Data Documentation
NCCOS Community Risk Assessment: RA2 MD

Dataset Information:

Title: NCCOS Assessment: A Community Risk Assessment of Flooding and Heat Hazards in Baltimore, MD, 2023-06-01 to 2025-09-30

Alternative URL:
https://coastalscience.noaa.gov/project/assessing-community-risk-in-relation-to-flood-hazards-in-the-baltimore-maryland-metro-area/

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Description:

This dataset includes census block group level component scores of various indices from the National Centers for Coastal Ocean Science (NCCOS) Community Risk Assessment of Flooding and Heat Hazards in Baltimore, MD. Indices included in this archived dataset include SoVI®, ecosystem services valuation, structural exposure, population projections, urban heat hazard, and flood hazard. Each component score is aggregated to the block group level geography provided by the U.S. Census Bureau. Additionally, intermediary raster-based datasets on stormwater flooding hazard are provided, as well as spatial data on wetlands and protected areas.

Methods:

This assessment uses a geospatial, indicator-driven approach to integrate data from a variety of sources related to community risk in Baltimore, MD, and the surrounding 5 counties of Baltimore, Harford, Howard, Anne Arundel, and Queen Anne's. The final aggregation geographies for this assessment are the census block group (2020).

An ecosystem services valuation aggregated index was derived from the total ecosystem services valuation layer of the Maryland Department of Natural Resources (Campbell et al., 2017). These include: (a) atmospheric pollution removal, (b) carbon sequestration, (c) groundwater recharge, (d) nitrogen removal, (e) flood prevention and stormwater mitigation, (f) wildlife habitat and biodiversity, and (g) surface water protection. The value is the mean for each block group, in dollars per year. The input raster data were aggregated to block groups using the average value and normalized 0–1.

A structural exposure aggregated index was calculated from the Department of Homeland Security's HIFLD, Maryland's iMap geospatial database, and ESRI's business analyst data (U.S. Department of Homeland Security, 2022; Maryland iMap, 2024; ESRI Business Analyst, 2023). The index includes the following: banks, bay access points, colleges, critical roadways, drinking water infrastructure, electricity

production, emergency shelters, farms, fire stations, gas stations and electric vehicle charging, government facilities, grocery stores, hardware stores, hazardous waste facilities, hospitals, places of worship, police stations, public transit lines, schools, shoreline protection, stormwater infrastructure, and wastewater infrastructure. The total structural exposure index score was developed by aggregating each contributing indicator to the block group by using the ArcGIS's Summarize Within tool, yielding a count for each block group of total sites or total meters of infrastructure (for roads and pipes). It was then calculated by min-max normalizing each contributing indicator to a scale of zero to one and adding the values for each block group together. The resulting index yields a range of 0-22 at the block group level. Data were also normalized to 0–1 at the census block group level.

SoVI® was derived from Census data and applied to each census block group (Cutter, & Emrich, 2017).

Population projections and densities are for the year 2050 (Baltimore Metropolitan Council, 2024), and were normalized to 0–1 at the census block group level.

Stormwater flooding potential in the Baltimore region was assessed using the FIGUSED methodology (Kazakis et al., 2015), which integrates seven indicators: Flow Accumulation (F), Rainfall Intensity (I), Geology/Hydrologic Soil Groups (G), Land Use (U), Slope (S), Elevation (E), and Distance to Drainage (D). Each indicator was scored from 0 (low risk) to 1 (high risk), and combined into a composite flood risk index. Flow Accumulation was calculated using a 30x30m Digital Elevation Model (DEM) from the U.S. Geological Survey (United States Geological Survey, 2021). The process included sink-filling, flow direction calculation, and accumulation modeling to quantify surface runoff convergence zones. Rainfall Intensity data came from NOAA and the PRISM Climate Group, based on 30-year normals (1991–2020) at 800m resolution (NOAA National Weather Service, 2024; PRISM Climate Group, 2024). This was resampled to 30m to align with the DEM. Geology/Hydrologic Soil Groups were derived from USDA's Web Soil Survey (National Resources Conservation Service Soil Survey Staff, 2023). Survey areas categorized under hydrologic groups A and B (indicating well-drained, or more absorbent soils) were assigned a value of 0, while areas falling into groups C, D, A/D, B/D, or C/D were given a value of 1, indicating a higher flood potential. Land Use classifications come from 1-meter resolution data by the Chesapeake Conservancy, USGS, and the University of Vermont Spatial Analysis Lab (Chesapeake Conservancy et al., 2022). Impervious surfaces and wetlands were assigned higher flood risk scores based on the following categories (Water & Impervious Structures – 10; Tree Canopy Over Impervious – 8; Barren – 6; Low Vegetation – 4; Tree Canopy & Scrub/Shrub – 2; Aberdeen Proving Ground – No Data). These were normalized and rescaled to 30x30m resolution for integration with the remaining contributing factors.

Slope and Elevation were extracted from the DEM. Lower elevations and flatter slopes that are more prone to water pooling were given higher flood risk scores (normalized 0–1). Distance to Drainage was calculated using flowline data from the National Hydrology Dataset (United States Geological Survey, 2020). A drainage density grid was created and normalized, with higher values indicating proximity to surface water networks. All seven layers were integrated within a GIS framework and summed into an additive index ranging from 0 to 7, then normalized 0–1 at the census block group level. Higher index values indicate greater stormwater flood potential.

Sea level rise estimates are derived from NOAA's Office of Coastal Management (NOAA Office for Coastal Management, 2024). These data from NOAA on sea level rise data use local tide gauge data from the Chesapeake Bay to update sea level rise predictions, updating the database and sea level rise layers regularly with new elevation models and sea level rise predictions. Data were aggregated to the block

group using a spatial join to estimate the total area impacted under a 2-foot year 2050 and a 5-foot year 2100 sea level rise scenario. Data were also normalized to 0–1 at the census block group level.

Category 2 and Category 4 storm surge estimates for this study use the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) Model. This dataset is created by the National Weather Service (NWS) and utilized by the National Hurricane Center (NHC) and the Federal Emergency Management Agency (FEMA), among many disaster response agencies (NOAA National Hurricane Center, 2024). The SLOSH model estimates storm surge heights and associated inundation based on historical, hypothetical, and predicted storms, hurricanes, and winds. Storm surge estimates were calculated by spatially joining input raster data to the block group geographies and calculating the mean inundation depth from the SLOSH model. These data were then normalized 0–1 at the census block group level.

An urban heat index was derived using input data from the Landsat 8 program data, in conjunction with land use/land cover data analysis (Trust for Public Land, 2019). This data shows where certain areas of cities are hotter than the average temperature for that same city as a whole. Urban heat is measured on a scale of 1 to 5, with 1 being a relatively mild heat area (slightly above the mean for the city), and 5 being a severe heat area (significantly above the mean for the city). The absolute heat above mean values are classified into 5 classes. The final urban heat index for the study site used a mean value of the predicted urban heat index for census block groups, indicating severity of heat on a scale of 1-5. Mean values were calculated for the census block groups and normalized 0-1.

Wetland Areas data come from the land use land cover dataset created by the Chesapeake Conservancy, the University of Vermont Spatial Analysis Lab, and the US Geological Survey (Chesapeake Conservancy et al., 2022). One-meter Resolution Land Cover data classified as wetlands were aggregated to the census block group by totaling the percent covered by wetland areas, including riverine, tidal, and terrine wetland extent; these data were also normalized 0–1 at the census block group level.

Protected Areas data are derived from Protected Areas Database of the United States (United States Geological Survey, 2024). The percentage of census block groups covered by protected areas, defined here as public land and voluntarily provided private protected areas from the Protected Areas Database of the United States was calculated, and normalized 0–1 at the census block group level.

Final data were aggregated at the census block group level and visualized using a bivariate choropleth mapping technique. All input data were normalized to a 0–1 scale to allow for direct comparison between indices. Each variable was classified into three categories, low, medium, and high using statistical quantile breaks, which ensure an equal number of observations per class. This classification method supports effective bivariate mapping by enabling the simultaneous visualization of two variables and their relative spatial distribution. As a result, the bivariate classifications reflect relative rankings across both indices, highlighting co-occurring patterns at the block group level.

Keywords:

Sea Areas, Water Bodies, Marine Protected Areas:

- Atlantic Ocean, Chesapeake Bay

NCCOS Keywords:

- Social Science
- Assessing Vulnerability and Resilience
- Atlantic
- Geospatial

- Maryland
- Baltimore

Related publication: Freitag, A.F., Auerswald, K.A., Pope, B., Regan, S.D., Sudol, T. (2025) NCCOS Assessment: A Community Risk Assessment of Flooding and Heat Hazards in Baltimore, MD, 2023-01-01 to 2025-09-30 NOAA Technical Memorandum NOS *report forthcoming*.

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    - Identifier: https://ror.org/05ba43f71

Date of Collection:
Start Date: 2023-06-01

End Date: 2025-03-01

Geospatial Metadata
Geographic Coverage: Baltimore, MD
Counties of Baltimore, Harford, Howard, Anne Arundel, and Queen Anne's, MD

Geographic Unit: Census Block Group, 30 x 30 meter raster grid

Geographic Bounding Box:
Northern Boundary: 39.723687
Southern Boundary: 38.706644
Western Boundary: -77.188030
Eastern Boundary: -75.737639

Data Sources:

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File Information

Total File Size: 1.94GB, 302 files, 1 folders; 653MB zipped
Data File Format(s):

- ESRI GRID
- Comma-separated value (.CSV)
- ShapeFile .SHP (and ancillary files .CPG, .DBF, .PRJ, .SBN, .SBX, .SHX)
- Geodatabase .gdb

Data File Compression: winzip
Data File Resolution: Census Block Group level, 30x30m raster grid
GIS Projection: NAD 1983/ NAD 1983 StatePlane Maryland FIPS 1900 (US Feet)

Data Files:

- Archived_Data_Files_RA2_MD.zip

Documentation Files:

- RA2_MD_Data_Dictionary_Archived_Data.xlsx
- RA2_MD_Data_Dictionary_Archived_Raster_Data.xlsx
- RA2_MD_Archive_Package_March_2025.pdf

Data Type(s)

- Community Risk

Parameter Description:

Parameters: Community Risk
Property Type: calculated
Units: census block group
Observation Category: modeled data
Sampling Instrument: secondary data analysis
Software name and version: ArcGIS Pro 3.4.0, SPSS
Sampling and Analyzing Method:

This project involved secondary data analysis, for full dataset methods please see the NOAA Technical Memorandum NOS NCCOS *report forthcoming*.

Documentation and Access to Sources:

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Table 1: RA2_MD_Data_Dictionary_Archived_Data.csv

Variable	Field Name	Definition	Units	Range
OBJECTID	OBJECTID	Object ID	n/a	Object ID
Shape	Shape	Geometry	n/a	Geometry
STATEFP	STATEFP	State	n/a	text
GEOID	GEOID	Geographic Identifier (U.S. Census)	n/a	text
Ecosystem services aggregated index	Ecosystem_Services_Index	Ecosystem services valuation aggregated index derived from the total ecosystem services valuation layer of the Maryland Department of Natural Resources. These include: a) atmospheric pollution removal, b) carbon sequestration, c) groundwater recharge, d) nitrogen removal, e) flood prevention and stormwater mitigation, f) wildlife habitat and biodiversity, and g) surface water protection. The value is the mean for each block	index score	0-700

		group, in dollars per year.		
Ecosystem services normalized index	Ecosystem_Services_Index_MIN_MAX	Ecosystem services valuation normalized index derived from the total ecosystem services valuation layer of the Maryland Department of Natural Resources. These include: a) atmospheric pollution removal, b) carbon sequestration, c) groundwater recharge, d) nitrogen removal, e) flood prevention and stormwater mitigation, f) wildlife habitat and biodiversity, and g) surface water protection. (normalized 0-1)	normalized index score	0-1
Structural exposure aggregated index	Structural_Index	Structural exposure aggregated index calculated from Department of Homeland Security's HIFLD, Maryland's iMap geospatial database, and ESRI's business analyst data. The index includes the following: banks, bay access points, colleges, critical roadways, drinking water infrastructure, electricity production, emergency shelters, farms, fire stations, gas stations + electric vehicle charging, government facilities, grocery stores, hardware stores, hazardous waste facilities, hospitals, places of worship, police stations, public transit	index score	0-22

		lines, schools, shoreline protection, stormwater infrastructure, and wastewater infrastructure.		
Structural exposure normalized index	Structural_Index_MIN_MAX	Structural exposure aggregated index. The index includes the following: banks, bay access points, colleges, critical roadways, drinking water infrastructure, electricity production, emergency shelters, farms, fire stations, gas stations + electric vehicle charging, government facilities, grocery stores, hardware stores, hazardous waste facilities, hospitals, places of worship, police stations, public transit lines, schools, shoreline protection, stormwater infrastructure, and wastewater infrastructure. (normalized 0-1)	normalized index score	0-1
SoVI aggregated index	SoVI_Index	SoVI® aggregated index, generated by principal components analysis of 29 demographic variables per 2019 methodology: https://sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/sovi/index.php.	index score	0-9.06
SoVI aggregated index, normalized	Social_Vulnerability_Index_MIN_MAX	SoVI® aggregated index, generated by principal components analysis of 29 demographic	normalized index score	0-1

		variables per 2019 methodology: https://sc.edu/study/colleges_schools/artsandsciences/centers_and_institutes/hvri/data_and_resources/sovi/index.php. (normalized 0-1)		
Population Projections in 2050	Pop_Projections_2050	Estimated population projections at the census block group for the year 2050.	index	0-30363
Population Projections in 2050, normalized	Pop_Projections_2050_MN_MAX	Estimated population projections at the census block group for the year 2050. (normalized 0-1).	normalized index	0-1
Population Density	Pop_Den_2050	Estimated population density in persons per square km at the census block group for the year 2050.	index	0-25209
Population Density, normalized	Pop_Den_2050_MIN_MAX	Estimated population density in persons per square km at the census block group for the year 2050. (normalized 0-1).	normalized index	0-1
Stormwater flooding aggregated index	Stormwater_Index	Mean value of stormwater flood potential raster based on the FIGUSED index that incorporates flow accumulation, precipitation, hydrologic soil groups, land use-landcover, slope, elevation, and drainage density). Index was aggregated to census geographies.	index score	0-7
Stormwater flooding	Stormwater_Index_MIN_MAX	Mean value of stormwater flood	normalized index score	0-1

aggregated index, normalized		potential raster based on the FIGUSED index that incorporates flow accumulation, precipitation, hydrologic soil groups, land use-landcover, slope, elevation, and drainage density). Index was aggregated to census geographies. (normalized 0-1)		
Sea level rise of 2ft aggregated index	SLR_2ft_Index	Total area covered (in square meters) in a 2ft of sea level rise scenario calculated from NOAA Office for Coastal Management data, 2024.	index score	0-14263554
Sea level rise of 2ft aggregated index, normalized	SLR_2ft_Index_MIN_MAX	Total area covered in a 2ft of SLR scenario calculated from NOAA Office for Coastal Management data, 2024. (normalized 0-1)	normalized index score	0-1
Sea level rise of 5ft aggregated index	SLR_5ft_Index	Total area covered (in square meters) in a 5ft of SLR scenario calculated from NOAA Office for Coastal Management data, 2024.	index score	0-15780485
Sea level rise of 5ft aggregated index, normalized	SLR_5ft_MIN_MAX	Total area covered in a 5ft of SLR scenario calculated from NOAA Office for Coastal Management data, 2024. (normalized 0-1)	normalized index score	0-1

Category 4 storm surge aggregated index	Cat4_Storm_Surge	Mean value of area covered in a Sea, Lake, and Overland Surge from Hurricanes (SLOSH) Model, Category 4.	index score	0-14
Category 4 storm surge aggregated index, normalized	Cat4_Storm_Surge_MIN_MAX	Mean value of area covered in a Sea, Lake, and Overland Surge from Hurricanes (SLOSH) Model, Category 4. (normalized 0-1)	normalized index score	0-1
Urban heat aggregated index	UHI	Mean value of predicted urban heat severity index for census block groups, indicating severity of heat on a scale of 1-5.	index score	1-5
Urban heat aggregated index, normalized	UHI_MIN_MAX	Mean value of predicted urban heat severity index for census block groups, indicating severity of heat on a scale of 1-5. (normalized 0-1)	normalized index score	0-1
Urban heat p.m. temperature including 90 degree threshold	UHI_Mean_PM_Temp	Average urban heat p.m. temperatures aggregated to census block groups.	score	82-93
Wetland Areas	Wetland_Percent_Covered	Percent of census block groups covered by wetland areas, including riverine, tidal, and terrine wetland extent.	index score	0-100
Protected Areas	Protected_Areas_Percent_Covered	Percent of census block groups covered by protected areas, defined	index score	0-100

		as public land and voluntarily provided private protected areas from the Protected Areas Database of the United States.		

Table 2: RA2_MD_Data_Dictionary_Archived_Raster_Data.csv

Variable	Filename	Definition	Units	Range	Resolution
Stormwater flooding potential index raster	SW_index	Stormwater potential flooding index based on the FIGUSED methodology that incorporates flow accumulation, precipitation, hydrologic soil groups, land use-landcover, slope, elevation, and drainage density. Higher values indicate higher stormwater potential flooding.	Continuous raster	0-7	30m
Flow accumulation	FLOW_FIGUSED	Flow accumulation data derived from digital elevation model (DEM) used in calculation of overall stormwater flooding potential index. (normalized 0-1)	Continuous raster	0-1	30m

Precipitation	PRISM_FIGUSED	Global Gridded Standardized Precipitation Index (SPI) from PRISM climate group, annual precipitation 30 year normals used in calculation of stormwater flooding potential index. (normalized 0-1)	Continuous raster	0-1	30m
Geology (hydrologic soil groups))	GEO_FIGUSED	Hydrologic soil group raster, using soil data from the USDA National Resources Conservation Service Soil Survey. Soil hydrologic groups A and B (indicating well-drained soils) were assigned a value of 0, while areas falling into groups C, D, A/D, B/D, and C/D were given a value of 1, indicating a higher flood potential. This was an input in the final stormwater flooding potential index.	Categorical	0-1	30m
Land use	LULC_FIGUSED	Resampled 1 meter resolution data to 30 meter raster categorized into 2, 4, 6, 8, and 10 based on contribution to stormwater flooding potential index.	Categorical	1-10	30m
Slope	SLOPE_FIGUSED	Slope was derived from the input Digital Elevation Model (DEM) used in the calculation of stormwater flooding potential index. (normalized 0-1)	Continuous raster	0-1	30m
Elevation	DEM_FIGUSED	Digital Elevation Model (DEM) used in calculation of stormwater flooding	Continuous raster	0-1	30m

		potential index. (normalized 0-1)			
Proximity to drainage networks	DRAINAGE_FIGUSED	Drainage network density grid created using flowline data from the National Hydrology Dataset. (normalized 0-1). This was an input to the final stormwater flooding potential index.	Continuous raster	0-1	30m
Urban Heat Index	URBAN_HEAT_INDEX	Urban heat index calculated from remotely sensed data from the Landsat 8 program. Data contains relative heat on a scale of 1 (mild) to 5 (severe).	Categorical raster	0-5	30m