CASE STUDY

Case Study: Using Maps to Visualize Vulnerability and Assets for Flooding Exposure in the New Hampshire Hampton-Seabrook Estuary

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Planted grass along the shore helps prevent erosion of the sand dunes. Photo by Kirkikis.

Case Example:

New Hampshire Division of Public Health Services was a CDC Climate Ready States and Cities grantee from 2012-2018. CDC grant funding enabled the completion of the first statewide climate and health assessment, which identified heat, extreme precipitation, and vector-borne disease as the top climate hazards. The state also established a mini-grant program that helped to initiate adaptation planning in several NH Public Health Networks to address these hazards. This laid the groundwork for several important adaptation success stories[2], featured here: About New Hampshire Tracking Program.[3]

Since that time, a variety of organizations have collaborated to build on this work. Partners include the New Hampshire Public Health Networks, city health departments, academic institutions, climatologists, state agencies, city and regional planners, community-based organizations, and non-profit groups.

To help address flood hazards, the New Hampshire Tracking Program created a state Social Vulnerability Index (SVI) tool to help emergency responders and public health professionals identify communities that will most likely need support before, during, and after a hazardous event.[4] This tool compiles census tract (neighborhood) level data on 16 factors in four categories: socioeconomic status, household/disability, minority/language, and housing/transportation. The state's SVI tool enables data to be easily accessible and integrated into many planning and response projects across the state.[5]

For example, researchers at the University of New Hampshire and UMass Boston received a NOAA grant to use the SVI data to support community adaptation planning and preparation for flood events in the Hampton-Seabrook Estuary. Partners, including the grant team, municipal staff, and the Seabrook Hamptons Estuary Alliance (SHEA), combined the SVI data with downscaled dynamic flood models, wetland models, PhotoVoice, and surveys to better understand potential risk and resilience based on different conditions and future climate scenarios.[6, 7] Overlays were created by mapping two or more indicators together, such as poverty and older age. This allows users to plan interventions and allocate resources to address specific areas of need. For example, emergency responders can quickly identify areas where older adults may have mobility impairments, where people may lack access to a vehicle, and or where housing stock may be vulnerable to flooding.

Maps and Visuals

Data shown below come from NH GRANIT[8] (New Hampshire's GIS database), overlaid with CDC/ATSDR Social Vulnerability Index (SVI) data[9], and flood models showing current and future flood zones (flood models were funded through a NOAA grant). Maps were created by the grant team and GIS consultants.

Overlays enabled identification of the most vulnerable census tracts based on the NH SVI (for example, in Figure 2, the red census tract is the most vulnerable; dark orange is the second-most vulnerable; green is the least vulnerable). Logistic regression models showed that a one-unit increase in the SVI was associated with 1.71 times higher odds of flooding (95% CI 1.53-1.90). This suggests that neighborhoods located in the most vulnerable census tract (which have an overall SVI score >=7) have significantly higher odds of flooding compared to those located in the least vulnerable census tracts. Community engagement methods included surveys, listening sessions, asset mapping, and PhotoVoice to co-interpret these findings and facilitate ongoing dialogue regarding climate action.

Figure 1. GIS map showing the Social Vulnerability Index for the Hampton-Seabrook Estuary (HSE) region of New Hampshire

The composite SVI score reflects the number of SV indicators in a given census tract that exceed the 90th percentile for NH. Maps identify or "flag" tracts with higher levels of vulnerability, e.g., exceeding the 90th percentile for the state.[4]

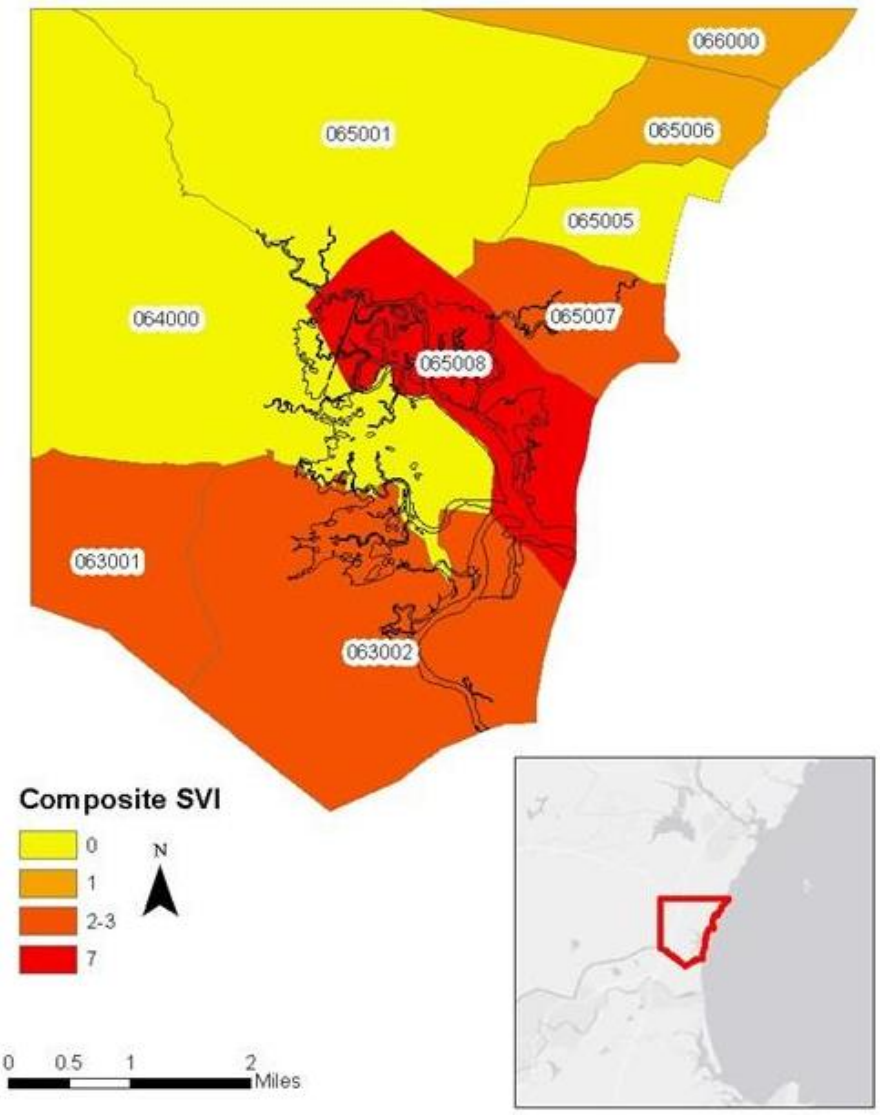
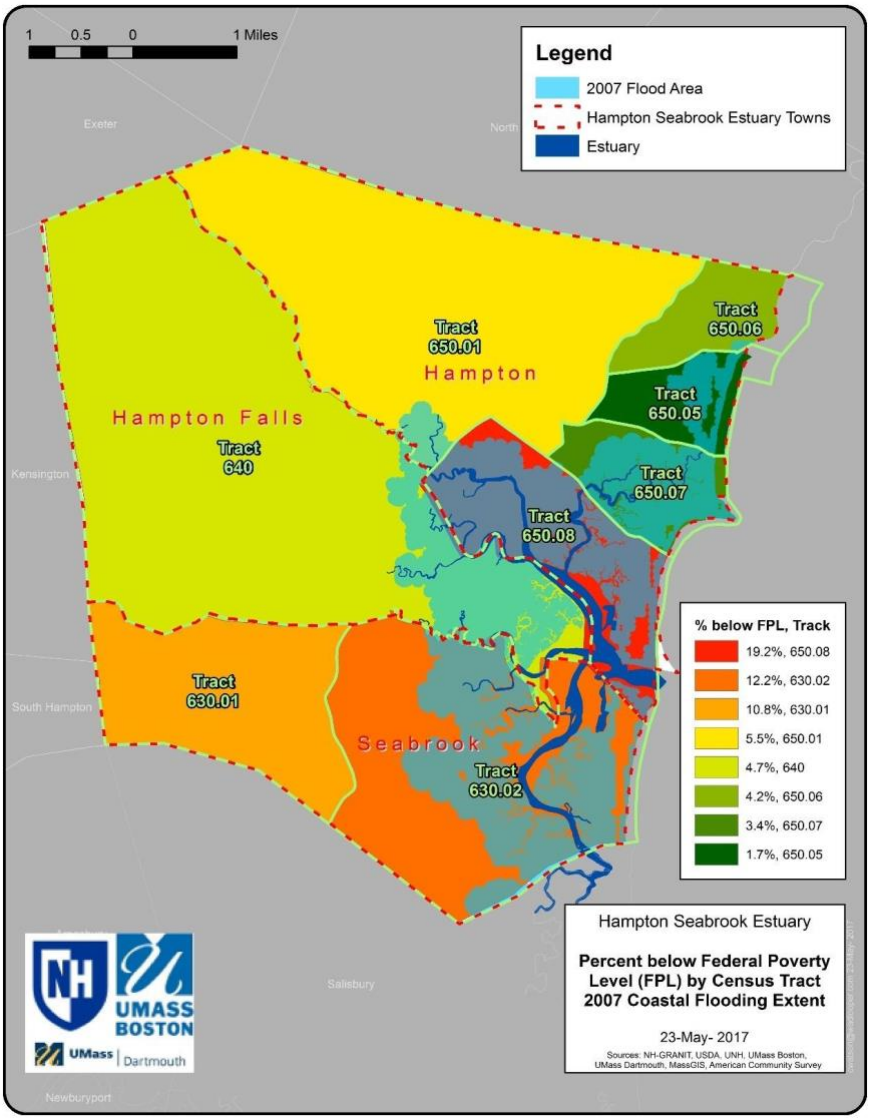


Figure 2. GIS map showing the Social Vulnerability Index (SVI) overlaid with dynamic flood model projections. The blue color depicts the most severe flooding



Climate hazards such as floods may also differentially affect persons with existing comorbidities. The most vulnerable (red) census tract has a higher percentage of persons living with cardiovascular disease compared to the state average, and a higher rate of drug overdose deaths per 100,000 compared to the state average.

Extreme weather events may pose challenges for persons with chronic disease and substance use disorders. These events can also increase stress and impact mental health, even after the flood waters recede.[10] Prior research showed that post-traumatic stress symptoms (PTSS) remained high 43 to 54 months after Hurricane Katrina.[11]

Through a community engagement process, stakeholders identified areas that they perceived as particularly important for their community, including assets such as schools, hospitals, libraries, police/fire stations, wastewater treatment plants, roads, parks, beaches, and recreational areas.

Figure 3. Asset Mapping and List of Anchor Institutions Identified through Community Engagement

1	Seabrook - Public Works
2	Seabrook Elementary School
3	Hampton - Fire Station
4	Seabrook - Town Office
5	Hampton Falls - Fire Department
6	Hampton Falls - Police Department
7	Hampton Falls Free Library
8	NorDx - Hampton
9	Hampton - Public Works
10	Hampton - Police Station
11	Hampton - Fire Station (substation)
12	Seabrook - Police Station
13	Seabrook - Fire Department
14	Seabrook Library

Figure 4. Detailed Maps with Flood Projections [100 Year Storm Event, and .73 meter Sea Level Rise (SLR)]

As the dynamic flood models were iteratively improved over time, projections with and without sea level rise were created, mapped, and discussed with stakeholders through the community engagement process.

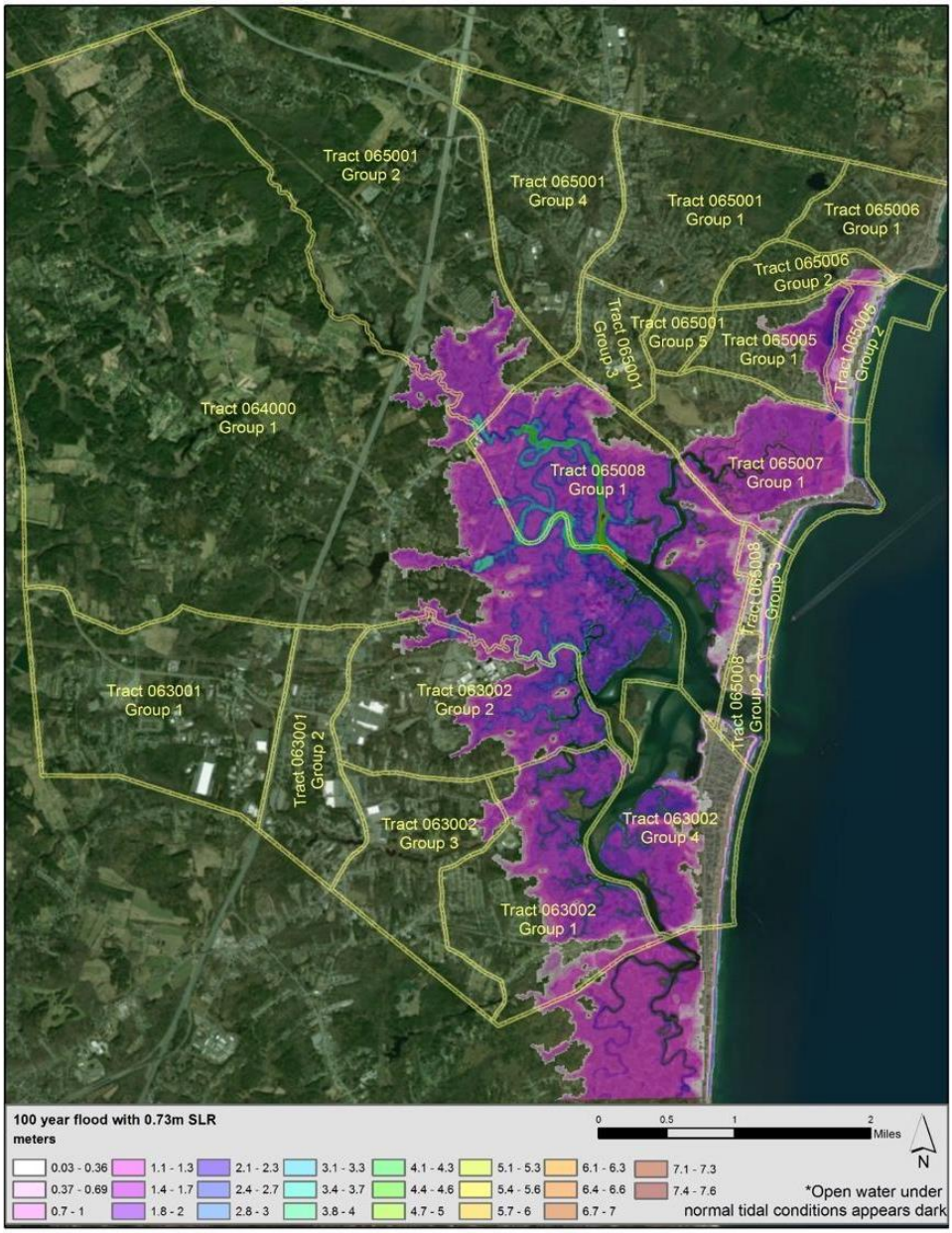


Figure 5. Maps of Social Vulnerability Overlaid with Iterative Flood Projections and Sea Level Rise

- *Red = most vulnerable census tract*
- *Pale green = second most vulnerable census tract*
- *Blue indicates the flood zone, as per downscaled flood models created for the region.*

In the HSE, one tract (shown in red) had five SV indicators flagged above the 90th percentile (indicating highest SV), one tract had 3 flags (pale green; moderate SV), two tracts had 2 flags (pink), one had 1 flag (purple; low SV); the remaining tracts had no indicators above 90th percentile.

**Higher SVI indicates a higher total number of social vulnerability indicators above the 90th percentile for the state*

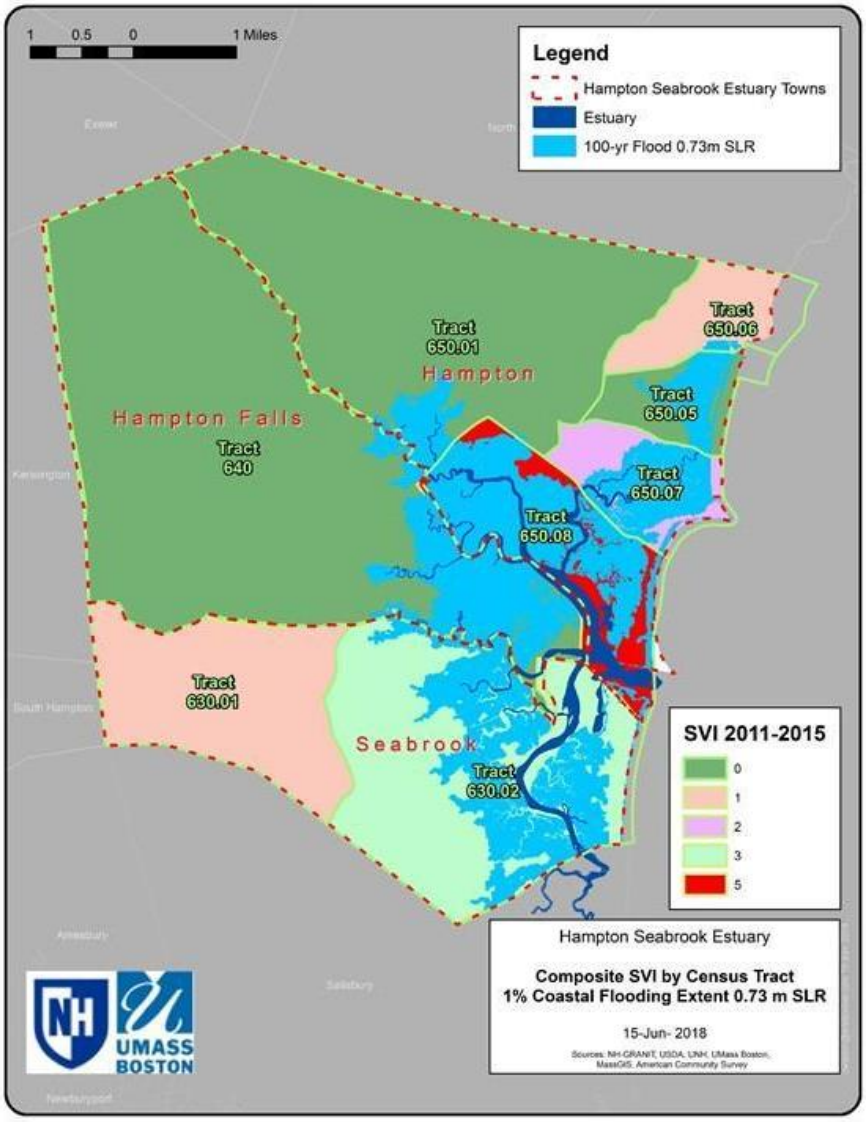


Figure 6. Map of Critical Infrastructure/Anchor Institutions with Flood Projections and Sea Level Rise

Locations of assets, critical infrastructure, and anchor institutions were ground-truthed and iteratively revisited over time through the community engagement process. For example, a wastewater treatment plant was relocated during the study period due to the projected vulnerability to flooding and sea level rise.

Anchor institutions are places such as schools and hospitals that maintain important social and economic functions for the community. They provide measurable benefits for children, families, and communities.

Discussion of Adaptation and Mitigation Actions: Example

Through community engagement, stakeholders discussed adding green infrastructure (e.g., a pedestrian/bike path along the beach) to protect the area from flooding and simultaneously increase active transportation and opportunities for physical activity.

Figure 7. Proposed Adaptation Actions (Active Transportation Example)

(Red Line=Proposed new pedestrian/bike way with green infrastructure). This borders the coastal portion of the most vulnerable census tract and also protects the salt marshes that create a natural barrier beach system.[7] *The proposed pedestrian/bike way would also provide safer physical activity spaces for residents living in the most vulnerable census tract.*[12] *In 2024, New Hampshire updated its Priority Climate Action Plan (PCAP), which identifies sustainable, multi-modal transportation as a priority for the state.*[13, 14]

Partnerships: From Data to Action

The data were leveraged by other partners, including municipal government leaders, the Hampton-Seabrook Estuary Alliance, NH Cooperative Extension, and the Rockingham Planning Commission (RPC), to inform coastal hazard adaptation planning and resilience efforts across the region. For example, a unique program called the "High Water Mark Initiative," led by Rockingham RPC, uses sculpture, signage, and public art to enable residents to learn about the effects of flooding and sea level rise on historic buildings, parks, and other valuable community assets.[15] Parks and walking trails display the signage, and local groups provide experiential education and outreach. New Hampshire's Cooperative Extension and conservation groups work to protect valuable plant species in the barrier beach dune area.

Green infrastructure was also considered as a way to support active transportation, augment aging infrastructure, and promote physical activity in the region. Additionally, a community-based financial institution, the New Hampshire Community Loan Fund, is working with residents of manufactured housing communities to help weatherize their homes and support adaptive governance through resident-owned communities. To help advance climate literacy among the healthcare workforce, partnerships have been established with New Hampshire Healthy Climate[16], the Nature Conservancy, and academic institutions. For example, the Institute for Health Policy and Practice at the University of New Hampshire implemented a virtual Project ECHO (Extension for Community Healthcare Outcomes) modular learning series entitled "Connecting Mental Health, Climate Justice, and Nature" to support systems thinking around the interconnections between natural resources, climate justice, and health.[17]

Other Examples of How Overlays Were Used

Overlays are created by mapping two or more social vulnerability indicators together, such as poverty and older age. This allows users to plan interventions and allocate resources to address specific areas of need.

Figure 8. Percent Older Age Overlaid with Poverty

This analysis enabled the team to identify areas where older persons with mobility limitations lived, including persons who might face barriers to evacuation during a storm event.

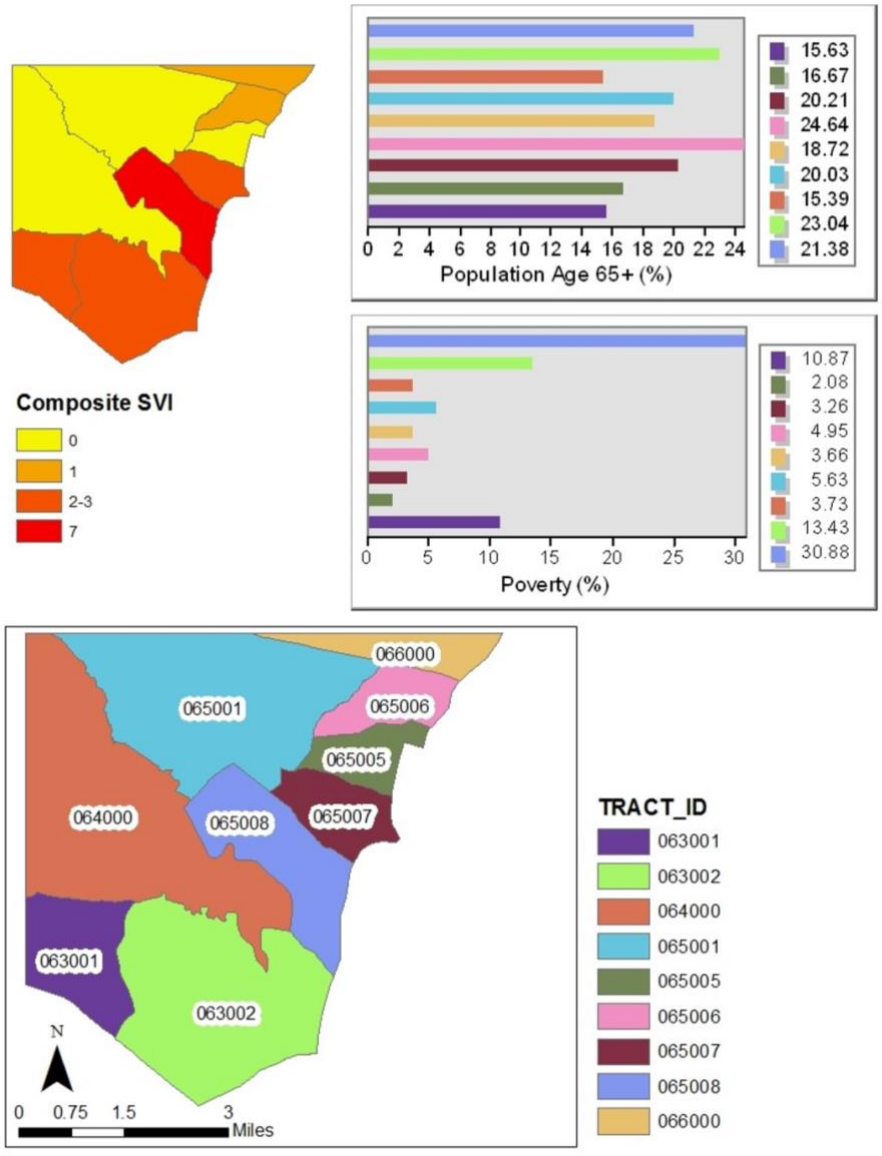
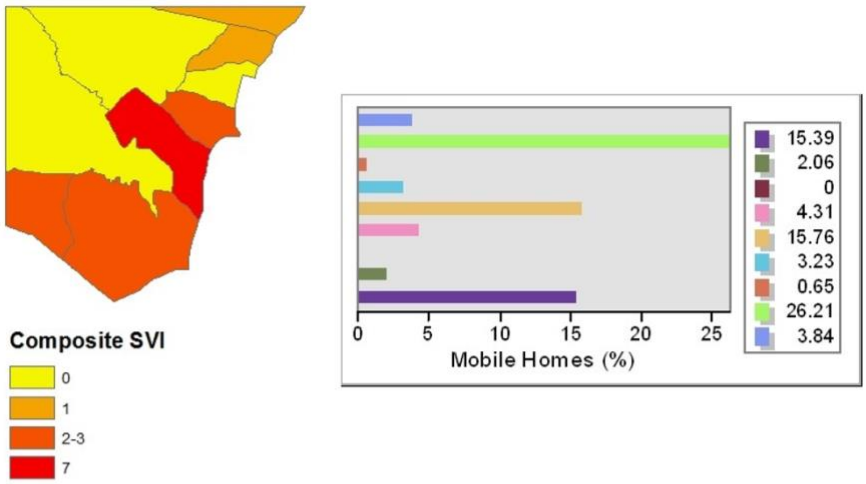
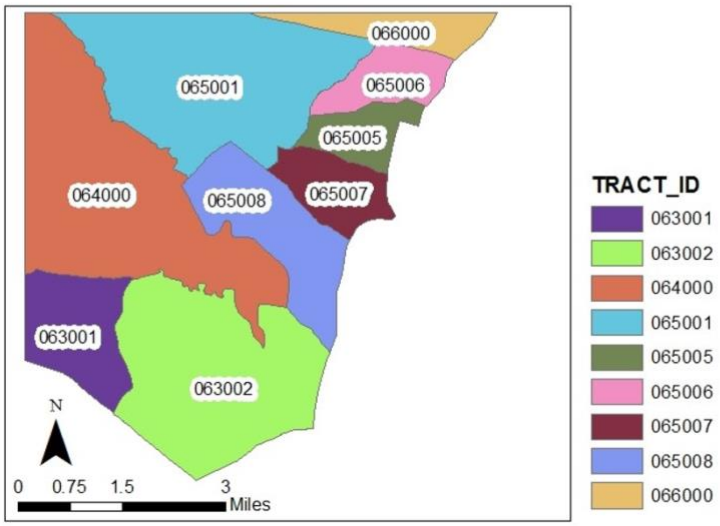


Figure 9. Overlays of Housing Issues: Percent of Population Living in Manufactured Housing

Affordable housing is a challenging issue in New Hampshire. The state has a relatively high percentage of persons living in manufactured housing (mobile homes), which can be particularly vulnerable to flooding and extreme weather.[18] *This analysis enabled the team to identify areas with the highest percentage of persons living in manufactured housing in the HSE.*





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