Assess Vulnerability and Risk | From Rulesets to Maps

WHO

This exercise is for the practitioner to complete in the Assess Vulnerability and Risk step.

WHAT

Develop maps from the rulesets for each potential impact. These maps are the spatial assessments in the Assess Vulnerability and Risk step.

SUPPORTING RESOURCES

- Use the list of spatial assessments from 3.1 Determine Assessment Type - Worksheet
- Refer to 3.4 Ruleset Development - Worksheet for the inputs for this exercise.

INSTRUCTIONS

- ☐ Using the guidance from 3.4 Ruleset Development - Worksheet and the list of spatial assessments from, 3.1 Determine Assessment Type - Worksheet construct maps for each potential impact.
- ☐ Decide how you are going to construct the maps:
    - Using tracing paper
    - Desktop GIS
    - Custom software designed for this task (AccelAdapt)

Discussion

There are three ways to create spatial displays (maps) for vulnerability and risk assessments. Review the Detailed Mapping Example to see how each of these maps would look, regardless of the approach taken.

Option 1. Use printed maps and tracing paper (an assessment with no GIS or software tools)

- Optimum scale for this option is a small geographic area, such as a neighborhood. Anything larger would make this a tedious approach.
- Print a base map showing information such as elevation, streets, and parcels.
- Print available flood (or other hazard) data at the same scale.
- Using tracing paper, trace the hazard outlines with various colors (100-year floodplain, 500-year floodplain).
- Walk through your work in resource 2.3 Community Asset Themes - Worksheet to identify areas with community "pain points" (areas exposed to the hazard. Start with a single asset, such as commercial property.
- Using the rulesets developed in resources 3.3 Ruleset Library - Guidance, 3.4 Ruleset Development - Worksheet, and 3.6 Quality Control Checklist - Guidance, create the suite of maps necessary to construct a full suite of vulnerability and risk maps.
- Consider creating some traced overlays of some metrics of social vulnerability to overlay looking for the connection to additional social stressors as outlined in the Implementing the Steps to Resilience: A Practitioner's Guide.

Option 2. Climate Adaptation Practitioner with GIS skills or access to a GIS Technician

- Optimum scale for this option is small to medium with readily available GIS data and information from a variety of sources.
- Using GIS, a knowledgeable user can walk through the steps covered in option one (see above) to create a suite of maps on their computer with appropriate proprietary or open source GIS software.
- The data is best displayed during meetings by using the same software, or a suite of maps could be printed for the Planning Team to review. The example maps in the Detailed Mapping Example were constructed in this manner.

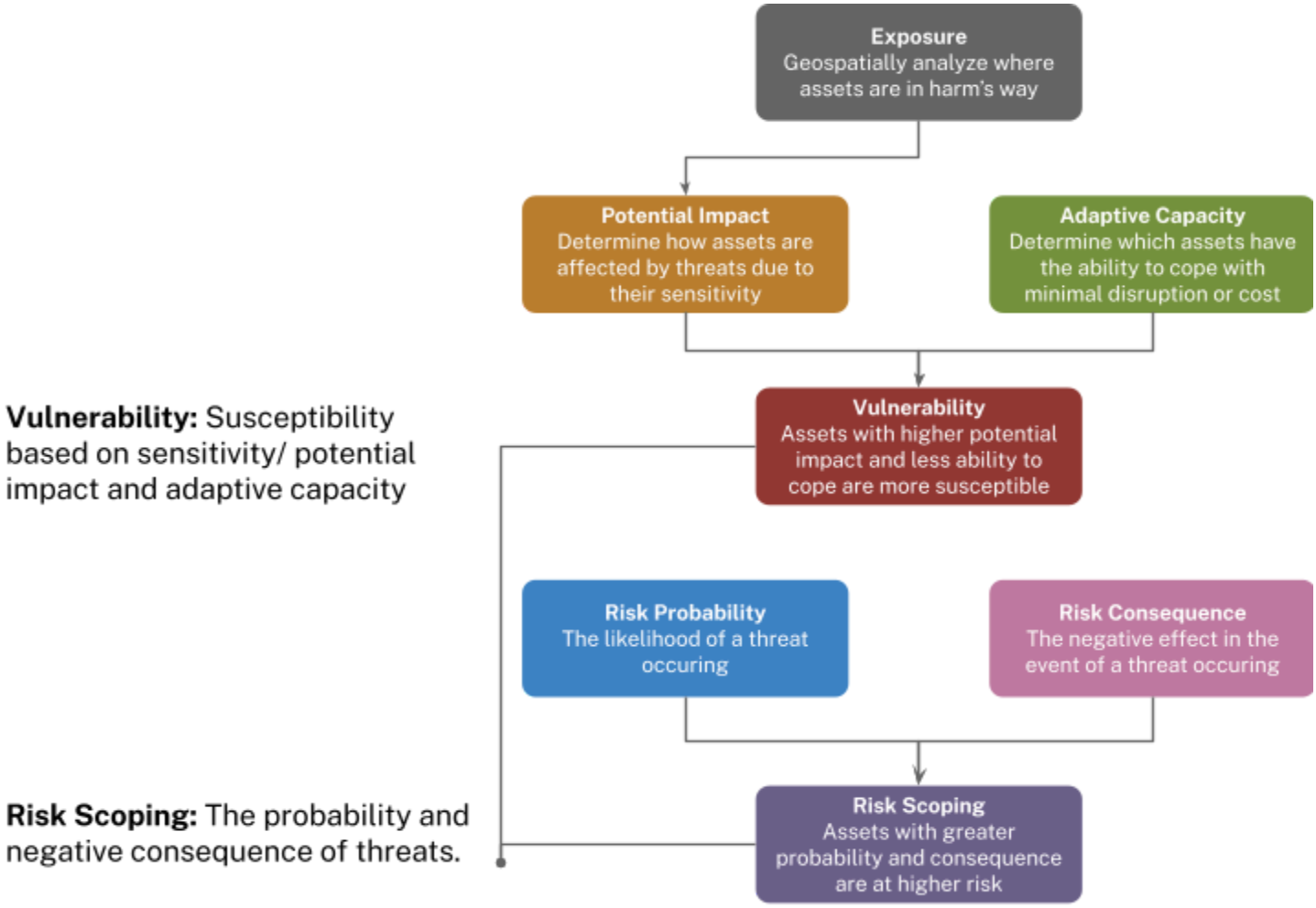
Option 3. Hire a consulting firm (e.g., FernLeaf) to use custom vulnerability and risk assessment software (e.g., AccelAdapt™)

- Optimum scale for this option is large with unlimited data sets and multiple impact pairs.
- Using a software like AccelAdapt™ is an efficient approach when handling larger scales and multiple hazards and assets. The software allows the Government Champion and Planning Team to easily view all the maps interactively in a short period of time without needing the support of a GIS Technician or having to deal with multiple printed maps.
- The Charleston Case Study maps and assessment (see Implementation Examples) and examples in the Steps to Resilience: A Practitioner's Guide were created in this manner.

Detailed Mapping Example

The process to create the maps follows the illustrated process shown in the figure. The Exposure map is constructed in Understand Exposure.

Vulnerability and Risk Assessment Components



Vulnerability: Susceptibility based on sensitivity/ potential impact and adaptive capacity

Risk Scoping: The probability and negative consequence of threats.

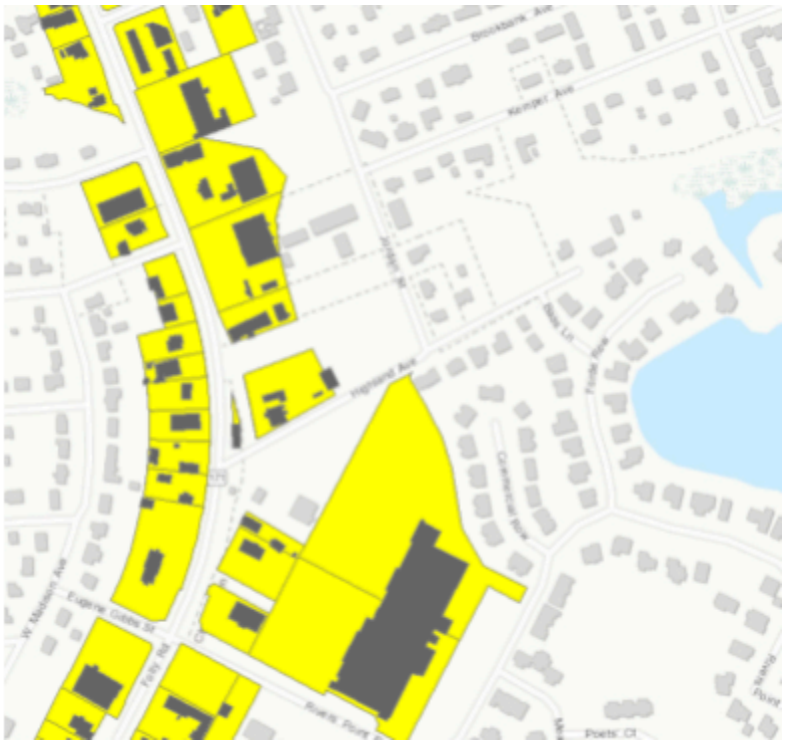
Asset Map

Assets are people, resources, ecosystems, infrastructure, and the services they provide. Assets are the tangible and intangible things people or communities value.

In the example below, all of the Commercial Properties were identified using the community's GIS dataset. The parcels shown in yellow are the commercial properties, with the associated structures shown in dark gray.

Asset: Commercial parcels and buildings

Only commercial and industrial parcels/ buildings are shown.



Hazard Map

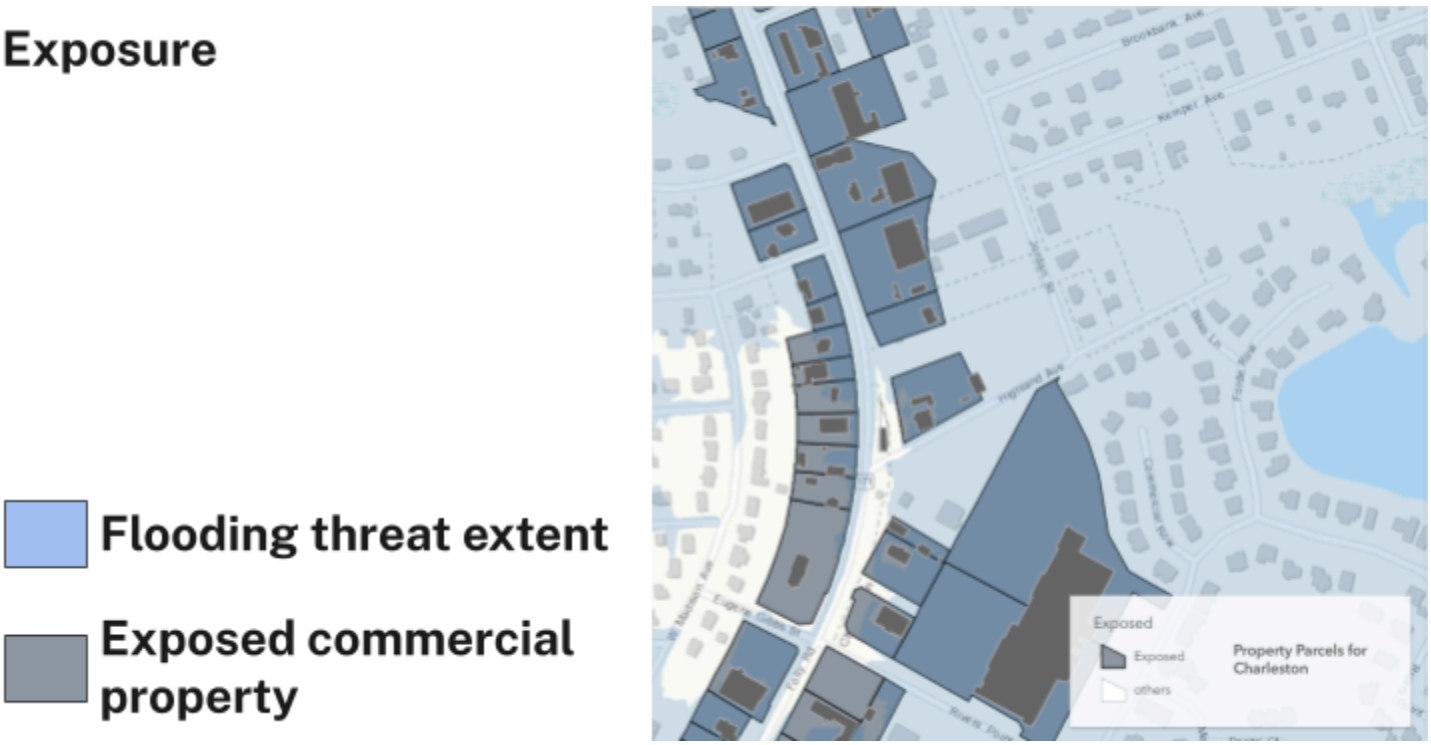
A **hazard** is an event or condition that may cause injury, illness, or death to people or damage to assets.

Rainfall Induced Flooding was identified as one of the primary hazards for the community. The data was accessed from the FEMA floodplain data used in the community's Emergency Management Plan. The extent of the flooding is shown in shades of blue, with the 500-year floodplain in the lighter blue and the 100-year floodplain in the darker blue. The 500-year extent represents a "once in 500-year extent, or 0.2% probability of occurrence. The 100-year extent represents a "once in 100 year extent" or 1% probability of occurrence.

Exposure Map

Exposure is the presence of People and Community Assets in places where they could be adversely affected by Hazards.

Exposure is calculated by overlaying the Asset Map with the Hazard Map. If any part of the asset parcel has the hazard in place, then the parcel is considered exposed. All commercial properties shown in this example are exposed and therefore shown in a dark gray color.



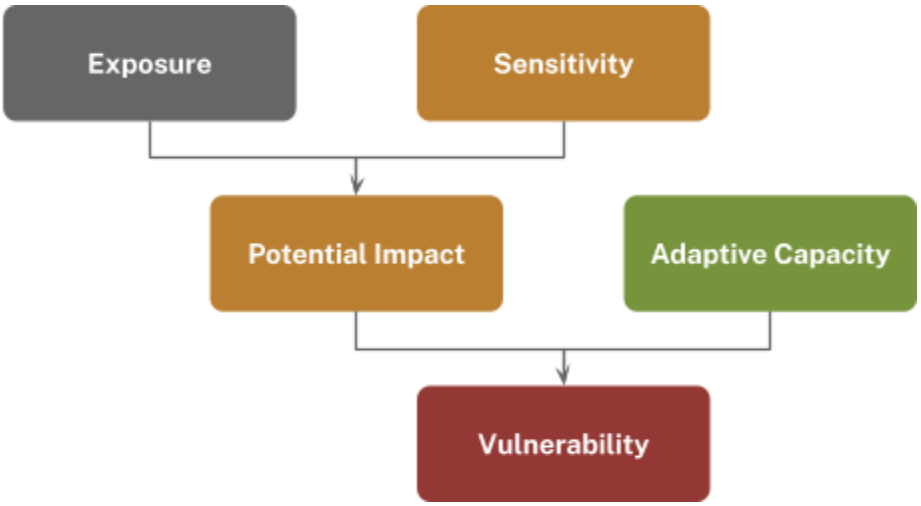
Vulnerability Maps

Vulnerability is the propensity or predisposition of People and Community Assets to be adversely impacted and encompasses exposure to potential impacts, sensitivity, and adaptive capacity.

Vulnerability: Understanding the susceptibility of societal assets due to physical and social factors.

Sensitivity: the degree to which assets are affected by a threat

Adaptive Capacity: the ability to cope with impacts



Potential Impact Map (and Sensitivity)

Potential impact is the degree to which societal assets are adversely impacted by a potential threat. Effects on community assets, including both natural and human systems, that result from hazards. Potential impact is determined by looking at exposed assets that are more sensitive.

Sensitivity is the degree to which a system, population, or resource is or might be affected by a given hazard. In other words, the degree to which an asset (and its related services) is affected. Within asset classes (such as commercial property), we determine levels of sensitivity by looking at the criticality or importance of the asset or its services. When looking at commercial property and flooding, the property is more sensitive if its primary structure is a historic structure, or provides key services such as retail, office, restaurant or hotel.

Potential Impact

Exposure + Sensitivity

High: Structure in floodplain and historic, retail, office, restaurant, or hotel

Medium: Structure in floodplain and warehouse or storage

Low: No structure in floodplain (land only)

Adaptive Capacity Map

Adaptive capacity is the ability of a person, asset, or system to withstand and adjust to a hazard, take advantage of new opportunities, or cope with change. In this example, the community had floodplain development ordinances that were established in 1971 and then updated in 2015. Levels of adaptive capacity were then tied to when the structures were built compared to when each ordinance was in place.

Adaptive Capacity

Ability to cope - influenced by floodplain development practices

Low: Structure in floodplain with no base flood elevation (built before 1971 or built in floodplain that is not regulated)

Medium: Structure in floodplain with elevation at BFE (built from 1971 to 2015)

High: Structure is built out of floodplain, or with elevation 1-2 ft above BFE (built 2015 to present)

Vulnerability Map

The final vulnerability map is created by overlaying the potential impact map with the adaptive capacity map. High vulnerability is defined when potential impact is high and adaptive capacity is low. Compare the final vulnerability map to the two maps used to construct the map to see how the relationships between potential impact and adaptive capacity affect the final vulnerability map.

Risk Maps

Risk is the potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard. Risk can be assessed by multiplying the probability of a hazard by the magnitude of the consequence or loss.

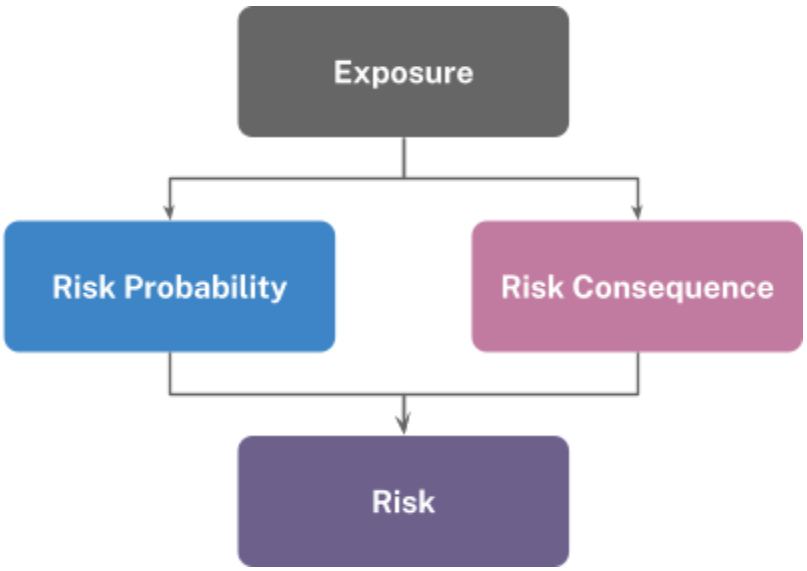
Risk must also consider uncertainty, so must address the changing probability (potential) of negative consequences in the future. Assets impacted by specific hazards with greater probability and consequence are at higher risk.

In quantitative risk scoping using community property values (usually from county tax records), risk scope represents the approximate replacement value of a set of assets (based on improvement value). It does not represent probabilistic loss estimates, associated economic damages, or other external damages and should only be used to understand the limits of one asset/ hazard pair compared with another asset/ hazard pair.

Risk Scoping: Understanding the probability and negative outcome of threats.

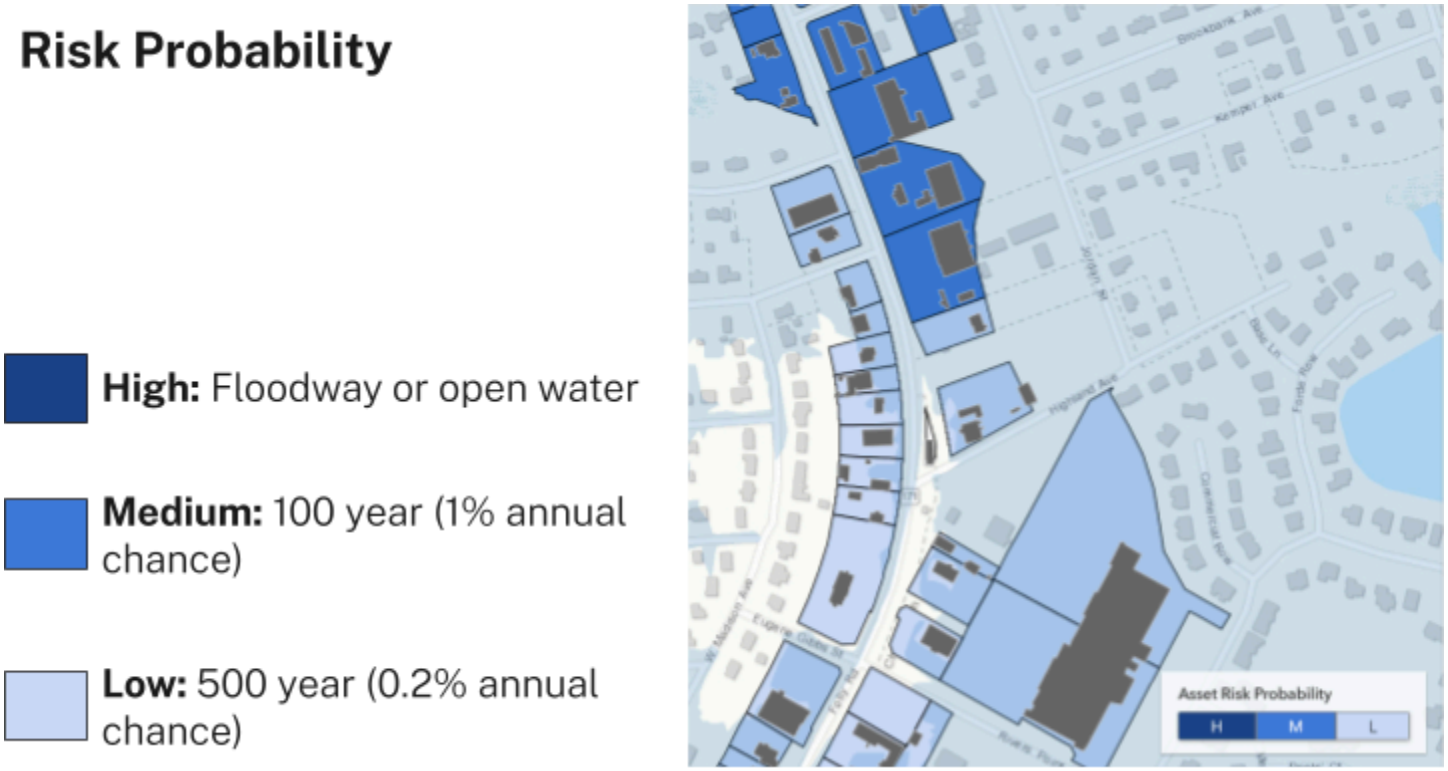
Probability: the likelihood of a threat or hazard event occurring

Consequence: the negative outcome of a threat or hazard event



Risk Probability Map

Probability is also referred to as likelihood, and is related to the frequency of the hazard occurring. This frequency is calculated in different ways by government agencies and insurance underwriters, but is typically based on the historical record of the past 30 to 50 years. This example uses the hazard map and its associated probabilities. Note that there are no floodway (or high probability) areas on this map.



Risk Consequence Map

The magnitude of impact is also referred to as severity and can be measured by the consequences related to death, injury, damage, or loss of services. In this example, the median value of commercial properties was determined from the community GIS database.

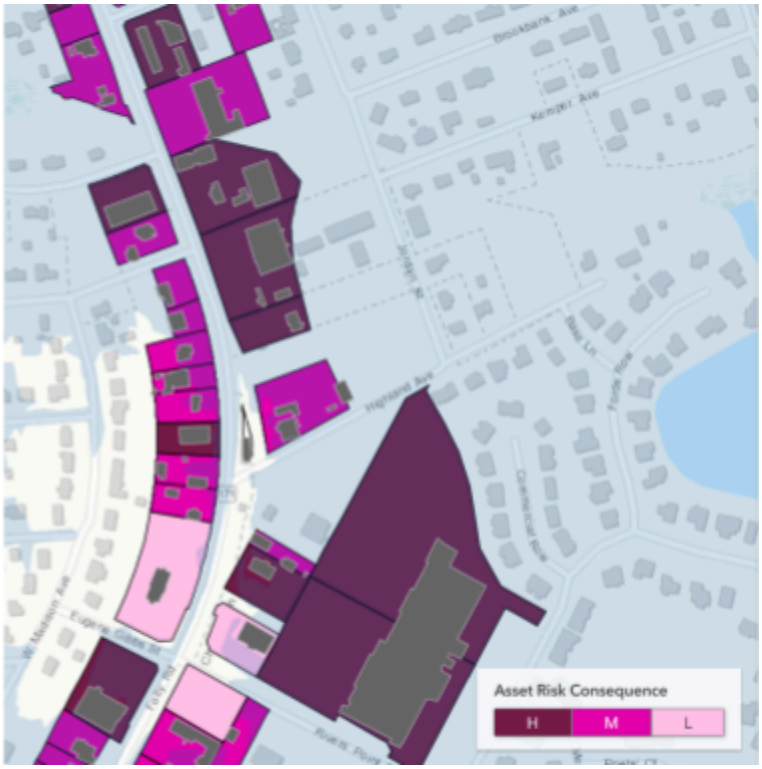
Risk Consequence

Based on structure value relative to other commercial properties (median $319K).

High: Structure exposed, above median value

Medium: Structure exposed, below median value

Low: No structure exposed

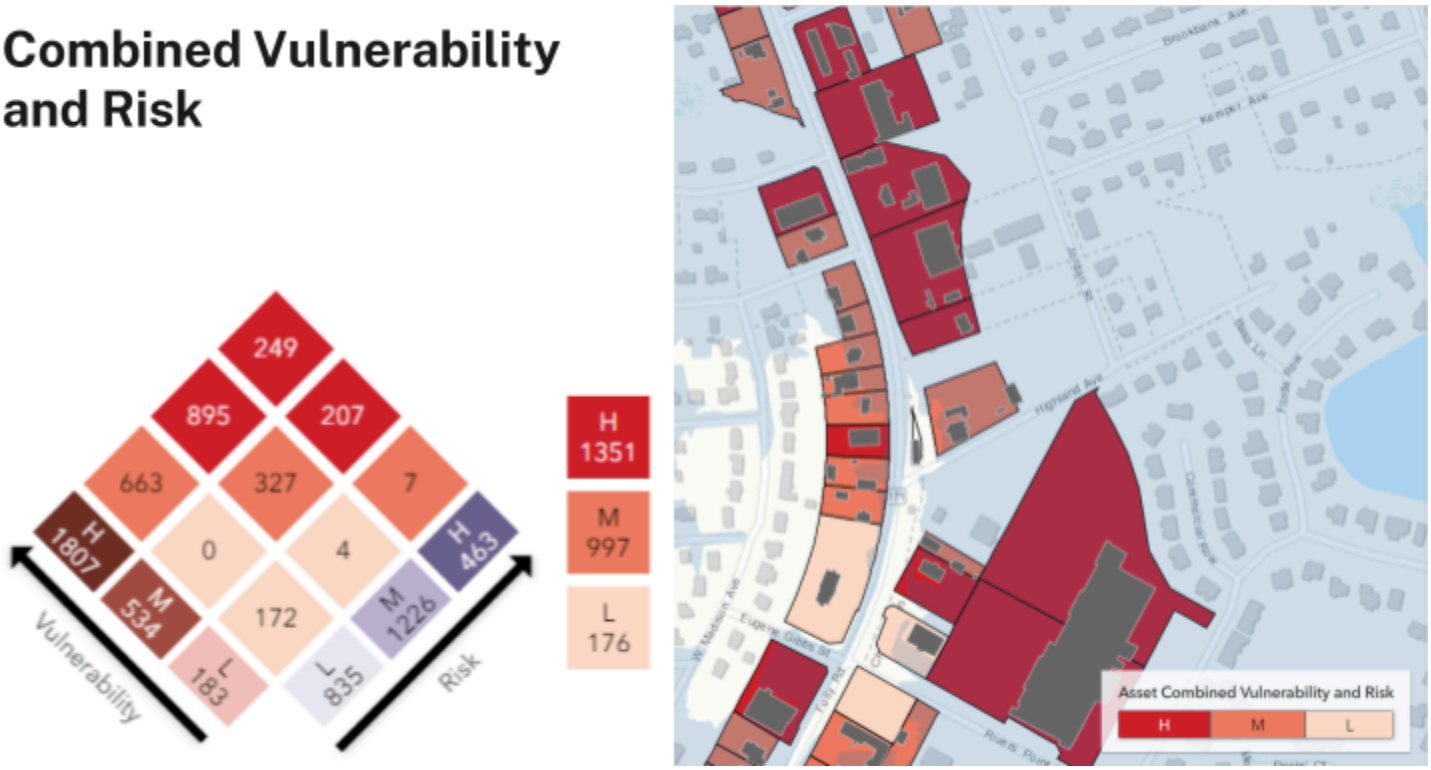


Risk Map

The final risk map is constructed by overlaying the two risk maps (probability and consequence). High risk is high probability of a hazard and high magnitude of the consequence or loss.

Combined Vulnerability and Risk Map

The final map for this stage of risk assessment is a combined vulnerability and risk map. Examine the two input maps (risk map and vulnerability map) and see the relationship between high risk and high vulnerability and the final combined map.



IMPLEMENTATION EXAMPLES

- An example of maps used in the City of Charleston All Hazards Vulnerability Assessment appear throughout the report.