Spokane Climate Vulnerability Index

Indicators Description

Date: **June 9, 2025**

Spokane is addressing Climate planning in its Comprehensive Plan to meet recent Growth Management Act (GMA) requirements in HB 1181. As part of that effort the City is preparing a Climate Risk and Vulnerability Assessment (CRVA). Climate vulnerability is defined as the combination of **exposure** to a changing climate, the inherent **sensitivity** of people or environments to a changing climate, and the **adaptive capacity** of the community and place to cope with the impacts of a changing climate.

To support the CRVA a Climate Vulnerability Index (CVI) has been developed to share geographical information. The Spokane CVI considers over 30 indicators of climate vulnerability and summarizes multiple sets of data into one measurement; the index allows for an "apples-to-apples" comparison across the community. The index identifies which census block groups are more or less vulnerable to extreme heat or extreme precipitation, ***relative*** to other areas in Spokane. The focus on comparing block groups within Spokane to each other differs from indices that compare census tracts or block groups in Spokane to others in the state (e.g., Washington State Department of Health Disparities Map) or the nation (e.g., EJScreen). The methodology to develop the CVI considers literature and studies about the effect of a changing climate on land, buildings, ecosystems, human health, economies, and more.[1]

The data include different climate hazard exposures, socioeconomic and health information, and built and natural environment data across the community. It also includes assets – people, places, and infrastructure that could be exposed to different climate related hazards.

[1] See for example: Yu, J. e. (2021). Geospatial indicators of exposure, sensitivity, and adaptive capacity to assess neighbourhood variation in vulnerability to climate change-related health hazards. *Environmental Health*, 20:31.

Administrative Boundaries

Exhibit 1. Administrative Boundaries – Layer List

Spatial Layer	Description	Source
Percent of Block Group Area within city limits	Blocks with 0%, 0-50%, and 51-100% inclusion in city limits. Allows for the calculation of index scores for city limits only (blocks with at least 50% inclusion in city limits) or full study area (city and urban growth area (UGA) combined).	US Census Bureau – block boundaries BERK – calculated share in city limits
Neighborhoods	Neighborhoods in Spokane	City of Spokane

Population and Race/Ethnicity

Population density is shown with 1 dot equaling a certain number of people (the map scales the people per dots based on the level of zoom). Population is based on the 2022 5-Year American Community Survey. Since population density will differ today and in the future based on the growth trends and potential policies of the Comprehensive Plan, population density can be an overlay on top of other layers. It can assist with policy development and resource prioritization.

Race and ethnicity is also provided along with block group information available when right clicking a block group. The data is based on the 2020 Decennial Census. See Exhibit 5. Adaptive Capacity Indicators – Layer List which includes Black, Indigenous, and People of Color (BIPOC) populations. These communities may have cumulative exposures to pollution and health and social disparities that can affect these communities' capacity to adapt to climate hazards. The BIPOC indicator is part of the Adaptive Capacity sub-index. Having the race/ethnicity data available outside of the index allows a person exploring the information to turn the information on top of other spatial information about assets, exposure, sensitivity, or other feature.

Population and race/ethnicity are represented for full block groups whether fully or partially in the city limits in order to accurately represent population density.

Critical Assets

Assets include communities, places, and infrastructure that could be exposed to different climate related hazards.

Exhibit 2. Critical Assets – Layer List

Spatial Layer	Source
Tribal Assets	
Locations of Tribal Importance	American Indian Community Center. Spokane Tribal Gathering Space, plaza adjacent to City Hall. Snxw Meneɔ (sin-HOO-men-huh). Rededicated to the Spokane Tribe in 2016. Formerly known as Canada Island.
Tribal Areas of Interest	Shows areas of interest for multiple tribes. These areas can be reviewed individually or overlapping. These are from the Department of Archaeology and Historic Preservation WISAARD map.
Public Facilities	
Airports	WSDOT
Public Schools	Washington State
Levees	Washington State Department of Ecology
Environmental Resources	
10-Year Wellhead Protection Areas	Washington State Department of Ecology
Aquifer	City of Spokane (Water Dept)
Hazardous Geology-Landslide Potential	This layer is a selection of geologic formations identified by Washington State Department of Natural Resources and adopted into the Spokane County Critical Area Ordinance as having a high susceptibility for landslides.
Wetlands	City of Spokane based on National Wetlands Inventory
City of Spokane Shoreline Jurisdiction	City of Spokane
Washington DNR Watercourses	Washington State Department of Natural Resources GIS Open Data
Washington DNR Waterbodies	Washington State Department of Natural Resources GIS Open Data

Spatial Layer	Source
Emergency Services and Medical Facilities	
Emergency Response & Law Enforcement	City of Spokane
Hospitals	Washington State
Clinics	Washington State DOH
Energy Facilities	
Dams	Dams | ArcGIS Hub (USDOT)
Electric Substations	Geospatial Energy Mapper (GEM)
Power Plants	Geospatial Energy Mapper (GEM)
Transmission Lines	Geospatial Energy Mapper (GEM)
Easements-Yellowstone Pipeline	City of Spokane Valley
Key Community Locations	
Parks	City of Spokane
Libraries	Spokane Public Library
Places of Worship	Esri World Geolocator
Food Access (Grocery Stores and Food Banks)	Esri World Geolocator
Restaurants	Esri World Geolocator
Commercial & Retail Locations	Buildings (City of Spokane)
Entertainment Venues	Open Street Map
Transportation Infrastructure	
City Streets	City of Spokane
Bridges – WSDOT	WSDOT - All Bridge and Tunnel Inventory (State & Local)
Bridges – City of Spokane	Bridge | City of Spokane
Sidewalks	City of Spokane
Trails	City of Spokane
Bike Lanes and Paths	City of Spokane
WSDOT Proposed State Highways	WSDOT - Functional Class - Overview
WSDOT State Route Climate Vulnerability	WSDOT
Railroad	City of Spokane

Spatial Layer	Source
Utilities	
Stormwater Swales	City of Spokane
Water Main	City of Spokane
Wastewater Treatment Plants	City of Spokane
Wastewater Sewer Overflow (CSO)	City of Spokane
Sewer Gravity Main	City of Spokane
Waste to Energy & Landfills	Entered manually from DOE

Exposure Indicators

Exposure identifies places that could be adversely affected by hazards including extreme heat, flooding, extreme precipitation, wildfire, and air pollution. The mean and median average for each indicator is included at the end of this document.

Exhibit 3. Exposure Indicators – Layer List

Indicator	Description	Source
Average Land Surface Temperature	Illustrates Urban Heat Islands. Grid cell values averaged by block group.	LANDSAT8 / BERK Consulting. Heat Severity - USA 2023 - Overview (arcgis.com) (source data for the previous Trust for Public Land heat severity data)
Area within Flood Zone	100- and 500-yr Floodplains; potentially exacerbated by extreme precipitation. Percent area of intersection calculated.	FEMA/City of Spokane https://my.spokanecity.org/projects/floodplain-management-update/ https://www.fema.gov/flood-maps
Area within Urban/Wildland Urban Interface	Percent area of intersection calculated with Interface and Intermix areas.	Washington Department of Natural Resources: DNR WUI Maps
Average Ozone Exposure	Ozone Concentration. Grid cell values averaged by block group.	NW-AIRQUEST Regional Background Design Values, 2014-2017 (Hosted on Idaho Department of Environmental Quality's Webpage); Washington Ambient Air Monitoring Network, Department of Ecology; Air Emissions Inventory, WA Department of Ecology; National Emissions Inventory, US EPA

Indicator	Description	Source
Average PM 2.5 Exposure	PM2.5 Concentration. Grid cell values averaged by block group.	NW-AIRQUEST Regional Background Design Values, 2014-2017 (Hosted on Idaho Department of Environmental Quality's Webpage); Washington Ambient Air Monitoring Network, Department of Ecology; Air Emissions Inventory, WA Department of Ecology; National Emissions Inventory, US EPA
Change in Chance of Extreme Precipitation	Extreme Precipitation - Percent Change in Magnitude of 2-year Storm, RCP 8.5, 2040-2069 vs 1980-2009. Grid cell values averaged by block group.	UW Climate Impacts Group https://data.cig.uw.edu/climatemapping/.

Sensitivity Indicators

Sensitivity addresses location of people with higher sensitivity to climate risks (due to health or demographic attributes) as well as the location of environmental conditions that predispose an area to be more at risk due to an exposure to climate hazards. The mean and median average for each indicator is included at the end of this document.

Exhibit 4. Sensitivity Indicators – Layer List

Indicator	Description	Source	Discussion
Population Under 5 years old	Percent of block group with population under 5 years.	ACS 2022 5-Year estimates for block group, Table B01001.	Children under 5 years of age are likely to experience higher risks for long-term mental health and socioeconomic impacts from climate hazards. They may be more susceptible to asthma, which can be made worse with increasing air pollution.
Population Over 65 years old or Older	Percent of block group with population over 65 years.	ACS 2022 5-Year estimates for block group, Table B01001.	Older individuals are more susceptible to the negative health consequences of heat exposure.
High Blood Pressure	Percent of tract adult population. Assign each block group the indicator value associated with its parent tract (all block groups within	CDC Places	Chronic medical conditions can be worsened by climate hazards. Increasing climate hazards can lead to more outdoor air pollutants and increased allergens and asthma, which can especially impact people with asthma and chronic obstructive
Asthma			
Coronary Heart Disease			

Indicator	Description	Source	Discussion
COPD (Chronic obstructive pulmonary disease)	a common tract will have the same value).		pulmonary disease (COPD), among other illnesses.
Diabetes			
Poor Mental Health			
Poor Physical Health			
Area within Potential Geologic Hazard	Percent of block group area intersecting hazard area.	City of Spokane	Extreme precipitation in the form of heavy rain and snow events could increase the frequency of landslides.
Area with Steep Slopes	Percent of block group area intersecting hazard area.	UW DEM files (to cover both city and UGA)	See above. Steep slopes above 40% are considered at risk for landslides.
Coverage by Impaired Waterbodies	Percentage of block group intersecting a 303d-listed freshwater stream or water body.	Ecology (303d)	Hazards such as increased stormwater runoff can further affect water quality, affecting people living near bodies of water.

Adaptive Capacity Indicators

Adaptive Capacity includes indicators regarding the ability of people, places, and community assets to cope with changing climate conditions. The mean and median average for each indicator is included at the end of this document.

Exhibit 5. Adaptive Capacity Indicators – Layer List

Indicator	Description	Source	Discussion
BIPOC Share of Population	Percent of block group population. BIPOC refers to residents who identify as any race other than "White Alone" (e.g., Black, Indigenous, and persons of color) OR who identify as Hispanic/Latino (even if they identify as white).	ACS 2022 5-Year estimates for block group, Table B03002	BIPOC populations may have cumulative exposures to pollution and health and social disparities that can affect these communities' capacity to adapt to climate hazards.

Indicator	Description	Source	Discussion
Limited English-Speaking Ability	Percent of block group population living in a household where no one speaks English at least "Well."	ACS 2022 5-Year estimates for block group, Table B16004	Adults with limited English proficiency may not get important information and access to resources in climate events when information is not provided in a language they speak.
People Living Alone	Percent of block group households.	ACS 2022 5-Year estimates for block group, Table B11001	People living alone are more likely to die in periods of unusually intense heat. People who live alone may not be checked on regularly during a climate emergency and have a higher risk of mortality compared to others who have social contacts and access to transportation.
Population Living in Poverty	Percent of block group population experiencing poverty	ACS 2022 5-Year estimates for block group, Table B17021	Low-income communities tend to have greater sources of environmental risk, including higher ambient air pollution concentrations. Workers with low-income levels may experience more hardship associated with reduced pay from lost labor hours. Lacking financial resources also reduces a person's ability to respond to climate risks (e.g., their ability to rebuild their home, afford health care, or evacuate/relocate to a less risk-prone location)
Persons with Disabilities	Percent of block group population with a disability.	2024 EJ Screen	Residents with disabilities may be impacted in several ways due to climate hazards. Emergency warnings may not address the needs of those with low vision, blindness, or hearing loss. Those with mobility difficulties may have trouble getting to safe places during flooding and heat waves. A climate-related disaster may inconvenience and endanger those dependent on transit.
Cost-Burdened Households	Percent of renter households spending more than 30% of income on housing	ACS 2022 5-Year estimates for block group, Table B25070	Housing cost burden can lead to financial stress and limit a household's ability to afford other essentials, such as healthcare and education.

Indicator	Description	Source	Discussion
Energy Cost Burden	Percent of gross household income spent on energy costs, calculated by dividing the average housing energy cost by the average annual household income. A household with 6% or greater energy burden is considered to be a high energy burden household.	Energy.gov	Lower-income households may spend more of their income on energy expenses, and may live in poorly insulated housing and results in higher energy demand. Costs to install more resilient forms of energy may be a barrier.
No High School Diploma	Percent of Population Age 25 or older with less than a high school degree	ACS 2022 5-Year estimates for block group, Table B15003	Individuals with lower educational attainment are at increased risk of ambient air pollution exposure and associated health effects. There may be barriers to understanding warning information and access to recovery information.
College Degree	Percent of block group population	ACS 2022 5-Year estimates for block group, Table B15003	See above.
Unemployment	Unemployment rate	ACS 2022 5-Year estimates for block group, Table B23025	The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster.
Median Household Income	Median annual income of households in the block group	ACS 2022 5-Year estimates for block group, Table B19013	See poverty above for effects on persons with lower incomes. Those with higher incomes may have more resources to respond to the climate hazard.
No Health Insurance	Percent of block group population	CDC Places	People without health insurance may be more vulnerable to the potential health effects of heat exposure, and more impacted economically by seeking emergency services.
Outdoor Professions	Percent of jobs in sectors likely to be performed outdoors (NAICS 11, 21, 23)	ACS 2022 5-Year estimates for block group, Table C24030	Outdoor workers are exposed to heat and smoke. They and other people dependent on natural resources may also experience anxiety and consequences to their economic stability from income loss.

Indicator	Description	Source	Discussion
Poor Housing Condition	Percent of housing units built before 1960	ACS 2022 5-Year estimates for block group, Table B25034	Homes built prior to modern building codes were often built without prioritization of energy efficiency, e.g., without insulation and with single-paned windows. These can be energy cost burdens to occupants and expensive to retrofit.
Access to Open Space	Residential properties within a 10-minute walk of park or open space.	Spokane Park Master Plan for in-city. Calculated for UGA.	Access to open space can reduce the rate of chronic diseases, and can improve resilience to climate change.
No Access to Vehicle	Percent of block group population without regular access to a vehicle.	ACS 2022 5-Year estimates for block group, Table B25044	A lack of access to a vehicle could limit people's ability to move to safer locations during extreme weather events, access essential resources like food and water, and impede adaptation post impact.
Access to Transit	Number of transit stops within the block group.	Spokane Transit	Transit dependent residents may face extreme weather disruptions.
Tree Canopy	Percent tree canopy coverage	NLCD - National Land Cover Database	Indicators like lack of tree canopy can represent an environmental injustice while also being highly correlated with urban heat islands, a climate impact.
Impervious Surface	Percent impervious surface coverage	NLCD - National Land Cover Database	High amounts of impervious surface contribute to urban heat islands, higher energy consumption, elevated emissions of air pollutant, and higher daytime and evening temperatures. Impervious surface may also hinder capacity to adapt to extreme precipitation.

Climate Context Data

Layers of information that may assist in the understanding of vulnerabilities to climate related impacts are listed below.

Exhibit 6. Planning Source Data – Layer List

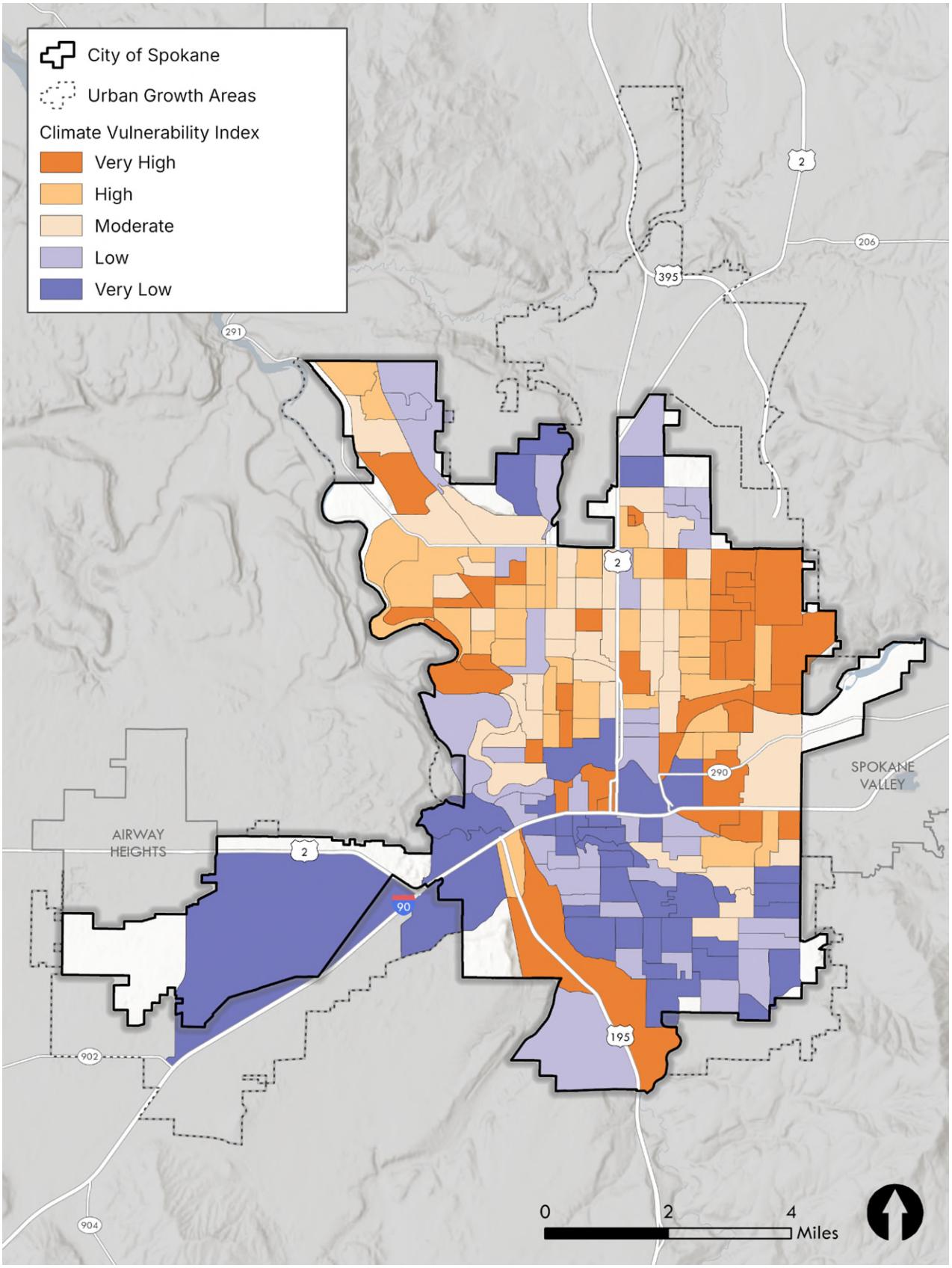
Spatial Layer	Description	Source
Flood Hazards	FEMA 100-Year and 500-Year data.	FEMA and City of Spokane https://my.spokanecity.org/projects/floodplain-management-update/ https://www.fema.gov/flood-maps
Historic Redlining	Redlining is a "ranking system that categorizes neighborhoods as more or less impoverished largely based on the race of the residents. Government maps were created so that banks could determine where it was a "safe" bet to lend money to residents." Areas of Spokane were categorized into "grades" – the first grade in green signified the lowest risk for lending, and the fourth grade, indicated in red, signified a "hazardous" risk area for lending. The historical redlining of Black and other minority neighborhoods is linked with more intense urban heat islands and exposes residents to more risk due to extreme heat than other communities.	Spokane Housing Action Plan, 2021 and City of Spokane GIS Data source, Digital Scholarship Lab, University of Richmond, *Mapping Inequality: Redlining in New Deal America*: https://dsl.richmond.edu/panorama/redlining/
Projected Change in Extreme Heat Days	Change in Days with Maximum Humidex Above 90° F, RCP 8.5, 2040-2069 vs 1980-2009. Assigned value of corresponding grid cell within which the tract falls.	UW Climate Impacts Group https://data.cig.uw.edu/climatemapping/. Due to level of granularity in data and availability of other sources, this layer is not included in the Exposure sub-index.
Projected Change in High Fire Danger Days	Change in the number of days per year, relative to 1971 - 2000, with high fire potential based on dry fuels, fuel moisture below the 20th percentile.	UW Climate Impacts Group https://data.cig.uw.edu/climatemapping/. Due to level of granularity in data and availability of other sources, this layer is not included in the Exposure sub-index.
Wildland Urban Interface	Source layer for the Area within Urban/Wildland Urban Interface layer in Exposure.	Washington State Department of Natural Resources, DNR WUI Maps

Spatial Layer	Description	Source
Ember Ignition Risk Areas	Embers from wildfire can travel and ignite structures up to 1.5 miles away or further, depending on wind conditions. This layer shows a 1.5 mile radius around wildland urban interface areas to represent the area that may be at risk of ember ignition.	City of Spokane Fire Department
Wildfire Risk to Communities Housing Unit Impact	The data depict components of wildfire risk specifically for populated areas in the United States. These datasets represent an index that incorporates the general consequences of fire on a home as a function of fire intensity and uses flame length probabilities from wildfire modeling to capture likely intensity of fire.	USDA, US Forest Service, 2024 Housing Unit Impact
Gonzaga Urban Heat Island Mapping, July 2022	2022 Heat Watch Spokane	Developed by Gonzaga University Institute for Climate, Water, and the Environment. Field data was collected in Spokane on July 16, 2022. Model output includes predicted morning, afternoon, and evening temperatures citywide. https://www.gonzaga.edu/climate-institute/our-work/climate-resilience-project/understanding/heat-mapping

Climate Vulnerability Index Maps

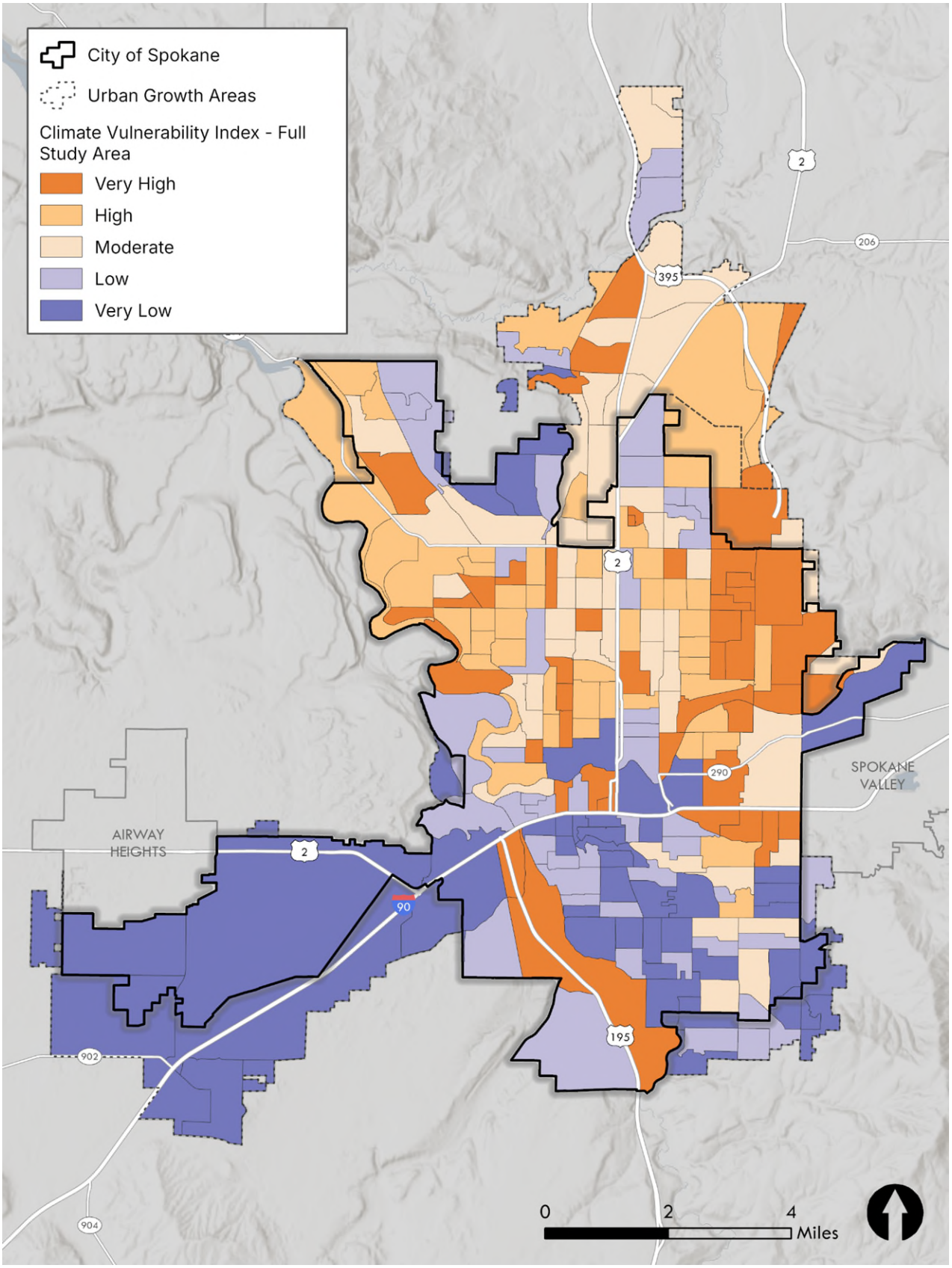
Based on the method and indicators, the overall Climate Vulnerability Index results are shared for the block that primarily lie in city limits. A similar evaluation was conducted addressing blocks that intersect with the unincorporated urban growth area (UGA) abutting the City of Spokane. This captures blocks in Latah/Hangman and Chief Gary Park that straddle the city/UGA boundary. Because the dataset is expanded and indicator averages shift, some blocks shift in quintile scores slightly.

Exhibit 7. City of Spokane Climate Vulnerability Index



Source: BERK Consulting, Inc. 2025.

Exhibit 8. City of Spokane Climate Vulnerability Index: City and Urban Growth Area



Source: BERK Consulting, Inc. 2025.

Vulnerability Indicator Averages

The following matrix lists the exposure sensitivity, and adaptive capacity indicators with the mean and median scores for the Census Blocks in the city limits and in the Urban Growth Area (UGA).

Exhibit 9. Matrix of Indicators and Mean and Median Averages for Census Blocks primarily in City Limits and Urban Growth Area (UGA)

Indicator	Units	Mean (City Only)	Median (City Only)	Mean (Full UGA)	Median (Full UGA)
E PM 2.5 Weighted Avg	Micrograms per cubic meter	19.1	19.4	18.9	19.4
E Ozone Weighted Avg	Parts per billion	58.3	58.2	58.4	58.4
E Urban Heat Island Mean	Degrees Celsius	39.2	39.5	39.1	39.3
E Humidex 8.5 Weighted Avg	Days	30.6	30.8	30.6	30.8
E Humidex 4.5 Weighted Avg	Days	21.0	21.1	21.1	21.1
E HeavyPrecip Weighted Avg	Days	16.7	17.6	16.8	17.6
E Flood Coverage	Percent	3.2%	0.0%	3.0%	0.0%
E WUI_Coverage	Percent	28.3%	0.0%	38.2%	19.2%
E Fire Danger Weighted Avg	Days	8.6	8.6	8.7	8.6
S Over 64 Percent	Percent	16.9%	14.4%	17.1%	14.8%
S Under 5 Percent	Percent	4.8%	3.8%	4.9%	3.8%
S GeoHazard Coverage	Percent	4.0%	0.0%	4.1%	0.0%
S Water Quality Coverage	Percent	0.3%	0.0%	0.3%	0.0%
S Steep Slopes Coverage	Percent	1.1%	0.0%	1.1%	0.0%
S Hypertension Percent	Percent	28.3%	28.2%	28.2%	28.2%
S Asthma Percent	Percent	12.1%	12.3%	12.0%	11.7%
S Heart Disease Percent	Percent	5.5%	5.2%	5.4%	5.2%
S COPD Percent	Percent	6.7%	6.3%	6.5%	6.1%
S Diabetes Percent	Percent	9.5%	8.9%	9.3%	8.9%

Indicator	Units	Mean (City Only)	Median (City Only)	Mean (Full UGA)	Median (Full UGA)
S Poor Mental Health Percent	Percent	18.9%	19.3%	18.4%	18.0%
S Poor Physical Health Percent	Percent	12.1%	11.8%	11.8%	11.3%
AC People of Color Percent	Percent	19.7%	18.0%	18.5%	17.1%
AC Linguistic Isolation Percent	Percent	1.4%	0.0%	1.3%	0.0%
AC Living Alone Percent	Percent	35.0%	31.4%	32.8%	29.3%
AC No Vehicle Percent	Percent	9.9%	5.2%	8.7%	4.2%
AC Below Poverty Percent	Percent	15.7%	10.9%	14.6%	10.1%
AC Housing Cost Burden Percent	Percent	43.7%	45.7%	44.6%	46.1%
AC Median Household Income	Dollars	$68,294.62	$65,167.00	$73,186.68	$66,563.00
AC Less than High School Percent	Percent	6.9%	4.9%	6.2%	4.8%
AC College Degree Percent	Percent	32.3%	30.2%	33.5%	31.4%
AC Unemployed Percent	Percent	6.7%	5.3%	6.4%	4.9%
AC Outdoor Professions Percent	Percent	6.5%	4.8%	7.0%	5.3%
AC Built before 1960 Percent	Percent	53.7%	59.0%	45.4%	49.0%
AC Disability Percent	Percent	17.1%	15.8%	16.3%	15.4%
AC No Health Insurance Percent	Percent	8.2%	7.9%	7.8%	7.3%
AC Access to Transit	Stops	5.6	4.0	5.0	4.0
AC Impervious Coverage	Percent	49.4%	50.9%	45.0%	48.2%
AC Tree Canopy Coverage	Percent	13.7%	10.3%	13.8%	12.0%
AC Energy Cost Burden	Percent	2.3%	2.0%	2.2%	2.0%
AC Access to Open Space Percent	Percent	88.1%	100.0%	74.3%	100.0%

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