NatureScore®
Priority Index

A tool to identify areas of nature deficiency and high SES deprivation.

7 — High SES Deprivation / Low Amounts of Beneficial Nature

Denver · Aurora · Glendale · Sheridan · Greenwood Village · Littleton · Columbine Valley

NatureScore Priority Index

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

High Nature / Low SES Deprivation — Low Nature / High SES Deprivation

Background

NatureQuant is a technology and research firm developing tools to assess and promote the health benefits of nature exposure.

NatureQuant has developed "NatureScore®", which measures the quantity and quality of natural elements for any location using a patent-pending system. For each location, NatureQuant analyzes and blends various data sets and processed information, including satellite infrared measurements, GIS and land classifications, park data and features, tree canopies, human modifications, air, noise, and light pollutions, and computer vision elements (aerial and street images). The considered elements are weighted to create the highest correlation with the predictive health impacts of given natural elements via a machine learning process. Note that certain "natural" elements that have not demonstrated positive health correlations, like sand or rock, therefore do not contribute to a high NatureScore™ in equal weightings to more predictive factors like live vegetation.

NatureScore®

Determine the quality and quantity of natural elements for a location.

Park Space

Open Water

Park Features

Tree Canopy

🌿 NatureScore 83.2

Satellite Infrared Vegetation Measurements

GIS & Land Classification Databases

Noise, Air, & Light Pollution
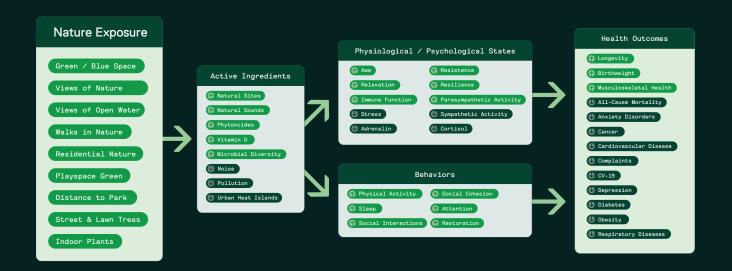
Computer Vision (aerial and street view analysis)

The NatureScore® provides a numerical score betweek 0-100 and quintiles of one-to-five color-coded "leafs". NatureScores® range from 0 (largely built environment) to 100 (largely natural environment) with an average of 50 and uniform distribution.
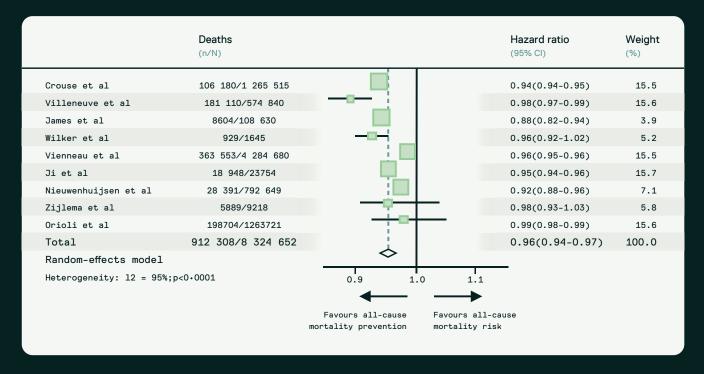
Nature Exposure & Health

A powerful body of scientific literature links nature exposure to improvements in physiological and psychological human health.

Over 150 observational studies and 100 interventional studies, tracking over 300 million individuals from 20 countries investigating 100 unique health outcomes, have convincingly demonstrated that greater nature exposure results in improvements in health span and longevity. In short, these studies prove that nature exposure can result in a longer, healthier, and even happier life. NatureScore® is optimized to leverage these findings.

The relationships that underpin the health and longevity benefits of nature exposure are complex and multifaceted, and a number of psychophysiological and social pathways have been proposed that generally link the benefits of nature to health, including improved environmental quality (air quality, heat islands, microbial diversity, etc), increased physical activity, more frequent social contacts, and decreased stress/anxiety.

Nature Exposure
- Green / Blue Space
- Views of Nature
- Views of Open Water
- Walks in Nature
- Residential Nature
- Playspace Green
- Distance to Park
- Street & Lawn Trees
- Indoor Plants

Active Ingredients
- Natural Sites
- Natural Sounds
- Phytoncides
- Vitamin D
- Microbial Diversity
- Noise
- Pollution
- Urban Heat Islands

Physiological / Psychological States
- Awe
- Relaxation
- Immune Function
- Stress
- Adrenalin
- Resistence
- Resilience
- Parasympathetic Activity
- Sympathetic Activity
- Cortisol

Behaviors
- Physical Activity
- Sleep
- Social Interactions
- Social Cohesion
- Attention
- Restoration

Health Outcomes
- Longevity
- Birthweight
- Musculoskeletal Health
- All-Cause Mortality
- Anxiety Disorders
- Cancer
- Cardiovascular Disease
- Complaints
- CV-19
- Depression
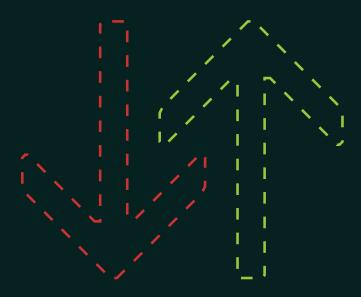- Diabetes
- Obesity
- Respiratory Diseases

This meta-analysis, including over 8 million people, found that increased greenness around homes is significantly associated with reduced premature mortality: a 4% reduction in premature mortality per each increment of 0.1 in vegetation score, within 500 meters of the residence.

	Deaths (n/N)		Hazard ratio (95% CI)	Weight (%)
Crouse et al	106 180/1 265 515		0.94(0.94-0.95)	15.5
Villeneuve et al	181 110/574 840		0.98(0.97-0.99)	15.6
James et al	8604/108 630		0.88(0.82-0.94)	3.9
Wilker et al	929/1645		0.96(0.92-1.02)	5.2
Vienneau et al	363 553/4 284 680		0.96(0.95-0.96)	15.5
Ji et al	18 948/23754		0.95(0.94-0.96)	15.7
Nieuwenhuijsen et al	28 391/792 649		0.92(0.88-0.96)	7.1
Zijlema et al	5889/9218		0.98(0.93-1.03)	5.8
Orioli et al	198704/1263721		0.99(0.98-0.99)	15.6
Total	912 308/8 324 652		0.96(0.94-0.97)	100.0
Random-effects model				
Heterogeneity: I2 = 95%;p<0•0001				

0.9   1.0   1.1

Favours all-cause mortality prevention   Favours all-cause mortality risk

Results from individual studies and a meta-analysis strongly demonstrating the influence of exposure to greenness favors longevity and prevention of all-cause mortality even when many other covariate factors are considered. Data from the meta-analysis by Rojas-Rueda et al, 2019.
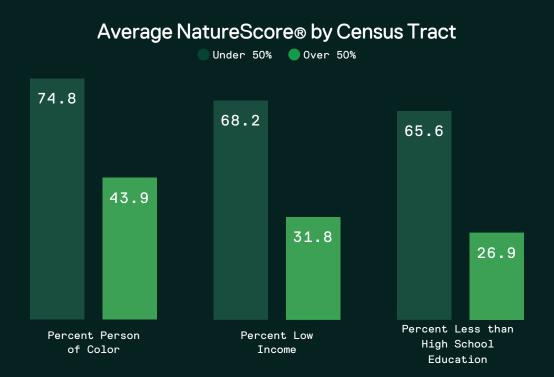
Nature Access & Environmental Justice (EJ)

Given the clear connections between nature and health, and the existing inequities in nature access in the U.S., Environmental Justice frameworks must include a measurement for nearby-nature.

The Environmenal Justice movement promotes equity by recognizing the direct links among economic, environmental, and health issues, and the movement further demands a safe, clean community and workplace environment for all. A healthy and safe environment is a public good to which every person in the United States has an equal right, both in principle and in law. However, the reality is that American society has distributed nature's benefits— as well as the harms of an industrial society—unequally by race, income, and education status.

Certain environmental injustices related to harmful pollutants, such as the disproportionate concentration of toxic air pollution near communities of color, have been thoroughly demonstrated; but automatically measuring proximity to nature has been more elusive. Nearby natural elements, like outdoor green spaces, blue spaces, and tree canopy, are unevenly and inequitably distributed. Particularly in communities of color and low-income communities, nature is often out of reach for many families. As the links between exposure to nature and mental and physical health become clear, access to nature must become another central component of the EJ movement.

When examining the relationship between NatureScores® and demographic indicators, we find that families of color, low income, or low education levels have materially less access to nature than others; in short, these communities are disproportionally nature-deprived.
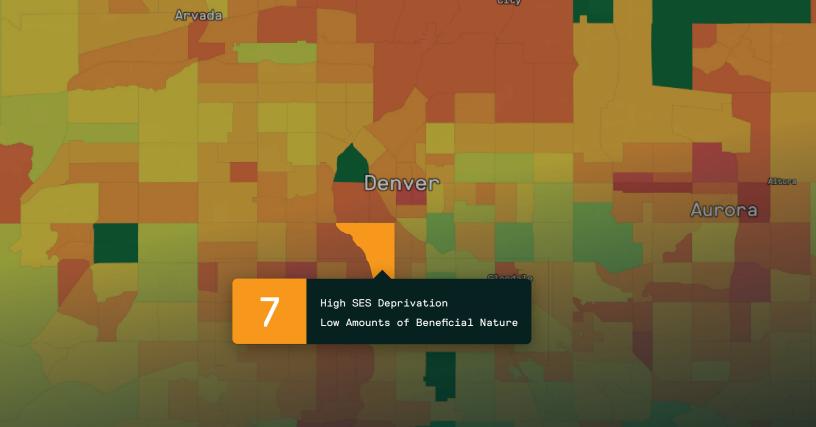
Average NatureScore® by Census Tract

● Under 50%   ● Over 50%

	Percent Person of Color	Percent Low Income	Percent Less than High School Education
Under 50%	74.8	68.2	65.6
Over 50%	43.9	31.8	26.9

Further, there is a strong negative association between NatureScores® and environmental hazards. Put simply, in areas with more nature people generally find better air quality and less environmental risk. Note, NatureScores® have also been demonstrated to be a helpful proxy for Urban Heat Islands.

There is a powerful inverse relationship between the presence of nature and the reduction of environmental risks.

Environmental Hazards

NatureScores

Inequities in nature access are particularly concerning because nature is not an amenity but a necessity for everyone's health and wellbeing.

In the places where human activities in the United States have destroyed the most nature, fewer trees filter the air and provide shade on a hot day; fewer wetlands and marshes clean the water and protect communities from floods; fewer parks offer children a place to play and adults to unwind; and fewer public spaces invite all people to forge a strong community and build solidarity.

7 High SES Deprivation
Low Amounts of Beneficial Nature

The NatureScore®
Priority Index (NPI)

NatureQuant has developed the The NatureScore® Priority Index to allow researchers, non-profits, municipalities, ESG investors, and others to be able to quickly and elegantly identify communities that are both nature deprived and have socioeconomic disadvantages (low income, low education, low employment, poor housing, etc.). The NPI can be used to prioritize the delivery of green infrastructure and help inform public health delivery and policy, especially for the most disadvantaged neighborhood groups.

The NPI combines NatureScores® with the Area Deprivation Index (ADI). The ADI is based on a measure created by the Health Resources & Services Administration (HRSA) over three decades ago, and has since been refined, adapted, and validated to the Census Block Group neighborhood level by Amy Kind, MD, PhD and her research team at the University of Wisconsin-Madison. It includes factors for the theoretical domains of income, education, employment, and housing quality.

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What do NatureScore® Priority Index scores mean?

The NPI provides a single score from 1 (low priority) to 10 (high priority) by census tract. A tract with a ranking of 1 indicates the lowest level of "disadvantage" (both in term of nature access and socioeconomic benefits) within the nation and an NPI with a ranking of 10 indicates the highest level of "disadvantage". Neighborhoods with high NPI scores should be prioritized for green infrastructure development.

Neighborhoods with high NPI scores are more likely to have poor health, urban heat islands, poor air quality, low income, etc. AND currently don't benefit from the many co-benefits natural elements can provide (which may be a circular occurrence). The NPI can be used by governments, researchers, Environmental Justice screening models, impact/opportunity zone investors, or general non-profit activity prioritization.

Notes & References

NatureScore® Priority Index is derived from an equal weighting of the NatureScore® and the Health Resources and Service Administration's Area Deprivation Index, delivered by census tract.

It is calculated as follows:

"NS": NatureScore for Census Tract (high score indicates more nature)

"ADI": Area Deprivation for Census Tract (high score indicates more deprivation)

"NPI": NatureScore® Priority Index (high score indicates a high priority neighborhood)

In Decile Rank from 1-10: [NPI=((100-NS)+ADI)/2]

NatureScore® Data Elements

NatureScore® has been developed by examining the following data. In many cases, NatureQuant has also developed a cross-referencing process to correct various data sources for edge cases, or other scenarios where an element (e.g. water, sand or an artificial turf field) is not correctly measured as "nature", due to the technique used to capture the data.

- Computer Vision of Aerial/Street Images
- NDVI processed satellite imagery
  - NatureQuant has a proprietary process for correcting and enhancing this data in relation to elements of nature.
- NDWI processed satellite imagery: measures water
- Parks GIS data
- Park features
  - NatureQuant examines various park amenities (playgrounds/sport courts/etc.).
  - Park quality ratings are included from public platforms (Yelp/Foursquare/Google
- Reviews/etc.).
- Natural/nature features GIS data
- GIS and land classification databases
- Human Modification (HM) Model (Theobald et. al. 2016)
- AQI: air quality monitoring
- Noise pollution
- Light pollution
- UV exposure (watt-hours per square meter)
- Impervious surface data
- Road density
- Tree canopy data
- Water quality data (select areas)
- Tree BioMass and Species Identification (select areas)
- Light Detection and Ranging (LIDAR) (select areas)
- In Development: Tassled Cap Values Data Structures
- In Development: Global Biodiversity Information Facility (Order/Family/Genus/Species Data)

Area Deprivation Index Data Elements

The ADI is a validated, factor-based deprivation index which uses 17 poverty, education, housing and employment indicators drawn from US Census data to create a measure of socioeconomic context for a particular census-based region. The ADI has previously been used to document a number of socioeconomic-health associations, including the direct relationship between area deprivation and all-cause, cardiovascular, cancer and childhood mortality, and between area deprivation and cervical cancer prevalence.

The ADI uses 17 US Census variables in its construction. The US Census variables are as follows:

- Percent of population aged >= 25 years with >= 9 years of education
- Percent of population aged >= 25 years with >= a high school diploma
- Percent of employed persons >= 16 years of age in white-collar occupations
- Median family income
- Income disparity (Defined by Singh as the log of 100 * the ratio of the number of households with <$10,000 in income to the number of households with $50,000 or more in income.) (25)

- Median home value
- Median gross rent
- Median monthly mortgage
- Percent owner-occupied housing units (home ownership rate)
- Percent of civilian labor force population >= 16 years of age unemployed (unemployment rate)
- Percent of families below the poverty level
- Percent of population below 150% of the poverty threshold
- Percent of single-parent households with children <= 18 years of age
- Percent of households without a motor vehicle
- Percent of households without a telephone
- Percent of occupied housing units without complete plumbing
- Percent of households with more than one person per room (crowding)

These 17 indicators are weighted using factor score coefficients to deliver appropriate weightings for the most influential elements.

More detail is available here:
https://www.ncbi.nlm.nih.gov/labs/pmc/articles/PMC4251560/