DRAFT

Suwannee Watershed Case Study

TMDL BASIN 06

FLORIDA
ATLANTIC
UNIVERSITY

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Executive Summary

Flooding is the most common and costly disaster in the United States. Over 98% of counties in the entire United States having experienced a flood and just one inch of water causing up to $25,000 in damage (FEMA 2018). Flooding can impact a community's social, cultural, environmental and economic resources, so making sound, science-based, long-term decisions to improve resiliency are critical to future prosperity and growth. To meet the longer-term goals to protect life and property, in 1990, FEMA created the National Flood Insurance Program's (NFIP) Community Rating System (CRS) program, a voluntary program for recognizing and encouraging community floodplain management activities. Nearly 3.6 million policyholders in 1,444 communities participate in the CRS program, but this is only 5% of the over 22,000 communities participating in the NFIP.

The Florida Department of Emergency Management (FDEM) contracted with FAU to develop data to enable local communities to reduce flood insurance costs through mitigation and resiliency efforts by developing watershed management plans. There are several steps to address the development of watershed plans including the development of a watershed planning template and development of support documents to establish risk associated with community risk within the watershed.

The effort discussed herein focusses on the development procedures for a screening tool to assess risk in the Suwannee TMDL in Florida, a watershed located in West-Central Florida, that combines readily available data on topography, ground and surface water elevations, tidal data for coastal communities, soils, open space and rainfall to permit an assessment of the risk of inundation of property in the area. Such knowledge permits the development of tools to permit local agencies to develop means to address high risk properties.

1.0 Introduction

The Suwannee TMDL basin is located in North West-central Florida (see Figure 1), and is home to the Cities of Live Oak, Steinhatchee, Wellborn, Mayo, and many others. This watershed covers almost 10,000 square miles in South Georgia, and North Florida. The Suwannee River Water Management District maintains most of the watershed. The watershed is adjacent to the Gulf of Mexico.

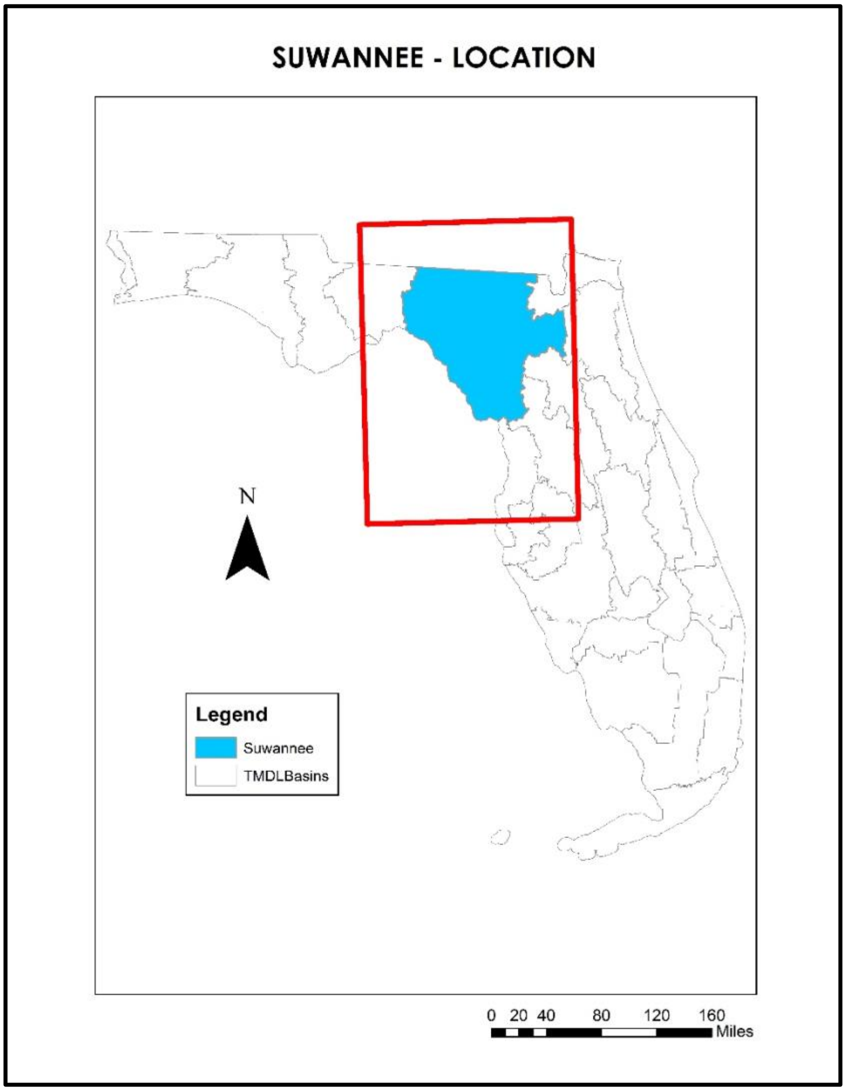


Figure 22. Location map of Suwannee basin

2.0 Summary of Watershed

2.1 General Description of Watershed

2.1.1 Climate and Ecology

Suwannee gets roughly 53 inches of rain per year, with 225 sunny days per year, and about 100 days contain some type of rainfall (bestplaces.net). Its ecology is primarily a large estuarine system at its confluence with the Gulf of Mexico. It lies outside the river mouth along an open coast. The main estuarine zone is Suwannee Sound. This is a shallow offshore area encompassed by a semi-continuous arc of oyster reefs. There is a transition from high to low salinity within the river (pubs.usgs.org). There is also a subsystem of tidal creeks and marshes south of the river mouth which acts as another section of the estuary which receives fresh water from different sources and conditions. At the high river stage, an abundance of fresh water over fills the low-elevation marshes to the south and flows into the tributaries of the estuary. This push makes areas south of the river experience sudden transitions from estuarine to freshwater conditions. At the lower stage, estuarine tributaries from freshwater, ground-water inflow. Tides provide freshwater at almost all stages.

2.1.2 Topography and Soils

The Suwannee River Basins has two physiographic regions; Northern Highlands and Gulf coastal Lowlands (mysuwanneeriver.com). The two major physiographic provinces in the District include the Northern Highlands and Gulf Coastal Lowlands (White, 1970; Ceryak et al., 1983). Characteristics of the Northern Highlands include gently rolling topography, generally from 100 - 200 feet above mean sea level. Soils typically range from sand to clayey sand. The presence of relatively low permeability clayey sediments, at or near the surface, limits the infiltration of rainfall.

Local rainfall drainage in the Northern Highlands (i.e., the Upper Suwannee and Santa Fe River basins) is characterized by surface water features. The Gulf Coastal Lowlands are characterized by elevations ranging from sea level to approximately 100 feet above mean sea level. The Gulf Coastal Lowlands feature a low relief, karstic topography, and shallow sandy soils with muck in many wetland areas. Karst landforms are widespread in the lowlands, with abundant sinkholes, sinking streams and springs, and a high degree of interconnection between surface water and groundwater systems. The Gulf Coastal Lowlands therefore have high rates of recharge to the limestone aquifer and extensive karst development, resulting in a groundwater-dominated (subsurface) drainage pattern throughout much of this region.

A significant geologic feature separating the two major physiographic provinces is the Cody Escarpment or Cody Scarp, which generally separates the Northern Highlands Physiographic Province and the Gulf Coastal Lowlands Physiographic Province. The Cody Scarp is an erosional geomorphologic feature which represents the break between the surface-water dominated hydrology of the Northern Highlands, and the groundwater dominated hydrology of the Coastal Lowlands. The Cody Scarp region is characterized by active sinkholes, springs, sinking streams, and river rises (Ceryak et al., 1983). During average and lower flows, with the exception of the Suwannee River, all rivers and streams, including the Santa Fe and Alapaha Rivers are completely captured by sinkholes as they cross the Cody Scarp. Some subsequently re-emerge downgradient as river rises.

The Northern highlands has a gently rolling topography that is roughly 100-200 feet above mean sea level. The soils in the area are mainly sand to clayey sand. The clayey sediments in the subsurface act as the base for the Surficial Aquifer System. They also slowdown infiltration of rainwater into the system while constituting portions of the Intermediate Aquifer Confining System. Thus, there are a surplus of surface-water features throughout the Northern Highlands. The lowlands have elevations above mean sea level at 100 feet. Carbonate rocks is most prevalent throughout this area. The surface is relatively flat, karstic topography and shallow, sandy soils with muck in many wetland areas. Karst landforms are most common, with sinkholes, sinking streams, and springs, with the surface water and ground water systems being highly interconnected.

2.1.3 Boundaries/Surface Waters

The Suwannee river Basin is about 29,500 square km, flowing through much of north Florida and leaving out of the eastern Gulf of Mexico (gulfbase.org). Withlacoochee River joins along the way. The Aucilla, Econfina, Fenholloway, Steinhatachee, Suwannee, Waccasassa and Withlacoochee Rivers drain into the estuarine areas of the Florida coast. Suwannee River provides over 50 percent of all the freshwater discharge. All of the surface waters are affected by groundwater inflow from the regional aquifer composed of limestone, or karst topography. It is relatively undeveloped and unpolluted compared to other regions in the state. There are mainly coastal marshes (i.e. Cedar Keys, Deadman Bay and Suwannee Sound). Cedar Key is the northernmost limit of distribution of mangroves on the Florida Gulf coast. It also has the second largest seagrass area in the eastern Gulf of Mexico.

2.1.4 Hydrogeological Considerations

There is a layer of clay preventing water from infiltrating down, these are the confined areas in Northern Florida (mysuwanneeriver.com). As a result, water will runoff downhill until it reaches a lake, stream, or an unconfined area where it can penetrate down into the aquifer. When it has infiltrated, the water will flow through pathways in the rock until it is pumped out of a well, taken up by plant roots for growth/photosynthesis, or until it reaches an area with the right geology to form a spring or seep. The springs in the area have dynamic flows which are affected by the river level and groundwater levels within the spring shed. When the river is high, the water pushes back against the ground water; either slowing, stopping or reversing the spring’s flow. When the river is low, there can be a large difference between groundwater and surface levels, which then result in high spring flows.

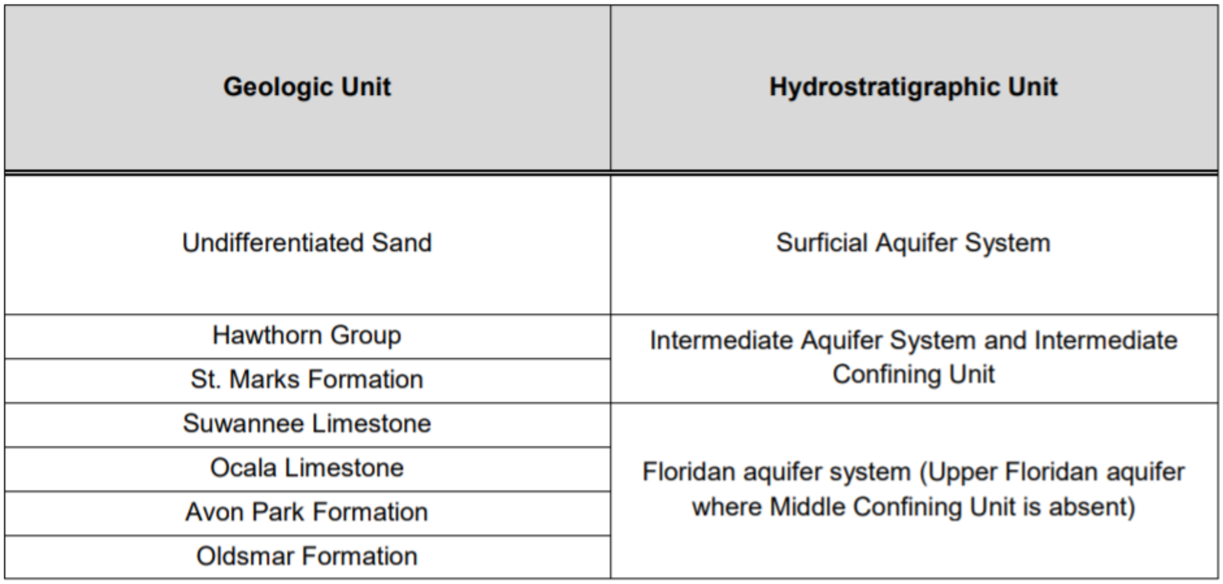
The aquifer system contains a sequence of limestone rock and dolomite mineral and can be divided into an upper and lower aquifer by the amount of permeability. The District has three primary hydrostratigraphic units which are, in descending order, the unconfined surficial aquifer system, the intermediate aquifer system/intermediate confining unit (located in the northeastern and eastern portions of the District), and the UFA.

The UFA is highly productive and represents the primary source of water supply and provides the baseflow to rivers and springs in the watershed. Most of the UFA system in the watershed is located near or at the surface, with some smaller areas being buried deep underground. Much of the Floridian aquifer in the watershed is unconfined, though there are small pockets of the aquifer that are thinly confined further inland.

In the Northern Highlands region, which includes the Upper Suwannee and Santa Fe River basins, the UFA is overlain by a thick confining layer of clay, which retards recharge into the UFA, whereas, to the south and west in the Gulf Coastal Lowlands, these clay layers are generally absent and the UFA is generally unconfined. The UFA in the Gulf Coastal Lowlands region experiences very high rates of recharge by way of sinking streams, sinkholes, and diffuse recharge through the land surface. Therefore, in this area, maintenance of groundwater levels is critically important to maintaining spring flow and baseflow in rivers (e.g., the Lower Santa Fe and Ichetucknee Rivers).

The presence or absence of the Hawthorn Group determines whether the UFA is confined/semi-confined or unconfined (Scott, 1988, 1992), respectively. Table 1 shows the aquifer layers in the basin.

Table 1. Overview of the aquifers in the Suwannee River Basin



Geologic Unit	Hydrostratigraphic Unit
Undifferentiated Sand	Surficial Aquifer System
Hawthorn Group	Intermediate Aquifer System and Intermediate Confining Unit
St. Marks Formation	
Suwannee Limestone	Floridan aquifer system (Upper Floridan aquifer where Middle Confining Unit is absent)
Ocala Limestone	
Avon Park Formation	
Oldsmar Formation	

For planning purposes, fresh groundwater is recognized as the only traditional water supply source, with all other water sources considered to be nontraditional (i.e., alternative water supplies; 373.019(1) F.S.). This WSA was conducted to determine whether fresh groundwater supplies in the District will be adequate to satisfy water supply demands for the 2015-2035 planning period while protecting natural systems. Existing use and future water demand projections were examined as required by Rule 62-40, Florida Administrative Code (F.A.C.). Total water demand in the District is projected to grow from 229 million gallons per day (mgd) to 300 mgd, with fresh groundwater from the FAS supplying over 90% of this demand. Agricultural Self-supply remains the largest use category in the District, and represents the largest projected water demand growth through 2035.

2.1.5 Special Features

There is a topographic feature called the Cody Scarp (mysuwanneeriver.com). This is an escarpment which is characterized by active sinkhole formation, large sinkholes and lakes, springs, sinking streams, and river resurgences.

2.2 Socio-economic Conditions of the Watershed

2.2.1 Demographics

As of 2017, Suwannee County had a population of 43, 814, a poverty rate of 20.4 percent, a median age of 41.7, a median household income of $40,600, and 80 percent of the population was white (non-Hispanic), and the next closest race, black, falling at less than 20 percent (datausa.io). Dixie County with a population of 16,826, a poverty rate of 23.7 percent, a median age of 47.6, a median household income of $35,910, and over 80 percent of the population was white (non-Hispanic), and the next closest race, black falling at less than 10 percent. Lafayette County with a population of 8,684, a poverty rate of 17.8 percent, a median age of 39.2, a median household income of $41,512, with 80 percent of the population as white, and the next closest race, black, falling above 15 percent. Gilchrist county with a population of 17,191, a poverty rate of 19.8 percent, a median age of 42.8, a median household income of $42,934, with over 80 percent of the population, and the next closest race, black falling at 10 percent. Levy county has a population of 38,713, a poverty rate of 21.9 percent, a median age of 46.4, a median household income of $36,554, with 85 percent of the population being white, and the next closest race, black, falling just below 10 percent. Columbia County has a population of 68,484, a poverty rate of 16.8 percent, a median age of 40.7, a median household income of $43,504, with a little over 70 percent of the population being white, and less than 20 percent of the population being black. Taylor County has a population of 22,350, a poverty rate of 16.4 percent, a median age of 41, a median household income of $37,188, with a little over 70 percent of the population being white, and a little over 20 percent of the population being black.

2.2.2 Property

Majority of the area is residential, with a decent amount of conservation areas/ environmentally sensitive areas along the coast, compared to other areas in Florida (datausa.io). The average property value is around $92,000.

2.2.3 Economic Activity/Industry

A good majority of the areas industries include natural resource/mining and construction. There is less development here, than in other parts of the state, so there is room for other industries (datausa.io).

3.0 Watershed Analysis

3.1 Catchments

Figure 2 shows the distribution of catchments in the Suwannee TMDL basin. This was determined by the longest connecting body of water from one catchment to the next. Another determining factor was how they cascaded into each other.

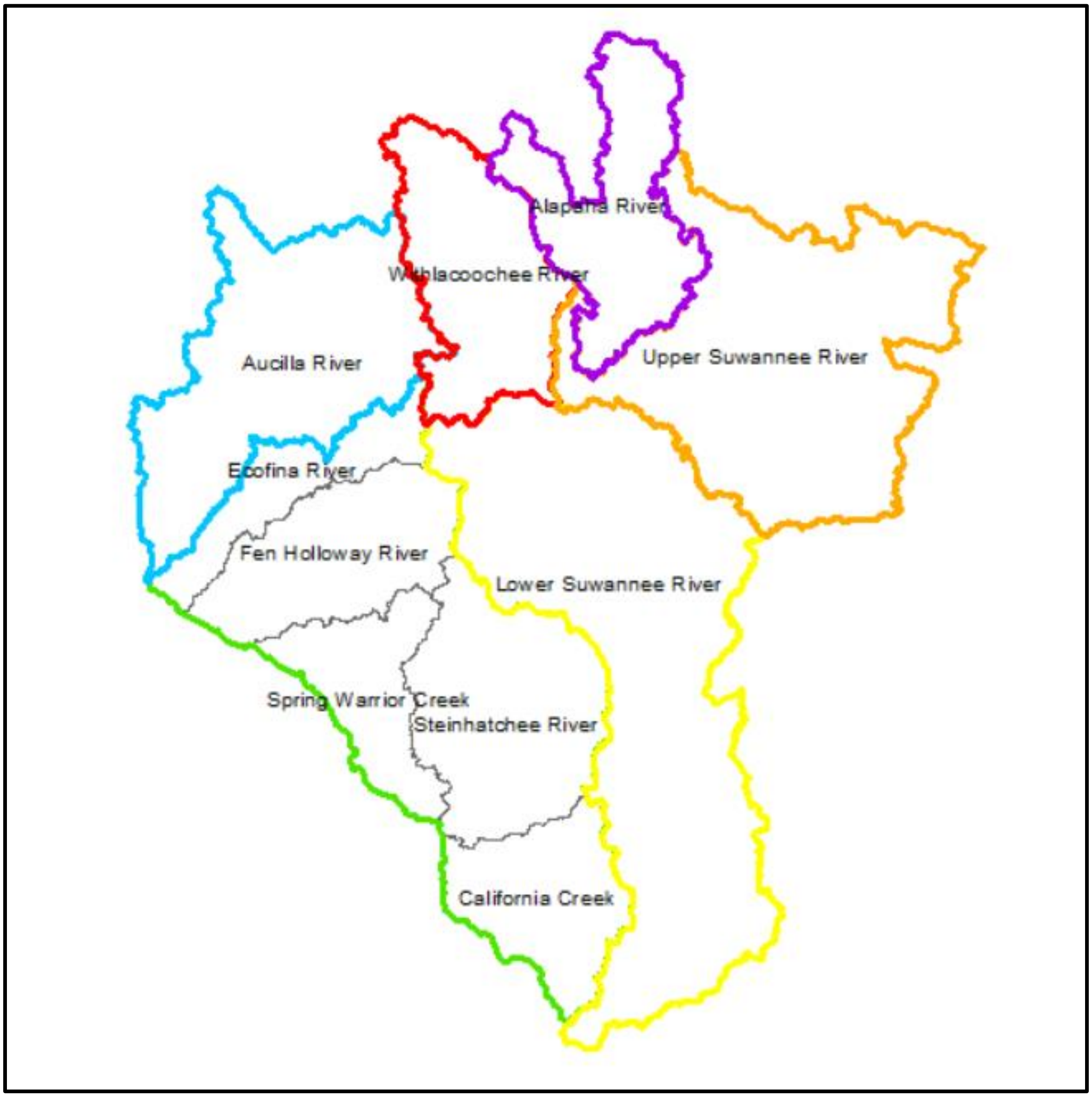


Figure 23. Suwannee Catchments

3.2 Data Sets

3.2.1 Topography

Figure 3 shows the results of the LiDAR 3-meter DEM processed conducted for the watershed. Along the western and southern areas, the elevation is low, ranging from 0 feet (sea level) to 20 feet. Further inland the elevation is higher and more varied, ranging from 40 to over 100 feet, with a maximum elevation of approximately 241 feet. There are higher elevations towards the northeast portion of this basin. This is explained by the terrain heading into Georgia. The elevations also change depending on how close they are to bodies of water, such as rivers where the elevation starts lower closest to the body of water and gets higher as it goes further away.

Figure 4 contains the impervious areas, primarily roads and structures. These are areas where water cannot seep into the soil, and as a result may travel on the surface. Figure 5 contains the areas that contain either water (ex. rivers, lakes, canals, etc.) or land in the Waccasassa watershed.

Lower Suwannee river has the largest area in size, while Upper Suwannee river has the highest elevation, seen in Table 1. The smallest catchments fall within HUC_102, where they have been broken up even further.

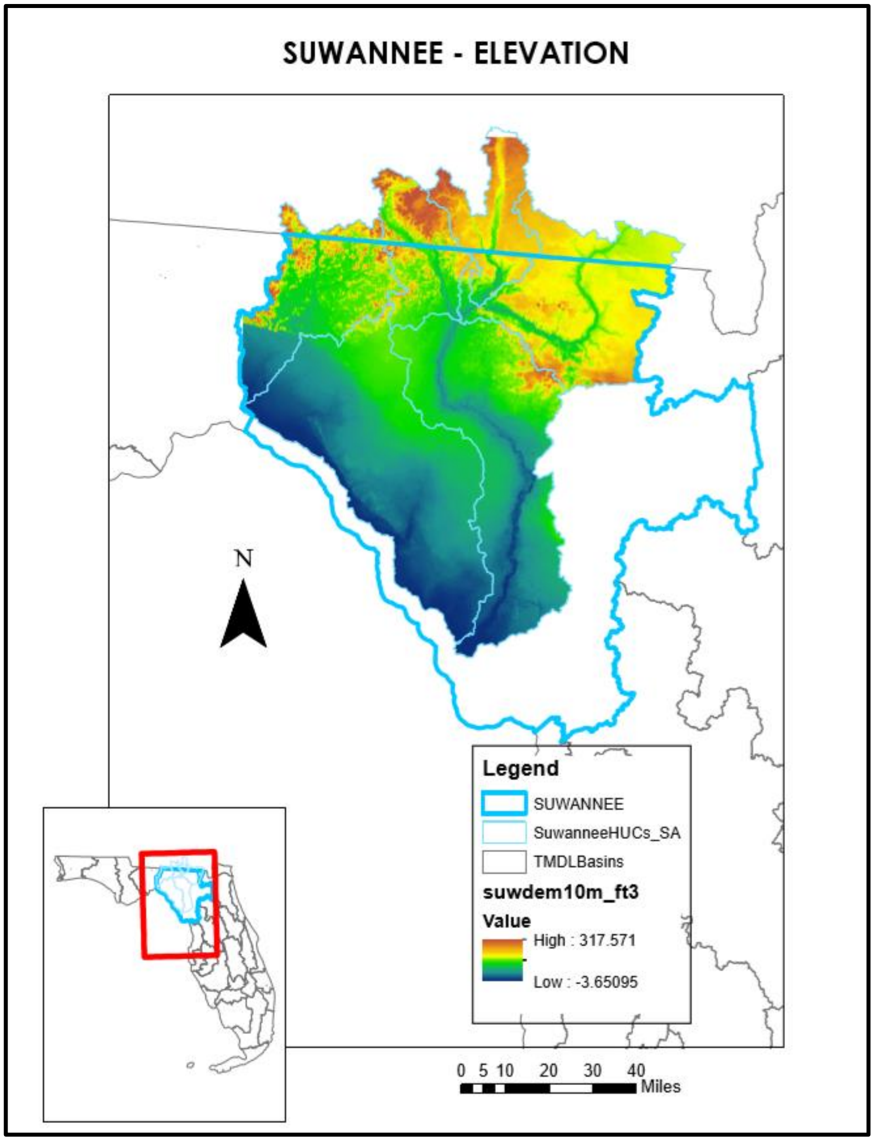


Figure 24. Topography of the Suwannee watershed based on LiDAR DEM

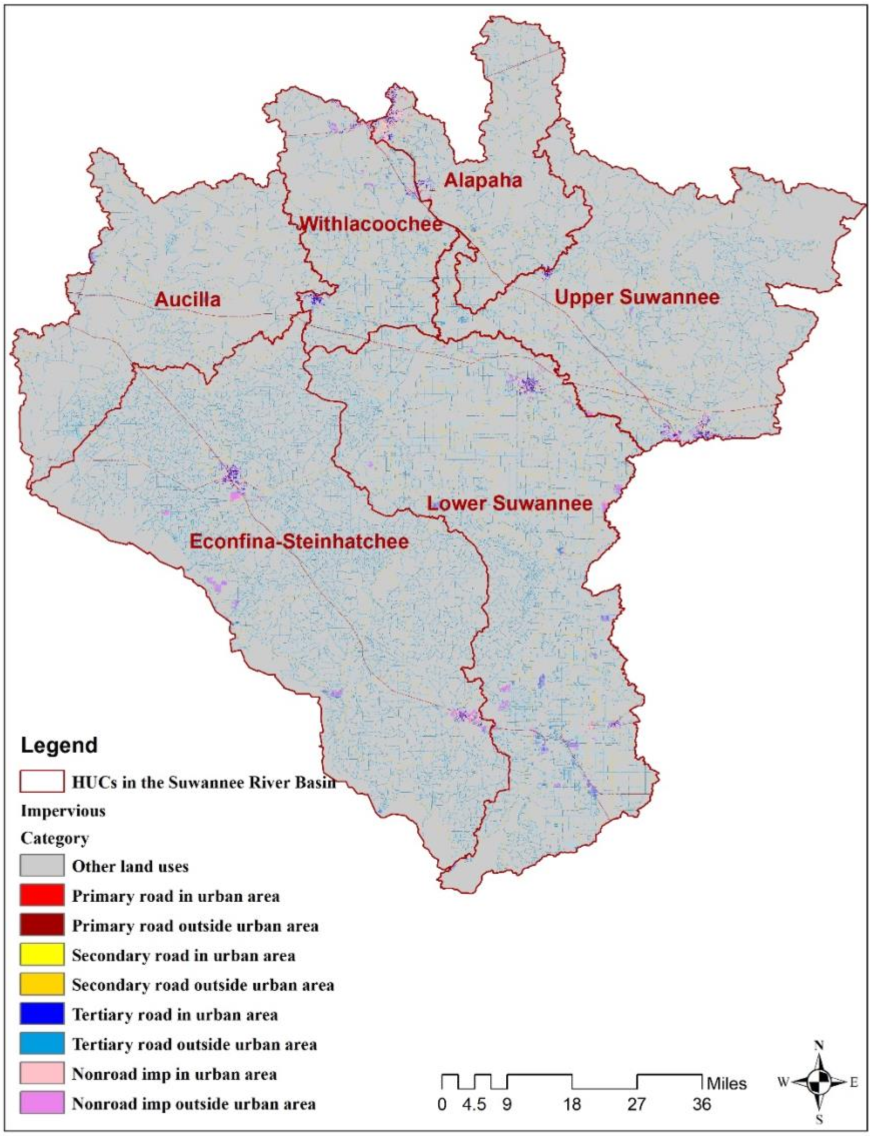


Figure 4. Impervious areas in the Suwannee River watershed.

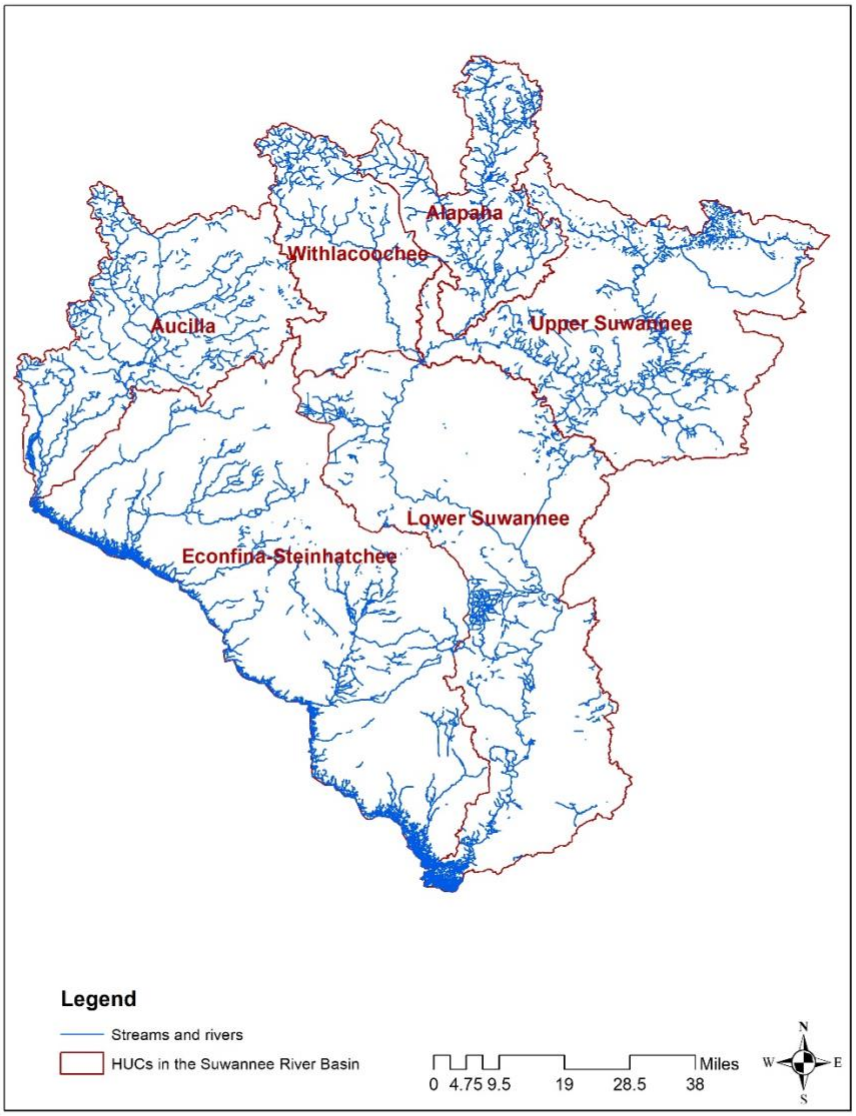
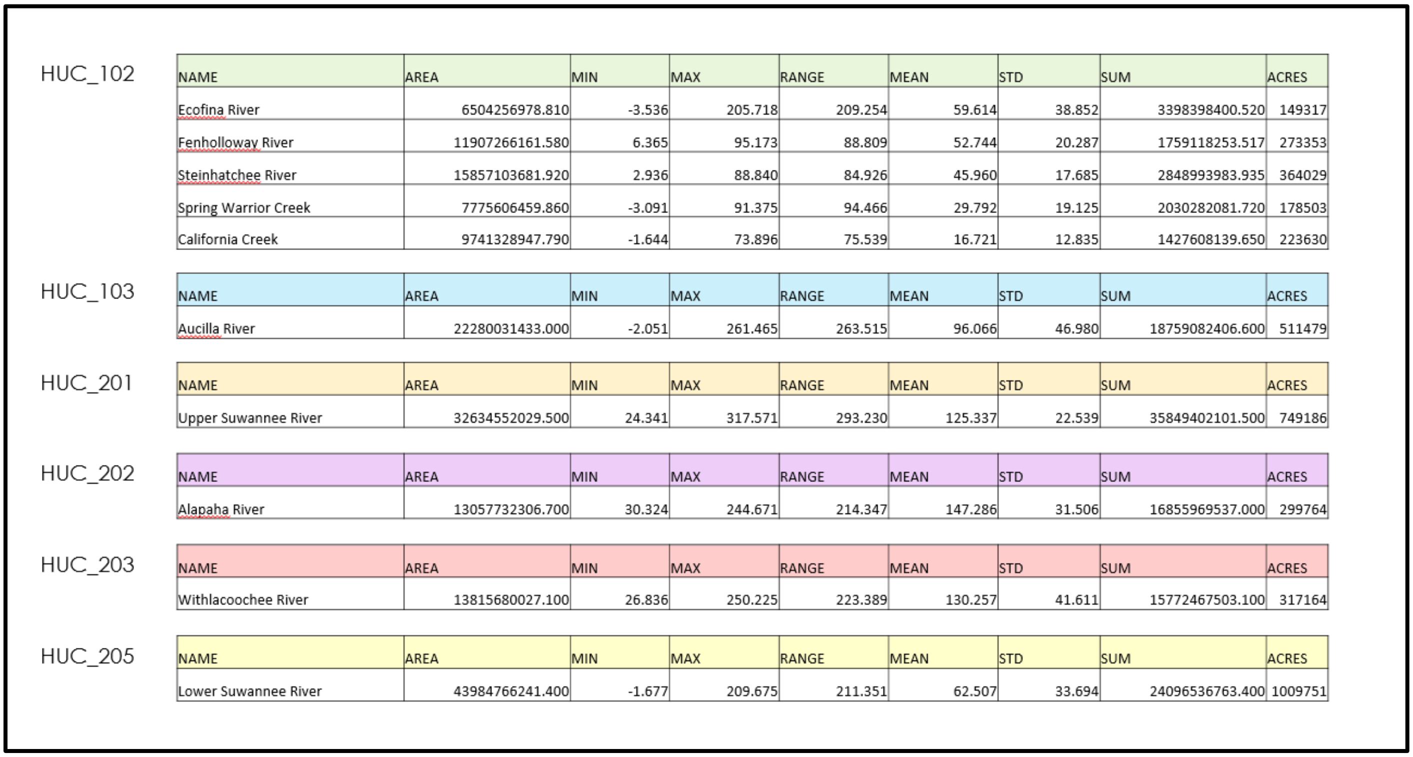


Figure 5. Streams and rivers in the Suwannee River watershed

Table 2 Elevation values through each catchment in Suwannee



HUC_102

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Ecofina River	6504256978.810	-3.536	205.718	209.254	59.614	38.852	3398398400.520	149317
Fenholloway River	11907266161.580	6.365	95.173	88.809	52.744	20.287	1759118253.517	273353
Steinhatchee River	15857103681.920	2.936	88.840	84.926	45.960	17.685	2848993983.935	364029
Spring Warrior Creek	7775606459.860	-3.091	91.375	94.466	29.792	19.125	2030282081.720	178503
California Creek	9741328947.790	-1.644	73.896	75.539	16.721	12.835	1427608139.650	223630

HUC_103

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Aucilla River	22280031433.000	-2.051	261.465	263.515	96.066	46.980	18759082406.600	511479

HUC_201

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Upper Suwannee River	32634552029.500	24.341	317.571	293.230	125.337	22.539	35849402101.500	749186

HUC_202

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Alapaha River	13057732306.700	30.324	244.671	214.347	147.286	31.506	16855969537.000	299764

HUC_203

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Withlacoochee River	13815680027.100	26.836	250.225	223.389	130.257	41.611	15772467503.100	317164

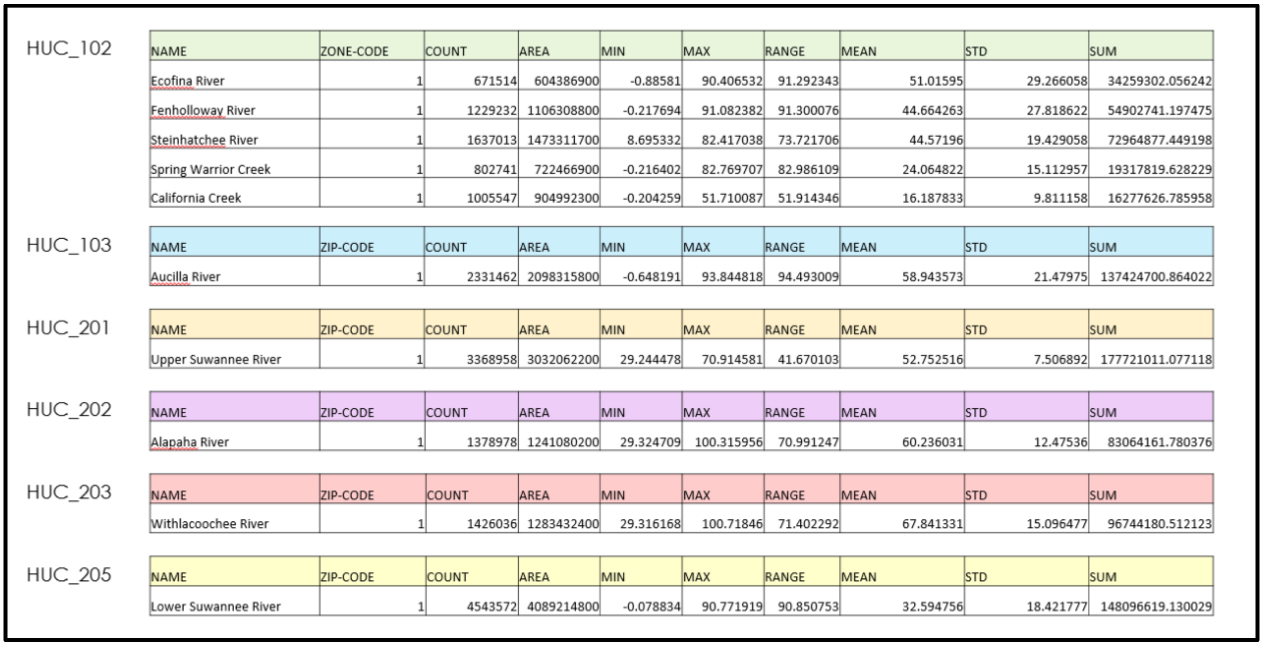
HUC_205

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	ACRES
Lower Suwannee River	43984766241.400	-1.677	209.675	211.351	62.507	33.694	24096536763.400	1009751

3.2.2 Groundwater

The groundwater table was determined by using the kriging approach that was used in Zhang et al. (2020) as there were limited wells within this watershed. The locations of the wells, surface water, and tidal gauge stations are displayed in Figure 6.The combination of the known water table readings from groundwater stations, surface water stations, and a tidal gauge were used to create the water table for the watershed as seen in Figure 7. This represents the surface level where the ground soil is permanently saturated with water. The area with the largest groundwater values belongs to Withlacoochee River, seen in Table 2. The area with the lowest groundwater values is Upper Suwannee River.

Table 3 Ground water values for the Suwannee Basin



HUC_102

NAME	ZONE-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Ecofina River	1	671514	604386900	-0.88581	90.406532	91.292343	51.01595	29.266058	34259302.056242
Fenholloway River	1	1229232	1106308800	-0.217694	91.082382	91.300076	44.664263	27.818622	54902741.197475
Steinhatchee River	1	1637013	1473311700	8.695332	82.417038	73.721706	44.57196	19.429058	72964877.449198
Spring Warrior Creek	1	802741	722466900	-0.216402	82.769707	82.986109	24.064822	15.112957	19317819.628229
California Creek	1	1005547	904992300	-0.204259	51.710087	51.914346	16.187833	9.811158	16277626.785958

HUC_103

NAME	ZIP-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Aucilla River	1	2331462	2098315800	-0.648191	93.844818	94.493009	58.943573	21.47975	137424700.864022

HUC_201

NAME	ZIP-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Upper Suwannee River	1	3368958	3032062200	29.244478	70.914581	41.670103	52.752516	7.506892	177721011.077118

HUC_202

NAME	ZIP-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Alapaha River	1	1378978	1241080200	29.324709	100.315956	70.991247	60.236031	12.47536	83064161.780376

HUC_203

NAME	ZIP-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Withlacoochee River	1	1426036	1283432400	29.316168	100.71846	71.402292	67.841331	15.096477	96744180.512123

HUC_205

NAME	ZIP-CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Lower Suwannee River	1	4543572	4089214800	-0.078834	90.771919	90.850753	32.594756	18.421777	148096619.130029

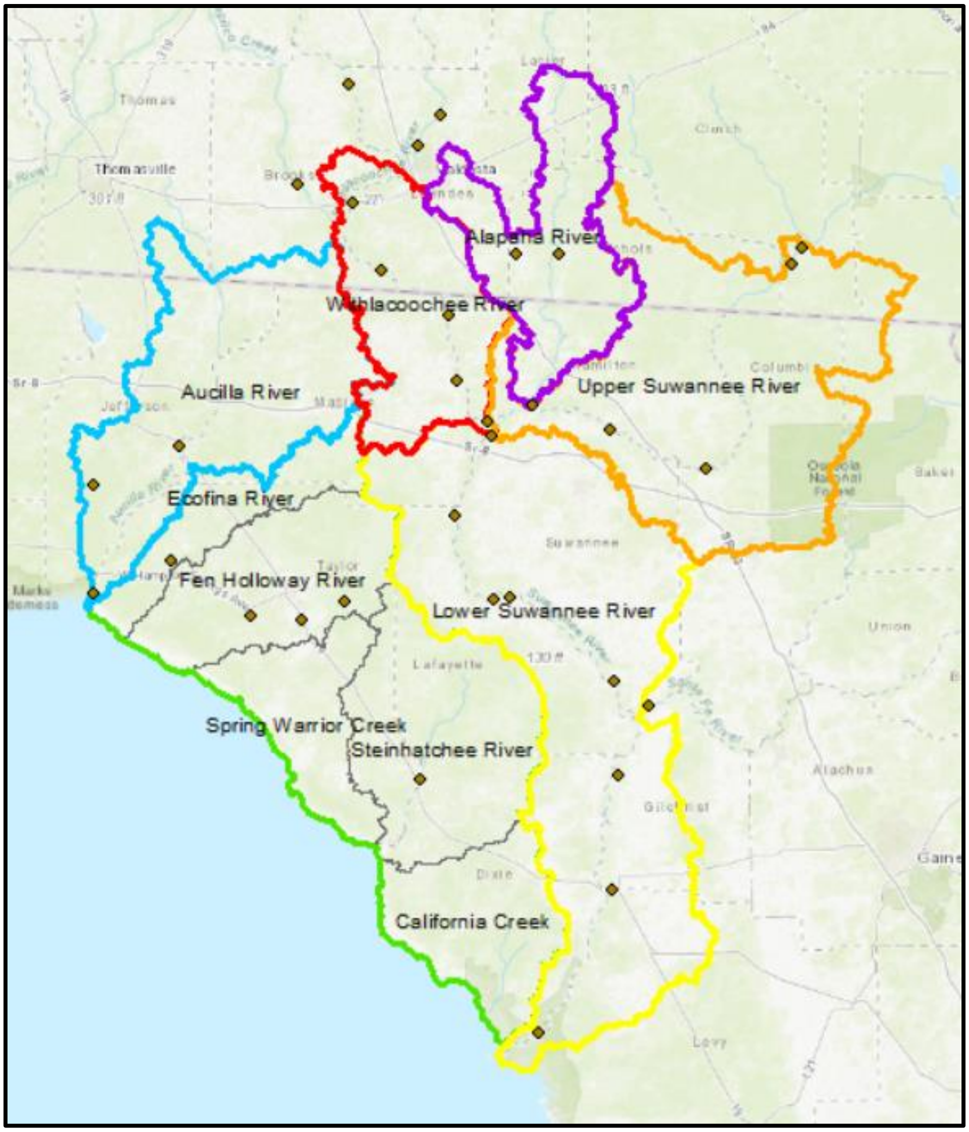


Figure 6. Locations of groundwater wells, surface water wells, and tidal gauge station in the Suwannee River watershed.

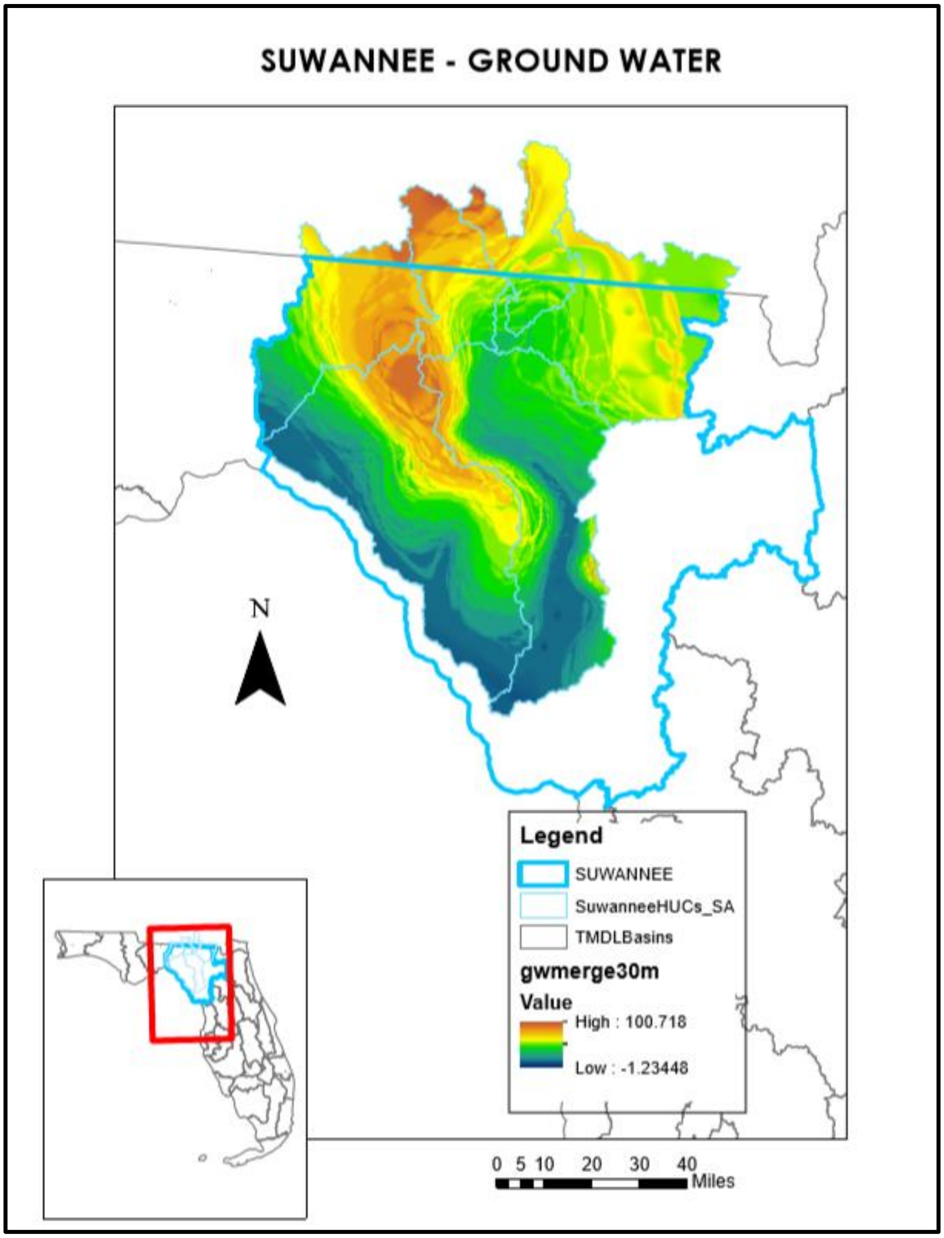


Figure 7. Groundwater layer in the Suwannee River watershed

3.2.3. Surface Waters

Figure 5 includes a map of the surface waters in the watershed, along with the locations of the groundwater stations, surface water stations and one tidal gauge for the basin. The common date chosen was 08/04/2018, which contained the highest recorded water levels of the active stations and reduced influence of unusually large storm events on the watershed.

3.2.4 *Open Space*

The open space map (Figure 7) is from the USGS NLCD 2016 land cover dataset and the open lands are displayed in the map.

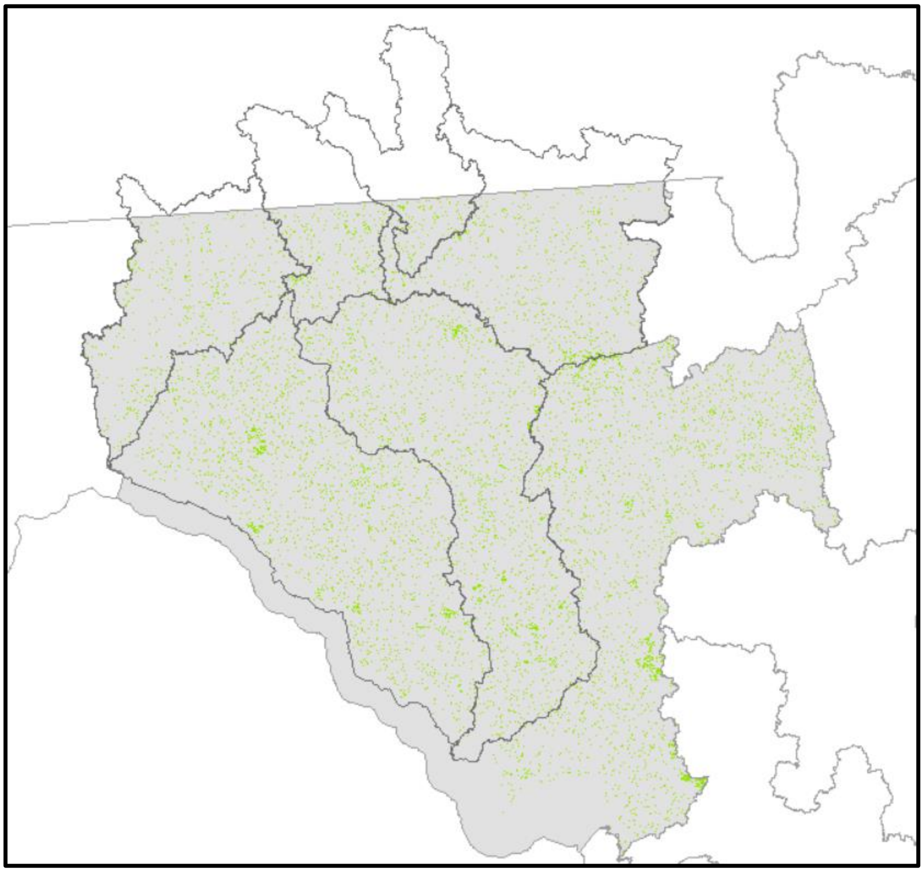


Figure 7. Open space in the Suwannee River watershed

3.1.5 *Soil Capacity*

The groundwater primarily occurs in the center of the Suwannee basin, as well as the northern portion which touches Georgia. Some of the eastern portion, touching the Atlantic Ocean, contains some groundwater storage. The edge on the Gulf of Mexico has little to no ground water storage. This translates to the southern central portion of the Suwannee area. There is more cascading in terms of the placement of the groundwater storage.

Figure 8 shows the soil capacity in the Suwannee River watershed. Much of the coastal areas, which includes impervious land and water, have no or very little water holding capacity. Areas found more inland have a higher soil capacity ranging from 0.10 to 1.00.

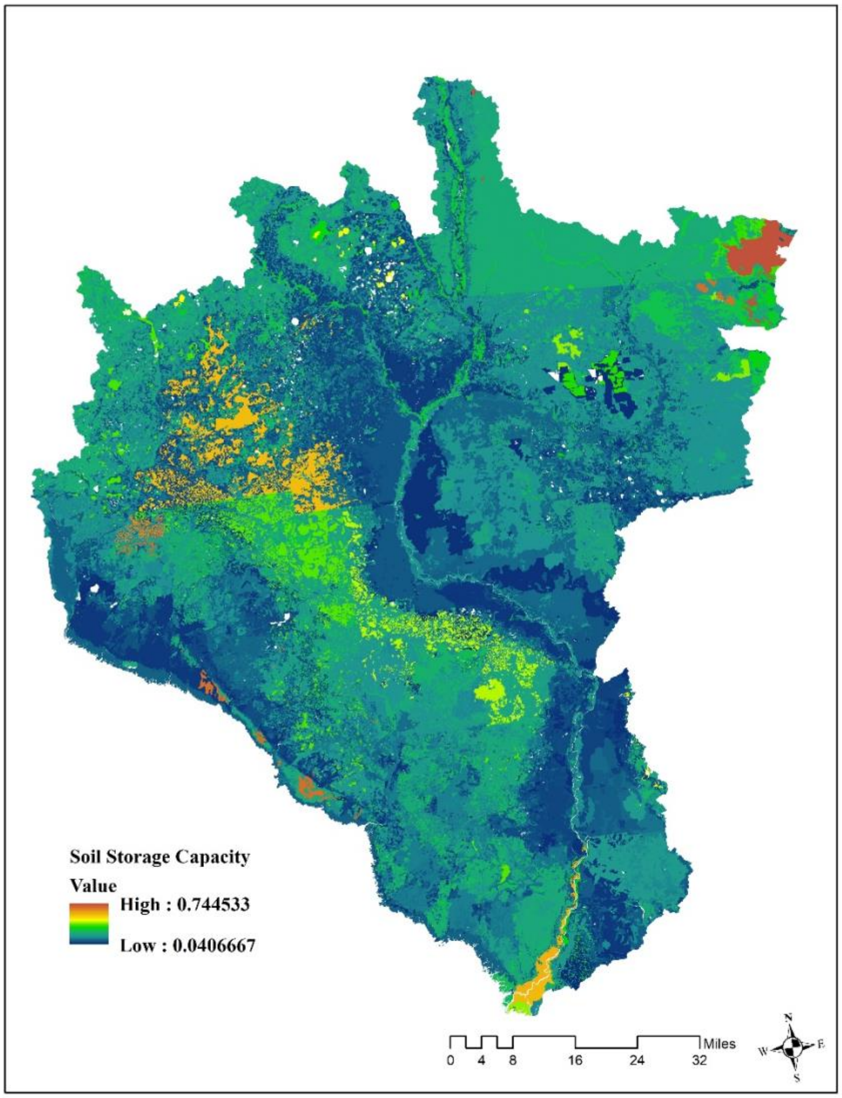
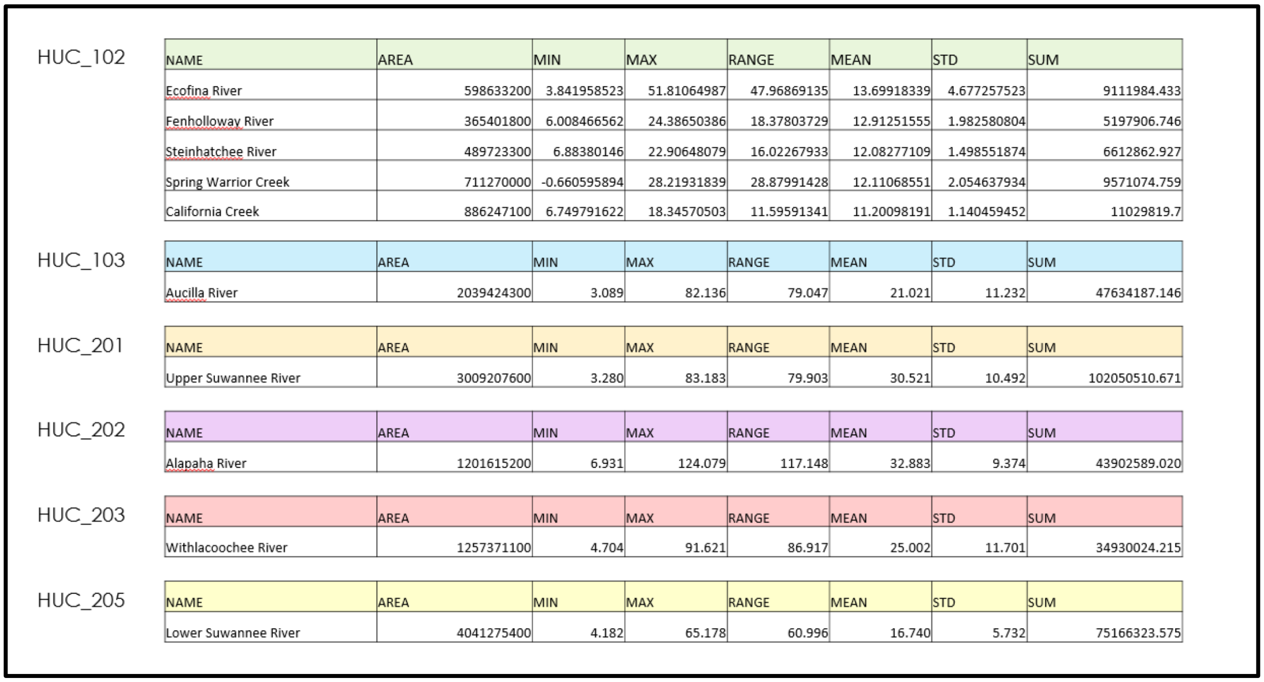


Figure 8. Soil storage capacity in the Suwannee River watershed (in inches)

There is not much ground storage in this area as shown in Table 2. The further north and east, the higher the ground storage. Upper Suwannee experiences the high level of ground storage, where Fen Holloway River, Spring Water Creek, Steinhatchee River, and California Creek have the least amount of ground storage; not fluctuating much. The area with the largest ground storage values belong to Alapaha River, located furthest north in the watershed, seen in Table 3. The lowest value is for HUC_102, and within that, California Creek is the lowest for ground storage.

Table 4 Ground storage values for Suwannee



HUC_102

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Ecofina River	598633200	3.841958523	51.81064987	47.96869135	13.69918339	4.677257523	9111984.433
Fenholloway River	365401800	6.008466562	24.38650386	18.37803729	12.91251555	1.982580804	5197906.746
Steinhatchee River	489723300	6.88380146	22.90648079	16.02267933	12.08277109	1.498551874	6612862.927
Spring Warrior Creek	711270000	-0.660595894	28.21931839	28.87991428	12.11068551	2.054637934	9571074.759
California Creek	886247100	6.749791622	18.34570503	11.59591341	11.20098191	1.140459452	11029819.7

HUC_103

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Aucilla River	2039424300	3.089	82.136	79.047	21.021	11.232	47634187.146

HUC_201

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Upper Suwannee River	3009207600	3.280	83.183	79.903	30.521	10.492	102050510.671

HUC_202

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Alapaha River	1201615200	6.931	124.079	117.148	32.883	9.374	43902589.020

HUC_203

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Withlacoochee River	1257371100	4.704	91.621	86.917	25.002	11.701	34930024.215

HUC_205

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Lower Suwannee River	4041275400	4.182	65.178	60.996	16.740	5.732	75166323.575

3.5 Precipitation

Precipitation follows a similar pattern as the previous watershed analysis, with the northeast experiencing less rainfall, and the southwestern portion experiencing higher levels of rainfall. The southwestern portion is adjacent to the Gulf of Mexico. Most of the area is low to medium rainfall. Almost exclusively, rainfall occurs in the southwest. Econfina River experiences the largest amount of rainfall, and behind that is Aucilla River, seen in Table 4. Econfina is located nearest the Gulf of Mexico. The area with the lowest rainfall, comparatively, is Alapaha River.

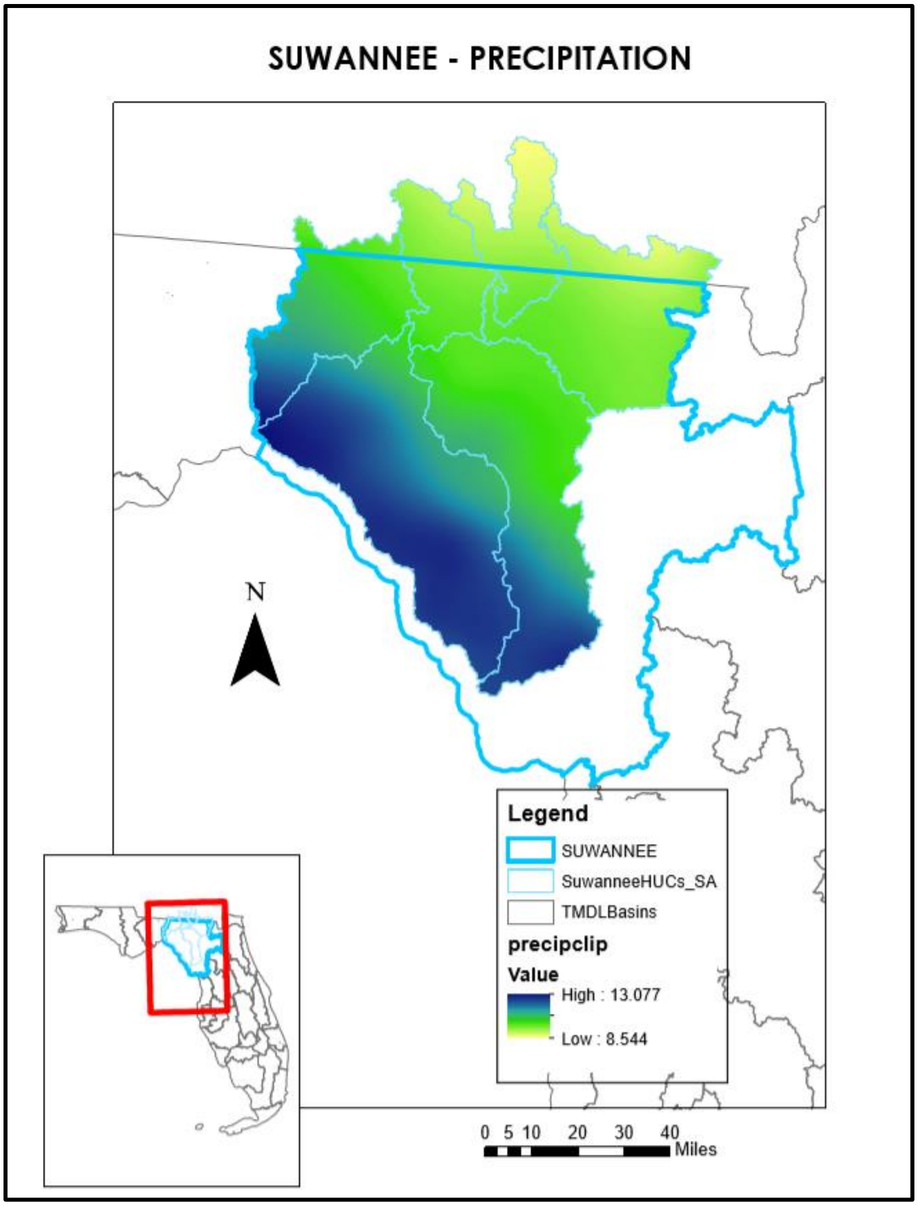
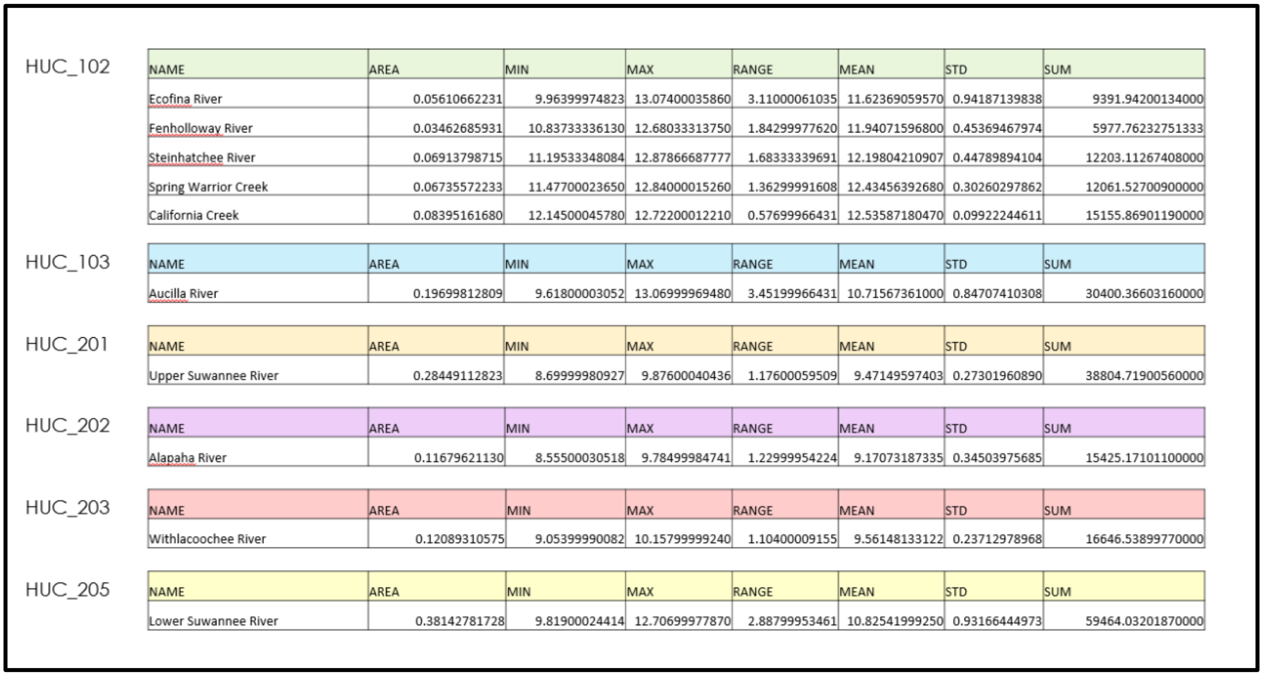


Figure 9. Average rainfall in the Suwannee River watershed

Table 5 Precipitation values for the Suwannee River Basin



HUC_102

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Ecofina River	0.05610662231	9.96399974823	13.07400035860	3.11000061035	11.62369059570	0.94187139838	9391.94200134000
Fenholloway River	0.03462685931	10.83733336130	12.68033313750	1.84299977620	11.94071596800	0.45369467974	5977.76232751333
Steinhatchee River	0.06913798715	11.19533348084	12.87866687777	1.68333339691	12.19804210907	0.44789894104	12203.11267408000
Spring Warrior Creek	0.06735572233	11.47700023650	12.84000015260	1.36299991608	12.43456392680	0.30260297862	12061.52700900000
California Creek	0.08395161680	12.14500045780	12.72200012210	0.57699966431	12.53587180470	0.09922244611	15155.86901190000

HUC_103

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Aucilla River	0.19699812809	9.61800003052	13.06999969480	3.45199966431	10.71567361000	0.84707410308	30400.36603160000

HUC_201

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Upper Suwannee River	0.28449112823	8.69999980927	9.87600040436	1.17600059509	9.47149597403	0.27301960890	38804.71900560000

HUC_202

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Alapaha River	0.11679621130	8.55500030518	9.78499984741	1.22999954224	9.17073187335	0.34503975685	15425.17101100000

HUC_203

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Withlacoochee River	0.12089310575	9.05399990082	10.15799999240	1.10400009155	9.56148133122	0.23712978968	16646.53899770000

HUC_205

NAME	AREA	MIN	MAX	RANGE	MEAN	STD	SUM
Lower Suwannee River	0.38142781728	9.81900024414	12.70699977870	2.88799953461	10.82541999250	0.93166444973	59464.03201870000

3.3 Modeling Protocol

The modelling of the watershed was done using ArcGIS, ArcHydro, and Cascade software. A 5-mile buffer was used instead of the original boundary, as to remove any inconsistencies or abnormalities that could occur near the edges of the watershed. The exception to this was the station data (Figure 6) as some stations could be found outside of the 5-mile buffer. The soil capacity (Figure 8) was created by multiplying the water mask, impervious mask, and a soil ratio dataset. The groundwater layer (Figure 5) was created by using the kriging method in ArcGIS software, which utilized the water levels that were found by the groundwater stations, surface water stations, and tidal gauges.

Figure 10 shows the quantity of the soil storage that was computed in preparation for the final flooding data. This was created by using the expression *DEM - groundwater layer * 12 * soil storage capacity*. The areas with the lowest storage were found along the coast and in the middle, which correspond low elevation and the presence of water (ex. rivers, swamps). The areas with the highest amount of soil storage over 8 inches were found in drier parts of the inland, along with areas in higher elevation.

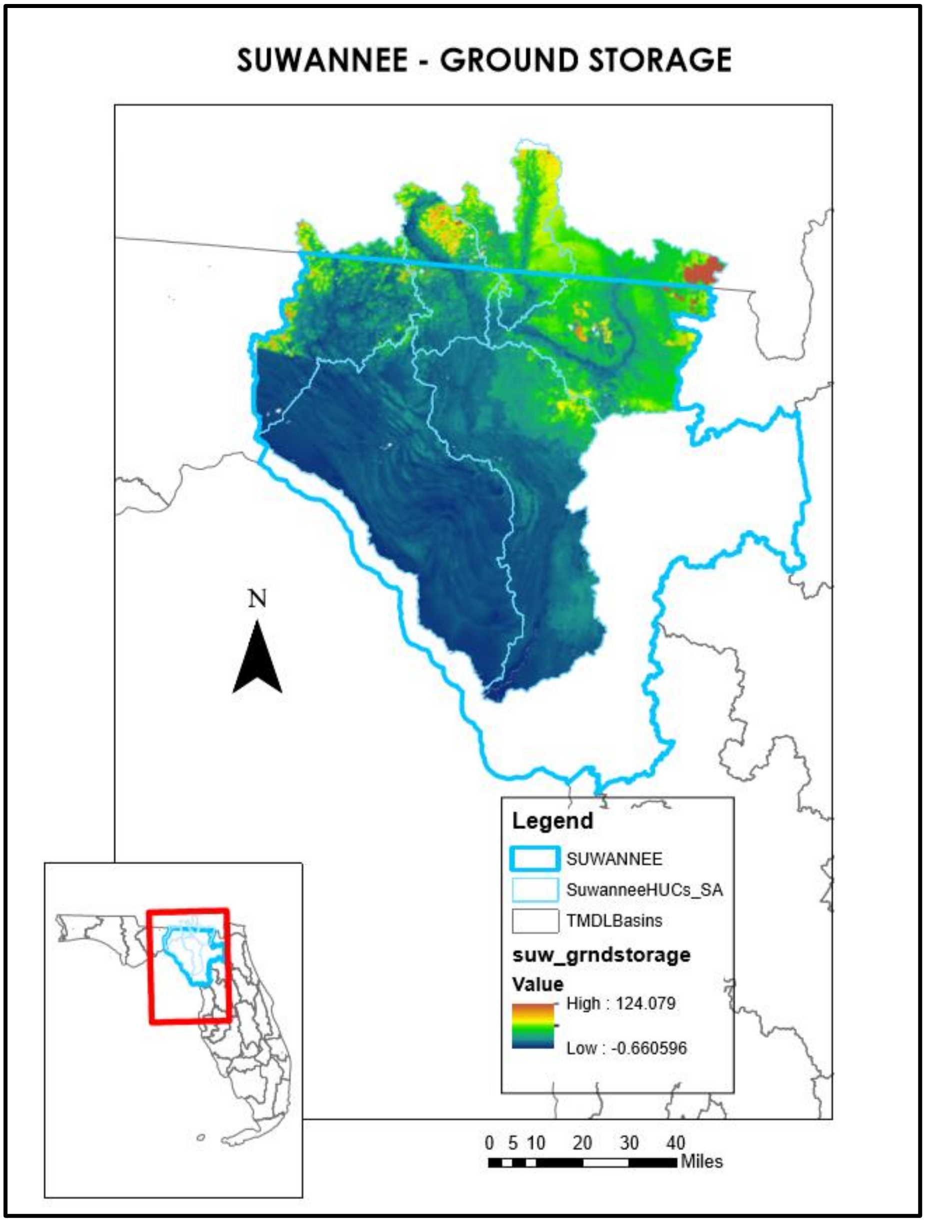


Figure 10. Ground storage in the Suwannee River watershed (in inches)

ArcHydro was then used to generate the catchments within the watershed, which also included the drainage lines and drainage points for each of the catchments. This was done to determine the direction and the longest drainage path for the catchments to understand where water would flow from areas of higher elevation to areas of lower elevation. The average rainfall, average soil storage, initial drainage elevation, maximum ground elevation, and area in acres was then calculated for each catchment for use in Cascade software in order to calculate the maximum headwater height for each catchment in preparation for the flood inundation. Once the headwater height was obtained from each catchment, the expression *(Headwater Height – DEM Elevation) +/- 0.46)* was used to calculate the Z-score for the entire watershed, which was assigned a probability of flood inundation for the entire watershed.

3.4 Modeling Results

3.4.1 Watershed pathways

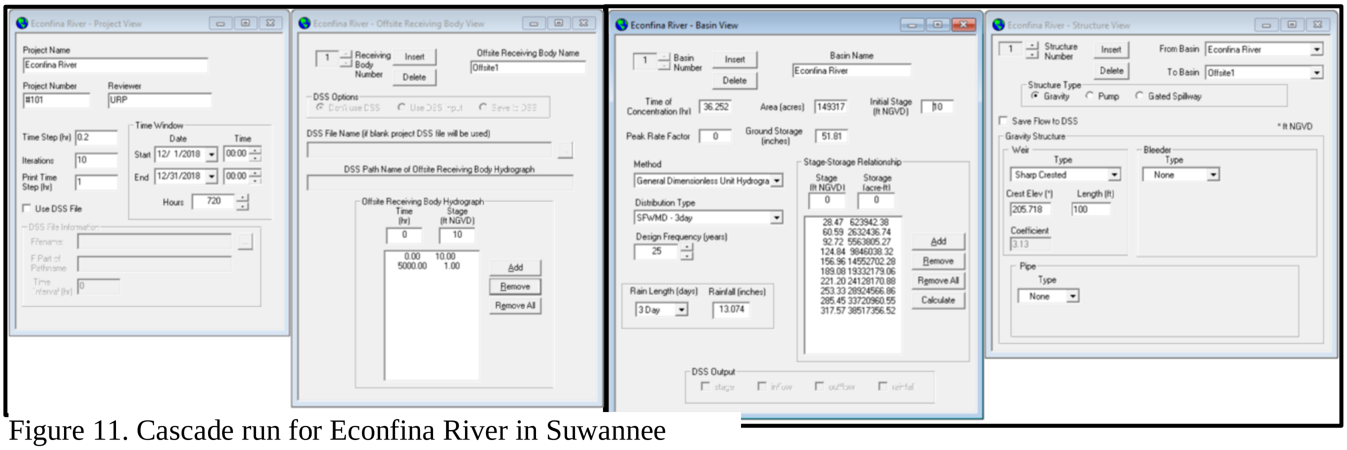
The catchments and waterway flow paths that were produced from ArcHydro as shown for the Suwannee River watershed can be found in Figure 11.

3.4.2 Cascade Results

The final results from Cascade can be seen in Table 5, which displays the predicted headwater height for each of the catchments, along with the area in acres, mean rain, mean soil storage capacity, initial stage, and the maximum elevation from ArcGIS and ArcHydro.

Cascade 2001 was used to find out the high head water for the Suwannee River Basin. Using the information from the watershed analysis.

1. Area: Basing this information on the DEM values, which were derived from merging the smaller catchments into larger ones, the area was determined and converted to acre-ft.
2. Offsites: These were given to each catchment. Which offsite, was determined by where the water body drained into.
3. The initial stage: This was determined by finding the outlets
4. Ground storage: Data came from soil storage/ ground storage tables
5. Time of concentration: determined by dividing the longest river length by 3600
6. Rainfall: Data was used from precipitation tables
7. Stage-Storage relationship:
8. Structure: Initial stage values were used for gravity structures.



Econfina River - Project View

Project Name: Econfina River

Project Number: #101

Reviewer: URP

Time Step (hr): 0.2

Iterations: 10

Print Time Step (hr): 1

☐ Use DSS File

Time Window

	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours: 720

DSS File Information

Filename:

F Part of Pathname:

Time Interval (hr): 0

Econfina River - Offsite Receiving Body View

Receiving Body Number: 1

Offsite Receiving Body Name: Offsite1

DSS Options: ● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)

DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	10
0.00	10.00
5000.00	1.00

Econfina River - Basin View

Basin Number: 1

Basin Name: Econfina River

Time of Concentration (hr): 36.252

Area (acres): 149317

Initial Stage (ft NGVD): 10

Peak Rate Factor: 0

Ground Storage (inches): 51.81

Method: General Dimensionless Unit Hydrogra

Distribution Type: SFWMD - 3day

Design Frequency (years): 25

Rain Length (days): 3 Day

Rainfall (inches): 13.074

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
28.47	623942.38
60.59	2632436.74
92.72	5563805.27
124.84	9846038.32
156.96	14552702.28
189.08	19332179.06
221.20	24128170.88
253.33	28924566.86
285.45	33720960.55
317.57	38517356.52

DSS Output: ☐ stage ☐ inflow ☐ outflow ☐ rainfall

Econfina River - Structure View

Structure Number: 1

From Basin: Econfina River

To Basin: Offsite1

Structure Type: ● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS

* ft NGVD

Gravity Structure

Weir Type: Sharp Crested

Crest Elev (*): 205.718

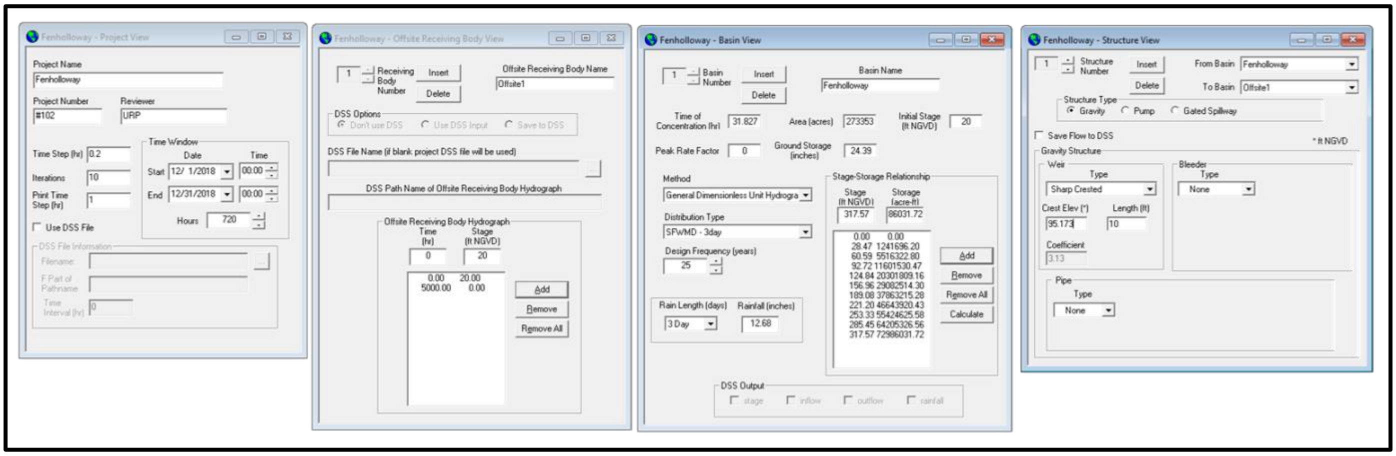
Length (ft): 100

Coefficient: 3.13

Bleeder Type: None

Pipe Type: None

Figure 11. Cascade run for Econfina River in Suwannee



Fenholloway - Project View

Project Name: Fenholloway

Project Number: #102

Reviewer: URP

Time Step (hr): 0.2

Iterations: 10

Print Time Step (hr): 1

☐ Use DSS File

Time Window

	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours: 720

DSS File Information

Filename:

F Part of Pathname:

Time Interval (hr): 0

Fenholloway - Offsite Receiving Body View

Receiving Body Number: 1

Offsite Receiving Body Name: Offsite1

DSS Options: ● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)

DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	20
0.00	20.00
5000.00	0.00

Fenholloway - Basin View

Basin Number: 1

Basin Name: Fenholloway

Time of Concentration (hr): 31.827

Area (acres): 273353

Initial Stage (ft NGVD): 20

Peak Rate Factor: 0

Ground Storage (inches): 24.39

Method: General Dimensionless Unit Hydrogra

Distribution Type: SFWMD - 3day

Design Frequency (years): 25

Rain Length (days): 3 Day

Rainfall (inches): 12.68

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
317.57	86031.72
0.00	0.00
28.47	1241696.20
60.59	5516322.80
92.72	11601530.47
124.84	20301809.16
156.96	29082514.30
189.08	37863215.28
221.20	46643920.43
253.33	55424625.58
285.45	64205326.56
317.57	72986031.72

DSS Output: ☐ stage ☐ inflow ☐ outflow ☐ rainfall

Fenholloway - Structure View

Structure Number: 1

From Basin: Fenholloway

To Basin: Offsite1

Structure Type: ● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS

* ft NGVD

Gravity Structure

Weir Type: Sharp Crested

Crest Elev (*): 95.173

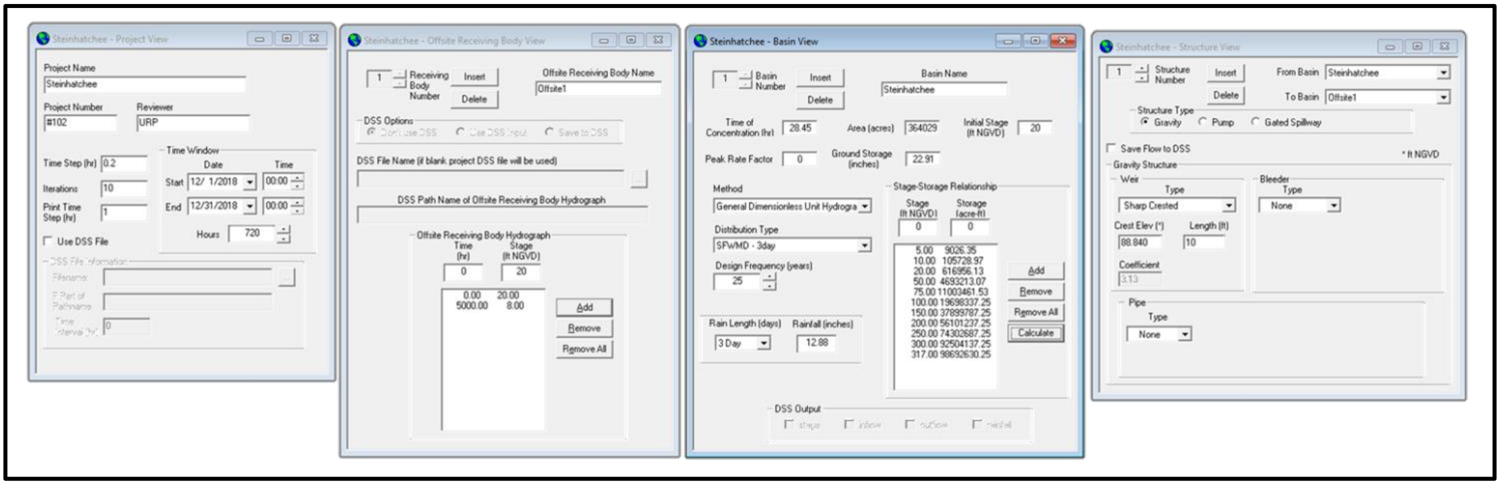
Length (ft): 10

Coefficient: 3.13

Bleeder Type: None

Pipe Type: None

Figure 12. Cascade run for Fenholloway River in Suwannee



Steinhatchee - Project View

Project Name: Steinhatchee
Project Number: #102
Reviewer: URP
Time Step (hr): 0.2
Iterations: 10
Print Time Step (hr): 1
☐ Use DSS File
Time Window: Start 12/ 1/2018 00:00; End 12/31/2018 00:00; Hours 720
DSS File Information: Time Interval (hr) 0

Steinhatchee - Offsite Receiving Body View

Receiving Body Number: 1
Offsite Receiving Body Name: Offsite1
DSS Options: ● Don't use DSS ○ Use DSS Input ○ Save to DSS
DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	20
0.00	20.00
5000.00	8.00

Steinhatchee - Basin View

Basin Number: 1
Basin Name: Steinhatchee
Time of Concentration (hr): 28.45
Area (acres): 364029
Initial Stage (ft NGVD): 20
Peak Rate Factor: 0
Ground Storage (inches): 22.91
Method: General Dimensionless Unit Hydrogra
Distribution Type: SFWMD - 3day
Design Frequency (years): 25
Rain Length (days): 3 Day
Rainfall (inches): 12.88

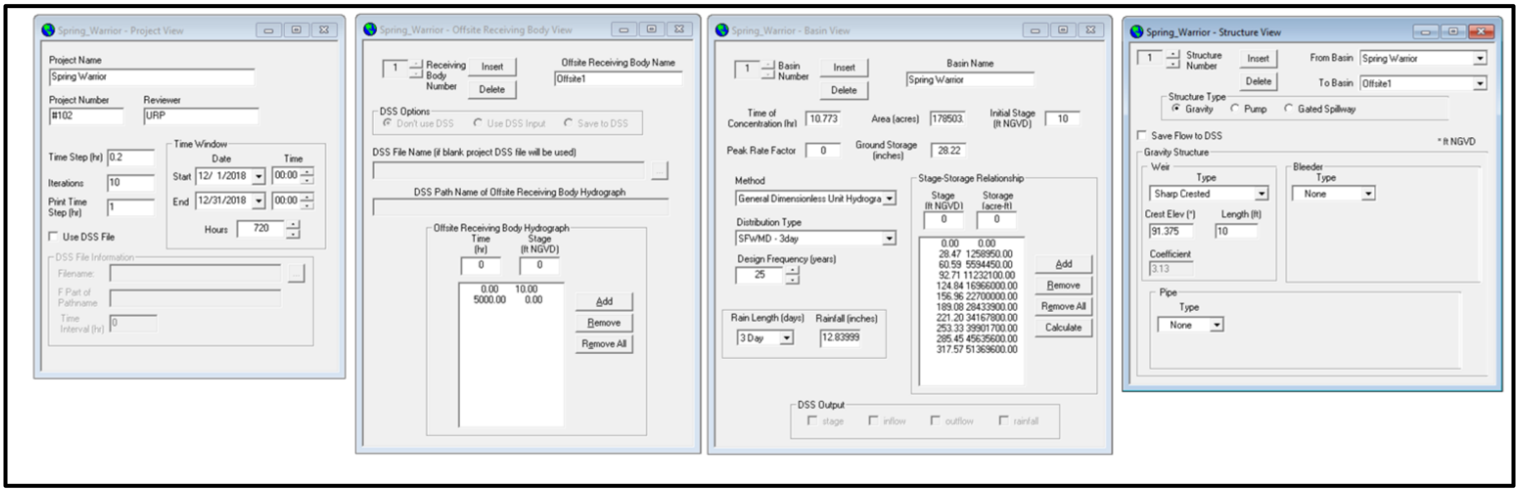
Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
5.00	9026.35
10.00	105728.97
20.00	616956.13
50.00	4693213.07
75.00	11003461.53
100.00	19698337.25
150.00	37899787.25
200.00	56101237.25
250.00	74302687.25
300.00	92504137.25
317.00	98692630.25

Steinhatchee - Structure View

Structure Number: 1
From Basin: Steinhatchee
To Basin: Offsite1
Structure Type: ● Gravity ○ Pump ○ Gated Spillway
☐ Save Flow to DSS
* ft NGVD
Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*): 88.840
Length (ft): 10
Coefficient: 3.13
Bleeder Type: None
Pipe Type: None

Figure 13. Cascade run for Steinhatchee River in Suwannee



Spring_Warrior - Project View

Project Name: Spring Warrior
Project Number: #102
Reviewer: URP
Time Step (hr): 0.2
Iterations: 10
Print Time Step (hr): 1
☐ Use DSS File
Time Window: Start 12/ 1/2018 00:00; End 12/31/2018 00:00; Hours 720
DSS File Information: Time Interval (hr) 0

Spring_Warrior - Offsite Receiving Body View

Receiving Body Number: 1
Offsite Receiving Body Name: Offsite1
DSS Options: ● Don't use DSS ○ Use DSS Input ○ Save to DSS
DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	0
0.00	10.00
5000.00	0.00

Spring_Warrior - Basin View

Basin Number: 1
Basin Name: Spring Warrior
Time of Concentration (hr): 10.773
Area (acres): 178503.
Initial Stage (ft NGVD): 10
Peak Rate Factor: 0
Ground Storage (inches): 28.22
Method: General Dimensionless Unit Hydrogra
Distribution Type: SFWMD - 3day
Design Frequency (years): 25
Rain Length (days): 3 Day
Rainfall (inches): 12.83999

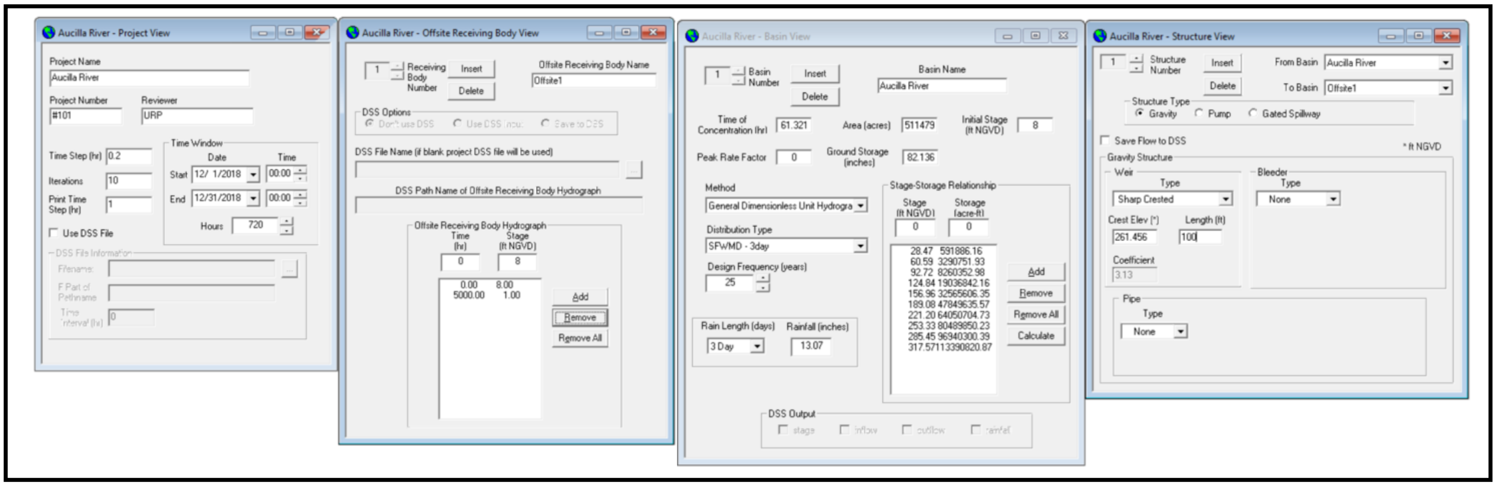
Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
0.00	0.00
28.47	1258950.00
60.59	5594450.00
92.71	11232100.00
124.84	16966000.00
156.96	22700000.00
189.08	28433900.00
221.20	34167800.00
253.33	39901700.00
285.45	45635600.00
317.57	51369600.00

Spring_Warrior - Structure View

Structure Number: 1
From Basin: Spring Warrior
To Basin: Offsite1
Structure Type: ● Gravity ○ Pump ○ Gated Spillway
☐ Save Flow to DSS
* ft NGVD
Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*): 91.375
Length (ft): 10
Coefficient: 3.13
Bleeder Type: None
Pipe Type: None

Figure 14. Cascade run for Spring Warrior Creek in Suwannee



Aucilla River - Project View

Project Name: Aucilla River
Project Number: #101
Reviewer: URP
Time Step (hr): 0.2
Iterations: 10
Print Time Step (hr): 1
☐ Use DSS File
Time Window: Start 12/ 1/2018 00:00; End 12/31/2018 00:00; Hours 720
DSS File Information: Time Interval (hr) 0

Aucilla River - Offsite Receiving Body View

Receiving Body Number: 1
Offsite Receiving Body Name: Offsite1
DSS Options: ● Don't use DSS ○ Use DSS Input ○ Save to DSS
DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	8
0.00	8.00
5000.00	1.00

Aucilla River - Basin View

Basin Number: 1
Basin Name: Aucilla River
Time of Concentration (hr): 61.321
Area (acres): 511479
Initial Stage (ft NGVD): 8
Peak Rate Factor: 0
Ground Storage (inches): 82.136
Method: General Dimensionless Unit Hydrogra
Distribution Type: SFWMD - 3day
Design Frequency (years): 25
Rain Length (days): 3 Day
Rainfall (inches): 13.07

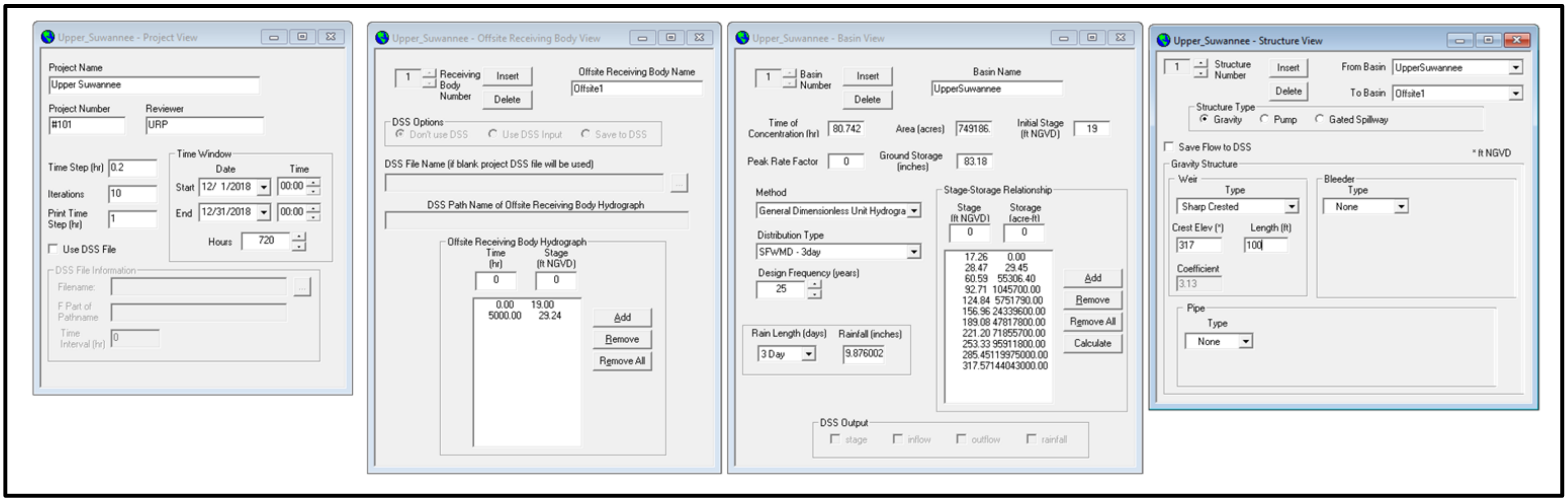
Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
28.47	591886.16
60.59	3290751.93
92.72	8260352.98
124.84	19036842.16
156.96	32565606.35
189.08	47849635.57
221.20	64050704.73
253.33	80489850.23
285.45	96940300.39
317.57	113390820.87

Aucilla River - Structure View

Structure Number: 1
From Basin: Aucilla River
To Basin: Offsite1
Structure Type: ● Gravity ○ Pump ○ Gated Spillway
☐ Save Flow to DSS
* ft NGVD
Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*): 261.456
Length (ft): 100
Coefficient: 3.13
Bleeder Type: None
Pipe Type: None

Figure 15. Cascade run for Aucilla River in Suwannee



Upper_Suwannee - Project View

Project Name
Upper Suwannee

Project Number
#101

Reviewer
URP

Time Step (hr) 0.2
Iterations 10
Print Time Step (hr) 1
☐ Use DSS File

Time Window

	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours 720

DSS File Information
Filename:
F Part of Pathname
Time Interval (hr) 0

Upper_Suwannee - Offsite Receiving Body View

1 Receiving Body Number
Offsite Receiving Body Name
Offsite1

DSS Options
● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	0
0.00	19.00
5000.00	29.24

Upper_Suwannee - Basin View

1 Basin Number
Basin Name
UpperSuwannee

Time of Concentration (hr) 80.742
Area (acres) 749186.
Initial Stage (ft NGVD) 19
Peak Rate Factor 0
Ground Storage (inches) 83.18

Method
General Dimensionless Unit Hydrogra

Distribution Type
SFWMD - 3day

Design Frequency (years)
25

Rain Length (days) 3 Day
Rainfall (inches) 9.876002

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
17.26	0.00
28.47	29.45
60.59	55306.40
92.71	1045700.00
124.84	5751790.00
156.96	24339600.00
189.08	47817800.00
221.20	71855700.00
253.33	95911800.00
285.45	119975000.00
317.57	144043000.00

DSS Output
☐ stage ☐ inflow ☐ outflow ☐ rainfall

Upper_Suwannee - Structure View

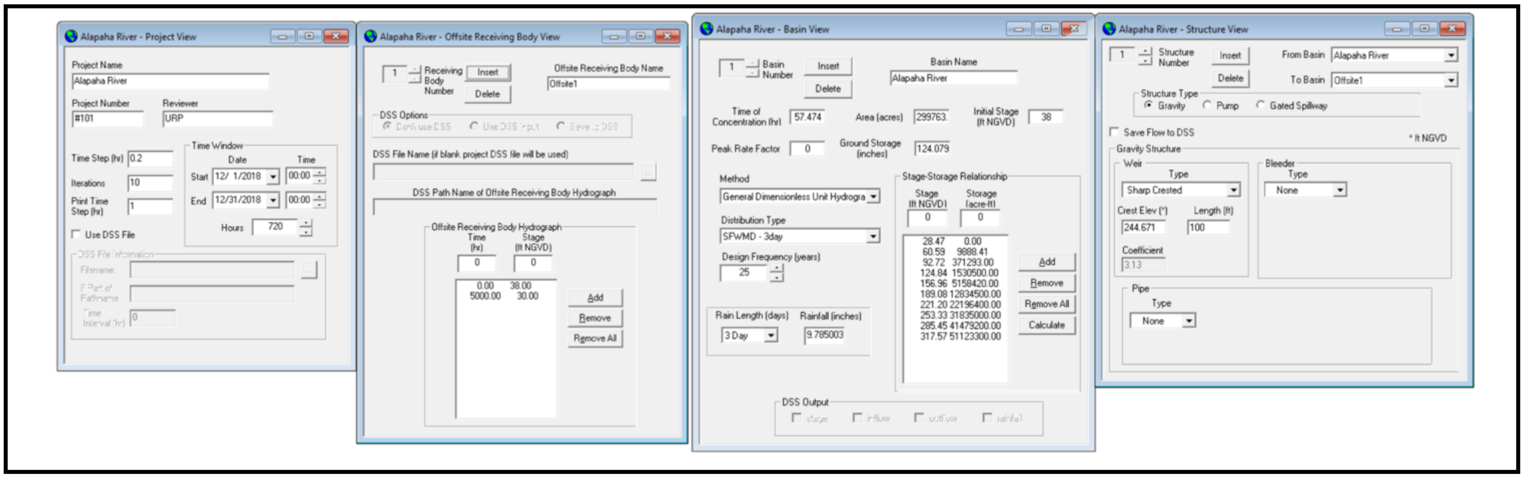
1 Structure Number
From Basin UpperSuwannee
To Basin Offsite1

Structure Type
● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS
* ft NGVD

Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*) 317
Length (ft) 100
Coefficient 3.13
Bleeder Type: None
Pipe Type: None

Figure 16. Cascade run for Upper Suwannee River in Suwannee



Alapaha River - Project View

Project Name
Alapaha River

Project Number
#101

Reviewer
URP

Time Step (hr) 0.2
Iterations 10
Print Time Step (hr) 1
☐ Use DSS File

Time Window

	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours 720

DSS File Information
Filename:
F Part of Pathname
Time Interval (hr) 0

Alapaha River - Offsite Receiving Body View

1 Receiving Body Number
Offsite Receiving Body Name
Offsite1

DSS Options
● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	0
0.00	38.00
5000.00	30.00

Alapaha River - Basin View

1 Basin Number
Basin Name
Alapaha River

Time of Concentration (hr) 57.474
Area (acres) 299763.
Initial Stage (ft NGVD) 38
Peak Rate Factor 0
Ground Storage (inches) 124.079

Method
General Dimensionless Unit Hydrogra

Distribution Type
SFWMD - 3day

Design Frequency (years)
25

Rain Length (days) 3 Day
Rainfall (inches) 9.785003

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
28.47	0.00
60.59	9888.41
92.72	371293.00
124.84	1530500.00
156.96	5158420.00
189.08	12834500.00
221.20	22196400.00
253.33	31835000.00
285.45	41479200.00
317.57	51123300.00

DSS Output
☐ stage ☐ inflow ☐ outflow ☐ rainfall

Alapaha River - Structure View

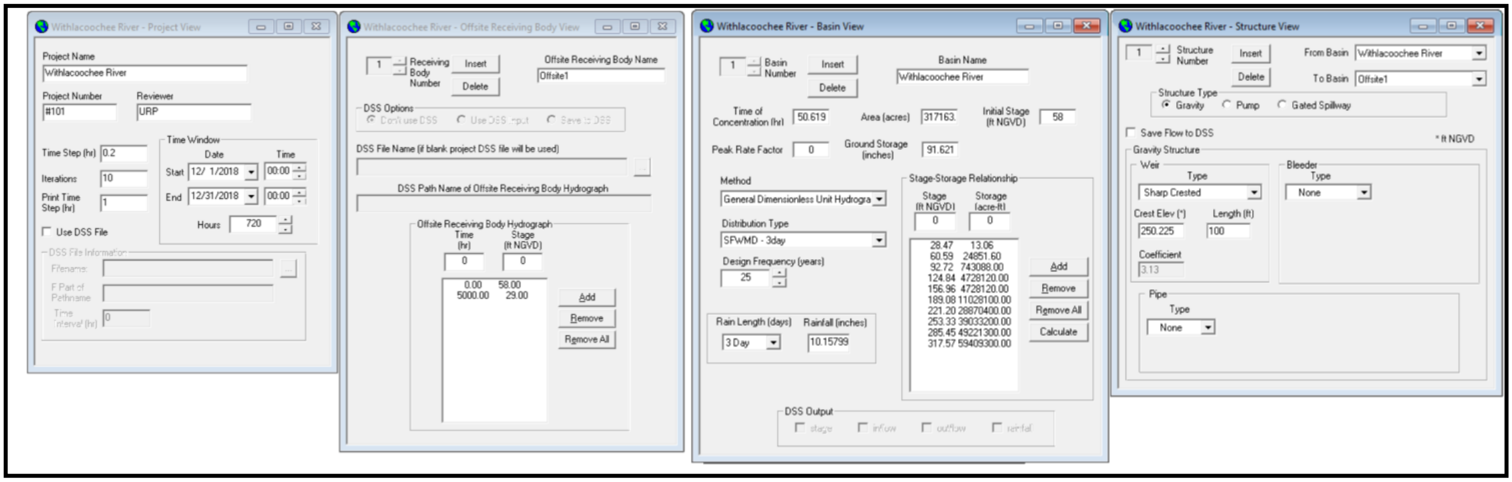
1 Structure Number
From Basin Alapaha River
To Basin Offsite1

Structure Type
● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS
* ft NGVD

Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*) 244.671
Length (ft) 100
Coefficient 3.13
Bleeder Type: None
Pipe Type: None

Figure 17. Cascade run for Alapaha River in Suwannee



Withlacoochee River - Project View

Project Name
Withlacoochee River

Project Number
#101

Reviewer
URP

Time Step (hr) 0.2
Iterations 10
Print Time Step (hr) 1
☐ Use DSS File

Time Window

	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours 720

DSS File Information
Filename:
F Part of Pathname
Time Interval (hr) 0

Withlacoochee River - Offsite Receiving Body View

1 Receiving Body Number
Offsite Receiving Body Name
Offsite1

DSS Options
● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)
DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	0
0.00	58.00
5000.00	29.00

Withlacoochee River - Basin View

1 Basin Number
Basin Name
Withlacoochee River

Time of Concentration (hr) 50.619
Area (acres) 317163.
Initial Stage (ft NGVD) 58
Peak Rate Factor 0
Ground Storage (inches) 91.621

Method
General Dimensionless Unit Hydrogra

Distribution Type
SFWMD - 3day

Design Frequency (years)
25

Rain Length (days) 3 Day
Rainfall (inches) 10.15799

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0
28.47	13.06
60.59	24851.60
92.72	743088.00
124.84	4728120.00
156.96	4728120.00
189.08	11028100.00
221.20	28870400.00
253.33	39033200.00
285.45	49221300.00
317.57	59409300.00

DSS Output
☐ stage ☐ inflow ☐ outflow ☐ rainfall

Withlacoochee River - Structure View

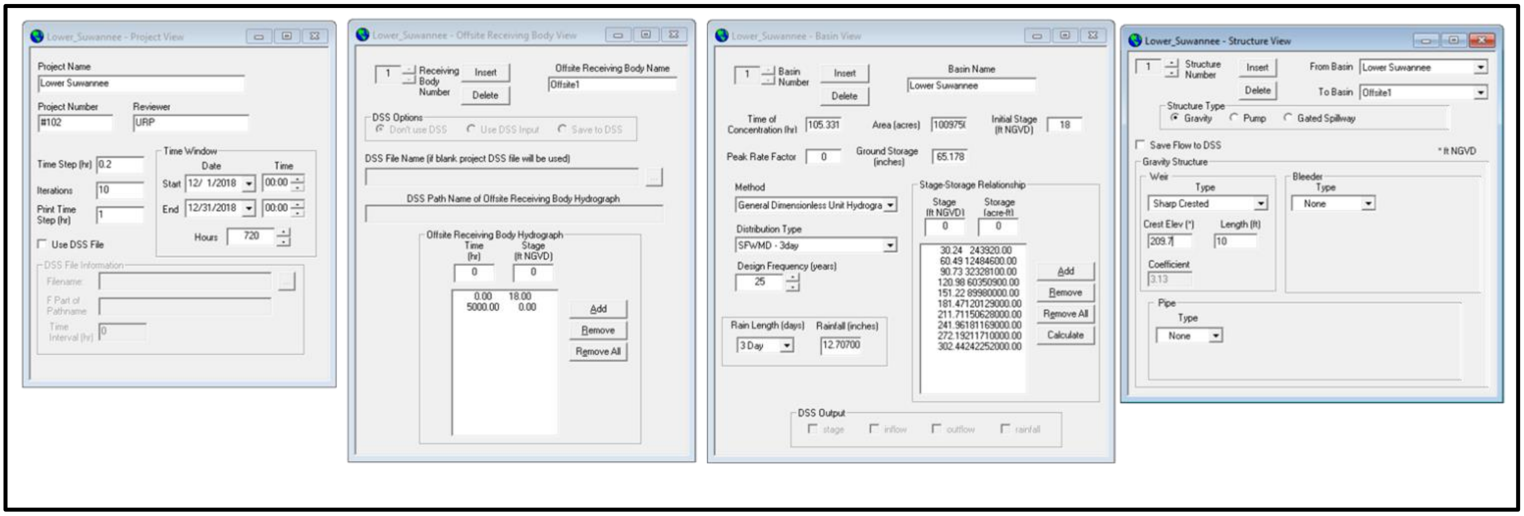
1 Structure Number
From Basin Withlacoochee River
To Basin Offsite1

Structure Type
● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS
* ft NGVD

Gravity Structure
Weir Type: Sharp Crested
Crest Elev (*) 250.225
Length (ft) 100
Coefficient 3.13
Bleeder Type: None
Pipe Type: None

Figure 18. Cascade run for Withlacoochee River in Suwannee



Lower_Suwannee - Project View

Project Name
Lower Suwannee

Project Number
#102

Reviewer
URP

Time Step (hr) 0.2
Iterations 10
Print Time Step (hr) 1
☐ Use DSS File

Time Window
	Date	Time
Start	12/ 1/2018	00:00
End	12/31/2018	00:00

Hours 720

DSS File Information
Filename:
F Part of Pathname
Time Interval (hr) 0

Lower_Suwannee - Offsite Receiving Body View

1 Receiving Body Number

Offsite Receiving Body Name
Offsite1

DSS Options
● Don't use DSS ○ Use DSS Input ○ Save to DSS

DSS File Name (if blank project DSS file will be used)

DSS Path Name of Offsite Receiving Body Hydrograph

Offsite Receiving Body Hydrograph

Time (hr)	Stage (ft NGVD)
0	0
0.00	18.00
5000.00	0.00

Lower_Suwannee - Basin View

1 Basin Number

Basin Name
Lower Suwannee

Time of Concentration (hr) 105.331
Area (acres) 100975(
Initial Stage (ft NGVD) 18
Peak Rate Factor 0
Ground Storage (inches) 65.178

Method
General Dimensionless Unit Hydrogra

Distribution Type
SFWMD - 3day

Design Frequency (years)
25

Rain Length (days)	Rainfall (inches)
3 Day	12.70700

Stage-Storage Relationship

Stage (ft NGVD)	Storage (acre-ft)
0	0

```
30.24  243920.00
60.49 12484600.00
90.73 32328100.00
120.98 60350900.00
151.22 89980000.00
181.47120129000.00
211.71150628000.00
241.96181169000.00
272.19211710000.00
302.44242252000.00
```

DSS Output
☐ stage ☐ inflow ☐ outflow ☐ rainfall

Lower_Suwannee - Structure View

1 Structure Number

From Basin Lower Suwannee
To Basin Offsite1

Structure Type
● Gravity ○ Pump ○ Gated Spillway

☐ Save Flow to DSS

* ft NGVD

Gravity Structure

Weir
Type
Sharp Crested
Crest Elev (*) 209.7
Length (ft) 10
Coefficient 3.13

Bleeder
Type
None

Pipe
Type
None

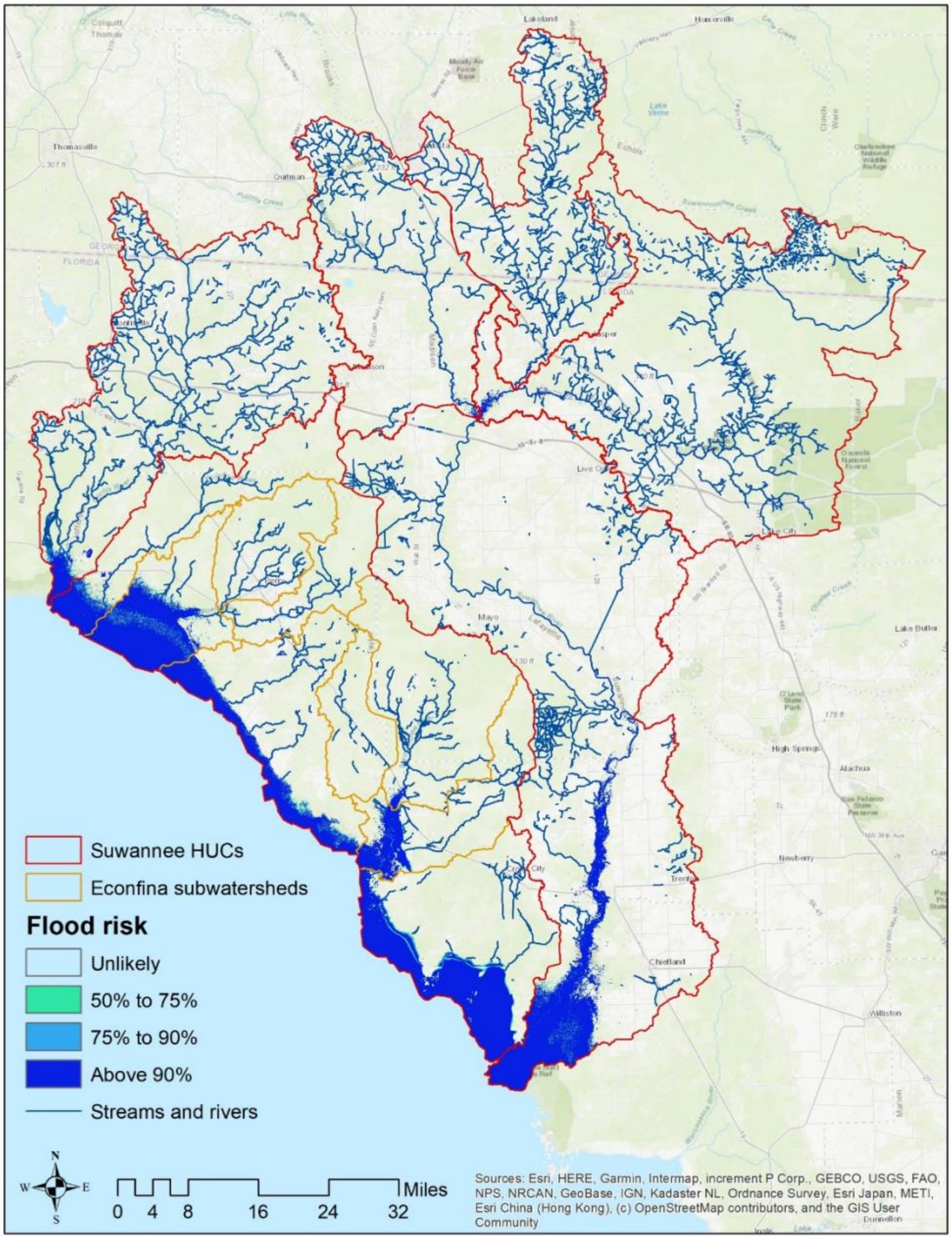
Figure 19. Cascade run for Lower Suwannee River in Suwannee Basin

3.4.3 Vulnerability to Flooding

Figure 20 contains the predicted likelihood of flooding in the Suwannee watershed. The probability of inundation was determined based on the Z-score for each of the pixels within the watershed, which was used to represent the confidence interval. Z-score values that were below 0 were considered having less than of 50% likelihood of flooding, between 0 and 0.675 having 50% - 75% likelihood of flooding, between 0.675 and 1.282 having 75% - 90% likelihood of flooding, and above 1.282 having over 90% of flooding. In addition, known bodies of water (ex. lakes, canals, rivers, etc.) were also displayed so to only show land-based flooding.

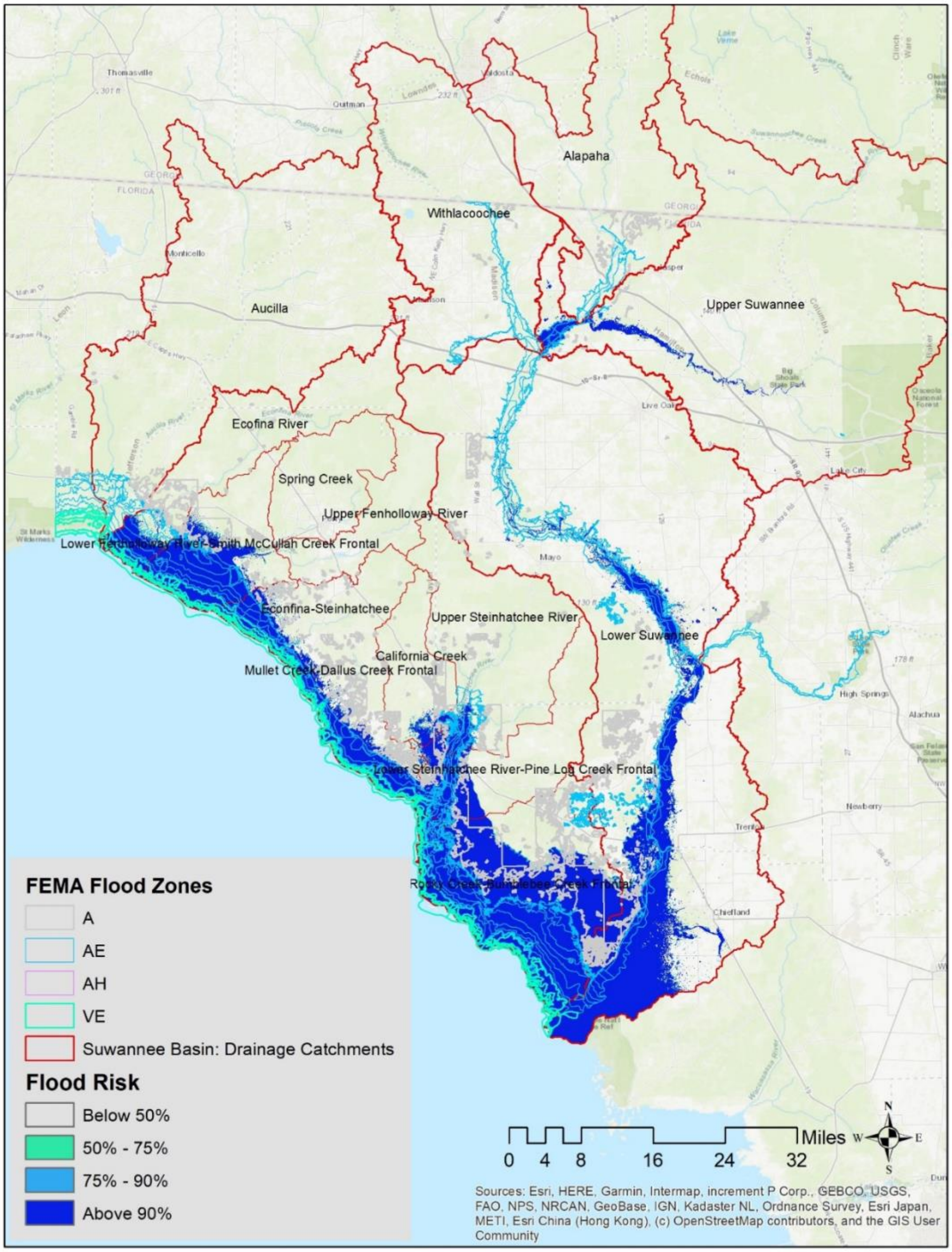
3.4.4 FEMA Flood map comparison

Figure 21 contains the risk of flooding for the watershed based on FEMA estimations of flood risk. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30. Moderate flood hazard areas, labeled Zone B or Zone X (shaded) are also shown on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled Zone C or Zone X (unshaded) (“Definitions of FEMA Flood Zone Designations,” n.d.).



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 20. Predicted flooding in the Suwannee River watershed



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 21. FEMA flood zones for Suwannee

3.4.5 Repetitive Loss Comparison

Figure 25 shows a comparison of the flood map and repetitive loss property locations for the basin. The loss areas coincide with the areas predicted by the FAU model as being at risk for flooding.

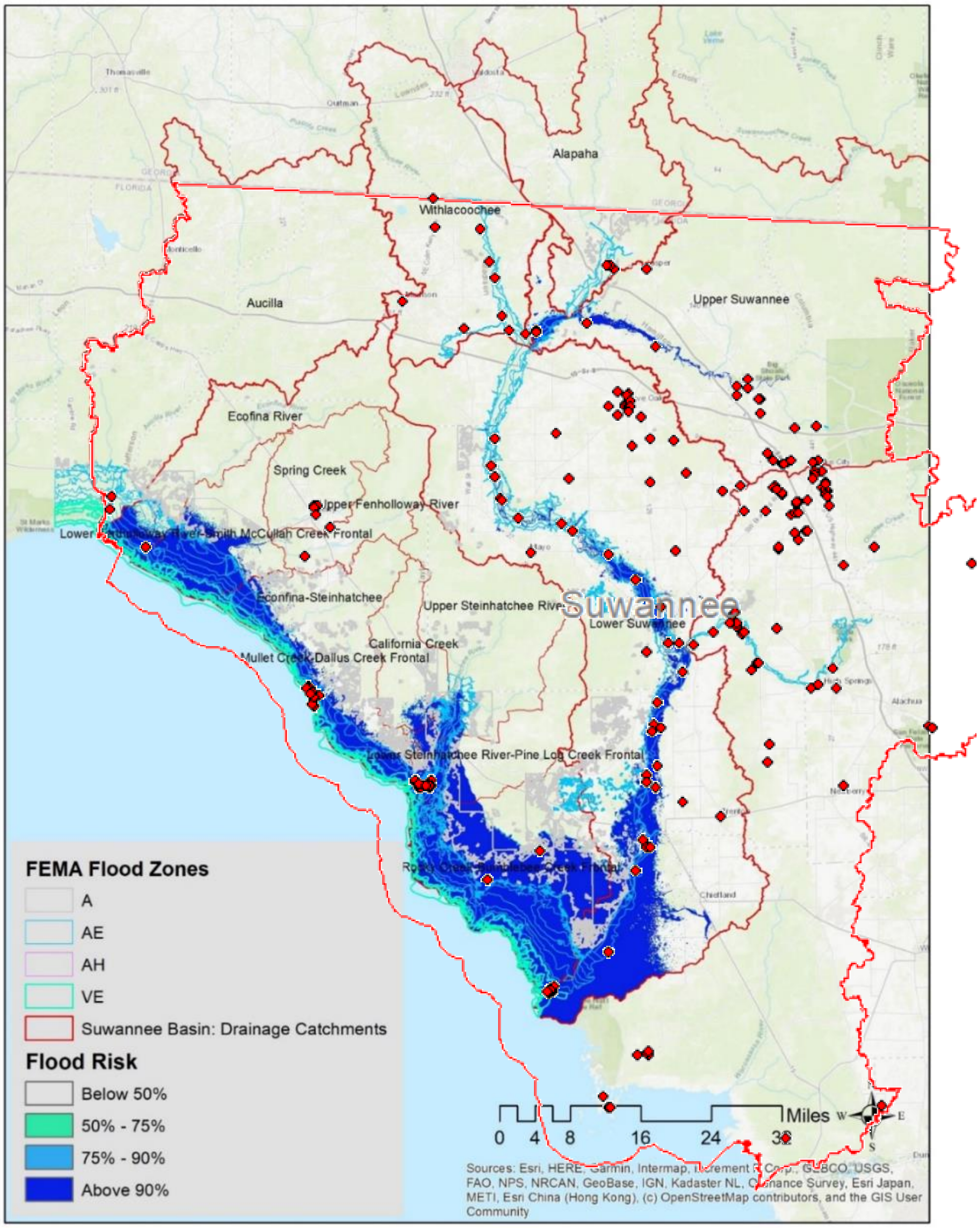
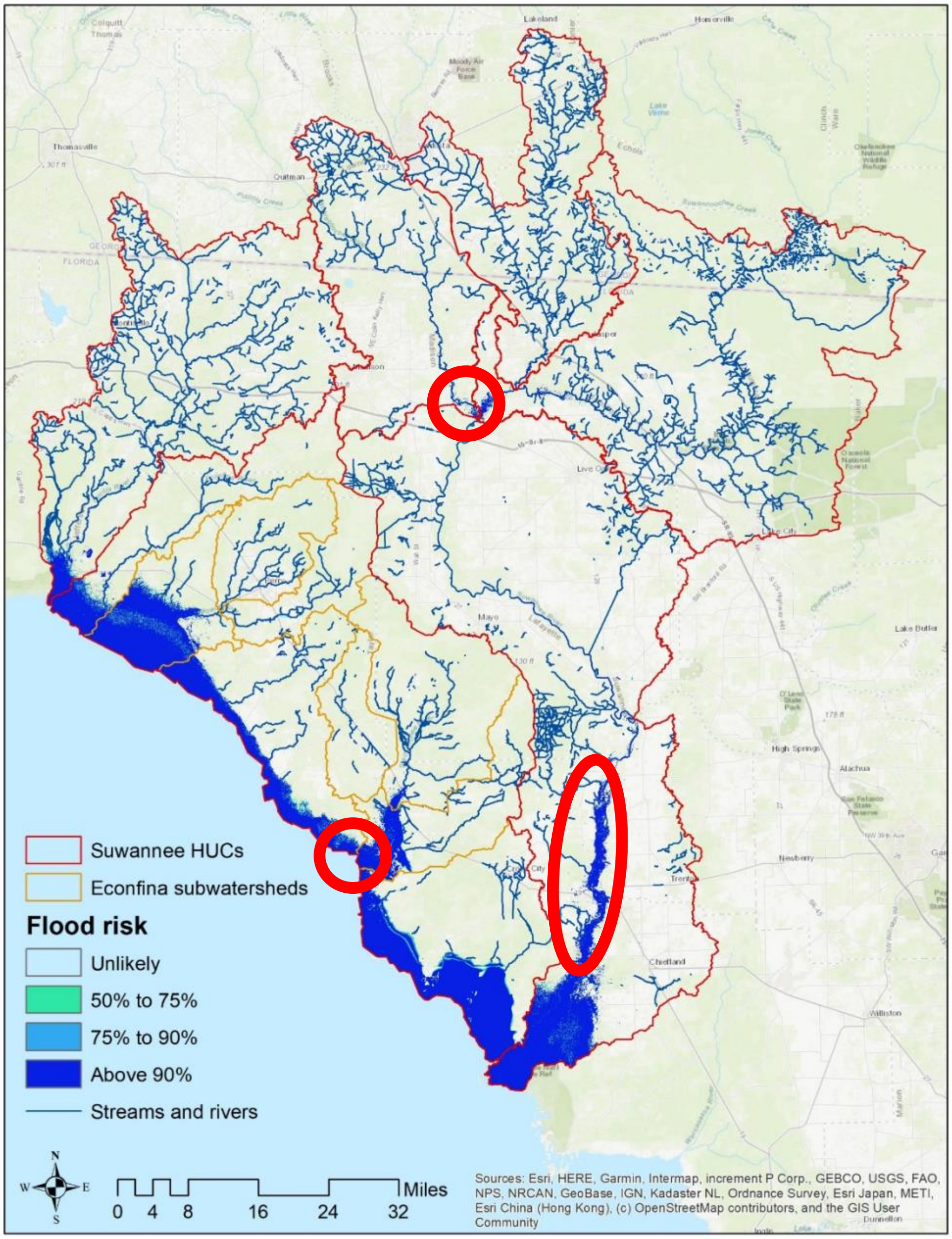


Figure 22. Repetitive loss areas from 2004 -2014 superimposed on the flood risk map created by FAU

3.5 Vulnerability of Flooding in Developed Areas

Figure 23 show the areas of the basin that are developed and flooded so further drill down could be conducted. Figures 24 to 26 show the extent of the flood risk along the Upper and Lower Suwannee River basins as well as along the coastal Econfina watershed.



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 23. Location of drilldown areas

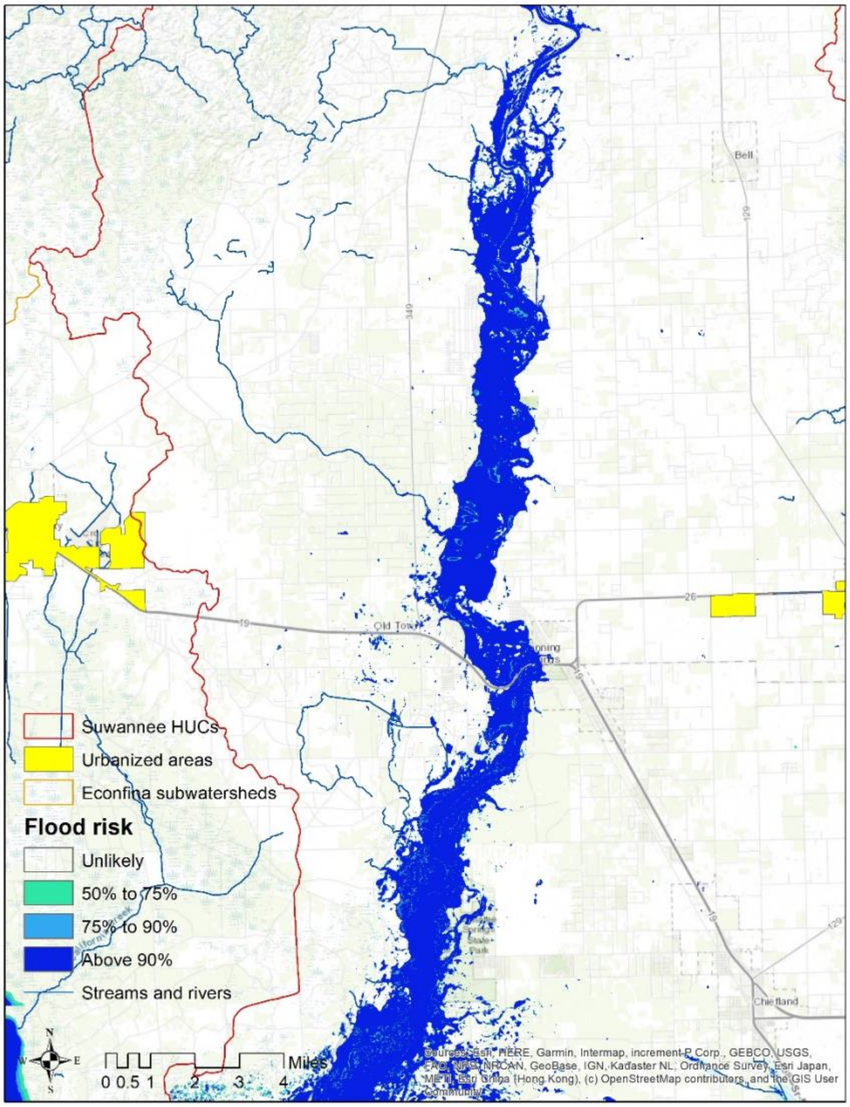
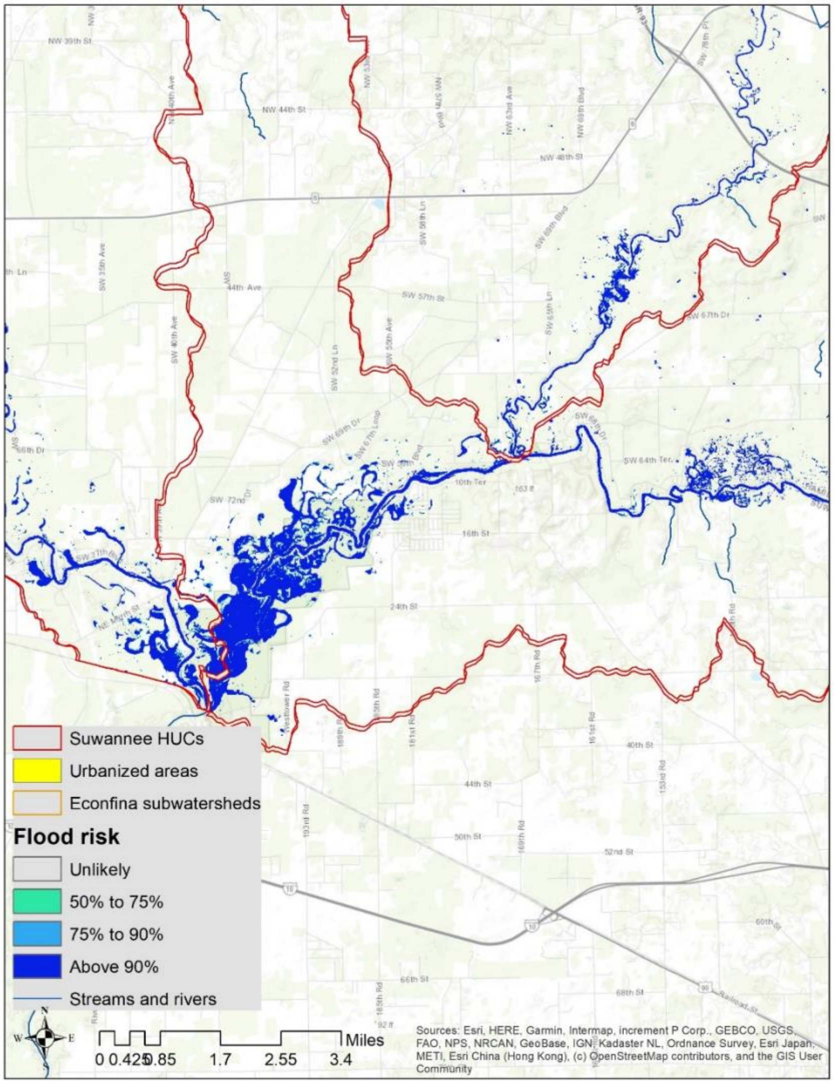
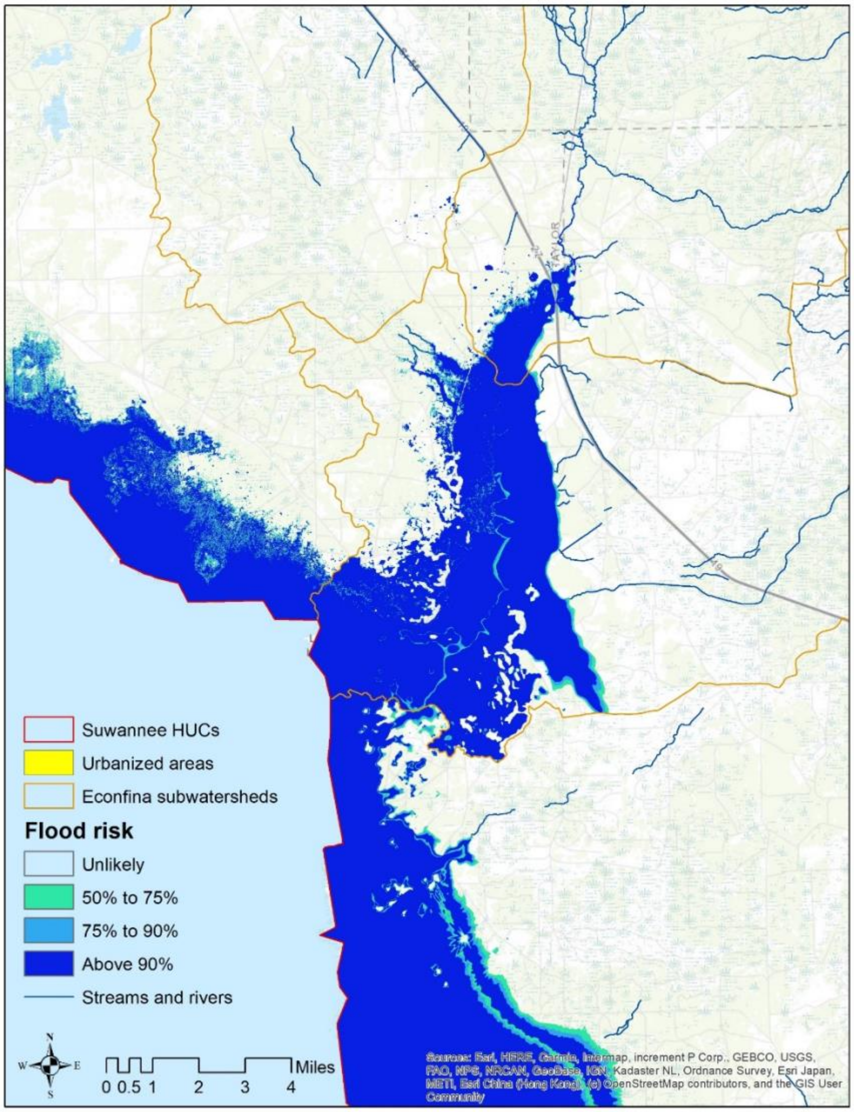


Figure 24. Flood risk along Lower Suwannee River Basin



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 25. Flood risk along Upper Suwannee River Basin



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 26. Flood risk in the Econfina Watershed

4.0 Conclusions

FDEM contracted with FAU to develop a screening tool of flood risk areas for 29 watershed basins. The effort discussed herein focusses on the development procedures for a screening tool to assess risk in the Suwannee River Basin (#6) basin, a watershed located in west Florida that combines readily available data on topography, ground, and surface water elevations, tidal information for coastal communities, soils, open space and rainfall to permit an assessment of the risk of inundation of property. The basin shows widespread flooding due to low elevation proximity to the Gulf of Mexico coast and extensive sensitive areas that currently received extensive environmental protection. A drilldown to the local communities indicates that the major developments are flood prone. Solutions to improve flood resiliency in this basin will yield long term benefits. The developed kriging approach produced a reasonable groundwater table pattern for this watershed, which is critical for further Cascade modeling. Application of the developed protocol for inundation mapping works well for this watershed.

References

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