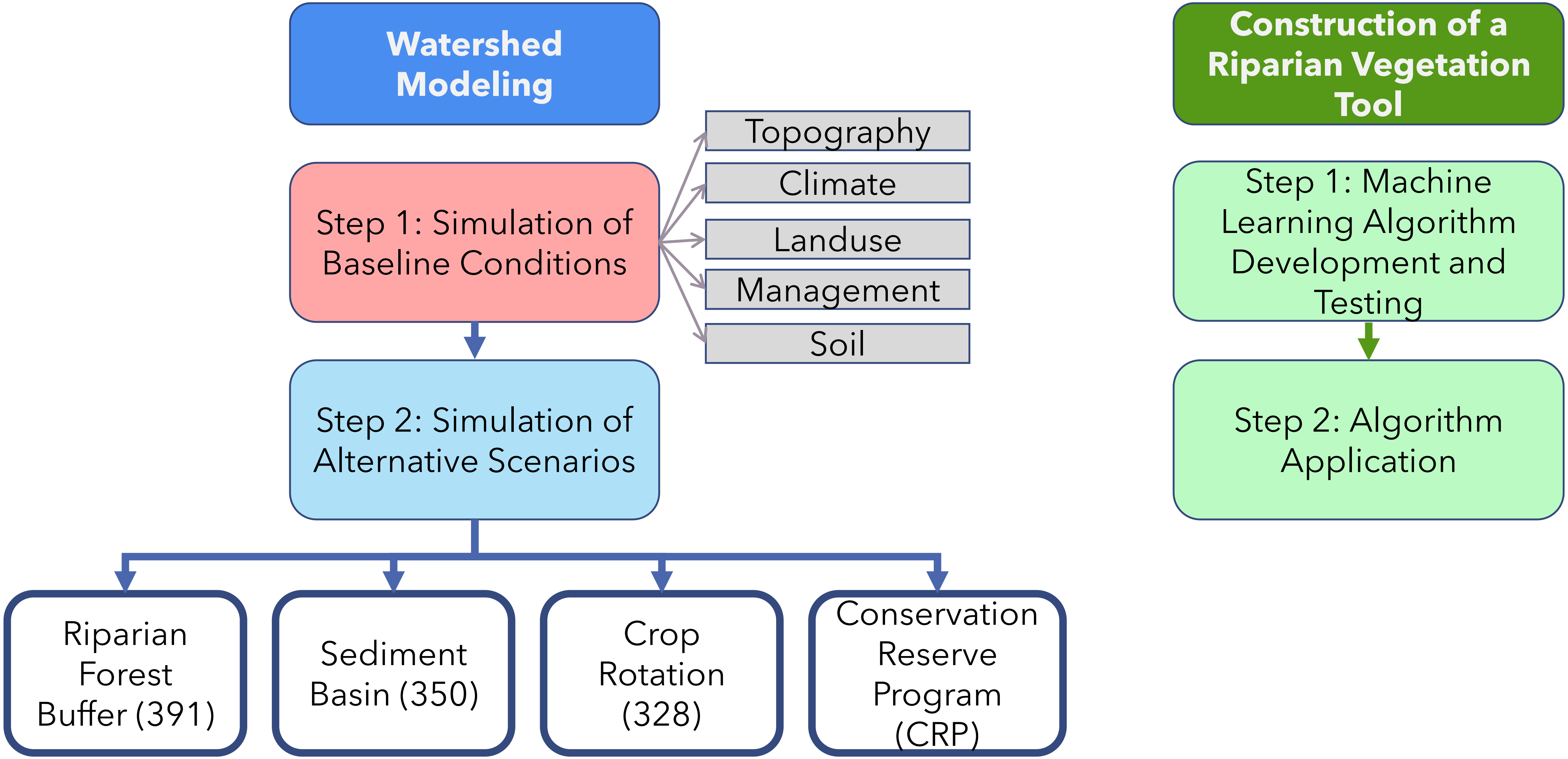


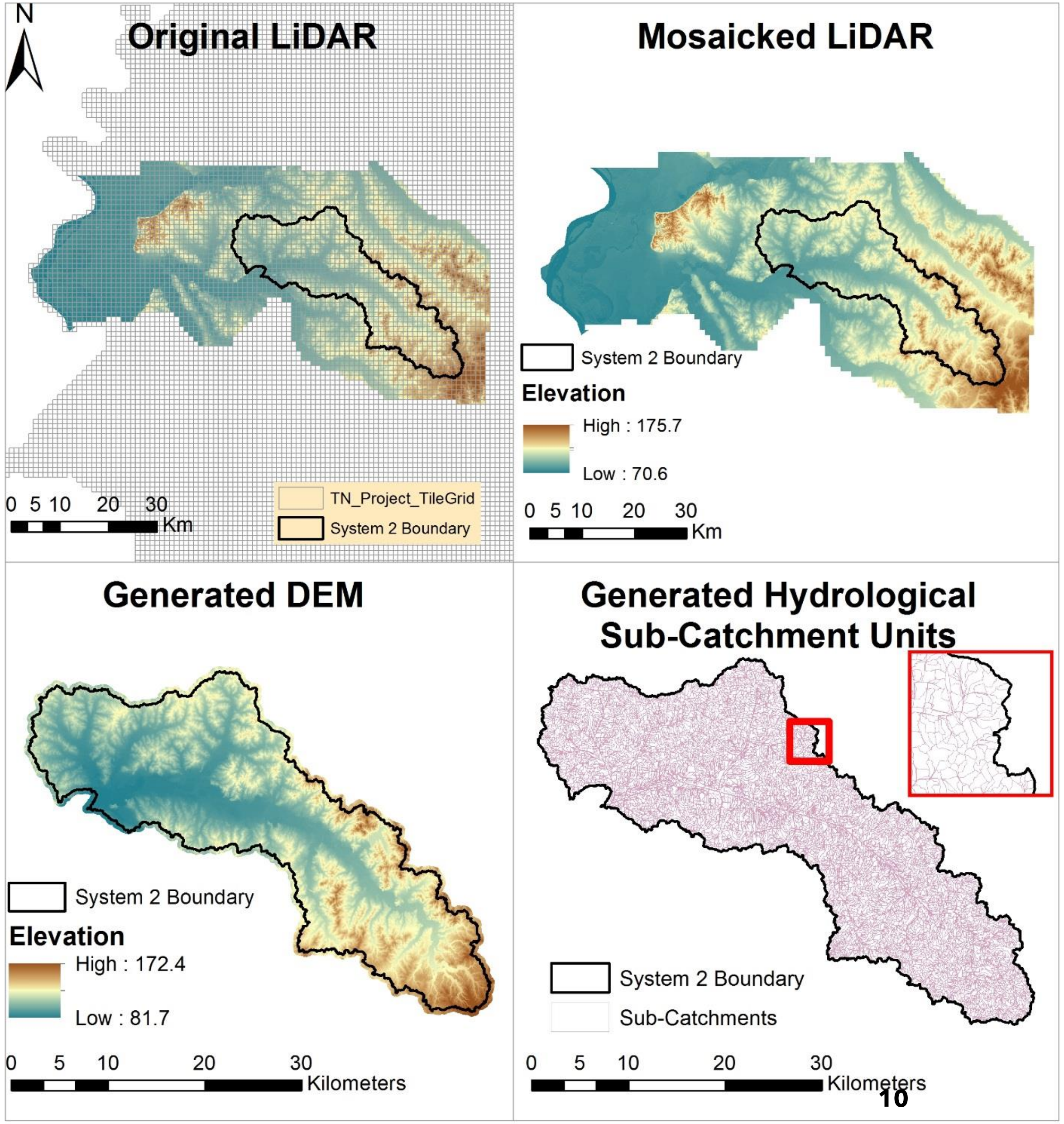
Watershed Modeling: Topography

- Topographic analyses were performed using standard flow routing algorithms applied to the study area Digital Elevation Model (DEM).

- The AnnAGNPS GIS component (TopAGNPS) was used because it streamlines most of the GIS steps and also generates the two topographic input data sections needed by the AnnAGNPS watershed model.

- DEMs for the state of Tennessee were collected from the Tennessee Department of Finance and Administration (https://www.tn.gov/finance/sts-gis/gis/data.html) and for the state of Kentucky from the Kentucky Division for Geographic Information (http://kymartian.ky.gov). These datasets were provided as 1-km tilled raster grids (DEMs) and at different spatial resolution, 1-m for Tennessee and 1.5-m for Kentucky.

- A total of 290 tiles were used for System 1 and 814 tiles were used for System 2

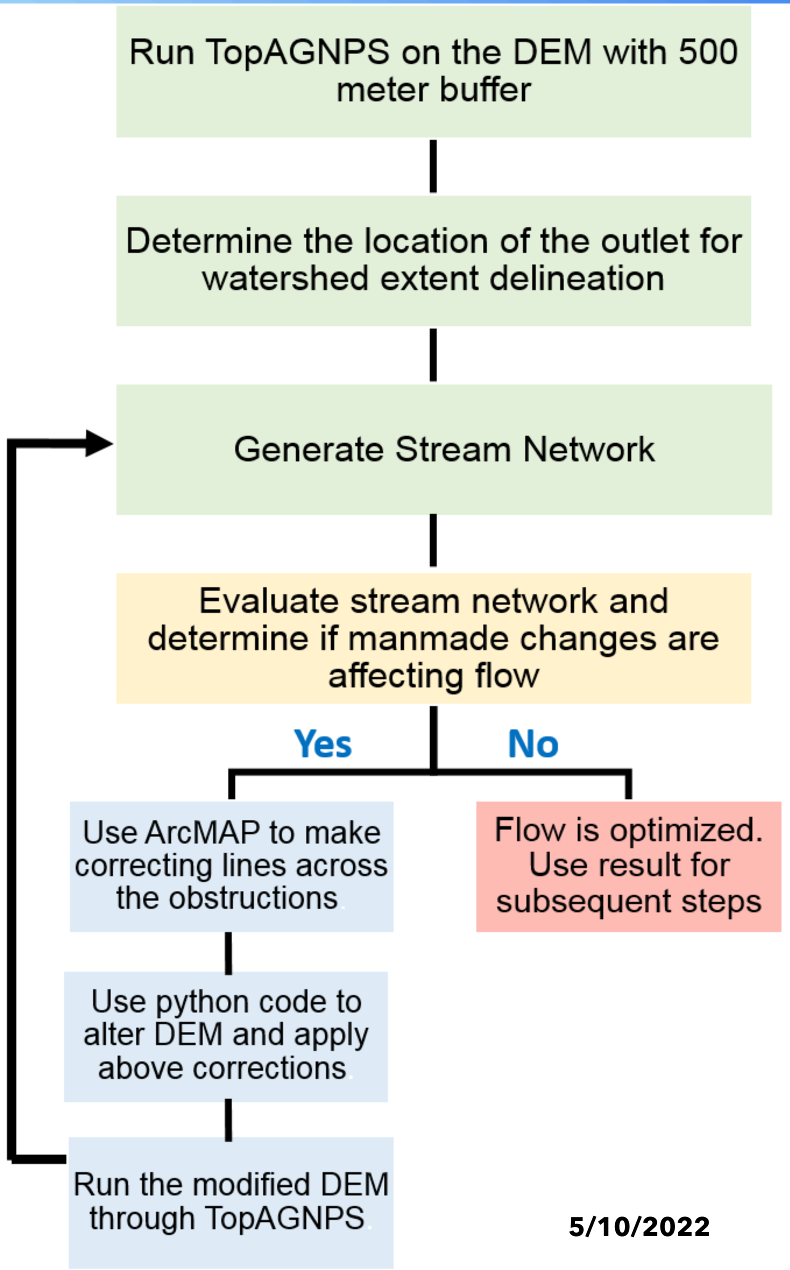


Watershed Modeling: Topography

- TopAGNPS software package was used to delineate the watershed boundaries and to generate the channel network (reaches) and sub-catchments (AnnAGNPS cells).

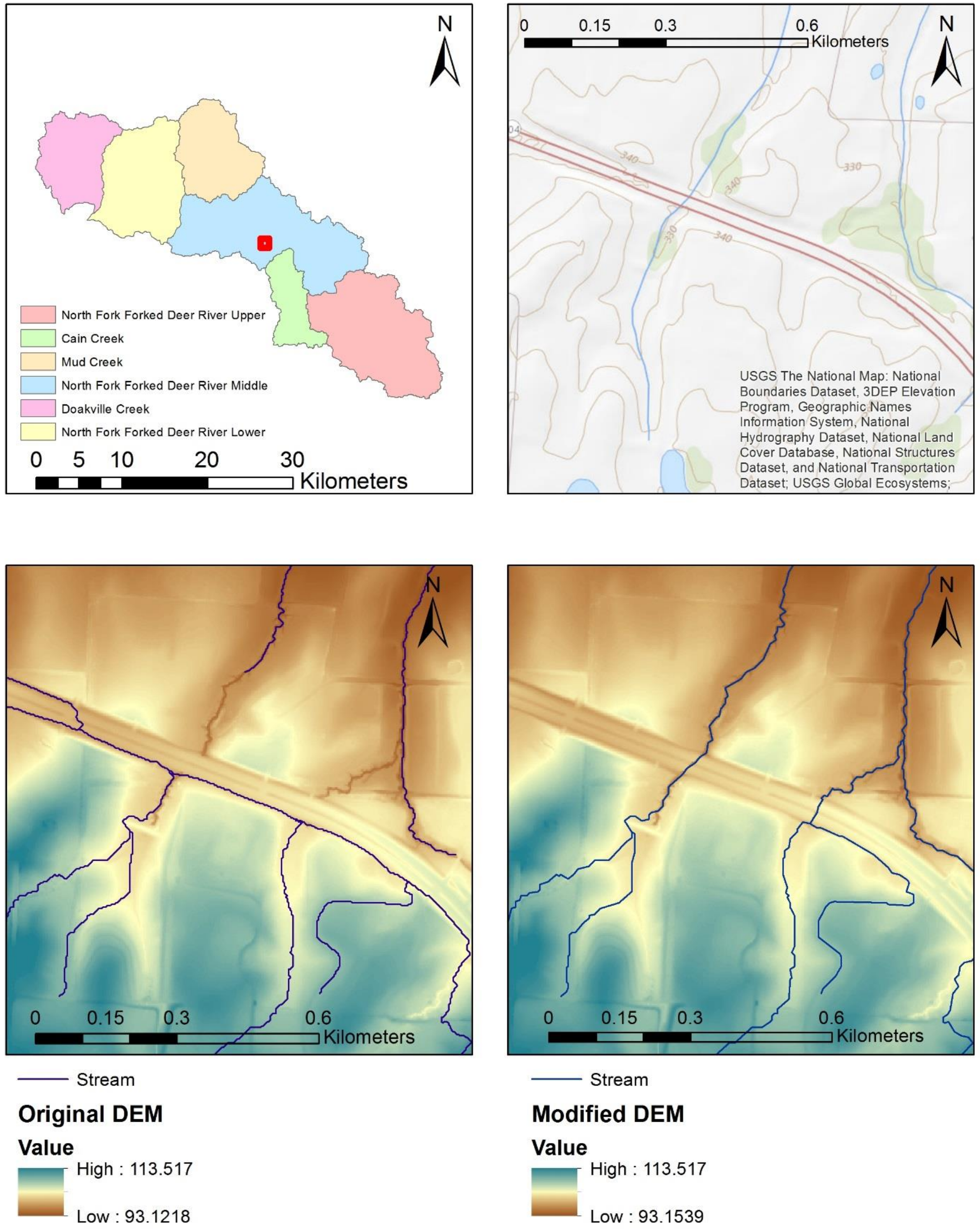
- Upon visual inspection of the generated channel network, it was observed that the DEM datasets obtained from state agencies were only partially hydrologically enforced. Only major man-made structures were artificially removed. This limitation forced us to perform hydrologically enforcing procedures. An iterative approach was applied.

- Datasets generated by the TopAGNPS computer program were visually analyzed and compared to high-resolution imagery and auxiliary GIS layers to determine whether manmade obstructions would hinder the flow routing algorithm causing these structures to work as pseudo-damns resulting in incorrect surface flow network and/or increase ponding beyond normal levels.



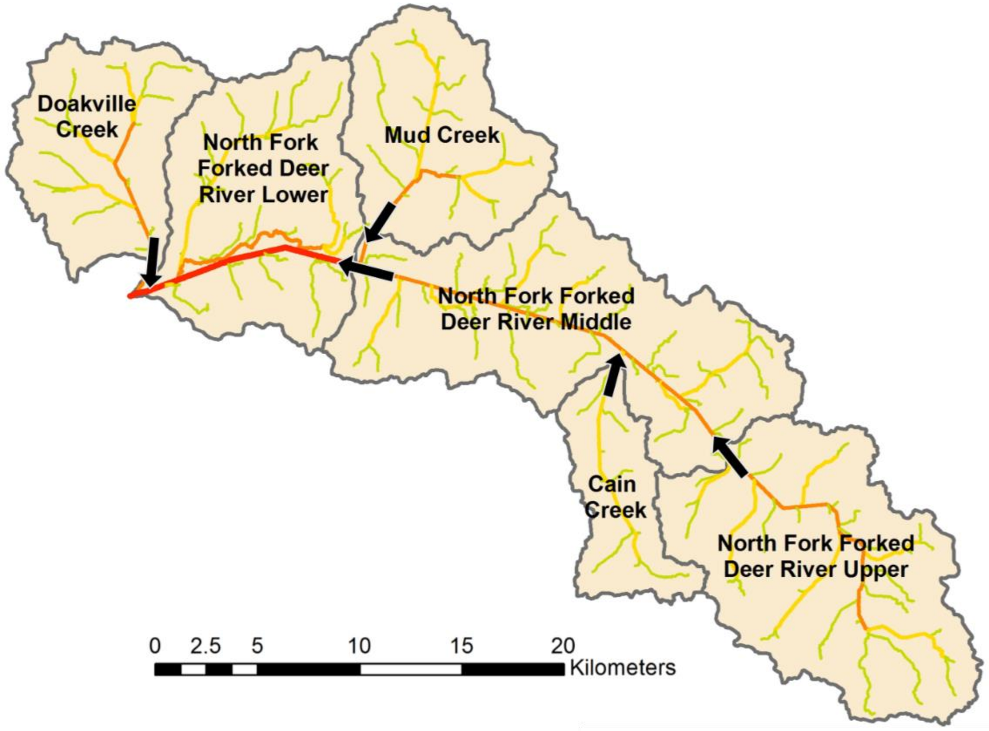
Watershed Modeling: Topography

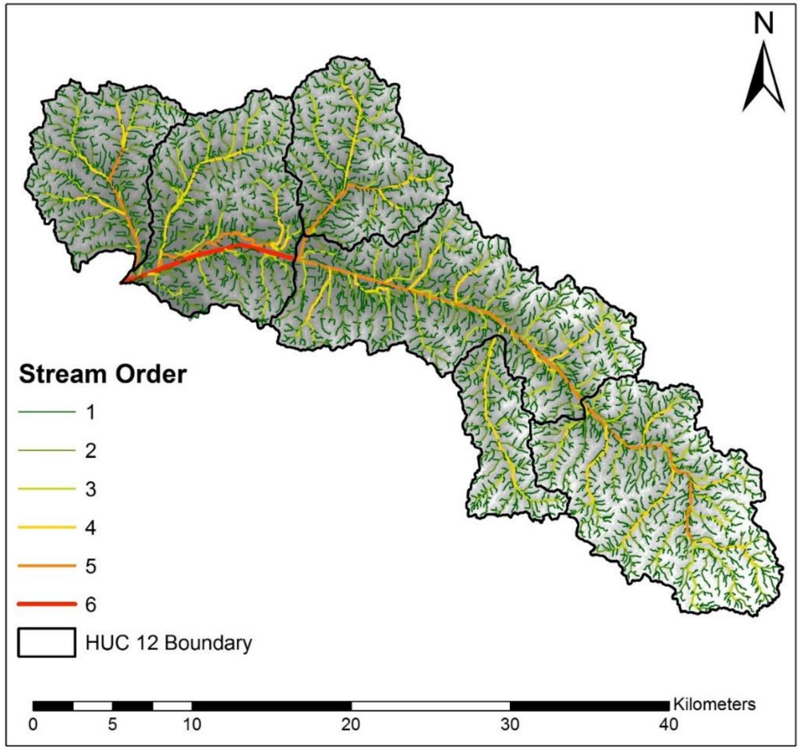
Example of Hydrological Correction



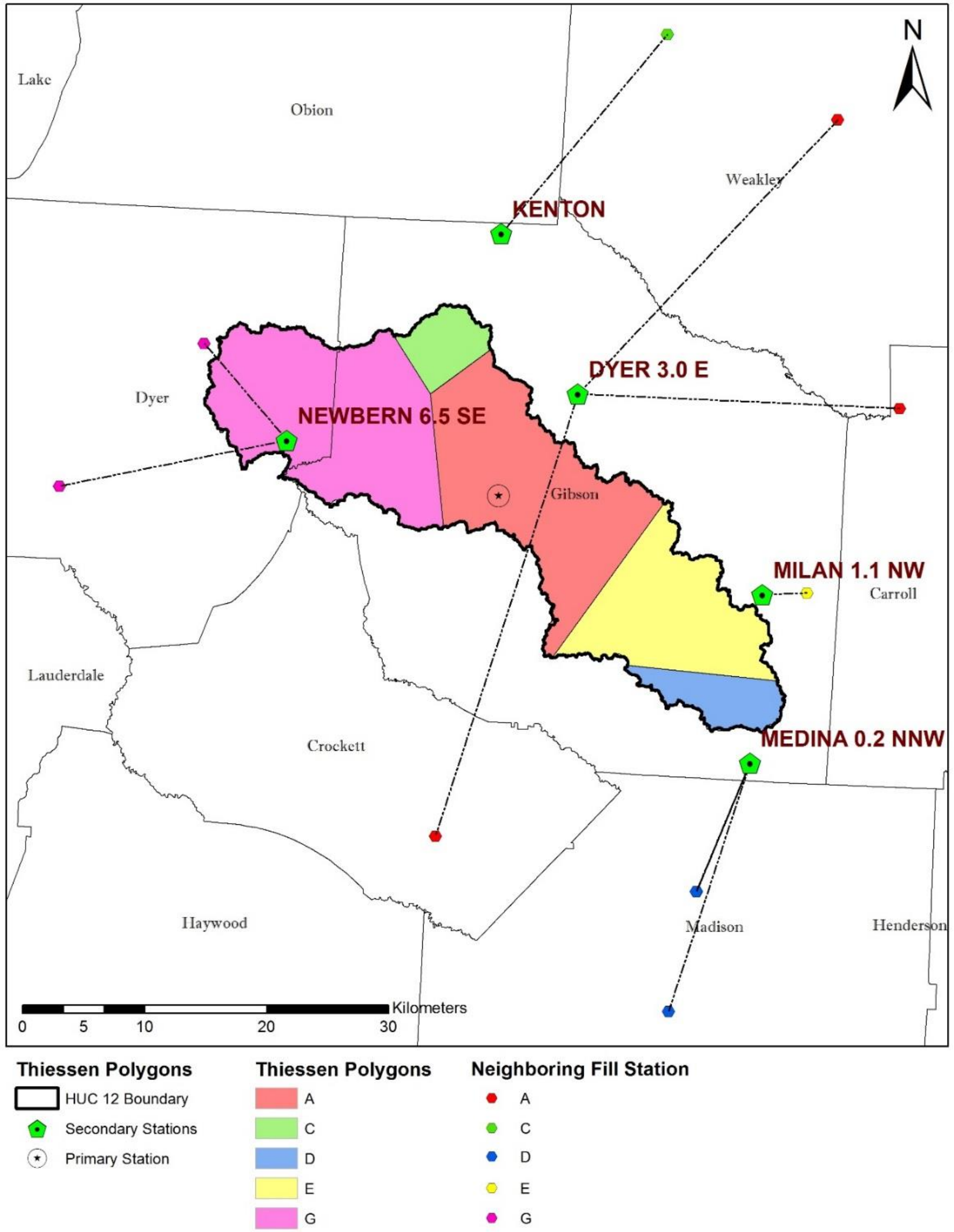
Watershed Modeling: Topography

HUC-12 Name	Number of AnnAGNPS Cells	Average Cell Area (Ha)	Average Cell Slope (%)	Average Cell Elevation (m)	Average Concentrated Flow Length (m)
North Fork Forked Deer River Upper	2946	5.00	0.08	120.51	46.45
Cain Creek	904	4.81	0.08	112.56	245.89
Mud Creek	1682	5.04	0.06	102.50	255.84
North Fork Forked Deer River Middle	3165	5.10	0.05	102.91	259.92
Doakville Creek	1561	4.95	0.06	96.97	243.84
North Fork Forked Deer River Lower	2311	4.99	0.04	94.18	259.56





Watershed Modeling: Climate



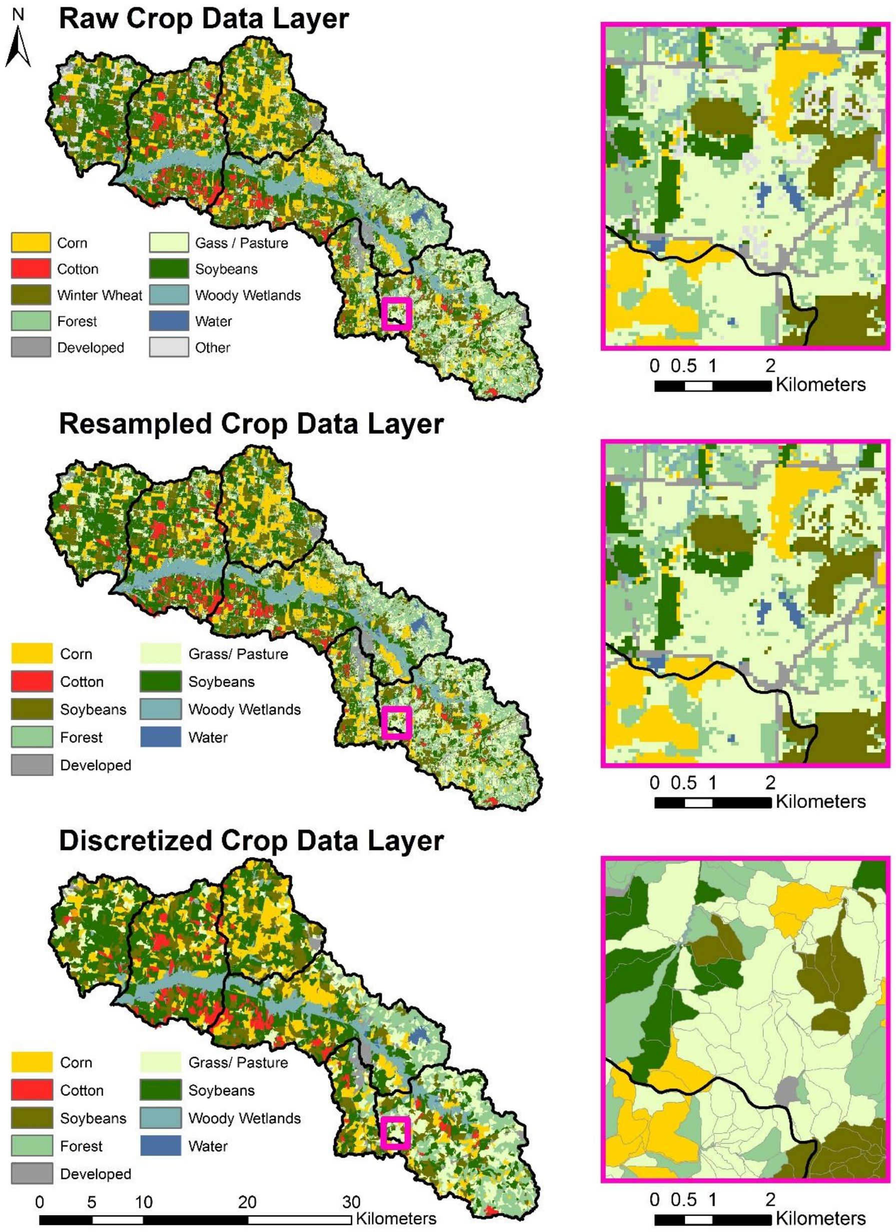
- Climate datasets (i.e. daily precipitation, daily maximum and minimum temperature) from 2008 to 2018 were obtained from the U.S. National Oceanic and Atmospheric Administration (NOAA).

- The data was spatially analyzed to identify the weather stations with the greatest temporal data coverage and their location in relation to the watershed. Neighboring stations from outside the watersheds were used to fill data gaps in the stations located within the study area.

- Once these stations record was filled, the stations were evaluated to ensure that the data distribution followed the climatic range for the closest cities in the region. The evaluation procedure also removed data anomalies.

- Synthetic weather characteristics not available form historic observations were also generated using AGNPS Climate Generator (agGEM) software package, including dew point, sky cover, wind speed, and solar radiation.

Watershed Modeling: Landuse



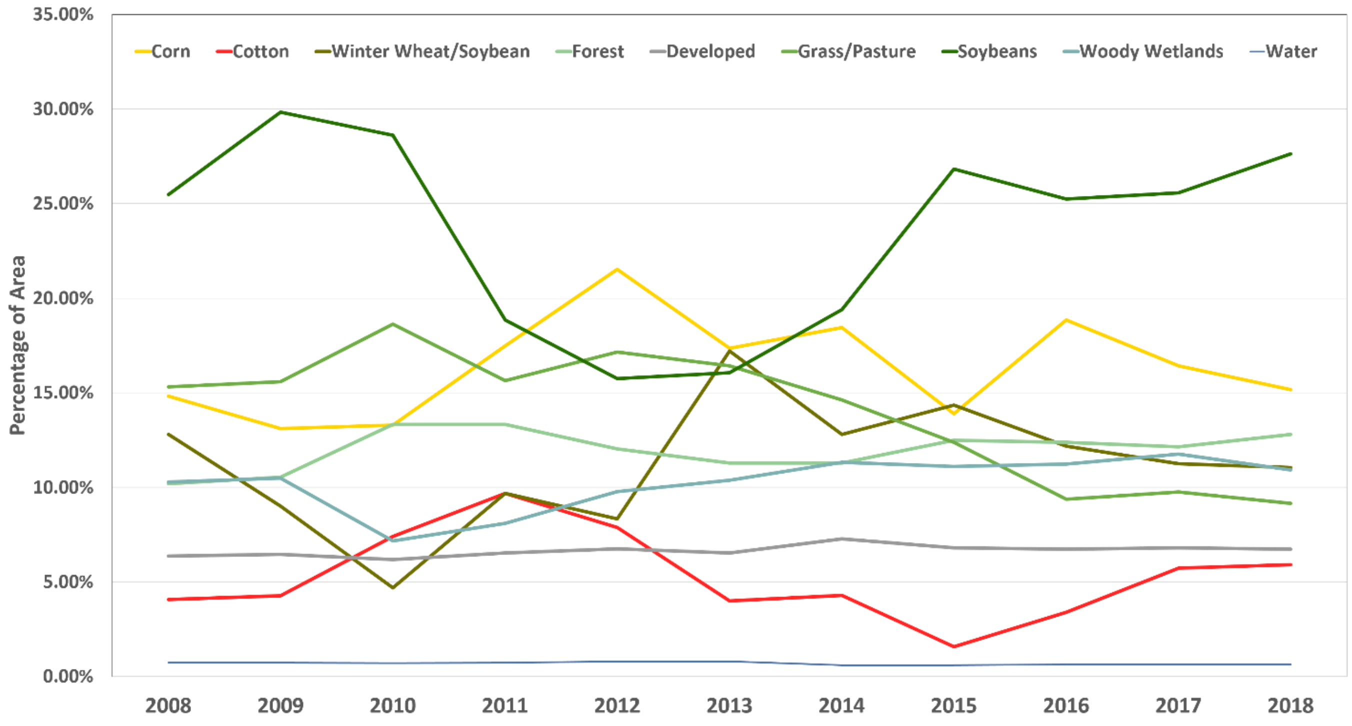
- Annual land use/land cover data describing crop type from 2008 to 2018 was obtained from the National Agricultural Statistics Service's Cropland Data Layer (CDL) as raster grid files.

- Statistical analyses were performed to determine dominant crop types based on datasets for years 2008, 2013, and 2018. Nine major classes were ascertained from the original land use classes. The nine dominant consistent classes are corn, cotton, winter wheat/soybean, forest, developed, grass/pasture, soybeans, woody wetlands, and water. These classes represented more than 90% of system 2. Crops that were less conventional, such as pumpkins or Christmas trees, were classified under "grass/pasture," given that they have a percentage of less than 0.01 of the total study area.

- The original land use/land cover raster grids for each system and for all years were resampled to the main nine land use classes. Additionally, the raster grids were resampled from 30 to 1-meter spatial resolution for improved results of spatial zonal statistic GIS analysis. This method was used to assign the representative land use to each AnnAGNPS cell (one dominant land use per year).

Watershed Modeling: Management Practices

- Farming management practices are generated by integrating:
  - spatiotemporal crop type information at raster grid cell scale (from CDL),
  - average crop yield at county scale (from USDA-NASS), and,
  - one-year farming management schedule (from USDA-NRCS). This represents typical farming operations and schedules for each crop type in this region. It includes information about when the plants are sowed, when the fertilizer and insecticide are applied, and when the harvest and fallow are conducted, among other management practices.



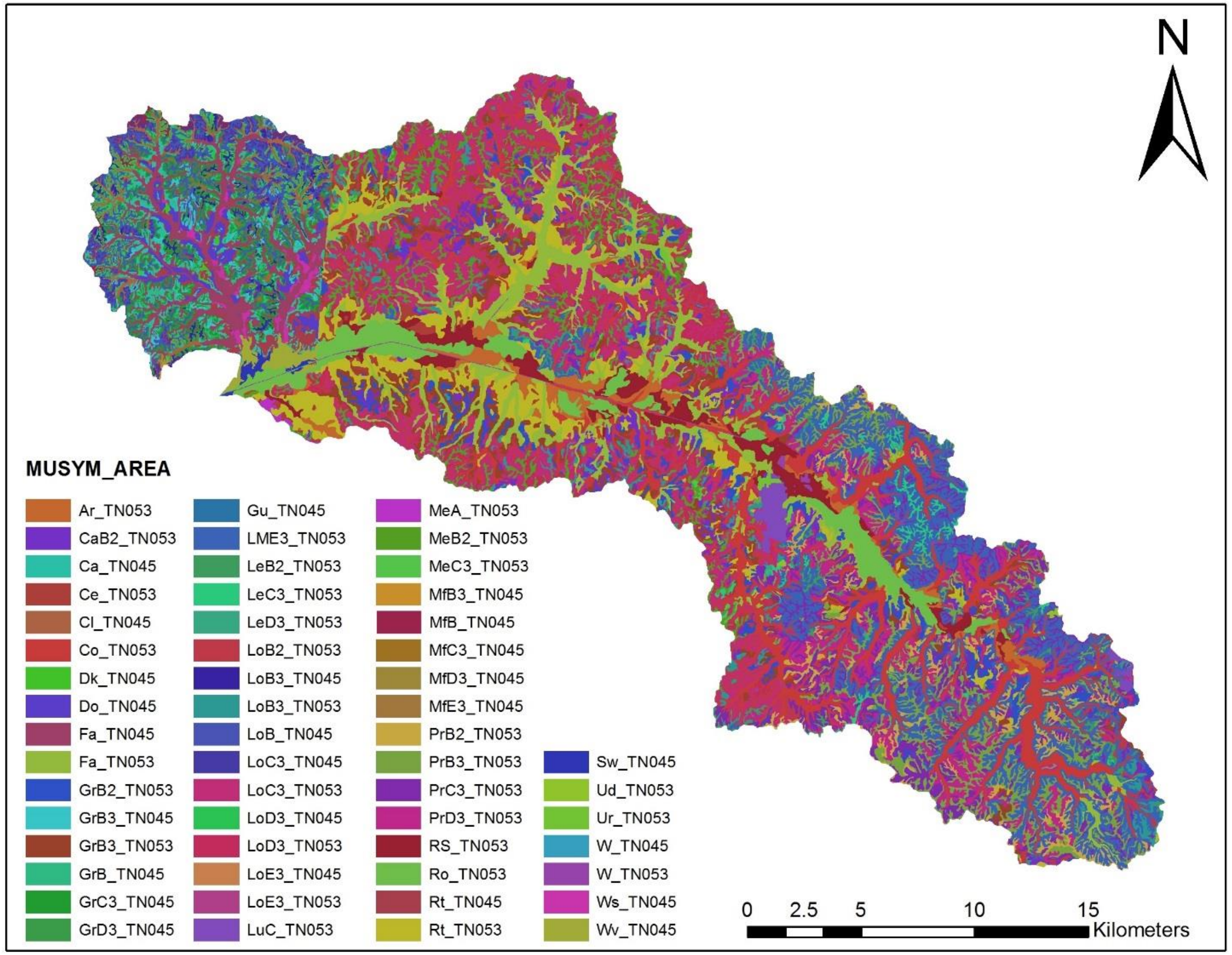
- This information is mapped to crop managements in the Revised Universal Soil Loss Equation (RUSLE2) database. The computer program RUSLE2 Import to AnnAGNPS (RITA) was used. The land use management files are then processed using two custom algorithms (Python programming language). The first code generates a management sequence for each AnnAGNPS cell and the second algorithm merges the sequence of land use with one-year management and operation templates to develop 11 years crop rotations in the required AnnAGNPS file format.

Watershed Modeling: Soil

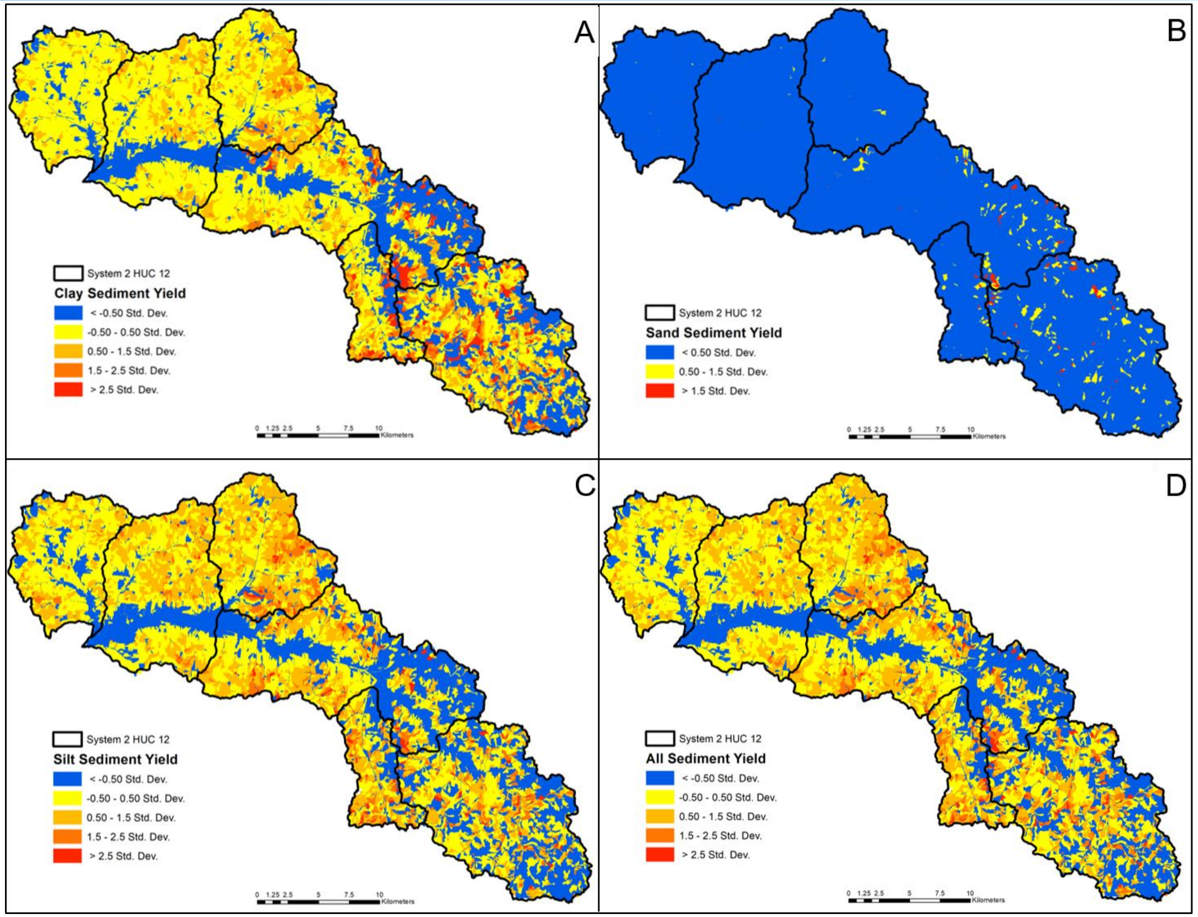
- Soil spatial data was retrieved from the Web Soil Survey (WSS) – by the Natural Resources Conservation Service's (NRCS).

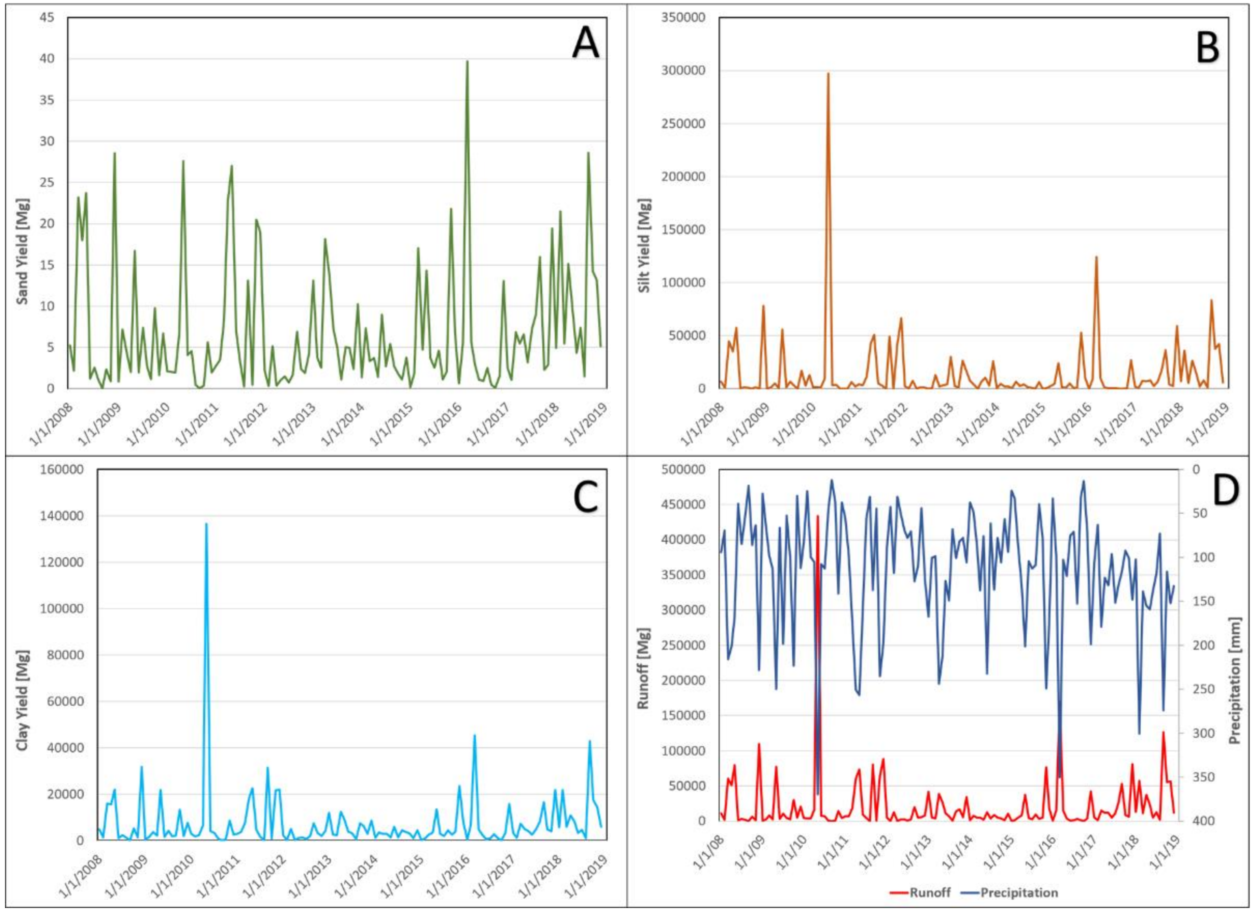
- Complementary soil description of physical and chemical properties in tabular format were retrieved from the USDA Soil Data Access website.

- These datasets were post processed using the NASIS Import to AnnAGNPS (NITA) software package to ensure the accuracy of the soil characteristic table. This procedure was performed one county at the time. Once the data was quality controlled, the soil characteristic data table was joined to the attribute table of the original soil shapefile.



Watershed Modeling: Baseline Conditions

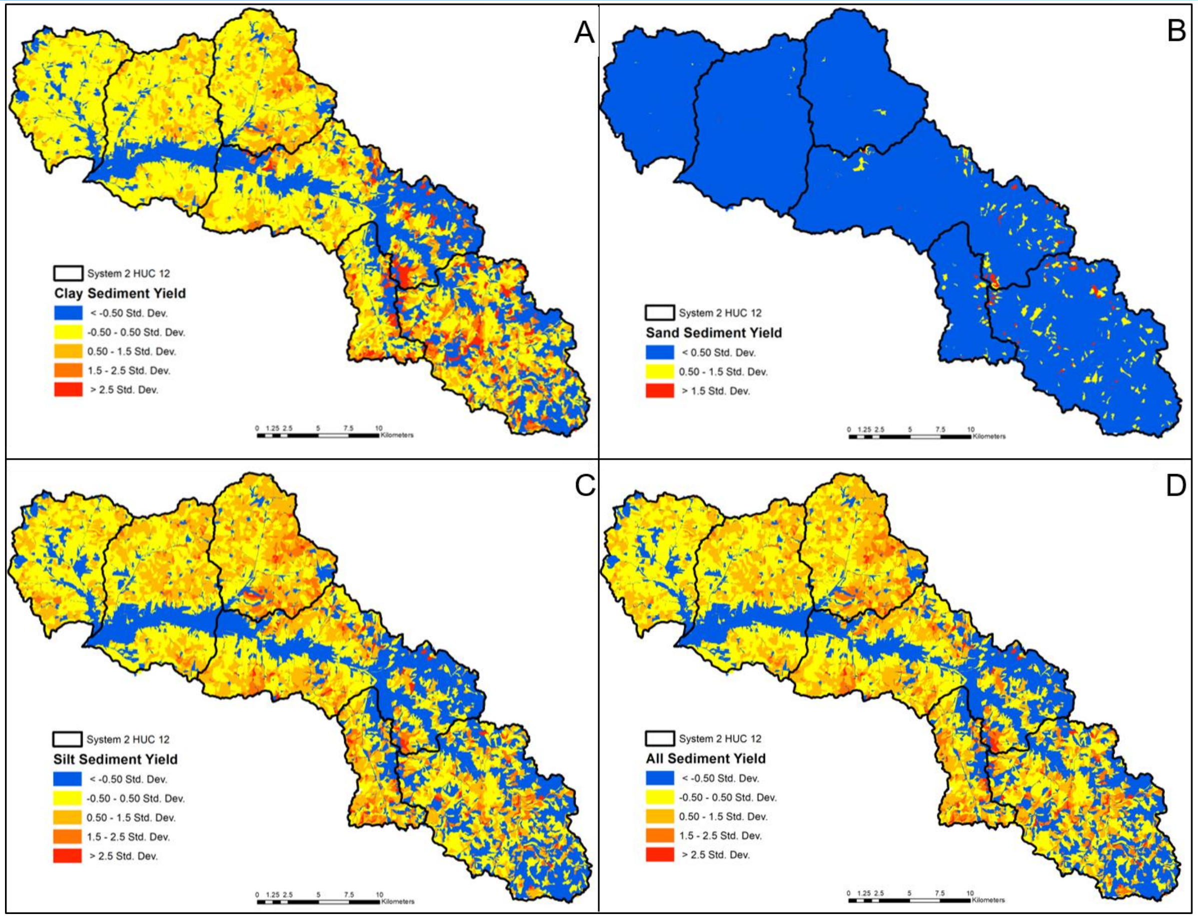


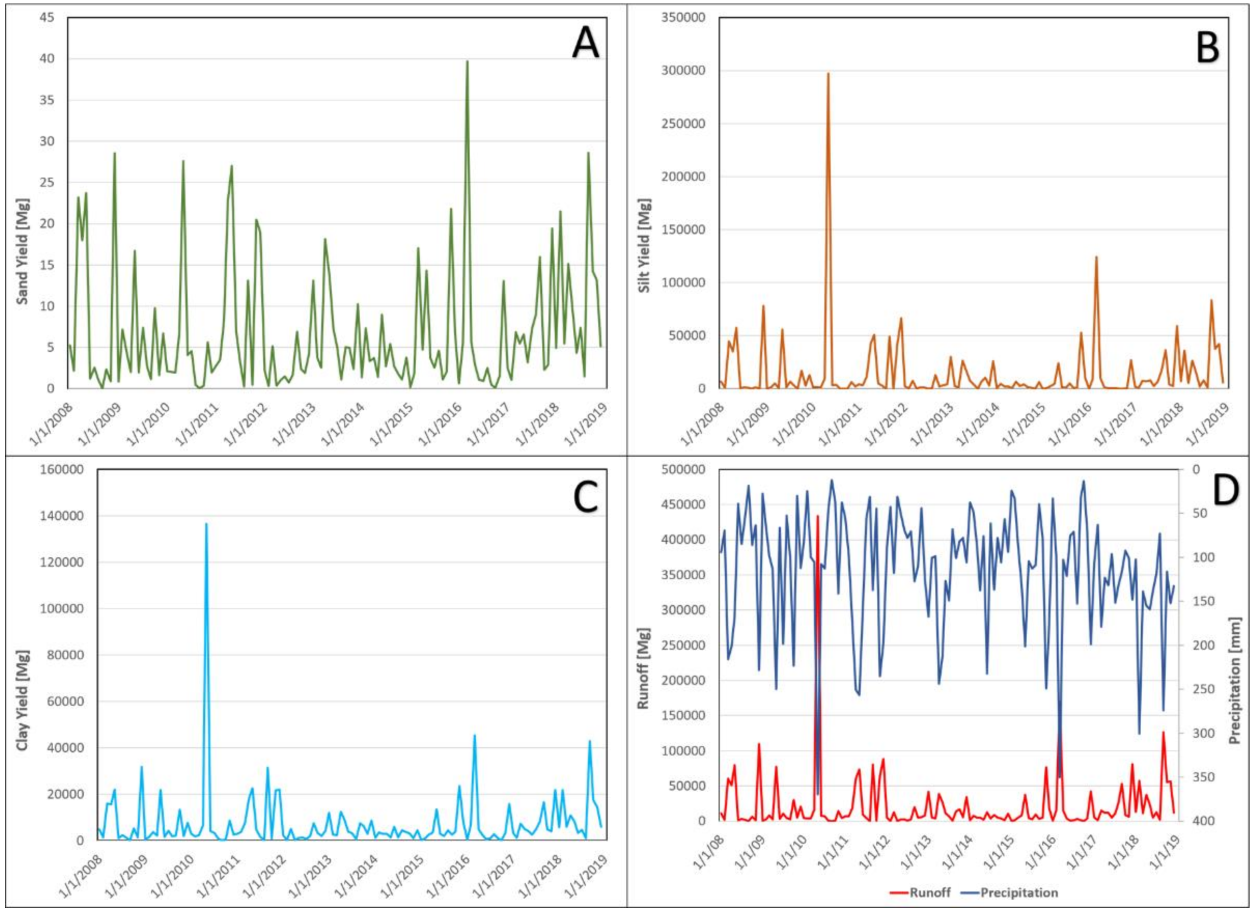


Results show the spatial distribution of sediment yield across the watershed. These maps serve as a guide to locate hot spot areas in term of sediment production and a guideline for the development of targeted implementation of the appropriate conservation practices in critical locations.

For instance, simulation results indicate high yield of clay and silt in system 2, especially in Mud Creek, North Fork Forked Deer River Lower and Doakville Creek in comparison to Cain Creek and North Fork Forked Deer River Upper.

Watershed Modeling: Baseline Conditions

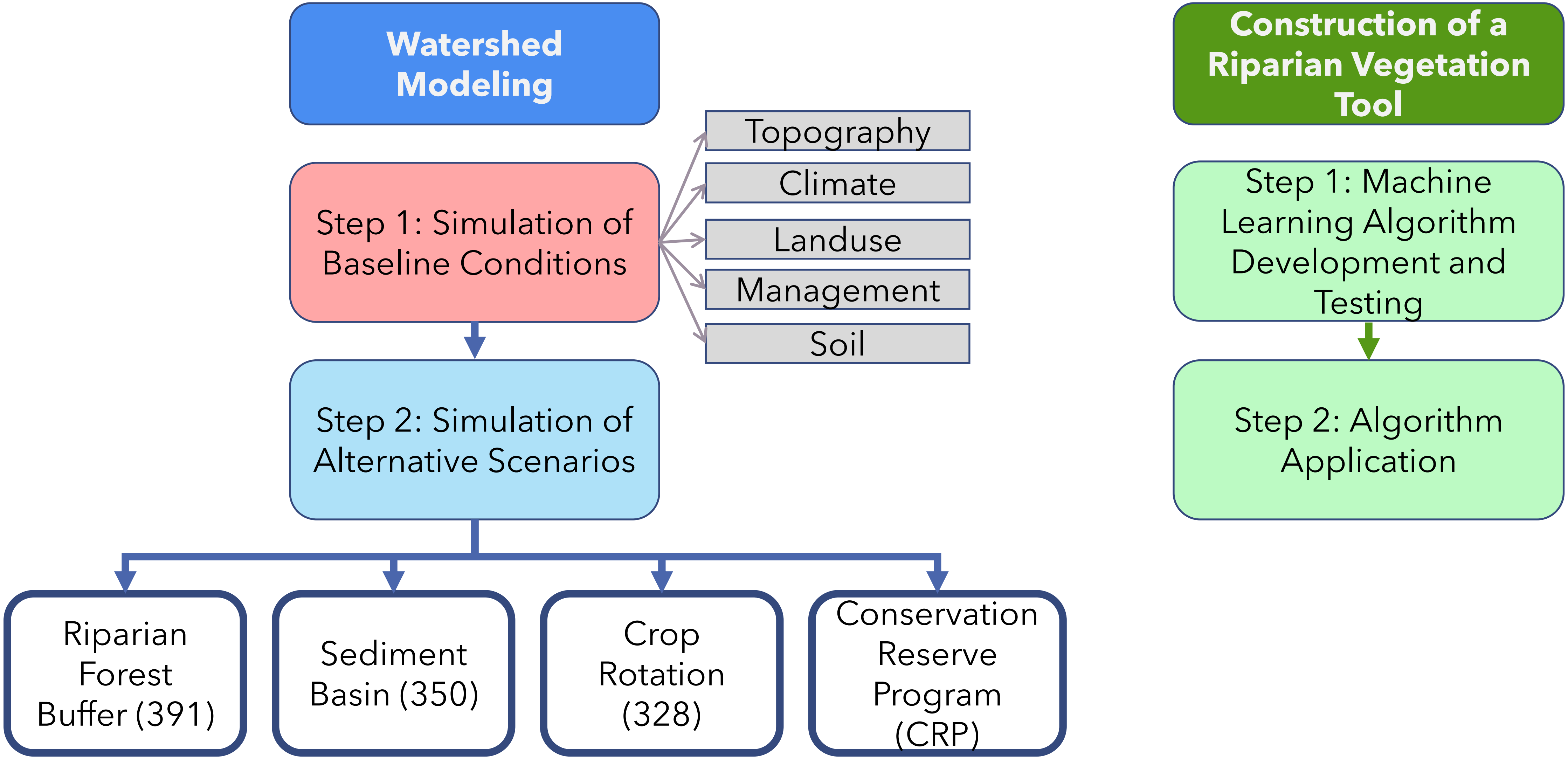




Baseline conditions summary also include sediment load temporal variation (total and by particle size). There is a temporal correlation between silt and clay yield but not with sand load, with a major peak in 2010. Sand yield peaked in 2016 in system 2. It is noticeable that estimates of sediment load of sand size particles are orders of magnitude smaller than silt and clay for all systems.

Similar results are available each watershed of system 1.

Project Structure



Project Structure

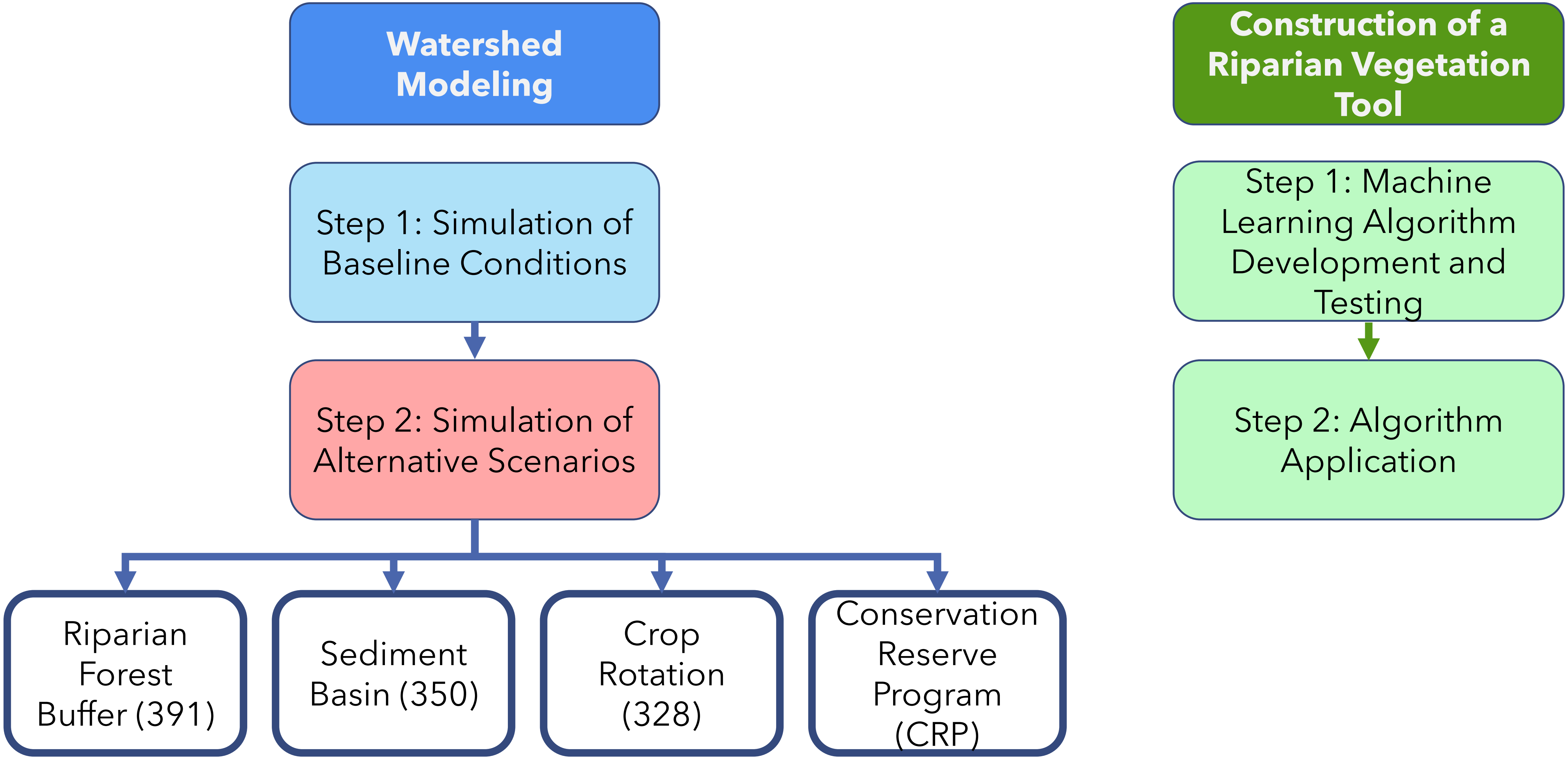
Watershed Modeling

- Step 1: Simulation of Baseline Conditions
- Step 2: Simulation of Alternative Scenarios
  - Riparian Forest Buffer (391)
  - Sediment Basin (350)
  - Crop Rotation (328)
  - Conservation Reserve Program (CRP)

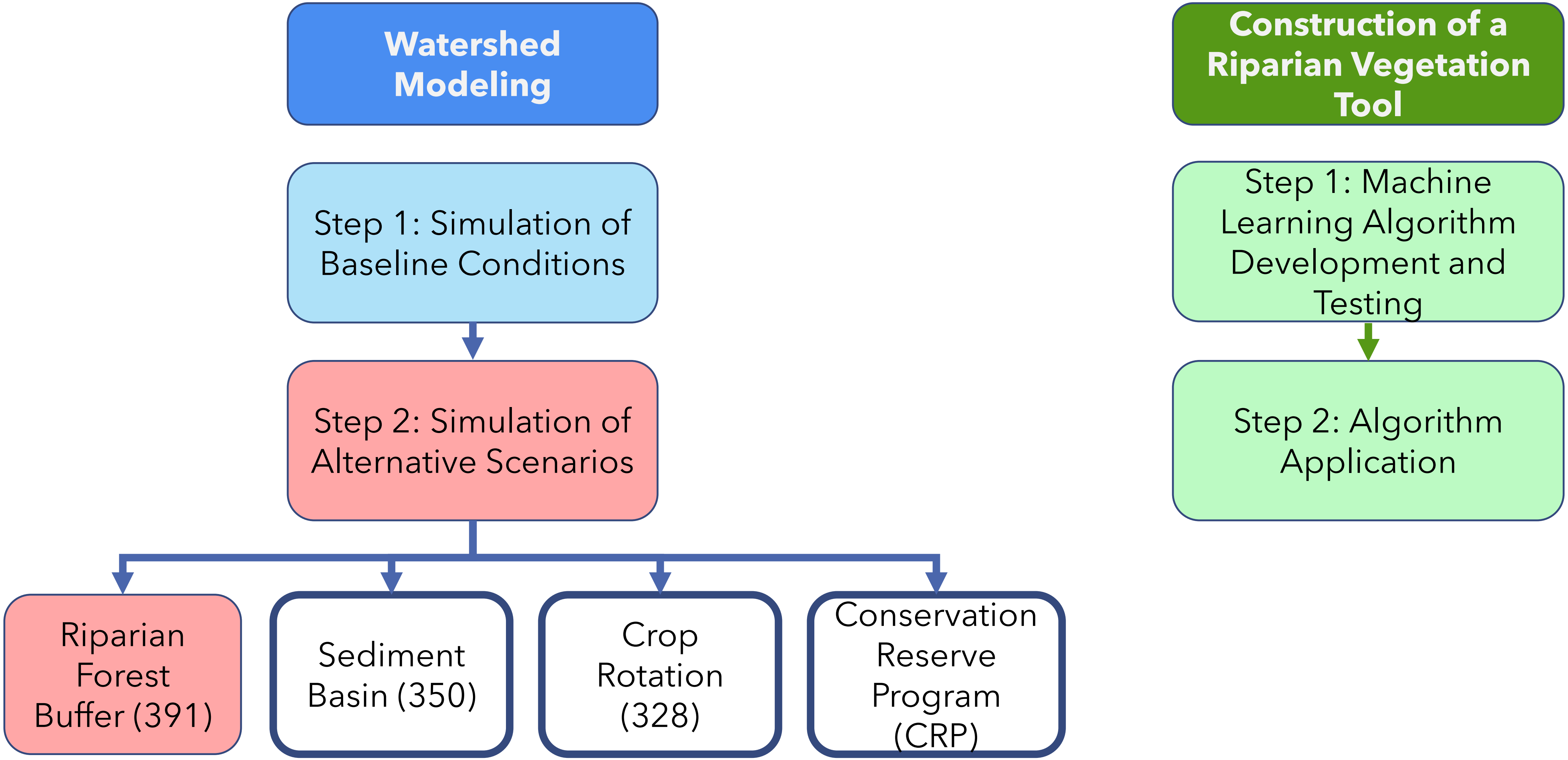
Construction of a Riparian Vegetation Tool

- Step 1: Machine Learning Algorithm Development and Testing
- Step 2: Algorithm Application

Project Structure



Project Structure



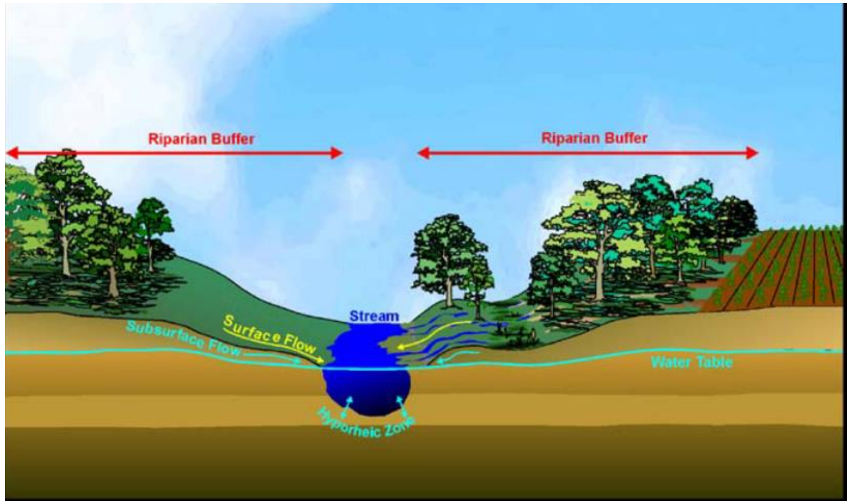
Simulation of Alternative Scenarios: Riparian Buffer (code 391)

- A riparian forest buffer is an area location adjacent to and up gradient from a water body predominantly covered by trees and/or shrubs. The presence of riparian forest buffers reduces the transport of sediments, chemicals, pesticides and pathogens to surface water.

- The **goal** is to run scenarios representing a spectrum of conditions on the ground and evaluate how much sediment reduction will be achieved. This will allow us to identify the optimal scenario in terms of sediment conservation.

- We evaluated the effectiveness of constructed riparian buffer scenarios ranging in **size and spatial extent**.

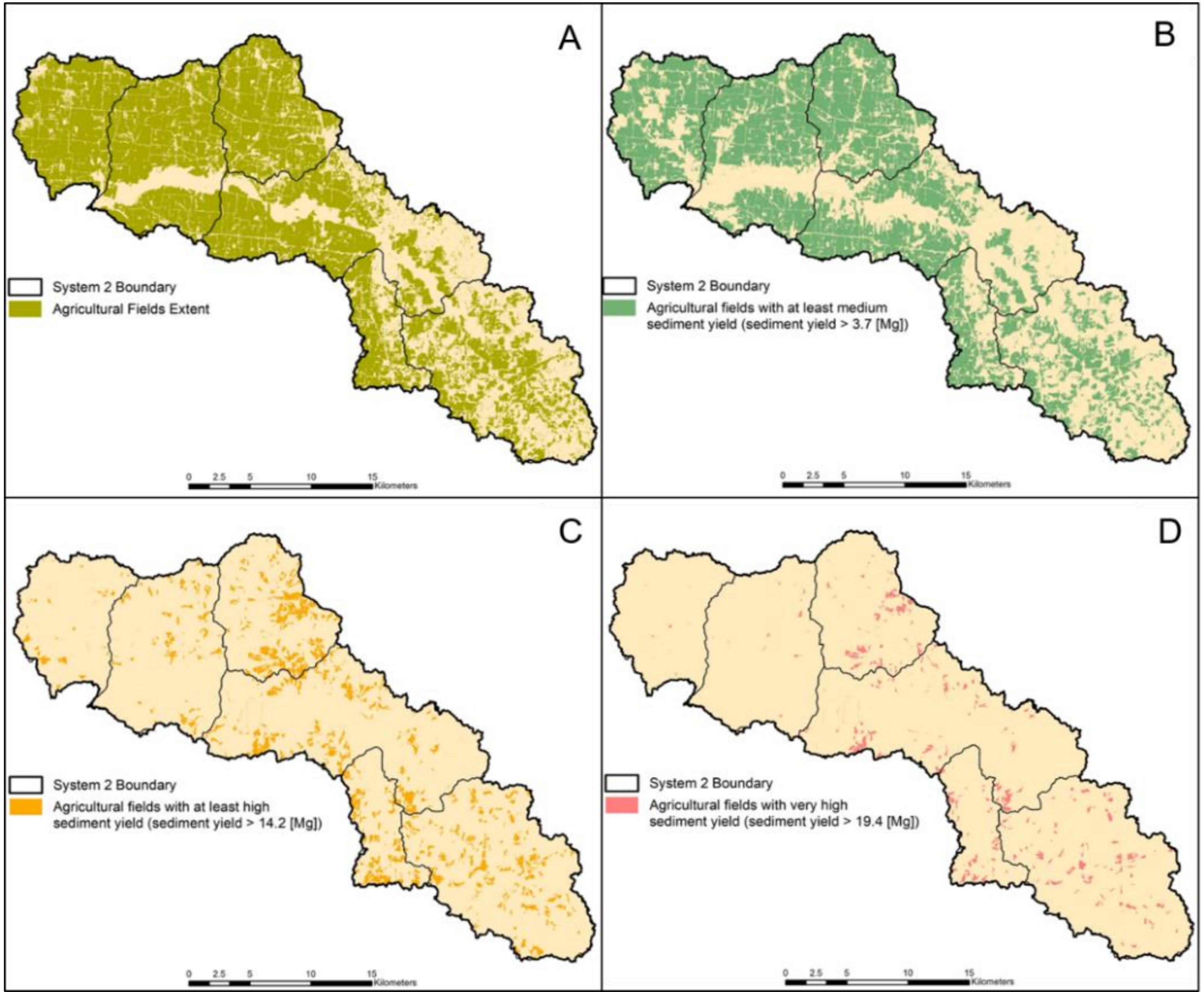
- **Size:** The riparian buffer sizes that were considered are 10m, 30m and 60m. We selected these buffer widths, given that the EPA defines narrow buffer width as 1 – 15 meters and wide buffer width as higher than 50 meters. State and federal guidelines range from seven to 200 meters



Simulation of Alternative Scenarios: Riparian Buffer (code 391)

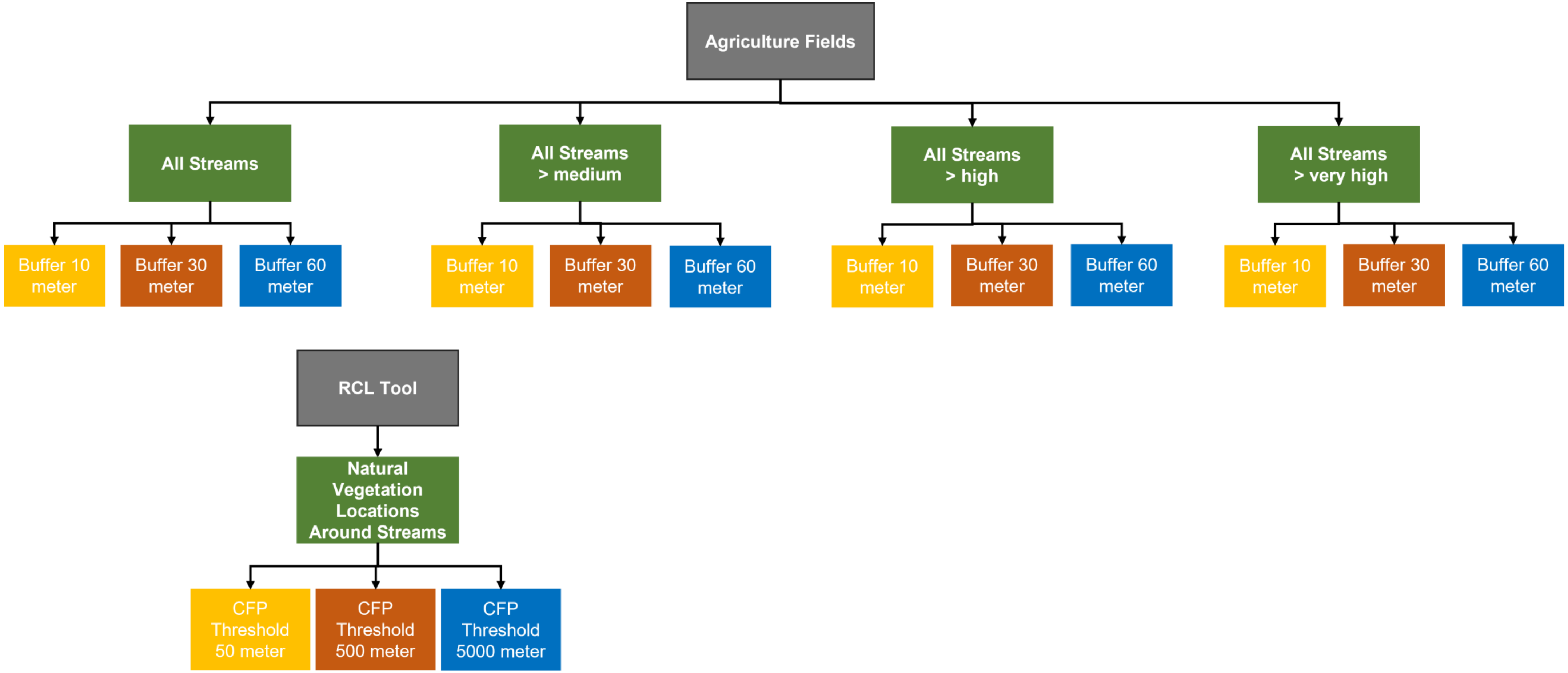
The managed riparian buffer locations that were considered are:

- Around all the streams
- Around all the streams adjacent to agricultural fields **(A)**
- Around all the streams adjacent to agricultural fields that have a sediment yield higher than mean – standard deviation **(B)**
- Around all the streams adjacent to agricultural fields that have a sediment yield higher than mean (referred to as "> high") (**C**)
- Around all the streams adjacent to agricultural fields that have a sediment yield higher than mean + standard deviation (referred to as "> Very High") (**D**)



Simulation of Alternative Scenarios: Riparian Buffer (code 391)

By combining these different conditions (i.e. sediment yield class, all or just agricultural areas, buffer width) we run 16 simulations representing 16 scenarios for each studied watershed. . A total of 64 AnnAGNPS simulations were performed for various riparian buffer conditions, with varying computer run time between 24 to 120 hours per simulation. The goal was to assess the impact of riparian buffers in a wide range of conditions.



Lower Elk Fork

Simulation ID	Location Description	Riparian Buffer Width	Total Sediment Load Mg	Sediment Reduction (%)
S2_ALL _10	All Streams	10m	2,090.147	68%
S2_ALL_30	All Streams	30 m	1,551.973	76%
S2_ALL_60	All Streams	60 m	1,555.262	76%
S2_AG_10	All streams adjacent to agricultural fields.	10 m	3,534.267	46%
S2_AG_30	All streams adjacent to agricultural fields.	30 m	3,228.49	51%
S2_AG_60	All streams adjacent to agricultural fields.	60 m	3,212.527	51%
S2_MED_10	All streams adjacent to agricultural fields with a sediment yield higher than 0.6 Mg	10 m	3,564.962	46%
S2_MED_30	All streams adjacent to agricultural fields with a sediment yield higher than 0.6 Mg	30 m	3,259.758	50%
S2_MED_60	All streams adjacent to agricultural fields with a sediment yield higher than 0.6 Mg	60 m	3,239.027	51%
S2_HIGH_10	All streams adjacent to agricultural fields with a sediment yield higher than 3.4 Mg	10 m	4,502.538	32%
S2_HIGH_30	All streams adjacent to agricultural fields with a sediment yield higher than 3.4 Mg	30 m	4,310.971	35%
S2_HIGH_60	All streams adjacent to agricultural fields with a sediment yield higher than 3.4 Mg	60 m	4,309.017	35%
S2_VH_10	All streams adjacent to agricultural fields with a sediment yield higher than 6.1 Mg	10 m	5,480.914	17%
S2_VH_30	All streams adjacent to agricultural fields with a sediment yield higher than 6.1 Mg	30 m	5,400.888	18%
S2_VH_60	All streams adjacent to agricultural fields with a sediment yield higher than 6.1 Mg	60 m	5,378.768	18%
Natural	Existing Buffer as delineated with the RCL tool	Variable	4,975.65	24%
Natural – 50m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 50 m^2	Variable	4,943.722	25%
Natural – 500m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 500 m^2	Variable	4,861.738	26%
Natural – 5000m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 5000 m^2	Variable	4,661.183	29%
Baseline Conditions	No buffer is integrated into the model	0 m	6,582.258	0%

Red River

Simulation ID	Location Description	Riparian Buffer Width	Total Sediment Load Mg	Sediment Reduction (%)
S2_ALL _10	All Streams	10m	3,298.30	54%
S2_ALL_30	All Streams	30 m	2,868.26	60%
S2_ALL_60	All Streams	60 m	2,880.13	60%
S2_AG_10	All streams adjacent to agricultural fields.	10 m	5,606.89	22%
S2_AG_30	All streams adjacent to agricultural fields.	30 m	5,492.71	23%
S2_AG_60	All streams adjacent to agricultural fields.	60 m	5,470.37	24%
S2_MED_10	All streams adjacent to agricultural fields with a sediment yield higher than 0.5 Mg	10 m	5,622.32	22%
S2_MED_30	All streams adjacent to agricultural fields with a sediment yield higher than 0.5 Mg	30 m	5,516.73	23%
S2_MED_60	All streams adjacent to agricultural fields with a sediment yield higher than 0.5 Mg	60 m	5,493.78	23%
S2_HIGH_10	All streams adjacent to agricultural fields with a sediment yield higher than 4.0 Mg	10 m	6,106.80	15%
S2_HIGH_30	All streams adjacent to agricultural fields with a sediment yield higher than 4.0 Mg	30 m	6,044.89	16%
S2_HIGH_60	All streams adjacent to agricultural fields with a sediment yield higher than 4.0 Mg	60 m	6,019.21	16%
S2_VH_10	All streams adjacent to agricultural fields with a sediment yield higher than 7.4 Mg	10 m	6,649.54	7%
S2_VH_30	All streams adjacent to agricultural fields with a sediment yield higher than 7.4 Mg	30 m	6,605.30	8%
S2_VH_60	All streams adjacent to agricultural fields with a sediment yield higher than 7.4 Mg	60 m	6,590.89	8%
Natural	Existing Buffer as delineated with the RCL tool	Variable	5,407.39	25%
Natural – 50m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 50 m^2	Variable	177,239.98	14%
Natural – 500m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 500 m^2	Variable	5,377.42	25%
Natural – 5000m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 5000 m^2	Variable	5,152.61	28%
Baseline Conditions	No buffer is integrated into the model	0 m	7,179.81	0%

Spring Creek

Simulation ID	Location Description	Riparian Buffer Width	Total Sediment Load Mg	Sediment Reduction (%)
S2_ALL _10	All Streams	10m	8,330.43	69%
S2_ALL_30	All Streams	30 m	5,477.88	80%
S2_ALL_60	All Streams	60 m	5,185.11	81%
S2_AG_10	All streams adjacent to agricultural fields.	10 m	15,240.99	44%
S2_AG_30	All streams adjacent to agricultural fields.	30 m	14,030.85	48%
S2_AG_60	All streams adjacent to agricultural fields.	60 m	13,804.65	49%
S2_MED_10	All streams adjacent to agricultural fields with a sediment yield higher than 1.2 Mg	10 m	15,572.45	42%
S2_MED_30	All streams adjacent to agricultural fields with a sediment yield higher than 1.2 Mg	30 m	14,446.03	47%
S2_MED_60	All streams adjacent to agricultural fields with a sediment yield higher than 1.2 Mg	60 m	14,237.86	47%
S2_HIGH_10	All streams adjacent to agricultural fields with a sediment yield higher than 3.2 Mg	10 m	18,910.93	30%
S2_HIGH_30	All streams adjacent to agricultural fields with a sediment yield higher than 3.2 Mg	30 m	18,179.08	33%
S2_HIGH_60	All streams adjacent to agricultural fields with a sediment yield higher than 3.2 Mg	60 m	18,009.42	33%
S2_VH_10	All streams adjacent to agricultural fields with a sediment yield higher than 5.1 Mg	10 m	23,262.73	14%
S2_VH_30	All streams adjacent to agricultural fields with a sediment yield higher than 5.1 Mg	30 m	23,040.19	15%
S2_VH_60	All streams adjacent to agricultural fields with a sediment yield higher than 5.1 Mg	60 m	22,943.50	15%
Natural	Existing Buffer as delineated with the RCL tool	Variable	21338.02	21%
Natural – 50m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 50 m^2	Variable	20881.77	23%
Natural – 500m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 500 m^2	Variable	20723.02	23%
Natural – 5000m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 5000 m^2	Variable	20262.37	25%
Baseline Conditions	No buffer is integrated into the model	0 m	27,080.50	0%

System 2

Simulation ID	Location Description	Riparian Buffer Width	Total Sediment Load Mg	Sediment Reduction (%)
S2_ALL _10	All Streams	10m	71,312.717	65%
S2_ALL_30	All Streams	30 m	44,970.192	78%
S2_ALL_60	All Streams	60 m	39,745.744	81%
S2_AG_10	All streams adjacent to agricultural fields.	10 m	113,389.27	45%
S2_AG_30	All streams adjacent to agricultural fields.	30 m	99,602.65	52%
S2_AG_60	All streams adjacent to agricultural fields.	60 m	96,321.708	53%
S2_MED_10	All streams adjacent to agricultural fields with a sediment yield higher than 3.7 Mg	10 m	118,246.48	43%
S2_MED_30	All streams adjacent to agricultural fields with a sediment yield higher than 3.7 Mg	30 m	105,205.77	49%
S2_MED_60	All streams adjacent to agricultural fields with a sediment yield higher than 3.7 Mg	60 m	101,905.84	51%
S2_HIGH_10	All streams adjacent to agricultural fields with a sediment yield higher than 14.2 Mg	10 m	178,229.71	13%
S2_HIGH_30	All streams adjacent to agricultural fields with a sediment yield higher than 14.2 Mg	30 m	175,074.39	15%
S2_HIGH_60	All streams adjacent to agricultural fields with a sediment yield higher than 14.2 Mg	60 m	174,123.99	15%
S2_VH_10	All streams adjacent to agricultural fields with a sediment yield higher than 19.4 Mg	10 m	195,271.08	5%
S2_VH_30	All streams adjacent to agricultural fields with a sediment yield higher than 19.4 Mg	30 m	194,101.35	6%
S2_VH_60	All streams adjacent to agricultural fields with a sediment yield higher than 19.4 Mg	60 m	193,756.37	6%
Natural	Existing Buffer as delineated with the RCL tool	Variable	178,956.221	13%
Natural – 50m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 50 m^2	Variable	177,239.98	14%
Natural – 500m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 500 m^2	Variable	175,173.82	15%
Natural – 5000m2	Existing Buffer as delineated with the RCL tool with a drainage area minimum of 5000 m^2	Variable	169,296.10	18%
Baseline Conditions	No buffer is integrated into the model	0 m	205,880.221	0%

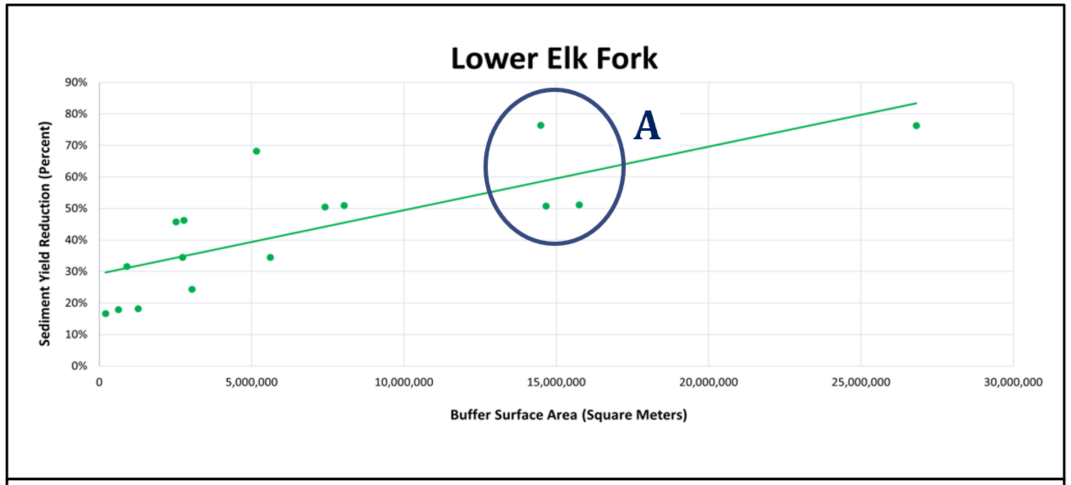
Simulation of Alternative Scenarios: Riparian Buffer (code 391)

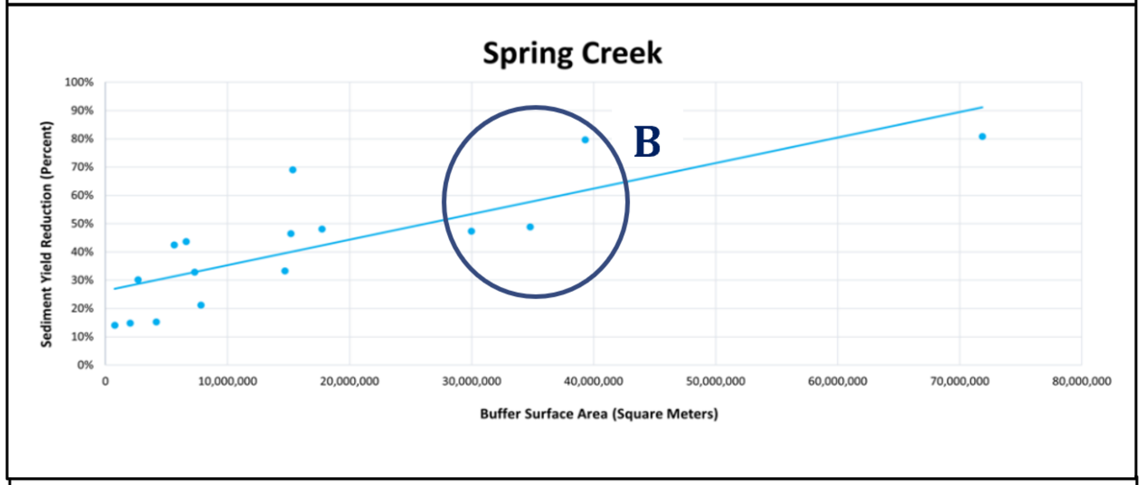
Riparian Buffer Results Highlights

- ❖Our simulations indicate that they are a very effective tool with a potential reduction of up to 81% in System 2, 76% in Lower Elk, 60% in Red River, and 81% in Spring Creek. It is important to note that these estimates represent the maximum potential reduction by this approach, and we understand that it may not be feasible to implement a buffer around every stream of the watershed. However, those 12 simulations (3 for each watershed) provide an estimate the maximum that can be reduced by this conservation practice.

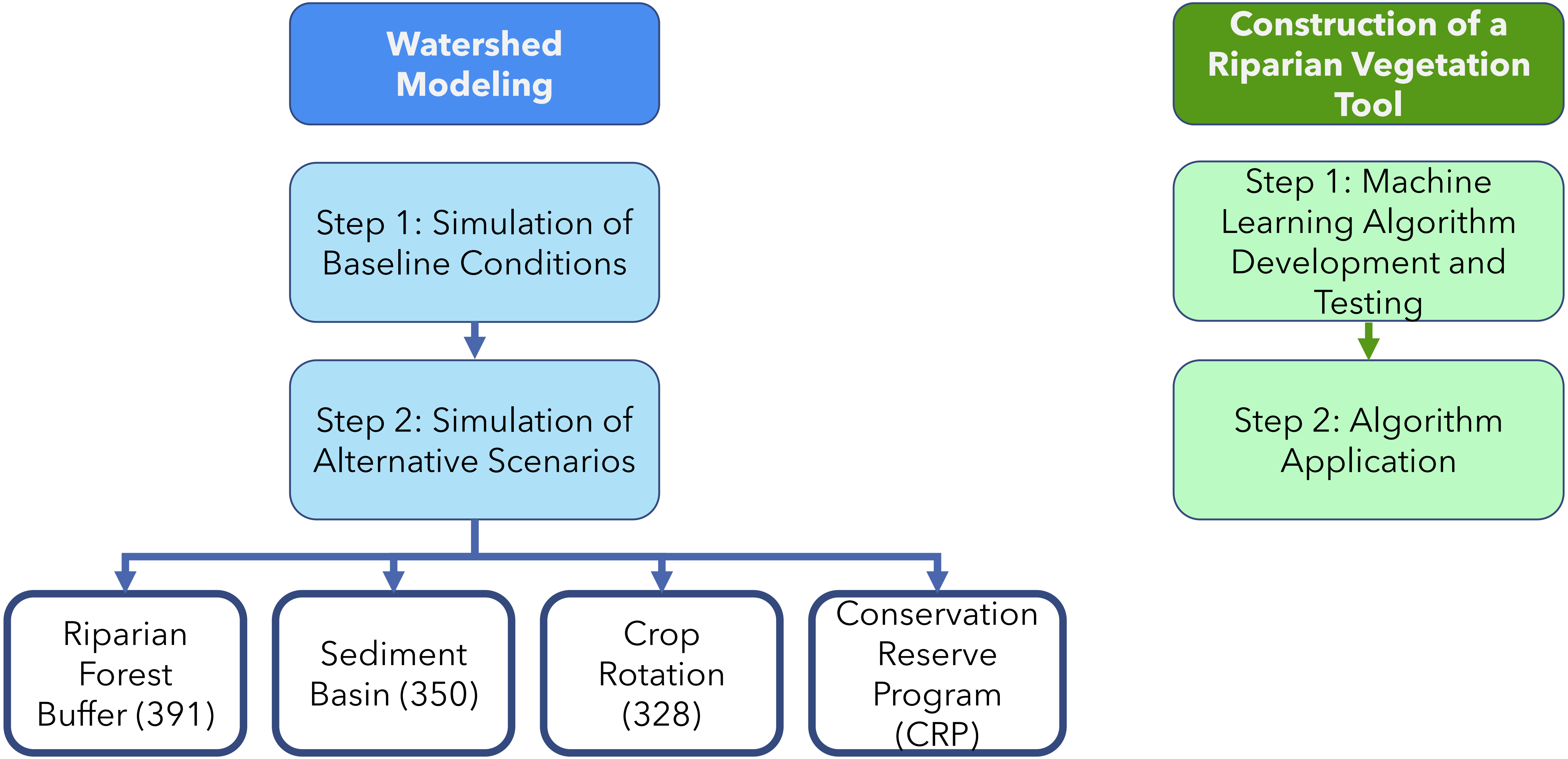
- ❖Simulations of existing riparian buffer conditions indicate that System 2, Lower Elk, and Spring Creek are under-served in terms of riparian buffer. Simulations of the existing buffer in System 2 indicate that it reduces sediment yield by 13% as opposed to a maximum potential of 81%. The existing buffer in Lower Elk reduces sediment yield by 24% as opposed to a maximum potential of 76%. The existing buffer in Spring Creek reduces sediment yield by 21% as opposed to a maximum potential of 81%. System 2 is the most underserved. In Red River, the existing riparian buffer, reduces sediment by 25% with the maximum being 60%, and therefore it is the most served.

- ❖The length of the buffer is a more impactful factor than the width, even when the total surface area of the buffer is the same. For instance, cluster A represents three scenarios with almost equal surface area (15,000,000 m^2), but the three scenarios vary in effectiveness: 51% for both LEF_MED_60 and LEF_AG_60, and 76% for LEF_ALL_30. We see a similar example in Spring Creek watershed.

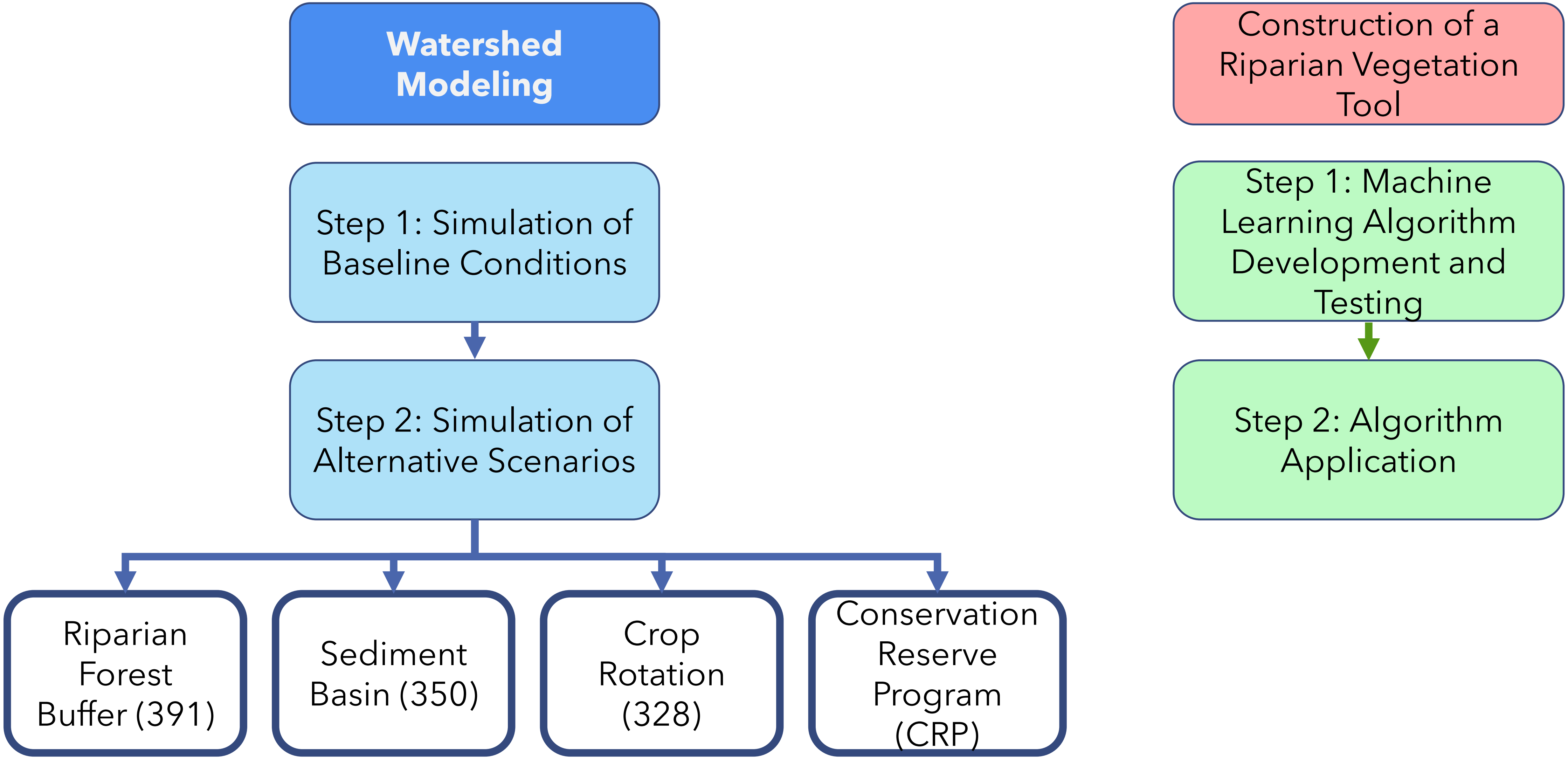




Project Structure



Project Structure



Riparian Classification from LiDAR (RCL) model

What is RCL?

- The main goal of this component of the project is to create a reproducible workflow for classifying landcover in the riparian buffer using only raw LiDAR point cloud as input. We have termed such a workflow as Riparian Classification from LiDAR (RCL) model.

- A specific pre-trained RCL model has been packaged for ease of use as an ArcGIS tool.

- We have endeavored to make the RCL model as robust as possible to variations in study area physiography and LiDAR collection methods so that the final model is generalizable. This allows the model to be agnostic of how or where the input data is collected and can produce a reliable output without exhaustive pre-input preparation and analysis.

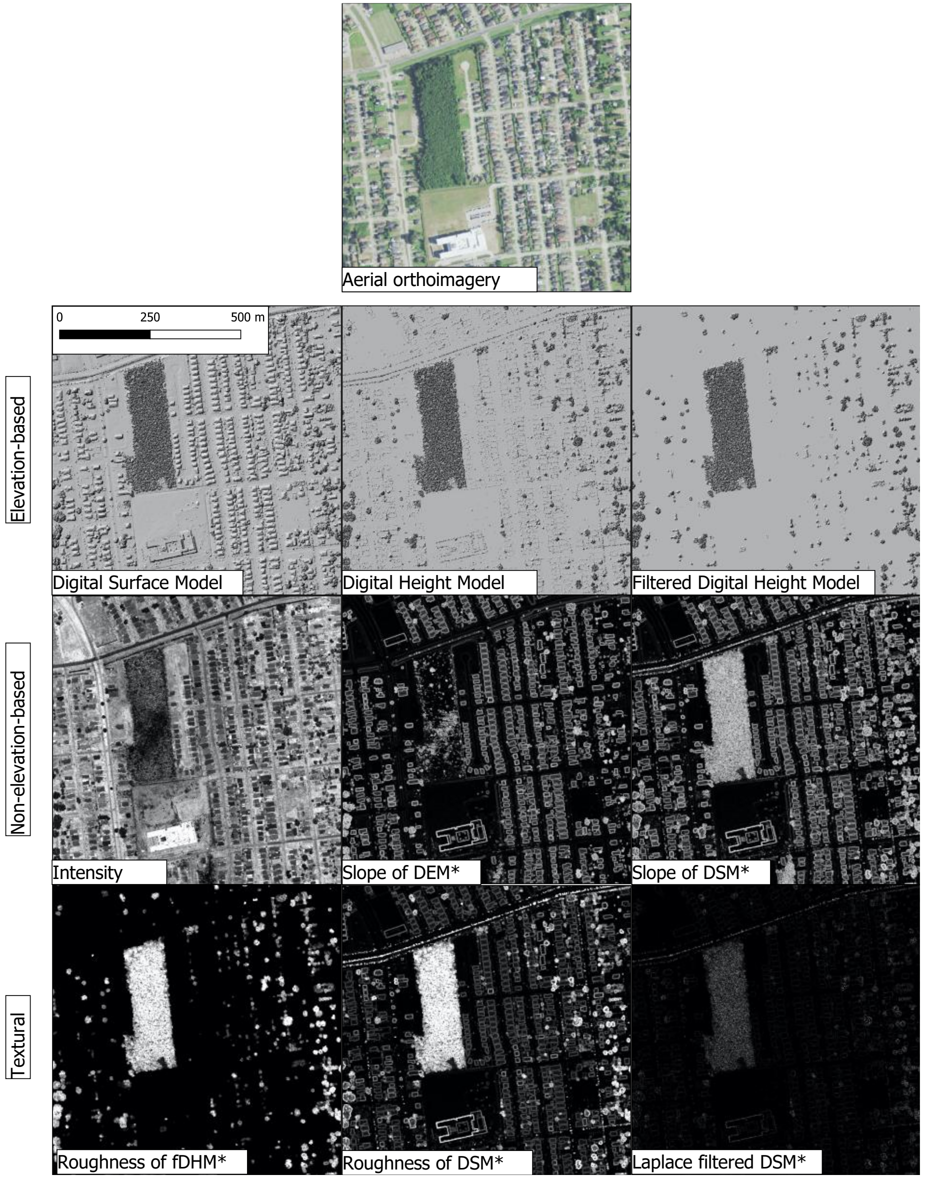
Riparian Classification from LiDAR (RCL) model

How was RCL created?

Data for a 2012 LiDAR mission covering system 2 was obtained and used to create multiple data products, including but not limited to a DEM, DSM, DHM, and derived slope models.

The watershed's landcover was manually classified into one of 19 categories, which was then used along with the LiDAR-derived data to train a decision tree to classify landcover.

Category	Reclassification
Forest	Trees
Linear Trees	Trees
Individual Trees/Small Clusters	Trees
Building Tops	Other
Building Edges	Other
Dirt/Bare Field	Other
Crops	Herbaceous Vegetation
Rough Vegetation	Herbaceous Vegetation
Other Impervious Surfaces	Other
Water	Other
Snow	Other
Bare Rock	Other
Sand	Other
Wetlands	Herbaceous Vegetation
Power Lines	Other
Charred Trees and Vegetation	(excluded)
Utility Easement	Herbaceous Vegetation
Large-Scale Urban	(excluded)
Canyon	Other



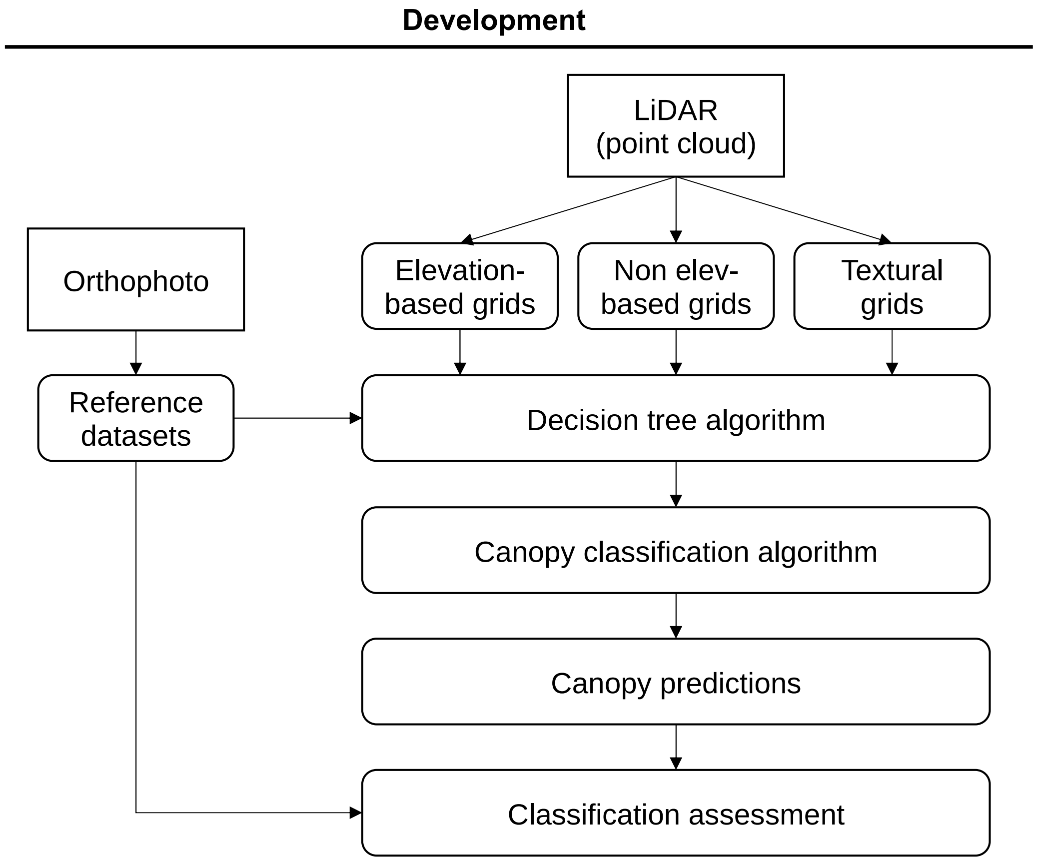
Riparian Classification from LiDAR (RCL) model

How was RCL created?

This process was repeated for nine additional watersheds across the continental US in order to evaluate the effects of physiography and LiDAR vendor on model validity.

The general classification model was trained using a portion of the training data from seven of the 10 watersheds; the model was then validated against the unused portion of the training data from those seven watersheds and the three-naïve watersheds.

	Precision	Recall	F1-Score
Trees	92.1%	97.3%	94.6%
Other	98.8%	96.2%	97.4%



Riparian Classification from LiDAR (RCL) model

Model Application

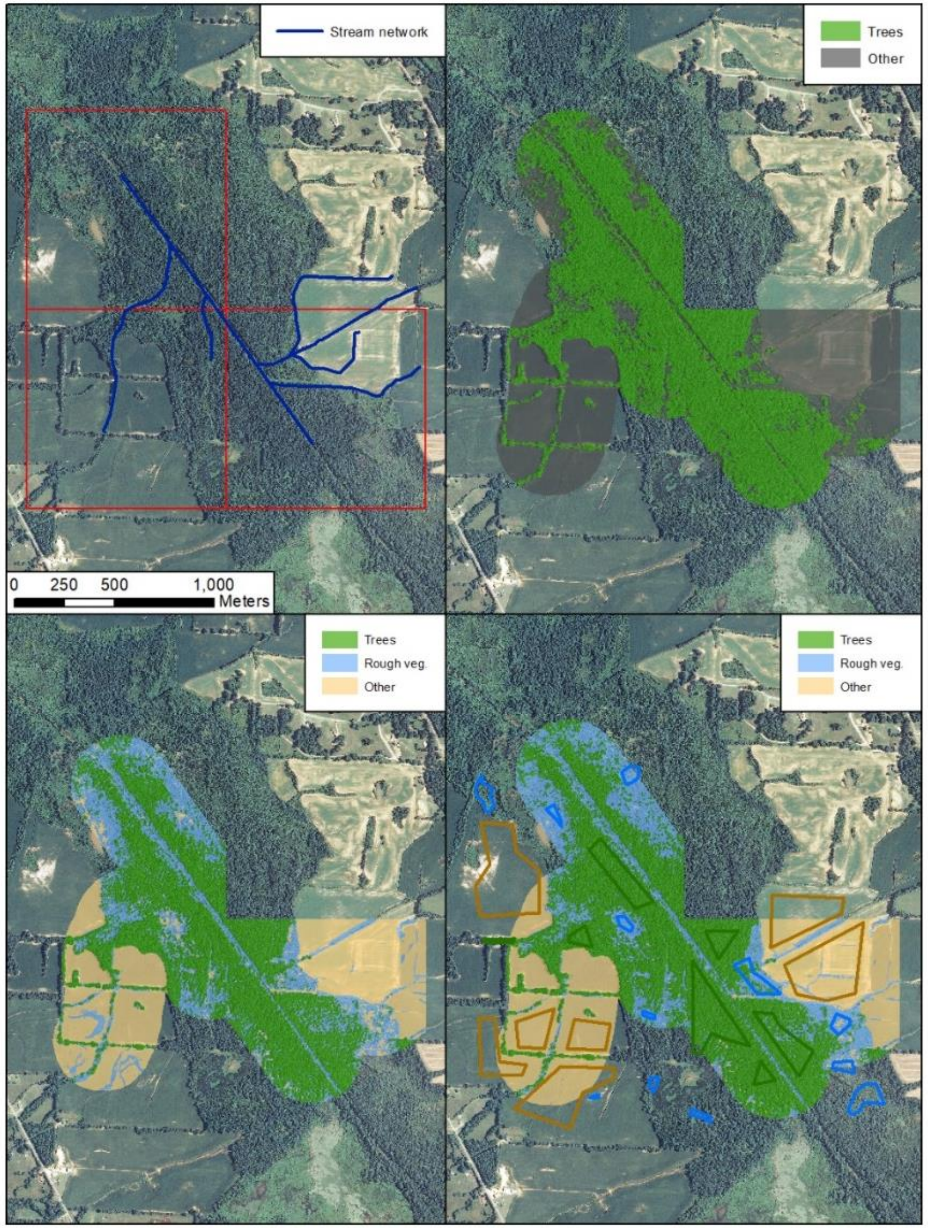
Application

LiDAR (point cloud)

- Filtered digital height model roughness
- Digital surface model roughness
- Laplace filter of digital surface model
- Slope of digital elevation model
- Slope of digital surface model

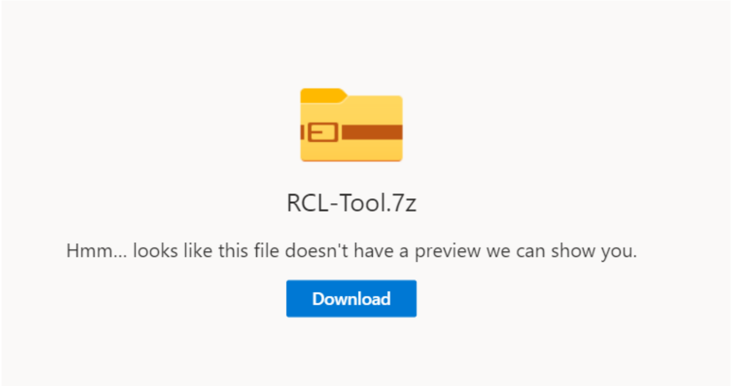
Canopy classification algorithm

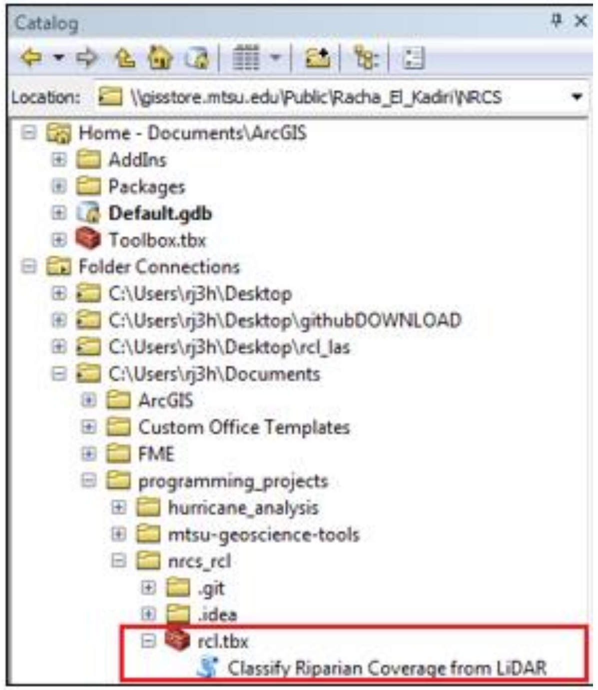
Canopy predictions



Riparian Classification from LiDAR (RCL) model

Final Product





RCL Tutorial

8.1 Walkthrough

8.1.1 Downloading the RCL Tool

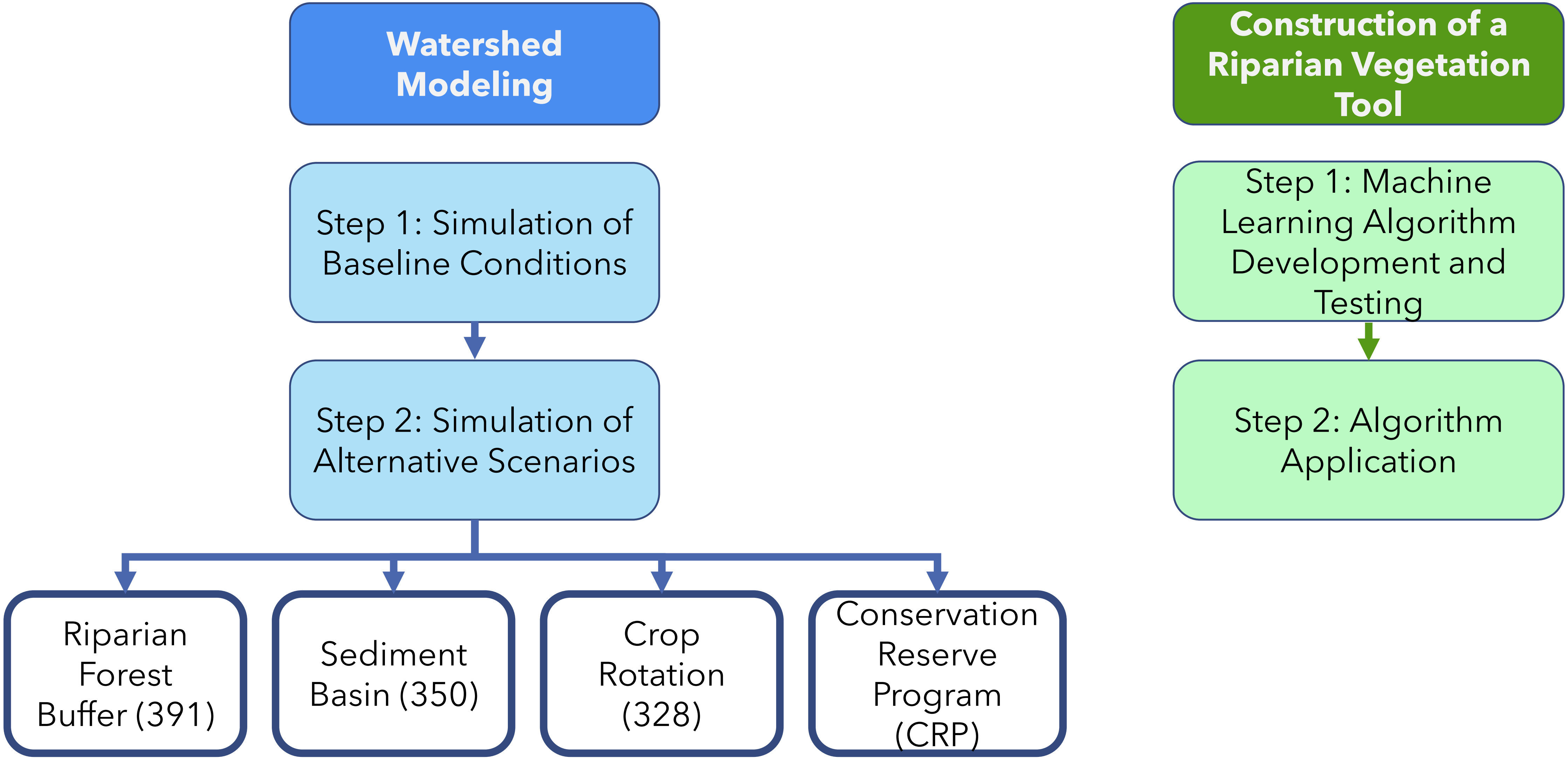
The RCL tool can be found at MTSU OnDrive." Unpack the zipped folder in a location that can be easily found later. This folder contains the RCL Python script and the associated ESRI Toolbox file, as well as supporting documentation (including this walkthrough).

8.1.2 Running the RCL Tool

To open the RCL interface, open ArcCatalog. The Catalog can be accessed either directly in the ArcCatalog application or through ArcMap by clicking the "Catalog" button in the toolbar. In the Catalog navigate to the folder downloaded in the previous step. Double click on rcl.tbx to expand it, then double click the *Riparian Classification from LiDAR (pretrained)* or *Riparian Classification from LiDAR (custom)* tool to open the tool dialogue (Figure 53). A graphical user interface similar to standard ESRI tools will appear. Fill each field as instructed by the tooltips.

- ✓ If you are using the pretrained version of the tool, the only required input is the folder of *.las* files.
- ✓ If you are using the custom version of the tool, both the folder of *.las* files and a shapefile of training data are required as input.

Project Structure



THANK YOU