Appendix IX – Understanding Urban Climate Vulnerability

Cities and other urban areas are major contributors to climate change (producing more than 60% of GHG emissions worldwide[1]) but simultaneously among the most susceptible landscapes to the impacts of climate change[2]. Cities concentrate both people and infrastructure, contributing to the development of "heat islands", and are often situated along rivers and other waterways, making homes, industry, and transportation highly vulnerable to floods and flood damage. Extreme weather in urban areas causes disruptions to critical infrastructure like water systems, sewer systems, roads, and power plants, particularly those already aging and in need of repair[3].

Furthermore, human vulnerability in urban areas is often unevenly distributed; that is, lower-income and underserved communities are often at higher risk to climate change impacts, due both to the geographic location of many of these communities (often near to polluting industrial and flood-prone areas) and the lack of available resources to escape or cope with disasters. Here we discuss elements of urban contributions to climate change and the vulnerabilities unique to these areas. While an in-depth assessment (for example, neighborhood-level) of all urban areas in Monroe County is outside the scope of this phase of the project, vulnerability of urban areas can be derived from our watershed analysis and some specific situations are highlighted below.

Floods in Urban Areas

Cities are tightly concentrated areas of "gray infrastructure" – roads, dams, canals, and more – built of concrete and other impervious, hard-surface materials that seal the soil and warm the environment[4]. Such "sealed soil" leads to increased storm water run-off, often artificially diverted to larger streams via canals and straightened drainage ditches, increasing the speed and volume of water reaching rivers during a storm event. Floodwaters may reach industrial sites, construction areas, and other areas of loosened soil substrates, carrying excess siltation, debris, and other hazards to downstream locations.

Critical infrastructure located in cities, such as hospitals and public safety sites, can be damaged, destroyed, or inaccessible due to flood waters and people may become stranded in their homes when roads are overcome. Flooding also brings risks of contamination and disease to residents. Floodwaters can carry raw sewage, leaked toxic chemicals from industrial areas, and runoff from hazardous sites. The impacts of flooding can be ubiquitous across a city, however due to the propensity for lower-income and underserved communities to be located near industry, toxic sites, landfills, and flood-prone areas[5], the risk of being impacted by floodwaters and the contaminants they can carry increases for these communities greatly.

Based on Flood Factor data, both Tomah and Sparta are likely to experience flooding in coming decades. Tomah is situated alongside the South Fork of the Lemonweir River and Council Creek, while Sparta is intersected by the La Crosse River. Flood Factor® data indicates that Tomah will generally have a moderate risk of flooding in coming decades, while Sparta's risk is much greater (major to severe risk; Figure 1).

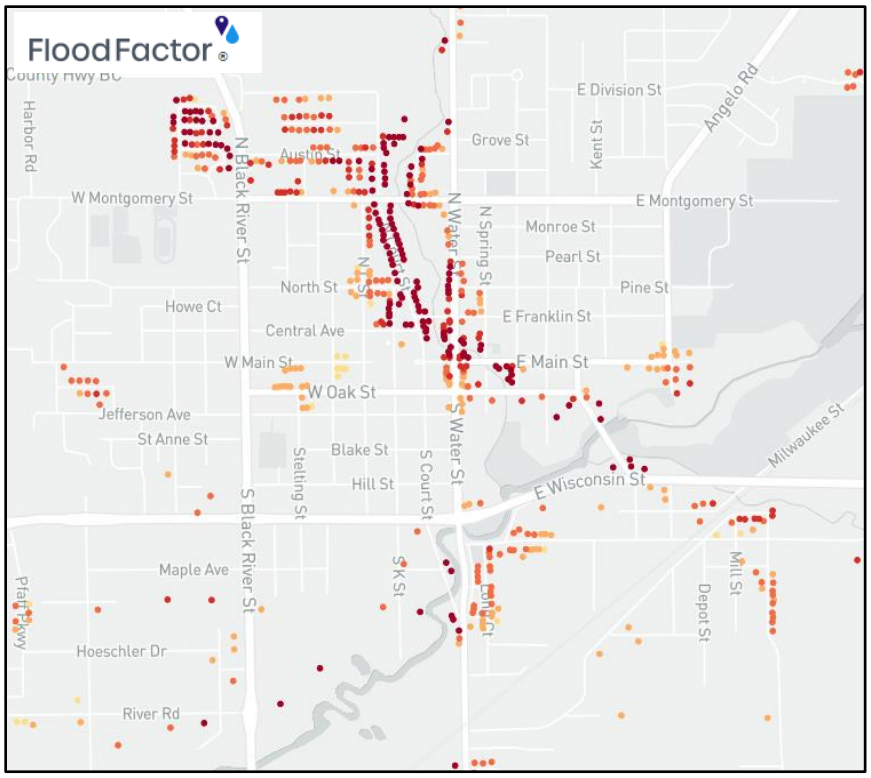

Figure 1. Flood Factor risk assessment for a portion of Sparta. Points represent overall risk (residential, industry, infrastructure, etc), with the darkest red dots considered to be in "extreme risk" of flooding by 2050 and those in orange considered "moderate".

Toxic Sites – Brownfields and Superfunds

Because toxic sites (often called Superfunds and Brownfields) are typically the result of manufacturing practices, improperly disposed industrial waste, and landfills, a vast majority of them are located within cities. **Superfund sites** are a formal Federal designation (CERCLA) through the US EPA and are considered severely polluted toxic locations requiring a long-term response to clean up hazardous material contaminations. Because of the severity of the contamination, Superfund EPA National Priorities List (NPL) designation allocates Federal dollars and resources to the clean-up of the site and authorizes Federal bodies to investigate responsible parties. The principal goal of Superfund remediation is to reduce the risks to human health through cleanup and controls. A secondary goal is to return the site to productive use as a business, recreation or as a natural ecosystem. A **Brownfield** is also contaminated but differs from a Superfund in that it is less severely contaminated, and thus less likely to be cleaned up with federal funds. Oftentimes Brownfield sites are former Superfunds that have received some level of cleanup and remediation, lowering the level of contaminants, but still requiring additional action to reduce or eliminate toxicity.

Data obtained from the Wisconsin DNR indicates that there are 4 Superfund sites and 26 Brownfield sites in Monroe County. Of these, 1 Superfund site and 4 Brownfields are in or within 100 feet of the floodplain, presenting risks of downstream hazardous waste contamination during a flood. One Superfund site and 8 Brownfields are located within Sparta, and 3 Superfunds and 7 Brownfields are located within Tomah.

Heat Islands

Engineered materials such as roads, parking lots and buildings alter the reflectivity of the land surface; rather than reflecting incoming solar radiation, cities absorb 80–85% of it, making them hotter than non-urban locations[6]. In addition, industrial and transportation activities produce waste heat emissions. Urban areas therefore become "islands" of higher temperatures, referred to as "heat islands." Heat islands can form day or night, in small or large cities, in northern or southern climates, and in any season. Daytime temperatures in urban areas can be up to 7°F higher than temperatures in outlying areas[7].

Heat islands in turn exacerbate climate change due to an increased demand for air conditioning to cool buildings. This increases overall electricity demand, peak energy demand, and air pollutants (due to increased power demand from fossil fuel power plants). During extreme heat events, which are exacerbated by heat islands, the increased demand for air conditioning can overload systems and cause blackouts or "brown-outs", causing the loss of critical cooling for many homes and businesses.

These factors in turn, contribute to heat-related deaths and illnesses ranging from respiratory difficulties to heat exhaustion and heat stroke. Sensitive populations are particularly at risk during these events. Older adults are among the most vulnerable to extreme heat events, however young children may also be at increased susceptibility. Populations with low-income are at greater risk of heat-related illnesses due to poor housing conditions, including lack of air conditioning and small living spaces, and inadequate resources to find alternative shelter during a heat wave. Disadvantaged communities, who have statistically higher rates of health conditions such as heart disease, diabetes, and asthma, are also at higher risk, as heat stress can exacerbate heart disease and diabetes, and warming temperatures result in more pollen and smog, which can worsen asthma and COPD[8].

Recommendations

Flood risk in urban areas should be evaluated more thoroughly using Flood Factor, FEMA, and other resources to evaluate risk and plan for adaptation. Areas near industrial sites, contamination sites, housing (esp. low-income and underserved areas) should receive special attention to ensure evacuation routes, resource availability (including access to emergency services), and contamination control. Efforts should be made to evaluate the extent of cleanup and remaining toxicity of Superfunds and Brownfields sites in Sparta, Tomah, and other areas throughout the county.

Mobile home parks, which are often placed in or near floodplains and industrial sites, are particularly at risk. The structural integrity of mobile homes likely would not be able to withstand damage from flood waters, and escaping residents may be exposed to floodwaters inundated with sewage and toxic wastes. Indeed, previous studies have investigated the flood exposure of mobile home residents and found them to be vulnerable due to widespread siting of mobile home parks in floodplains, structural fragility, and poverty[9]. This case example represents the interacting elements of climate factors interacting with non-climate stressors and hazards, in an area with socially vulnerable people and critical infrastructure. **Environmental justice issues, especially in urban areas, should be more thoroughly assessed in the County.**

Appendix IX References

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Flood Factor data for Monroe County can be found at: https://floodfactor.com/county/monroe-county-wisconsin/55081_fsid