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Subtask 2.1: Draft Flood Risk Resiliency Types and Sources of Flooding Inventory Gap Analysis

North Carolina Flood Resiliency Blueprint

Prepared for the North Carolina Department of Environmental Quality by AECOM and ESP Associates

November 2023

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Definitions

A comprehensive list of definitions applicable to multiple Flood Resiliency Blueprint documents is provided in a separate document.

Acronyms

1D – One-dimensional

2D – Two-dimensional

3D – Three-dimensional

AI – Artificial Intelligence

API – Application Programming Interface

BCA – Benefit-Cost Analysis

Blueprint – North Carolina Flood Resiliency Blueprint

CDC – Centers for Disease Control and Protection

CEJST – Climate and Economic Justice Screening Tool

CEQ – Council on Environmental Quality

CERA – Coastal Emergency Risks Assessment

CGIA – Center for Geographic Information and Analysis

CIP – Capital Improvement Plan

CMRA – Climate Mapping for Resilience and Adaptation

CoCoRAS – Community Collaborative Rain, Hail, and Snow Network

CoNED – Coastal National Elevation Database

CPD – Continuing Professional Development

CRS – Community Rating System

DOT – U.S. Department of Transportation

DPS – Department of Public Safety

EAL – Expected Annual Loss

EDH – Elevation Derived Hydrography

EOS – Earth Observing System

EPA – Environmental Protection Agency

ESA – European Space Agency

ESRI – Environmental Systems Research Institute, Inc.

FEMA – Federal Emergency Management Agency

FFE – First Floor Elevation

FIMAN – Flood Inundation Mapping and Alert Network

FINS – Flood Information Notification System

FIRM – Flood Insurance Rate Map

FMA – Flood Mitigation Assistance

FRIS – Flood Risk Information System

FY – Fiscal Year

GCM – Global Climate Model

GIS – geographic information system

GPS – global positioning system

GW – groundwater flooding

H&H – Hydrologic and Hydraulic

HEC – Hydrologic Engineering Center

HMGP – Hazard Mitigation Grant Program

HUD – U.S Department of Housing and Urban Development

IA – Individual Assistance

IPCC – Intergovernmental Panel on Climate Change

LANCE – Land, Atmosphere Near real-time Capability of earth observing system

LiDAR – Light Detection and Ranging

LIP – Local Intense Precipitation

LMI – Low and Moderate Income-

LOMR – Letter of Map Revision

ML – Machine Learning

MODIS – Moderate Resolution Imaging Spectroradiometer

MRLC – Multi-Resolution Land Characteristics

N/A – not applicable

NASA – National Aeronautics and Space Administration

NC – North Carolina

NCDEQ – North Carolina Department of Environmental Quality

NCDOT – North Carolina Department Transportation

NCDWR – North Carolina Department of Water Resources

NCEM – North Carolina Emergency Management

NCFS – North Carolina Forest Service

NCGS – North Carolina Geological Survey

NCSU – North Carolina State University

NFIP – National Flood Insurance Policy

NLCD –

NOAA – National Oceanic and Atmospheric Administration

NRCS – Natural Resources Conservation Service

NRI – National Risk Index

NWM – National Water Model

PA – Public Assistance

PAC – Percent Annual Chance

PMF – Probable Maximum Flood

PMP – Probable Maximum Precipitation

RAS – River Analysis System

RRP – Regional Response Plan

SACS – South Atlantic Coastal Study

SBA – Small Business Administration

SE – Southeast

SFHA – Special Flood Hazard Area

SVI – Social Vulnerability Index

TBD – to be determined

TLC – The Land Conservancy

UK – United Kingdom

UNC – University of North Carolina

US – United States

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

USGS – United States Geological Survey

WRISARS – Water Resources Information, Storage, Analysis, and Retrieval System

WSEL – Water Surface Elevation

WWTP – Wastewater Treatment Plant

1 Introduction

1.1 Purpose

Subtask 2.1 – Inventory types and sources of flooding that create negative impacts (e.g., flooded infrastructure, structural damage, human safety, acute environmental impacts), along with frequencies/spatial extent.

Subtask 2.2 – Document resources that can be used to identify and quantify: existing risk, future risk, and measures of risk; people and infrastructure; ecosystem; spatial/frequency, data used to assign risk; programs that assess risk.

The purpose of this document is to identify and evaluate datasets in North Carolina that could be available for use in projects performed as part of the North Carolina Flood Resiliency Blueprint (Blueprint). These datasets contain the critical components of a successful flood resiliency effort such as probability of hazard occurrence, risk assessments, estimated damages enabling the evaluation of the effectiveness of mitigation, and resiliency projects.

1.2 Types and Sources of Flooding

There are many types and sources of flooding that create negative impacts to human safety, structures, infrastructure, and the environment. These sources of flooding may occur independently, but often occur concurrently with each other. The specific sources included in this report have been categorized and illustrated in Figure 1-1 below.

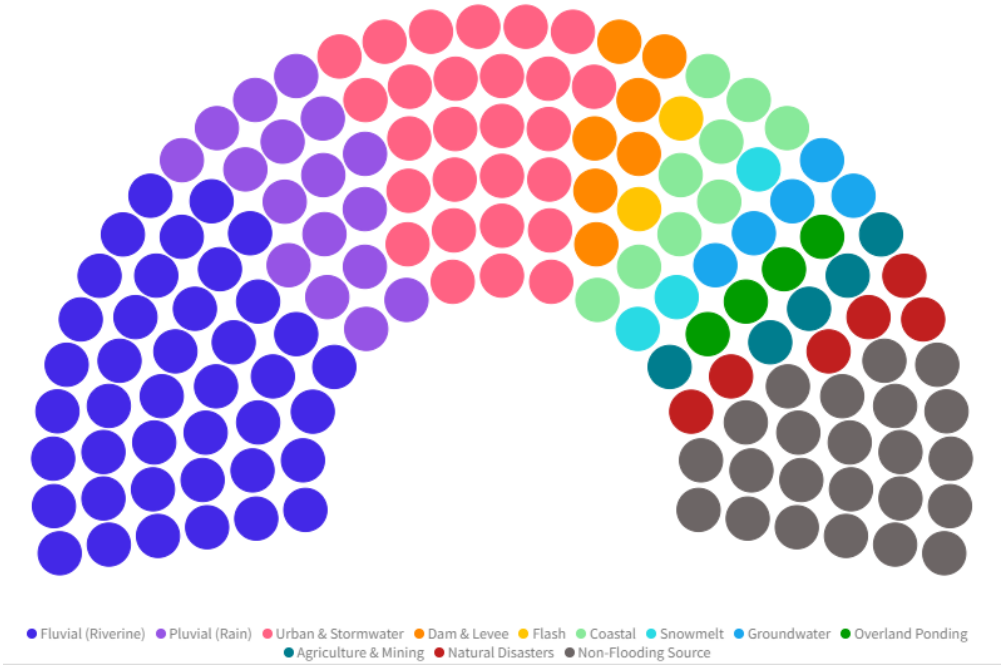


Figure 1-1: Distribution of Resources that Identify Sources of Flooding

1.2.1 Primary Sources of Flooding

Fluvial (Riverine) Flooding occurs when stream and rivers exceed the capacity of their natural or constructed channels to accommodate water flow, and therefore, water overflows the banks, spilling out into adjacent low-lying, dry land.

Pluvial (Rain) Flooding occurs when a rainfall event creates a flood independent of an overflowing water body.

Urban and Stormwater Flooding occurs when excess rainfall in an urban area is greater than can be conveyed away from the developed area by the urban drainage system.

Flash Flooding is characterized by a rapid rise in water, high velocities, and a large amount of debris. Rainfall intensity and duration, as well as the steepness of watershed and stream gradients, are major factors in flash flooding. The differentiator in this type of flooding is the speed of onset as opposed to origin of flood water.

Dam and Levee Flooding occurs when a dam or levee fails to contain floodwater. The failure can result from floodwater overtopping the dam or levee as well as if the dam or levee experience a structural failure, or breach, resulting in a release of floodwater.

Coastal Flooding is caused by water from the ocean coming on land either as tides, storm surge, sea level rise, or wave action.

1.2.2 Other Sources of Flooding

Frozen forms of water may contribute to or result in flooding when large amounts of snow and ice melt quickly due to warm temperatures, rain, or other factors, resulting in a sudden increase in water flow in waterways, or when still-frozen water, in the form of avalanches or ice, disrupt fluvial flow.

Groundwater Flooding occurs when the water table in an area rises above the ground surface.

Overland ponding occurs when water accumulates on low-lying areas, resulting in the formation of ponds or standing water. This can happen during heavy rainfall events, when drainage systems are overwhelmed and water cannot be carried away quickly enough, or when there are obstructions or barriers that prevent water from flowing away from an area.

Agricultural Flooding occurs when agricultural areas experience excess water due to heavy rainfall, poor drainage, or other factors. In this case, agriculture is not the source of—but rather the asset affected by—flooding.

Mining Flooding occurs when water accumulates in mining operations such as open pits, underground mines, and tailings dams. This can occur due to a range of factors, including heavy rainfall, equipment failures, and human error. As with agricultural flooding, mine facilities are the assets affected. In addition, mines can be the source of flooding in instances where tailings dams experience a breach or overtop, or when a mine blowout occurs.

Natural Disasters. Natural disaster flooding refers to flooding that occurs as a result of natural events such as hurricanes, typhoons, wildfires, ice jams, meteor impacts, etc., but are not caused by precipitation.

1.3 Flood Modeling

The current trend in modeling is moving away from one-dimensional (1D) modeling and focusing on two-dimensional (2D) modeling for better accuracy and greater product availability. One-dimensional modeling is characterized by more confined flow, generally in one direction, and with data and results available at cross sections. 2D modeling is characterized by unconfined flow in multiple directions and has data and results available at each individual mesh or grid cell. 2D modeling allows analysis of pluvial flooding and are often referred to as pluvial models when used for this purpose, although 2D models can and are also are used to analysis combined fluvial and pluvial flooding. As technology improves and higher quality is demanded in the future, another transition may occur from 2D to three-dimensional (3D) modeling.

The hydraulic models typically referenced by the data sources are often based on peak flows or time-series of flows that are developed by hydrologic modeling. Traditional hydrologic modeling has typically been based on either statistical analysis of stream gage flow data or by watershed modeling. Statistical analysis of gage records, by way of frequency analysis gage flow records, can provide estimates of the flood quartiles, flow duration curves, or low-flow quartiles at gaged locations. These hydrologic estimates can be transferred spatially to other locations by a variety of means, including drainage area transposition, flow correlation relations, or by regional regression analysis.

Watershed modeling typical involves numeric simulation of hydrologic processes such as precipitation losses, transformation of excess precipitation to runoff, estimation of baseflow component of streamflow, and the hydrologic routing of runoff through the watershed. More complex watershed modeling also includes the interaction between groundwater recharge/discharge and streamflow. Recently, in conjunction with the trend toward 2D methods in hydraulic modeling, the use of 'rain-on-grid' hydrologic approach has become more prevalent. The rain-on-grid approach uses traditional watershed modeling techniques to determine excess precipitation, then uses 2D hydraulic methods to route the excess precipitation across the watershed into the stream channels. The watershed modeling approach, including the inclusion of modeling the surface water/groundwater interactions and the merging of traditional excess precipitation modeling with 2D hydraulic methods in the rain-on-grid approach, can result in a model, if properly calibrated and validated, that can be used to simulate a variety of existing and hypothetical conditions. Table 1-1 below summarizes the benefits and limitations of each type of modeling.

Table 1-1: Comparison of 1D, 2D, and 3D Modeling

	Limitations	Benefits
1D	Model only represents the cross sections placed along the stream at key topographic transitions and features. Assumes linear changes between two cross sections. Not as useful in coastal applications.	Model can be easy to process and provide quick estimates, especially for simple, well-defined areas. Requires less terrain data and storage. Often easier to calibrate.
2D	Process and data intensive, the technology is changing, standards are not well defined, and a detailed model is effort intensive.	Can model complex geometries, flow obstructions, and variations as well as compute additional factors such as transverse momentum.
3D	Often not feasible, especially in large scale application because they require high-quality input data, intensive computation power, and may be overly complex.	Most realistic representation of hydraulic systems, capable of simulating complex flow patterns, phenomena, and turbulence in all three dimensions.

1.4 Dataset Classifications

Within the development of the Flood Resiliency Blueprint, all data sources are classified as follows:

Hazards and Engineering Study Datasets: One of the primary steps in the study process is identification of the flood hazard. Essential elements of the dataset include hydrologic, hydraulic, and coastal modeling that can be used as-is or enhanced to be used in scenario analyses. This dataset type also includes elements involved with determination of future flooding, including climatological modeling. Each model type discussed should be evaluated as to specific applicability to Blueprint. Even a well-calibrated model will not always hold up and provide realistic outputs a short distance downstream/for a lower reach, especially if there is influence from incoming tributaries.

Model evaluation and what is "good enough" often depends on who developed the model and what their organizational mission is, as well as the specific questions/goals for which each model was developed. Candidate models are evaluated/compared to one another using criteria that link back to the goals of the Blueprint, and speak to 1) their capability to address the array of hazards, impacts, mitigation strategies of interest; and 2) accuracy (under what conditions/where/at what level of granularity?), which may reflect how the model was calibrated and validated, and over what time scales/event sizes/locations.

Foundational Datasets: Foundational data elements are the building block datasets that are necessary to construct, enhance, or provide essential context to other flood-risk related data. These include datasets such as topography, bathymetry, and base map elements.

Natural Environment Datasets: Natural environment datasets include geospatial data that can assist in the model development and alternative analyses. These may include wetlands delineations, soils data, existing and future land use data, and other natural environmental datasets that will support the study.

Built Environment Datasets: Current and future built-environment datasets are used to identify built assets that may be vulnerable to, and negatively impacted by, flood hazards. Often, building structures are a primary focus; however, impacts can include infrastructure, agricultural areas, natural resources, indirect economic impacts, or anything else that could be negatively impacted by flooding. Built-environment datasets also include critical infrastructure resources and facilities, such as emergency services, healthcare, communications, and water and wastewater infrastructure.

Demographic Datasets: Demographic datasets include information that can assist in model development and alternative analyses. Demographic datasets that depict the socioeconomic make-up of hazard areas are essential to understanding natural hazard impacts on local population, and how to optimally prepare for, and respond to, these impacts. More resources covering these topics will be explored in subtask 2.14.

Mitigation Support Datasets: Mitigation Support datasets aid in the determination of flood risks within the region, as well as datasets that help to inform the mitigation strategies required to lessen those flood risks. Relevant mitigation support datasets include National Flood Insurance Policy (NFIP) data, repetitive and severe repetitive loss data, elevation certificates, hazard mitigation plans, capital improvement plans (CIPs), comprehensive plans, transportation plans, and resiliency plans. These datasets will help with determination of flood risk in the basin, as well as avoiding duplicative effort, and building on data collected from previous outreach efforts and existing engineering analyses. These data can be mined for current planned mitigation strategies, actions, and projects, as well as

areas of interest to stakeholders. These strategies will be reviewed and included for consideration in the study as applicable.

A total of 129 resources that consider sources of flooding were identified and classified by source of flooding (Table 1-2 and Figure 1-2) and dataset classification (Table 1-3 and Figure 1-3).

Table 1-2: Resources That Identify Sources of Flooding

Source of Flooding	Amount
Fluvial (Riverine) Flooding	61
Pluvial (Rain) Flooding	32
Urban and Stormwater Flooding	45
Dam and Levee Flooding	7
Flash Flooding	7
Coastal Flooding	17
Frozen Sources	3
Groundwater Flooding	5
Overland Ponding	7
Agriculture and Mining Flooding	5
Natural Disaster	6
Non-Flooding Source	26
All Flooding Sources	1

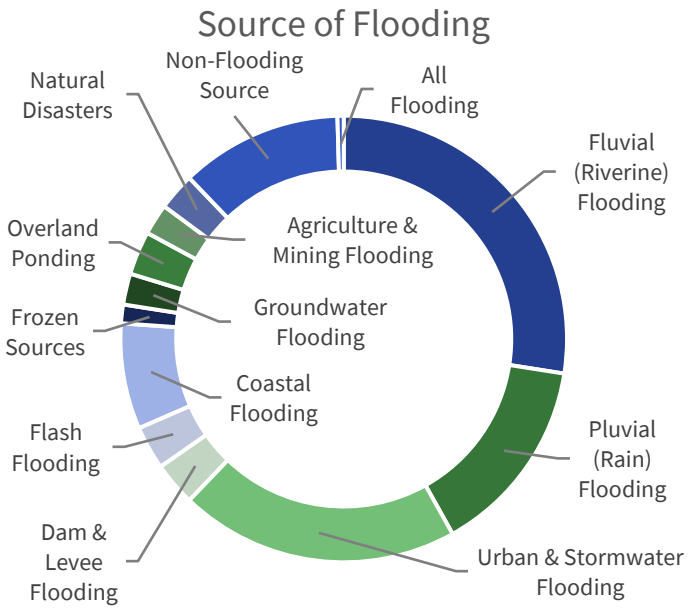


Figure 1-2: Resources that Identify Sources of Flooding

Table 1-3: Dataset Classification

Dataset Classification	Amount
Hazards and Engineering Studies	62
Foundational	11
Natural Environment	21
Built Environment	15
Demographic	10
Mitigation Support	10

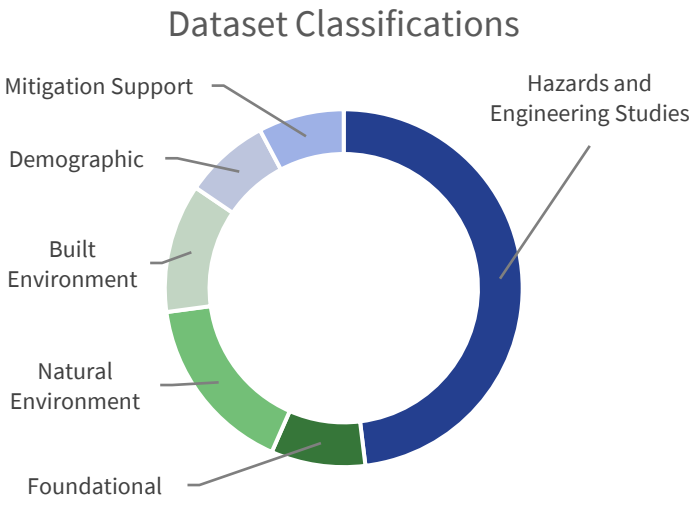


Figure 1-3: Dataset Classification

1.5 Dataset Gap Analysis Scoring

A gap analysis was performed by scoring each dataset's applicability to use in the Blueprint. The scores will be used to identify the most essential datasets for use in the Blueprint. Note that the scoring is not an overall reflection of the value of the dataset, because the dataset may have higher values for other purposes outside of the Blueprint. The highest score is a ten, and the lowest a one. Some datasets receive a "TBD" (to be determined) instead of a score to mark that these datasets require further investigation. Scores were assigned for the gaps in Geospatial, Database, Specification and Quantity, Temporal, and Engineering Modeling as defined below.

Geospatial Gaps occur when the dataset needed for the engineering study inputs or mitigation alternative analyses does not cover the study area sufficiently for a complete and accurate analysis.

Database Gaps may exist with databases such as missing feature class attributes. In many locally obtained datasets the data will be compiled from various sources and may have different classes and formats that will need to be normalized. Additionally, some datasets may be more comprehensive than others with respect to attributes such as first floor elevations (FFEs) or foundation types. This will create a completeness gap that may require additional data collection or a consistent methodological solution to be developed.

Specification and Quality Gaps are found where the current data are unsuitable for use because they do not meet current standards for any given product. This can be common in geospatial data, or where the datasets were produced to an older specification that no longer meets current criteria or guidelines.

Temporal Gaps may exist where temporal changes in natural and manmade features are no longer reflected in the data available. This is common in areas of significant and constant change such as areas experiencing rapid growth or depopulation. For such areas, the more recent datasets are likely to be the most effective, but these datasets will need to be reviewed and potentially revised or augmented.

Engineering Modeling Gaps – Viable flood mitigation alternatives typically involve hydrological, hydraulic, and coastal modeling and analysis. Any models used in analysis for the Blueprint will need to be reviewed for accuracy and completeness. Areas where additional modeling and mapping are required will need to be identified, and models developed. Data collected such as high water marks, Individual Assistance applications, Federal Emergency Management Agency's (FEMA's) Coordinated Needs Management Strategy data, NFIP claims, and local stakeholder feedback can be useful in determining where modeling gaps exist or where new modeling may need to be performed.

The results of the dataset gap analysis scoring are presented in Tables 5 through 10, found in the beginning of subsequent sections that contain the dataset summary sheets for the respective dataset types.

1.6 Dataset Event Frequencies

Part of risk quantification involves determining the frequency of a hazard event. Each source was analyzed for which frequencies could be extracted as the following Percent Annual Exceedance Chance (PAC): 20 percent, 10 percent, 4 percent, 2 percent, 1 percent, 1 percent Minus and 1 percent Plus (standard error approach used in FEMA Risk Maps), 0.5 percent, 0.2 percent, 0.1 percent, Historical Event, Probable Maximum Precipitation (PMP), Probable Maximum Flood (PMF), Real Time,

Forecasted, and/or other PAC. These are noted in the summary sheets, but also illustrated in Table 1-4 and Figure 1-4.

Table 1-4: Dataset Event Frequencies

Source of Flooding	Amount
20 PAC	7
10 PAC	15
4 PAC	15
2 PAC	15
1 PAC	18
1 PAC MINUS	9
1 PAC PLUS	9
0.5 PAC	7
0.2 PAC	15
0.1 PAC	7
Other	8
Historical Event	33
PMP	5
PMF	5
Real Time	19
Forecasted	15

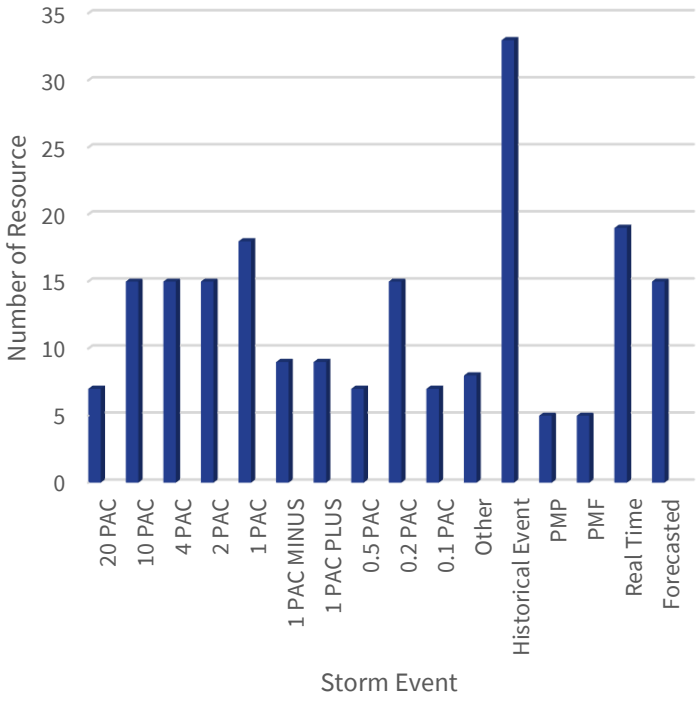


Figure 1-4: Dataset Event Frequencies

1.7 Risk Analysis

The ability to quantify risk for each source was analyzed. The sources are identified as capable of quantifying existing risk, future risk, existing and future risk, or not able to quantify risk based on variables derived from each source. For example, 25 sources that include hydrology variables could be used as both "existing and future risk identifiers," 11 sources covering hydrology could be used to determine future risk, etc.

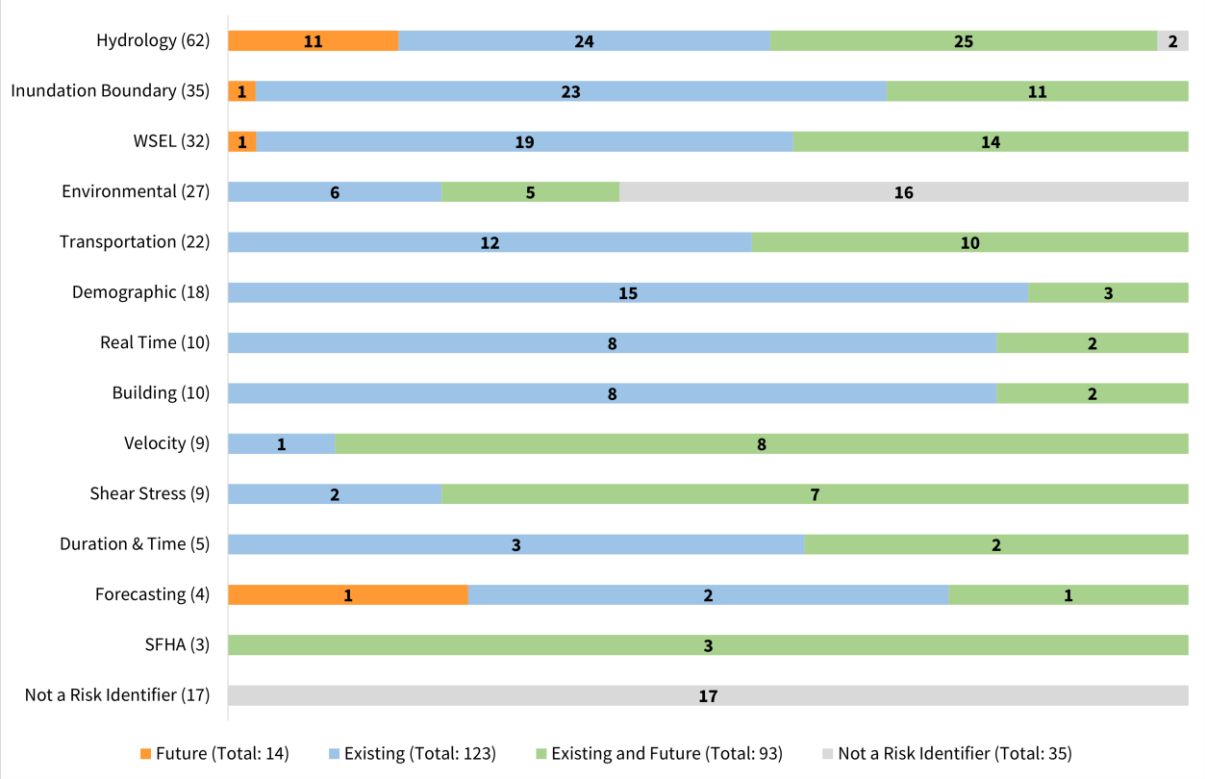


Figure 1-5: Variables That Quantify Risk

2 Summary Sheets

2.1 Hazards and Engineering Studies Datasets

There are 62 datasets that have been identified, reviewed, and classified as Hazards and Engineering Studies datasets for use in the Blueprint. Of the 62 total Hazards and Engineering Studies datasets, 17 are classified as essential and 45 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-1.

Table 2-1: Hazard and Engineering Studies Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
North Carolina Floodplain Mapping Regulatory Modeling	F, P, U	8	8	8	6	6
North Carolina Floodplain Mapping Advisory Modeling	F, P, U, OP	4	10	6	8	6
North Carolina Emergency Management (NCEM): Multi-Frequency Floodplain Raster Mapping Datasets	F, P, U	6	10	6	6	6
NCEM: NC Floodplain Mapping's Enterprise "Flood" Database (FRIS FLOOD Database)	F, U	10	10	10	8	8
North Carolina Department of Water Resources (NCDWR), NC Climate Office, United States Army Corps of Engineers (USACE), and United States Geological Survey (USGS): Water Resources Information, Storage, Analysis, and Retrieval System (WRISARS)	F	TBD	TBD	TBD	TBD	TBD
Various Local Governments: Models Developed by Local Governments	F, U	TBD	TBD	TBD	TBD	TBD
USACE, North Carolina State University (NCSU), and NCDEQ: Models Developed by Other Agencies	F	TBD	TBD	TBD	TBD	TBD
NC Floodplain Mapping Program: Flood Warning and Inundation Datasets (**Flood Inundation Mapping and Alert Network** (FIMAN]) and FIMAN-T Libraries	F, U	4	10	8	8	6
The National Water Model	F	8	8	6	10	8

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
(NWM)						
World Climate Research Programme: Future Climate Data and Model – CMIP6	F, P, U	10	10	2	8	6
Southeast (SE) Climate Adaptation Science Center and NCSU: Downscaled Future Climate Data and Model – GCM	F, P, U	10	8	8	8	6
IPCC: Future Climate Data and Model	F, P, U	10	8	6	8	6
NCDOT: 2D Modeling from Other Agencies	F, P, U	4	4	6	6	8
NCDOT: Roadway Inundation Tool	F, U	4	6	4	6	6
FEMA: Regulatory Hydrologic, Hydraulic and Coastal Modeling	C	6	8	8	6	8
USACE: South Atlantic Coastal Study (SACS)	C	10	9	10	10	10
National Oceanic and Atmospheric Administration (NOAA): Gauge Data	C	4	8	10	10	10
NASA: Land, Atmosphere Near real-time Capability of EOS (LANCE)	F	8	TBD	4	6	4
European Space Agency: Flood Event Satellite Aerial Imagery	F	8	TBD	4	6	4
USGS: Flood Event Satellite Aerial Imagery (Landsat & Sentinel 1 and 2)	F	8	TBD	4	6	4
NOAA: Storm Aerial Imagery	F	8	TBD	TBD	8	TBD
European Commission Joint Research Centre, JRC Global Surface Water	F	6	TBD	4	6	4
Multiple: Artificial Intelligence and Machine Learning Models	F	TBD	TBD	TBD	TBD	TBD
The Nature Conservancy: Historical Events (Hurricanes Matthew and Florence)	F, P, U	6	6	4	10	N/A
USGS: Stream Gauge Data	F, U	6	8	8	10	8
NCEM and NCDOT: Stream Gauge Data	F, U	4	4	6	10	8
FEMA: High Water Marks	F, U	6	6	6	10	6

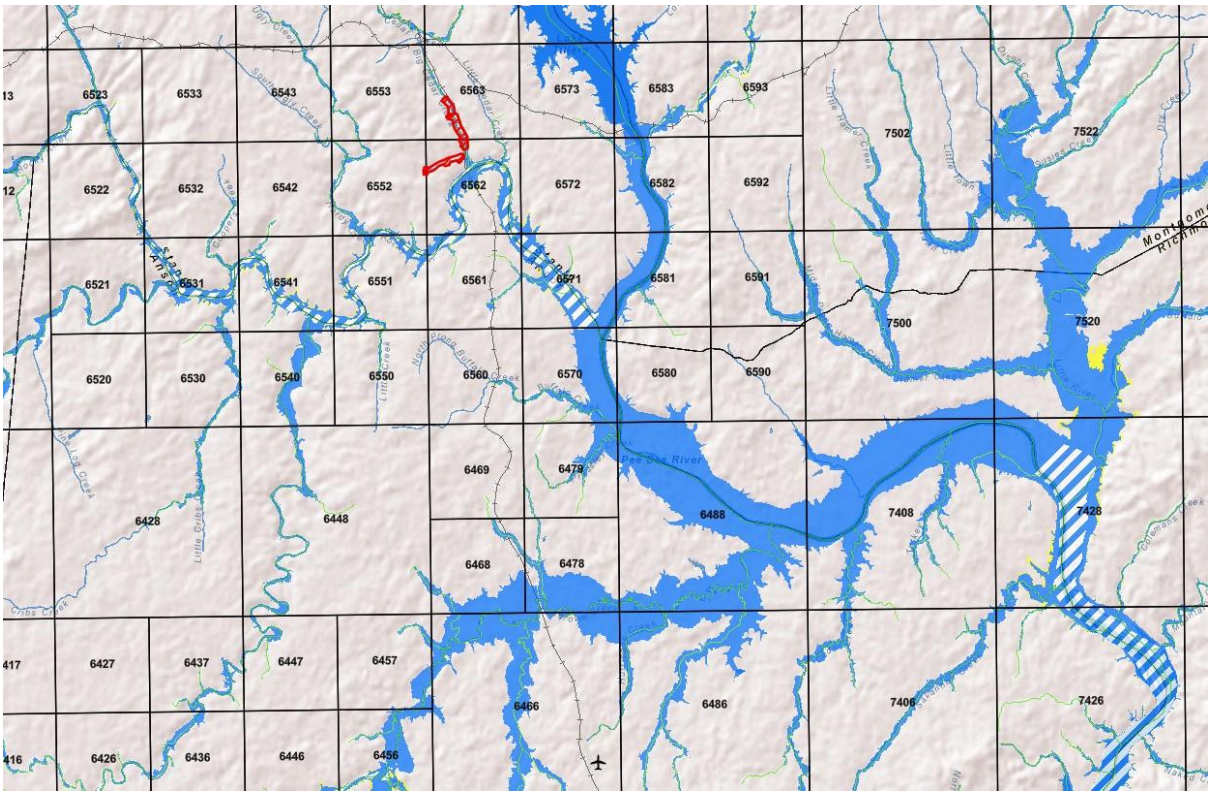
Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
USGS: High Water Marks	F, U	6	6	6	10	6
NCEM: High Water Marks	F, U	6	6	6	10	6
NOAA: Meteorological Data	F, P, U	8	10	8	10	6
NCSU and MESOWEST: Rain Gauge	F, P, U	8	8	8	10	6
State Climate Office of NC: Climate Voyager	F, P, U	10	6	8	6	6
NCSU Climate Office: Meteorological Data	F, P, U	8	10	10	10	6
USGS: Stage-Discharge Rating Curves	F	4	8	8	6	6
USGS: Rain Gauge	F, P, U	4	8	8	10	N/A
Community Collaborative Rain, Hail, and Snow Network (CoCoRAS): Rain Gauge	F, P, U	10	8	6	8	6
NOAA, NASA, etc.: Radar Such as Multi-Radar Multi-Sensor Quantitative Precipitation Estimate	F, P, U	10	8	6	10	6
NOAA: Precipitation Frequency Grids	F, P, U	10	8	8	8	8
NASA and USGS Earth Resources Observation and Science: Moderate Resolution Imaging Spectroradiometer (MODIS) Satellite	F, P, U	10	8	6	8	6
Greater Raleigh Region: Tomorrow Now	U	TBD	TBD	TBD	TBD	TBD
Public: Citizen Science (Social Media)	U	6	6	6	8	6
Charlotte's Emerald System: Stormwater Complaints	U	TBD	6	6	8	8
Hazards and Vulnerability Research Institute at the University of South Carolina: Incident and Fatalities	F, P, U	TBD	TBD	TBD	TBD	TBD
NCDOT: NCDOT Stormwater Asset Inventories, Policies, and Maintenance Plans	U	6	6	8	8	10
Local Governments: Large Municipality (Population>100k) Stormwater Asset Inventories, Policies, CIP, and	U	6	6	6	4	6

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
Maintenance Plans						
Local Governments: Small Municipality (Population<100k) Municipal Stormwater Asset Inventories, Policies, and CIP Maintenance Plans	U	4	4	4	4	4
NOAA: Flash Flood	FF	TBD	TBD	TBD	TBD	TBD
Unidentified: Debris Jam	F, P, U, FF	TBD	TBD	TBD	TBD	TBD
University of North Carolina (UNC): King Tides Project	C	4	6	8	10	6
CERA: Hurricane Surge Forecast	C	6	4	6	4	6
NOAA: Sea Level Rise	C	8	8	8	6	6
NOAA: Potential Storm Surge	C	TBD	TBD	TBD	TBD	TBD
NOAA: Event Specific Storm Surge	C	TBD	TBD	TBD	TBD	TBD
Deltares: Global Flood Maps	C	4	4	4	4	4
USGS: Coastal Change Hazards Portal	C	6	8	6	6	6
North Carolina Forest Service (NCFS), NASA, NCSU, CMRA and Google: Wildfire	ND	TBD	TBD	TBD	TBD	TBD
Climate Mapping for Resilience and Adaptation (CMRA): Historical and Future Drought	ND	TBD	TBD	TBD	TBD	TBD
National Drought Mitigation Center: Real Time Drought	ND	8	8	8	8	8
NASA: Meteor	ND	TBD	TBD	TBD	TBD	TBD
USGS: Earthquake	ND	TBD	TBD	TBD	TBD	TBD
North Carolina Geological Survey (NCGS): Landslide	ND	8	8	8	8	8
Climate Reports (Multiple)	NFS	10	8	8	8	8

[a] Future conditions hydrology using rainfall runoff parameters developed using build out conditions.

N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding, A&M; Mining Flooding, A&M; Natural Disasters, ND; Non-Flooding Source, NFS; All Types of Flooding, ALL; CIP, Capital Improvement Plan; NCDEQ, Department of Environmental Quality; H&H, Hydrologic and Hydraulic.

2.1.1 North Carolina Floodplain Mapping Regulatory Modeling



Note: *Subtask 2.4 report contains detailed discussion of this dataset*

Dataset Summary Information

Source of Information	North Carolina Emergency Management – Floodplain Mapping Program
Link to Online Data	https://fris.nc.gov/fris/Home.aspx?ST=NC
Data Owner	State of North Carolina
Date Created	2000
Date of Access	February 2023
Frequency of Updates	Annual Funding for cyclical updates throughout the state
Updates Needed	Yes – Constant Updates necessary to maintain reliable products
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x	x	x		x		x					

Benefits:

Near statewide coverage that will be achieved later as 2D modeling is expanded. Models (HEC-RAS and HEC-HMS) can be modified for future conditions, additional storm events, mitigation scenarios, enhancements to quality, or fill gaps and needs to progress onward.

Limitations:

Some models may contain outdated hydrology, terrain, assumptions, limited flood boundary extents, and limited data such as future conditions. Additionally, hydraulic models built for regulatory purposes may not reflect all infrastructure in and along the flooding source; for example, breached dams from old mills, uncertified levees, and offline storage. If models are to be used for alternative analyses, then updates to model geometry should be considered. A multitude of obstacles exists in the paradigm shift from a 1D deterministic (fixed model weights) to a 2D probabilistic (model incorporates random variables and probability distributions) approach. Many models may be unable to adapt to be useful in the future. Model accuracy is not verified. One-dimensional models that do not map headwaters may encourage development on top of streams, leading to flooding. This is because land known to flood can be sold at a lower cost, which attracts buyers (often developers) who expect the regulatory models to protect against such development, which they do not in these instances.

Dataset should be updated by:

Prioritize updating 1D modeling with 2D modeling for a more consistent and holistic dataset, which provides a more future-proof product that can be transitioned to technologies such as a digital twin down the road. Also update mapping with new bathymetry, topo, hydrology, Dataset Event Frequencies, and future conditions. Consider establishing quality standards for new 2D studies to limit variations. Determine a means to incorporate verification of models such as historical storm events.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Inundation Boundary, water surface elevation (WSEL), Special Flood Hazard Area (SFHA), Transportation Attributes (Roads and Bridges), Velocity, Shear Stress, and Hydrology. To quantify risk, determine objects in the special flood hazard areas. WSEL for various events can be extracted from cross section and profiles; however, this would require additional effort.

2.1.2 North Carolina Floodplain Mapping Advisory Modeling

Note: *Subtask 2.4 report contains detailed discussion of this dataset*

Dataset Summary Information

Source of Information	North Carolina Emergency Management – Floodplain Mapping Program
Link to Online Data	https://flood.nc.gov/advisoryflood/
Data Owner	State of North Carolina
Date Created	2022
Date of Access	February 2023
Frequency of Updates	Annual Funding for cyclical updates throughout the state
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban and Stormwater, Overland

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
X	x	x	x	x	x	x	x	x	x	x					

Benefits:

Potentially, could be a comprehensive and equitable fluvial flooding identification source. Keen to detect realized significant flood risk and damage because during hurricanes Matthew and Florence, approximately 70 percent of damage claims were outside of the regulatory floodplain. These models use the 1 percent annual chance rainfall, in addition to rainfall plus 10 percent, 20 percent, and 30 percent. Models (HEC-RAS and HEC-HMS) can be modified for future conditions, additional storm events, mitigation scenarios, enhancements to quality, or to fill gaps and needs.

Limitations:

Spatially, the data are limited to less than one-third of the State of North Carolina (the eastern portion of the state as shown in graphic of this dataset). The modeling assumptions and input may be performed at a coarse level, so models may need refinement, at least in hot spots. Channel routing was not included because flow descends through downstream basins. Model verification varies based on available data. Where data were available, models were calibrated.

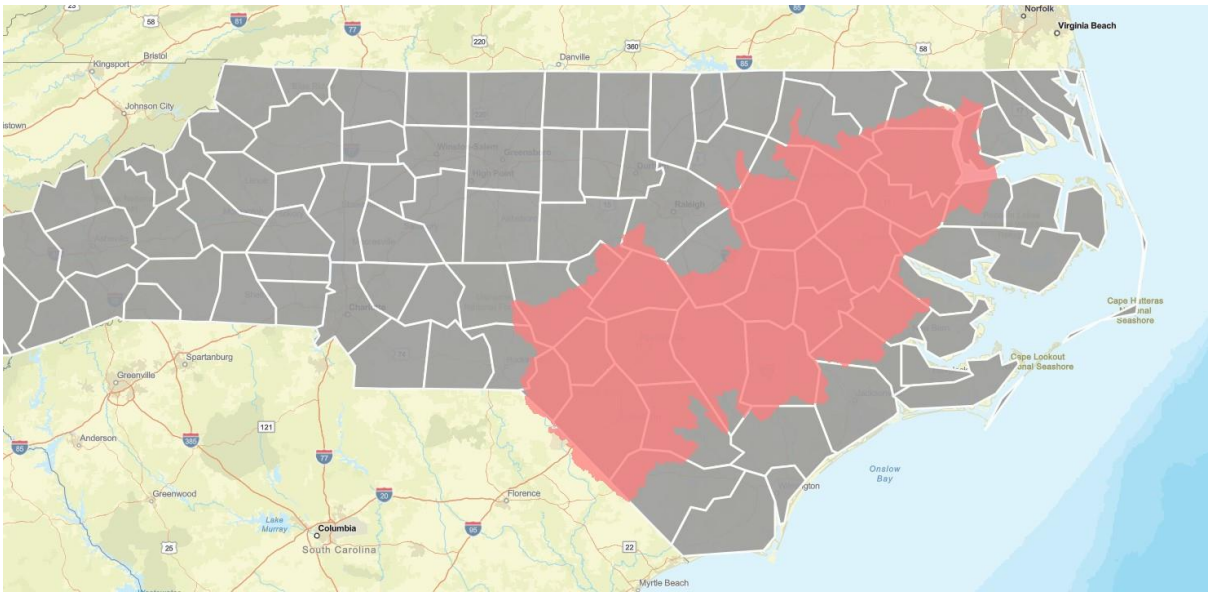
Dataset should be updated by:

Refine the current models and complete the remaining sub-basins in the Neuse Watershed. Refined modeling should be performed at least in hot spots (areas of interest) supporting additional mitigation alternative analysis. Additional refinements would include topographic breaklines, hydro connectors, hydraulic structures, mesh alignment, and calibrated regions. Continue to expand 2D modeling across the state to account for smaller drainage areas. Use FEMA's Guidance for Flood Risk Analyses and Mapping documents (Base Level Engineering) Analysis and Mapping and Hydraulics: Two-Dimensional Analysis) to determine modeling procedure and limit variations. Determine a means to incorporate verification of models such as historical storm events. Consider using these as the base for a digital twin.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, Water Surface Elevation and Depth. Where available, future risk can be quantified using this dataset, although the definition of future conditions is limited.

2.1.3 NCEM: Multi-Frequency Floodplain Raster Mapping Datasets



Dataset Summary Information

Source of Information	North Carolina Emergency Management – Floodplain Mapping Program
Link to Online Data	https://fris.nc.gov/fris/Home.aspx?ST=NC
Data Owner	State of North Carolina
Date Created	Fiscal Year (FY) 2008
Date of Access	February 2023
Frequency of Updates	Annual Funding for cyclical updates throughout the state
Updates Needed	Datasets updated as new counties go preliminary and effective
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x	x					

Benefits:

Used to establish spatial extent, depth and frequency of flooding, support flood risk calculations, and assist in outreach. Can be expanded to include other useful raster layers such as duration of flooding.

Limitations:

Regulatory and Advisory multi-frequency rasters are currently stored in two different geographic information system (GIS) datasets. Advisory is limited to approximately 25 percent of the State of North Carolina (the eastern portion of the state). The level of detail and availability of future conditions vary across products.

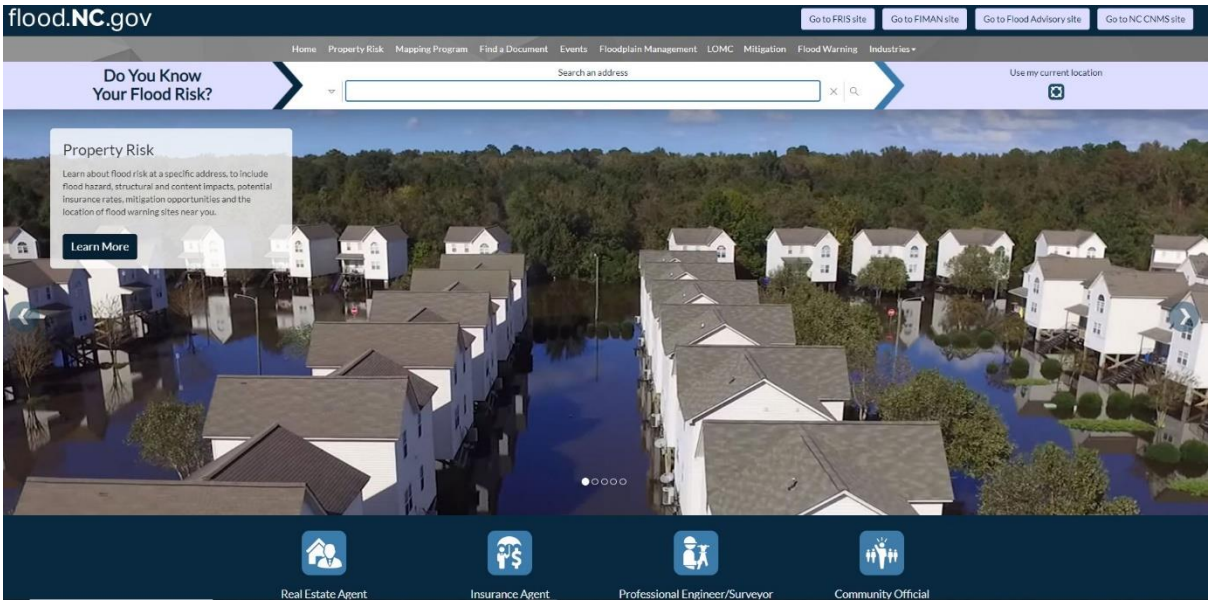
Dataset should be updated by:

Update grids with any new or updated modeling that is developed. Merge data sources for comprehensive coverage. Consider adding more rasters such as duration of flooding or arrival time.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, Water Surface Elevation and Depth. Where available, future risk can be quantified using this dataset, although the definition of future conditions is limited.

2.1.4 NCEM: NC Floodplain Mapping's Enterprise "Flood" Database (FRIS Flood Database)



Dataset Summary Information

Source of Information	North Carolina Emergency Management – Floodplain Mapping Program
Link to Online Data	https://fris.nc.gov/fris/Home.aspx?ST=NC
Data Owner	State of North Carolina
Date Created	2010
Date of Access	February 2023
Frequency of Updates	Ongoing
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

* Site is access restricted

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x	x					

Benefits:

This database contains significant amounts of the supporting data needed for new or revised analysis including modeling, mapping, and risk assessments.

Limitations:

The supporting modeling for this dataset may not reflect current land use, infrastructure, or include future conditions or climate change. The data may lack the detailed quality for the task such as a mitigation project.

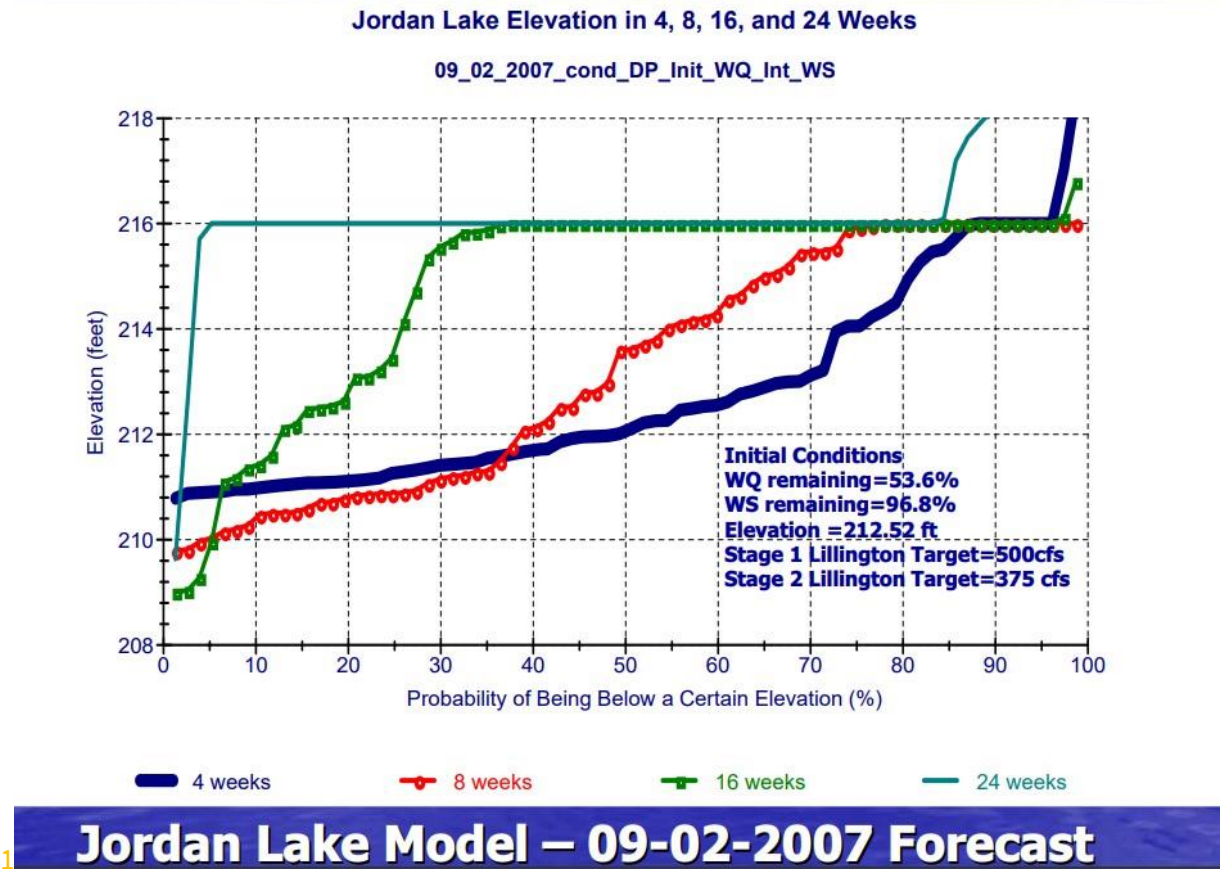
Dataset should be updated by:

This dataset contains all data required for FEMA Flood Insurance Rate Map (FIRM) and Flood Risk Product databases. Additional data in the flood analysis and risk assessment can be leveraged from either models, calculations, or spatial datasets. These could prove useful for the Blueprint.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, Water Surface Elevation and Depth. Where available, future risk can be quantified using this dataset, although the definition of future conditions is limited.

2.1.5 NCDWR, NC Climate Office, USACE, and USGS: Water Resources Information, Storage, Analysis, and Retrieval System



Dataset Summary Information

Source of Information	NCDWR, NC Climate Office, USACE, and USGS
Link to Online Data	Data no longer available
Data Owner	NCDWR, NC Climate Office, USACE, and USGS
Date Created	N/A
Date of Access	February
Frequency of Updates	N/A
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
														x	x

Benefits:

N/A

Limitations:

Data no longer available.

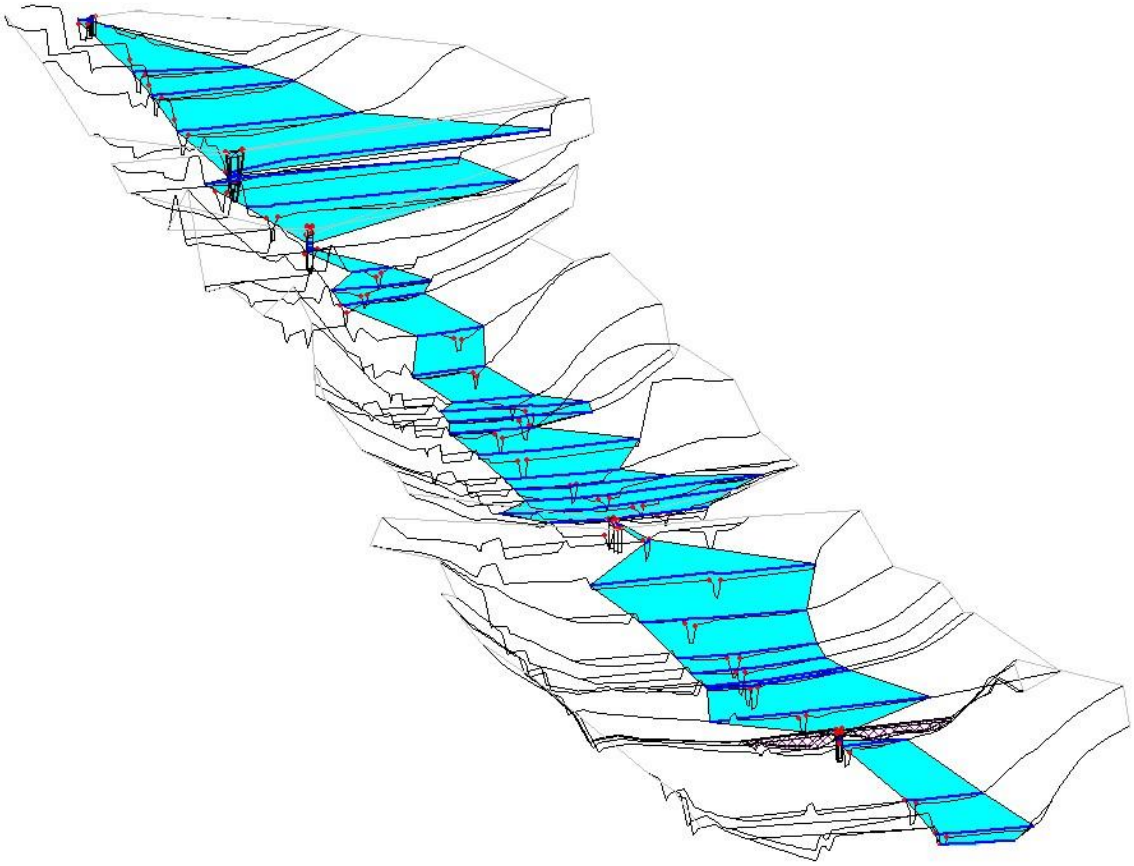
Dataset should be updated by:

N/A

Risk Quantifier:

N/A

2.1.6 Various Local Governments: Models Developed by Local Governments



Dataset Summary Information

Source of Information	Various Local Governments
Link to Online Data	TBD
Data Owner	Various Local Governments
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
X	x	x	X	x				x							

Benefits:

Localized and detailed flood modeling that should take precedence over other generic modeling sources or be incorporated into those. May also contain useful local information not observed in other datasets.

Limitations:

The model datasets referenced here were developed by a number of different local governments, often using differing approaches to meet differing objectives in addition to floodplain regulation and management; in addition the age, completeness of supporting documentation and level of QA/ QC of the datasets will and thus the usefulness of the model datasets will likely vary according to the local government source that generated the datasets A detailed review of the model datasets would be required to fully assess the usefulness for each source.

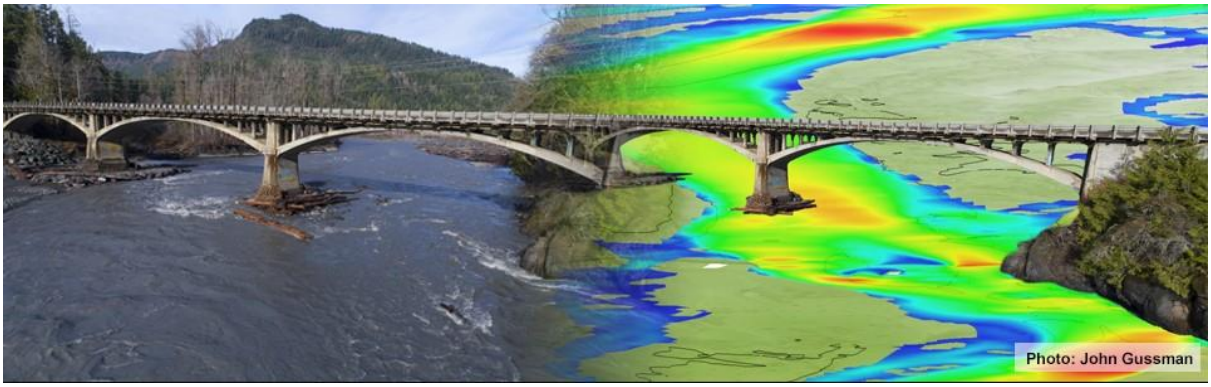
Dataset should be updated by:

Locate models and studies, ensure they are complete, and determine how to incorporate useful information. For example, a local detailed study should take precedence over an approximate regulatory study.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), Velocity, Shear Stress, and Hydrology. Additionally, future risk can be quantified using this dataset where analysis of future conditions have been performed. To quantify risk, determine WSEL of objects from a more detailed model.

2.1.7 USACE, NCSU, UNC, and NCDEQ: Models Developed by Other Agencies



Dataset Summary Information

Source of Information	USACE, NCSU, UNC, NCDEQ
Link to Online Data	https://www.saw.usace.army.mil/ https://ncseagrant.ncsu.edu/coastwatch/current-issue/summer-2021/mapping-the-future/ https://www.deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment https://hydro.web.unc.edu/
Data Owner	USACE, NCSU, NCDEQ
Date Created	Varies
Date of Access	February 2008
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x				x				x	x		

Benefits:

Localized and detailed flood modeling that could take priority over other FEMA regulatory modeling sources or be incorporated into those. May also contain useful local information not observed in other datasets.

Limitations:

Access to sites containing models will differ. It is yet to be determined which models will be available. A significant effort would be required to track studies down and research them. Quality of models are currently unknown.

Dataset should be updated by:

Complete assessment of model input data specifications and quality, identifying computational methodology. Then compare data from other agency models with FEMA regulatory models. If model developed by other agency uses more refined data and better methodology, then the agency model would be considered for uses in alternative analysis.

Risk Quantifier:

Models will need to be obtained and assessed. Determine if model includes existing land use and hydrology only or if future land use and hydrology are also included. Based upon modeled scenarios, then ability to quantify risk can be determined.

2.1.8 NC Floodplain Mapping Program: Flood Warning and Inundation Datasets FIMAN and FIMAN-T Libraries

Dataset Summary Information

Source of Information	North Carolina Emergency Management
Link to Online Data	https://fiman.nc.gov/Map.aspx
Data Owner	North Carolina Emergency Management
Date Created	2005
Date of Access	February 2023
Frequency of Updates	Ongoing
Updates Needed	No
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x						

Benefits:

Identifies extent of flooding and inundation at critical gauged locations in real-time as well as in non-event-based flooding scenarios. Can be used to identify inundation areas as well as roads and structures inundated during flood events and the frequency and duration of flooding of critical transportation routes. There is a strong relationship with NCDOT with communication including alerts, reports, backend survey datasets, and field information being provided. Data is an excellent source of information to calibrate and validate models and will likely be the only accurate information available in many areas.

Limitations:

Some gauges have flow/stage relationships and some only track water surface height. Gauges also can have different data record length/quality, which could impact which event frequencies can be evaluated. Coverage is only provided in the vicinity of select stream gauges. Gauges with higher quality data records tend to be concentrated around larger rivers, while smaller tributaries are less likely to be well-represented. There is also some bias toward better-resourced communities, which has Environmental Justice implications. These are important fundamental biases to be aware of, particularly if outputs from these models are used for training machine learning-based flood hazard models.

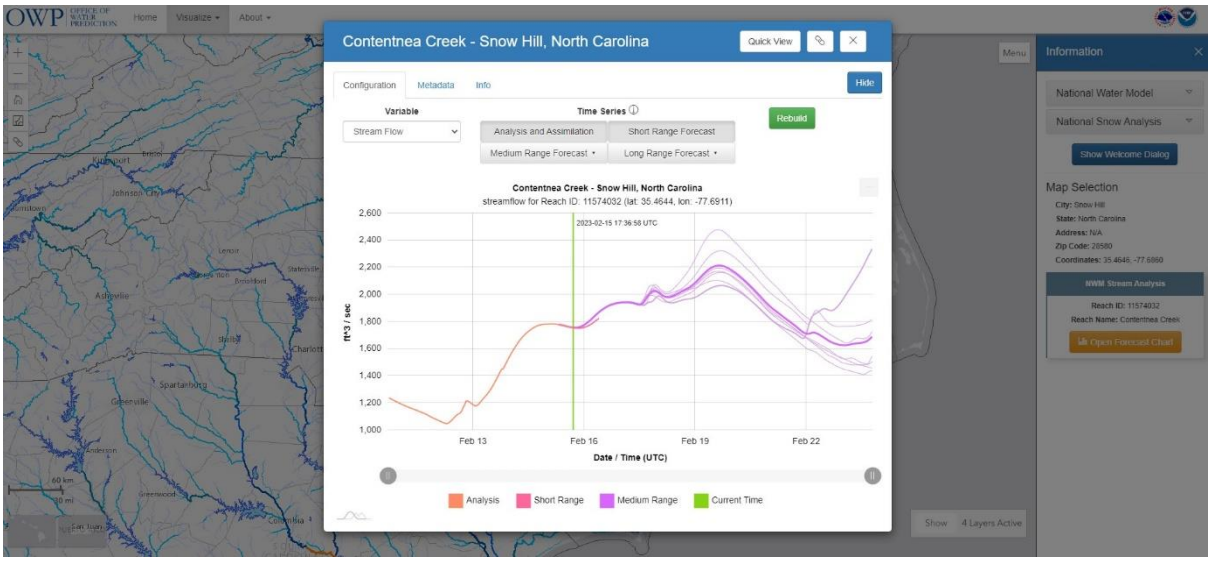
Dataset should be updated by:

The flood warning gauge system should be expanded with prioritized installations and additional flood warning datasets to expand FIMAN and FIMAN-T. Focus on confirming accuracy of data, especially on both sides of structures to improve modeling. Alternatively, low-cost gauge sensors could create a larger network that could use machine learning. Add frequencies of storm events and relations to historical events.

Risk Quantifier:

Event-specific gauge data can be used to calculate event-associated risk. Inundation boundaries can be used to calculate existing and future risk if the flood elevation at the gauge is determined through modeling.

2.1.9 The National Water Model



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://water.noaa.gov/map https://registry.opendata.aws/nwm-archive/
Data Owner	NOAA
Date Created	2015
Date of Access	February 2023
Frequency of Updates	Uncertain. Data products are “live”
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
														x	x

Benefits:

Ensemble forecast, current, and past flows at any point of a stream as well as a wealth of variables used to calculate results. The source is quickly improving and will soon map flood boundaries.

Retrospective dataset can be applied to provide historical context to current near real-time streamflow, soil moisture, and snowpack conditions. The retrospective data can be used to infer flow frequencies and perform temporal analyses with hourly streamflow output and 3-hourly land surface output. This dataset can also be used in the development of end user applications, which require a long baseline of data for system training or verification purposes.

Limitations:

Relatively poor validation, particularly in coastal plain. Does not include hydraulics or inundation mapping. Proposed future Height Above Nearest Drainage approach does not physically model hydraulics or include hydraulics structures, and only uses a representative flood depth for an entire reach. Forecast streamflow and inundation for near-term forecast not used in traditional hazard analysis.

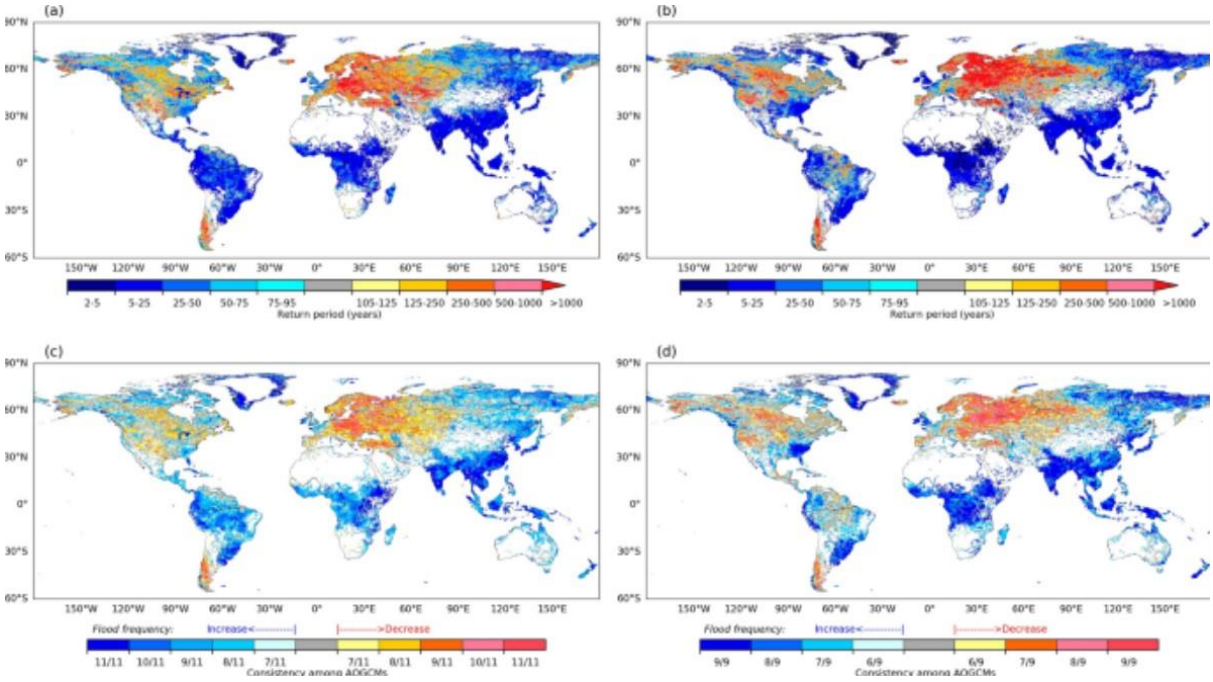
Dataset should be updated by:

N/A

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, Forecasting, Real Time, and Hydrology. To quantify risk, perform real-time and forecasted risk analyses. Future version might be used to back-calculate annual chance interval.

2.1.10 World Climate Research Programme: Future Climate Data and Model – CMIP6



Dataset Summary Information

Source of Information	World Climate Research Programme
Link to Online Data	https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6
Data Owner	World Climate Research Programme
Date Created	2020
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

Alternatives for determination of climate-informed future rainfall depths. Widely peer-reviewed and considered state-of-the-art in the field of climate science.

Limitations:

A local approach would be preferable. Impacts of climate change on rainfall depths and patterns are not yet well understood and have an elevated level of variability depending on the selected approach. As with any model, it contains simplifications, uncertain parameters, limited processing, biases, and assumptions.

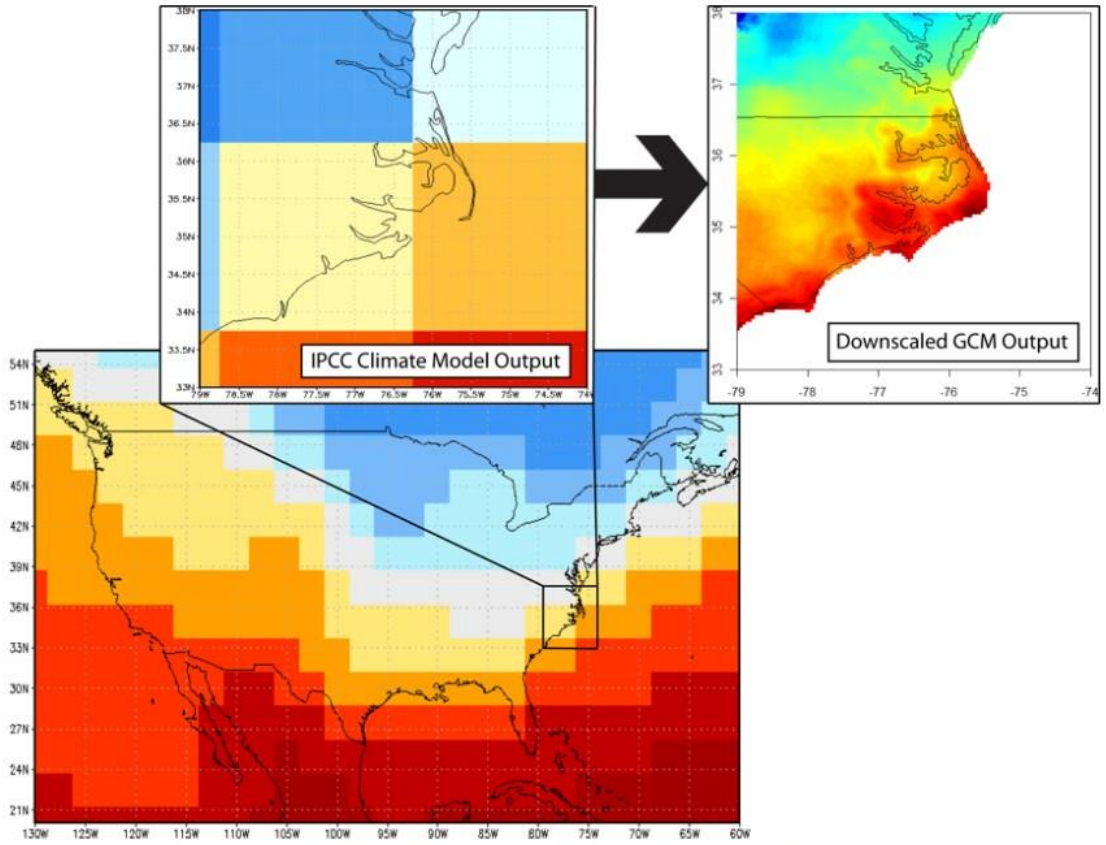
Dataset should be updated by:

Continue to monitor developments in the science of global climate modeling (GCM) and determine which methods are deemed appropriate for development of future rainfall depths in other studies around the nation.

Risk Quantifier:

This source can be a future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.11 SE Climate Adaptation Science Center and NCSU: Downscaled Future Climate Data and Model – GCM



An example of downscaled global climate model (GCM) output from the coarser IPCC projections.

Dataset Summary Information

Source of Information	Southeast Climate Adaptation Science Center and NCSU
Link to Online Data	https://secasc.ncsu.edu/resources/downscaled-climate-projections-for-the-southeast/
Data Owner	SE Climate Adaptation Science Center and NCSU
Date Created	2020
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

Local approach of climate-informed future rainfall depths.

Limitations:

The ability of downscaled global climate models to simulate the impacts of climate change on rainfall depths and patterns are limited due to computational resources, uncertainties, and scale mismatch. High-resolution downscaling requires substantial computational power and resources that can limit the spatial and temporal resolution of simulations. There are several uncertainties that limit GCMs including initial conditions data availability and accuracy, emission scenarios, natural variability, capturing extreme events, etc.

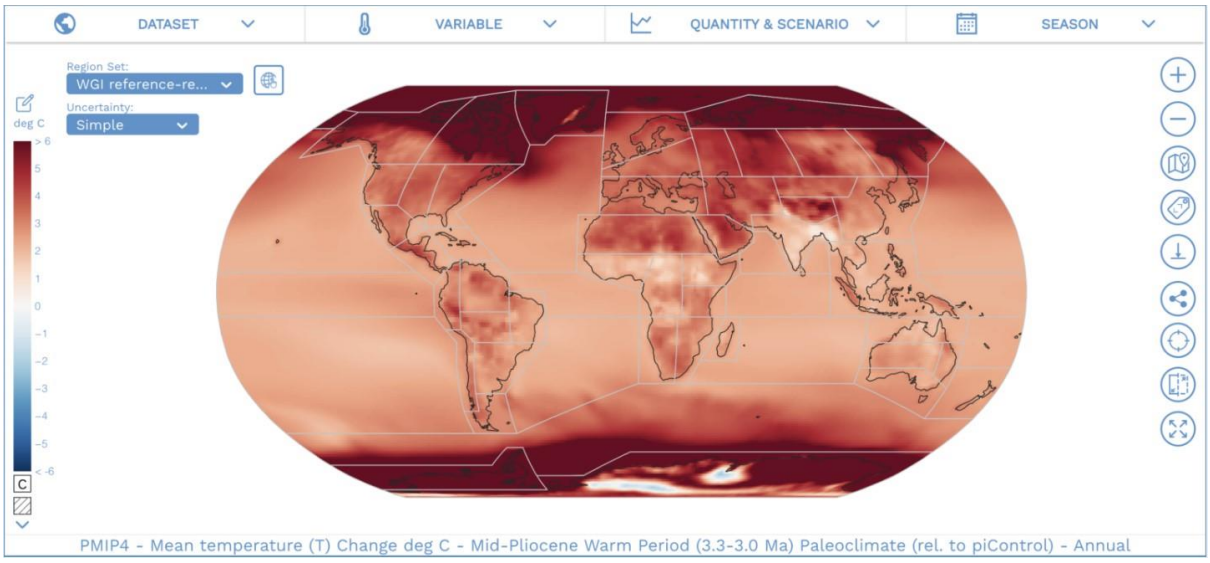
Dataset should be updated by:

Continue to monitor developments in the science of global climate modeling and which methods are deemed appropriate for development of future rainfall depths in other studies around the nation.

Risk Quantifier:

This source can be a future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.12 IPCC: Future Climate Data and Model



Dataset Summary Information

Source of Information	Intergovernmental Panel on Climate Change (IPCC)
Link to Online Data	https://www.ipcc-data.org/data_catalogue.html
Data Owner	IPCC
Date Created	1988
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

Alternatives for determination of climate-informed future rainfall depths. Widely peer reviewed and considered state-of-the-art in the field of climate science.

Limitations:

Not a local approach. Impacts of climate change on rainfall depths and patterns are not yet well understood and have an elevated level of variability depending on the selected approach. As with any model, it contains simplifications, uncertain parameters, limited processing, biases, and assumptions.

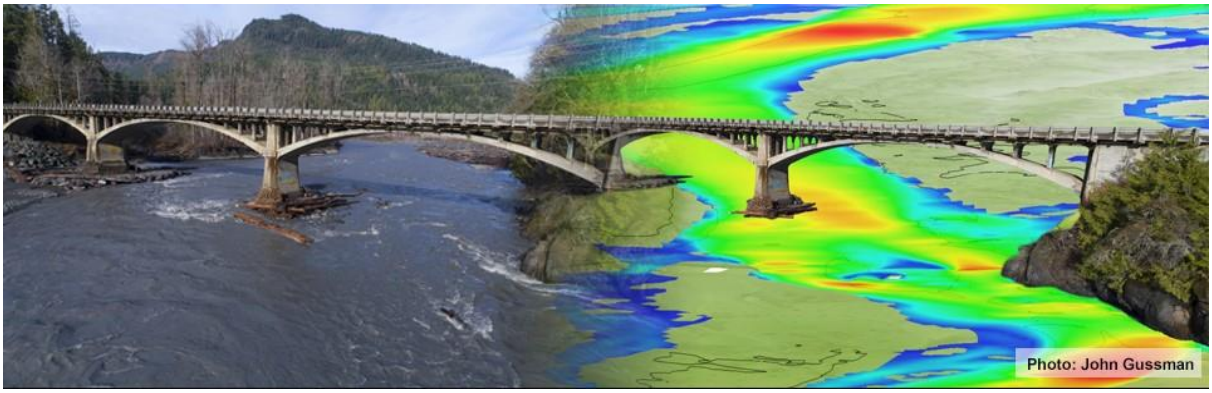
Dataset should be updated by:

Continue to monitor developments in the science of global climate modeling and which methods are deemed appropriate for development of future rainfall depths in other studies around the nation.

Risk Quantifier:

This source can be a future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.13 NCDOT: 2D Modeling from Other Agencies



Dataset Summary Information

Source of Information	North Carolina Department of Transportation (NCDOT)
Link to Online Data	Unidentified
Data Owner	NCDOT
Date Created	Unknown
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	Unknown
Type of Flooding	Fluvial, Pluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x				x							

Benefits:

Localized and detailed flood modeling that could take precedence over models with less detail or outdated inputs. May also contain useful local information not observed in other datasets.

Limitations:

Access requirements to sites containing models may differ. It is yet to be determined which models will be available. Quality of models is currently unknown.

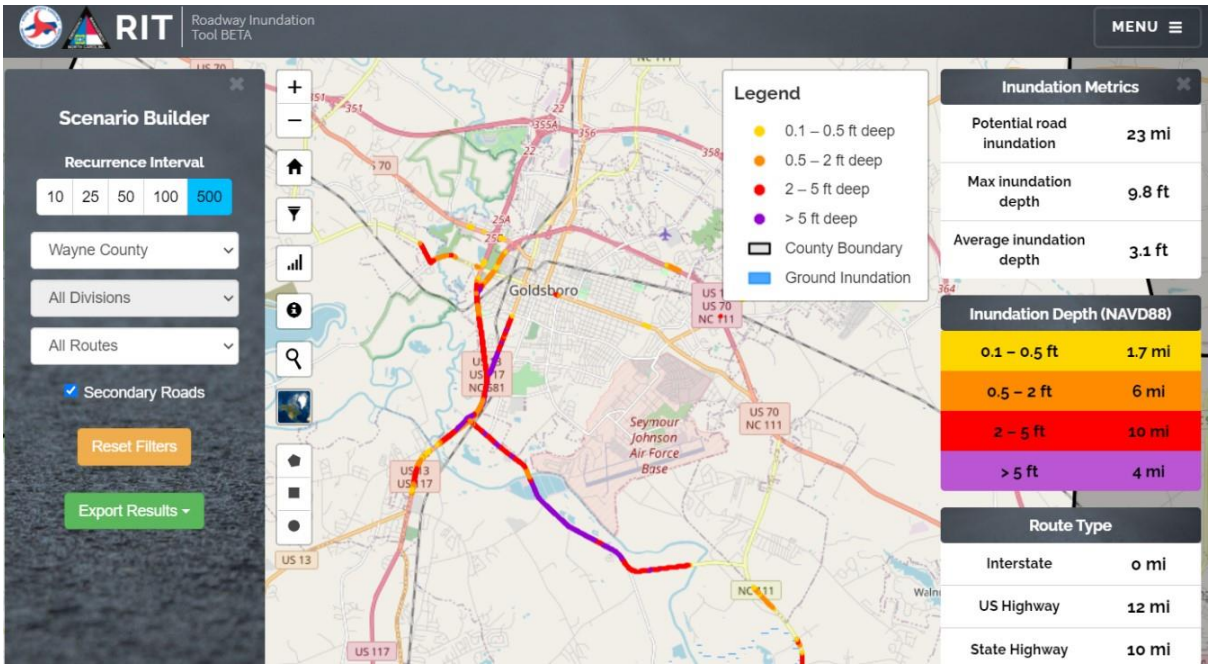
Dataset should be updated by:

Locate models and studies, ensure they are complete, and determine how to incorporate useful information. For example, a local detailed study should take precedence over an approximate regulatory study.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Inundation Boundary, WSEL, Duration and Time Variable, Velocity, Shear Stress, and Hydrology. To quantify risk, determine WSEL of objects from a more detail model.

2.1.14 NCDOT: Roadway Inundation Tool



Dataset Summary Information

Source of Information	NCDOT
Link to Online Data	https://www.ncdot-raft.info/applications.php
Data Owner	NCDOT
Date Created	2017
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
										x	x			x	x

Benefits:

Help identify roads that are subject to damage and inundation from past, current, and future flooding events. Also useful for determining transportation routes that are critical or cut off populations during flood events and therefore require available alternate routes.

Limitations:

Only includes major roads. Does not account for future events. Does not identify problem areas by feature class. Likely inaccurate.

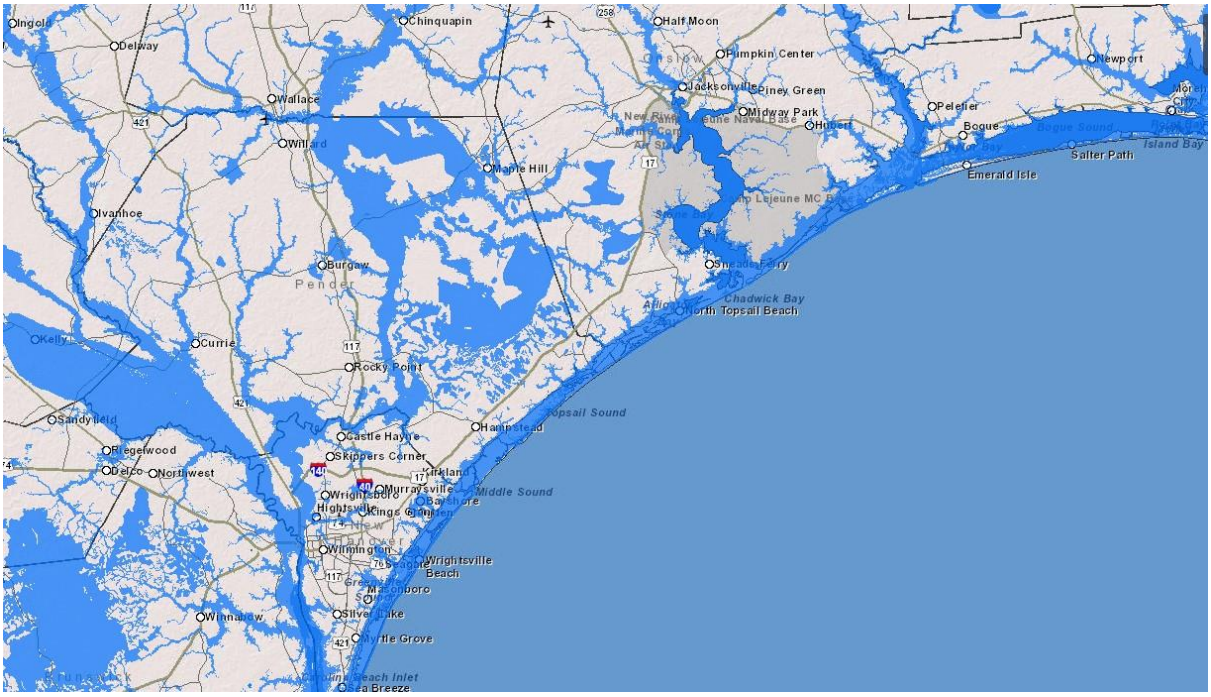
Dataset should be updated by:

Would be a valuable layer used in multiple analyses, modeling, and overall worthwhile to improve despite the extensive effort. Identify routes that need redundancy and store data by feature class. Add frequencies and future conditions. Expand coverage area using advisory flood dataset and ensure detail in model is sufficient. Consider time variables such as arrival or duration. Consider addition of all roads.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Transportation Attributes (Roads and Bridges). To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.15 FEMA: Regulatory Hydrologic, Hydraulic, and Coastal Modeling



Dataset Summary Information

Source of Information	North Carolina Emergency Management – Floodplain Mapping Program
Link to Online Data	https://fris.nc.gov/fris/Home.aspx?ST=NC
Data Owner	State of North Carolina
Date Created	2000-Present
Date of Access	February 2023
Frequency of Updates	Annual Funding for cyclical updates throughout the state
Updates Needed	No
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x	x	x		x							

Benefits:

Coastal flooding risk hazard.

Limitations:

Some models may contain outdated hydrology, terrain, assumptions, limited flood boundary extents, and limited data such as future condition. Currently, lacks a probabilistic and future conditions approach.

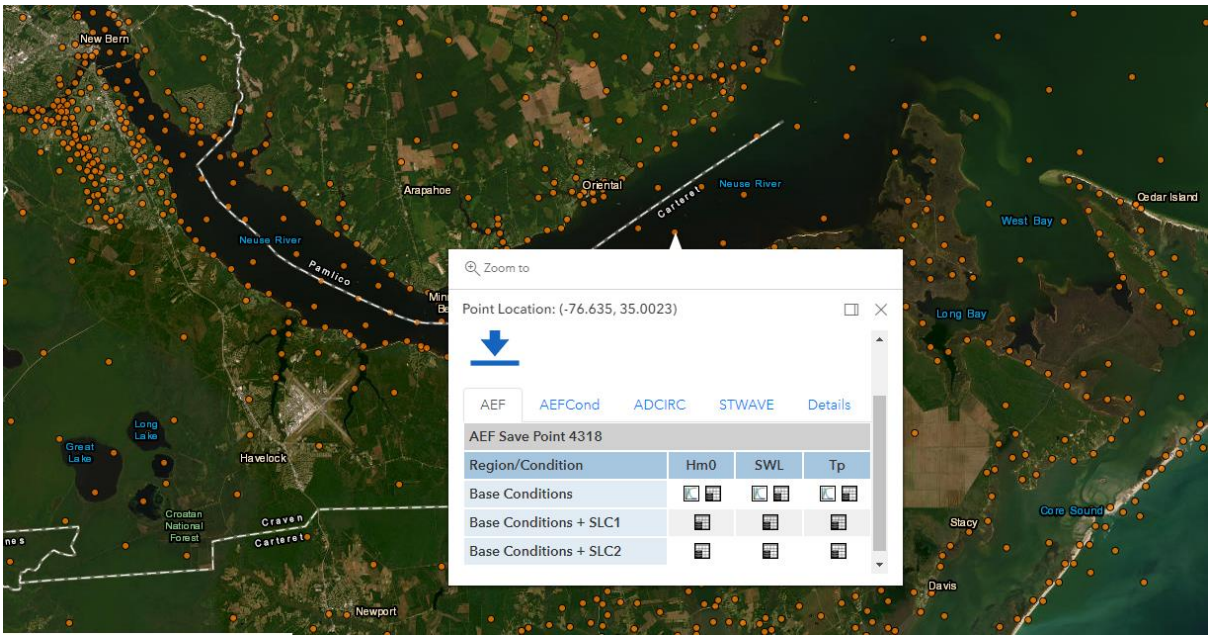
Dataset should be updated by:

Coastal flooding often impacts areas much further inland than scoped in these studies, and is also influenced by riverine, stormwater, and other sources of flooding. An approach to bridge the combination of these factors needs to be created. In addition, consider supplementing these data with more events, scenarios, and historical data.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Inundation Boundary, WSEL, SFHA, Transportation Attributes (Roads and Bridges), Velocity, Shear Stress, and Hydrology. To quantify risk, determine objects in the special flood hazard areas. WSEL for various events can be extracted from cross section and profiles; however, this would require additional effort.

2.1.16 USACE: South Atlantic Coastal Study



Dataset Summary Information

Source of Information	USACE
Link to Online Data	https://www.sad.usace.army.mil/SACS/
Data Owner	USACE
Date Created	2022
Date of Access	August 2023
Frequency of Updates	Periodic
Updates Needed	Additional Sea Level Rise Scenarios in surge modeling
Type of Flooding	Coastal Flooding

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x	x	x				

Benefits:

Analysis similar to FEMA study with additional frequencies, updated statistical methods, and enhanced risk products based on additional datasets.

Limitations:

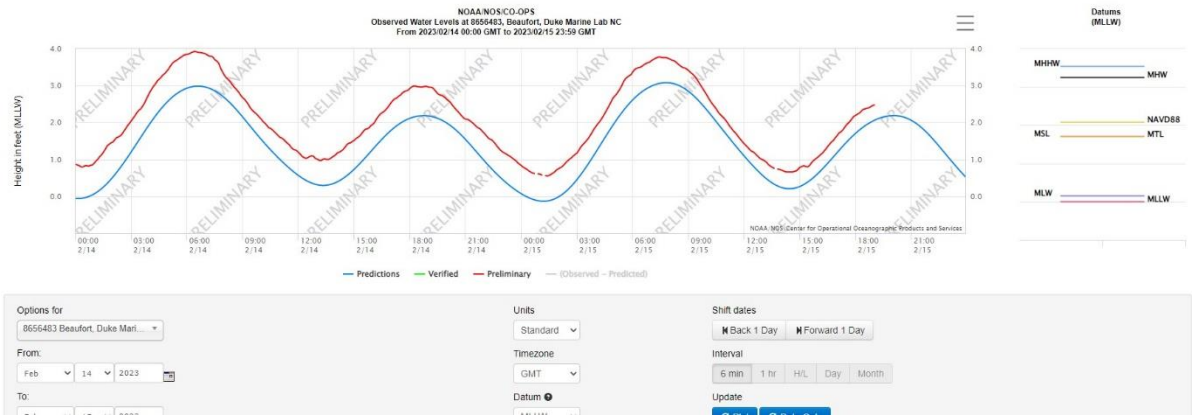
Specific sea level rise scenarios may need to be added to predicted water levels to achieve desired product.

Dataset should be updated by:

Modeling surge frequencies with additional sea level rise scenarios. It should be noted that there is a near 1-to-1 correlation between added sea level rise and increase in storm surge, so this update is not critical for planning purposes.

Risk Quantifier:

2.1.17 NOAA: Gauge Data



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://tidesandcurrents.noaa.gov/waterlevels.html?id=8656483
Data Owner	NOAA
Date Created	1867
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Real-time and historical coastal gauge data.

Limitations:

Requires some adjusting to datum. Limited years of information may skew assumptions.

Dataset should be updated by:

Using to determine historical coastal gauge data.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: WSEL, Real Time, and Hydrology. To quantify risk, perform gauge, trend, real-time, or other analysis to determine risk probabilities that can be applied to models from other sources.

2.1.18 NASA: Land, Atmosphere Near real-time Capability of EOS

Dataset Summary Information

Source of Information	NASA
Link to Online Data	Users can visualize imagery related to floods in Worldview, or download data using the links below: • Register for an Earthdata Login to start downloading data. • Read the Land, Atmosphere Near real-time Capability of EOS (LANCE) disclaimer for more information about using the data.
Data Owner	NASA
Date Created	Ongoing
Date of Access	June 2023
Frequency of Updates	1-, 2-, and 3-Day cycle
Updates Needed	No – continually collected
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

This dataset provides flood Inundation boundaries from satellite aerial imagery. The flood product has three compositing periods (1-day, 2-day, and 3-day) because the best product for a given flood event depends on four unpredictable factors: the specific area of interest; cloud cover; spatial extent of likely flood water; and likely duration of flooding. It is recommended that the user view both the 2- and 3-day products unless latency is a primary concern. Ultimately determining which product provides the best information for a particular event of interest will be up to the user. LANCE imagery can be overlaid with the following data sets from NASA's Socioeconomic Data and Applications Center, which are also available as layers in Worldview: Flood Hazard Frequency and Distribution, Flood Hazard-Mortality Risk, and Flood Hazard Economic Risk.

Limitations:

Limited to time-of-capture of imagery, which may miss peak flooding or be blocked by cloud cover. Resolution is too coarse to accurately capture.

Dataset should be updated by:

None

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Inundation Boundary. To quantify risk, identify historical inundation boundaries. Also, potential to calculate aftermath damage such as finding washed-out and debris strewn crossings.

2.1.19 European Space Agency: Flood Event Satellite Aerial Imagery

Dataset Summary Information

Source of Information	NASA, European Space Agency, USGS, and National Oceanic and Atmospheric Administration NOAA
Link to Online Data	https://planetarycomputer.microsoft.com/dataset/group/sentinel-1
Data Owner	NASA, European Space Agency, USGS, and NOAA
Date Created	April 2014
Date of Access	February 2023
Frequency of Updates	6-Day cycle
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies Benefits:

Flood Inundation boundaries from satellite aerial imagery.

Limitations:

Limited to time-of-capture of imagery, which may miss peak flooding or be blocked by cloud cover. Resolution is too coarse to accurately capture detail.

Dataset should be updated by:

Potential to map flooding occurrence based on satellite data but has many limitations that makes it difficult to use.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Inundation Boundary. To quantify risk, identify historical inundation boundaries. Also, potential to calculate aftermath damage such as finding washed-out and debris strewn crossings.

2.1.20 USGS: Flood Event Satellite Aerial Imagery (Landsat and Sentinel 1 and 2)

Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://planetarycomputer.microsoft.com/dataset/group/sentinel-1 https://landsat.gsfc.nasa.gov/data/
Data Owner	NASA, European Space Agency, USGS, and NOAA
Date Created	April 2014
Date of Access	February 2023
Frequency of Updates	5- to 6 -Day cycle
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies Benefits:

Flood Inundation boundaries from satellite aerial imagery.

Limitations:

Limited to time of capture of imagery, which may miss peak flooding or be blocked by cloud cover. Resolution is too coarse to accurately capture.

Dataset should be updated by:

Potential to map flooding occurrence based on satellite data but has many limitations that makes it difficult to use.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Inundation Boundary. To quantify risk, identify historical inundation boundaries. Also, potential to calculate aftermath damage such as washed-out and debris-strewn crossings.

2.1.21 NOAA: Storm Aerial Imagery

Dataset Summary Information

Source of Information	NOAA
Link to Online Data	National Geodetic Survey – Emergency Response Imagery Index (noaa.gov)
Data Owner	NOAA
Date Created	Variable, based upon event date
Date of Access	June 2023
Frequency of Updates	Typically flown once per event over multiple days with some overlap between daily flights.
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Flood Inundation boundaries for specific events from aerial imagery.

Limitations:

Limited to time of capture of imagery, which may miss peak flooding or be blocked by cloud cover.

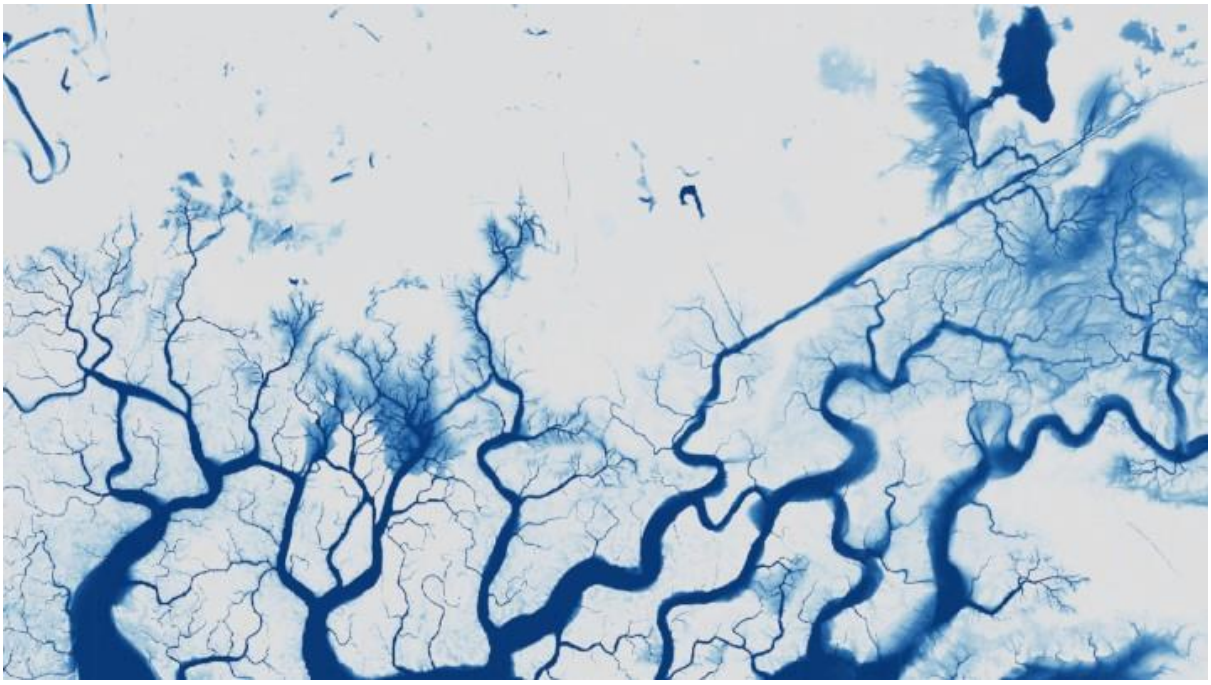
Dataset should be updated by:

N/A

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Inundation Boundary. To quantify risk, identify historical inundation boundaries, washed-out stream crossings, and debris accumulation at crossings and elsewhere.

2.1.22 European Commission Joint Research Centre, JRC Global Surface Water



Dataset Summary Information

Source of Information	European Commission Joint Research Centre
Link to Online Data	JRC Global Surface Water | Planetary Computer (microsoft.com)
Data Owner	European Commission Joint Research Centre
Date Created	1984
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	No
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Describes the occurrence, change, and seasonality of surface water from 1984-2021. Future updates are also planned.

Limitations:

Does not capture seasonal, short time span, or small water bodies. Resolution is coarse and imagery is often blocked by cloud coverage. Does not appear to be an ongoing operation.

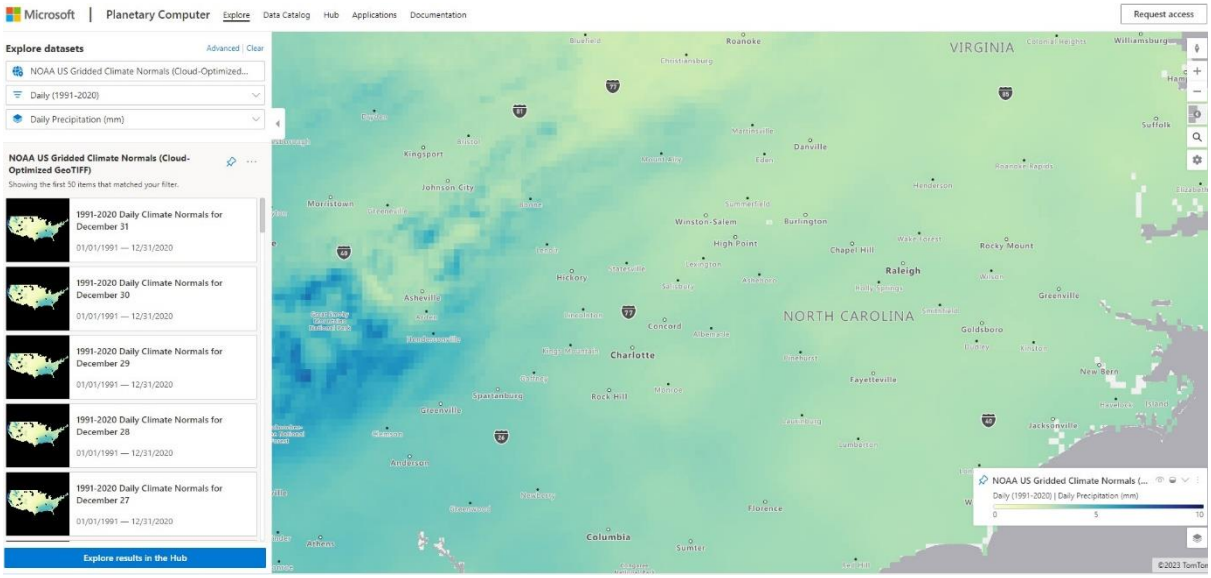
Dataset should be updated by:

Potential to map flooding occurrence based on real satellite data but has many limitations that make it difficult to use.

Risk Quantifier:

This source cannot be used as an existing or future risk quantifier. Note: This source could be especially important for mapping natural infrastructure and as input in future model development to account for and estimate benefits of wetland systems.

2.1.23 Multiple: Artificial Intelligence and Machine Learning Models



Dataset Summary Information

Source of Information	Multiple
Link to Online Data	Unidentified
Data Owner	Multiple
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	Yes
Type of Flooding	Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Benefits:

Artificial Intelligence (AI)-powered platforms provide real-time flood mapping and forecasting that can be used in emergency management or floodplain management. They may use machine deep

learning algorithms, drones, satellites, weather data and gauges, and social media to predict the likelihood and severity of flooding.

Limitations:

The technology is new and changing quickly, which makes it difficult to develop a long-term approach. The current resolution and detail are often lacking in these systems. Most sources are proprietary, and not free of charge.

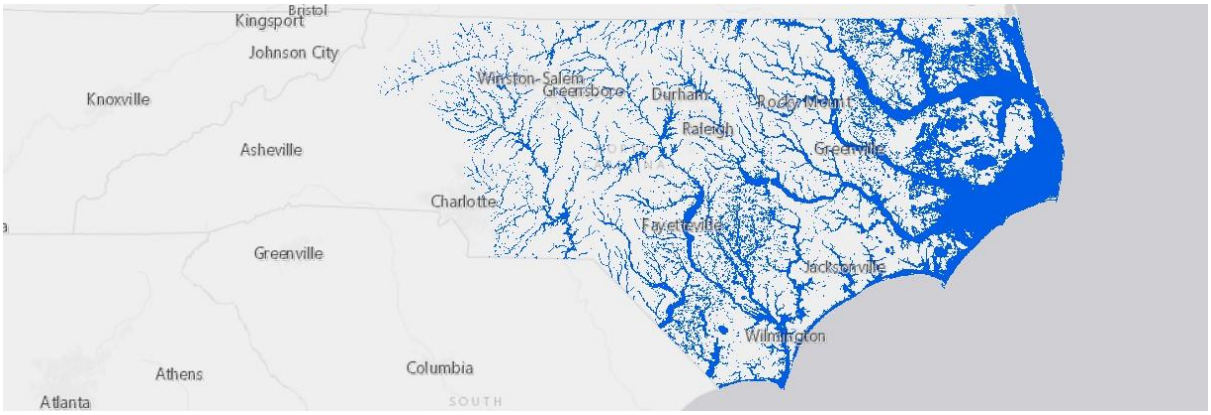
Dataset should be updated by:

Further research into existing sources such as Microsoft Planetary Computer, NCDOT/WSP, Fathom, FloodMapp, Premonition, Deep Flood, Flood Modeler, IBM's Water Management Platform, DHI Flood and Drought Portal, Aquantix, and Flood IO. Then consider creating system for the Blueprint, or how to incorporate existing sources.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Inundation Boundary, WSEL, Duration and Time Variable, Velocity, Shear Stress, Forecasting, Real Time, and Hydrology. To quantify risk, it will depend on the source for process and variables.

2.1.24 The Nature Conservancy: Historical Events (Hurricanes Matthew and Florence)



Dataset Summary Information

Source of Information	The Nature Conservancy
Link to Online Data	https://data-nconemap.opendata.arcgis.com/datasets/hurricane-matthew-flood-extent-across-the-piedmont-and-coastal-plain-of-north-carolina/explore?location=35.686302 percent2C-79.830727 percent2C8.84 https://data-nconemap.opendata.arcgis.com/datasets/hurricane-florence-flood-extent-across-the-piedmont-and-coastal-plain-of-north-carolina/explore?location=35.099971 percent2C-79.888824 percent2C7.91
Data Owner	The Nature Conservancy and Arizona State University
Date Created	2018, 2020
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Understand historic events and use the information to calibrate and verify models.

Limitations:

Assessment of accuracy and uncertainty described in detail at following link: Repeated Hurricanes Reveal Risks and Opportunities for Social-Ecological Resilience to Flooding and Water Quality Problems | Environmental Science and Technology (acs.org)

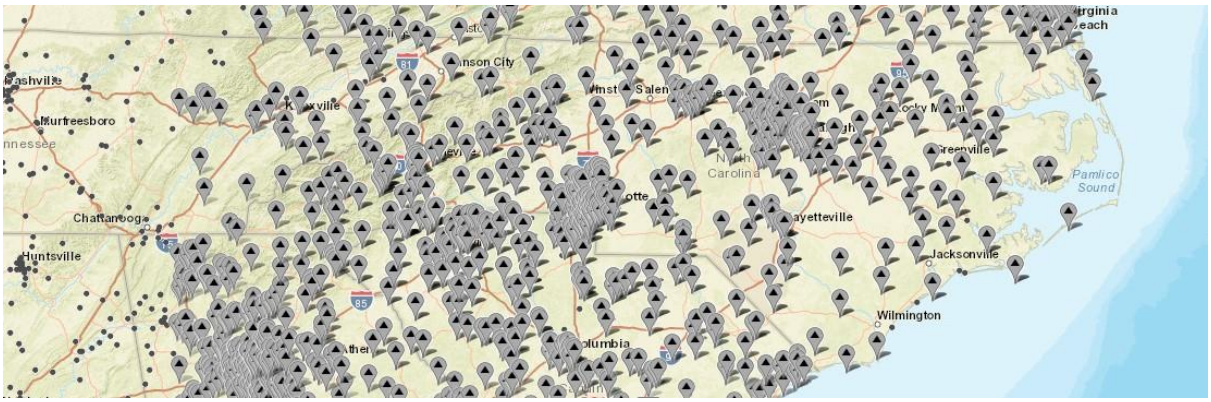
Dataset should be updated by:

Consider a method to recreate major historic events such as using 2D models as a digital twin.

Risk Quantifier:

The individual maps for the two large recent events can be used to complement the state's flood hazard mapping. This source can be an existing risk quantifier using the following factor: Inundation Boundary. To quantify risk, use the historical event flood information.

2.1.25 USGS: Stream Gauge Data



Dataset Summary Information

Source of Information	US Geological Survey
Link to Online Data	https://maps.waterdata.usgs.gov/mapper/index.html (Preliminary peak stage and streamflow data – Hurricane Florence [NC]) – stage https://pubs.usgs.gov/of/2018/1172/ofr20181172.pdf
Data Owner	USGS
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Benefits:

Large, reputable network of real measurements. Contains historical information to perform a gauge analysis or observe other trends.

Limitations:

Denser coverage in metropolitan areas such as Charlotte, Greensboro, and Raleigh, but less-dense spatial coverage in outlying and rural areas. The location of a USGS stream gauge reflects the purpose of the gauge and the cooperator who is helping to fund the data collection. For example, many of the stream gauges in Charlotte are part of the Flood Information Notification System (FINS) network for flood alerts that has been established and expanded over time. Raleigh has a new flood alert system that will likely grow, and Greensboro is likewise beginning to explore a flood alert system. Additional gauges in areas with limited coverage would be beneficial for the Blueprint.

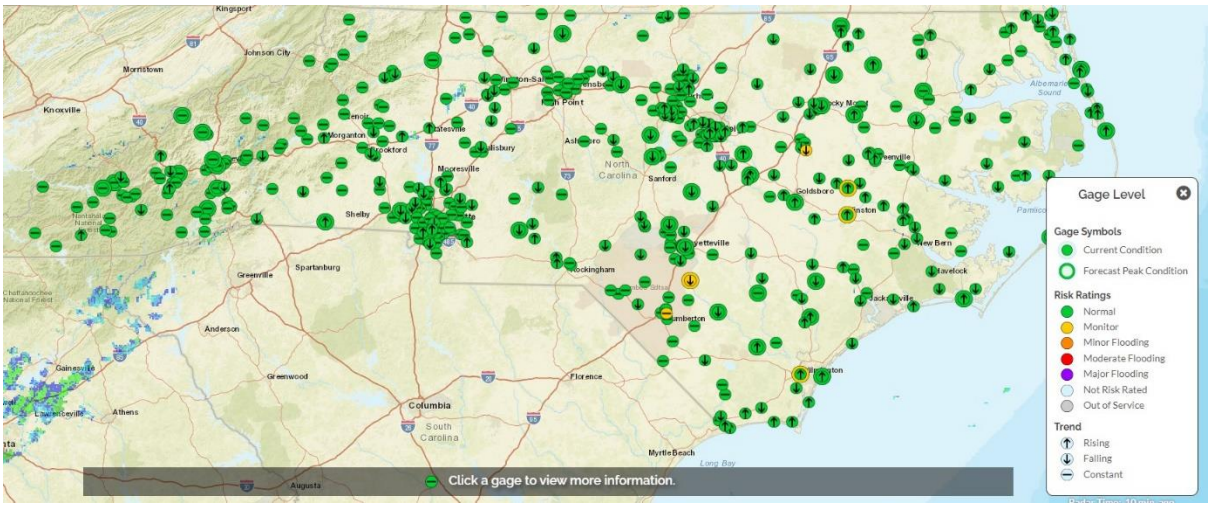
Dataset should be updated by:

USGS stream gauge data used as a primary means of model verification. Depending on the type of streamflow data needed, there may be cost-effective alternatives for stream gauge data and information to provide for expanded statewide coverage.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, perform gauge, trend, or other analysis to determine risk probabilities that can be applied to models from other sources.

2.1.26 NCEM and NCDOT: Stream Gauge Data



Dataset Summary Information

Source of Information	North Carolina Emergency Management (NCEM) and North Carolina Department of Transportation (NCDOT)
Link to Online Data	https://fiman.nc.gov/Map.aspx
Data Owner	NCEM and NCDOT
Date Created	Unknown
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	x

Benefits:

Additional gauges that are usually placed at key locations or areas prone to flood.

Limitations:

Data are often limited, such as rapid deployment gauges with only a few events. Often not useable for gauge analysis or other purposes.

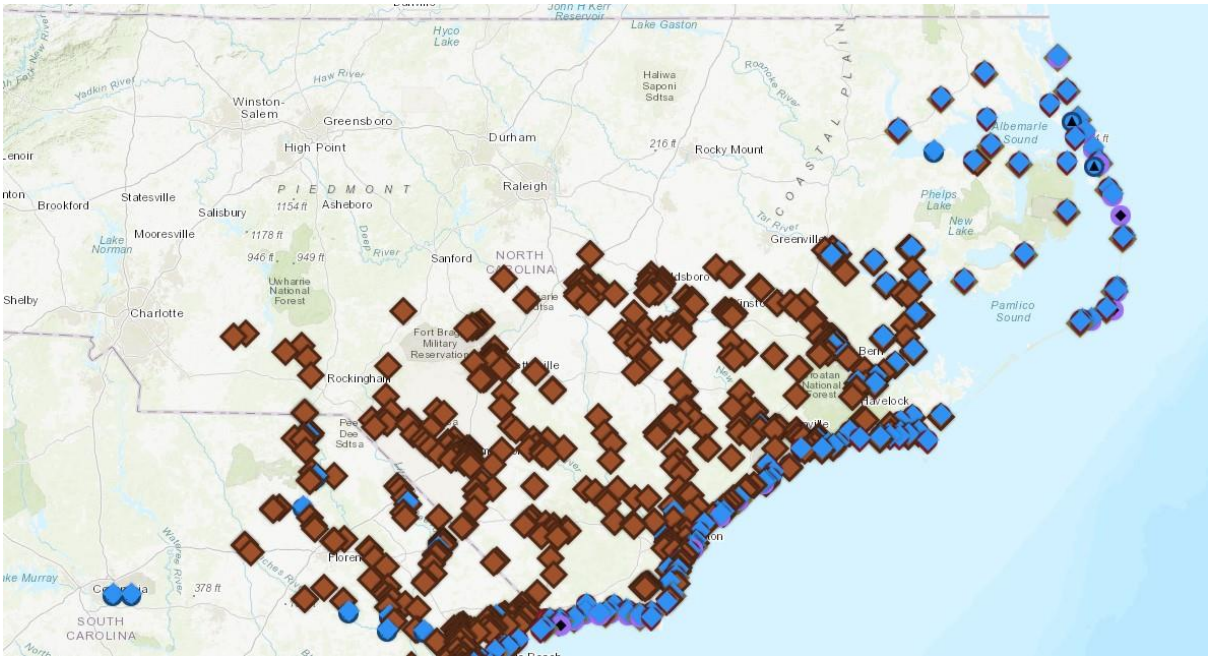
Dataset should be updated by:

Prioritize these gauge locations to determine next locations to become permanent, or have additional variables added for when funding becomes available because they are important.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk—perform gauge, trend, or other analysis to determine risk probabilities that can be applied to models from other sources.

2.1.27 FEMA: High Water Marks



Dataset Summary Information

Source of Information	USGS, NCEM, FEMA, NCDOT, USACE and local
Link to Online Data	https://www.fema.gov/flood-maps/products-tools/high-water-mark-initiative https://stn.wim.usgs.gov/FEV/#MatthewOctober2016 https://ncem-gis.maps.arcgis.com/apps/GeoForm/viewer.html?appid=e4b0124896264c37aa7e235de3d89809
Data Owner	Multiple entities
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	As appropriate based on flooding events
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Means to verify models and flood depths at additional locations outside of USGS gauges.

Limitations:

High water mark coverage limited to water levels observed during specific flood events.

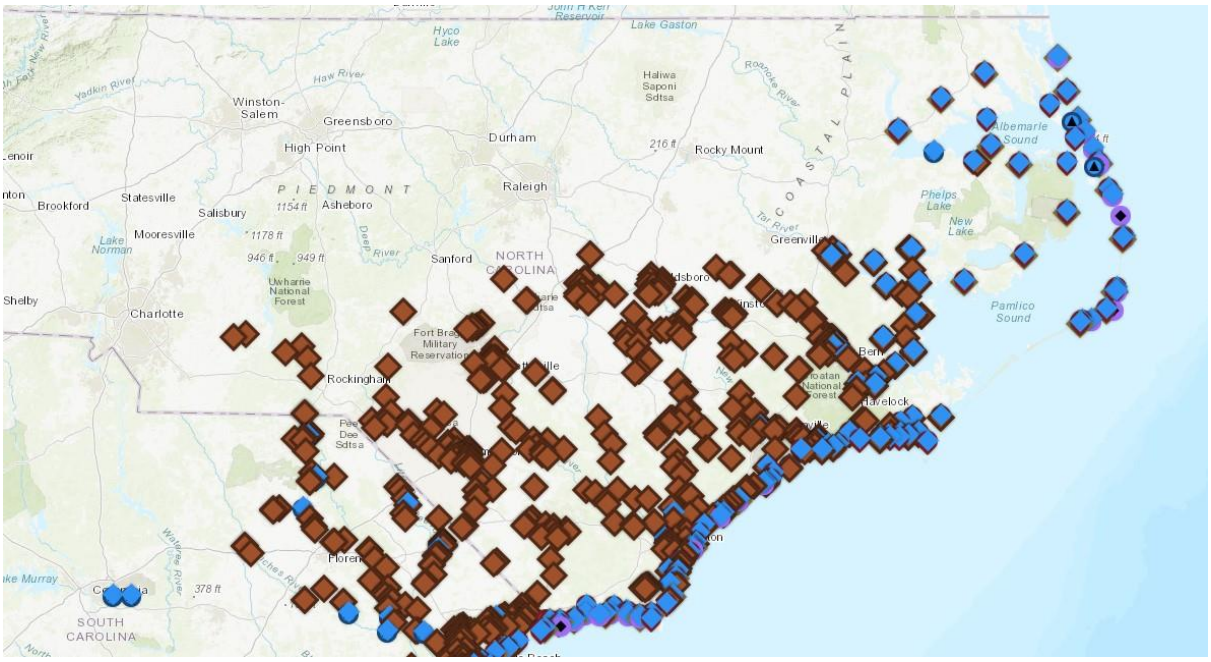
Dataset should be updated by:

Compile all sources into a single database. Consider a long-term approach for future inputs as well as citizen science and input.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: WSEL and Hydrology. To quantify risk, use the historical WSELs to determine risk.

2.1.28 USGS: High Water Marks



Dataset Summary Information

Source of Information	USGS, NCEM, FEMA, NCDOT, USACE, and local
Link to Online Data	https://www.fema.gov/flood-maps/products-tools/high-water-mark-initiative https://stn.wim.usgs.gov/FEV/#MatthewOctober2016 https://ncem-gis.maps.arcgis.com/apps/GeoForm/viewer.html?appid=e4b0124896264c37aa7e235de3d89809
Data Owner	Multiple entities
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	As appropriate based on flooding events
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies:

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Means to verify models and flood depths at additional locations outside of USGS gauges.

Limitations:

High water mark coverage limited to water levels observed during specific flood events.

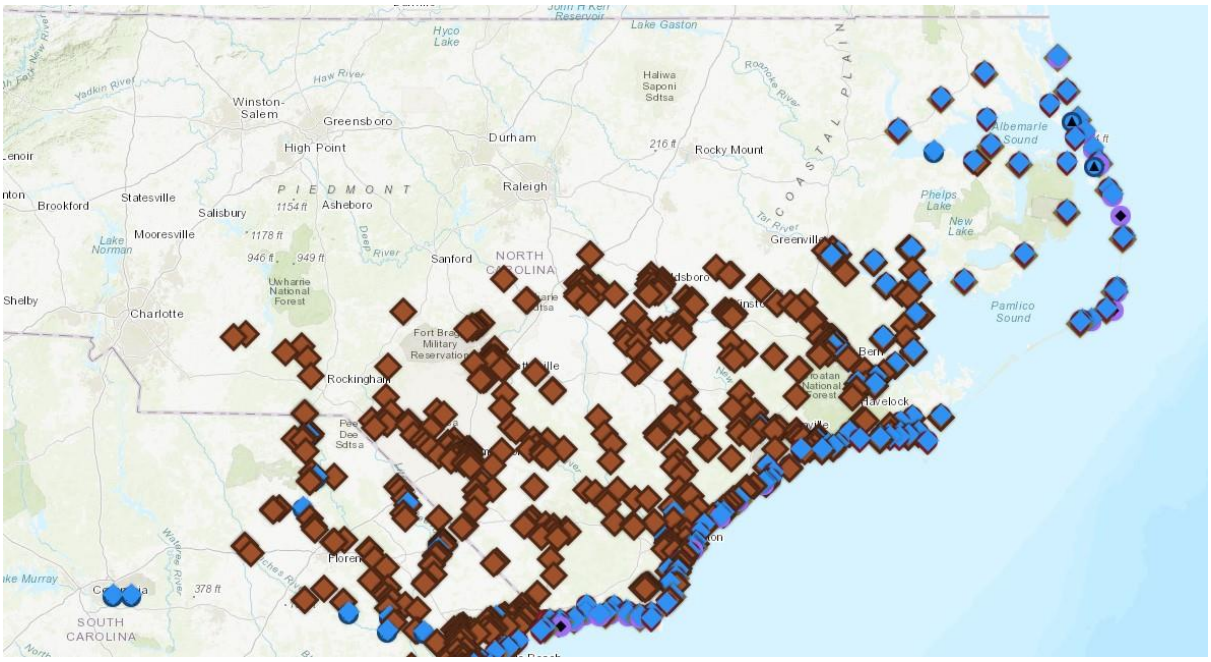
Dataset should be updated by:

Compile all sources into a single database. Consider a long-term approach for future inputs as well as citizen science and input.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: WSEL and Hydrology. To quantify risk, use the historical WSELs to determine risk.

2.1.29 NCEM: High Water Marks



Dataset Summary Information

Source of Information	USGS, NCEM, FEMA, NCDOT, USACE and local
Link to Online Data	https://www.fema.gov/flood-maps/products-tools/high-water-mark-initiative https://stn.wim.usgs.gov/FEV/#MatthewOctober2016 https://ncem-gis.maps.arcgis.com/apps/GeoForm/viewer.html?appid=e4b0124896264c37aa7e235de3d89809
Data Owner	Multiple entities
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	As appropriate based on flooding events
Updates Needed	Yes
Type of Flooding	Fluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Means to verify models and flood depths at additional locations outside of USGS gauges.

Limitations:

High water mark coverage limited to water levels observed during specific flood events.

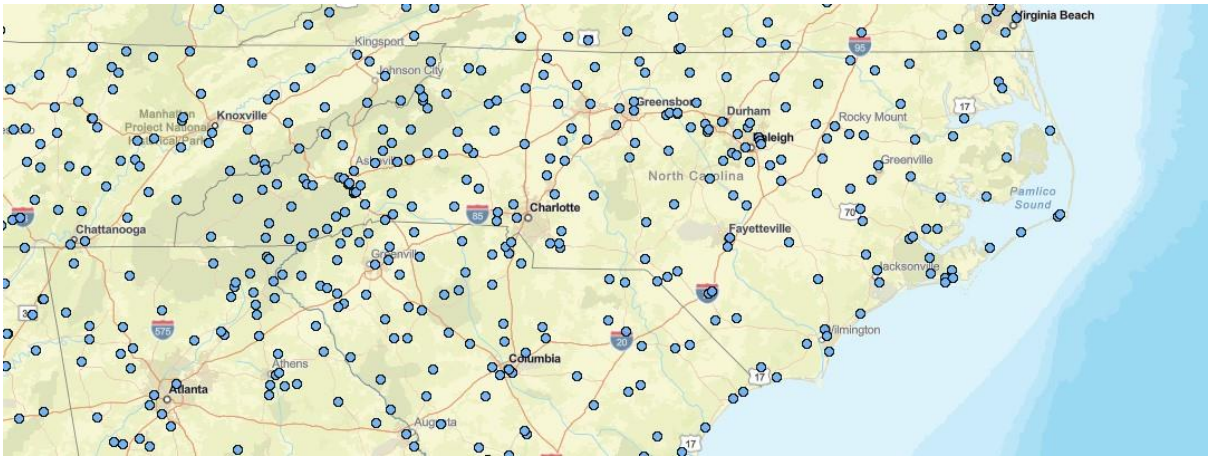
Dataset should be updated by:

Compile all sources into a single database. Consider a long-term approach for future inputs as well as citizen science and input.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: WSEL and Hydrology. To quantify risk, use the historical WSELs to determine risk.

2.1.30 NOAA: Meteorological Data



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	About | National Centers for Environmental Information (noaa.gov)
Data Owner	NOAA
Date Created	1870
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
										X					

Benefits:

Reliable original source data for many variables.

Limitations:

Data might be too coarse to use for accuracy, especially in local areas.

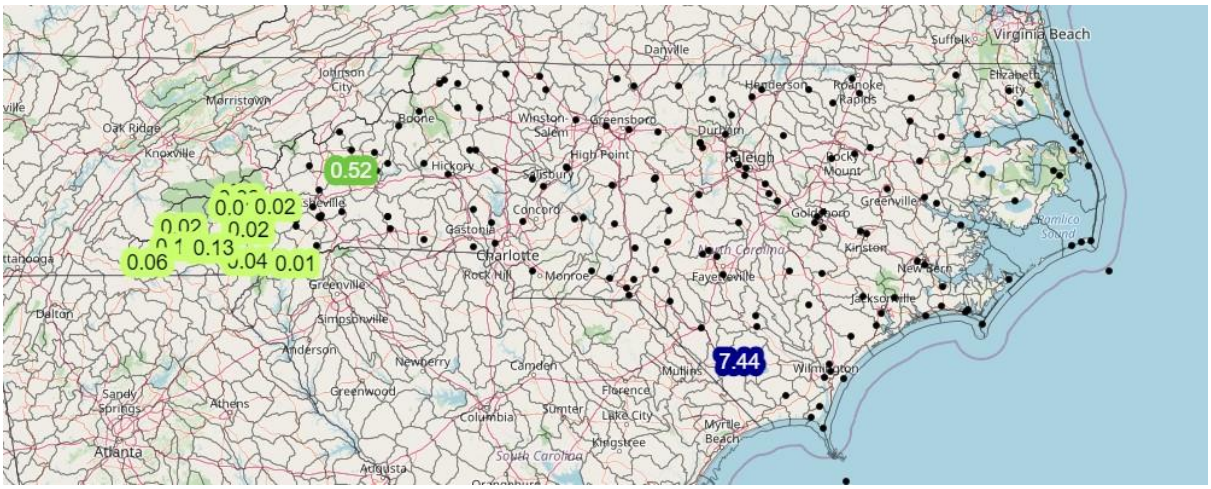
Dataset should be updated by:

Ensure direct access the data through an Application Programming Interface (API) when retrieving information.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, use the meteorological data as inputs or to perform analysis.

2.1.31 NCSU and MESOWEST: Rain Gauge



Dataset Summary Information

Source of Information	NCSU and MESOWEST (weather data delivery system)
Link to Online Data	https://products.climate.ncsu.edu/map/ https://mesowest.utah.edu/cgi-bin/droman/mesomap.cgi?state=NC&rawsflag=3
Data Owner	NCSU and MESOWEST
Date Created	1995
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Dataset should be updated by:

Combine, or verify these data to other sources.

Benefits:

Creates a larger combined network of weather data.

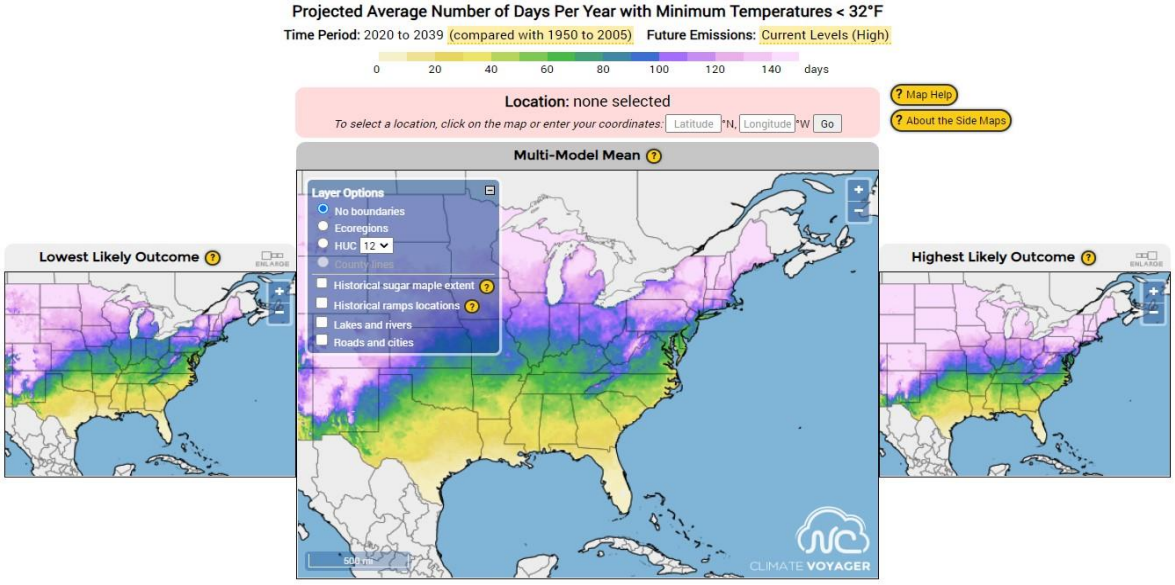
Limitations:

The network is too sparse for most of the state.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.32 State Climate Office of NC: Climate Voyager



Dataset Summary Information

Source of Information	State Climate Office of North Carolina
Link to Online Data	Climate Voyager (ncsu.edu)
Data Owner	State Climate Office of North Carolina
Date Created	2007
Date of Access	February 2023
Frequency of Updates	Sporadic
Updates Needed	NA: Data access necessary
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies:

N/A

Benefits:

Predicts change in temperature, precipitation, and drought from 20 climate models. Available in four future 20-year time periods from 2020 to 2099.

Limitations:

Based on historical average from 1986 to 2005, which is limited.

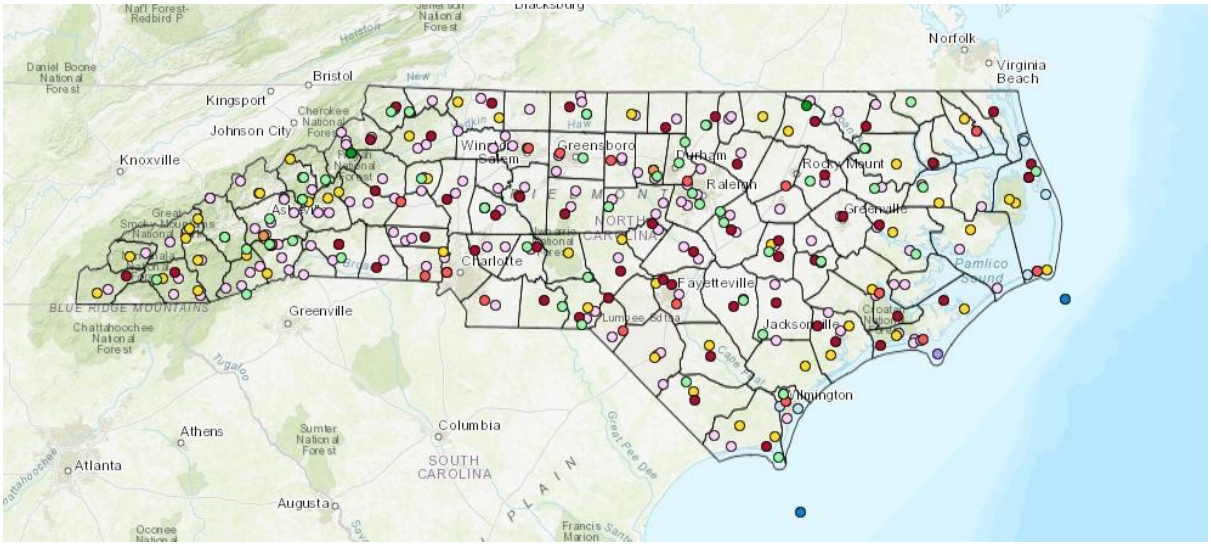
Dataset should be updated by:

Find a means to access the data directly.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, determine hydrology input parameters that can be used in models from other sources.

2.1.33 NCSU Climate Office: Meteorological Data



Dataset Summary Information

Source of Information	NCSU Climate Office
Link to Online Data	https://products.climate.ncsu.edu/data/
Data Owner	NCSU Climate Office
Date Created	1980
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
										X					

Benefits:

Past, current, and future conditions filtered to North Carolina.

Limitations:

Data might be too coarse to use for accuracy, especially in local areas.

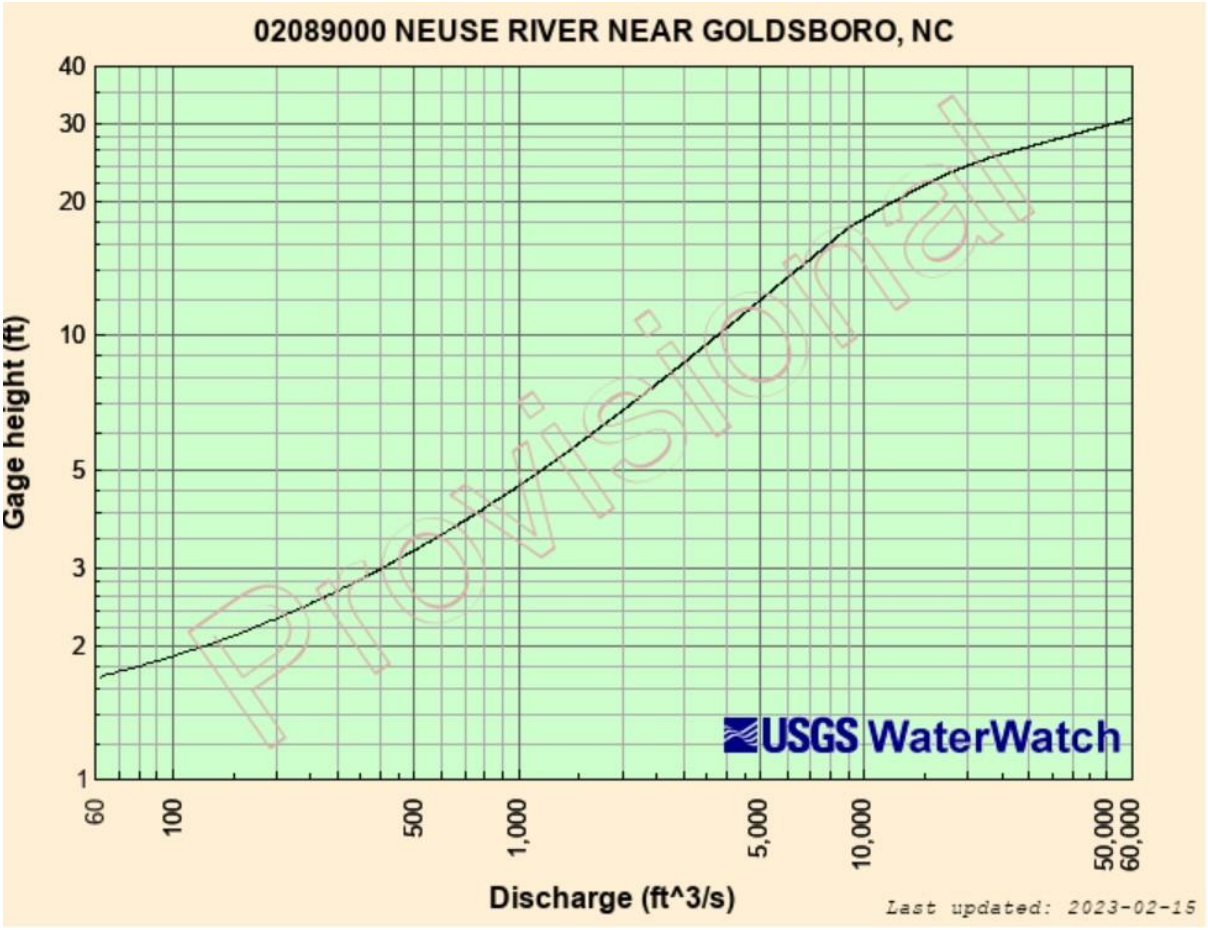
Dataset should be updated by:

Ensure direct access the data through an API when retrieving information.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, use the meteorological data to use as inputs or to perform an analysis.

2.1.34 USGS: Stage-Discharge Rating Curves



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://waterdata.usgs.gov/nwisweb/get_ratings?file_type=exsa&site_no=03451500 *This URL is for a specific stream gauge. URL must be updated for stream gauge of interest. All data not available at a single URL.
Data Owner	USGS
Date Created	Not defined, as availability of rating curves vary by periods of records among stream gauges
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial

Dataset Event Frequencies:

N/A

Benefits:

Real measurements to verify models. Possibility to reduce expenses to replace survey and modeling structures.

Limitations:

See comments above in gap table; use of rating curve to compute discharge does have limitations as noted; however, there are gauges in NC coastal areas where discharge is computed using direct/real-time velocity measurements.

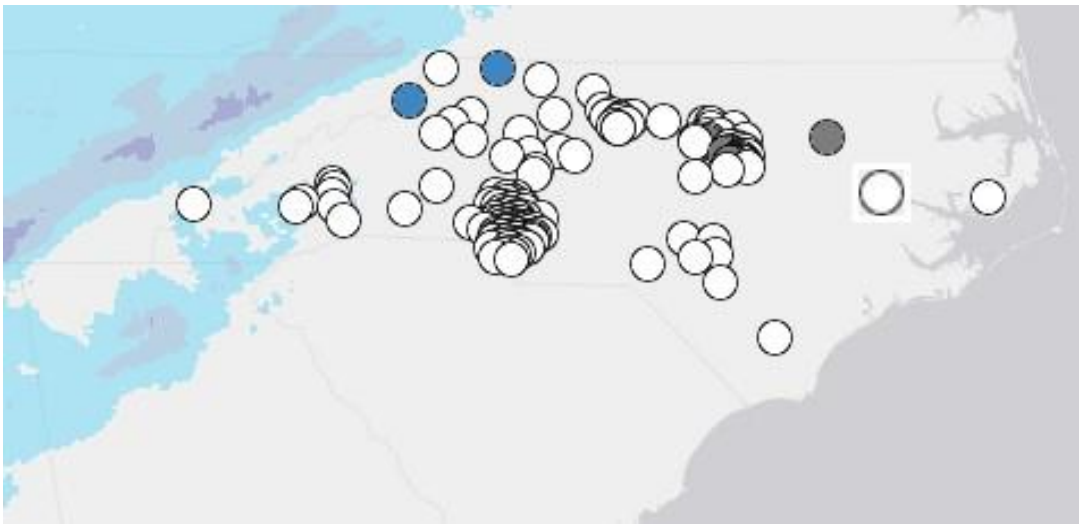
Dataset should be updated by:

Generate a database of rating curves as well as create more from historical information, high water marks, and models. Pilot a project to determine if these can reduce expenses in modeling as a better boundary condition and structure.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: WSEL. To quantify risk, convert WSEL to Flow, for example, FIMAN could apply rating curves to better quantify risk.

2.1.35 USGS: Rain Gauge



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://nc.water.usgs.gov/realtime/rainfall.php
Data Owner	USGS
Date Created	1980s
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Reliable, local data with great coverage for Charlotte and Raleigh. Also contains a high-resolution timestep.

Limitations:

Coverage is limited and concentrated in the major metro areas.

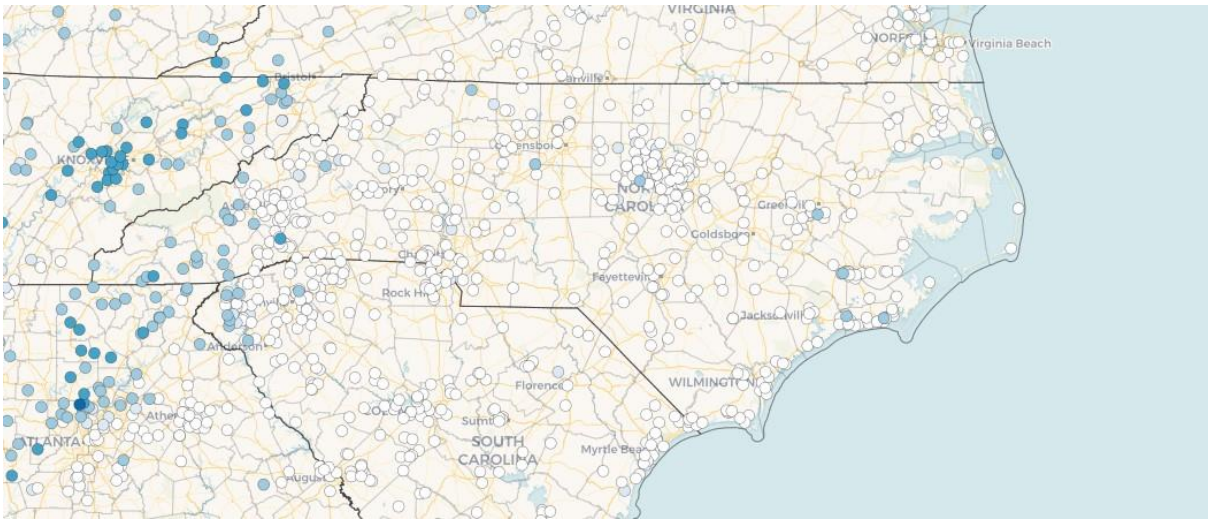
Dataset should be updated by:

Use these data for Charlotte and Raleigh; otherwise, they might only be supplemental for other areas.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.36 CoCoRAS: Rain Gauge



Dataset Summary Information

Source of Information	CoCoRAS
Link to Online Data	https://www.cocorahs.org/
Data Owner	CoCoRAS
Date Created	1998
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Largest amount of gauge stations spread out across the state. Data have high-resolution timesteps.

Limitations:

Most gauge sites are volunteer based and subject to error. Volunteer stations have trended lower in numbers with time. A large effort is required to clean the data before use.

Dataset should be updated by:

Consider an AI tool to clean the data and compare them to other rain gauge data.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.37 NOAA, NASA, etc.: Radar Such as Multi-Radar Multi-Sensor Quantitative Precipitation Estimate

Dataset Summary Information

Source of Information	NOAA, NASA, etc.
Link to Online Data	https://www.hec.usace.army.mil/confluence/hmsdocs/hmsguides/working-with-gridded-boundary-condition-data/gridded-data-sources https://planetarycomputer.microsoft.com/catalog
Data Owner	NOAA, NASA, etc.
Date Created	2006
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Full coverage that can used can be used with only a few intermediary steps.

Limitations:

The 4-kilometer grid or distance between stations might be too coarse.

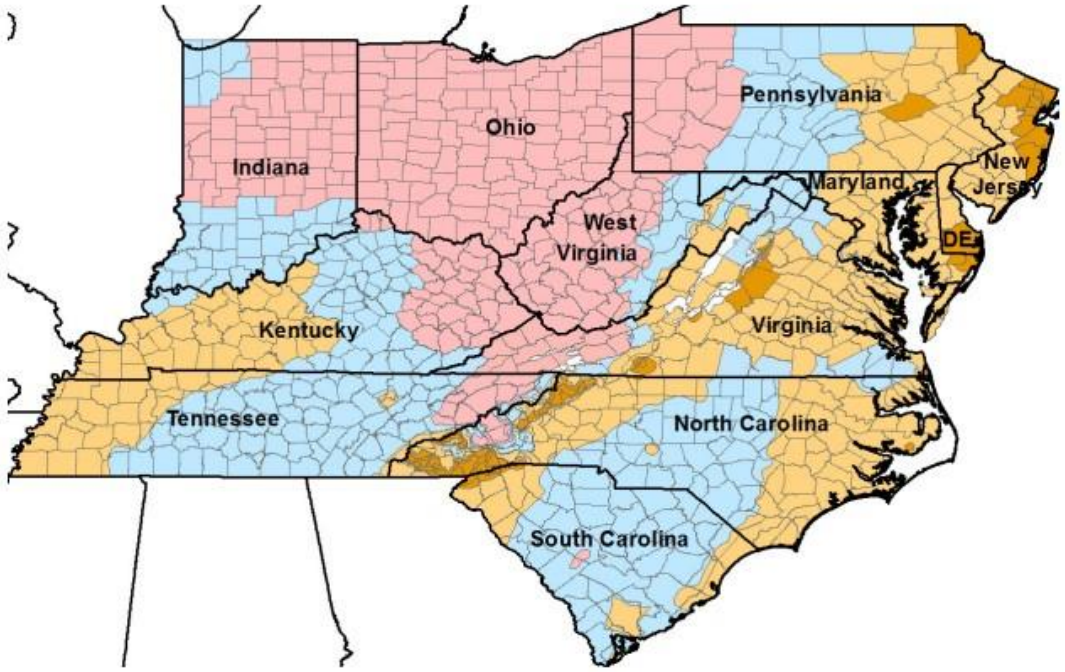
Dataset should be updated by:

Quick-use application. Will need to determine which of the radars best suits the needs of the projects, and research further.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.38 NOAA: Precipitation Frequency Grids



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_gis.html
Data Owner	NOAA
Date Created	2000
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	No
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
x	x	x	x	x	x	x	x	x	x						

Benefits:

Reputable source for rainfall depths nationwide.

Limitations:

Can have jumps in data at borders between regions.

Dataset should be updated by:

Use as the default source for existing rain depths.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

NASA Fluvial, Pluvial, Urban.

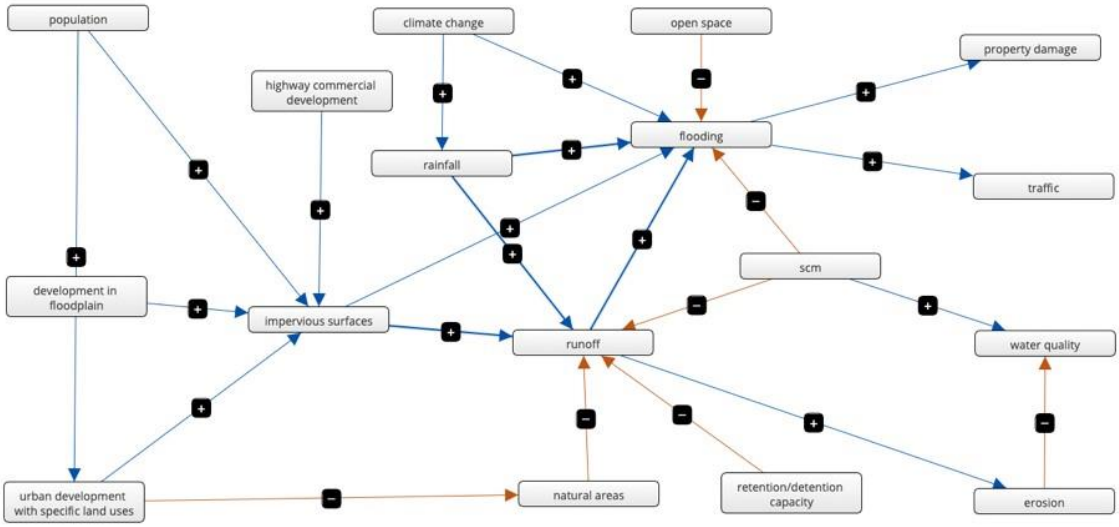
Limitations:

Resolution is coarse.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.39 Greater Raleigh Region: TomorrowNow



Dataset Summary Information

Source of Information	Greater Raleigh Region
Link to Online Data	TomorrowNow | Center for Geospatial Analytics (ncsu.edu)
Data Owner	Greater Raleigh Region
Date Created	2018
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
										X					

Benefits:

"Collaborative project led by four universities in North Carolina focused on developing a serious game that can help a greater number, and a greater diversity, of people affect decisions that impact the places where they live and work." –Tomorrow Now website

Limitations:

Uncertainty on how active and organized the group is.

Dataset should be updated by:

Reach out to them to appoint a stakeholder to participate.

Risk Quantifier:

This source cannot be used to quantify existing or future risk.

2.1.40 Public: Citizen Science (Social Media)

Dataset Summary Information

Source of Information	Public
Link to Online Data	Unidentified
Data Owner	Public
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Urban and Stormwater Flooding

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Allows the public to document flooding with evidence through photos and descriptions. This information serves to verify models, identify issues, and help support analysis.

Limitations:

Legal risk and challenges of allowing anyone to upload information and how to analyze it without their direct acknowledgment. Attempts to scrape Twitter feeds have been unsuccessful due to geotags being blocked; however, policy changes with the app could occur in the future.

Dataset should be updated by:

Strongly recommend creating a public input option as well as looking through past social media to create a database of flooding that will provide valuable information outside of other data sources. AECOM (United Kingdom) has an AI system developed to determine flooding extents from images. A challenge with this type of data is the lack of quality control verification.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, First Floor Elevations (FFE), Building Attributes, and Transportation Attributes (Roads and Bridges). To quantify risk, extract as many quantifying attributes from pictures and text that could be correlated to other sources.

2.1.41 Charlotte's Emerald System: Stormwater Complaints

Dataset Summary Information

Source of Information	Charlotte's Emerald System
Link to Online Data	https://charlottenc.gov/StormWater/ReportAProblem/Pages/default.aspx
Data Owner	City of Charlotte
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Continually identifies problematic areas and gets the community involved.

Limitations:

No statewide program, and many municipalities do not offer such a service.

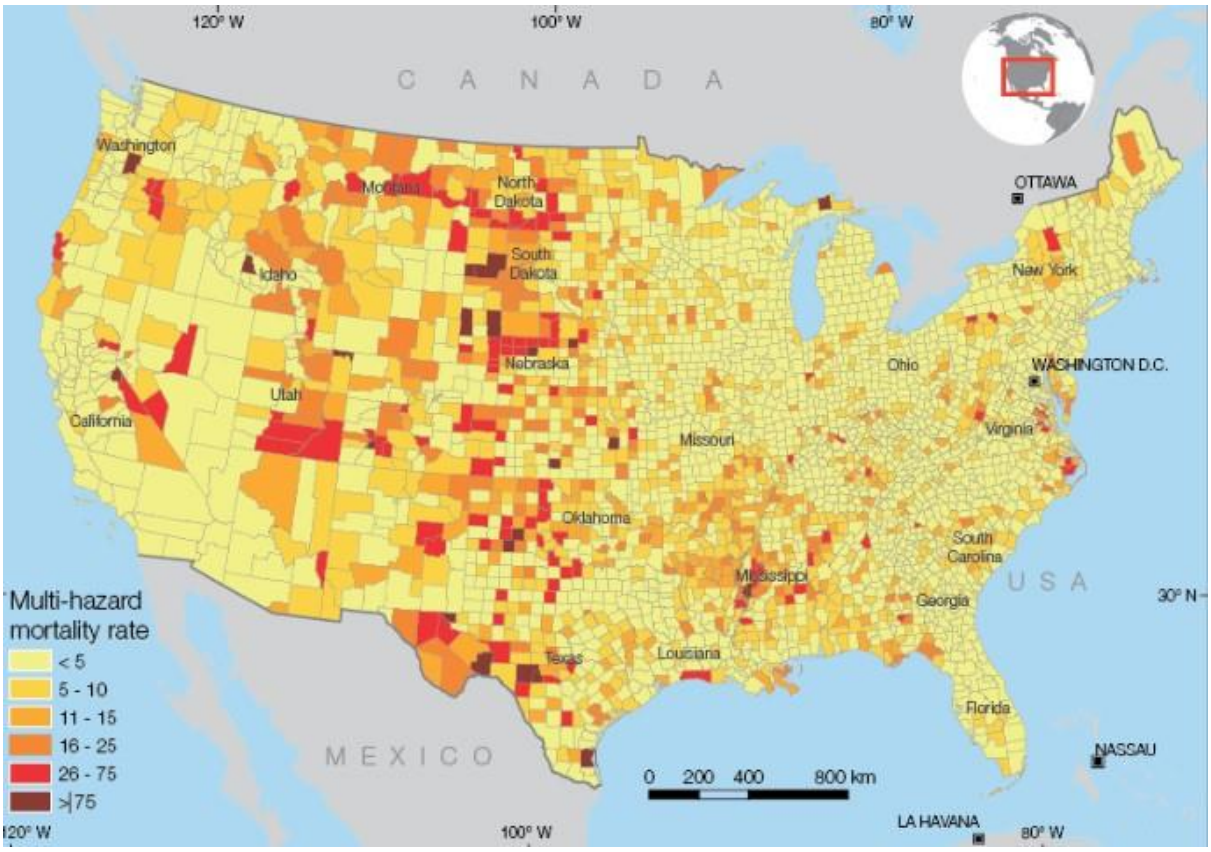
Dataset should be updated by:

Either assist smaller municipalities to create a system or implement a statewide system. Compile and standardize systems.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the location of historical flooding hot spots. Would need additional investigation or information to quantify risk.

2.1.42 Hazards and Vulnerability Research Institute at the University of South Carolina: Incidents and Fatalities



Dataset Summary Information

Source of Information	Hazards and Vulnerability Research Institute at the University of South Carolina
Link to Online Data	https://cemhs.asu.edu/sheldus
Data Owner	Hazards and Vulnerability Research Institute at the University of South Carolina
Date Created	2023
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Assess subscription model
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Large database with many fields.

Limitations:

Appears to need a paid subscription.

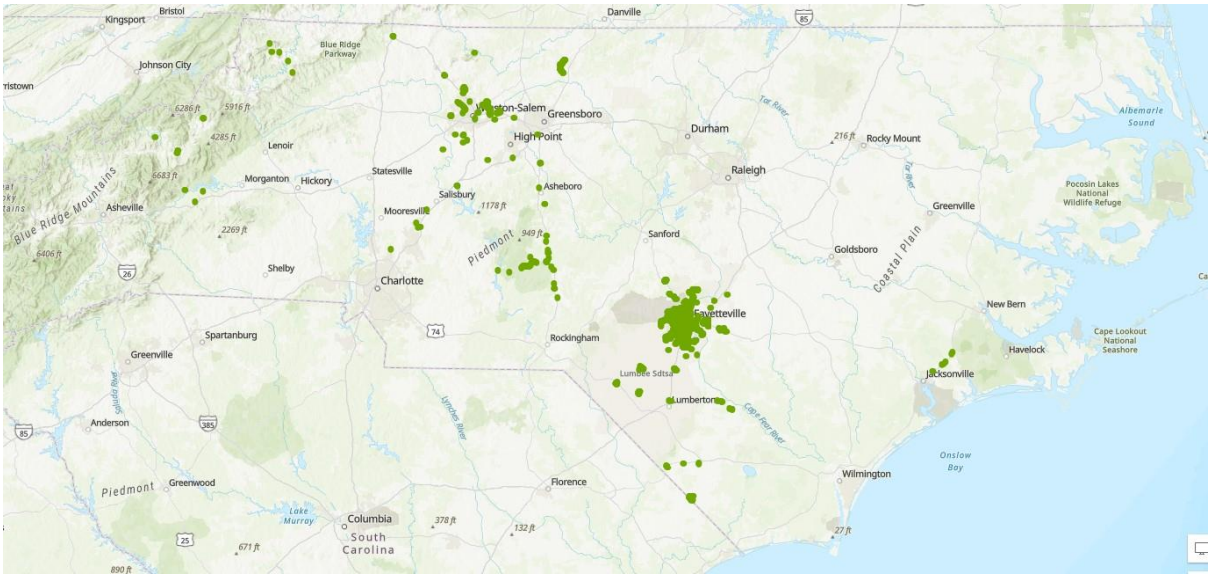
Dataset should be updated by:

Look into source further to identify if it would be useful and worth the subscription.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the location of historical flooding hot spots. Would need additional investigation or information to quantify risk.

2.1.43 NCDOT: NCDOT Stormwater Asset Inventories, Policies, and Maintenance Plans



Dataset Summary Information

Source of Information	NCDOT Stormwater Asset Inventories, Policies, and Maintenance Plans
Link to Online Data	https://connect.ncdot.gov/resources/hydro/DrainageStudiesGuidelines/2022 percent20Guidelines percent20for percent20Drainage percent20Studies percent20and percent20Hydraulic percent20Design.pdf https://connect.ncdot.gov/resources/roadside/EnvironmentalOperationsDocuments/Stormwater percent20Control percent20Inspection percent20and percent20Maintenance percent20Manual.pdf https://www.arcgis.com/apps/mapviewer/index.html?layers=1bc2689221d34cb284b8ce30a3fc493f
Data Owner	NCDOT
Date Created	1979
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x											

Benefits:

Best available data for helping identify potential issues and mitigation solutions for urban flooding and flash flooding. Data can be used to identify potential issues with capacity, maintenance, or aging assets that results in urban flash flooding. Also helps to refine drainage basin delineations.

Limitations:

Uncertain methodology in application of stormwater systems in Hydrologic Engineering Center's River Analysis System (HEC-RAS). It is expected that many drains, canals, pipes, and outlets are clogged and damaged if not well maintained. The designed system may be less effective, and a safety factor may be needed.

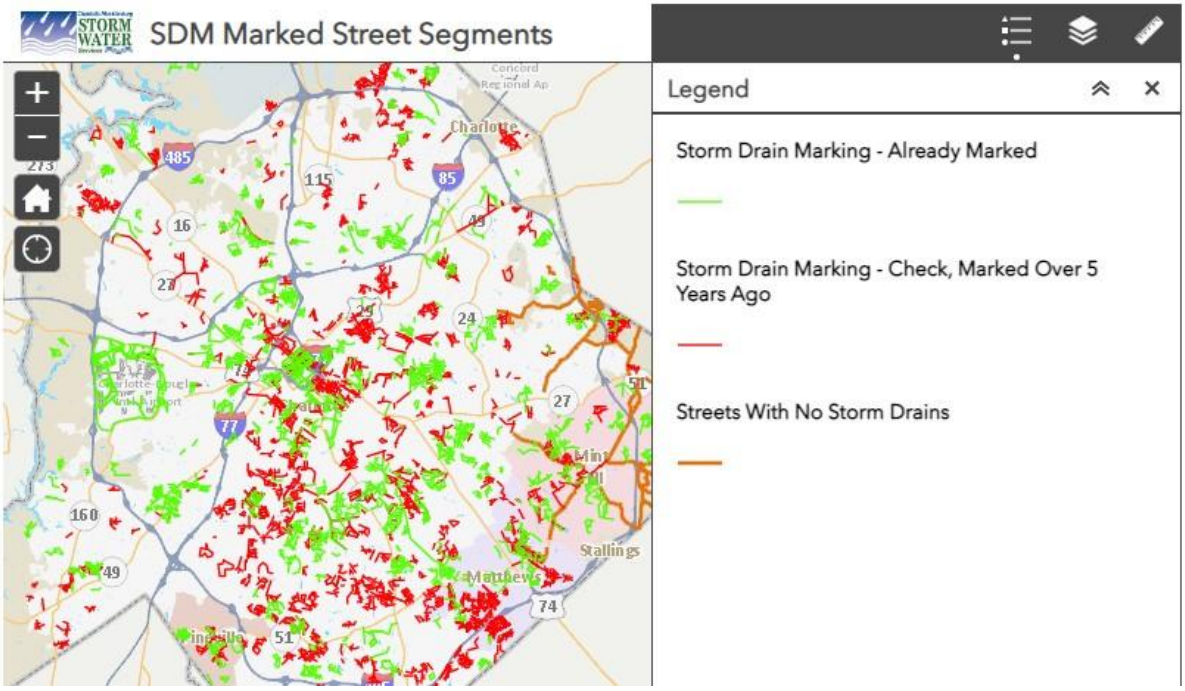
Dataset should be updated by:

Continue investigation into other municipalities to determine all that have stormwater asset inventories. Obtain available inventories. Assess each dataset for completeness and recency of update. Where data are deemed reliable, develop a layer to use in 2D models to account for these structures. Develop modeling for stakeholder-identified hot spots using up-to-date rainfall and hydrology information and field or survey data of infrastructure.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), and Hydrology. To quantify risk, determine capacity and limit of stormwater drainage systems.

2.1.44 Local Governments: Large Municipality (Population>100k) Stormwater Asset Inventories, Policies, Capital Improvement Plan, and Maintenance Plans



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	Various
Data Owner	Local Governments
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x							x			x	

Benefits:

Best available data for helping identify potential issues and mitigation solutions for urban flooding and flash flooding. Data can be used to identify potential issues with capacity, maintenance, or aging assets that results in urban flash flooding. Also helps to refine drainage basin delineations.

Limitations:

Some communities likely do not have a comprehensive inventory. In addition to communities lacking a comprehensive inventory, accuracy could also be a problem. Many data providers are unwilling to share data for security reasons, although of all infrastructure, they seem to be more willing to share stormwater data.

Any available modeling may be unavailable or outdated. Modeling likely would not account for climate adaptation considerations.

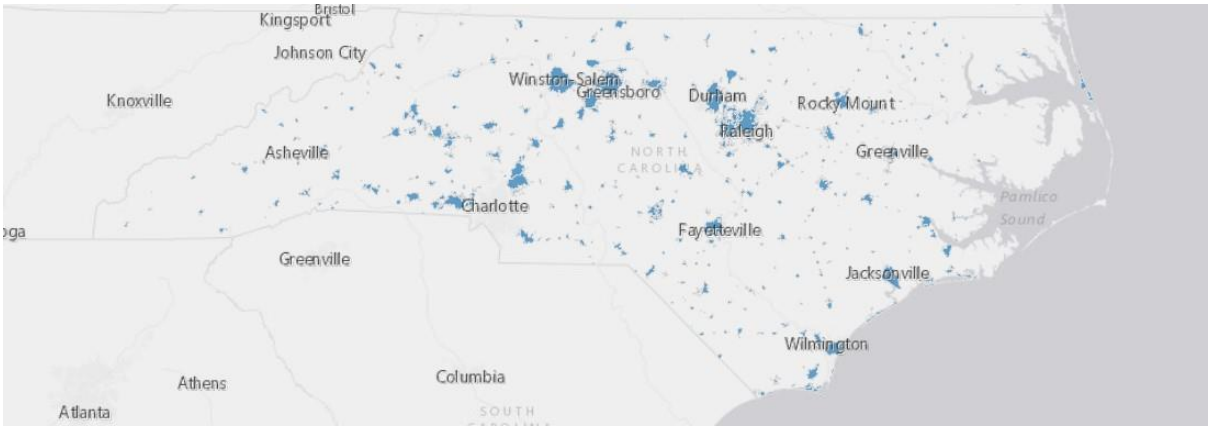
Dataset should be updated by:

Compile all useful information from each community and engage activity.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), and Hydrology. To quantify risk, determine capacity and limit of stormwater drainage systems.

2.1.45 Local Governments: Small Municipality (Population<100k) Municipal Stormwater Asset Inventories, Policies, and CIP Maintenance Plans



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	https://data-nconemap.opendata.arcgis.com/datasets/nconemap::public-municipal-stormwater-systems/explore?location=35.957309 percent2C-79.902965 percent2C11.29https://data-nconemap.opendata.arcgis.com/datasets/nconemap::public-municipal-stormwater-systems/explore?location=35.957309 percent2C-79.902965 percent2C11.29
Data Owner	Local Governments
Date Created	Various
Date of Access	February 2023
Frequency of Updates	No updates since 2007
Updates Needed	Yes
Type of Flooding	Urban

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
	x	x	x	x							x			x	

Benefits:

Best available data for helping identify potential issues and mitigation solutions for urban flooding and flash flooding. Data can be used to identify potential issues with capacity, maintenance, or aging assets that results in urban flash flooding. Also helps to refine drainage basin delineations.

Limitations:

Smaller communities likely do not have a comprehensive inventory. Any modeling may be unavailable or outdated. In addition, modeling likely would not account for climate adaptation considerations.

Dataset should be updated by:

Data are likely obsolete, and a new dataset would need to be developed.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), and Hydrology. To quantify risk, determine capacity and limit of stormwater drainage systems.

2.1.46 NOAA: Flash Flood

Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://www.weather.gov/media/rah/science/SAWC2022_Kren_EnhancedFlashFloodClimatology.pdf
Data Owner	NOAA
Date Created	2000
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Flash Flooding

Dataset Event Frequencies:

N/A

Dataset should be updated by:

No known source or methodology. Would need to determine how to address flash flooding, especially in the west where the orographic effect occurs.

Benefits:

Potentially could reduce human deaths, which often occur with flash flooding.

Limitations:

Database not found, methodology unknown, many other unknowns.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.47 Unidentified: Debris Jam

Dataset Summary Information

Source of Information	Unidentified
Link to Online Data	Unidentified
Data Owner	Unidentified
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban, Flash Flooding

Dataset Event Frequencies:

N/A

Benefits:

Identify hazard from a debris jam.

Limitations:

Data do not exist, and this type of hazard may be too erratic to model.

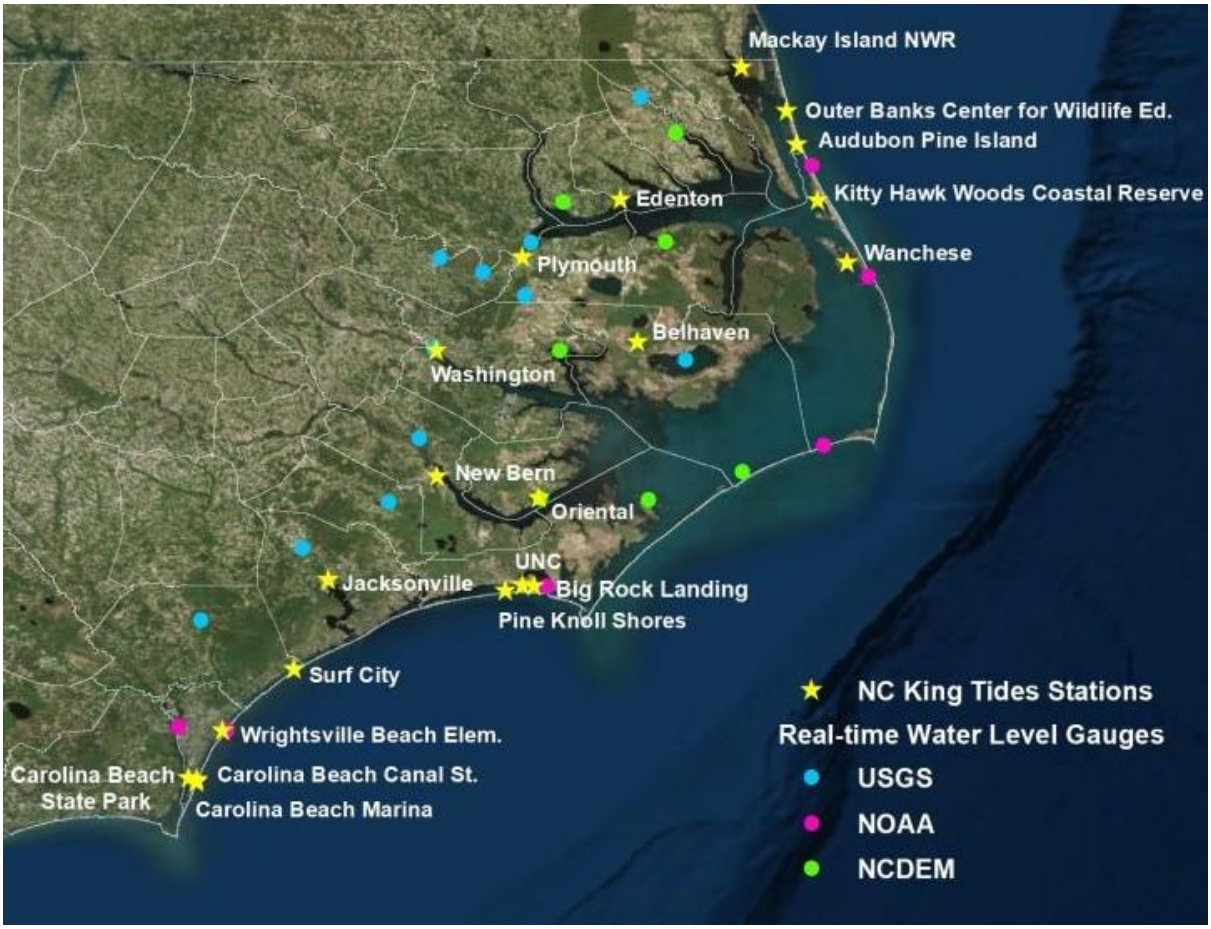
Dataset should be updated by:

No source identified for North Carolina; consider creating one or modifying existing studies to account for jams in prone areas.

Risk Quantifier:

This source cannot be used to quantify existing or future risk using Environmental Attributes. The process to quantify risk is currently unknown.

2.1.48 UNC: King Tides Project



Dataset Summary Information

Source of Information	UNC
Link to Online Data	https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=8e4a278576964f47b4fc050e51f344ca https://nckingtides.web.unc.edu/whats-your-water-level-app-data-download/
Data Owner	UNC
Date Created	2017
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Citizen-supplied photo documentation of high water marks, especially coastal tides.

Limitations:

Would need a method to quantify photo and information provided.

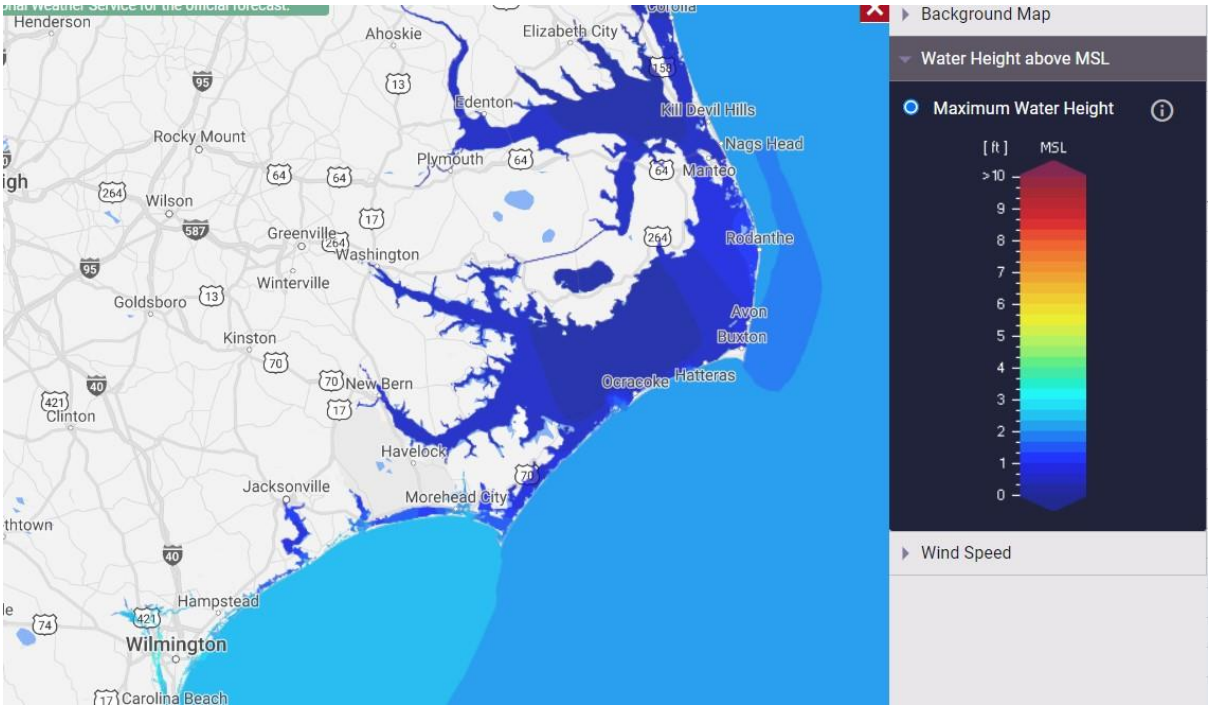
Dataset should be updated by:

Combine this with the citizen science database layer.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: WSEL, Real Time, and Hydrology. To quantify risk, determine risk probabilities that can be applied to models from other sources.

2.1.49 Coastal Emergency Risks Assessment: Hurricane Surge Forecast



Dataset Summary Information

Source of Information	Coastal Emergency Risks Assessment (CERA)
Link to Online Data	https://cera.coastalrisk.live/
Data Owner	CERA
Date Created	2020
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

Forecasted surge along coast.

Limitations:

Accuracy unknown, would need additional modeling for inundation boundary.

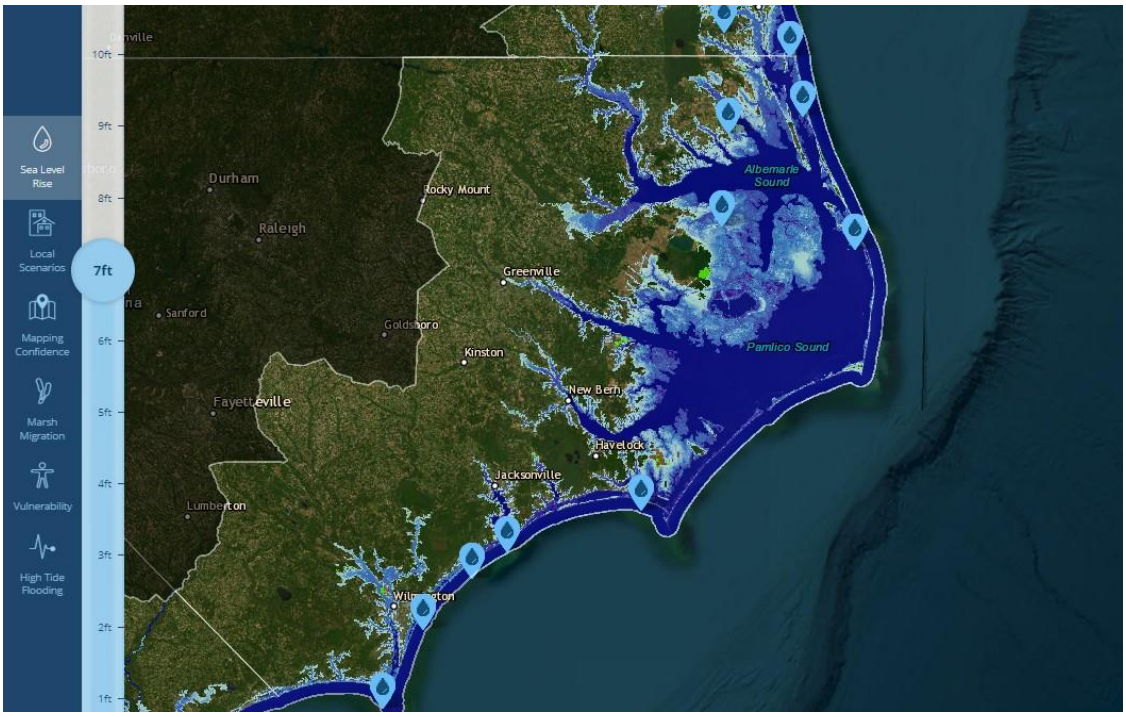
Dataset should be updated by:

Use for forecasting coastal flooding, such as before a hurricane.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Real Time and Hydrology. To quantify risk, determine hydrology input parameters that can be used in forecast models from other sources.

2.1.50 NOAA: Sea Level Rise



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://coast.noaa.gov/slr/#/layer/slr
Data Owner	NOAA
Date Created	2017
Date of Access	February 2023
Frequency of Updates	5-Year cycle
Updates Needed	TBD
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

View the flooding extents and depths from various amounts of sea level rise.

Limitations:

Does not specify which level of sea level rise should be chosen.

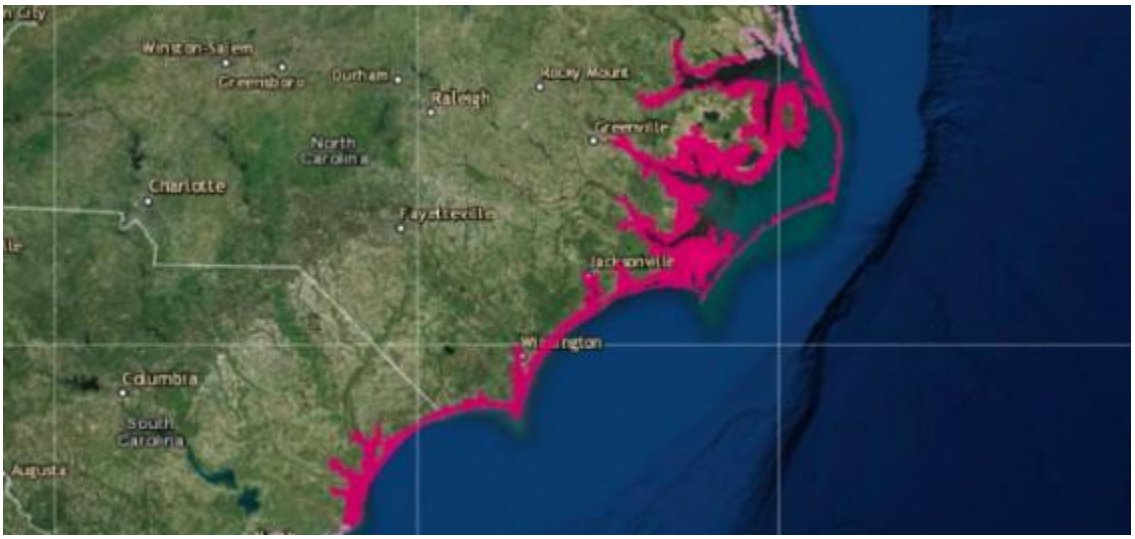
Dataset should be updated by:

Determine an appropriate risk of sea level rise and use this layer.

Risk Quantifier:

This source can be a future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.1.51 NOAA: Potential Storm Surge



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://www.nhc.noaa.gov/nationalsurge/ https://slosh.nws.noaa.gov/psurge/index.php?R=CONUS&S=Lee2023&Adv=37&Ty=e10&D=agl&Ti=cum&Msg=17&Mp=Street&Z=5&Lt=34.505242&Lg=-78.813606&Help=about
Data Owner	NOAA
Date Created	March 2020
Date of Access	February 2023
Frequency of Updates	10 Minutes
Updates Needed	Yes – link outdated
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
															x

Benefits:

View potential coastal flood information.

Limitations:

Quality uncertain.

Dataset should be updated by:

Locate the data because they are missing.

Risk Quantifier:

This source can be a future risk quantifier using the following factors: Inundation Boundary, WSEL, Forecasting, and Hydrology. To quantify risk, determine future storm surge.

2.1.52 NOAA: Event-Specific Storm Surge

Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://data-nconemap.opendata.arcgis.com/maps/noaa-event-specific-hurricane-storm-surge-inundation-areas/explore?location=30.720923 percent2C-75.064809 percent2C6.60
Data Owner	NOAA
Date Created	March 2020
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	Yes – link outdated
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

View historic coastal flood information.

Limitations:

Quality uncertain.

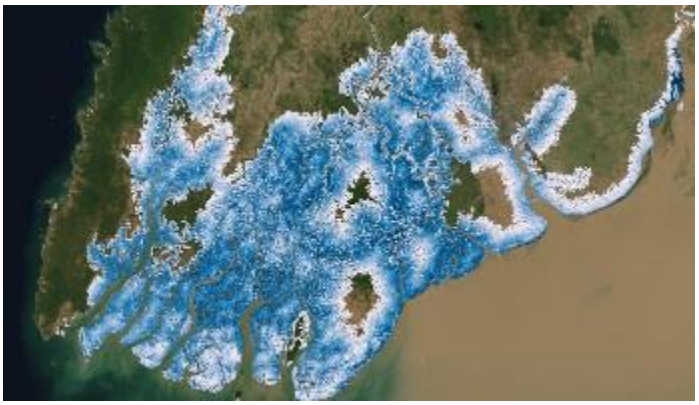
Dataset should be updated by:

Locate the data because they are missing.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, and Hydrology. To quantify risk, determine historic storm surge.

2.1.53 Delta res: Global Flood Maps



Dataset Summary Information

Source of Information	Deltares
Link to Online Data	TBD
Data Owner	Deltares
Date Created	1970
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Coastal

Dataset Event Frequencies:

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Model that is triggered by extreme water levels containing surge and tide from GTSMip6 that considers water level attenuation and is forced by sea level.

Limitations:

In its current version, the model does not account for varying roughness over land and permanent water bodies such as rivers and lakes, and it does not account for the compound effects of waves, rainfall, and river discharge on coastal flooding. It also does not include the mitigating effect of coastal flood protection. Flood extent therefore must be interpreted as the area that is potentially exposed to flooding without coastal protection.

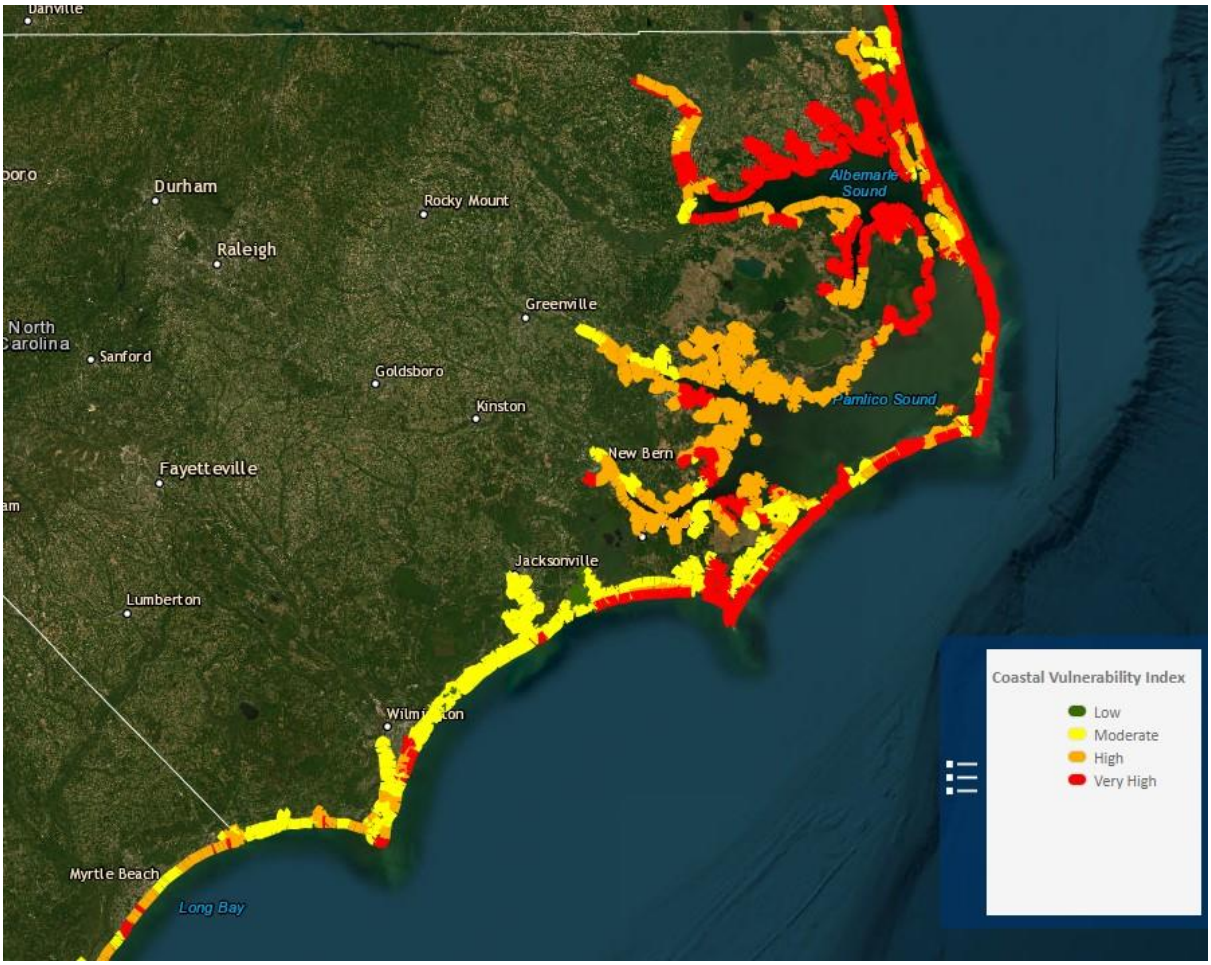
Dataset should be updated by:

Locate the source and determine if coverage is available in North Carolina.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, and Real Time. To quantify risk, use real-time inundation extents and WSEL.

2.1.54 USGS: Coastal Change Hazards Portal



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://marine.usgs.gov/coastalchangehazardsportal/ https://cmgds.marine.usgs.gov/data-releases/datarelease/10.5066-P9W91314/
Data Owner	USGS
Date Created	Various
Date of Access	February 2023
Frequency of Updates	Various
Updates Needed	
Type of Flooding	Coastal

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Multiple analyses of how the coastline has changed, is changing, and will change.

Limitations:

Accuracy has not been determined.

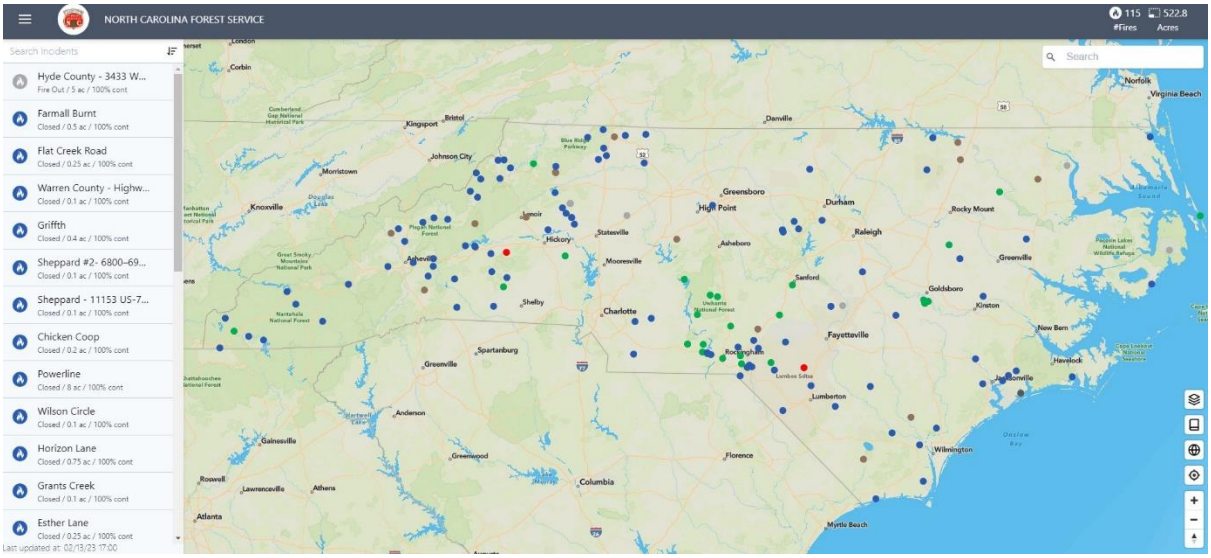
Dataset should be updated by:

Consider using the data to predict future coastline changes.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Environmental Attributes. To quantify risk, determine how the coastline has and will change as input for models.

2.1.55 NCFS, NASA, NCSU, Climate Mapping for Resilience and Adaptation and Google: Wildfire



Dataset Summary Information

Source of Information	NCFS, NCSU, Climate Mapping for Resilience and Adaptation (CMRA), NASA, and Google
Link to Online Data	https://ncfspublic.firesponse.com/ percent0a https://firms.modaps.eosdis.nasa.gov/map/ https://legacy.climate.ncsu.edu/fwip/ percent0a https://resilience.climate.gov/#open-data
Data Owner	NCFS, NCSU, CMRA, NASA, and Google
Date Created	2017
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	No
Type of Flooding	Natural Disasters

Dataset Event Frequencies:

N/A

Benefits:

Real-time wildfire data are available from dozens of sources. Data can be used to identify areas where additional analysis due to land use/land cover change may be needed.

Limitations:

Not a direct input for any evaluated flooding type.

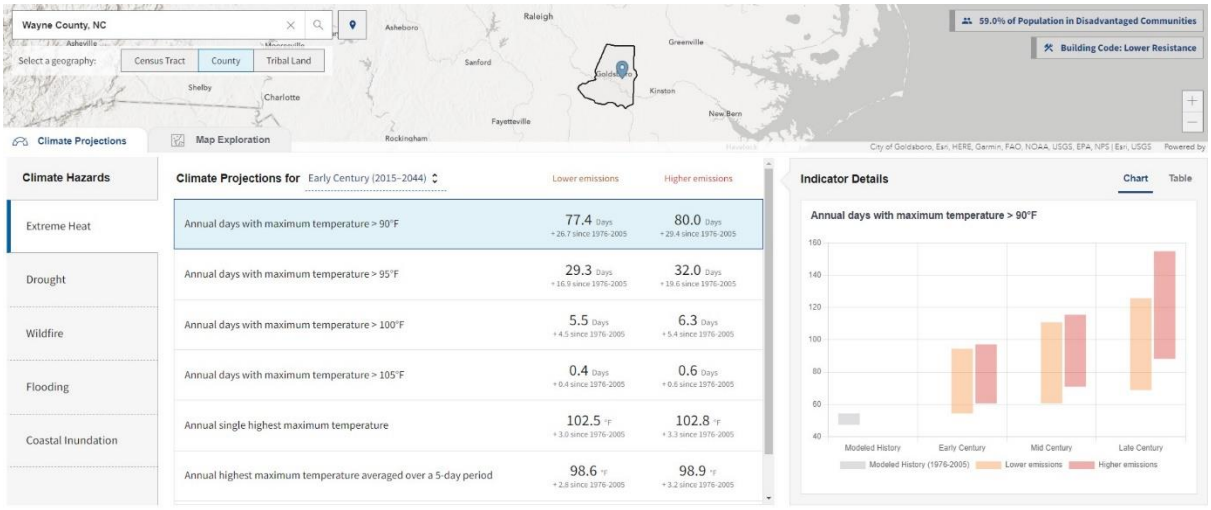
Dataset should be updated by:

Recommend using and automatically updating appropriate models to account for change, or at least account for wildfire scenarios in prone areas.

Risk Quantifier:

This source could be used to support calculation of existing or future risk scenarios due to changes in hydrology.

2.1.56 Climate Mapping for Resilience and Adaptation: Historical and Future Drought



Dataset Summary Information

Source of Information	Climate Mapping for Resilience and Adaptation (CMRA)
Link to Online Data	https://resilience.climate.gov/#open-data
Data Owner	CMRA
Date Created	August 2022
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Natural Disasters

Dataset Event Frequencies:

N/A

Benefits:

Historical and future drought information.

Limitations:

Coarse broad information.

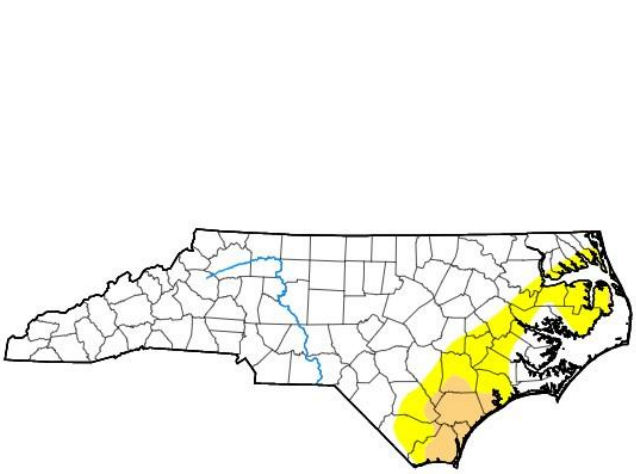
Dataset should be updated by:

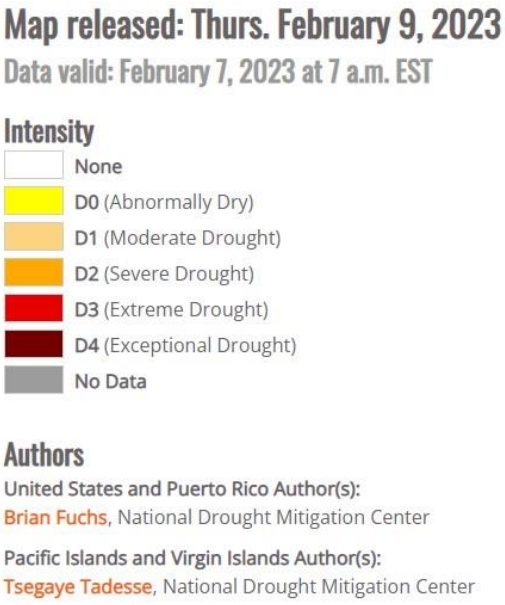
Recommend using and automatically updating appropriate models to account for changes, or at least account for drought scenarios in prone areas.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Real Time and Hydrology. To quantify risk, determine hydrology input parameters that can be used in models from other sources.

2.1.57 National Drought Mitigation Center: Real-Time Drought





Dataset Summary Information

Source of Information	National Drought Mitigation Center
Link to Online Data	https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?NC
Data Owner	National Drought Mitigation Center
Date Created	January 2000
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Natural Disasters

Dataset Event Frequencies:

N/A

Benefits:

Real-time drought.

Limitations:

Coarse broad information.

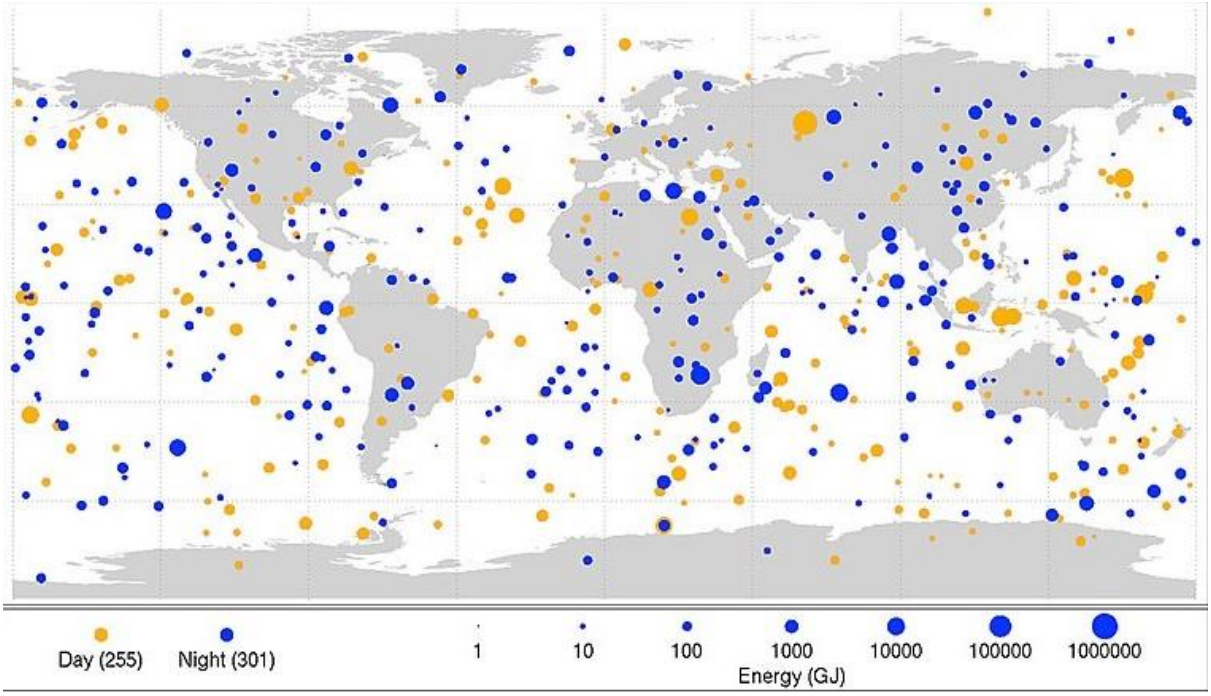
Dataset should be updated by:

Recommend using and automatically updating appropriate models to account for change, or at least to account for drought scenarios in prone areas.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Real Time and Hydrology. To quantify risk, determine hydrology input parameters that can be used in models from other sources.

2.1.58 NASA: Meteor



Dataset Summary Information

Source of Information	NASA
Link to Online Data	https://www.jpl.nasa.gov/asteroid-watch
Data Owner	NASA
Date Created	January 1998
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Natural Disasters

Dataset Event Frequencies:

N/A

Benefits:

Identifies meteors that have hit earth or could hit earth in the future. An impact could start a flood from the splash, the destruction of a dam, or altering the terrain.

Limitations:

This is an extreme case that would be too difficult and expensive to determine the impact.

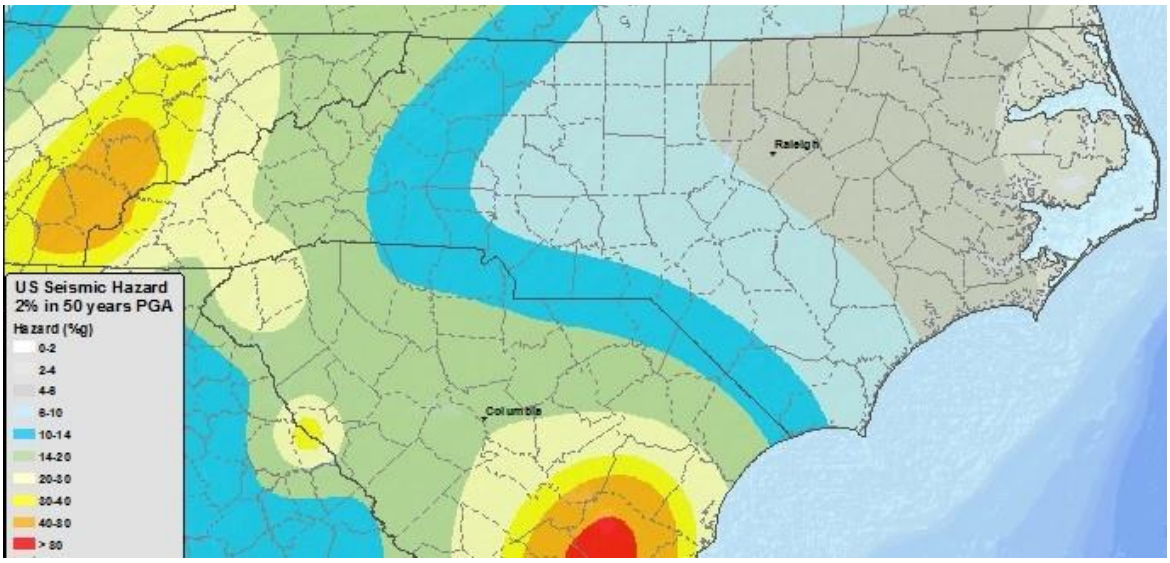
Dataset should be updated by:

This is an extreme case that would be too difficult and expensive to determine the impact.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.1.59 USGS: Earthquake



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://www.usgs.gov/media/images/2014-seismic-hazard-map-north-carolina
Data Owner	USGS
Date Created	2014
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	N/A
Type of Flooding	Natural Disasters

Dataset Event Frequencies:

N/A

Benefits:

Identifies the seismic hazard that primarily could cause a dam failure.

Limitations:

This is an extreme case that would be too difficult and expense to determine the impact.

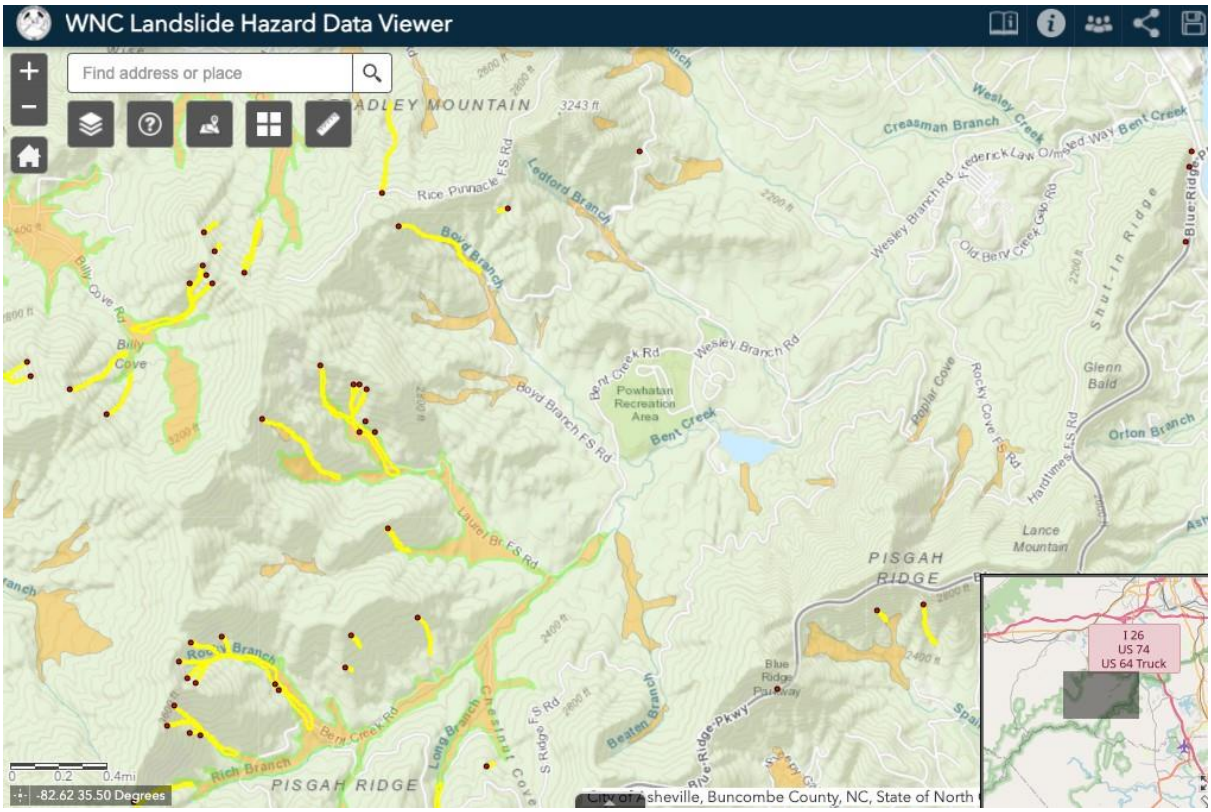
Dataset should be updated by:

This is an extreme case that would be too difficult and expense to determine the impact.

Risk Quantifier:

The following source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.1.60 NCGS: Landslide



Dataset Summary Information

Source of Information	NCGS
Link to Online Data	https://unca.maps.arcgis.com/apps/webappviewer/index.html?id=e9f79de934f24e40a71bab8db8050612/
Data Owner	NCGS
Date Created	2005
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Natural Disasters

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Identify potential and historical landslide areas, especially in western NC.

Limitations:

Project is in progress with many counties yet to be done.

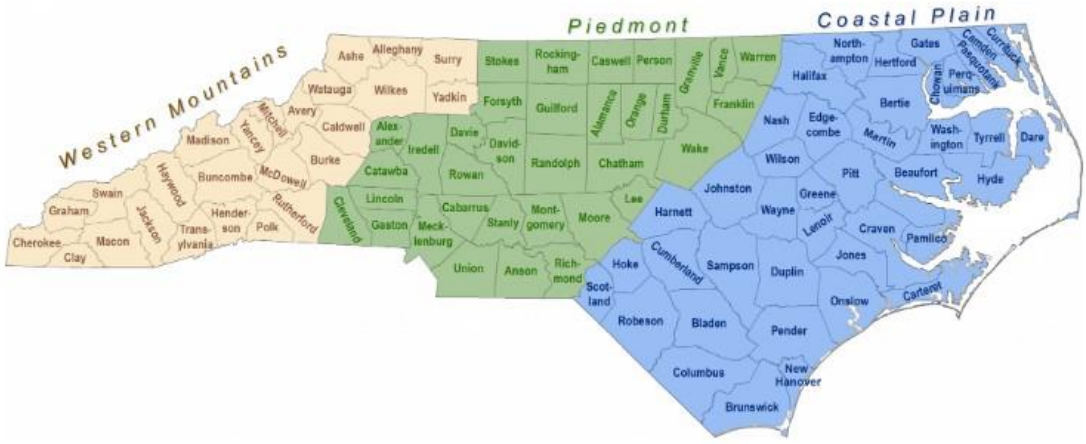
Dataset should be updated by:

Overlap data with building footprints and other critical infrastructure to ensure the threat is not imminent. Perhaps modify to use as avalanche layer.

Risk Quantifier:

The following source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.1.61 Climate Reports (Multiple)



Dataset Summary Information

Source of Information	Fourth National Climate Assessment The Climate Explorer State Climate Summaries NC Climate Science Report
Link to Online Data	North Carolina Climate Science Report: North Carolina Institute for Climate Studies (ncics.org)
Data Owner	Multiple
Date Created	2020
Date of Access	March 2023
Frequency of Updates	Sporadic
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Dataset should be updated by:

Data may be useful for future hydraulic modeling.

Benefits:

Data focus on long-term climate patterns and future climate repercussions.

Limitations:

Uncertainty in future climate.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine hydrology input parameters that can be used in models from other sources.

2.2 Foundational Datasets

There are 11 datasets that have been identified, reviewed, and classified as foundational datasets for use in the Blueprint. Of the 11 total foundational datasets, 8 are classified as essential, and 3 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-2.

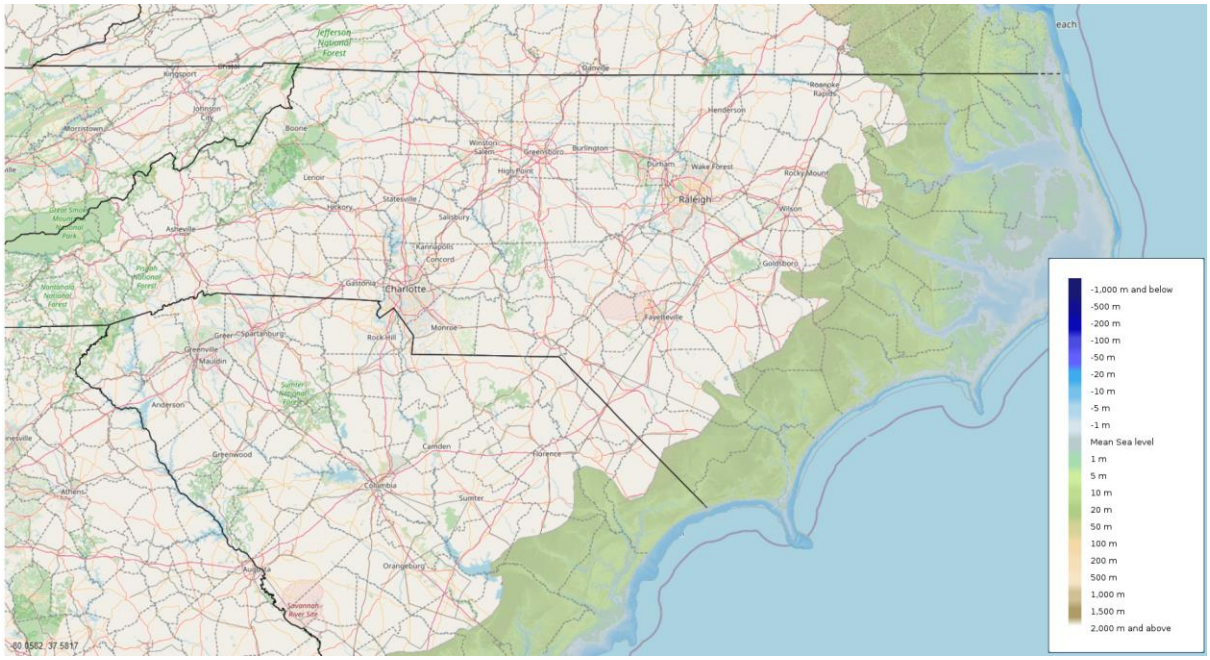
Table 2-2: Foundational Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
USGS: Coastal National Elevation Database (CoNED)	F, C	9	9	8	8	N/A
USGS 3D Elevation Program	F, C	10	8	8	8	N/A
NCEM: Terrain Data	NFS	10	10	10	8	N/A
NOAA: Coastal Topographic LiDAR	NFS	10	10	10	8	N/A
NCEM and NCDOT: Survey Data	NFS	6	6	10	8	10
NCDOT: Transportation	NFS	6	8	6	8	10
NC Center for Geographic Information and Analysis: Political Boundaries	NFS	10	8	10	8	8
Local Governments: Zoning	NFS	4	4	4	TBD	TBD

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
NOAA: Bathymetry	F, C	4	6	6	6	N/A
USACE: Bathymetry	F, C	4	6	6	6	8
USGS: Hydrography	F, P	TBD	TBD	TBD	TBD	TBD

N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding, A&M; Mining Flooding, A&M; Natural Disasters , ND; Non-Flooding Source, NFS; All Types of Flooding, ALL

2.2.1 USGS: Coastal National Elevation Database (CoNED)



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://www.usgs.gov/special-topics/coastal-national-elevation-database-applications-project
Data Owner	USGS
Date Created	2016
Date of Access	August, 2023
Frequency of Updates	8-year nationwide LiDAR acquisition planning cycle
Updates Needed	Yes
Type of Flooding	Fluvial, Coastal

Dataset Event Frequencies:

N/A

Benefits:

High-resolution elevation data have applications to coastal hazard prediction and mitigation, forest and wetland ecology, and benthic habitat structure and ecosystem function.

Limitations:

Spatial resolution varies from 1 meter to 3 meters. Because this dataset is produced as a combination of various elevation data sources from different time periods, the product may include artifacts and inconsistencies along the near-shore coastal area. This product is hydro-corrected, and most major hydraulic connections have been included for the purposes of flood modeling; however, it should be noted that not every hydraulic connection and water body may be accurately depicted.

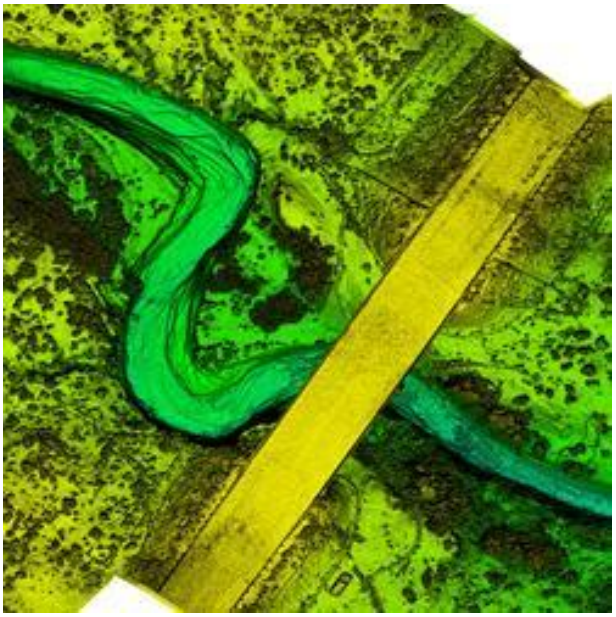
Dataset should be updated by:

USGS aims to collect new LiDAR data over the same areas on an 8-year return cycle. As North Carolina-specific data are updated, the tool will need to reflect these changes.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Hydrologic and Inundation Boundary factors. To quantify risk, apply to other sources such as hydraulic models or inundation hazard zone delineation, which are highly dependent on elevation information.

2.2.2 USGS 3D Elevation Program



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://www.usgs.gov/3d-elevation-program
Data Owner	USGS
Date Created	2016-2023
Date of Access	August, 2023
Frequency of Updates	As needed and 8-year nationwide LiDAR acquisition planning cycle
Updates Needed	Yes
Type of Flooding	Fluvial, Coastal

Dataset Event Frequencies:

N/A

Benefits:

High resolution (1 meter Digital Elevation Models); simple data acquisition contracts and specialized data quality assurances.

Limitations:

Gaps in coverage; gaps in when data were collected between adjacent areas. Spatial resolution and source data and data collection methodology vary between products.

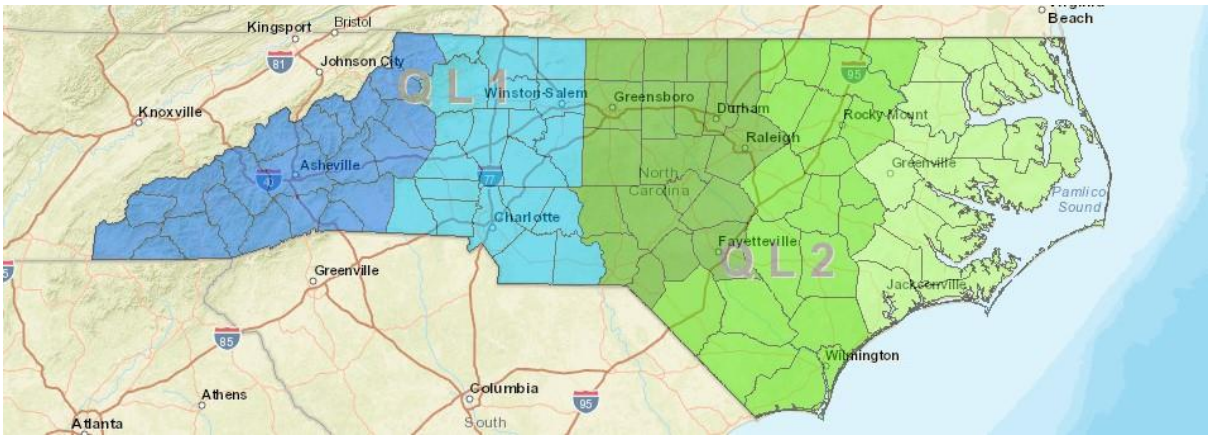
Dataset should be updated by:

USGS aims to collect new LiDAR data over the same areas on an 8-year return cycle. As North Carolina–specific data are updated, the tool will need to reflect these changes.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following variables: Hydrology, Inundation Boundary, Transportation Attributes (Roads and Bridge), Building Attributes, and Environmental Attributes.

2.2.3 NCEM: Terrain Data



Dataset Summary Information

Source of Information	North Carolina Emergency Management
Link to Online Data	https://sdd.nc.gov/
Data Owner	North Carolina Emergency Management
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	Ongoing
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Terrain data are the basis of hydrologic and hydraulic models and establishment of flooding extent. They are used in risk assessments to establish key structural elevations where survey is not available.

Limitations:

Potential for changes due to construction projects, but likely not a major issue. Flood analysis issues outside of LOMR areas. Gaps around military installations.

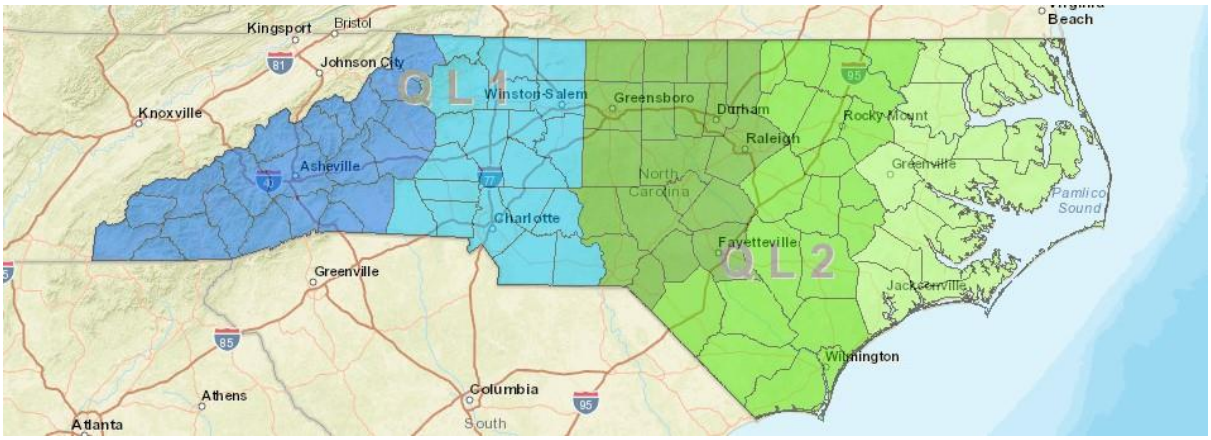
Dataset should be updated by:

Data collection is on a maintenance schedule; LOMR topography may not be included—need to update in tools as appropriate.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Environmental Attributes. To quantify risk, apply to other sources such as hydraulic models or object elevations that are highly dependent on terrain information.

2.2.4 NOAA: Coastal Topographic LiDAR



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	NOAA: Data Access Viewer
Data Owner	NOAA
Date Created	1996 to present
Date of Access	May 2023
Frequency of Updates	Ongoing
Updates Needed	Yes.
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

There may also be specific acquisitions after large storms.

Limitations:

LiDAR data arrive in various forms, which are standardized for storage purposes by format, datum, and projection. Some data are further processed to generate bare-earth products. Errors are removed when possible. Coverage varies from location to location—some areas have multiple years, while others have none. Users should not use the data for critical applications without a full awareness of their limitations. NOAA reviews these data but does not guarantee reported vertical or horizontal accuracies. Survey reports are linked in the metadata where they exist.

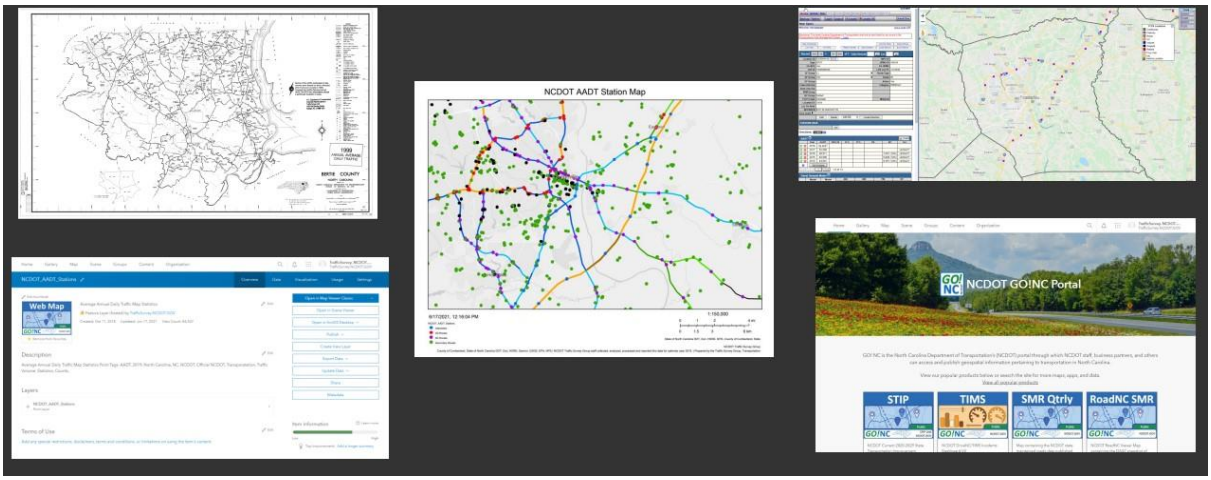
Dataset should be updated by:

N/A

Risk Quantifier:

This dataset can be used as a source in coastal and riverine models with the goal of existing and/or future hazard identification, which can be used to determine risk.

2.2.5 NCEM and NCDOT: Survey Data



Dataset Summary Information

Source of Information	NCEM and NCDOT
Link to Online Data	https://connect.ncdot.gov/resources/gis/pages/gis-data-layers.aspx
Data Owner	NCEM and NCDOT
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Survey data are used to support modeling, risk assessments, and verify existing data. These are best available data for structures or hydraulic assets and should be used for detailed modeling and alternatives analyses.

Limitations:

Age of data results in exclusion of new structures or changing terrain near water.

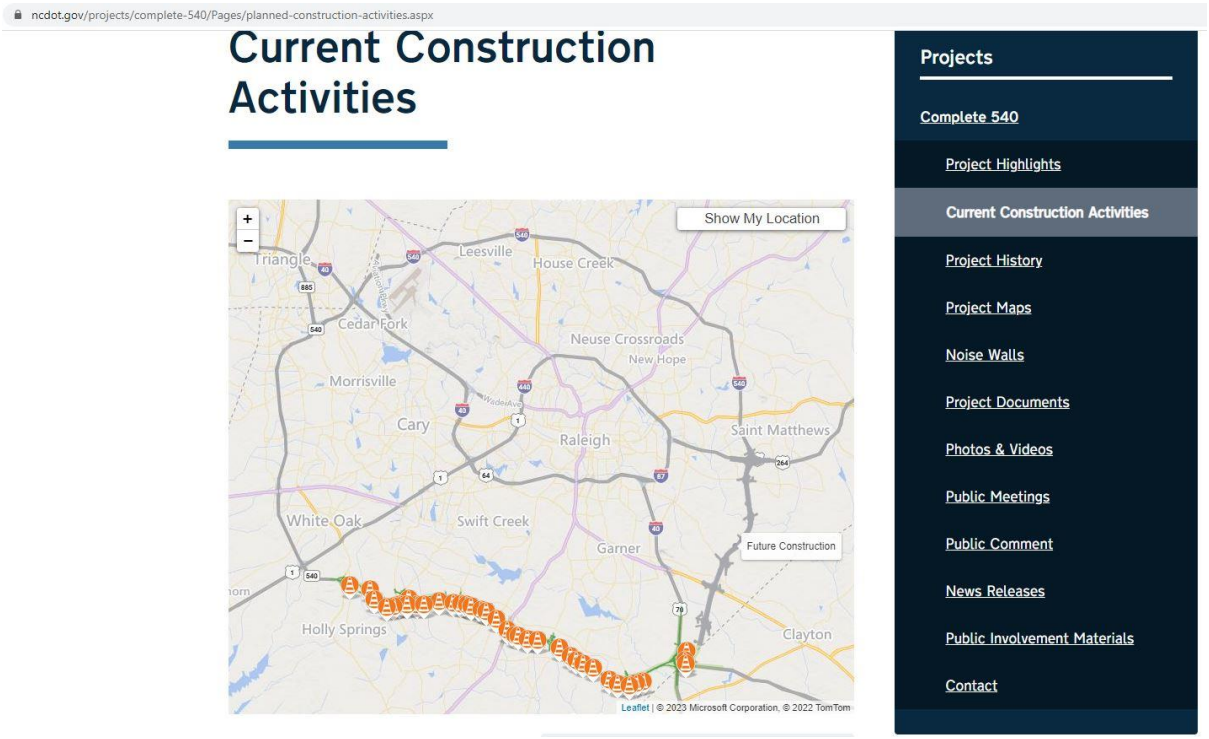
Dataset should be updated by:

Collect new data as appropriate in areas identified for potential mitigation projects.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Transportation Attributes (Roads and Bridges). To quantify risk, set thresholds of when bridges, roads, and other structures are inundated, and use to calculate costs. Also improves the accuracy of models.

2.2.6 NCDOT: Transportation



Dataset Summary Information

Source of Information	NCDOT
Link to Online Data	https://www.ncdot.gov/projects/complete-540/Pages/planned-construction-activities.aspx
Data Owner	NCDOT
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Data are used to develop hydraulic modeling and perform risk assessments on transportation assets.

Limitations:

Datasets may need updates based on current and planned construction activities.

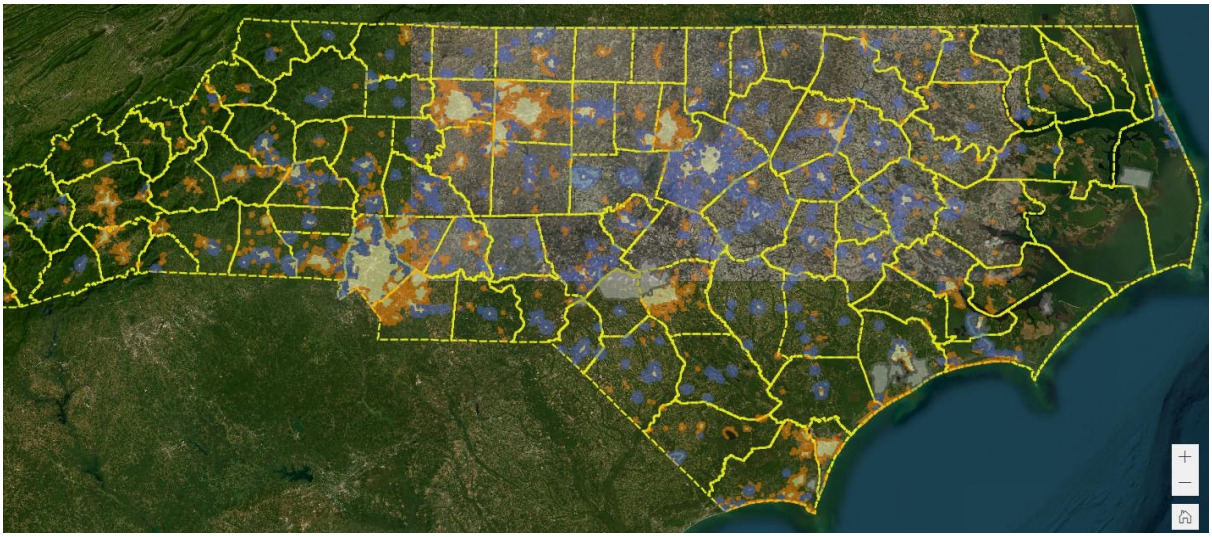
Dataset should be updated by:

Incorporate current and future construction when investigating mitigation options.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factor: Transportation Attributes (Roads and Bridges). To quantify risk, combine with other demographic sources to calculate damage cost.

2.2.7 NC CGIA: Political Boundaries



Dataset Summary Information

Source of Information	NC CGIA
Link to Online Data	https://www.nconemap.gov/pages/municipal-boundaries
Data Owner	NC CGIA
Date Created	11/3/2021
Date of Access	March 2023
Frequency of Updates	Monthly
Updates Needed	Dataset is in Quality Control to verify all municipalities have reviewed and approved what is shown. Updates will be needed as reviews occur.
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

All appropriate entities should be identified with appropriate spatial limits. Data are needed to coordinate projects with stakeholders, as well as for project reviews and compliance with local ordinances.

Limitations:

Datasets may need updates based on recent or planned annexations. A dataset is maintained by NCEM as part of the FRIS.

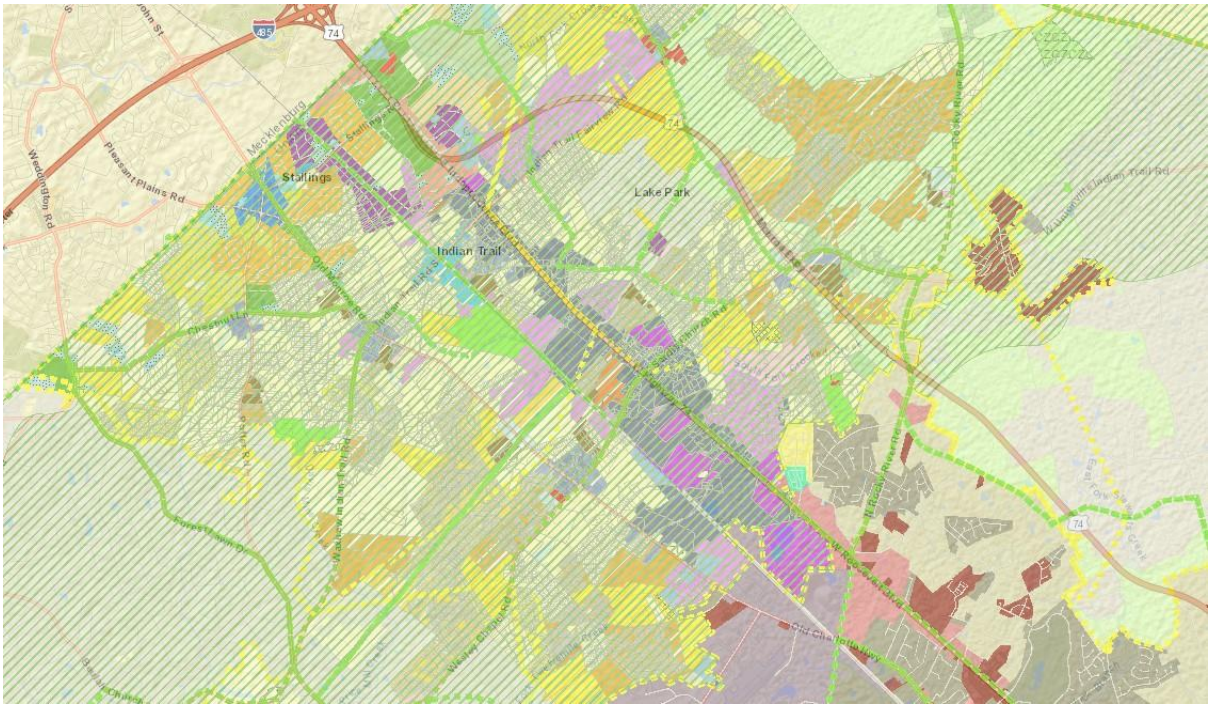
Dataset should be updated by:

Coordinate during outreach to obtain up-to-date jurisdictions and planned revisions.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.2.8 Local Governments: Zoning



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	local government websites
Data Owner	Local Governments
Date Created	Various
Date of Access	March 2023
Frequency of Updates	Various
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Municipalities can lay the foundation for improved flood resilience through their comprehensive plans and zoning ordinances. Zoning plans guide how a community should be developed and where development should not occur. This allows opportunity to build in flood awareness and mitigation strategies to reduce flooding, and appropriately zone areas of significant flood risk while directing development to areas of low risk.

Limitations:

Zoning data are not aggregated across communities, so many coverages will need to be obtained. The zoning classifications are subject to frequent changes.

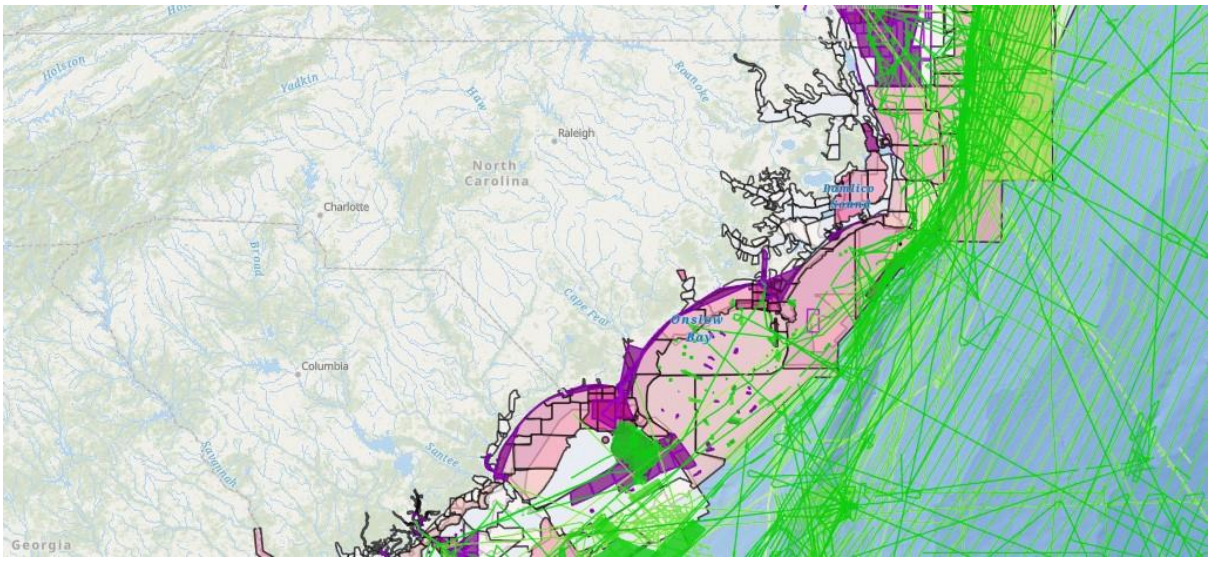
Dataset should be updated by:

Aggregate zoning data and identify areas of proposed change. Establish a maintenance plan for zoning coverage.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.2.9 NOAA: Bathymetry



Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://www.ncei.noaa.gov/maps/bathymetry/
Data Owner	NOAA
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	Variable
Updates Needed	Yes
Type of Flooding	Fluvial, Coastal

Dataset Event Frequencies:

N/A

Benefits:

Capture the terrain beneath the water, which topographic LiDAR does not do.

Limitations:

Limited to coastline and requires formatting to use.

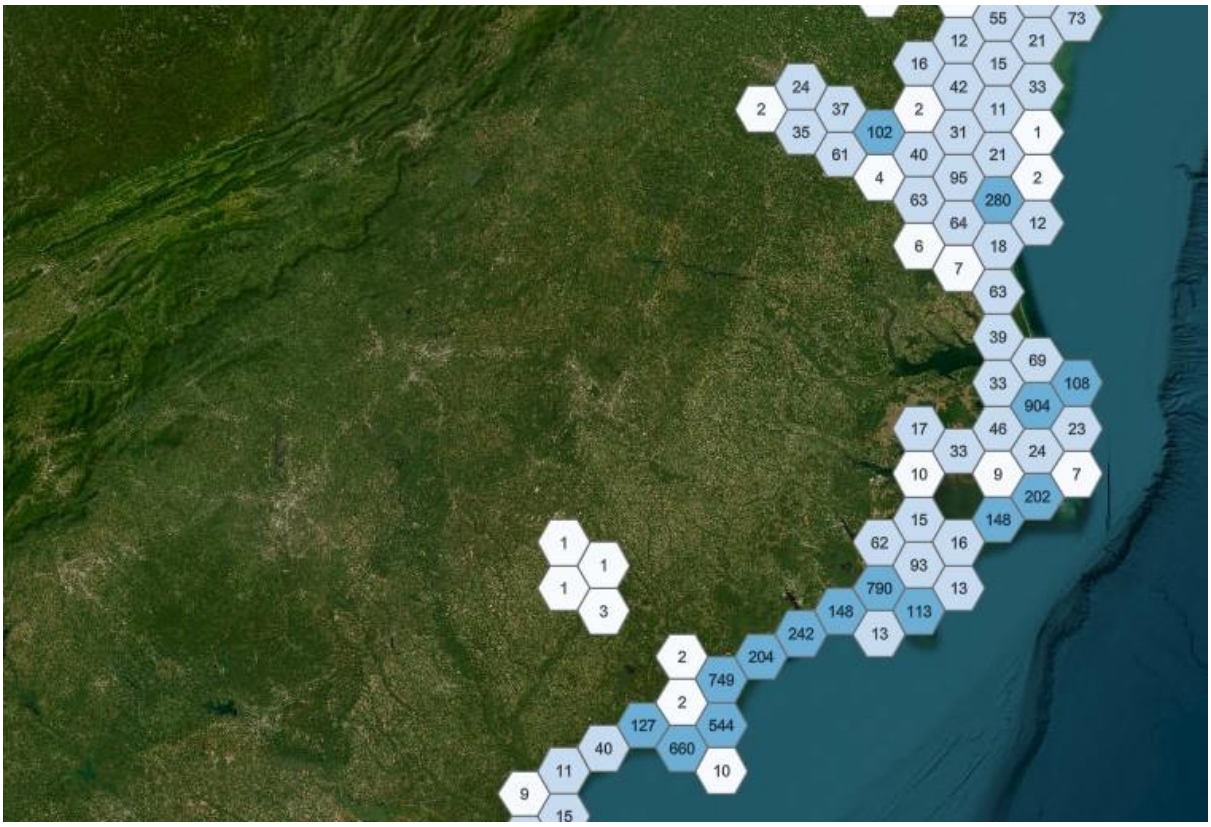
Dataset should be updated by:

Compile and generate a statewide bathymetry layer. Determine missing bathymetry and determine how to fill that gap.

Risk Quantifier:

This source cannot be used to quantify existing or future risk.

2.2.10 USACE: Bathymetry



Dataset Summary Information

Source of Information	USACE
Link to Online Data	https://www.arcgis.com/apps/dashboards/index.html#/4b8f2ba307684cf597617bf1b6d2f85d
Data Owner	USACE
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	Yes
Type of Flooding	Fluvial, Coastal

Dataset Event Frequencies:

N/A

Benefits:

Capture the terrain beneath the water, which LiDAR does not do.

Limitations:

Limited to navigable areas of the coastline and requires formatting to use.

Dataset should be updated by:

Compile and generate a statewide bathymetry layer. Determine missing bathymetry and determine how to fill that gap. When studying a river, we should know the river's terrain (LiDAR does not penetrate below the water surface).

Risk Quantifier:

This source cannot be used to quantify existing or future risk unless used in a model.

2.2.11 USGS: Hydrography

Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://www.usgs.gov/national-hydrography/3d-national-topography-model-call-action-part-1-3d-hydrography-program
Data Owner	USGS
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial

Dataset Event Frequencies:

N/A

Benefits:

Includes opportunities for better linkages to other water datasets like the U.S. Fish and Wildlife Service National Wetlands Inventory, as well as positional accuracy, alignment to elevation data, and frequent updates.

Limitations:

Funding will be required to create this dataset. NCDEQ has made a start with the headwater stream spatial dataset, but that dataset does not meet the specifications of EDH and would need to be updated.

Dataset should be updated by:

Dataset should be developed. USGS will initially pull the existing National Hydrologic Dataset (NHD) into the Elevation Derived Hydrography (EDH) model. It will not have the 3D benefit of EDH. From there, EDH would need to be developed for NC.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.3 Natural Environment Datasets

There are 21 datasets that have been identified, reviewed, and classified as Natural Environment datasets for use in the Blueprint. Of the 21 total Natural Environment datasets, 6 are classified as essential and 15 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-3.

Table 2-3: Natural Environment Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
Multi-Resolution Land Characteristics (MRLC): Existing Land Cover and Pervious Cover National Land Cover Dataset	F, P, U	10	8	6	4	6
MRLC: Cropland Data Layer	F, P, U	10	8	6	4	6
NOAA: Coastal Change Analysis Program	F, P, U	10	10	7	8	N/A
ESA, ESRI, USGS, NOAA: Global Future Land Use	F, P, U	10	8	4	4	6
NCSU: Natural Infrastructure GIS Layers	OP	TBD	TBD	TBD	TBD	TBD

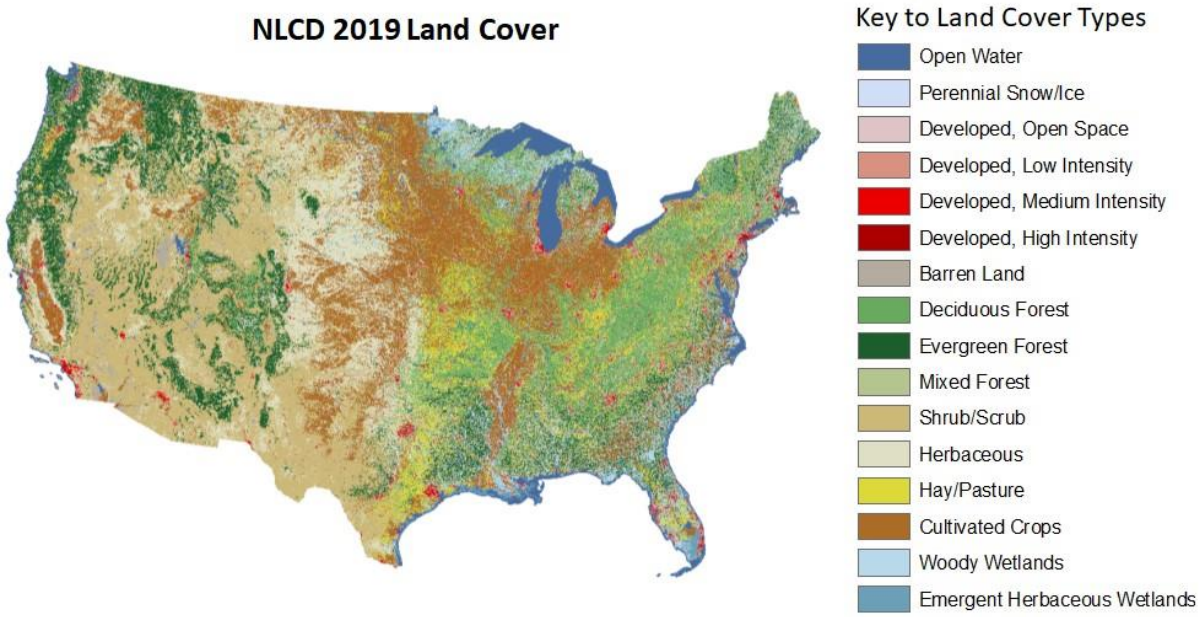
Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
U.S. Department of Agriculture (USDA) and **Natural Resources Conservation Service** (NRCS): Soils	NFS	10	8	6	8	8
NCDEQ: River Restoration or Diversions	F, P	4	6	8	6	8
Environmental Protection Agency (EPA): EnviroAtlas	F, P	6	8	7	7	8
Unidentified: Snowmelt	S	TBD	TBD	TBD	TBD	TBD
Unidentified: Avalanche	S	TBD	TBD	TBD	TBD	TBD
Unidentified: Ice Jam	S	TBD	TBD	TBD	TBD	TBD
Duke University: Pocosins	GW	8	8	8	6	10
USGS: Groundwater Levels	GW	4	TBD	TBD	TBD	TBD
NCDEQ: Monitoring Network and Studies	GW	6	8	8	10	8
Land Subsidence: Vertical Land Motion and Horizontal Velocity Data for US Atlantic Coast	GW	5	7	5	6	5
USGS: Karst Features and Sinkholes	GW	8	6	4	6	4
Carolina Bays	OP	TBD	TBD	TBD	TBD	TBD
US Fish and Wildlife: Wetland Restoration	OP	10	8	8	6	8
N.C. Wildlife Resources: Threatened and Endangered Species	A/M	TBD	TBD	TBD	TBD	TBD
NCDEQ: Livestock	A/M	8	8	8	8	6
Hazards and Vulnerability Research Institute at the University of South Carolina and United States Department of Agriculture: Crops	A/M	8	8	8	8	TBD

(N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding,

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods

A&M; Mining Flooding, A&M; Natural Disasters , ND; Non-Flooding Source, NFS; All Types of Flooding, ALL)

2.3.1 MRLC: Existing Land Cover and Pervious Cover NLCD



Dataset Summary Information

Source of Information	MRLC
Link to Online Data	https://www.mrlc.gov/
Data Owner	MRLC
Date Created	2019
Date of Access	February 2023
Frequency of Updates	3-Year cycle
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies:

N/A

Benefits:

Wide coverage available, including remotely sensed data that can be augmented by locally developed or manually delineated data.

Limitations:

Datasets from local entities may have different classifications from other datasets such as the remotely sensed National Land Cover Database, which has the benefit of consistent methodology but may not be as accurate. Requires cross referencing/mapping to categories in TR55 with established curve numbers. Requires review to ensure that recent development is accounted for in the coverage. NLCD has a 5-year update interval, and typically has a lag time between collection and publication to allow for processing and review.

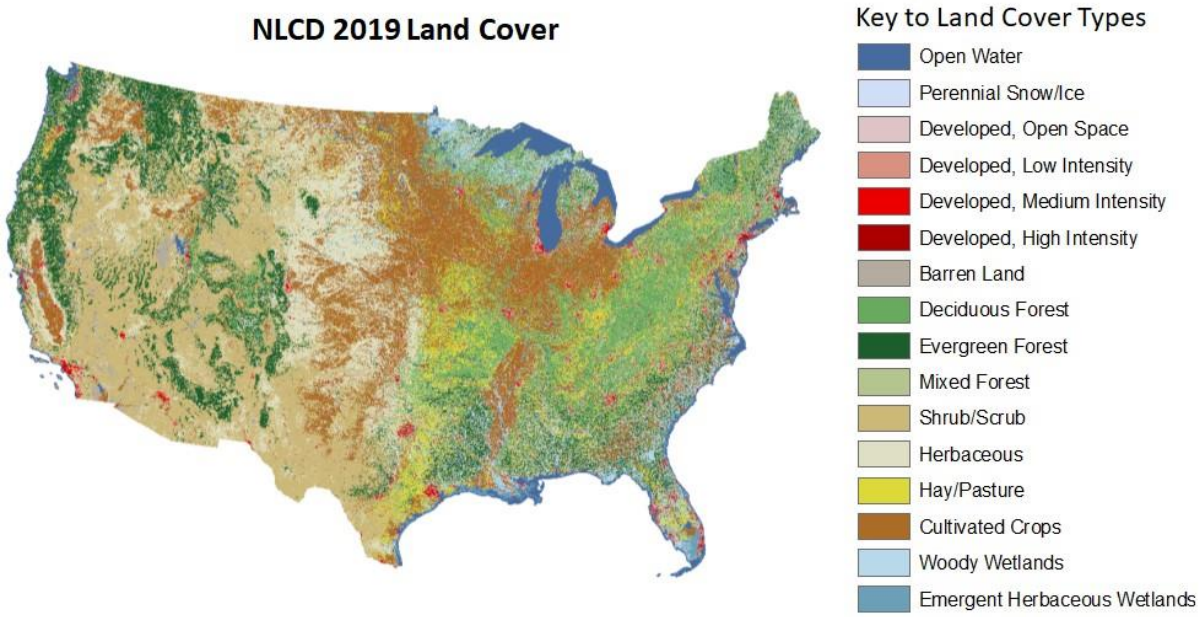
Dataset should be updated by:

Move to an automatic AI generated system combined with LiDAR; Use this dataset as the comparison basis when creating the AI. Combine with Natural Environment datasets such as Carolina bays and Pocosins. Alternatively, normalize all locally derived data to NLCD standards, review all data against recent orthophotography, and manually adjust for new development.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine existing hydrology input parameters that can be used in models from other sources.

2.3.2 MRLC: Cropland Data Layer



Dataset Summary Information

Source of Information	MRLC
Link to Online Data	https://www.mrlc.gov/data
Data Owner	MRLC
Date Created	2021
Date of Access	August, 2023
Frequency of Updates	5-year update interval
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies:

N/A

Benefits:

Wide coverage available, including remotely sensed data that can be augmented by locally developed or manually delineated data.

Limitations:

Datasets from local entities may have different classifications from other datasets such as the remotely sensed National Land Cover Database, which has the benefit of consistent methodology but may not be as accurate. Requires cross-referencing/mapping to categories in TR55 with established curve numbers. Requires review to ensure that recent development is accounted for in the coverage. NLCD has a 5-year update interval, and typically has a lag time between collection and publication to allow for processing and review.

Dataset should be updated by:

Move to an automatic AI-generated system combined with LiDAR; use this dataset as the comparison basis when creating the AI. Combine with Natural Environment datasets such as Carolina bays and Pocosins. Alternatively, normalize all locally derived data to NLCD standards, review all data against recent orthophotography, and manually adjust for new development.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine existing hydrology input parameters that can be used in models from other sources.

2.3.3 NOAA: Coastal Change Analysis Program

Dataset Summary Information

Source of Information	NOAA
Link to Online Data	https://coast.noaa.gov/digitalcoast/data/ccapregional.html
Data Owner	NOAA
Date Created	Multiple. Most recent update 2016
Date of Access	May 2023
Frequency of Updates	Variable
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies:

N/A

Benefits:

The use of standardized data and procedures assures consistency through time and across geographies.

Limitations:

This is a national and regional data set that should be used only as a screening tool for very local or site-specific management decisions. Small features and changes should be verified with a higher resolution data source.

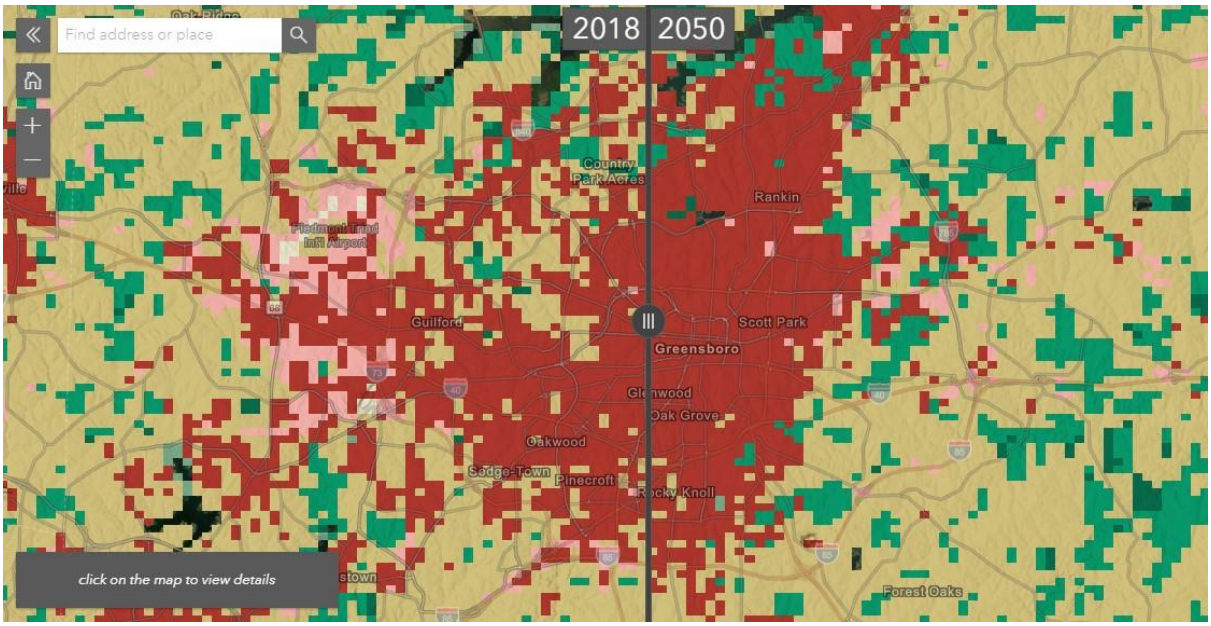
Dataset should be updated by:

Move to an automatic AI-generated system combined with LiDAR; use this dataset as the comparison basis when creating the AI. Combine with Natural Environment datasets such as Carolina bays and Pocosins. Alternatively, normalize all locally derived data to NLCD standards, and review all data against recent orthophotography, and manually adjust for new development.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Hydrology. To quantify risk, determine existing hydrology input parameters that can be used in models from other sources.

2.3.4 ESA, ESRI, USGS, NOAA: Global Future Land Use



Dataset Summary Information

Source of Information	ESA, ESRI, USGS, NOAA
Link to Online Data	https://livingatlas.arcgis.com/landcover-2050/ https://planetarycomputer.microsoft.com/catalog
Data Owner	ESA, ESRI, USGS, NOAA
Date Created	2020
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban

Dataset Event Frequencies:

N/A

Benefits:

Freely available data based on remote sensing research. Coverages developed by Environmental Systems Research Institute, Inc. (ESRI) and by USGS are available, and projections extend through 2100. These data will be useful for estimating percent changes in runoff due to future development.

Limitations:

Not specific to NC or informed by existing land use plans. Uncertain of updates but assumed to update with regular land use.

Dataset should be updated by:

Data could be fine-tuned based on stakeholder input regarding local trends and community planning (e.g., municipal and county-level future land use plans). Develop statewide dataset for future land use that amalgamates existing local data with a consistent format and uses ESRI data to fill gaps.

Risk Quantifier:

This source can be a future risk quantifier using the following factor: Hydrology. To quantify risk, determine future hydrology input parameters that can be used in models from other sources.

2.3.5 NCSU: Natural Infrastructure GIS Layers

Dataset Summary Information

Source of Information	NCSU
Link to Online Data	https://storymaps.arcgis.com/stories/5cce242ca04645438b819addf05cf44f
Data Owner	NCSU
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	Yes
Type of Flooding	Overland Ponding

Dataset Event Frequencies:

N/A

Benefits:

This coverage can be used to determine areas where natural infrastructure projects could produce benefits with respect to flood reduction. NCSU has developed these data for the Middle Neuse River Basin.

Limitations:

Dataset does not cover entire Neuse River Basin; there are other natural infrastructure practices that could be evaluated and located.

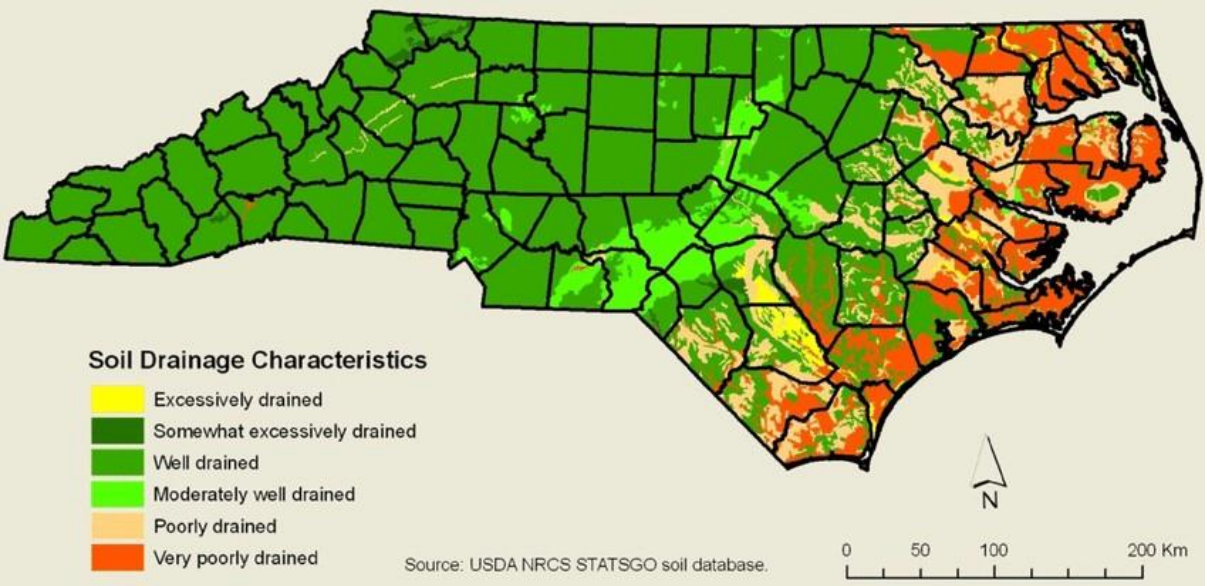
Dataset should be updated by:

Expand footprint of dataset as appropriate; identify other natural infrastructure practices and locations that are applicable within the basin.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.6 USDA and NRCS: Soils



Dataset Summary Information

Source of Information	USDA and NRCS
Link to Online Data	https://nrcs.app.box.com/v/soils/file/1055530066630
Data Owner	USDA and NRCS
Date Created	2022
Date of Access	March 2023
Frequency of Updates	10-year cycle
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

This is an authoritative, national dataset that fully covers the Neuse River Basin.

Limitations:

Resolution is coarse.

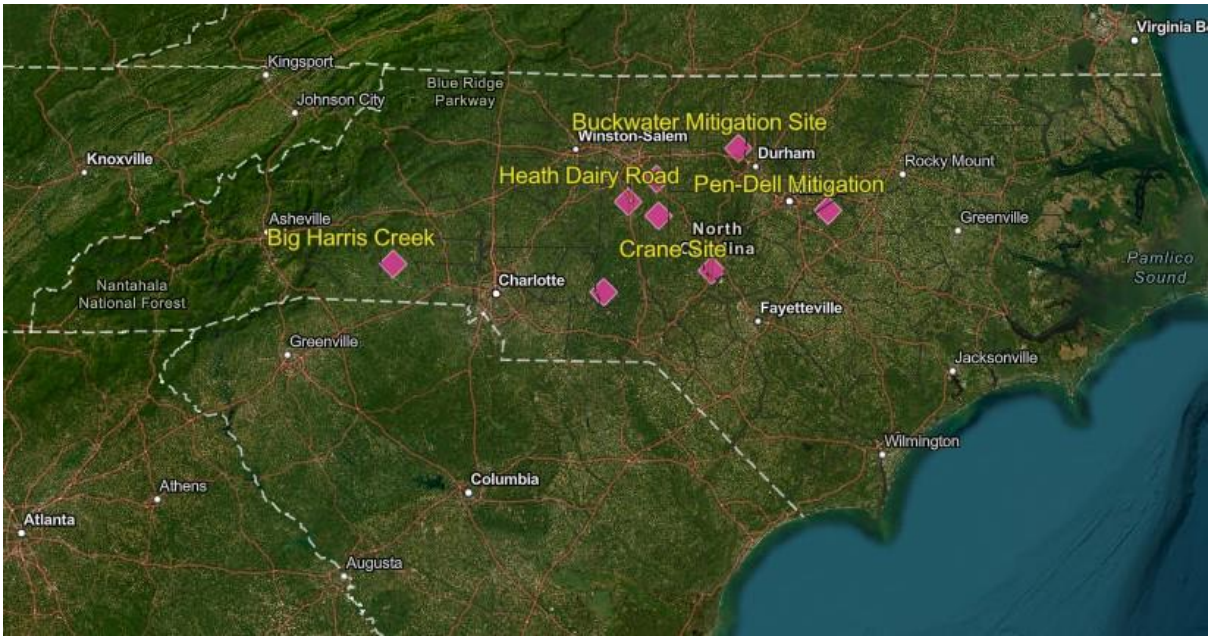
Dataset should be updated by:

Data used as input parameter for hydraulic modeling.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Environmental Attributes and Hydrology. To quantify risk, determine hydrology input parameters that can be used in models from other sources.

2.3.7 NCDEQ: River Restoration or Diversions



Dataset Summary Information

Source of Information	NCDEQ
Link to Online Data	https://deq.nc.gov/about/divisions/mitigation-services/science-analysis/stream-restoration-water-quality
Data Owner	NCDEQ
Date Created	1972
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial

Dataset Event Frequencies:

N/A

Benefits:

Improved stream and wetland function, and monitoring helps ensure that projects are having the desired effects on water quality and the aquatic habitat. Water quality assessments specifically measure nutrients, suspended solids, and fecal coliform before and after restoration. Big picture, rerouting flooding away from developed areas.

Limitations:

No accessible source identified for potential projects.

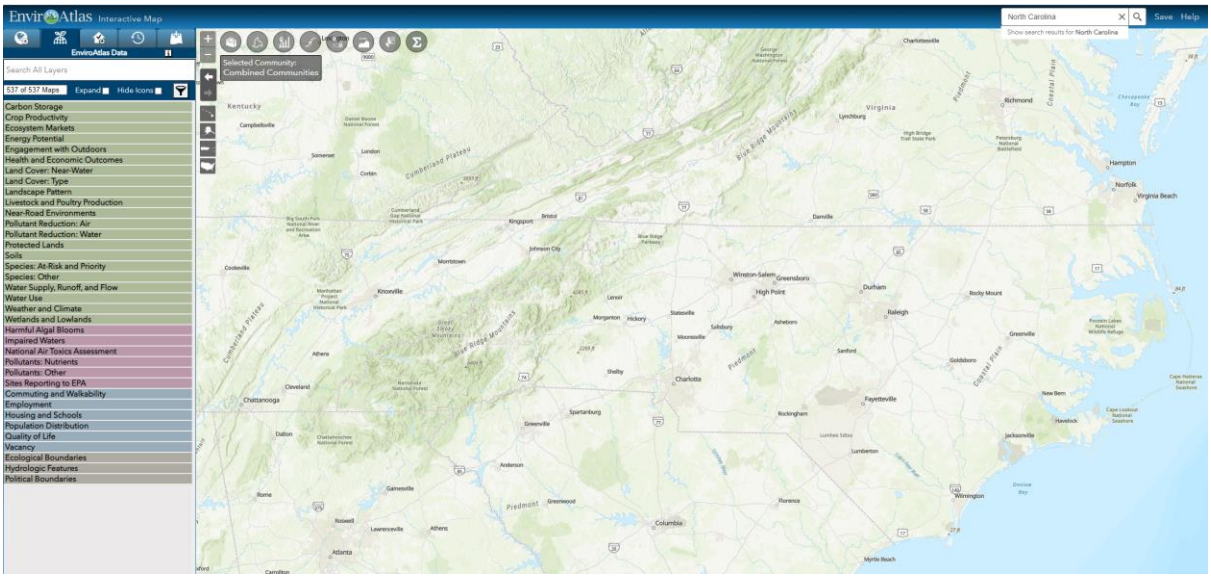
Dataset should be updated by:

Study current and future stream restoration projects, potential river diversions, and mitigation projects and their impacts.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Velocity, Shear Stress, and Hydrology. To quantify risk, determine boundary and WSEL of objects from a more detailed model.

2.3.8 EPA: EnviroAtlas



Dataset Summary Information

Source of Information	EPA
Link to Online Data	https://www.epa.gov/enviroatlas/enviroatlas-dynamic-data-matrix
Data Owner	EPA
Date Created	Varied
Date of Access	August, 2023
Frequency of Updates	Varied
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial

Dataset Event Frequencies:

N/A

Benefits:

Provides numerous datasets, composed of a variety of reputable sources that relate numerous topics to flood sources, including land uses, stream/lake buffer aspects, impervious surface cover, potentially restorable wetlands, agriculture, soil loss, stormwater runoff, environmental markets, transportation, etc.

Limitations:

The national extent of the datasets has a limited specificity and reliability when applied to the local setting.

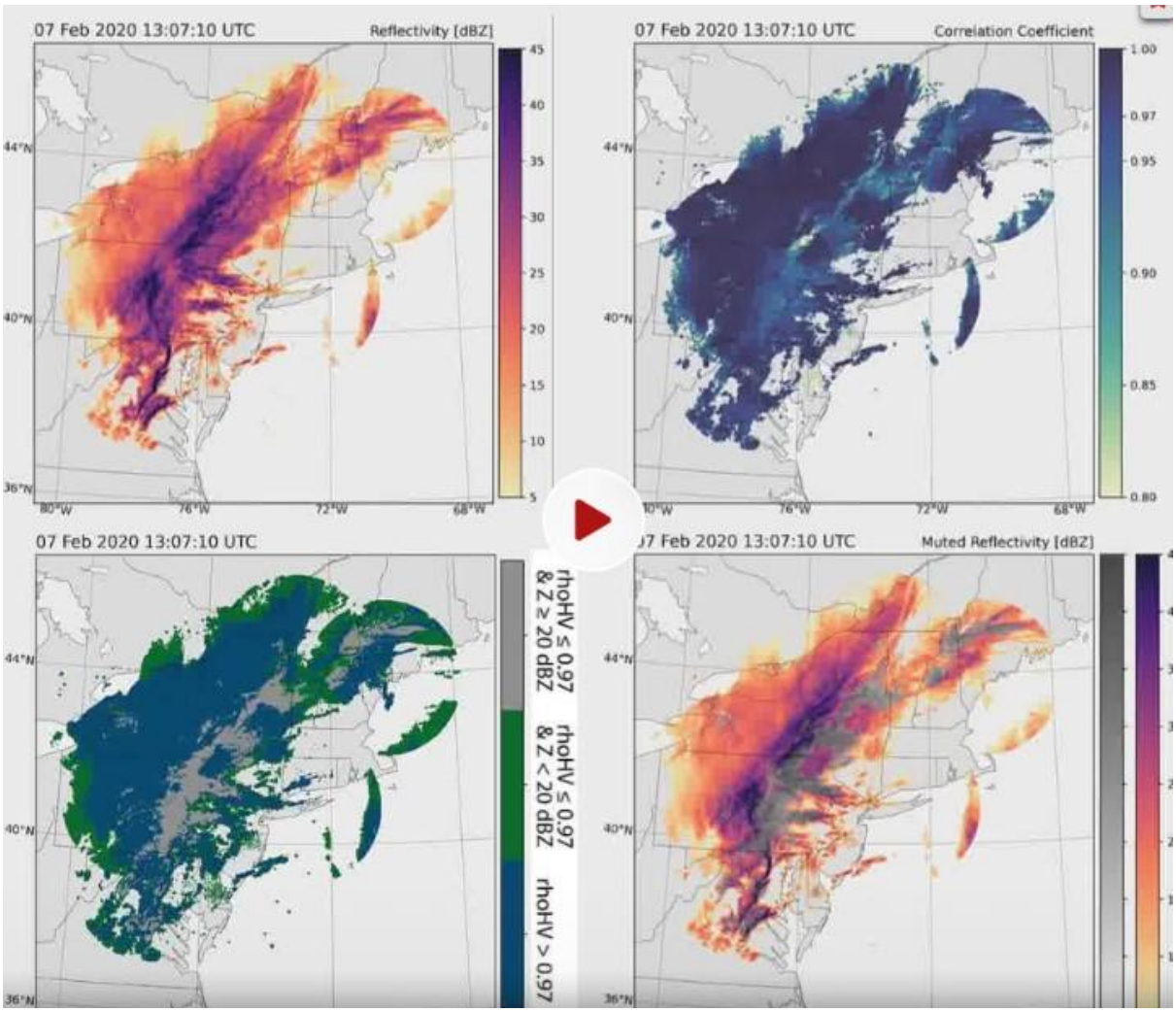
Dataset should be updated by:

Ground-truthing data prior to local use as well reviewing foundational data used for age and methods of analysis/collection.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Hydrology, Inundation Boundary, Environmental, Demographic, Building, Velocity, and Transportation.

2.3.9 Unidentified: Snowmelt



Dataset Summary Information

Source of Information	Unidentified
Link to Online Data	https://cnr.ncsu.edu/geospatial/news/2022/11/15/new-visualization-tool-heavy-snow/ https://planetarycomputer.microsoft.com/dataset/modis-10A1-061
Data Owner	Unidentified
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	N/A
Type of Flooding	Snowmelt

Dataset Event Frequencies:

N/A

Benefits:

Could help predict areas of high risk; shown in real time.

Limitations:

Only benefits a small rural portion of the state, and the expense to create the source may outweigh the benefits.

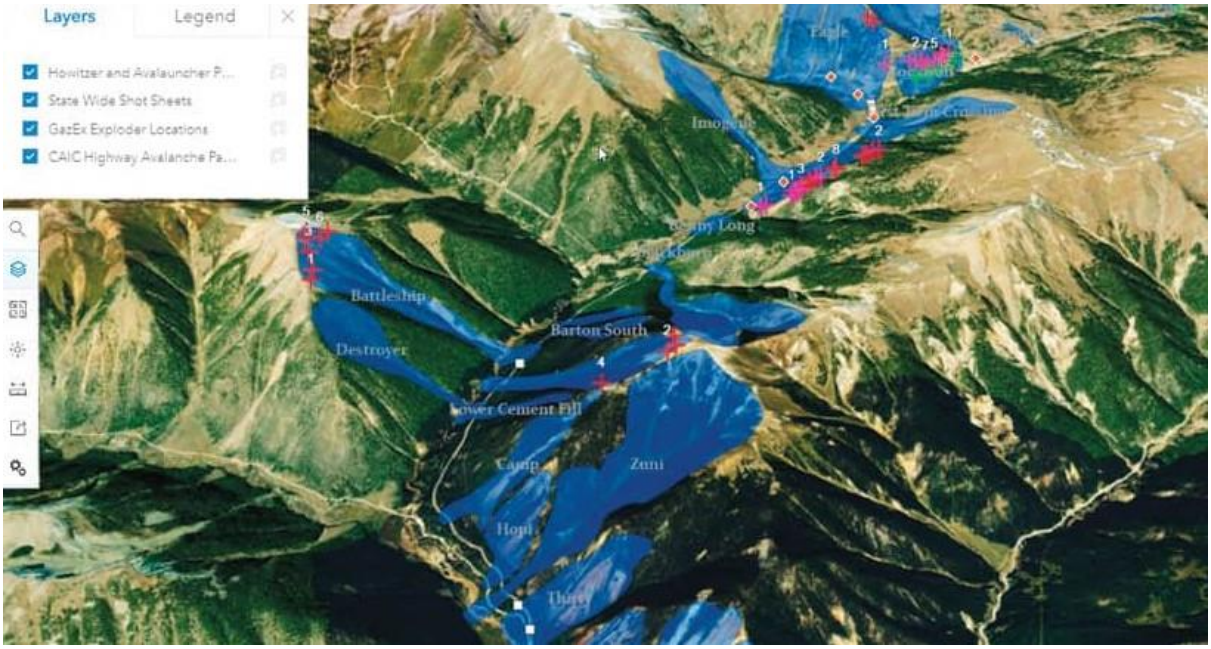
Dataset should be updated by:

No source identified for North Carolina; consider creating one.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.3.10 Unidentified: Avalanche



Dataset Summary Information

Source of Information	Unidentified
Link to Online Data	https://www.esri.com/about/newsroom/arcnews/reducing-the-risk-of-avalanches-with-gis-and-machine-learning/
Data Owner	Unidentified
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	N/A

Type of Flooding	Snowmelt

Dataset Event Frequencies:

N/A

Dataset should be updated by:

No source identified for North Carolina; consider creating one.

Benefits:

Could help predict areas of high risk or show real-time locations.

Limitations:

Only benefits a small rural portion of the state, and the expense to create the source may outweigh the benefits.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.3.11 Unidentified: Ice Jam

Dataset Summary Information

Source of Information	Unidentified
Link to Online Data	Unidentified
Data Owner	Unidentified
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	N/A
Type of Flooding	Snowmelt

Dataset Event Frequencies:

N/A

Benefits:

Could help predict areas of high risk or show real-time locations.

Limitations:

Only benefits a small rural portion of the state, and the expense to create the source may outweigh the benefits.

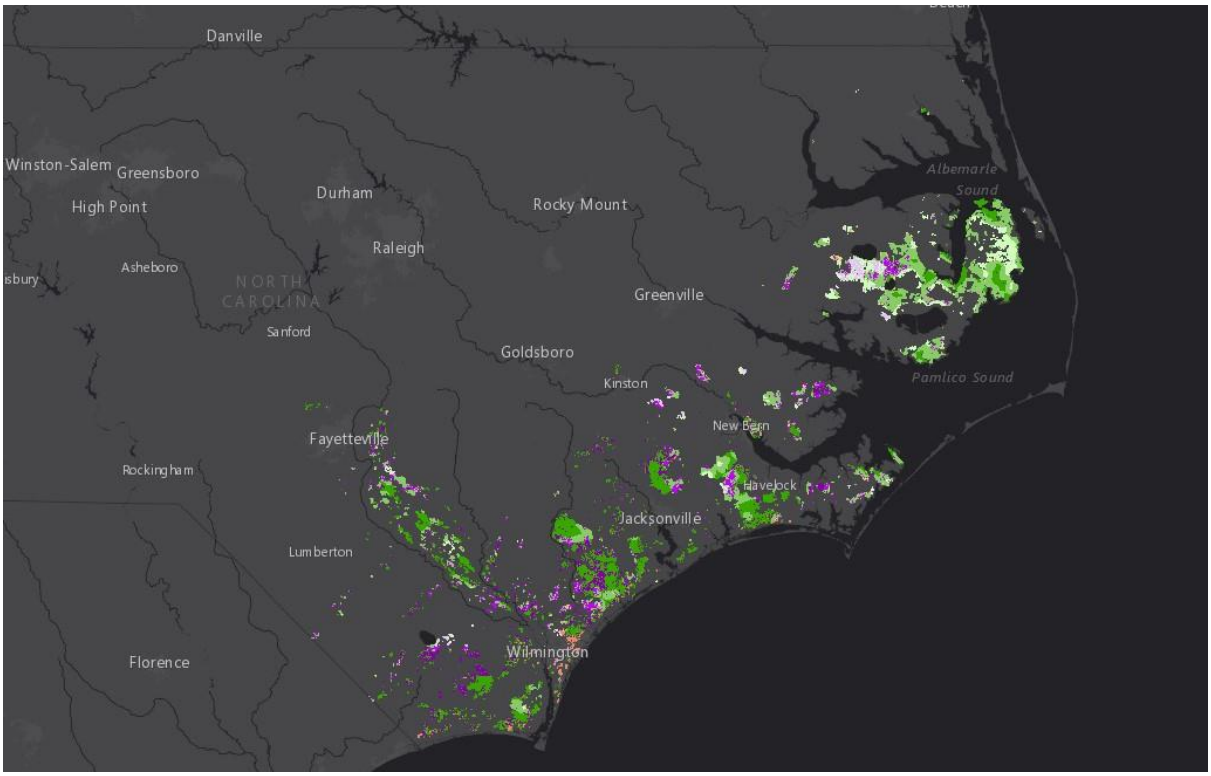
Dataset should be updated by:

No source identified for North Carolina; consider creating one.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.3.12 Duke University: Pocosins



Dataset Summary Information

Source of Information	Duke University
Link to Online Data	https://nicholasinstitute.duke.edu/project/north-carolina-pocosins-mapping percent0a https://research.repository.duke.edu/concern/datasets/2z10wr05h?locale=en
Data Owner	Duke University
Date Created	June 2021
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Groundwater Flooding

Dataset Event Frequencies:

N/A

Benefits:

Identifies Pocosins that are unique to flooding and is able to account for them.

Limitations:

Unknown methodology to implement the data.

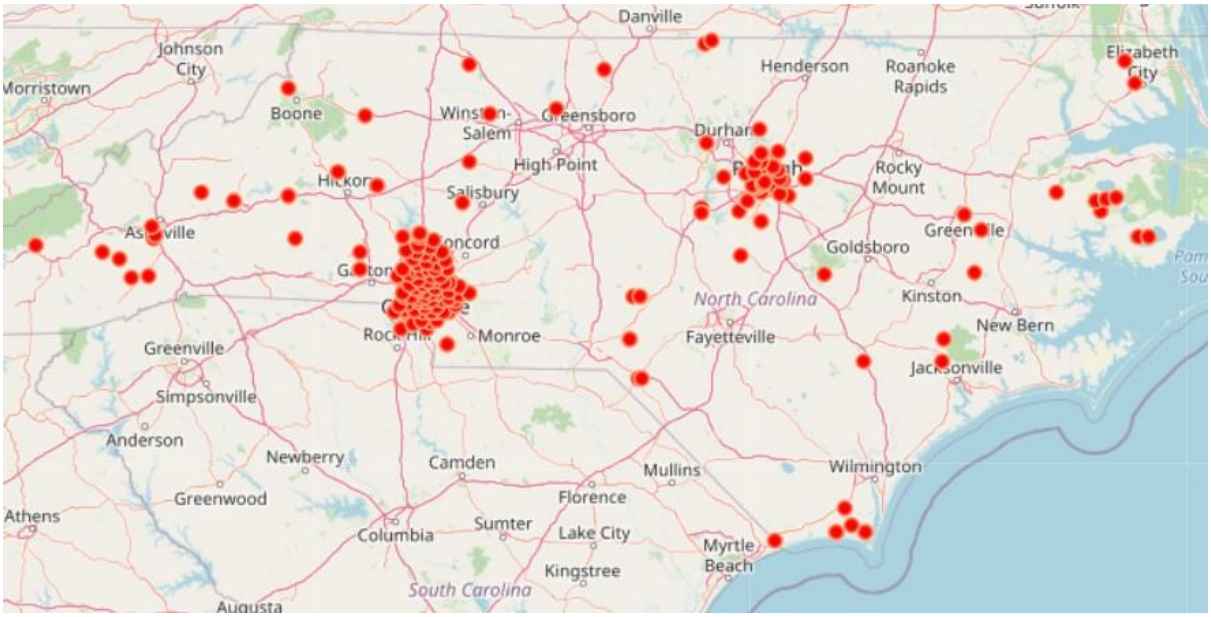
Dataset should be updated by:

Determine if this dataset makes enough of an impact to be worth using, as well as how it should be applied.

Risk Quantifier:

This source cannot be used to quantify existing or future risk of Environmental Attributes. The process to quantify risk is currently unknown.

2.3.13 USGS: Groundwater Levels



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://waterdata.usgs.gov/nc/nwis/current/?type=gw
Data Owner	USGS
Date Created	Various dates for observation well installations.
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Groundwater Flooding

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Gauge locations that track groundwater.

Limitations:

Uncertain how much groundwater interacts with other sources of flooding. Also, uncertain how to use the data except for anything built below the ground.

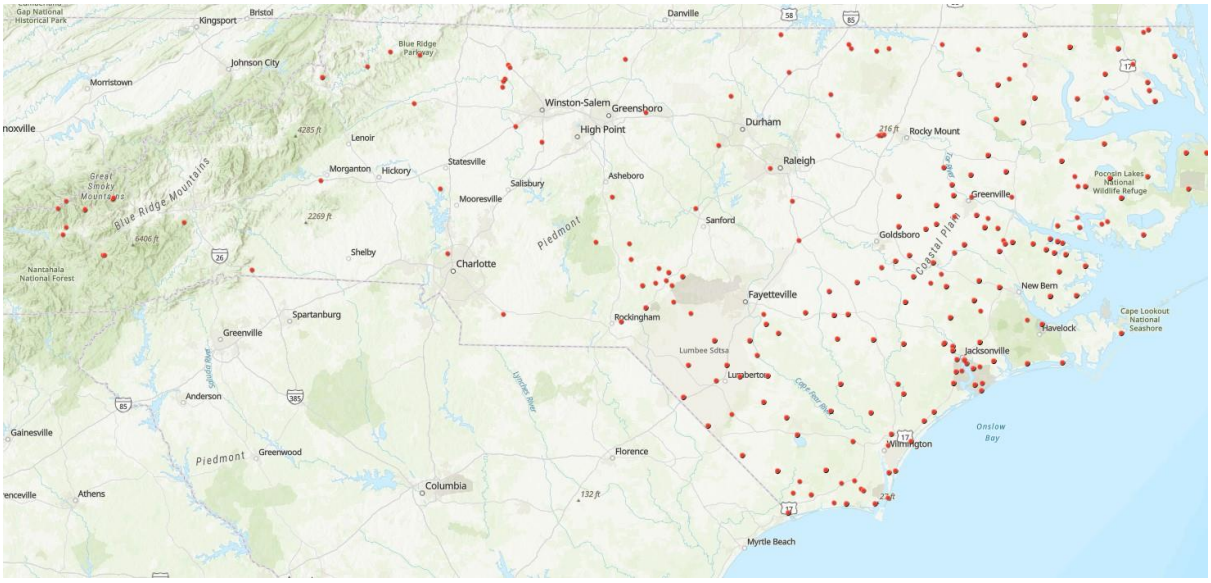
Dataset should be updated by:

Determine if this dataset makes enough of an impact to be worth using, as well as how it should be applied.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.14 NCDEQ: Monitoring Network and Studies



Dataset Summary Information

Source of Information	NCDEQ
Link to Online Data	https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=6a0293762cf249ed92b657bd9b7465cf percent0a https://deq.nc.gov/about/divisions/water-resources/water-resources-data-statistics-and-maps
Data Owner	NCDEQ
Date Created	October 2022
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Groundwater Flooding

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Network includes 700 wells at 235 stations monitoring groundwater.

Limitations:

Uncertain how much groundwater interacts with other sources of flooding. Also, uncertain how to use the data except for anything built below the ground.

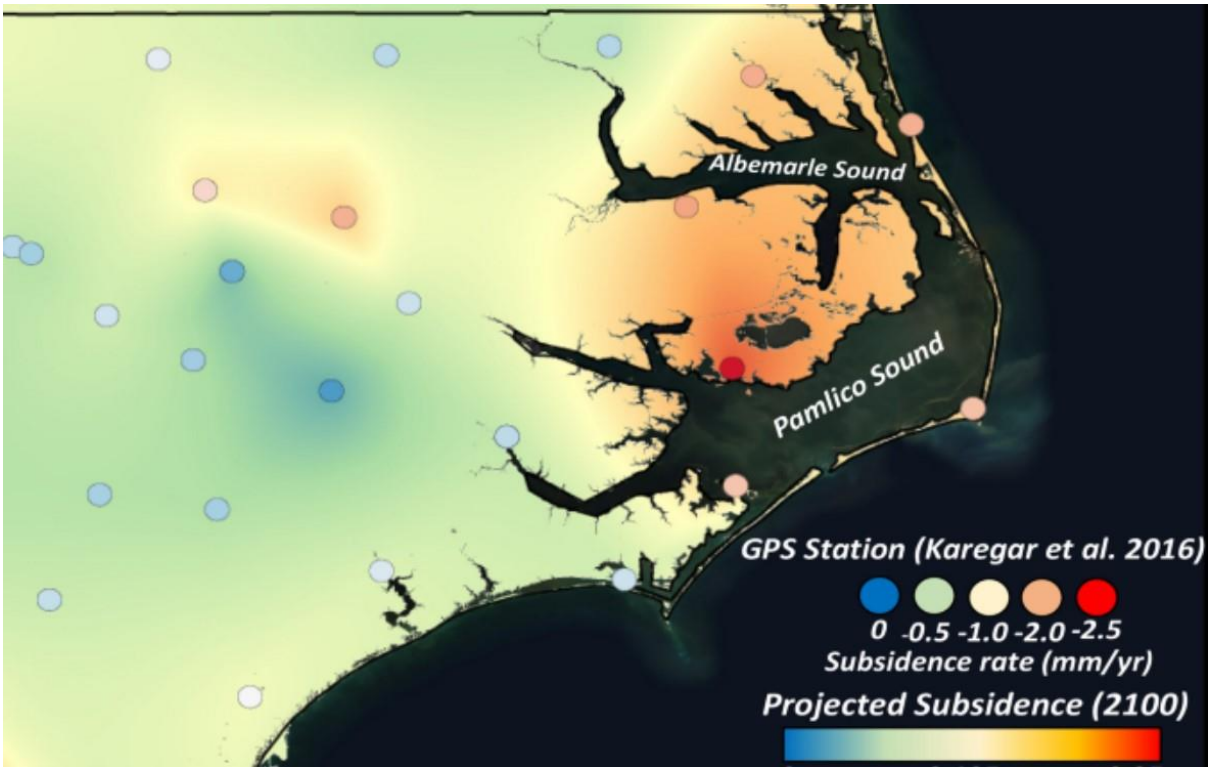
Dataset should be updated by:

Determine if this dataset makes enough of an impact to be worth using, as well as how it should be applied.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes and Hydrology. The process to quantify risk is currently unknown.

2.3.15 Land Subsidence: Vertical Land Motion and Horizontal Velocity Data for US Atlantic Coast



Dataset Summary Information

Source of Information	Virginia Polytechnic Institute and State University (Virginia Tech)
Link to Online Data	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL068015# https://data.lib.vt.edu/articles/dataset/VLM_Data_for_US_Atlantic_coast/19350959?file=34378535
Data Owner	Universal Public Domain
Date Created	Study published in March 2016 Data published April, 2023
Date of Access	February 2023
Frequency of Updates	Version 1 of data released March 2022 Version 2 of data released November 2022 Version 3 of data released April 2023
Updates Needed	Yes
Type of Flooding	Groundwater Flooding

Dataset Event Frequencies:

N/A

Benefits:

Data depict “present day” subsidence rates through continuous global positioning system (GPS) station data collection. Study provides a possible model of data collection and land subsidence modeling that the state could adopt and apply to acquire more detailed/state-specific data.

Limitations:

Limited data collection (extent) in NC due to GPS station availability.

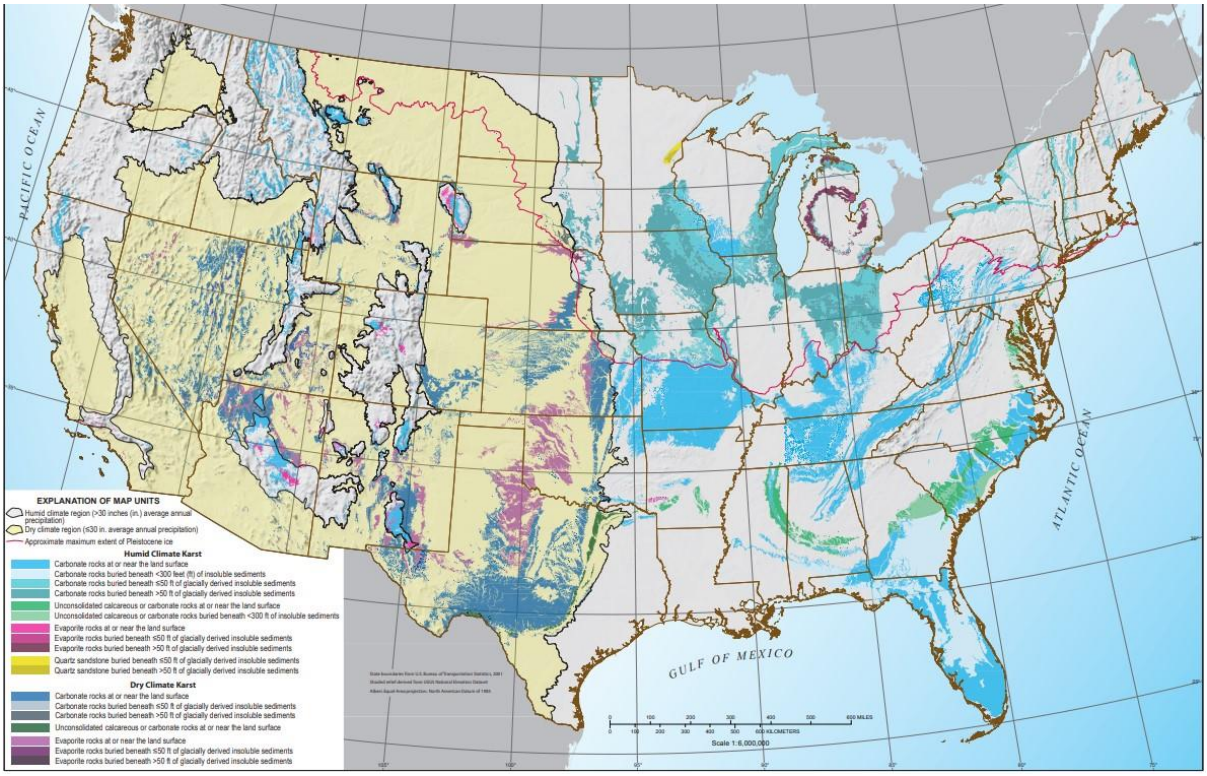
Dataset should be updated by:

Determine the extent and level of detail of North Carolina–specific data in resource.

Risk Quantifier:

This source can be used to quantify existing and future risk: Environmental Attributes. To quantify risk, integrate subsidence rates with sea level rise projections and coastal hazard models.

2.3.16 USGS: Karst Features and Sinkholes



Dataset Summary Information

Source of Information	USGS
Link to Online Data	https://pubs.er.usgs.gov/publication/ofr20141156
Data Owner	USGS
Date Created	2014
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	No
Type of Flooding	Groundwater Flooding

Dataset Event Frequencies:

N/A

Benefits:

Potentially used to improve modeling where infiltration is rampant, or at least justify extremes needed in modeling to match reality.

Limitations:

Data are too broad and generic to be useful.

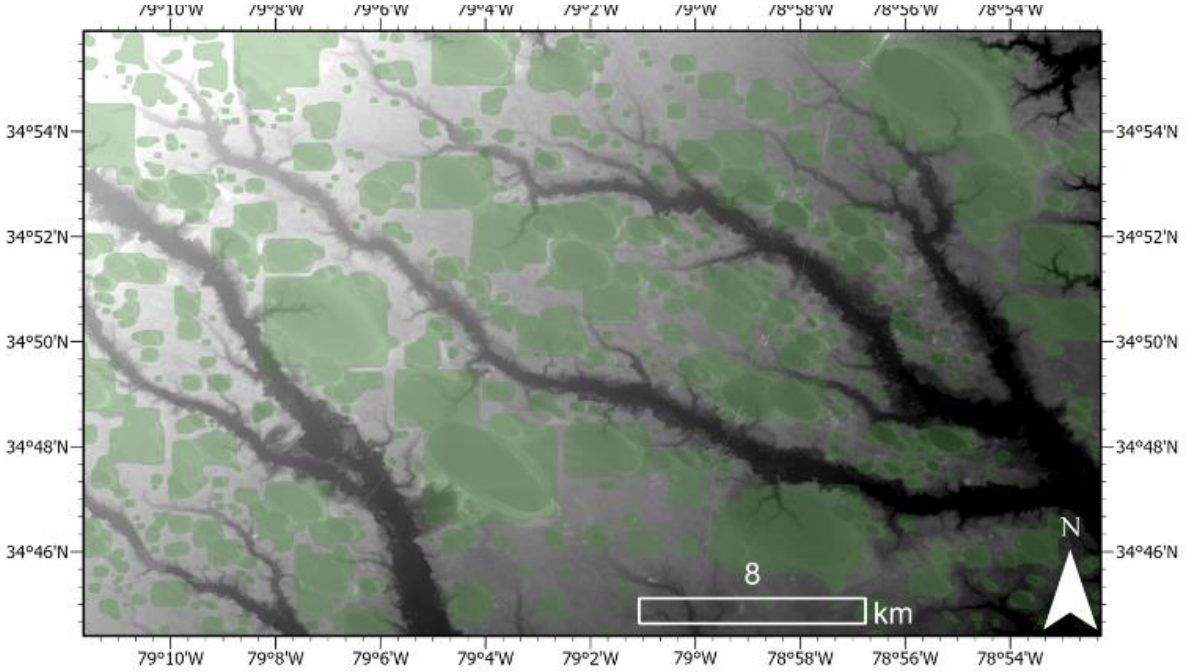
Dataset should be updated by:

Enhance this dataset with localized data of existing known sinkholes, caves, and other karst features, or at least local potential.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.17 Carolina Bays



Dataset Summary Information

Source of Information	Using Convolutional Neural Networks for Detection and Morphometric Analysis of Carolina Bays from Publicly Available Digital Elevation Models
Link to Online Data	https://www.mdpi.com/2072-4292/13/18/3770 https://github.com/mlundine/CarolinaBayDetection
Data Owner	University of Delaware School of Marine Science and Policy
Date Created	September 2021
Date of Access	August 2023
Frequency of Updates	None
Updates Needed	Yes
Type of Flooding	Overland Ponding

Dataset Event Frequencies:

N/A

Benefits:

Fast and accurate Convolutional Neural Network-based object detection on LiDAR DEMs is a very useful tool for geomorphic feature detection. Identify current flooding issues as well prevent future flooding occurring in Carolina bays, which are probably overlooked in floodplain management. Many Carolina bays have altered hydrology (e.g., upstream water diversions, ditching) that prevents them from holding water. Restoring degraded bays (i.e., through plugging ditches) is a mitigation strategy that would hold more water on the landscape, with additional water provisioning benefits for drought conditions.

Limitations:

Would need to create the dataset, because none exist, which can be done relatively easily.

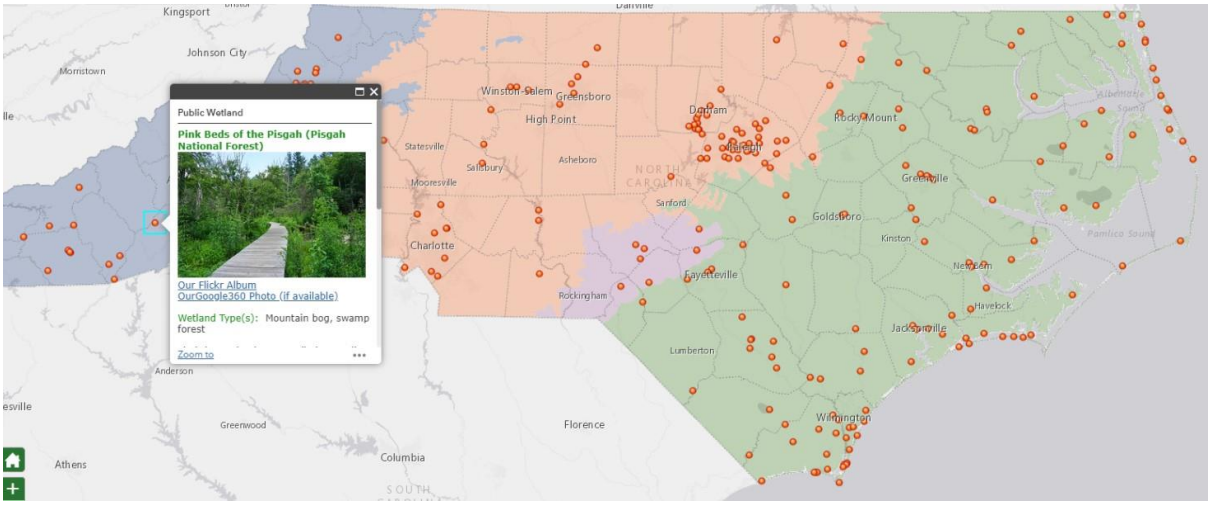
Dataset should be updated by:

Strongly recommend creating a North Carolina-focused Carolina Bays dataset. Immediately examine development in these areas, considering the methods used in this resource. Consider means to incorporate these high-risk areas into other programs.

Risk Quantifier:

This source can be used to quantify existing risk through Hydrology Attributes. To quantify risk, identified Carolina Bays should be integrated into hydraulic modeling efforts.

2.3.18 US Fish and Wildlife: Wetland Restoration



Dataset Summary Information

Source of Information	US Fish and Wildlife
Link to Online Data	https://deq.nc.gov/about/divisions/coastal-management/coastal-management-gis-data/download-coastal-wetlands-spatial percent0a https://planetarycomputer.microsoft.com/dataset/fws-nwi
Data Owner	US Fish and Wildlife
Date Created	1999
Date of Access	February 2023
Frequency of Updates	5 Year cycle
Updates Needed	TBD
Type of Flooding	Overland Ponding

Dataset Event Frequencies:

N/A

Benefits:

Current wetlands and potential wetland restorations that could mitigate flooding.

Limitations:

Wetlands might be subject to additional variable databases.

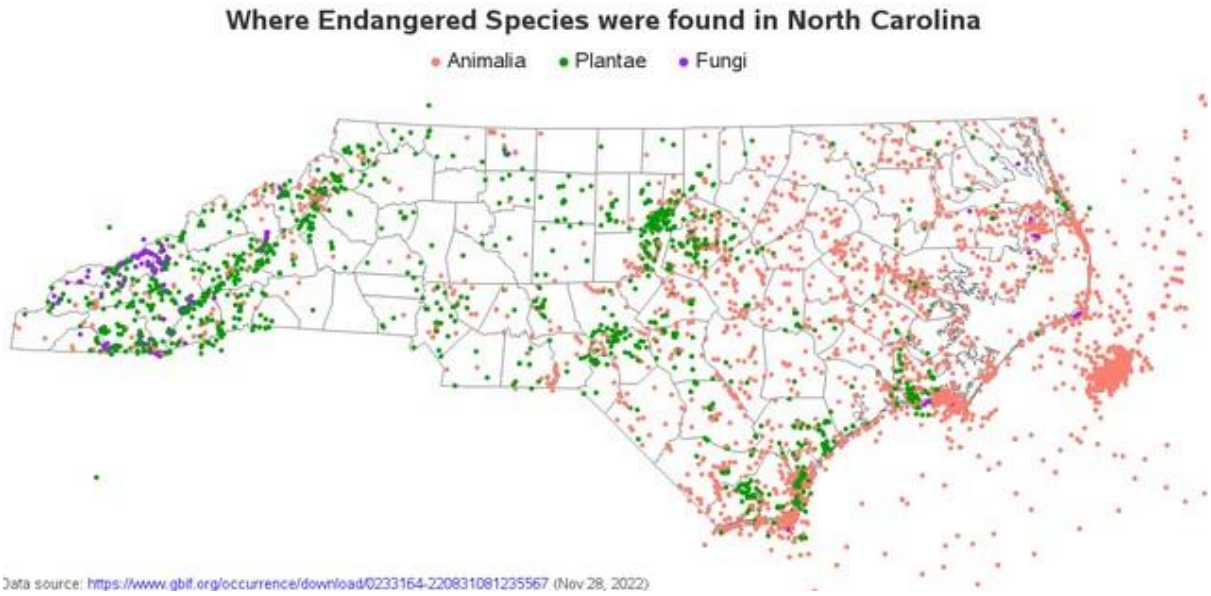
Dataset should be updated by:

Restore natural waterways and storage areas.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.19 N.C. Wildlife Resources: Threatened and Endangered Species



Dataset Summary Information

Source of Information	NC Wildlife Resources
Link to Online Data	https://www.ncwildlife.org/planpercent0a http://tecumseh.zo.ncsu.edu/coa/
Data Owner	NC Wildlife Resources
Date Created	N/A
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	TBD
Type of Flooding	Agricultural and Mining Flooding

Dataset Event Frequencies:

N/A

Benefits:

Identify areas to protect form flooding, or other needed actions.

Limitations:

No data found.

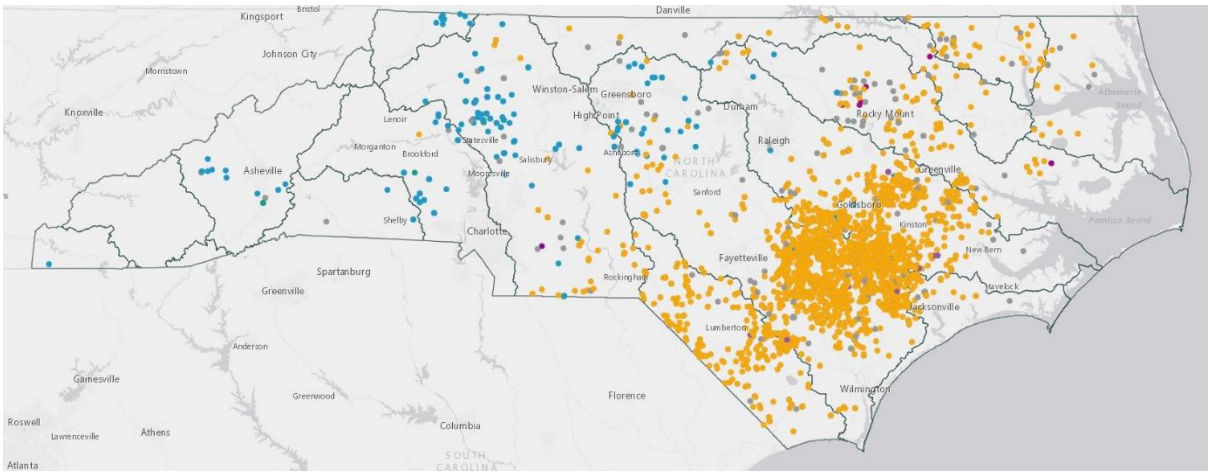
Dataset should be updated by:

Determine if the expense to create the layer is worth it.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.20 NCDEQ: Livestock



Dataset Summary Information

Source of Information	NCDEQ
Link to Online Data	https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=85ae6392d0e94010a305eedf06e3f288
Data Owner	NCDEQ
Date Created	2015
Date of Access	February 2023
Frequency of Updates	3 Year cycle
Updates Needed	Yes
Type of Flooding	Agricultural and Mining Flooding

Dataset Event Frequencies:

N/A

Benefits:

Provides locations of livestock.

Limitations:

Lacks detailed information about each location.

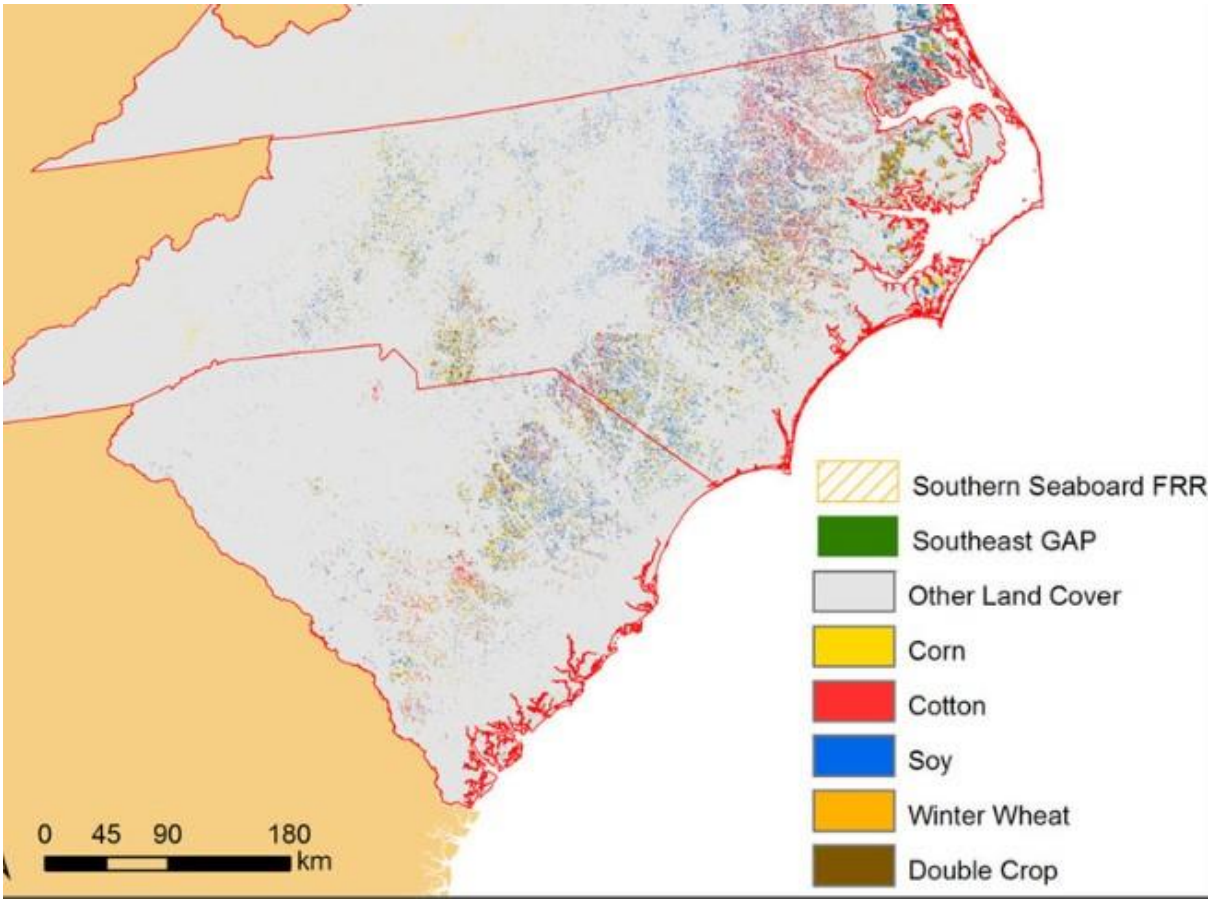
Dataset should be updated by:

Consider how to quantify this information from a loss of livestock.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.3.21 Hazards and Vulnerability Research Institute at the University of South Carolina and United States Department of Agriculture: Crops



Dataset Summary Information

Source of Information	Hazards and Vulnerability Research Institute at the University of South Carolina and United States Department of Agriculture
Link to Online Data	https://cemhs.asu.edu/sheldus https://planetarycomputer.microsoft.com/dataset/usda-cdl
Data Owner	Hazards and Vulnerability Research Institute at the University of South Carolina and United States Department of Agriculture
Date Created	2003
Date of Access	February 2023
Frequency of Updates	N/A
Updates Needed	Yes

Type of Flooding	Agricultural and Mining Flooding

Dataset Event Frequencies:

N/A

Benefits:

Large database with many fields.

Limitations:

Appears to need a paid subscription; however, source data may be publicly accessible through USGS/USDA. GAP data are not updated frequently.

Dataset should be updated by:

Look into further if this would be useful.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.4 Built Environment

There are 15 datasets that have been identified, reviewed, and classified as Built-Environment datasets for use in the Blueprint. Of the 15 total Built-Environment datasets, 65 are classified as essential and 10 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-4.

Table 2-4: Built-Environment Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
NC Risk Database, Oak Ridge Lab, and Microsoft BING: Building Footprints	F, P, U, FF, C, OP	10	8	8	6	8
NCEM: Critical Infrastructure and Key Resources (NCEM)	F, P, U, FF, C, OP	8	8	8	8	10
NCEM: Dam Breach Modeling of High and Intermediate Hazard Dams	D/L, F	4	4	6	8	8
USACE: Dam Inventory	D/L, F	6	4	8	8	6
NC Center for Geographic Information and Analysis (CGIA): Parcel	NFS	8	6	6	6	8

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
Local Governments: Sewer Overflow	U, FF	4	4	4	8	6
EPA and NCDEQ: Storage Tanks, Wastewater Treatment Plant (WWTP), Power Plants. Factories, Contaminated Areas/Brownfields, etc.	U, FF	10	6	8	8	6
NCDOT: Loss of Service (Traffic Count)	F, P, U, FF, C, OP	6	8	8	8	8
Duke Energy: Duke Energy Studies	D/L, F	TBD	TBD	TBD	TBD	TBD
Duke Energy: Duke Energy Lake Regulations	D/L, F	4	2	6	8	6
NCDEQ: National Dam and Levee Inventory Databases	D/L, F	8	6	6	8	8
Deltares: Global Water Availability	D/L, F	TBD	TBD	TBD	TBD	TBD
National Aquatic Barrier Inventory and Prioritization Tool	D/L, F	7	9	8	5	6
USDA Census of Agriculture	A/M	TBD	TBD	TBD	TBD	TBD
NCDEQ: Mining	A/M	10	4	4	8	4

(N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding, A&M; Mining Flooding, A&M; Natural Disasters , ND; Non-Flooding Source, NFS; All Types of Flooding, ALL)

2.4.1 NC Risk Database, Oak Ridge Lab, and Microsoft BING: Building Footprints

Dataset Summary Information

Source of Information	NC Risk Database, Oak Ridge Lab, and Microsoft BING
Link to Online Data	https://fris.nc.gov/arcgis/rest/services/Shared/NC_AllBuildings/MapServer https://fris.nc.gov/fris/Home.aspx?ST=NC https://disasters.geoplatform.gov/publicdata/Partners/ORNL/USA_Structures/North percent20Carolina/ https://blogs.bing.com/maps/2018-06/microsoft-releases-125-million-building-footprints-in-the-us-as-open-data
Data Owner	NC Risk Database, Oak Ridge Lab, and Microsoft BING
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban, Flash, Coastal, Overland

Dataset Event Frequencies:

N/A

Benefits:

Essential data for determination of structural flood risk. Useful for investigation, evaluation, and comparison of mitigation options, and disaster planning and response.

Limitations:

Data needs to be updated because this was compiled once across the state approximately 10 years ago. Minor updates in the identified SFHA during Advisory Flood project. Data confidence varies greatly based on original data sources used for conflation of attributes (field-derived/parcel-derived/HAZUS-derived). There is no sole authoritative building footprint source (universal across all applications (FIMAN, FRIS, State Emergency Response Application (SERA)). Limited options for determination of future risk to structures.

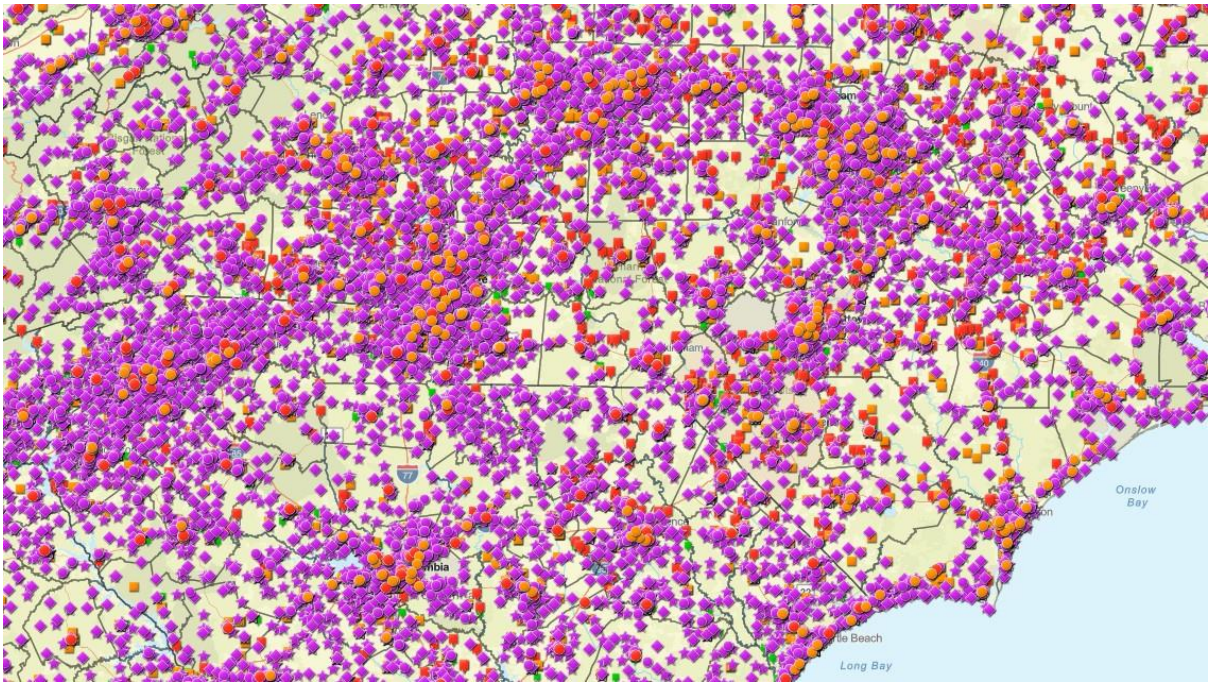
Dataset should be updated by:

NCEM is currently updating building footprints, having completed this task for roughly half of the state, and should complete the remainder of the state by next year. Need to gather new FFE data in the floodplain. Improve North Carolina's existing footprints with AI to capture ongoing developments and demolitions. Modernize and normalize the schema and update iRISK workflow and associated tools and applications/websites. More comprehensive effort to identify and update existing building footprints (strategy for data maintenance is in development at CGIA/NCEM). Formalize parcel data across the state to provide a consistent standard to be used for attribution of risk-based data for building footprints. Ghost footprints have been used to project structure risk in the near future. Future risk determinations for mid-century and end-of-century would need to include developed future hazard analyses as well as future assets at risk by using projected parcel or landcover data.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: FFE and Building Attributes. To quantify risk, use to providing building attributes to calculate damage cost, typically from damage depth-curves.

2.4.2 NCEM: Critical Infrastructure and Key Resources (NCEM)



Dataset Summary Information

Source of Information	NCEM
Link to Online Data	https://fris.nc.gov/arcgis/rest/services/RMT2 https://fema.maps.arcgis.com/apps/webappviewer/index.html?id=90c0c996a5e242a79345cdbc5f758fc6
Data Owner	NCEM
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban, Flash, Coastal, Overland

Dataset Event Frequencies:

N/A

Benefits:

Identify structures of critical importance for prioritization of risk reduction. It is essential to know at what flood frequency these facilities require evacuation or when access may be compromised.

Limitations:

Data need to be updated; this was compiled once across the state approximately 10 years ago. Need to analyze any access issues, as well as transportation routes in general, for redundancy during flood emergencies.

Dataset should be updated by:

Determine other ESRI data that exist or are being developed. Identify planned critical structures. Update data to include any critical facilities developed or planned since the last update of the database.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Transportation Attributes (Roads and Bridges), Demographic Attributes (Economic, Social, etc.), and Environmental Attributes. To quantify risk, identify location, and potentially the impact area of various key resource to calculate damage costs.

2.4.3 NCEM: Dam Breach Modeling of High and Intermediate Hazard Dams

Note: Subtask 2.4 report contains detailed discussion of this dataset

Dataset Summary Information

Source of Information	North Carolina Emergency Management
Link to Online Data	https://sera.nc.gov/SERA/*
Data Owner	State of North Carolina
Date Created	2017
Date of Access	February 2023
Frequency of Updates	Uncertain
Updates Needed	No
Type of Flooding	Dam and Levee, Fluvial

* Site is access restricted

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
				x				x				x	x		

Benefits:

Identifies flooding of dam and levee breaches.

Limitations:

Often limited to a few scenarios and may be out of date.

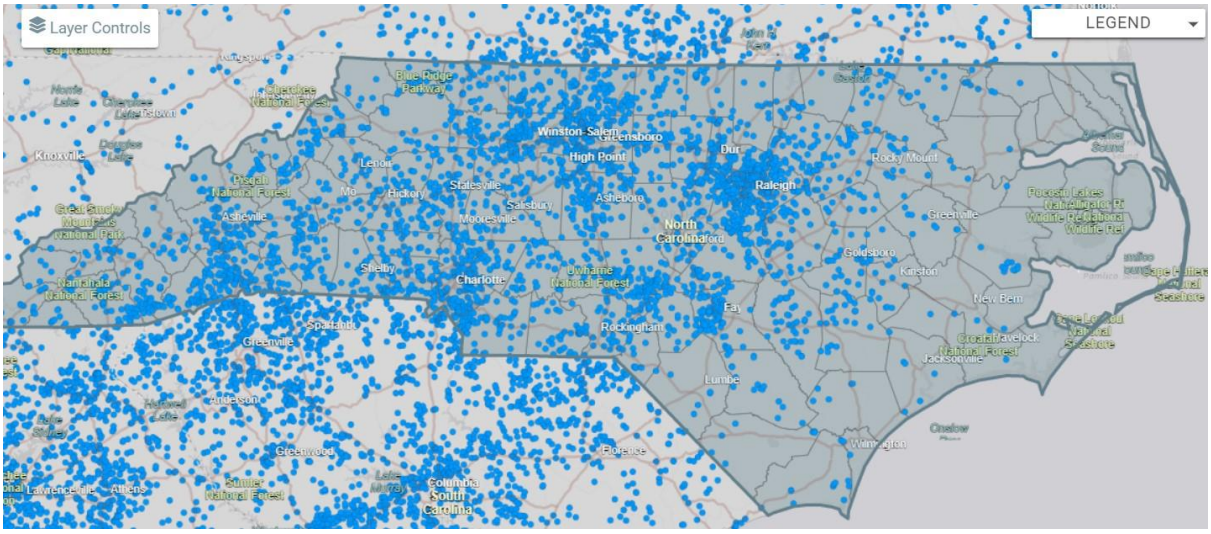
Dataset should be updated by:

Ensure a digital dataset exists with the appropriate attributes.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), Duration and Time Variable, and Hydrology. To quantify risk, determine the impact of a dam or levee breach.

2.4.4 USACE: Dam Inventory



Dataset Summary Information

Source of Information	USACE
Link to Online Data	https://nid.usace.army.mil/#/ https://fris.nc.gov/arcgis/rest/services/NC_Effective/FRIS_Structures/MapServer
Data Owner	USACE
Date Created	1975
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies:

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
				x				x				x	x		

Benefits:

Identifies areas at risk in event of dam breach and quantifies risk to manmade environment. Can help identify areas at potential risk from a dam or lagoon breach. Used for identification and analysis of mitigation solutions related to physical or operational changes to dams.

Limitations:

Need to add more breach scenarios, does not include low hazard, including many agricultural lagoons, and NCEM 2D analysis does not cover all dams in the Neuse River Basin. Inconsistent availability of Operations and Maintenance data, and all significant structural data for some dams.

Dataset should be updated by:

Identify dams that may provide mitigation benefits, and perform additional analysis as needed. Complete risk analysis on dams not analyzed by NCEM.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), Duration and Time Variable, and Hydrology. To quantify risk, determine the impact of a dam or levee breach.

2.4.5 NC Center for Geographic Information and Analysis (CGIA): Parcel Data

Dataset Summary Information

Source of Information	North Carolina Center for Geographic Information and Analysis (CGIA)
Link to Online Data	https://www.nconemap.gov/pages/parcels
Data Owner	CGIA
Date Created	Various
Date of Access	March 2023
Frequency of Updates	Quarterly
Updates Needed	Yes
Type of Flooding	Non- Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Data from parcel information can be conflated with building footprints and incorporated into the NC Risk Database and used for risk assessments. Can be used in combination with zoning data and adjacent parcels to develop estimates of future land use.

Limitations:

Locally derived parcel data lacks consistent attributes. Many communities do not have the appropriate level of data to support detailed risk analyses.

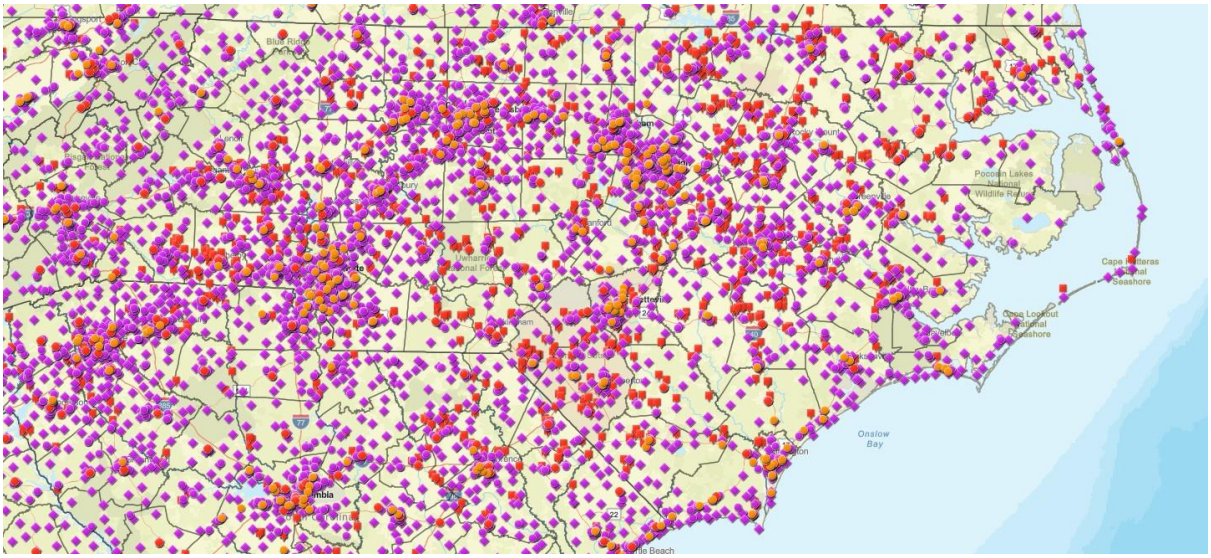
Dataset should be updated by:

Compile and normalize data. Consider comparing footprints because multiple buildings may be on a single parcel, demolished, or built.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Building Attributes. To quantify risk, relate parcel information to building footprints for additional and more up-to-date information.

2.4.6 Local Governments: Sewer Overflow



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	Unidentified
Data Owner	Local Governments
Date Created	Varies
Date of Access	February
Frequency of Updates	Varies
Updates Needed	No
Type of Flooding	Urban, Flash

Dataset Event Frequencies:

N/A

Benefits:

Not to be confused with stormwater; sewer systems become flooded and overflow.

Limitations:

Would likely require an enormous effort to gather and analyze all the systems. Each municipality would have varying quality and availability of datasets.

Dataset should be updated by:

Consider identifying historic or current areas experiencing overflowing sewer systems as potential mitigation problems.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Environmental Attributes. To quantify risk, identify location and potentially the impact area of various key resources to calculate damage costs.

2.4.7 EPA and NCDEQ: Storage Tanks, WWTP, Power Plants, Factories, Contaminated Areas/Brownfields, etc.

Dataset Summary Information

Source of Information	EPA and NCEM
Link to Online Data	https://www.epa.gov/airmarkets/power-plants-and-neighboring-communities-map https://deq.nc.gov/about/divisions/waste-management/science-data-and-reports/gis-maps/brownfields-projects-map-inventory-and-document-download https://geodata.epa.gov/arcgis/rest/services/OEI/FRS_Wastewater/MapServer/
Data Owner	EPA and NCDEQ
Date Created	Varies
Date of Access	February 2023
Frequency of Updates	Varies
Updates Needed	Yes
Type of Flooding	Urban, Flash

Dataset Event Frequencies:

N/A

Benefits:

Flooding can happen from other sources besides water or mix with the floodwaters and create a worse hazard such as flooding of hog lagoons, other agricultural waste lagoons, and non-point sources.

Limitations:

May need to look beyond the database for quantitative information.

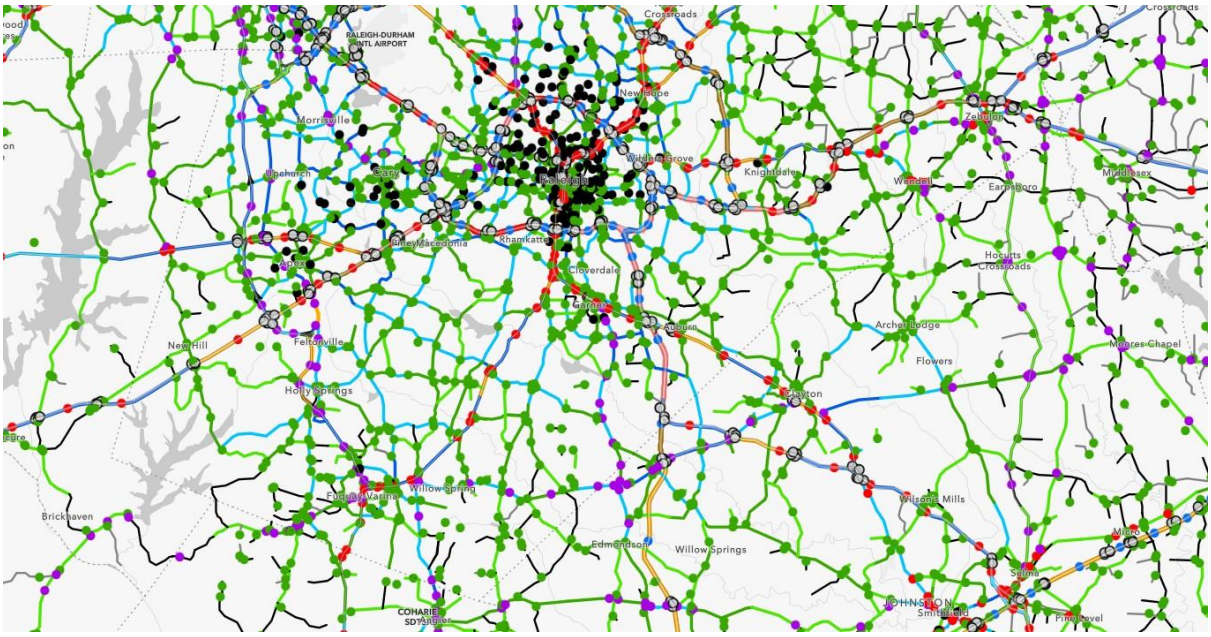
Dataset should be updated by:

Identify all potential pollutant hazards that could occur when flooding and determine how to implement these.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Environmental Attributes. To quantify risk, identify location and potentially the impact area of various key resource to calculate damage costs.

2.4.8 NCDOT: Loss of Service (Traffic Count)



Dataset Summary Information

Source of Information	NCDOT
Link to Online Data	https://ncdot.maps.arcgis.com/apps/webappviewer/index.html?id=964881960f0549de8c3583bf46ef5ed4 https://connect.ncdot.gov/resources/State-Mapping/Pages/Traffic-Survey-GIS-Data.aspx
Data Owner	NCDOT
Date Created	2021
Date of Access	February 2023
Frequency of Updates	Annually
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban, Flash, Coastal, Overland

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Great for calculating loss of service cost in a Benefit-Cost Analysis (BCA), expected impact of flood, etc.

Limitations:

Does not cover minor or private roads.

Dataset should be updated by:

Consider linking or appending it to other NCDOT layers.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Transportation Attributes (Roads and Bridges). To quantify risk, calculate loss of service costs, determine evacuation routes, etc.

2.4.9 Duke Energy: Duke Energy Studies

Dataset Summary Information

Source of Information	Duke Energy
Link to Online Data	Unidentified
Data Owner	Duke Energy
Date Created	Unknown
Date of Access	February 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
												x	x		

Dataset should be updated by:

Use to map flood hazard for the dam and obtain information such as Local Intense Precipitation (LIP), PMP, PMF.

Benefits:

Study looks at: storm surge, LIP – PMP, streams and rivers (river; PMF), failure of dams and onsite water control/storage structures under PMF conditions, seiche, tsunami (only applicable to evaluating coastal sites, Brunswick), ice-induced flooding (in the Carolinas, this is not applicable), and channel migrations/diversions.

Limitations:

Studies may be out of date, and permission may not be given to access the information.

Dataset should be updated by:

Use to map flood hazard for the dam and obtain information such as LIP, PMP, and PMF.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Inundation Boundary, WSEL, Transportation Attributes (Roads and Bridges), Duration and Time Variable, and Hydrology. To quantify risk, determine the impact of a dam or levee breach.

2.4.10 Duke Energy: Duke Energy Lake Regulations

Current Lake Levels

Lake levels are reported with normal full pond elevation of 100 feet. Please select a lake to view more details.

Catawba - Wateree

NAME OF LAKE	ACTUAL	TARGET	MINIMUM	MAXIMUM	DROUGHT STAGE	RANGE	DATE LAKE MESSAGE UPDATED
LAKE JAMES	95.4	94.5	92	100	ND	View	None
LAKE RHODHISS	97.7	97	94	100	ND	View	1/9/2023 12:34:00 PM
LAKE HICKORY	98.6	96.5	94	100	ND	View	None
LOOKOUT SHOALS LAKE	96.8	97	94	100	ND	View	None
LAKE NORMAN	96.3	94.6	91.6	100	ND	View	None
MOUNTAIN ISLAND LAKE	97.0	96	94.3	100	ND	View	None

Dataset Summary Information

Source of Information	Duke Energy
Link to Online Data	https://www.duke-energy.com/community/lakes https://files.nc.gov/ncdeq/Water percent20Quality/Planning/BPU/BPU/Catawba/Catawba percent20Plans/2010 percent20Plan/Chapter percent204 percent20- percent20Chain percent20of percent20Lakes.pdf
Data Owner	Duke Energy
Date Created	1904
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies:

N/A

Benefits:

Understand regulation of lakes.

Limitations:

Cryptic information that needs to be decoded to use. Scheduled flow releases are subject to variability based on natural conditions and/or unexpected changes in hydro project operation. Duke Energy may, at any time and without warning, modify the scheduled flow releases, which may affect water levels, water availability, and arrival or recession times.

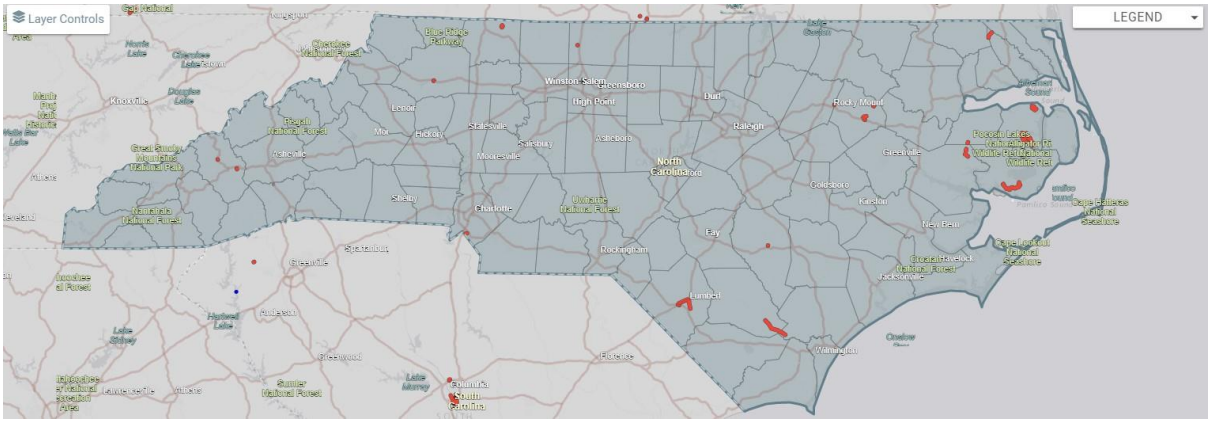
Dataset should be updated by:

Decipher information and determine how to use this information when considering regulated lakes controlled by Duke Energy.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: WSEL and Real Time. To quantify risk, predict real-time discharges and storage of dams from lake operating elevations.

2.4.11 NCDEQ: National Dam and Levee Inventory Databases



Dataset Summary Information

Source of Information	NCDEQ
Link to Online Data	https://northcarolinadeptofenvandnat.sharefile.com/share/view/s5bc5eb354fa54907b0d903b2de0c447a/fo90c5d4-716c-47a3-8521-c8b4280ce3ea
Data Owner	NCDEQ
Date Created	2022
Date of Access	February 2023
Frequency of Updates	2-Year cycle
Updates Needed	Yes

Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
				x				x							

Benefits:

Identifies locations of dams with their associated hazard and attributes.

Limitations:

Many useful fields are missing.

Dataset should be updated by:

Dams are challenging because they greatly impact (benefit/worsen) flooding and are erratic in discharge and operations. One failure can also lead to a chain of failures. For modeling purposes, a rating curve would be ideal at each location with operating (timing) procedures. Additionally, the ability to compare current WSEL versus typical and operating would be beneficial to account for storage or discharge volume.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.4.12 Deltares: Global Water Availability

Dataset Summary Information

Source of Information	Deltares
Link to Online Data	https://planetarycomputer.microsoft.com/dataset/deltares-water-availability
Data Owner	Deltares
Date Created	1970
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x			x	

Benefits:

Hydrological model approach to simulate historical daily reservoir variations for 3,236 locations across the globe for the period 1970-2020 using the distributed **wflow_sbm** model. The model outputs long-term daily information on reservoir volume, inflow, and outflow dynamics, as well as information on upstream hydrological forcing.

Limitations:

Only covers a few reservoirs.

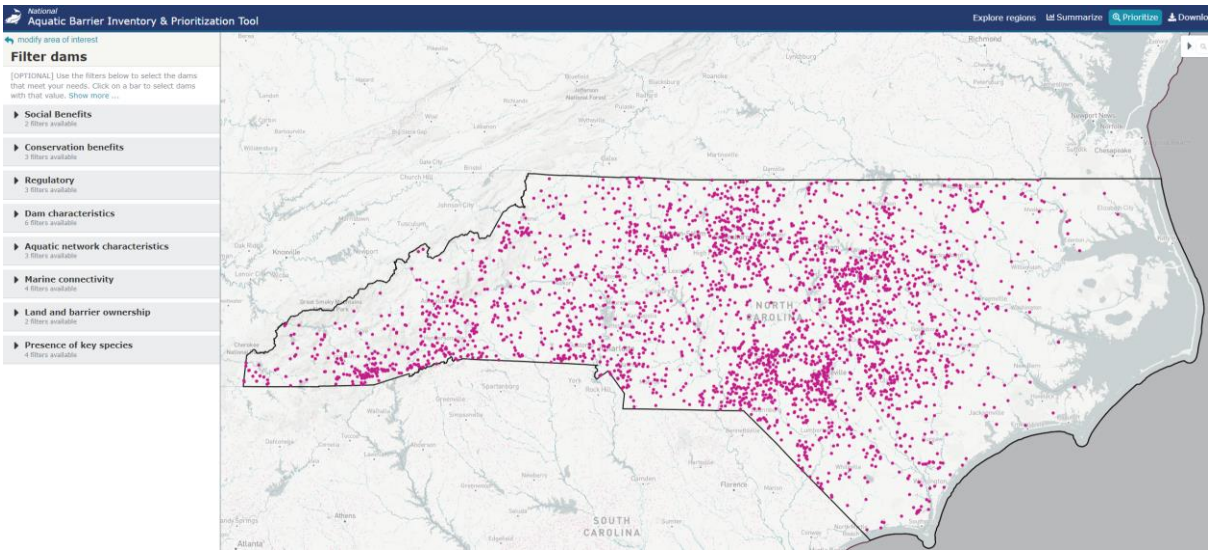
Dataset should be updated by:

Consider creating a similar process specific to North Carolina.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: WSEL and Real Time. To quantify risk, predict real-time discharges and storage of dams from lake operating elevations.

2.4.13 National Aquatic Barrier Inventory and Prioritization Tool



Dataset Summary Information

Source of Information	Southeast Aquatic Resources Partnership
Link to Online Data	https://aquaticbarriers.org/
Data Owner	Southeast Aquatic Resources Partnership
Date Created	Data version: 3.0.0 (7/14/2023)
Date of Access	August, 2023
Frequency of Updates	Automatic scripts extract data approximately four times a year and check for updates to incorporate into the National Inventory
Updates Needed	Yes

Type of Flooding	Dam and Levee, Fluvial

Dataset Event Frequencies:

N/A

Benefits:

Pulls from numerous sources and intersects a variety of variables.

Limitations:

Some data attributes are missing. Does not include beaver dams or other non-structural barriers.

Dataset should be updated by:

Referring to National Inventory after each quarterly data update.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Hydrology, Environmental, Demographic, Building, Sheer Stress, and Transportation.

2.4.14 USDA Census of Agriculture

Dataset Summary Information

Source of Information	USDA
Link to Online Data	https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/North_Carolina/index.php
Data Owner	USDA
Date Created	2017
Date of Access	August 2023
Frequency of Updates	Once every 5 years (next update in 2024)
Updates Needed	Yes
Type of Flooding	Agricultural and Mining

Dataset Event Frequencies:

N/A

Benefits:

Covers multiple interrelated agricultural topics.

Limitations:

Geospatial extent limited.

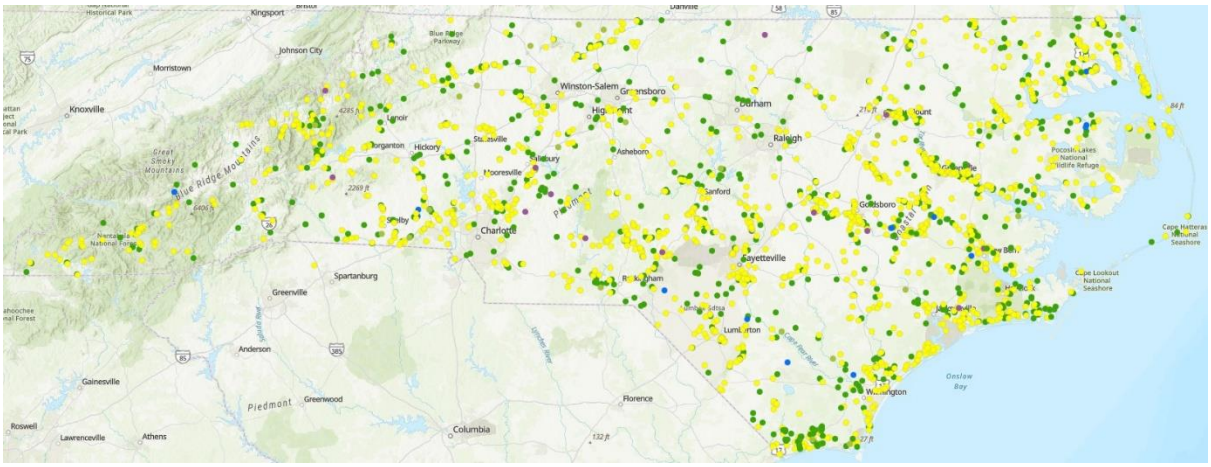
Dataset should be updated by:

Refers to updated census data every 5 years.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.4.15 NCDEQ: Mining



Dataset Summary Information

Source of Information	NCDEQ
Link to Online Data	https://www.arcgis.com/apps/View/index.html?appid=0e67f71c4a0d4deb8da73f1b42f4b577
Data Owner	NCDEQ
Date Created	1971
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Agricultural and Mining

Dataset Event Frequencies:

N/A

Benefits:

Provides locations of mines.

Limitations:

Lacks detail.

Dataset should be updated by:

Consider how to use this as a flood sink, or a flood hazard, etc.

Risk Quantifier:

This source cannot be used to quantify existing or future risk: Environmental Attributes. The process to quantify risk is currently unknown.

2.5 Demographic Datasets

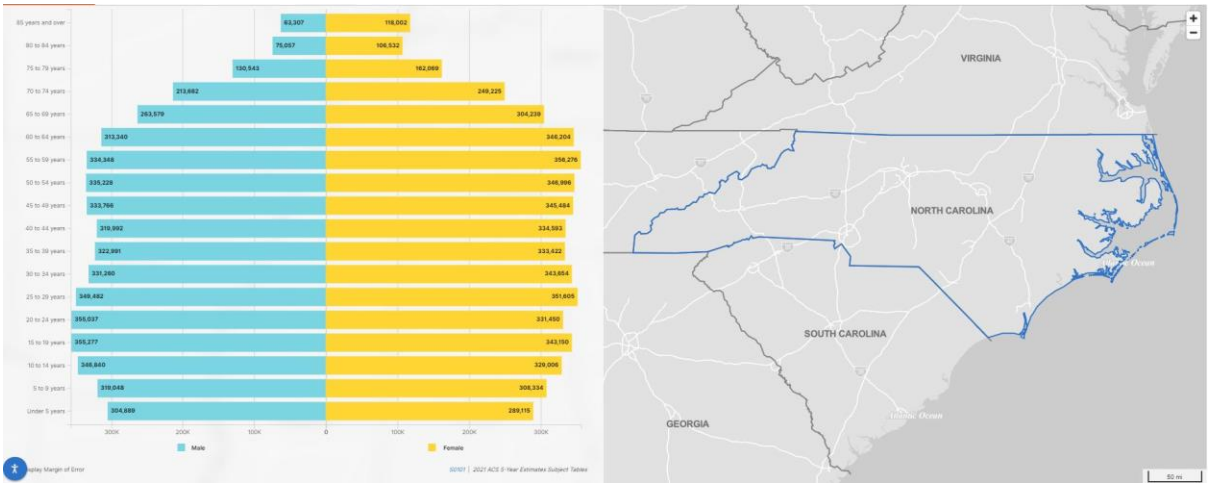
There are 10 datasets that have been identified, reviewed, and classified as Demographics datasets for use in the Blueprint. Of the 10 total Demographics datasets, 8 are classified as essential and 2 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-5.

Table 2-5: Demographics Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
US Census: Population Datasets	NFS	10	6	6	6	6
CDC: CDC Social Vulnerability Index (SVI) and Dr. Susan Cutter SoVI	NFS	10	8	6	6	8
CEQ: Climate and Economic Justice Screening Tool (CEJST	NFS	10	8	8	6	8
U.S Department of Housing and Urban Development (HUD)/Community Planning and Development (CPD): Low to Moderate Income	NFS	10	6	6	4	6
NC State Historic Preservation Office, National Registry of Historic Places: Cultural Resources	NFS	10	8	8	6	6
FEMA: National Risk Index (NRI)	NFS	10	8	8	6	8
EPA: EPA EJSCREEN	NFS	10	8	8	6	8
Local Governments: Elected/Community Officials	NFS	TBD	TBD	TBD	TBD	TBD
United States Census Bureau: Commuter Information (US Census, Onthemap)	NFS	10	8	8	8	10
The Land Conservancy (TLC), Riverkeepers, etc.: Non-Profits	NFS	TBD	TBD	TBD	TBD	TBD

(N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding, A&M; Mining Flooding, A&M; Natural Disasters , ND; Non-Flooding Source, NFS; All Types of Flooding, ALL)

2.5.1 US Census: Population Datasets



Dataset Summary Information

Source of Information	US Census
Link to Online Data	https://data.census.gov/profile/North_Carolina?g=0400000US37 https://www.osbm.nc.gov/facts-figures/population-demographics/state-demographer/countystate-population-projections
Data Owner	US Census Bureau
Date Created	2021
Date of Access	March 2023
Frequency of Updates	10-Year cycle
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Useful for Benefit Cost Analysis(BCA) and funding to show populations (numbers and demographics) benefiting from activities that increase resilience to disasters.

Limitations:

May be out of date.

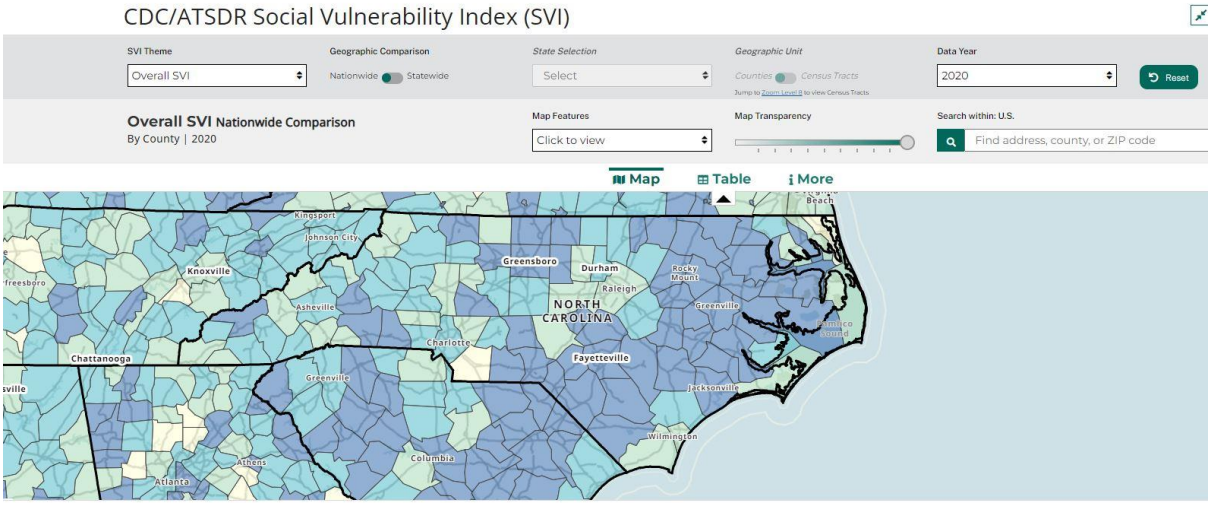
Dataset should be updated by:

Supplement with other datasets for a more accurate dataset, such as the Office of State Budget and Management data (URL in link to online data above).

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.2 CDC: CDC Social Vulnerability Index (SVI) and Dr. Susan Cutter SoVI



Dataset Summary Information

Source of Information	CDC
Link to Online Data	https://www.atsdr.cdc.gov/placeandhealth/svi/interactive_map.html
Data Owner	CDC
Date Created	2020
Date of Access	March 2023
Frequency of Updates	2 to 4 Years
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

This dataset is widely used by many federal agencies and programs to estimate social vulnerability, to develop community support plans and stakeholder engagement plans, pre- and post-disaster emergency response, and is often tied to project funding.

Limitations:

No clear indicators that provide information on unhoused populations, which is difficult data to collect.

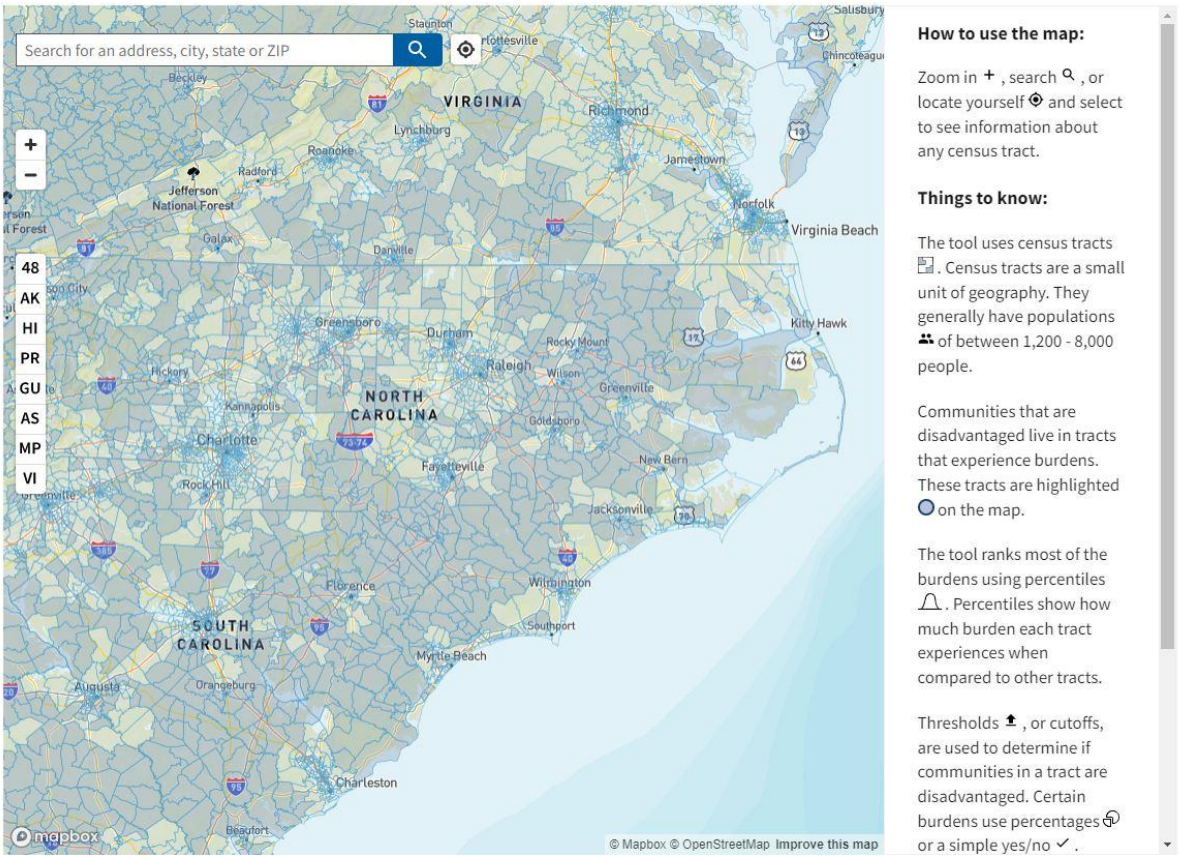
Dataset should be updated by:

Supplement with other datasets (NRI, SVI, EJSCREEN, SoVI, etc.) for a more comprehensive view of risk, burden, vulnerability, and resiliency.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.3 CEQ: Climate and Economic Justice Screening Tool (CEJST)



Dataset Summary Information

Source of Information	Council on Environmental Quality (CEQ)
Link to Online Data	https://screeningtool.geoplatform.gov/en/#6.29/35.385/-78.958
Data Owner	CEQ
Date Created	2022
Date of Access	March 2023
Frequency of Updates	N/A
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Identifies whether projects fall in communities that will contribute to the J40 goal, which also comes into play with infrastructure Investment and Jobs Act (IIJA) funding.

Limitations:

Does not consider race in any way, which is a primary indicator of environmental and social vulnerability. Has weak climate change indicators. Uses limited socioeconomic indicators.

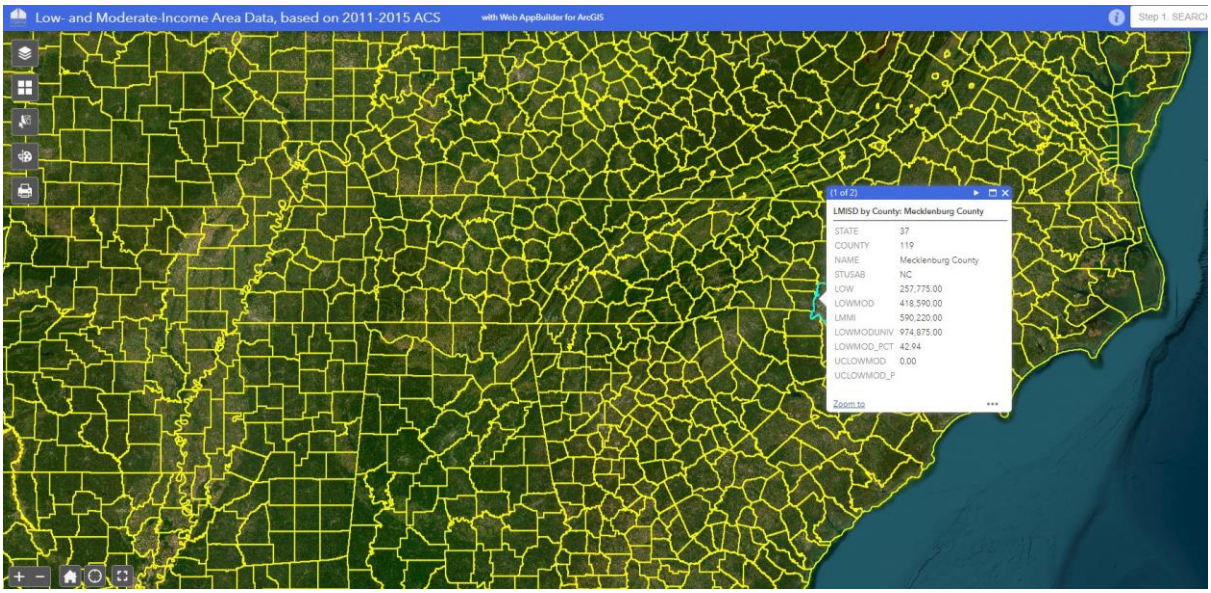
Dataset should be updated by:

Supplement with other datasets (NRI, SVI, EJSCREEN, SoVI, etc.) for a more comprehensive view of risk, burden, vulnerability, and resiliency.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.4 HUD/CPD: Low to Moderate Income



Dataset Summary Information

Source of Information	HUD/CPD
Link to Online Data	https://hud.maps.arcgis.com/apps/webappviewer/index.html?id=ffd0597e8af24f88b501b7e7f326bedd
Data Owner	HUD/CPD
Date Created	2022
Date of Access	March 2023
Frequency of Updates	5-Year cycle
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

The LMI is used for funding purposes and in BCA to support funding in traditionally underserved areas. Typically, projects can apply for certain funding, such as the Community Development Block Group (CDBG) program if the average LMI value of the project area is above 51 percent.

Limitations:

Multiple groupings can be chosen that lead to inconsistent results. Drastic changes between versions. Ground truth may not match data.

Dataset should be updated by:

Supplement with other datasets (NRI, SVI, EJSCREEN, SoVI, etc.) for a more comprehensive view of risk, burden, vulnerability, and resiliency.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.5 NC State Historic Preservation Office, National Registry of Historic Places: Cultural Resources

Dataset Summary Information

Source of Information	National Registry of NC State Historic Preservation Office
Link to Online Data	https://www.ncdcr.gov/about/history/division-historical-resources/state-historic-preservation-office/gis-maps-and-data#GISDataDownload-1754
Data Owner	National Registry of NC State Historic Preservation Office
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	N/A
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Protecting culturally or historically significant areas from flooding is vital to preserving benefits of historical areas and can help support project funding. Areas or structures at risk that carry this classification may merit higher consideration for mitigation or may impact decisions in the alternative analyses.

Limitations:

Last updated in 2018, so may be out of date. Source information may not be accurate.

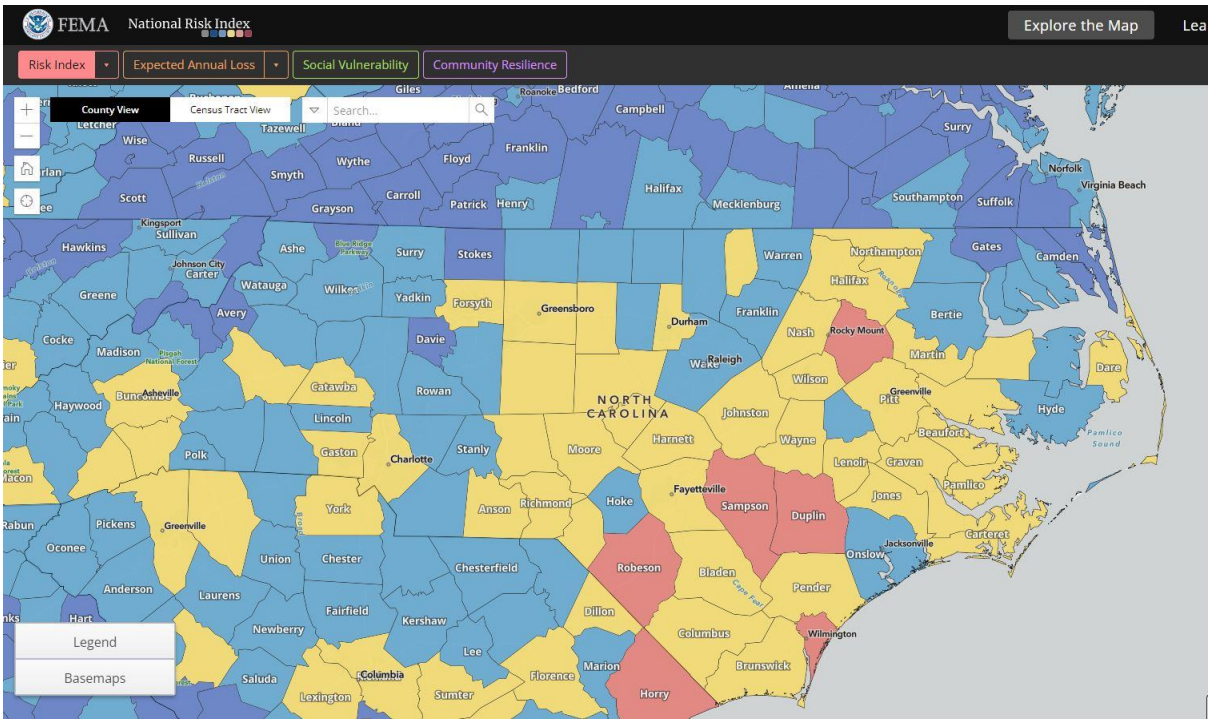
Dataset should be updated by:

Determining what fields would be useful and if the dataset is complete.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify Historic properties with a special risk, because they cannot be replaced.

2.5.6 FEMA: National Risk Index (NRI)



Dataset Summary Information

Source of Information	FEMA
Link to Online Data	https://hazards.fema.gov/nri/map
Data Owner	FEMA
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	N/A
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Provides flood risk assessment based on expected losses, social vulnerability, and community resilience. Rating is provided on each of those individually, as well as a combined risk score.

Limitations:

Uses Expected Annual Loss (EAL), which is a dollar value partially based on building value as part of the scoring. This inherently provides a less equitable viewpoint of loss because underserved areas will often have lower building values. FEMA has recently decided the social vulnerability component of the NRI will switch from using SoVI® to CDC's SVI. It is not known when that change will be incorporated. Does not consider future climate changes in evaluating risk.

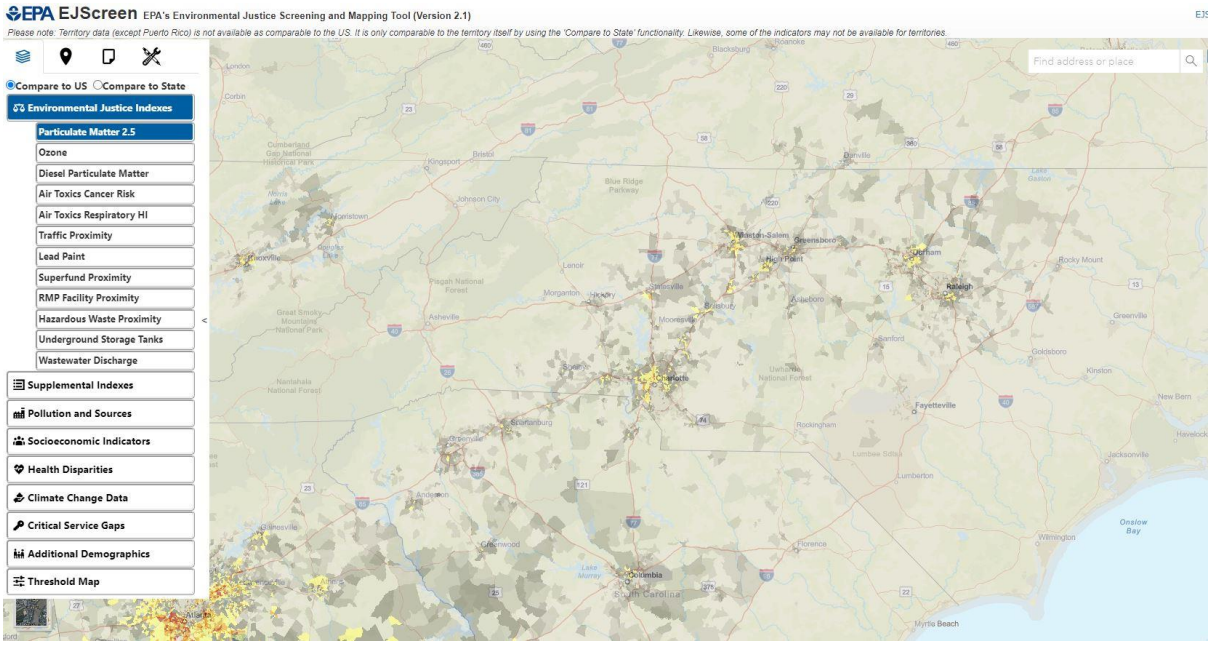
Dataset should be updated by:

Incorporate use of EAL Rates rather than EAL to provide a more equitable viewpoint of expected annual losses. Assess the EAL and Resiliency scores rather than the overall risk score, and view vulnerability using SVI. Another option is to develop a unique risk score calculation subbing SVI for SoVI®, or a mix of the two. Incorporate use of climate change indicators, tools, and datasets.

Risk Quantifier:

This source can be an existing and future risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.7 EPA: EPA EJSCREEN



Dataset Summary Information

Source of Information	EPA
Link to Online Data	https://ejscreen.epa.gov/mapper/
Data Owner	EPA
Date Created	N/A
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Widely used to assess environmental burdens that further exasperate a community's resiliency.

Limitations:

Does not assess cumulative impacts. Can assess individual environmental and socioeconomic indicators.

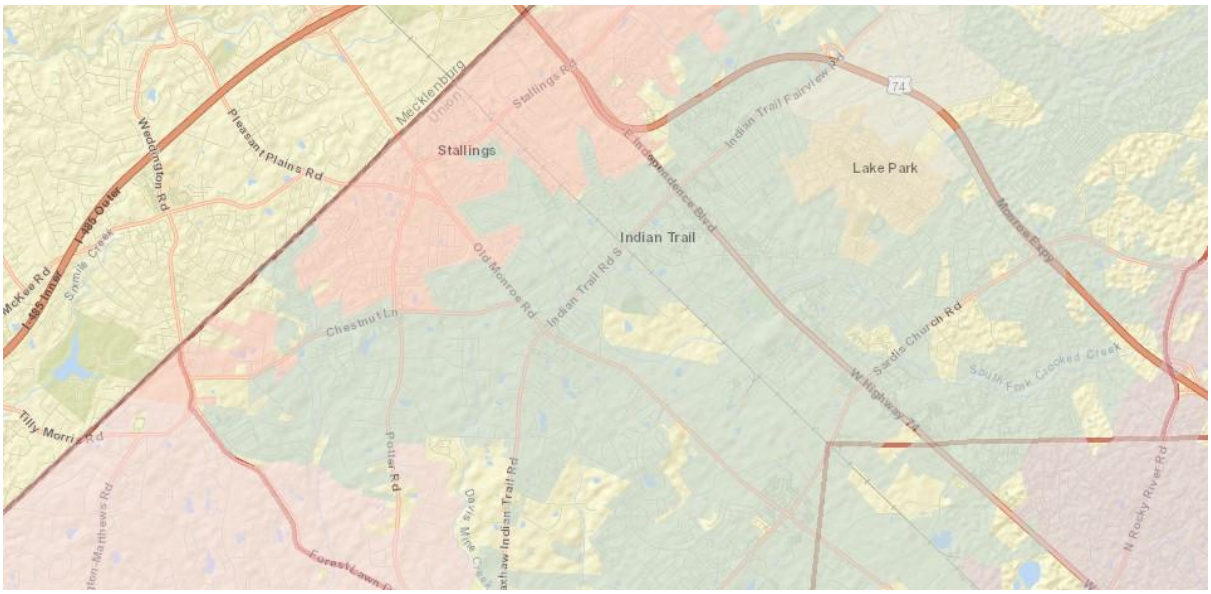
Dataset should be updated by:

Develop an approach to assessing overall cumulative impacts of indicators essential to a given community/region of a project. Incorporate any local/regional environmental data specifically of concern to the region.

Risk Quantifier:

This source can be an existing risk quantifier using the following factor: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the demographic and its risk, help plan evacuations, etc.

2.5.8 Local Governments: Elected/Community Officials



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	Unidentified
Data Owner	Local Governments
Date Created	Various
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Points of contact.

Limitations:

Updates would need to be frequent, and the data would need Quality Assurance/Quality Control. Governments and responsibilities may change with time.

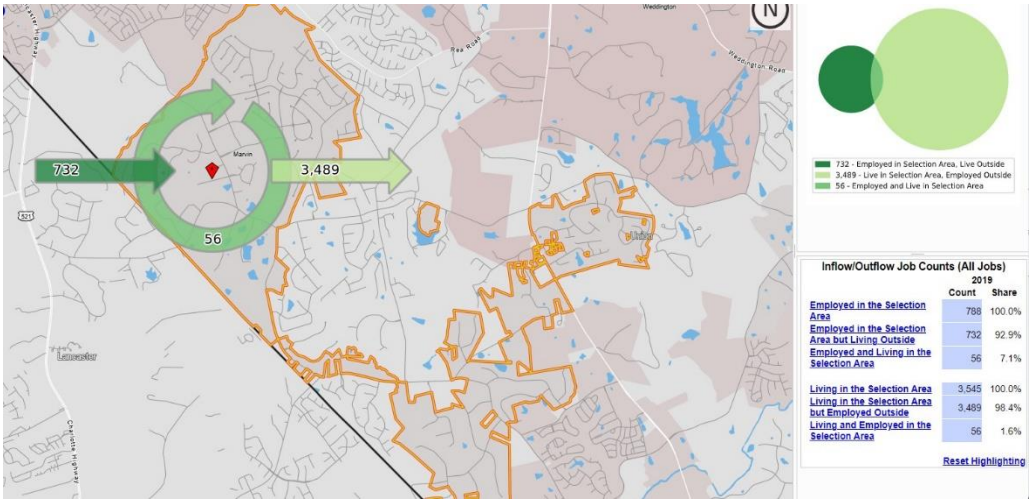
Dataset should be updated by:

Creating and maintaining this dataset may be more work than it is beneficial, so it might be best to limit the data to the main points of contacts.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.5.9 United States Census Bureau: Commuter Information (US Census, Onthemap)



Dataset Summary Information

Source of Information	United States Census Bureau
Link to Online Data	https://onthemap.ces.census.gov/
Data Owner	United States Census Bureau
Date Created	2019
Date of Access	February 2023
Frequency of Updates	Annually
Updates Needed	Yes
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Provides detailed information about where people travel for their jobs, including travel time, direction, salary, industry, and age.

Limitations:

Data are generic and would need to be estimated if applying data to a specific road. Also, updates may rely on older data because the main census is performed every 10 years.

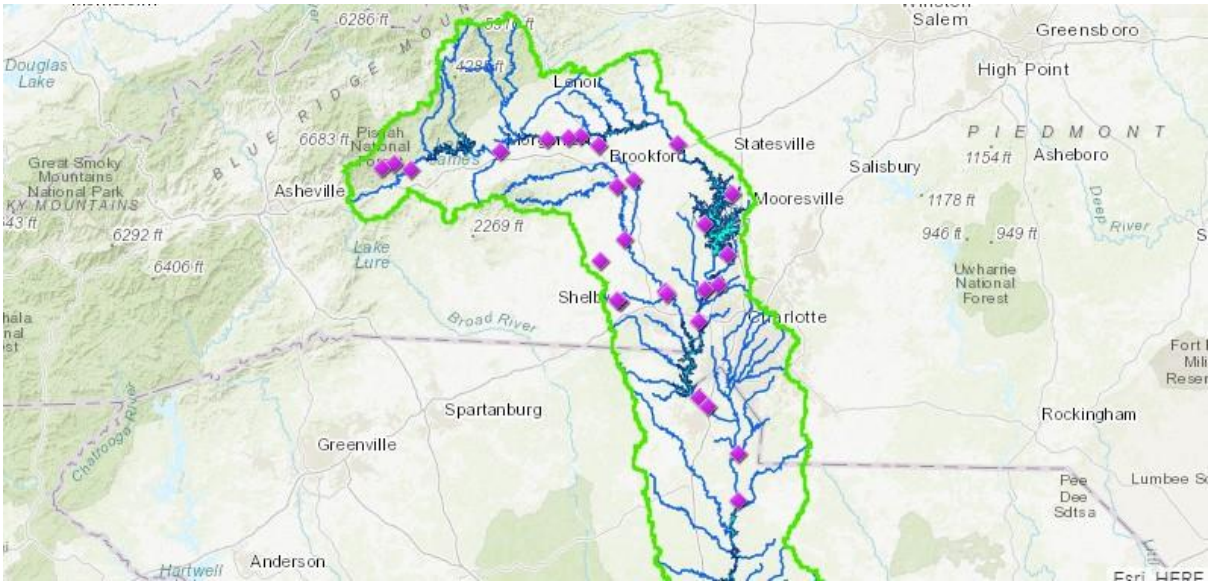
Dataset should be updated by:

Use this source to calculate economic loss of work. However, with the rise of work from home, the calculations may need additional assumptions.

Risk Quantifier:

This source can be an existing risk quantifier using Transportation Attributes (Roads and Bridges) and Demographic Attributes (Economic, Social, etc.) to quantify risk, calculate loss of service costs, determine evacuation routes, etc.

2.5.10 The Land Conservancy, Riverkeepers, etc.: Non-Profits



Dataset Summary Information

Source of Information	TLC, Riverkeepers, etc.
Link to Online Data	https://www.riverkeeper.org/riverkeeper-mission/our-story/ percent0a https://triangleland.org/strategic-conservation/planning
Data Owner	TLC, Riverkeepers, etc.
Date Created	Various
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Additional useful information and considers other important factors not already addressed.

Limitations:

With the number of organizations and the amount of information available, an extensive effort would be required to use these resources.

Dataset should be updated by:

Compile important organizations and stakeholders impacted by flooding and hazards. Research what they have already generated.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.) and Environmental Attributes. To quantify risk, determine locations of specific resources and risks.

2.6 Mitigation Support Datasets

There are 10 datasets that have been identified, reviewed, and classified as Mitigation Support datasets for use in the Blueprint. Of the 10 total Mitigation Support datasets, 4 are classified as essential and 6 are classified as supporting. The results of the dataset gap analysis scoring, as well as the associated flooding types, are summarized in Table 2-6.

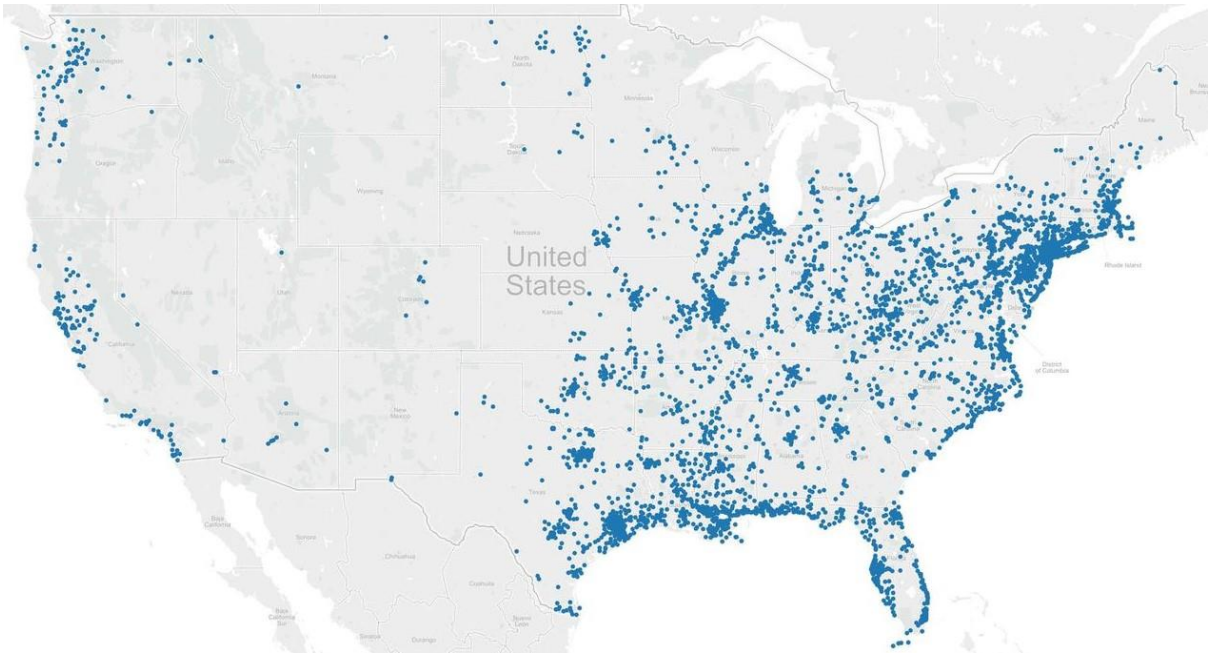
Table 2-6: Mitigation Support Dataset Gap Analysis Scoring

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
FEMA: Insurance Data (NFIP Policies and Repetitive Loss Properties)	F, P, U	4	6	8	8	10
NCEM and NCDOT: Existing Mitigation Studies in Neuse, Tar-Pamlico, Cape Fear, Cashie River and Lumber	NFS	TBD	TBD	TBD	TBD	TBD
DPS and NCORR: Existing Mitigation Plans Including HMPs, RRPs	NFS	TBD	TBD	TBD	TBD	TBD
Federal (FEMA), State, and Local: Policy Data	NFS	TBD	TBD	TBD	TBD	TBD
FEMA: Historical Flooding Support Information (e.g., IA and PA Claims, Small Business Administration [SBA] and **Hazard Mitigation Grant Program** [HMGP] Applications)	F, P, U	6	8	8	10	10
FEMA: Flood Mitigation Assistance (FMA) Grant Program	All	TBD	TBD	TBD	TBD	TBD

Dataset	Flooding Type	Gap Type and Score				
		Geospatial	Database	Specification and Quality	Temporal	Engineering Methods
Peer State Program Review	NFS	TBD	TBD	TBD	TBD	TBD
Local Governments: Other Policy Information Related to Flood Risk Mitigation and Resilience	NFS	TBD	TBD	TBD	TBD	TBD
Local Governments: Elevation Certificates	NFS	2	6	10	10	10
FEMA: CRS Communities	NFS	TBD	TBD	TBD	TBD	TBD

(N/A, Not Applicable; TBD, To Be Determined; Fluvial (Riverine) Flooding, F; Pluvial (Rain) Flooding, P; Urban and Stormwater Flooding, U; Dam and Levee Flooding , D&L; Flash Flooding, FF; Coastal Flooding, C; Frozen, S; Groundwater Flooding, GW; Overland Ponding, OP; Agricultural Flooding, A&M; Mining Flooding, A&M; Natural Disasters , ND; Non-Flooding Source, NFS; All Types of Flooding, ALL)

2.6.1 FEMA: Insurance Data (NFIP Policies and Repetitive Loss Properties)



Dataset Summary Information

Source of Information	FEMA
Link to Online Data	https://www.fema.gov/about/openfema/data-sets
Data Owner	FEMA
Date Created	1996
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	Yes
Type of Flooding	Fluvial, Pluvial, Urban,

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

These data provide a resource to spatially identify and view areas of mitigation interest and can also be used to drive stakeholder engagement. Understanding why there are fluctuations in policy base, and where there are repeat events of impacts contributes to project prioritization.

Limitations:

Limited to only claimed damages when there may be more damage not being claimed. Also, might be restricted because of personal data.

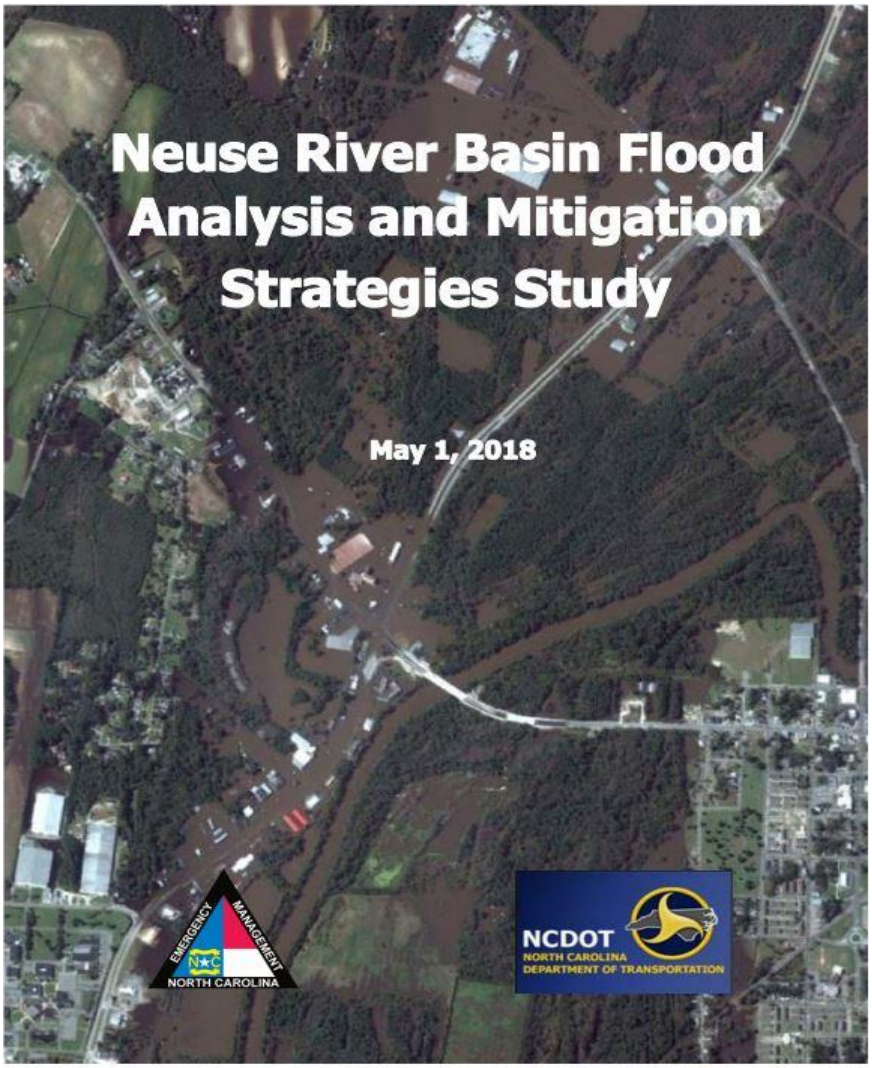
Dataset should be updated by:

Develop an analysis to better understand fluctuations in the policy base. Identify areas for repetitive loss and evaluate the opportunity to develop a Repetitive Loss Area Analysis to better understand flooding impacts at the local level.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Building Attributes. To quantify risk, identify the location of historical flooding hot spots. Additional investigation or information would be needed to quantify risk.

2.6.2 NCEM and NCDOT: Existing Mitigation Studies in Neuse, Tar-Pamlico, Cape Fear, Cashie River and Lumber



Dataset Summary Information

Source of Information	NCEM and U.S. Department of Transportation (DOT)
Link to Online Data	https://files.nc.gov/rebuildnc/documents/files/neuse_mitigation_report.pdf
Data Owner	NCEM and DOT
Date Created	Various
Date of Access	March 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Each of these studies contain useful information the Blueprint should leverage and build on, including identification of areas of key interest and historical flooding issues, recommended projects, and areas for additional study. The Blueprint needs to build on work performed to avoid exasperating local officials. Data mining these reports will help to focus effort in areas with identified flooding problems.

Limitations:

Different issues with each study, including limits on scope, study area, and age of study. This is just a sampling of the many study efforts that have taken place in the basin.

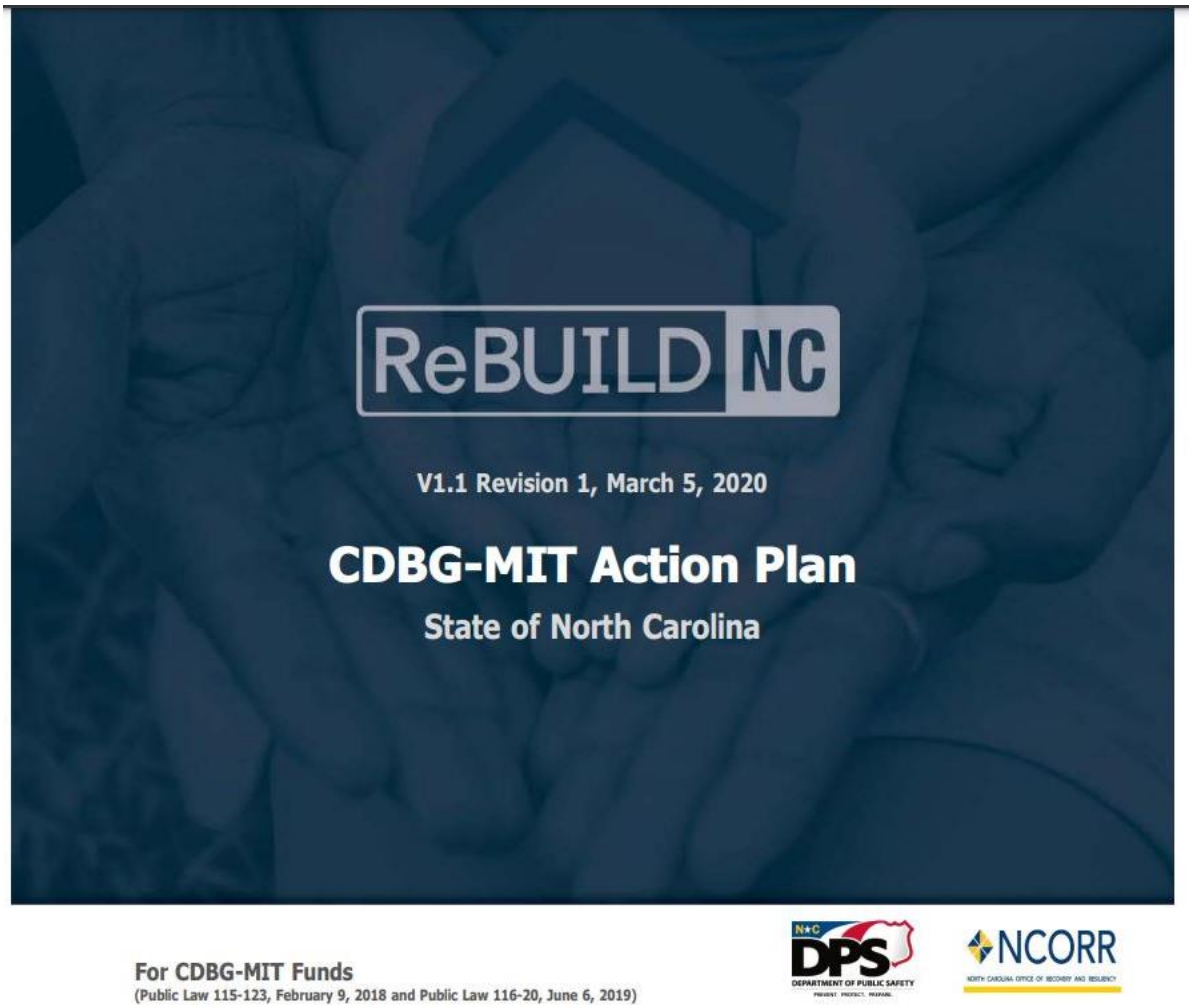
Dataset should be updated by:

Review studies and identify gaps (e.g., Pluvial, or urban flooding not addressed).

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.6.3 DPS and NCORR: Existing Mitigation Plans, Including HMPs, RRPs



Dataset Summary Information

Source of Information	DPS and NCORR
Link to Online Data	https://www.rebuild.nc.gov/media/1373/open
Data Owner	DPS and NCORR
Date Created	Various
Date of Access	March 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Having these data provides a starting point for identifying areas of concern for local officials that can be refreshed.

Limitations:

RRPs performed after Matthew, and likely need to revisit to ensure priorities are still consistent. Local officials and key stakeholders may be weary of revisiting the same issues through a new process.

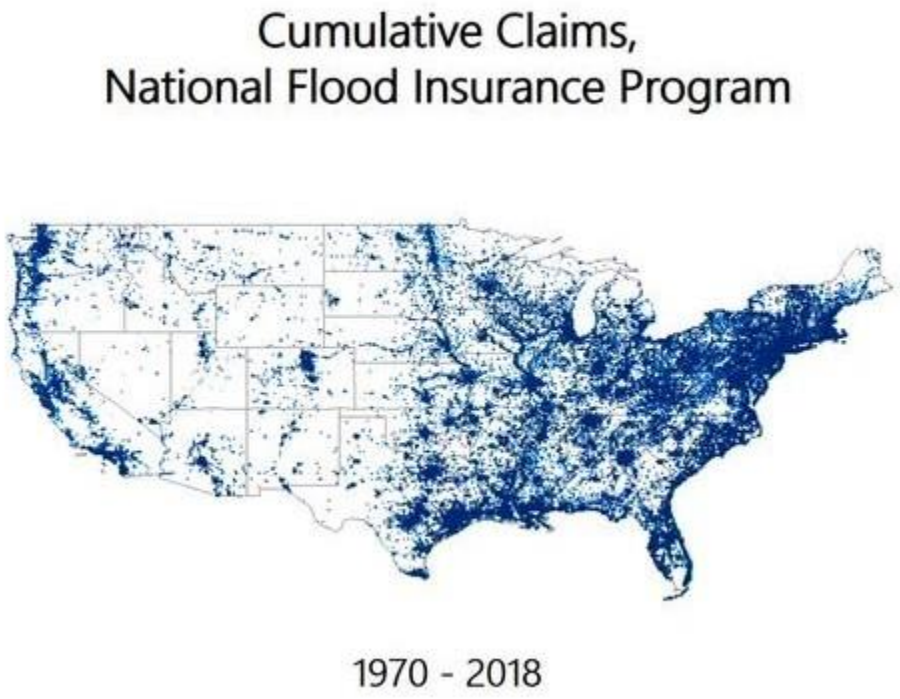
Dataset should be updated by:

Apply lessons learned from other planning activities, focus on developing a stakeholder engagement plan that address how to overcome any fatigue related to flood mitigation planning, and connect with key stakeholders from other efforts to ensure there is good alignment moving forward with any concurrent planning and implementation efforts.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.6.4 Federal (FEMA), State, and Local: Policy Data



Dataset Summary Information

Source of Information	Federal (FEMA), State, and Local
Link to Online Data	https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/regulations-guidance
Data Owner	Federal (FEMA), State, and Local
Date Created	Unknown
Date of Access	March 2023
Frequency of Updates	None
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

A deep understanding of policy can be a key data point in critical decision-making associated with the Blueprint.

Limitations:

Policy change is a key non-structural flood mitigation strategy that promotes resilience, and it requires strong stakeholder engagement to drive political will.

Dataset should be updated by:

Continue to closely track policy drivers and develop strategies to pursue meaningful policy changes at the local and state levels.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.6.5 FEMA: Historical Flooding Support Information (e.g., IA and PA Claims, SBA and HMGP Applications)

Dataset Summary Information

Source of Information	FEMA
Link to Online Data	https://www.fema.gov/about/openfema/data-sets
Data Owner	FEMA
Date Created	1979
Date of Access	February 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Fluvial, Pluvial, Urban,

Dataset Event Frequencies

Percent Annual Chance										Other					
20	10	4	2	1	1 PAC MINUS	1 PAC PLUS	0.5	0.2	0.1	Other	Historical Event	PMP	PMF	Real Time	Forecast
											x				

Benefits:

Well-documented flood information based on reality, and if funding is there, then it is probably there for a good reason.

Limitations:

Limited to only claimed areas, might be restricted because of personal data.

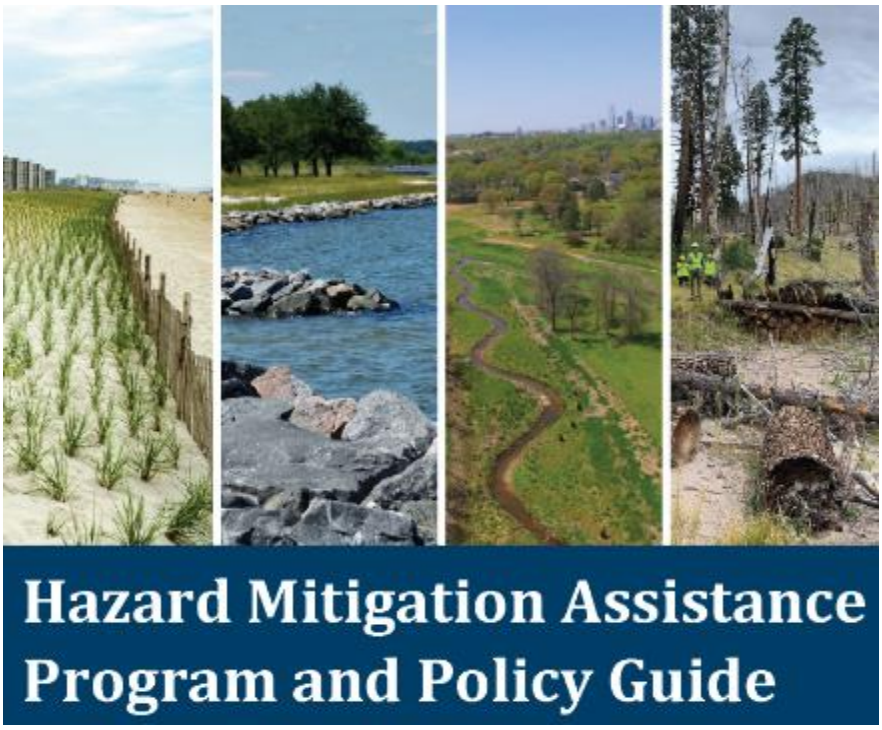
Dataset should be updated by:

Gain access to this information to determine hot spots and mitigation projects; also can be used to verify models.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: Demographic Attributes (Economic, Social, etc.). To quantify risk, identify the location of historical flooding hot spots. Would need additional investigation or information to quantify risk.

2.6.6 FEMA: Flood Mitigation Assistance Grant Program



Dataset Summary Information

Source of Information	FEMA
Link to Online Data	Open FEMA Data Sets | FEMA.gov
Data Owner	FEMA
Date Created	1994
Date of Access	Unable to access
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	All

Dataset Event Frequencies:

N/A

Benefits:

Applications are well-documented flood information based on historical events.

Limitations:

Limited to areas that applied for grants, might be restriction due to Personal Identifiable Information (PII).

Dataset should be updated by:

Gain access to the grant application to determine any historical flooding frequencies.

Risk Quantifier:

This source can be an existing risk quantifier when identifying the location of historical hazard areas. Would need additional investigation or information to quantify risk.

2.6.7 Peer State Program Review

Dataset Summary Information

Source of Information	Multiple States and Regions
Link to Online Data	Unidentified
Data Owner	Multiple States and Regions
Date Created	Unknown
Date of Access	March 2023
Frequency of Updates	None
Updates Needed	N/A
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

The opportunity to learn from peer states can inform the technical approach and information from peer state programs, can provide proofs of concepts supporting ideas for the framework of the Blueprint.

Limitations:

There is no peer state program that mirrors the objectives of the Blueprint. It is likely there will be inflection points in the development of the Blueprint for which there is no specific match to apply lessons learned and best practices.

Dataset should be updated by:

As other states begin to pursue program solutions like the Blueprint, engage for information sharing to support continued connectivity with peer states.

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.6.8 Local Governments: Other Policy Information Related to Flood Risk Mitigation and Resilience

Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	Unidentified
Data Owner	Local Governments
Date Created	Unknown
Date of Access	March 2023
Frequency of Updates	None
Updates Needed	N/A
Type of Flooding	

Dataset Event Frequencies:

N/A

Benefits:

Research on a local government level for other policies for jurisdictions that follow FEMA policies at a minimum but have higher Flood Risk Mitigation Standards.

Limitations:

N/A

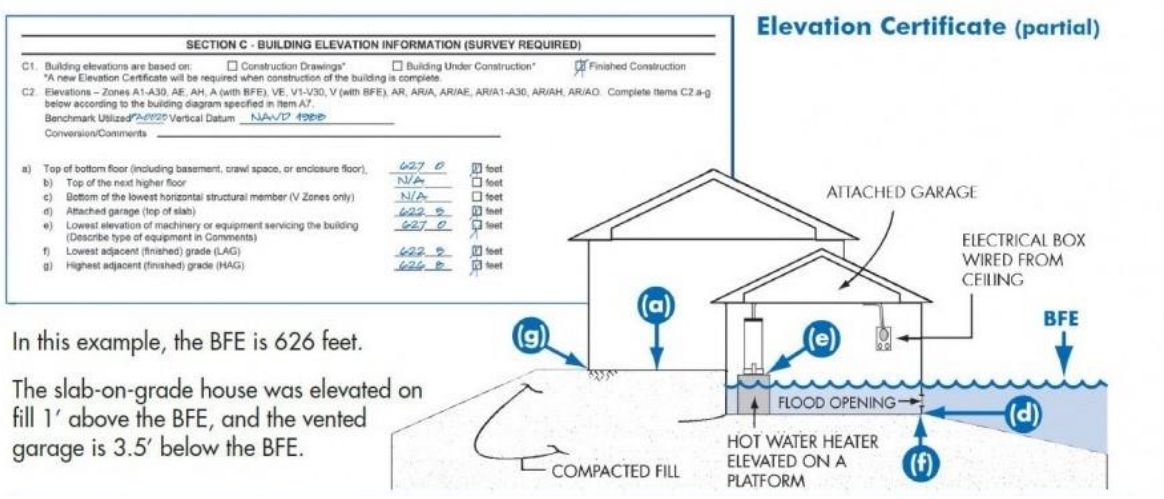
Dataset should be updated by:

N/A

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown.

2.6.9 Local Governments: Elevation Certificates



Dataset Summary Information

Source of Information	Local Governments
Link to Online Data	Unidentified
Data Owner	Local Governments
Date Created	Various
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Provides necessary safety measures for development near a floodplain. Elevation Certification must be completed prior to project completion.

Limitations:

Elevation Certification process differs between local governments.

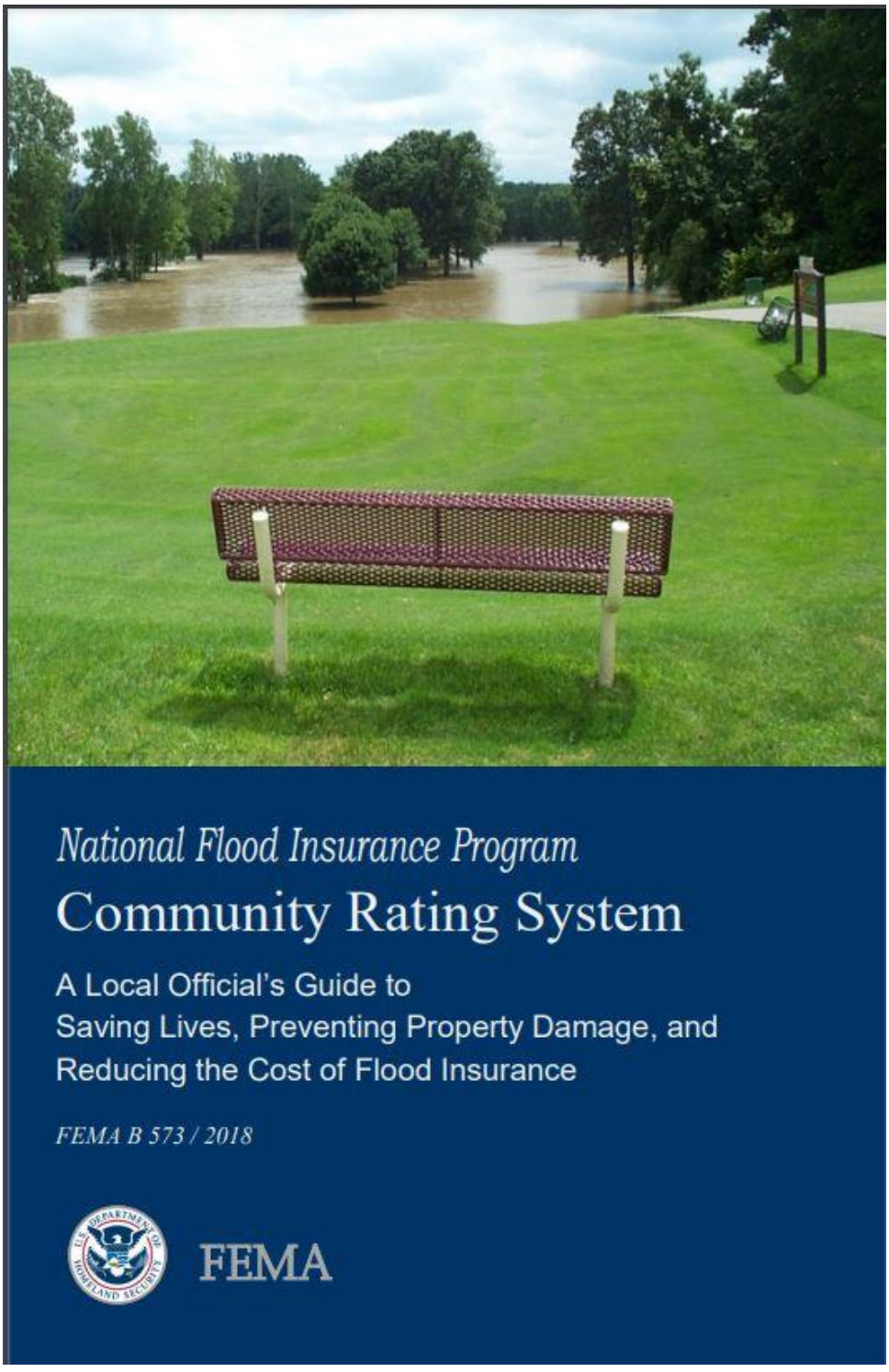
Dataset should be updated by:

Supplement building footprints are needed with this information.

Risk Quantifier:

This source can be an existing risk quantifier using the following factors: FFE, and Transportation (Roads and Bridges) Attributes. To quantify risk, append with building footprints to determine FFE.

2.6.10 FEMA: CRS Communities



Dataset Summary Information

Source of Information	FEMA
Link to Online Data	https://www.fema.gov/sites/default/files/documents/fema_community-rating-system_local-guide-flood-insurance-2018.pdf
Data Owner	FEMA
Date Created	2018
Date of Access	March 2023
Frequency of Updates	Continuous
Updates Needed	TBD
Type of Flooding	Non-Flooding Source

Dataset Event Frequencies:

N/A

Benefits:

Beneficial as an educational tool to show how the community rating system works, and potential discounts, etc.

Limitations

N/A

Dataset should be updated by:

N/

Risk Quantifier:

This source cannot be used to quantify existing or future risk. The process to quantify risk is currently unknown. Repetitive Loss Area Analysis completed for CRS would offer insight complimentary to loss histories.