Environmental

Version

Release 2026B

Base Geography

Census Block (2020)
Census Block Group (2020)

Content

The environmental suite of data consists of several separate database components including:

- Weather Risks
- Coastal Risks
- Seismological Risks
- Flood Risk
- Natural Hazards
- Climate
- Air Quality
- Toxic Releases
- Transportation Noise
- Land Cover and Wetlands
- Elevation and Terrain
- Solar Radiation Potential

A wide range of applications benefit from these databases, including insurance underwriting, retail merchandising, real estate, and a wide range of applications benefit from these databases, including insurance underwriting, retail merchandising, and real estate. In some cases, many of these variables are simply useful for reference purposes or general interest.

The weather risk data covers five separate risks:

- Hurricane
- Tornado
- Hail
- Damaging Winds
- Costal Storm Surge

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The seismology risk includes both earthquake risk and tsunami risk, and can provide surprising insights in areas outside the well-known seismic zones of the far western states.

Wildfires are an annual major risk in most areas of the western United States, and while large fires often burn in the rugged and generally unpopulated mountainous areas, the combination of dry conditions, heat, and winds can often lead to major disasters along what is known as the wildland-urban interface.

The Flood Risk index provides national coverage of flood hazards, based on FEMA flood maps where they exist and on modeled estimates where they do not.

For automated merchandising systems, the climate data (average monthly and annual temperatures, rainfall, and snowfall) can help to avoid costly stocking errors. The heating and cooling degree days can assist in determining demand for heating and cooling equipment, for example. The growing season and plant hardiness measures can support lawn and garden merchandising. These measures also are of general interest, especially in residential real estate applications.

In addition, the coastal sea level rise risk index is useful for long term planning, assuming that sea levels may rise over the coming decades due to climate change.

The air quality, toxic release, noise and radon measures can be important to individuals contemplating relocation, health care research, and commercial site selection and economic development.

The nature of the local terrain can be of great interest to real estate developers and others; local terrain variables include elevation (minimum, maximum, average), slope (average and

variation), and ruggedness. The TRI (Terrain Ruggedness Index) encapsulates the overall nature of the local terrain.

Methodology

Indexing

Most of the risk indexes (weather, seismological, flood, sea level rise, etc.) are presented on a "100" basis, meaning that the average value for the nation is 100.

Rare hazards (avalanche, volcanic and tsunami) are presented as the percentage of land within the hazard area alongside a 0 to 10 scaled index, since an index based on the national average would be skewed significantly by a handful of extreme values.

Within the Snapshot engine, any of these indexes can be recomputed onto any fixed scale (e.g. a 1 to 7 scale). Many of the core indexes are also available on a 0 to 10 scale. This assists users in interpreting the values between indexes.

Weather Risks

The core risk database consists of four separate types of weather-related hazards: hurricanes, tornadoes, hail, and damaging winds. The data are the results of a series of spatial analyses carried out on records compiled from publicly available NOAA sources (the Storm Prediction Center and the National Hurricane Center), aimed at producing risk index estimates at the block level and above.

Cartographic databases, while certainly interesting, do not provide any "actionable" information to the user, as it is extremely difficult to interpret the likely risk for any given point using historical location data. The spatial analysis undertaken is based on several underlying facts:

- At a "macro" scale, there is a clear pattern of incidents of any type (e.g. "tornado alley").

- At a “micro” scale, the particular path which a single tornado or hurricane takes, or the precise location of high wind incidents or hail, is essentially a random occurrence. It is only through the accumulation of a large number of historical records that the randomness at the local scale begins to show a pattern at a regional scale.

As such, a simple count of how many tornadoes have passed through any particular block is of no value, as this certainly falls within the “micro” scale. Given a long enough historical record (e.g. several thousand years), this might be an appropriate technique for evaluating the potential risk. However, given the relative shortness of these data series, a simple arithmetic exercise is not sufficient. Instead, for any particular point occurrence (e.g. a hail observation) a conical filter was applied using a simple distance decay measure. For path events (e.g. a tornado path or hurricane track), a distance-decayed linear filter was applied. For any particular point in space, the accumulated probabilities could then be calculated by summing the areas underneath these conical and linear filters.

All of the resulting indexes are “100” based, which means that a value of 100 for a particular level of geography is the average national value. A value of 200 indicates that the area has two times the average risk level, while a value of 50 indicates that the area is at half the average risk level. For example, a value of 200 for the hail index indicates that the particular area is two times as likely to suffer hail damage in any given time period than an area with a 100 score.

Hurricane track data was obtained from the National Hurricane Center’s historical records. Atlantic hurricane coverage is from 1851 to 2025, and Pacific hurricane coverage is from 1949 to 2025. Storm locations are tracked every six hours while the storm maintains at least tropical storm strength. Along with location, the database includes information on wind speed and barometric

pressure. The risk indexes were derived using a distance decay spatial filter along the line of the storm track.

Tornado records from 1950 through 2025 were analyzed for the purpose of identifying relative risk at the block level. Unlike hurricanes, which are always presented as a hurricane path, tornadoes are presented either as a path or as a single touchdown point. A total of 73,458 separate tornado events were analyzed. Similar spatial filters to those described under hurricanes were applied to both the point and path data. The tornado measures cover frequency, intensity, fatalities and damage.

Reports of damaging hail (0.75 inch in diameter or larger) and of damaging winds from the NOAA, consisting of 413,963 records dating back to 1955. Point filters were applied to these databases to derive relative frequency and intensity measures at the block level. Where an area has no recorded events within range, its severity measures are zero. The WindRisk data elements are based on 562,088 damaging wind reports since 1955.

The composite risk index presents a unified risk index based on the relative damage expected from each type of event. The relative weights of each of the source indexes were derived by weighting estimates of total annual damage caused by storms of each type.

Coastal Risks

The storm surge index is derived from the National Hurricane Center's storm surge risk maps, which show the expected depth of flooding from hurricanes of each category. For each block, the depth of flooding over its land was weighted by the historical frequency of hurricanes of each category in that region. Coasts outside the hurricane model areas (the Pacific Northwest, northern California, Alaska and the Great Lakes) were modeled from NOAA tide and lake gauge records of extreme water levels.

The sea level rise index is based on a census block level analysis of NOAA's Sea Level Rise Viewer, computing the percentage of each block's land that would be newly flooded at one-foot intervals above high tide, including low-lying areas behind levees. These were then weighed by NOAA's 2022 projections of sea level for 2050 and 2100.

Seismological Risks

QuakeRisk presents the relative risk of damaging earthquakes on a 100 based scale, with 100 being the national average risk. The data was constructed from the USGS 2023 National Seismic Hazard Model, using the level of ground shaking with a 10 percent chance of being exceeded in 50 years. The model uses 0.05-degree grids, except in Hawaii where a 0.02-degree grid was utilized, and Alaska which used a 0.1-degree grid.

The tsunami measures were built from the official tsunami hazard zones published by California, Oregon, Washington, Hawaii and Alaska. The tsunami zone share shows the percentage of each block's land within an official zone. The tsunami 0 to 10 scale also considers how often tsunamis of each size are expected, along with risk along the Atlantic and Gulf coasts based on research models of rare undersea landslide events. Along remote stretches of the Alaska coast without official maps, the zone was estimated from elevation.

Flood Risk

The flood risk index measures the share of each block's land in flood hazard areas. It is based on FEMA's National Flood Hazard Layer and supplemented by FEMA preliminary maps, FEMA Base Level Engineering studies, and state/local flood studies. Coastal areas subject to wave action and regulatory floodways carry additional weight. Some areas, typically rural, have never been mapped by FEMA. To provide complete national coverage, the flood risk in these areas is estimated from terrain-based models and FEMA National Risk Index data.

A separate field shows the percentage of each block's land covered by actual flood maps, so that modeled values can be identified. The percentage of land within mapped 100-year and 500-year floodplains were included, along with a future flood risk index based on available mapped FEMA future-conditions. Like FEMA's maps, the flood risk index does not reflect flooding from heavy rainfall outside mapped floodplains, and areas protected by levees generally appear as lower risk.

Wildfire Risk
Wildfire Risk is based on the United States Forest Service Wildfire Risk to Communities project (2024), which models the likelihood and intensity of wildfire across the nation, including Alaska and Hawaii. The core index shows the relative risk of wildfires at the block level of geography and has been calibrated to the scale of earlier releases.

Additional variables include annual burn probability, risk to potential structures, and wildfire smoke. The wildfire smoke variables count the average annual number of days with overhead smoke, based on NOAA satellite data from 2011 to 2025.

Landslide Risk
Landslide Risk is based on the USGS 2024 national landslide susceptibility model. It is derived from the percentage of each block's area susceptible to landslides.

Avalanche Risk
Avalanche Risk captures an area's risk exposure to avalanches. It is derived by modelling PRISM snowfall and USGS elevation data against avalanche event data.

Volcanic Risk
Volcanic Risk measures the share of land within USGS volcanic threat zones, by threat level. For Hawaii, the share of land in each USGS lava flow hazard zone was also considered.

Drought Risk
Drought Risk is derived from the U.S Drought Monitor database. It shows the percentage of weeks each area was in moderate, severe or extreme drought since 2000 and 2021. Drought frequency was captured from the FEMA National Risk Index.

Winter Weather, Ice Storm, Lightning Risk These indexes were based on FEMA's National Risk Index (NRI), which contains frequencies at the census tract level. Lightning data in Hawaii was cleaned with NASA satellite data and recalibrated to mainland tracts.

Climate
The climate database was created from two primary sources. Temperature, precipitation and dew point are from the PRISM Group at Oregon State University, which publishes 30-year climate averages (1991 to 2020; 1981 to 2010 for Alaska) on an 800-meter grid that accounts for elevation, coastlines and other terrain effects. Heating and cooling degree days and snowfall were derived from these values and official NOAA climate averages for several thousand weather stations. Hawaii values were derived from NOAA weather stations, adjusted for elevation.

The heat and cold measures count the average number of days above, or below certain degree thresholds to identify the typical frequency of freezing nights, warm days, etc. These are based on daily gridMET weather records from 1996 to 2025 and refined with local terrain variables. Because the minimum temperature for a cold alert differs between state governments, the cold alert variable uses the standard of the local National Weather Service office.

The growing season measures are based on a daily gridMET feed from 1991 to 2020. They provide the average dates of the last spring freeze and first fall freeze, number of frost-free days, and share of years with a freeze

Precipitation days show the average annual number of days with precipitation above meaningful thresholds, and for each month. Cloud cover and the number of sunny and cloudy days were captured from NOAA satellite observations (2014 to 2023). Average wind speed is based on the Global Wind Atlas, with measured heights of 10 meters or 100 meters available.

The climate classification uses the well-known Köppen-Geiger model, which consists of five primary climate groups based on temperature and precipitation (tropical, dry, temperate, continental, and polar) and many more detailed climate types, such as steppe, desert and tundra. These values were derived from the Beck et al. (2023) Köppen-Geiger Global 1-km Climate Classification Maps for 1991 to 2020.

Plant hardiness zones are based on 2023 USDA Plant Hardiness Zone Map. They provide the climatological average annual lowest winter temperature, which is used for ensuring that plant selection matches local climate.

Air Quality

The air quality measures include annual average levels of ozone, nitrogen dioxide, carbon monoxide, fine particulate matter (PM2.5), coarse particulate matter (PM10) and sulfur dioxide, alongside a lead emissions exposure score. Each is also presented as an index, where 100 is the national average.

These estimates come from the latest satellite-based and computer-model air quality surfaces published by the EPA and university research groups. The nitrogen dioxide and carbon monoxide measures also consider the AGS traffic volume model, so that road level detail is possible. The lead score is based on the EPA's 2023 National Emissions Inventory of lead-emitting facilities, weighted by distance. EPA's Risk-Screening Environmental

Indicators (RSEI) model provides a toxicity-weighted air concentration score and its national percentile.

Transportation Noise
Transportation noise estimates are based on the U.S. Department of Transportation's National Transportation Noise Map (2020), which models 24-hour average noise from road, aviation and rail traffic. The measures are average noise level and the percentage of each area exposed to 55 and 65 decibels or more and by mode (road, aviation and rail).

Night Lights
Night light data is based on VIIRS satellite imagery (2023). The data includes average night-time brightness, a brightness index, and the percentage of each area by detectable artificial light and by urban-level brightness.

Radon
The radon measures include the EPA Map of Radon Zones, presented as the percentage of land in Zone 1 (highest), Zone 2 and Zone 3, and a new estimate of the typical indoor radon level by ZIP code area from a national model based on about six million radon tests (Li et al., 2025). EPA recommends testing every home regardless of zone; these values describe the community and are not a substitute for a home test. Values for Hawaii and Alaska were estimated at their EPA zones due to a lack of reporting.

Land Cover and Wetlands

Land Cover
Land cover shows the percentage of each block's area in water, trees, built-up land, crops, rangeland, bare ground, snow and ice, and flooded vegetation. Data for the contiguous United States was based on the National Land Cover Database. Time series data from the ESRI/Impact Observatory Sentinel-2 10m Land Cover satellite imagery layer was used for Alaska and Hawaii. Tree canopy cover is from the U.S. Forest Service, and impervious surface (pavement and rooftops) from the 2024 National Land Cover Database.

Wetlands are from the U.S. Fish and Wildlife Service National Wetlands Inventory.

Elevation and Terrain

The USGS publishes digital elevation model files nationwide at very high resolution (1 arc-second). Alaska is at a slightly lower resolution (2 arc-seconds). These files were processed for each census block by tracking maximum, minimum, and average elevation, and by computing the slope between each point on the USGS grid and its adjacent neighbors. These computations yield an excellent set of slope variables for very small areas, including average slope and the variation of slopes within each block.

The terrain ruggedness index uses the Terrain Ruggedness Index developed by Riley et al (1999). This measures the difference in elevation between each point and its neighbors: the higher the value, the more rugged the local terrain.

Solar Radiation Potential

Monthly and annual solar radiation estimates are provided for three separate measures: Global horizontal irradiance, Direct normal irradiance, and Latitude Equals Tilt irradiance. Measures are in kilowatt-hours per square meter per day. The annual values are from the Global Solar Atlas, and monthly patterns were derived from NASA's POWER project.

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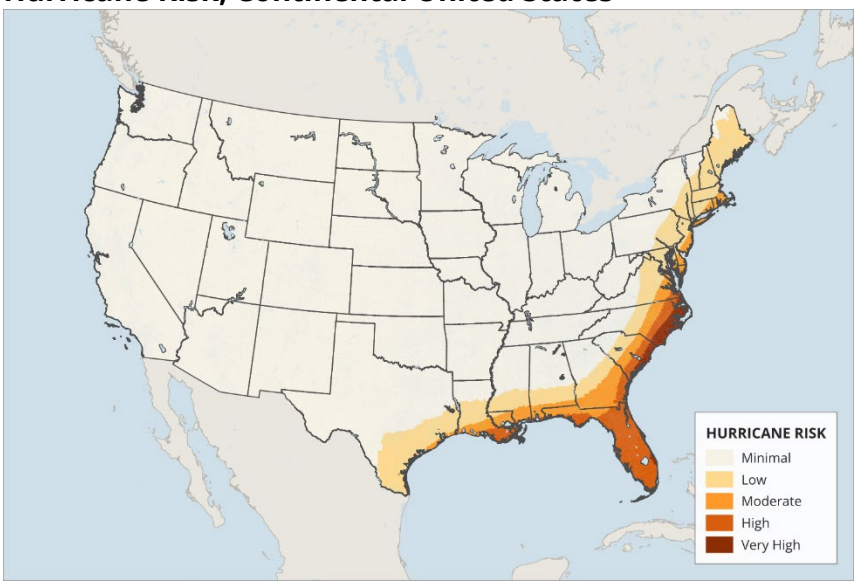
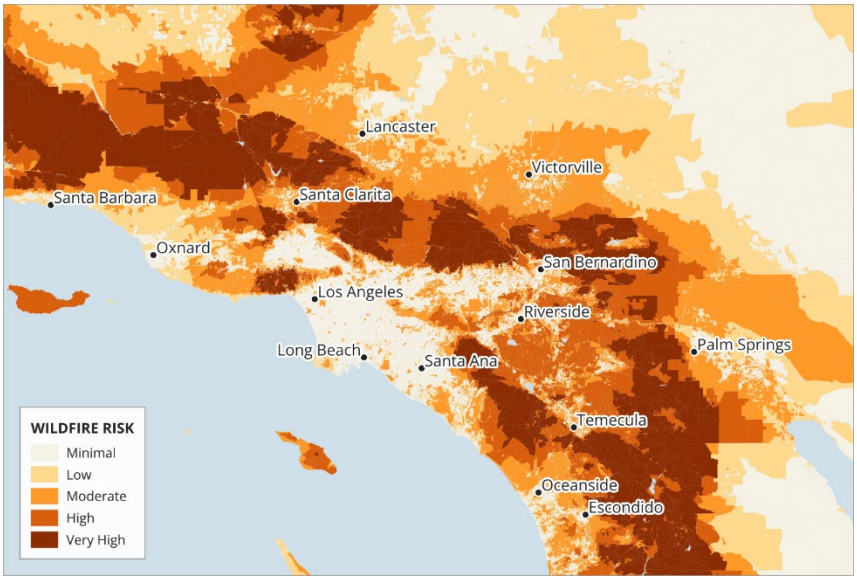
Selected Maps

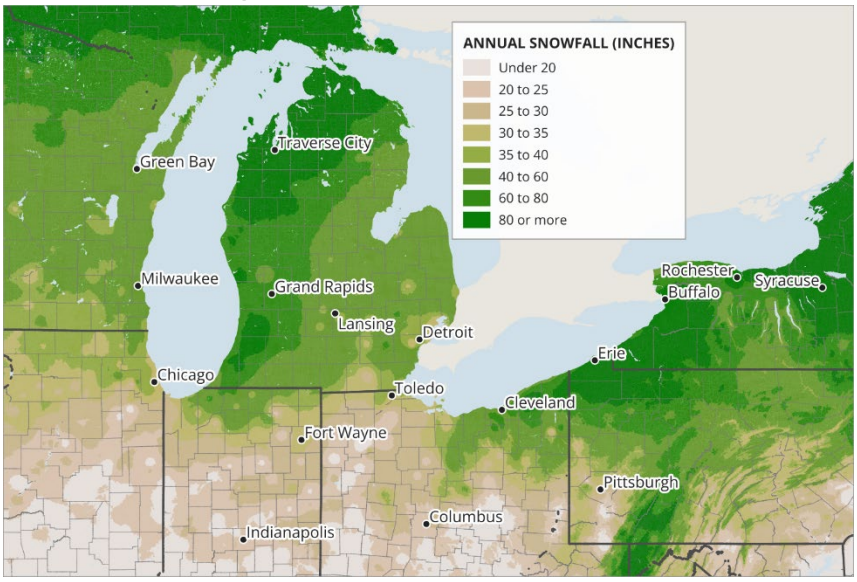
Hurricane Risk, Continental United States



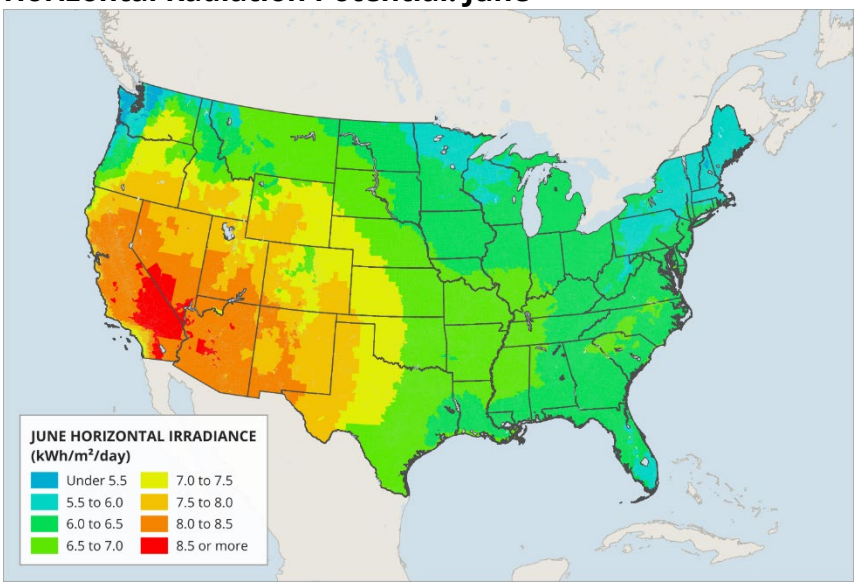
Wildfire Risk, Southern California



Annual Snowfall, Lower Great Lakes



Horizontal Radiation Potential: June



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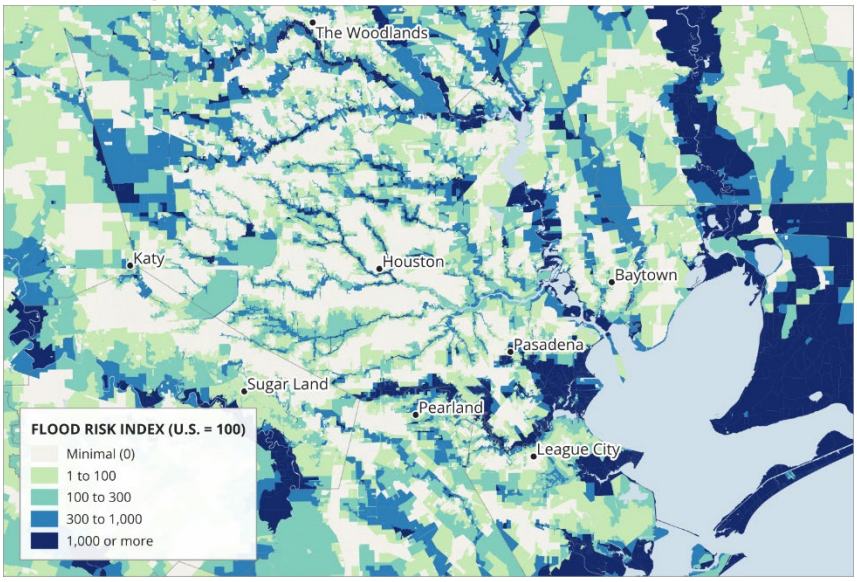
Flood Risk, Houston Area



Data Sources

NOAA Storm Prediction Center severe weather database, 1950–2025
NOAA National Hurricane Center HURDAT2 and National Storm Surge Risk Maps
NOAA Sea Level Rise Viewer and 2022 Interagency Sea Level Rise Technical Report
USGS 2023 National Seismic Hazard Model
State tsunami hazard zones (California, Oregon, Washington, Hawaii, Alaska)
FEMA National Flood Hazard Layer, preliminary and Base Level Engineering studies; state and local flood studies
FEMA National Risk Index, version 1.20 (2025)
USDA Forest Service Wildfire Risk to Communities (2024)
NOAA Hazard Mapping System smoke analyses, 2011–2025
USGS landslide susceptibility (2024), National Volcanic Threat Layer and Hawaii lava flow hazard zones
U.S. Drought Monitor, 2000–2026

PRISM Group, Oregon State University, 1991–2020 climate normals
NOAA National Centers for Environmental Information, 1991–2020 climate normals
University of Idaho gridMET daily weather, 1991–2025
NOAA PATMOS-x cloud climate data record, 2014–2023
Global Wind Atlas 4.0 and Global Solar Atlas 2.0; NASA POWER
Köppen-Geiger climate maps (Beck et al., 2023); 2023 USDA Plant Hardiness Zone Map
EPA air quality monitoring, 2023 National Emissions Inventory, Toxics Release Inventory 2022–2024, RSEI, and National Priorities List
Satellite and model air quality surfaces (Washington University in St. Louis PM2.5 2024; GHAP; EPA CMAQ)
U.S. DOT Bureau of Transportation Statistics National Transportation Noise Map, 2020
VIIRS night-time lights, 2023
EPA Map of Radon Zones (1993); National Radon Exposure Model (Li et al., 2025)
National Land Cover Database; USFS Tree Canopy Cover; USFWS National Wetlands Inventory
USGS 3D Elevation Program; PAD-US 4.1; 2020 Census blocks

Notices

This product uses the Federal Emergency Management Agency's National Risk Index dataset API or downloadable datasets but is not endorsed by FEMA. The Federal Government or FEMA cannot vouch for the data or analyses derived from these data after the data have been retrieved from the Agency's website(s).

Plant hardiness zones are derived from the 2023 USDA Plant Hardiness Zone Map (USDA-ARS and the PRISM Group, Oregon State University). This is not the official USDA Plant Hardiness Zone Map.

California tsunami zones: modified from California Geological Survey, Official GIS data of the Tsunami Hazard Area (2022). Alaska tsunami zones are derived from Alaska Division of Geological &

Geophysical Surveys inundation and hazard assessments; these modifications have not been approved by the Alaska Department of Natural Resources or DGGS, whose results are intended for emergency planning, evacuation and public education, not for land-use regulation or actuarial purposes.

The following sources are used under the Creative Commons Attribution 4.0 International license (https://creativecommons.org/licenses/by/4.0/). All have been modified by AGS and in some cases combined with other sources or rescaled to indices:

- Global Solar Atlas 2.0: a free, web-based application developed and operated by Solargis s.r.o. on behalf of the World Bank Group, utilizing Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). https://globalsolaratlas.info
- Global Wind Atlas 4.0: a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU), released in partnership with the World Bank Group, utilizing data provided by Vortex, with funding provided by ESMAP. https://globalwindatlas.info
- NASA POWER: these data were obtained from the NASA Langley Research Center (LaRC) POWER Project funded through the NASA Earth Science/Applied Science Program. https://power.larc.nasa.gov
- Daymet: Thornton, M.M., et al. Daymet: Monthly Climate Summaries on a 1-km Grid for North America, Version 4 R1. ORNL DAAC. https://doi.org/10.3334/ORNLDAAC/2131
- Köppen-Geiger climate classification: Beck, H.E., et al. (2023). High-resolution (1 km) Köppen-Geiger maps for 1901–2099 based on constrained CMIP6 projections. *Scientific Data* 10:724. https://doi.org/10.1038/s41597-023-02549-6
- Global Forest Change: Hansen, M.C., et al. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* 342:850–853. Data: Global Forest Change 2000–2025 v1.13, Hansen/UMD/Google/USGS/NASA.

- Global Human Settlement Layer: European Commission, Joint Research Centre; Pesaresi, M., Politis, P. (2023). GHS-BUILT-S R2023A. doi:10.2905/9F06F36F-4B11-47EC-ABB0-4F8B7B1D72EA
- Land cover (Alaska and Hawaii): Esri | Sentinel-2 10 m Land Use/Land Cover, produced by Impact Observatory, Microsoft and Esri (Karra et al. 2021).
- Wetlands: U.S. Fish and Wildlife Service, National Wetlands Inventory. doi:10.7944/USFWS.NWI
- Night-time lights: WorldPop (Woods et al. 2024, doi:10.5258/SOTON/WP00772), from VIIRS Nighttime Lights v2 (Elvidge et al. 2021), Earth Observation Group, Payne Institute for Public Policy, Colorado School of Mines.
- Fine particulates (PM2.5): Atmospheric Composition Analysis Group, Washington University in St. Louis, V6.GL.03 (Shen et al. 2024).
- Ozone, nitrogen dioxide and carbon monoxide: Wei, J., et al. Global High Air Pollutants (GHAP) 1 km datasets, Zenodo.
- Sulfur dioxide: Lu, X., et al. (2026). Global Land Daily Ground-Level SO2 (2004–2024) from Two-Stage Multi-Source Data Fusion and LightGBM. Zenodo. https://doi.org/10.5281/zenodo.20749701

Also credited: PRISM Group, Oregon State University; the U.S. Drought Monitor (National Drought Mitigation Center, USDA, NOAA and NASA; map courtesy of NDMC); the IMPROVE monitoring network; and Deng et al. (2026) 1 km ozone.

Further Information

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