Flood Risk Assessment: Geospatial Dataset Development

Project Description

As a result of stakeholder input and assessing regional data needs, the Regional Planning Commission (RPC) is initiating the development of various geospatial datasets and products that can assist local policymakers, planners and engineers by providing data driven insights to enhance regional flood resilience and inform infrastructure investments.

This effort will leverage existing GIS and spatial datasets to quantify land cover and surface runoff potential across the region's varied landscapes, integrating precipitation data to assess flood vulnerability.

By combining high-resolution digital elevation models (DEMs), land cover, impervious surface data, soil characteristics, and terrain analysis, this effort will generate sub-catchment-level runoff coefficients and spatial outputs such as runoff depth and peak flow areas. These outputs will identify flood-prone areas and support scenario planning for urban growth and green infrastructure interventions.

The resulting tools are not intended to supplant surveyed data but to provide policymakers, planners, and engineers with data-driven insights to enhance regional flood resilience and guide infrastructure investments.

Project Background

This project is undertaken as part of the Louisiana Watershed Initiative (LWI) a state-led collaborative program designed to reduce flood risk through integrated watershed and floodplain management. LWI emphasizes a holistic approach that considers both natural systems and human development patterns to better understand and mitigate flood risks within watershed boundaries.

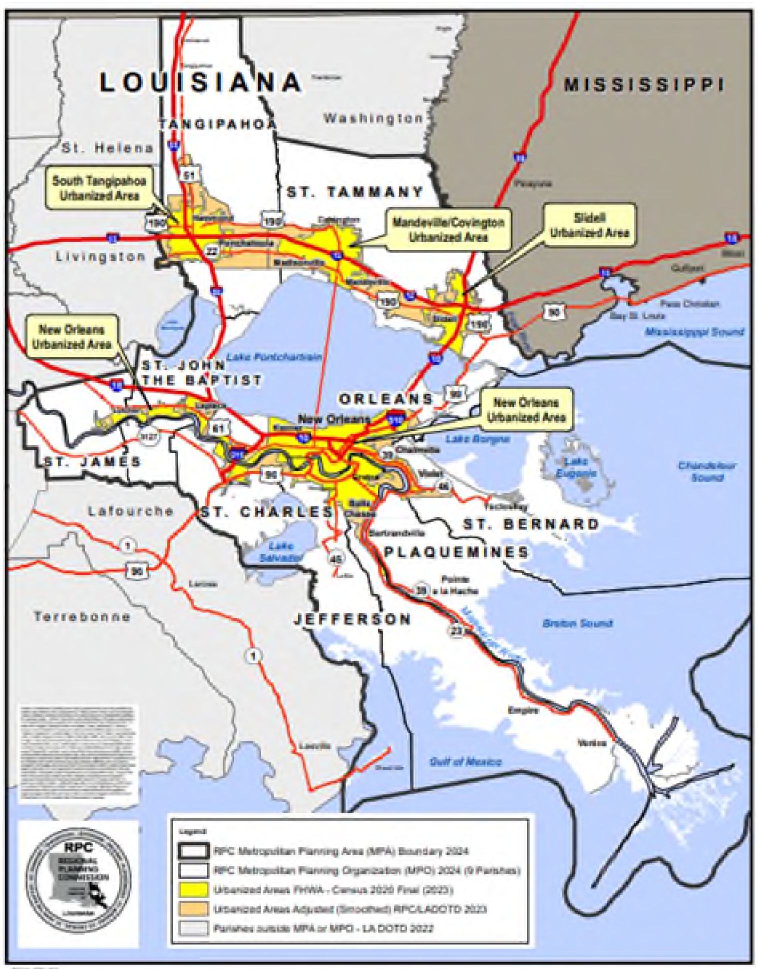
Extreme precipitation is the leading cause of flash flooding and riverine overflow in Louisiana. Tropical storms from the Gulf of America exacerbate this risk, bringing heavy rainfall, wind, and storm surge that impact both coastal and inland areas. Additionally, eustatic sea level rise and subsidence (land sinking) further increase flood vulnerability, allowing tides to reach farther inland and lowering ground elevations in critical habitats and communities.

Since 2000, Louisiana has faced 28 federally declared flood and hurricane disasters**,** resulting in over $16 billion in public assistance costs. The frequency and severity of these events continue to rise, threatening both natural ecosystems and built infrastructure.

In response, RPC—serving as the fiscal agent for LWI Region 8 in partnership with the Louisiana Office of Community Development—is conducting a Technical Watershed Report and Plan for Region 8 (Jefferson, Orleans, Plaquemines, St. Bernard, and St. Charles Parishes) and additional RPC parishes (St. John the Baptist, St. James, St. Tammany, and Tangipahoa). This initiative aims to develop a comprehensive flood risk profile using geospatial modeling of rain-induced flooding, informed by land development intensity, land cover, elevation, and precipitation patterns.

The resulting assessment will provide a planning-level tool to better understand and manage runoff-induced flooding in a region where high rainfall, impervious surfaces, and low-lying terrain make communities especially vulnerable. By linking development intensity, land cover, soils, and slope to runoff risk, the developed datasets will support resilient, data-informed decision-making for regional and local planning, hazard mitigation, and emergency preparedness.

Project Area



Project Components

The purpose of this Request for Proposals (RFP) is to engage a qualified entity or team to develop geospatial data sets that can be used to undertake a Pluvial Flood Risk Assessment for the RPC region. These data sets will be integrated into existing Regional Flood Risk Profiles and support flood risk reduction planning in alignment with Louisiana Watershed Initiative (LWI) Regional Watershed Plan requirements.

The entity will be responsible for developing the following key components:

- Digital Elevation Model (DEM): High-resolution elevation data to support hydrologic modeling.
- Roadway DEM (R-DEM): Elevation model of the Federal Aid Network and evacuation routes
- Landscape Development Intensity Index (LDII): A spatial index quantifying development pressure.
- Geospatial Intensity-Duration-Frequency (IDF) Curve Model: Rainfall modeling for flood risk scenarios.
- Runoff Coefficient Model**:** GIS-based mapping of runoff variability across land cover, soil types, and slopes.
- Pluvial Flood Risk Index: Identification of flood risk hotspots at the block group level by combining LDII and runoff coefficients.

These will be developed using existing, validated data sources.

Major Data Sources Provided by RPC

RPC will supply the following datasets to support end product development:

- LiDAR Data: High-resolution elevation data for slope, drainage, and watershed delineation.
- Land Cover Data: Classification of land uses to assess impervious surfaces and infiltration.
- Hydrological Features: Rivers, bayous, canals, lakes, and coastal features for runoff routing.
- Hydrological Soils Data: SSURGO and RPC datasets describing soil texture and drainage.
- Vegetation Data: Wetlands, forests, and grasslands for evapotranspiration analysis.
- Precipitation Data**:** NOAA Atlas 14/15 rainfall data for model calibration and scenario testing.

These datasets will form the foundation for a geospatial runoff coefficient model that reflects the region’s complex hydrological and environmental dynamics.

Project Requirements and Specifications

Business Requirements

Outputs must support the following planning and policy goals:

- Identification of rain-induced flood risk hotspots.
- Infrastructure investment and construction management.
- Water supply and water quality initiatives, including point source pollution.
- Local, parish, and regional planning efforts.
- Watershed, hazard mitigation, and climate adaptation planning.
- Flexibility to adapt to changes in model area boundaries.
- Maintainability by RPC staff as base data is updated.

Data and Methodology Requirements

Data Review and Gap Assessment

- Assess all RPC-provided and publicly available datasets for spatial resolution, temporal coverage, and thematic detail.
- Identify and document data gaps.
- Recommend strategies to fill gaps, including public datasets, commercial data, or new data collection as applicable.
- Deliver a summary brief or report outlining data strengths, limitations, and gaps.

Quality Control and Assurance (QC/QA)

- Conduct structured QC/QA on all datasets to ensure accuracy and consistency.
- Verify spatial accuracy and coordinate system alignment.
- Validate attribute data and correct errors or duplicates.
- Document QC/QA procedures and corrective actions.

Modeling Methodology

- Use industry-standard hydrological and GIS-based methods.
- Integrate topography, soils, hydrology, and land cover into a geospatial framework.
- Calculate LDII, runoff coefficients, and flood risk at the block group level, with scalability to subwatershed, parish, and regional levels.
- Incorporate precipitation scenarios into flood risk modeling.
- Submit and implement a validation plan to ensure technical reliability.

Software Requirements

Core Platform

- All spatial analysis and modeling must be conducted within a GIS environment.
- Deliverables must be compatible with ArcGIS Pro and include geodatabases, shapefiles, and raster datasets.

Integration and Interoperability

- Ensure full compatibility with RPC's existing GIS workflows.
- Supplemental modeling tools (e.g., HEC-HMS, SWMM, Python/R libraries) must produce GIS-importable outputs.

Visualization and Accessibility

- Include GIS maps and symbology for visualizing runoff coefficients by land use and watershed.
- Consider web-based GIS delivery (e.g., ArcGIS Online, ArcHub) for stakeholder access.

Licensing and Deliverables

- All deliverables must be compatible with RPC's licensed software.
- Proprietary software is acceptable only if it can export fully functional GIS datasets.

Project Scope of Services

Consultants are invited to propose a detailed work program for the development a comprehensive Rain-Induced Flood Risk Assessment for the RPC region, including the creation of geospatial models and analytical tools identified in the previous section that support planning, mitigation, and infrastructure investment decisions. The scope of services is organized into a series of tasks that collectively lead to the development of a Pluvial Flood Risk Index, aligned with the Louisiana Watershed Initiative (LWI) Regional Watershed Plan requirements.

Each task is designed to build upon RPC's planning framework and existing datasets, or other publicly available data sets as needed, and must result in fully functional, GIS-compatible outputs that can be maintained and updated by RPC staff. The consultant shall propose a detailed work program that addresses each task, including methodology, deliverables, timelines, and quality control procedures.

Task 1 – Project Management

The consultant shall provide comprehensive project management services to ensure timely delivery, quality control, and effective communication throughout the duration of the project.

Task Objectives:

- Establish a clear project structure and communication plan.
- Maintain consistent coordination with RPC staff.
- Monitor progress and ensure adherence to scope, schedule, and budget.

Key Activities:

- Conduct a project kickoff meeting with RPC to confirm scope, expectations, and deliverables.
- Develop a detailed project management plan outlining task schedule, milestones, communication protocols, and quality control procedures.
- Facilitate monthly progress meetings or conference calls with RPC.
- Submit monthly progress reports and invoices in the required format.
- Maintain an organized archive of all project files, datasets, and documentation.

Deliverables:

- Project Management Plan
- Kickoff meeting summary
- Monthly progress reports and invoices
- Archive of all project-related files and data

Task 2 – Data and Model Architecture

The consultant shall work with RPC to finalize the structure and specifications of all data outputs and models prior to development. This task ensures that all modeling components are clearly defined and aligned with project goals.

Task Objectives:

- Define the architecture and workflow for data and model development.
- Establish validation criteria and data requirements.
- Ensure transparency and reproducibility of modeling methods.

Key Activities:

- Collaborate with RPC to confirm the structure, inputs, and outputs of each model component.
- Identify the types and sources of data required for each model.
- Define validation parameters and performance metrics.
- Document the modeling framework, including assumptions, dependencies, and integration points.

Deliverables:

- Draft and final Model Architecture Report
- Presentation summarizing the model architecture and development approach

Task 3 – Data Aggregation or Acquisition (if applicable)

The consultant shall identify additional datasets necessary to fill gaps in the modeling framework. If not readily available, entity may be tasked with acquiring appropriate data. This task ensures that all required data is available, licensed, and ready for use.

Task Objectives:

- Address data gaps that may hinder model accuracy or completeness.
- Ensure all datasets are properly licensed and documented.
- Maintain consistency with the model architecture and validation plan.

Key Activities:

- Review RPC-provided datasets and assess for completeness.
- Identify missing or insufficient data elements.
- Acquire supplemental datasets through aggregation, purchase, or public sources.
- Document all acquired datasets and associated licenses.

Deliverables:

- All datasets aggregated or purchased under this contract
- Documentation of data sources and licensing terms
- Exceptions noted in the Model Architecture Report, if applicable

Task 4 – Geographic Base Layer Inputs and Standardization

The consultant shall compile, standardize, and prepare all foundational spatial datasets required for the development of the runoff coefficient model and Pluvial Flood Risk Index. These base layers will serve as the geographic framework for integrating environmental, infrastructure, and hydrologic data.

Task Objectives:

- Ensure all geographic base layers are spatially accurate, consistently formatted, and aligned to a common coordinate system.
- Prepare all datasets for seamless integration into modeling workflows.
- Support calibration of the Landscape Development Intensity Index (LDII) and other model components.

Key Activities:

- Compile RPC-provided datasets including:
  - Administrative boundaries (parish, municipality, subwatershed)
  - Transportation networks (roads, railways, bridges, maritime routes)
  - Hydrographic features (rivers, lakes, canals, levees)
  - Parcels or building footprints for LDII calibration
- Standardize all datasets to a unified coordinate system and projection compatible with RPC's GIS environment.
- Perform quality checks to ensure spatial accuracy, completeness, and logical consistency.
- Prepare datasets for integration into subsequent modeling tasks (e.g., DEM, LDII, runoff coefficient model).

Deliverables:

- Fully standardized geographic base layers in GIS-compatible formats
- Metadata for each dataset, compliant with FGDC/ISO standards
- Technical documentation describing data sources, preprocessing steps, and quality control procedures

Task 5 – Digital Elevation Model (DEM)

The consultant shall develop a high-resolution Digital Elevation Model (DEM) to serve as the foundational dataset for hydrologic and hydraulic modeling across the RPC planning area. This DEM will be used to delineate watersheds, analyze surface flow, and support runoff coefficient calculations.

Task Objectives:

- Create a seamless, hydrologically conditioned DEM that accurately represents terrain across all RPC parishes.
- Derive secondary hydrologic products such as slope, flow direction, and watershed boundaries.

- Ensure the DEM meets national standards for flood risk modeling and is compatible with FEMA and USACE specifications.

Key Activities:

- Utilize RPC-provided LiDAR datasets and supplement with publicly available elevation data as needed.
- Conduct preprocessing steps including:
    - Vertical accuracy checks
    - Void filling
    - Hydrologic conditioning (e.g., breaching, depression filling)
    - Coordinate system alignment
- Generate hydrologically relevant secondary layers:
    - Slope and aspect
    - Flow direction and flow accumulation
    - Watershed and subwatershed boundaries
- Validate DEM accuracy using ground control points, benchmarks, or other reference data consistent with USGS/NGA LiDAR Base Specifications.

Deliverables:

- Hydrologically conditioned DEM covering the full RPC region
- Derived slope, aspect, flow direction, flow accumulation, and watershed boundary layers
- Metadata and technical documentation detailing preprocessing steps, validation methods, and data sources

Task 6 – Road and Bridge Digital Elevation Model (R-DEM)

The consultant shall develop a Road and Bridge Digital Elevation Model (R-DEM) by integrating transportation infrastructure into the regional DEM. This enhanced model will support hydrologic and hydraulic analysis by accurately representing how roads, bridges, and culverts influence surface water flow and ponding.

Task Objectives:

- Embed transportation features into the DEM to reflect their impact on runoff and drainage.
- Identify areas where infrastructure may obstruct or redirect flow, contributing to localized flooding.
- Support the calculation of runoff coefficients and the Pluvial Flood Risk Index by incorporating transportation-related elevation data.

Key Activities:

- Integrate RPC-provided datasets for roads, bridges, and culverts into the base DEM.
- Perform hydrologic conditioning to ensure realistic flow paths across transportation corridors, including:
    - Embedding elevation profiles of roads and bridges.
    - Accounting for hydraulic structures (e.g., culverts, overpasses) to prevent artificial flow barriers.

    - Adjusting flow direction and accumulation rasters to reflect infrastructure influence.
- Validate the modified DEM using field-verified elevation points, design specifications, or high-resolution LiDAR data.
- Ensure hydrologic connectivity is preserved while accurately modeling transportation features.

Deliverables:

- Hydrologically conditioned R-DEM with embedded transportation features.
- Updated flow direction and accumulation rasters reflecting infrastructure impacts.
- Seamless raster DEM incorporating roads and bridges.
- Derived watershed and subwatershed boundaries adjusted for transportation effects.
- Metadata and technical documentation describing methodology and validation.

Task 7 – Landscape Development Intensity Index (LDII)

The consultant shall develop a Landscape Development Intensity Index (LDII) to quantify the degree of human development across the RPC region. This index will serve as a key input for runoff modeling and flood risk assessment by identifying areas with high imperviousness and urbanization.

Task Objectives:

- Integrate multiple datasets—land cover, impervious surface data, population density, and building footprints (if available)—to calculate development intensity.
- Classify development intensity into categories (e.g., low, moderate, high) based on spatial patterns and thresholds relevant to hydrologic modeling.
- Correlate LDII values with runoff coefficients to support scenario-based flood risk analysis.
- Ensure LDII is scalable and adaptable for use at block group, subwatershed, parish, and regional levels.

Key Activities:

- Compile and preprocess input datasets (land cover, imperviousness, population, parcels/buildings).
- Develop a geospatial model to calculate LDII values for defined spatial units.
- Validate LDII classifications using aerial imagery, local planning data, or field verification (if available).
- Create lookup tables linking LDII categories to runoff coefficients and other hydrologic variables.

Deliverables:

- GIS-based LDII layer with polygon-level classifications.
- LDII–Runoff Coefficient lookup table.
- Summary maps and statistics showing development intensity across the region.
- Metadata and technical documentation describing methodology, assumptions, and limitations.

Task 8 – Runoff Coefficient Model

The consultant shall develop a geospatial Runoff Coefficient Model to quantify surface runoff potential across the RPC region. This model will serve as a core analytical tool for assessing rain-induced flood risk and evaluating the hydrologic impact of land use, development intensity, and environmental conditions.

Task Objectives:

- Calculate runoff coefficients at the polygon level using integrated geospatial datasets.
- Capture spatial variability in runoff potential based on land cover, soil type, slope, vegetation, and precipitation.
- Support scenario-based planning for flood mitigation, infrastructure investment, and climate adaptation.

Key Activities:

- Integrate the following datasets into a GIS-based modeling framework:
  - Hydrologically conditioned DEM and derived slope/aspect layers
  - Land cover and impervious surface data
  - Hydrologic soil group classifications
  - Vegetation and evapotranspiration data
  - Precipitation intensity-duration-frequency (IDF) curves
  - Landscape Development Intensity Index (LDII)
  - Transportation infrastructure (roads, bridges, culverts)
- Calculate runoff coefficients for each polygon (e.g., block group, subwatershed, parish) using industry-standard hydrologic methods.
- Link each polygon to its associated environmental attributes in the model's attribute table.
- Conduct scenario testing to evaluate runoff under varying precipitation and land use conditions.

Deliverables:

- GIS layer (ESRI Geodatabase) containing polygon-level runoff coefficients
- Attribute tables linking coefficients to LDII, land cover, soil type, slope, and vegetation
- Derived hydrologic layers (e.g., flow direction, accumulation, watershed boundaries)
- Technical documentation detailing methodology, assumptions, and validation procedures
- Metadata compliant with FGDC/ISO standards

Task 9 – Pluvial Flood Risk Index

The consultant shall develop a Pluvial Flood Risk Index (PFRI) to identify and quantify areas within the RPC region that are most vulnerable to rain-induced (pluvial) flooding. This composite index will integrate multiple environmental and development-related variables to support planning, mitigation, and emergency preparedness.

Task Objectives:

- Combine geospatial data on runoff potential and development intensity to assess flood risk at a granular level.
- Identify flood-prone areas at the block group scale, with flexibility to aggregate results at subwatershed, parish, and regional levels.
- Provide a planning-level tool for evaluating the impact of land use and infrastructure on flood vulnerability.

Key Activities:

- Integrate outputs from the Runoff Coefficient Model and LDII to calculate flood risk scores.
- Incorporate precipitation scenarios (historical, IDF-based, projected climate events) to simulate flood risk under varying conditions.
- Normalize and weight contributing factors (e.g., slope, imperviousness, soil type, vegetation) to produce a composite risk score.
- Map flood risk hotspots and generate summary statistics for use in planning and policy development.

Deliverables:

- GIS-based Pluvial Flood Risk Index layer with block group-level resolution
- Scenario maps showing flood risk under different rainfall and development conditions
- Analytical tables and summary statistics
- Metadata and technical documentation detailing methodology, assumptions, and limitations

Task 10 – Quality Control, Quality Assurance (QC/QA) and Statistical Validation

The consultant shall implement a structured Quality Control and Quality Assurance (QC/QA) process and a comprehensive Validation Plan to ensure the accuracy, reliability, and usability of all datasets and model outputs developed under this project. This task is critical to confirming that the final products meet technical standards and are suitable for planning, engineering, and decision-making applications.

Task Objectives:

- Ensure all input datasets and model outputs are accurate, complete, and consistent.
- Validate model performance using industry-standard metrics and comparison with observed data.
- Document all QC/QA and validation procedures to support transparency and reproducibility.

Key Activities:

- Conduct QC/QA checks on all input datasets, including:
  - Spatial accuracy and coordinate system alignment
  - Attribute completeness and logical consistency
  - Identification and correction of duplicate, outdated, or erroneous records
- Apply QC/QA protocols to all model outputs, including runoff coefficients, LDII, and the Pluvial Flood Risk Index.
- Develop and implement a Validation Plan that includes:
  - Calibration using observed hydrologic data (e.g., flow measurements, flood records)
  - Independent validation using external datasets or benchmarks
  - Sensitivity and uncertainty analysis to assess model robustness
  - Performance evaluation using metrics such as:
    - Nash-Sutcliffe Efficiency (NSE)
    - Percent Bias (PBIAS)
    - Root Mean Square Error (RMSE)

Deliverables:

- Draft Validation Report**:**
  - Summary of validation parameters, methods, and preliminary results
  - Submitted electronically in Microsoft Word format
- Final Validation Report**:**
  - Comprehensive documentation of final validation results, performance metrics, and conclusions
  - Submitted electronically in Microsoft Word format
- QC/QA Documentation**:**
  - Description of error detection methods, corrective actions, and quality assurance protocols
  - Metadata for all validated datasets, compliant with FGDC/ISO standards

Task 11 – Documentation

The consultant shall produce complete documentation of the model development process, including data sources, methodologies, validation procedures, and operational guidance.

Task Objectives:

- Ensure transparency and reproducibility of all modeling components.
- Provide RPC with a comprehensive reference for future updates and applications.
- Provide RPC with communications documents exemplifying potential uses, limitations, and/or constraints.
- Written disclaimer for data usage and responsibility of user.

Key Activities:

- Document all model components, including inputs, processing steps, and outputs.
- Describe estimation procedures, validation methods, and assumptions.
- Ensure metadata for all datasets conforms to FGDC/ISO standards.

Deliverables:

- Draft and final model development report
- Brief user guide and talking points for communicating usage, limitations, and constraints.
- Metadata for all model outputs.