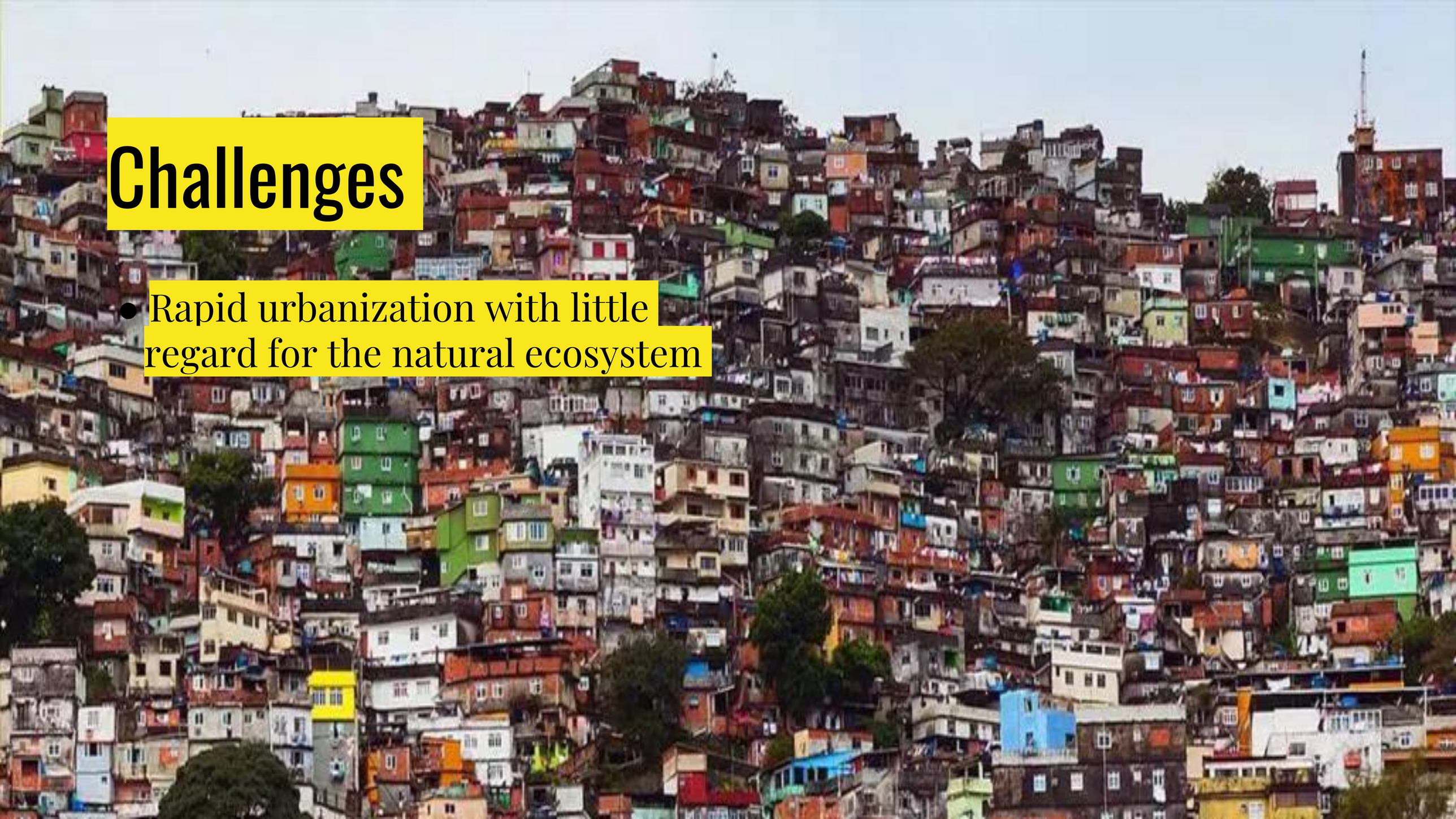
# Using geospatial big data for urban forestry quality assessments

**Nadine Galle**
University College Dublin and Trinity College Dublin
Connecting Nature (H2020-SCC02-2016)

**www.greencitywatch.org**



# Challenges

- Rapid urbanization with little regard for the natural ecosystem

# Challenges

- Hurricane Harvey in Houston, Texas (100+ direct- and indirect fatalities)
- $125 billion in damages
- Land of ultra-lax zoning regulations


# Challenges

- Landslides in Freetown, Sierra Leone (1000+ dead or missing)
- Deforestation led to loss of protective natural drainage systems

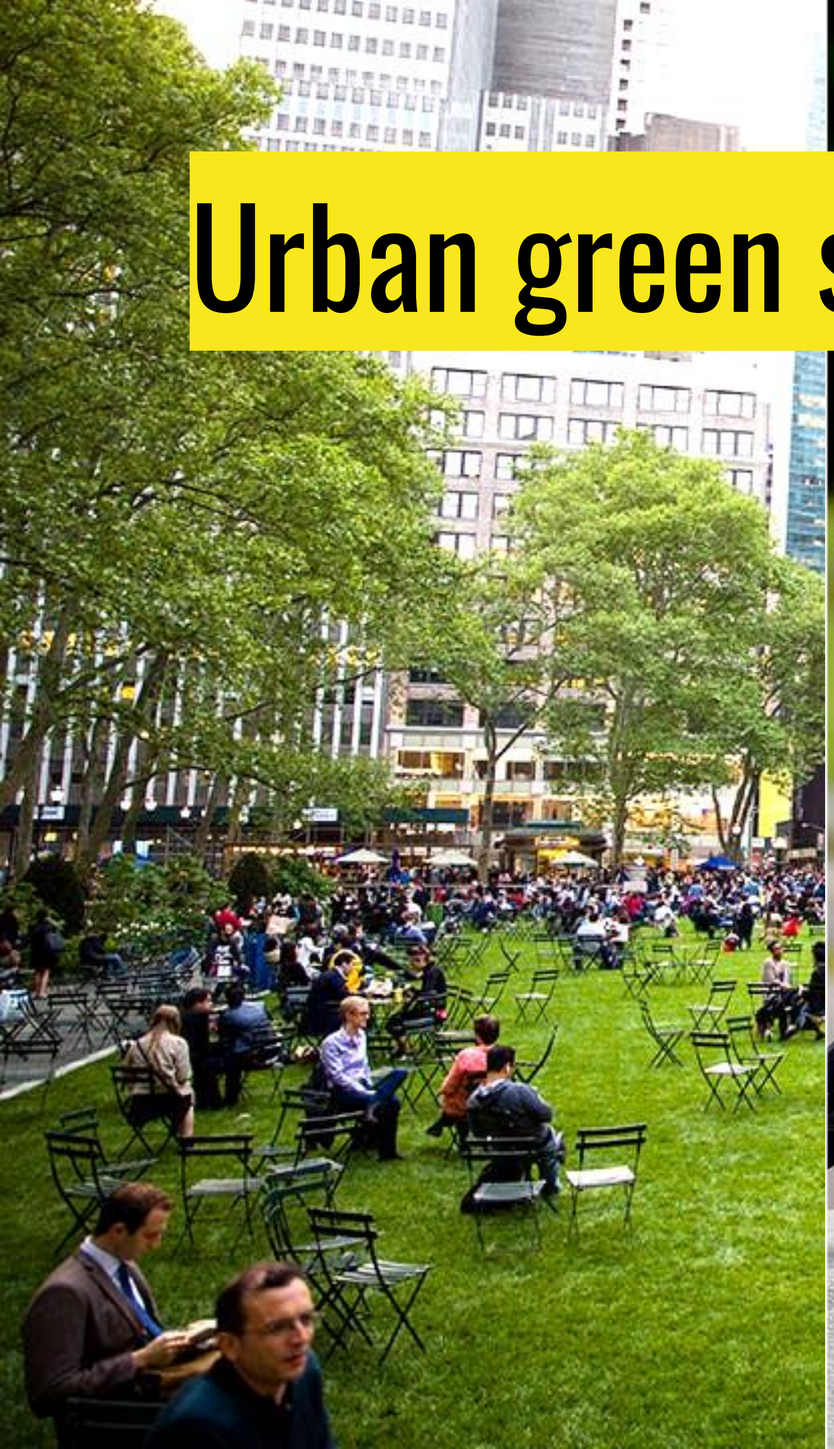
# Challenges

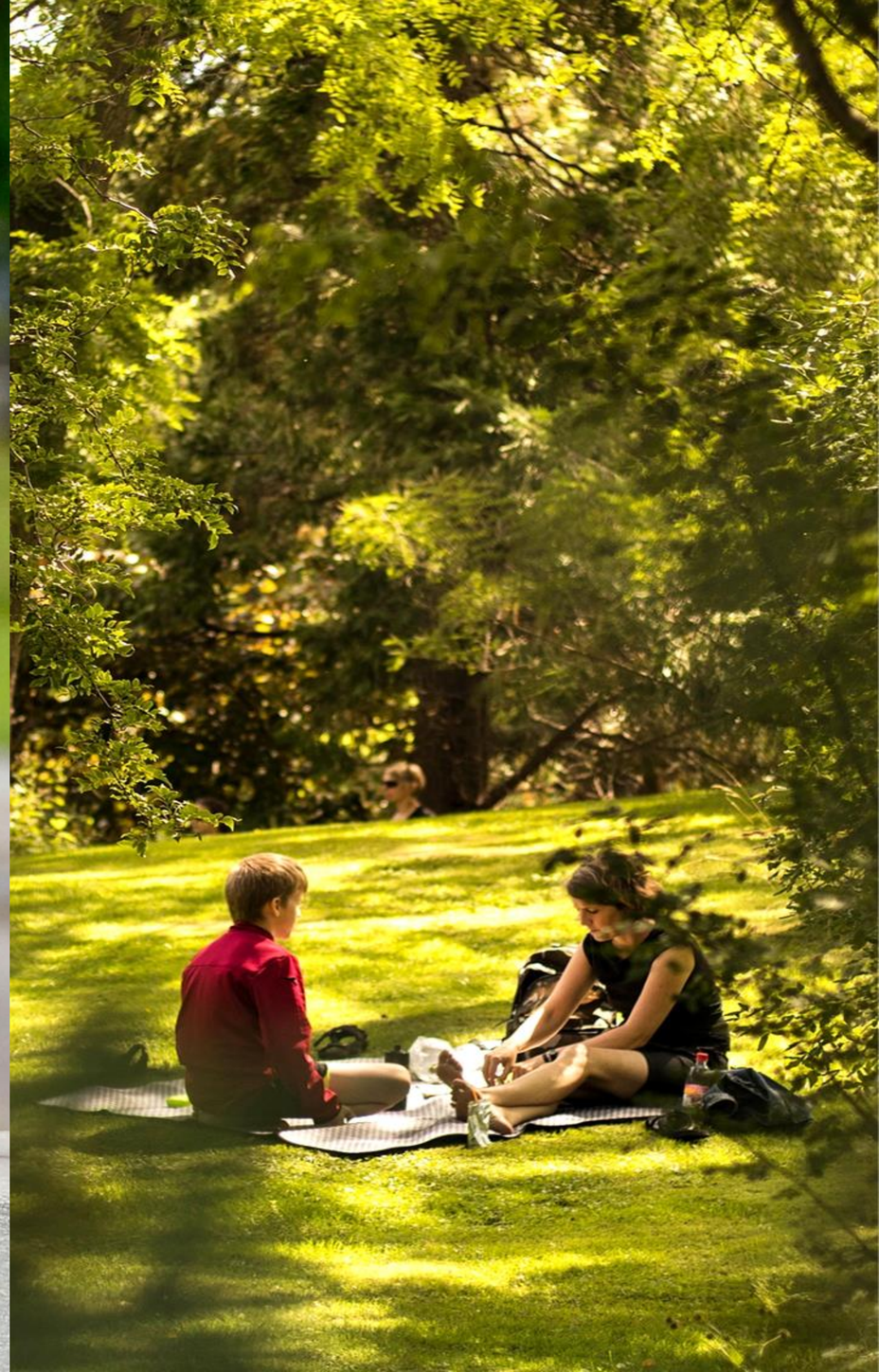
- Not enough safe, outdoor playing areas for children and teens
- “Nature deficit disorder”

# Challenges

- Living in an urban environment is long known to be a risk factor for psychiatric diseases such as major depression or schizophrenia

# Urban green space can help





# 40+ years of research to prove it

**Abstract:** "Green spaces have a range of health benefits
development in children. This study, based on compreh
ding

"The Racial/Ethnic Distribution of Heat Risk-Related Land Cover in Relation to Residential
egation"
ale, Bill M.; Morello-Frosch, Rachel; Cushing, Lara. *Environmental Health Perspectives,* July 2013, Vol. 121,
e 7. doi: 10.1289/ehp.1205919.

e examined the distribution of heat risk–related land cover (HRRLC) characteristics
ups and degrees of residential segregation…. Results: After adjustment for ecoregion
g segregation level constant, non-Hispanic blacks were 52% more likely (95% CI:
: Asians 32% more likely (95% CI: 18%, 47%), and Hispanics 21% more likely (95% CI:
C conditions compared with non-Hispanic whites. Within each racial/ethnic group,
sed with increasing degrees of metropolitan area-level segregation. Further
wnership and poverty did not substantially alter these results, but adjustment for
metropolitan area population attenuated the segregation effects, suggesting a
g role. Conclusion: Land cover was associated with segregation within each
ch may be explained partly by the concentration of racial/ethnic minorities into
ation of greater frequency
planting trees in urban
sses racial/ethnic


Journal of Public Health | Vol. 33, No. 2, pp. 212–222 | doi:10.1093/pubmed/fdq068 | Advance Access Publication 10 September 2010

Articles found were appraised for their relevance, critically reviewed and graded accordingly. Their findings were then thematically categorized.

**Results** There is weak evidence for the links between physical, mental health and well-being, and urban green space. Environmental factors such as the quality and accessibility of green space affects its use for physical activity. User determinants, such as age, gender, ethnicity and the perception of safety, are also important. However, many studies were limited by poor study design, failure to exclude confounding, bias or reverse causality and weak statistical associations.

**Conclusion** Most studies reported findings that generally supported the view that green space have a beneficial health effect. Establishing a causal relationship is difficult, as the relationship is complex. Simplistic urban interventions may therefore fail to address the underlying determinants of urban health that are not remediable by landscape redesign.

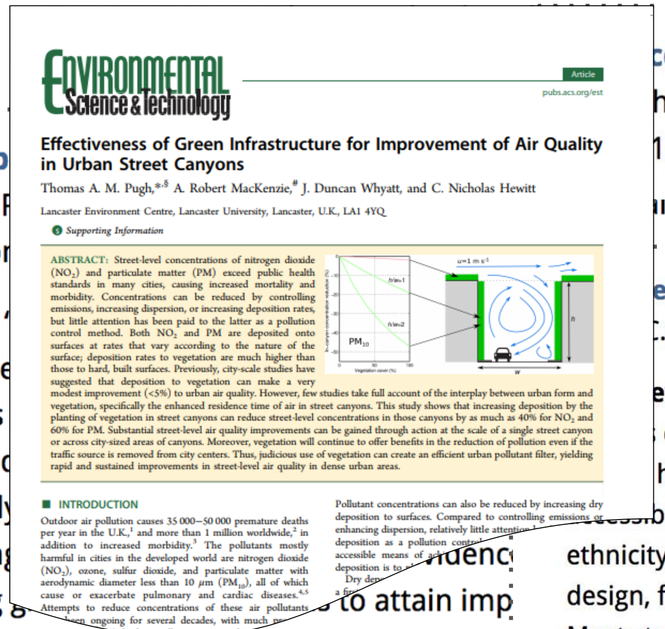
**Keywords** environment, geography, public health

**Introduction**

Globally, a dramatic demographic shift towards urbanization is occurring.[1] Between 2000 and 2050, the proportion of people living in urban areas is projected to rise from 46.6 to 69.6%.[2] Urbanization poses problems through effects such as environmental pollution, accidents, heat island effects and climate change.[3,4] This has flagged up the need for multi-sectoral action to promote health in urban populations and led to the rise of the 'Healthy Cities' movement.[5,6]

Physical and psychological benefits have been linked to green spaces through their purported effects on physical activity.[7] Numerous health benefits of physical activity have documented, such as the effects on cardio

Whilst urbanization clearly has health impacts, there is uncertainty as to whether the purported health benefits of green spaces, such as parks and playing fields, are an urban myth or fact. Urban developments are costly projects. It is therefore important that urban design and planning decisions are informed by robust evidence. Th
sought to broadly examine the evid
health benefits of green spa
summary for health


ENVIRONMENTAL Science & Technology

Article

pubs.acs.org/est

**Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons**

Thomas A. M. Pugh,*[,§] A. Robert MacKenzie,[#] J. Duncan Whyatt, and C. Nicholas Hewitt

Lancaster Environment Centre, Lancaster University, Lancaster, U.K., LA1 4YQ

*Supporting Information*

ABSTRACT: Street-level concentrations of nitrogen dioxide ($NO_2$) and particulate matter (PM) exceed public health standards in many cities, causing increased mortality and morbidity. Concentrations can be reduced by controlling emissions, increasing dispersion, or increasing deposition rates, but little attention has been paid to the latter as a pollution control method. Both $NO_2$ and PM are deposited onto surfaces at rates that vary according to the nature of the surface; deposition rates to vegetation are much higher than those to hard, built surfaces. Previously, city-scale studies have suggested that deposition to vegetation can make a very modest improvement (<5%) to urban air quality. However, few studies take full account of the interplay between urban form and vegetation, specifically the enhanced residence time of air in street canyons. This study shows that increasing deposition by the planting of vegetation in street canyons can reduce street-level concentrations in those canyons by as much as 40% for $NO_2$ and 60% for PM. Substantial street-level air quality improvements can be gained through action at the scale of a single street canyon or across city-sized areas of canyons. Moreover, vegetation will continue to offer benefits in the reduction of pollution even if the traffic source is removed from city centers. Thus, judicious use of vegetation can create an efficient urban pollutant filter, yielding rapid and sustained improvements in street-level air quality in dense urban areas.




■ INTRODUCTION

Outdoor air pollution causes 35 000−50 000 premature deaths per year in the U.K.,[1] and more than 1 million worldwide,[2] in addition to increased morbidity.[3] The pollutants mostly harmful in cities in the developed world are nitrogen dioxide ($NO_2$), ozone, sulfur dioxide, and particulate matter with aerodynamic diameter less than 10 μm ($PM_{10}$), all of which cause or exacerbate pulmonary and cardiac diseases.[4,5] Attempts to reduce concentrations of these air pollutants
been ongoing for several decades, with much re
usually center on

Pollutant concentrations can also be reduced by increasing dry deposition to surfaces. Compared to controlling emissions or enhancing dispersion, relatively little attention
deposition as a pollution contr
accessible means of
deposition is to

Dry dep
a fr

to attain imp

"Green Sp
Dadvand, P
10.1073/pr

**Abstract:** "
developme
greenness
schoolchild
particularly
Our findin
improving

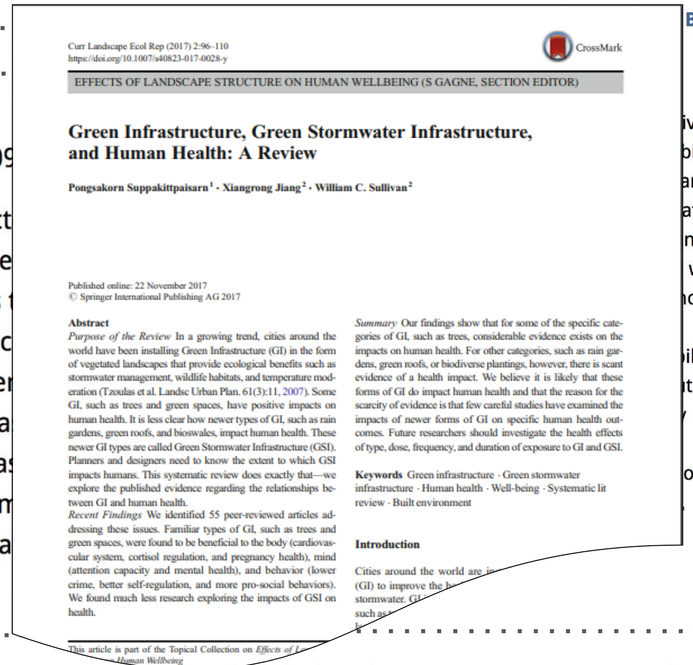
ccess to Green
hen-Cline, Han
15, 69:523-529
m improveme

alth: A Twin Study"
nal of Epidemiology and Community Health,
population level."

ealth Benefits of Urban Green Spaces: A Review of the Evidence"
.K.; Maheswaran, R. *Journal of Public Health*, 2010. Vol. 33, Issue 2. doi: 10.109

**ew:** "Methods: A literature search of academic and grey literature was conduct
of the health effects of green space…. Results: There is weak evidence for the
health and well-being, and urban green space. Environmental factors such as
bility of green space affects its use for physical activity. User determinants, suc
ethnicity and the perception of safety, are also important. However, many studies wer
design, failure to exclude confounding, bias or reverse causality and weak statistical a
Most studies reported findings that generally supported the view that green space has
effect. Establishing a causal relationship is difficult, as the relationship is complex. Sim
interventions may therefore fail to address the underlying determinants of urban hea
remediable by landscape redesign."

Built-
ived
birth
anada.
at may
nd
was
hood of
ility, and
tcomes
omes."


Curr Landscape Ecol Rep (2017) 2:96–110
https://doi.org/10.1007/s40823-017-0028-y

CrossMark

EFFECTS OF LANDSCAPE STRUCTURE ON HUMAN WELLBEING (S GAGNE, SECTION EDITOR)

**Green Infrastructure, Green Stormwater Infrastructure, and Human Health: A Review**

Pongsakorn Suppakittpaisarn[1] · Xiangrong Jiang[2] · William C. Sullivan[2]

Published online: 22 November 2017
© Springer International Publishing AG 2017

**Abstract**

*Purpose of the Review* In a growing trend, cities around the world have been installing Green Infrastructure (GI) in the form of vegetated landscapes that provide ecological benefits such as stormwater management, wildlife habitats, and temperature moderation (Tzoulas et al. Landsc Urban Plan. 61(3):11, 2007). Some GI, such as trees and green spaces, have positive impacts on human health. It is less clear how newer types of GI, such as rain gardens, green roofs, and bioswales, impact human health. These newer GI types are called Green Stormwater Infrastructure (GSI). Planners and designers need to know the extent to which GSI impacts humans. This systematic review does exactly that—we explore the published evidence regarding the relationships between GI and human health.

*Recent Findings* We identified 55 peer-reviewed articles addressing these issues. Familiar types of GI, such as trees and green spaces, were found to be beneficial to the body (cardiovascular system, cortisol regulation, and pregnancy health), mind (attention capacity and mental health), and behavior (lower crime, better self-regulation, and more pro-social behaviors). We found much less research exploring the impacts of GSI on health.

*Summary* Our findings show that for some of the specific categories of GI, such as trees, considerable evidence exists on the impacts on human health. For other categories, such as rain gardens, green roofs, or biodiverse plantings, however, there is scant evidence of a health impact. We believe it is likely that these forms of GI do impact human health and that the reason for the scarcity of evidence is that few careful studies have examined the impacts of newer forms of GI on specific human health outcomes. Future researchers should investigate the health effects of type, dose, frequency, and duration of exposure to GI and GSI.

**Keywords** Green infrastructure · Green stormwater infrastructure · Human health · Well-being · Systematic lit review · Built environment

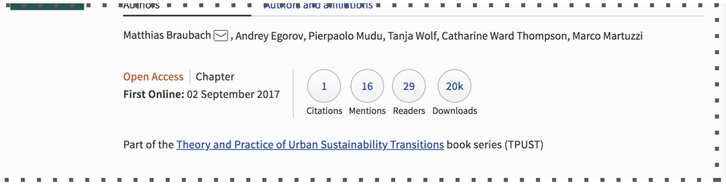
**Introduction**

Cities around the world are i
(GI) to improve the h
stormwater. GI
such as

This article is part of the Topical Collection on *Effects of L*
*Human Wellbeing*

"Humans and Nature: How Knowing and Experiencing Nature Affect Well-being"
Russel, Roly; et al. *Annual Review of Environment and Resources,* 2013, Vol. 38. doi: 10.1146/annurev-environ-012312-110838.

**Abstract:** "We synthesize multidisciplinary peer-reviewed research on contributions of nature or ecosystems to human well-being mediated through nontangible connections (such as culture). We characterize these connections on the basis of the channels through which such connections arise (i.e., knowing, perceiving, interacting with, and living within) and the components of human well-being they affect (e.g., physical, mental and spiritual health, inspiration, identity). We found enormous variation in the methods used, quantity of research, and generalizability of the literature. The effects of nature on mental and physical health have been rigorously demonstrated, whereas other effects (e.g., on learning) are theorized but seldom demonstrated. The balance of evidence indicates conclusively that knowing and experiencing nature makes us generally happier, healthier people. More fully characterizing our intangible connections with nature will help shape decisions that benefit people and the ecosystems on which we depend."


Authors | Authors and affiliations

Matthias Braubach, Andrey Egorov, Pierpaolo Mudu, Tanja Wolf, Catharine Ward Thompson, Marco Martuzzi

Open Access | Chapter
**First Online:** 02 September 2017

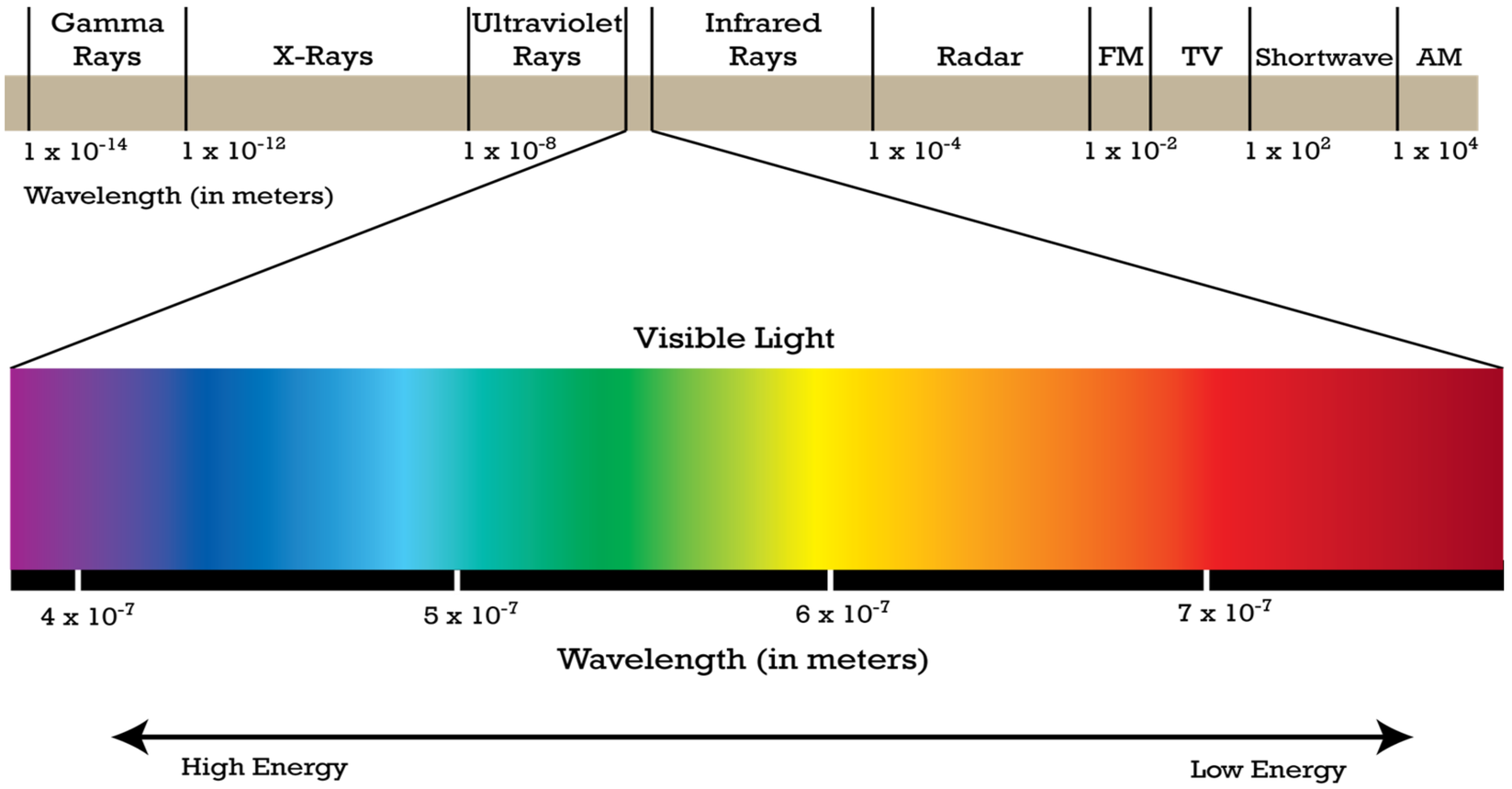
1 Citations | 16 Mentions | 29 Readers | 20k Downloads

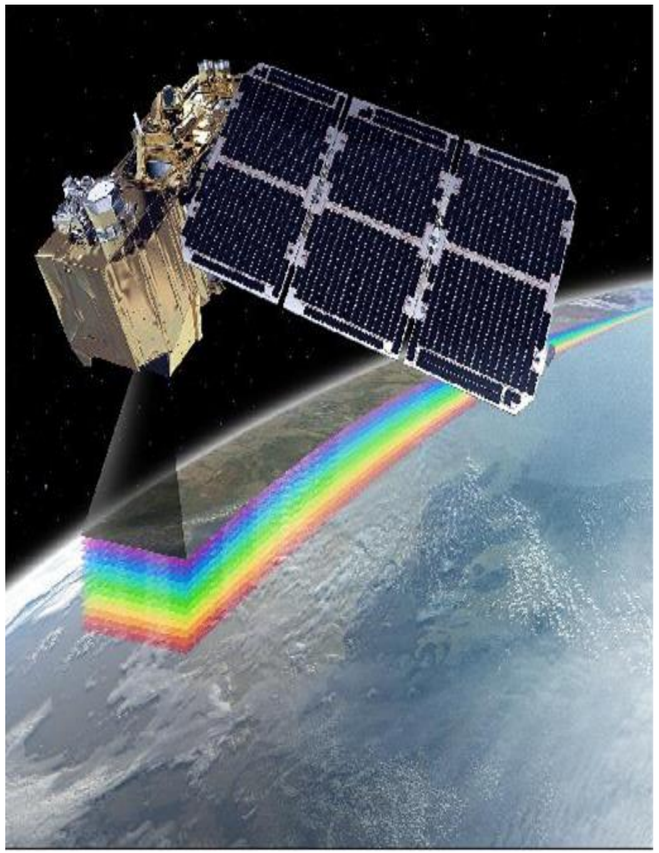
Part of the Theory and Practice of Urban Sustainability Transitions book series (TPUST)

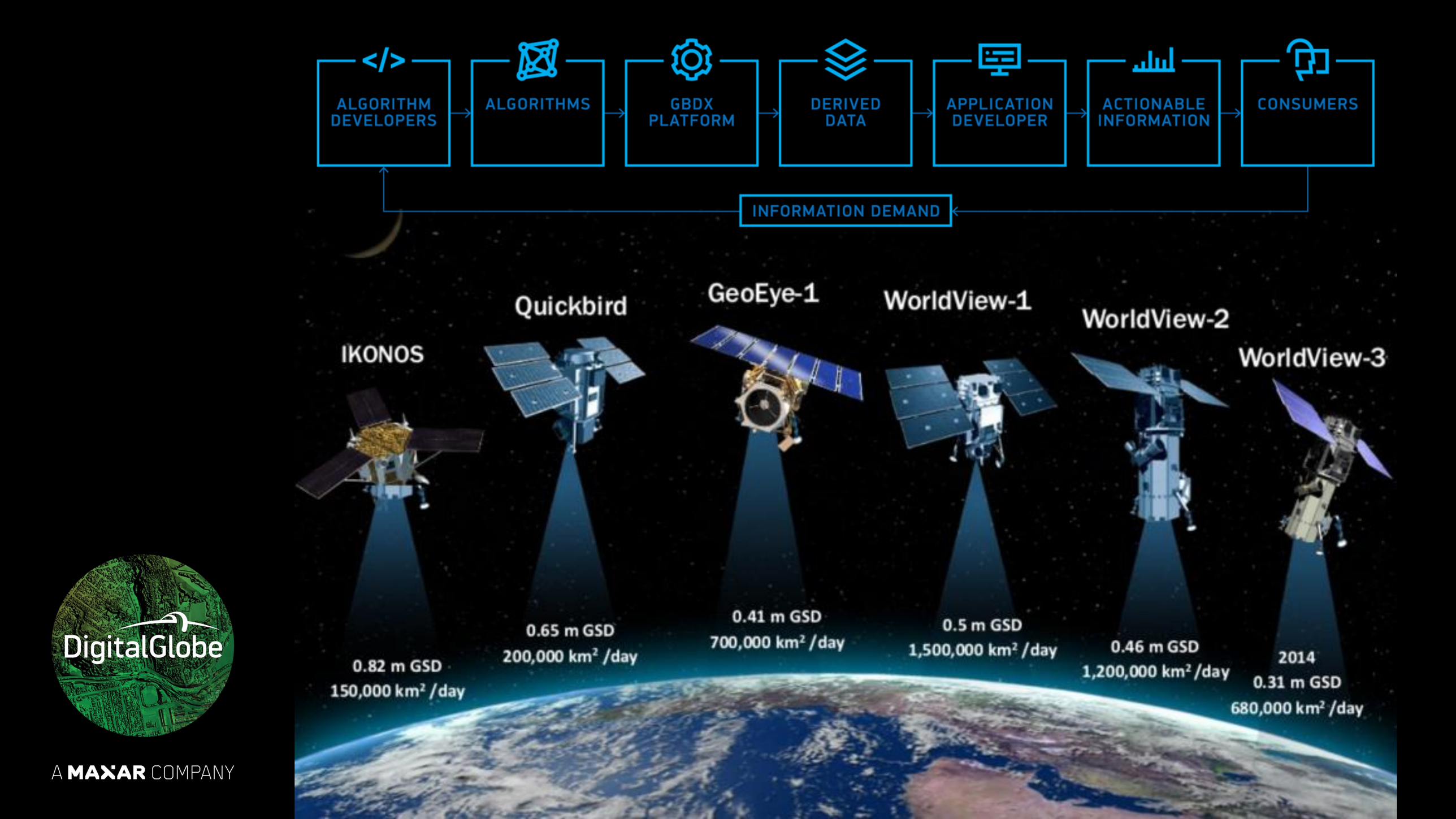
"The Impact of Interventions to Promote Physical Activity in Urban Green Space: A Systematic Review and Recommendations for Future Research"
Hunter, Ruth F.; et al. *Social Science & Medicine*, Volume 124, January 2015, Pages 246–256. doi:10.1016/j.socscimed.2014.11.051


But requires costly time and resources
to monitor properly

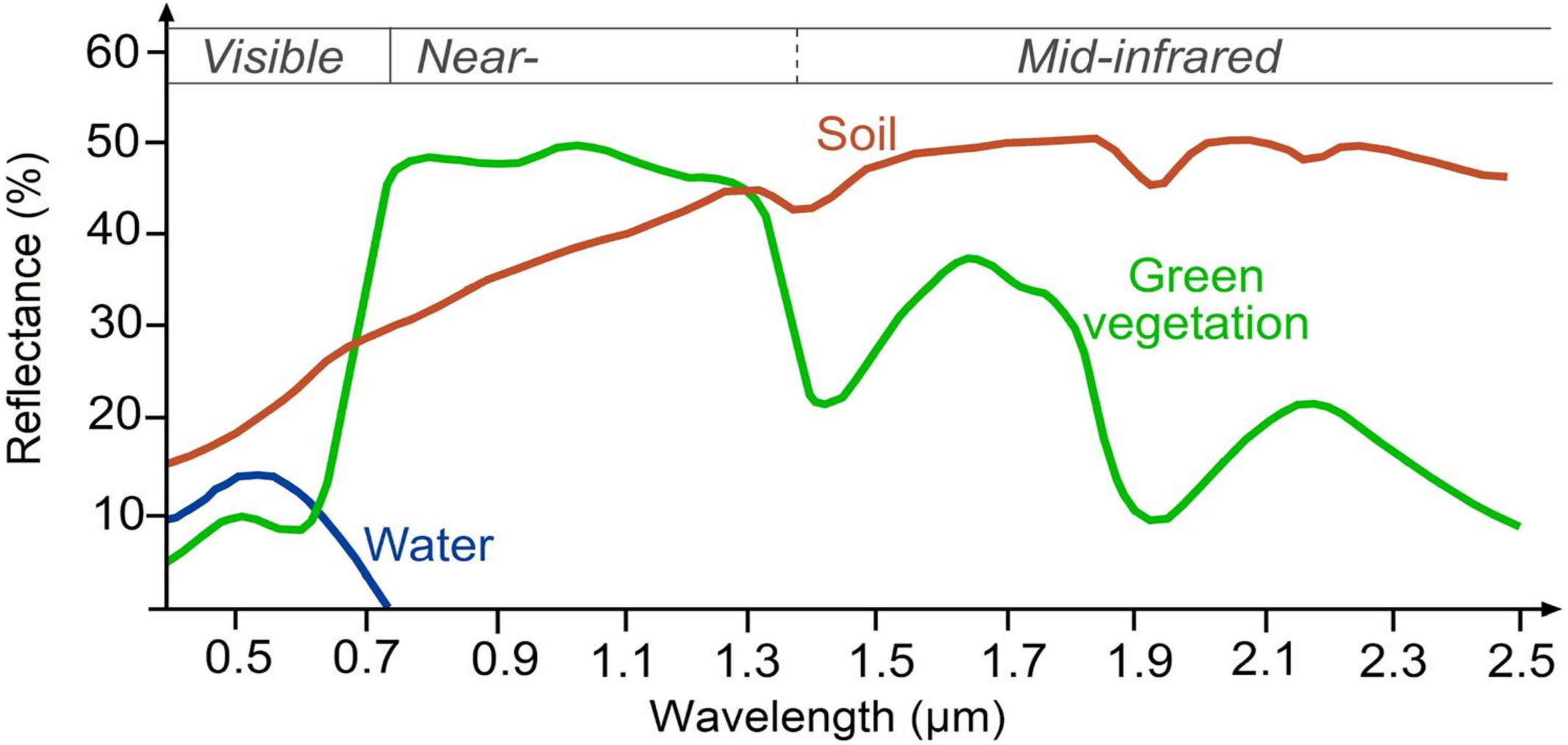
# Satellite imagery can help




ALGORITHM DEVELOPERS
ALGORITHMS
GBDX PLATFORM
DERIVED DATA
APPLICATION DEVELOPER
ACTIONABLE INFORMATION
CONSUMERS
INFORMATION DEMAND
IKONOS
Quickbird
GeoEye-1
WorldView-1
WorldView-2
WorldView-3
0.82 m GSD
150,000 km² /day
0.65 m GSD
200,000 km² /day
0.41 m GSD
700,000 km² /day
0.5 m GSD
1,500,000 km² /day
0.46 m GSD
1,200,000 km² /day
2014
0.31 m GSD
680,000 km² /day
DigitalGlobe
A MAXAR COMPANY

# Spectral remote sensing



Machine learning + Image processing algorithms + High res satellite imagery

= Valuable insights about the quality of urban green space

# ‘Urban Green Classification Index’ based on lit-review

| KPI CATEGORY | DIMENSION | MEASUREMENT |
|---|---|---|
| *Ecological* | Temperature regulation | Leaf Area Index |
| | | Width of blue space in a park |
| | Infiltration capacity | Stormwater capture potential |
| | | Width of riparian buffer zone |
| | | Total % of impervious surfaces |
| *Social* | Amenities and recreational facilities | Presence of amenity OSM |
| | Grey versus green | Green:paved ratio |

# Using citizen science: OpenStreetMap

Help Over Aanmelden Registreren

Zoeken Waar is dit? OK

**Weg: 71706974**

大島小松川公園一部修正

bijna 8 jaar geleden bewerkt door futen
Versie #1 · Wijzigingenset #5450688

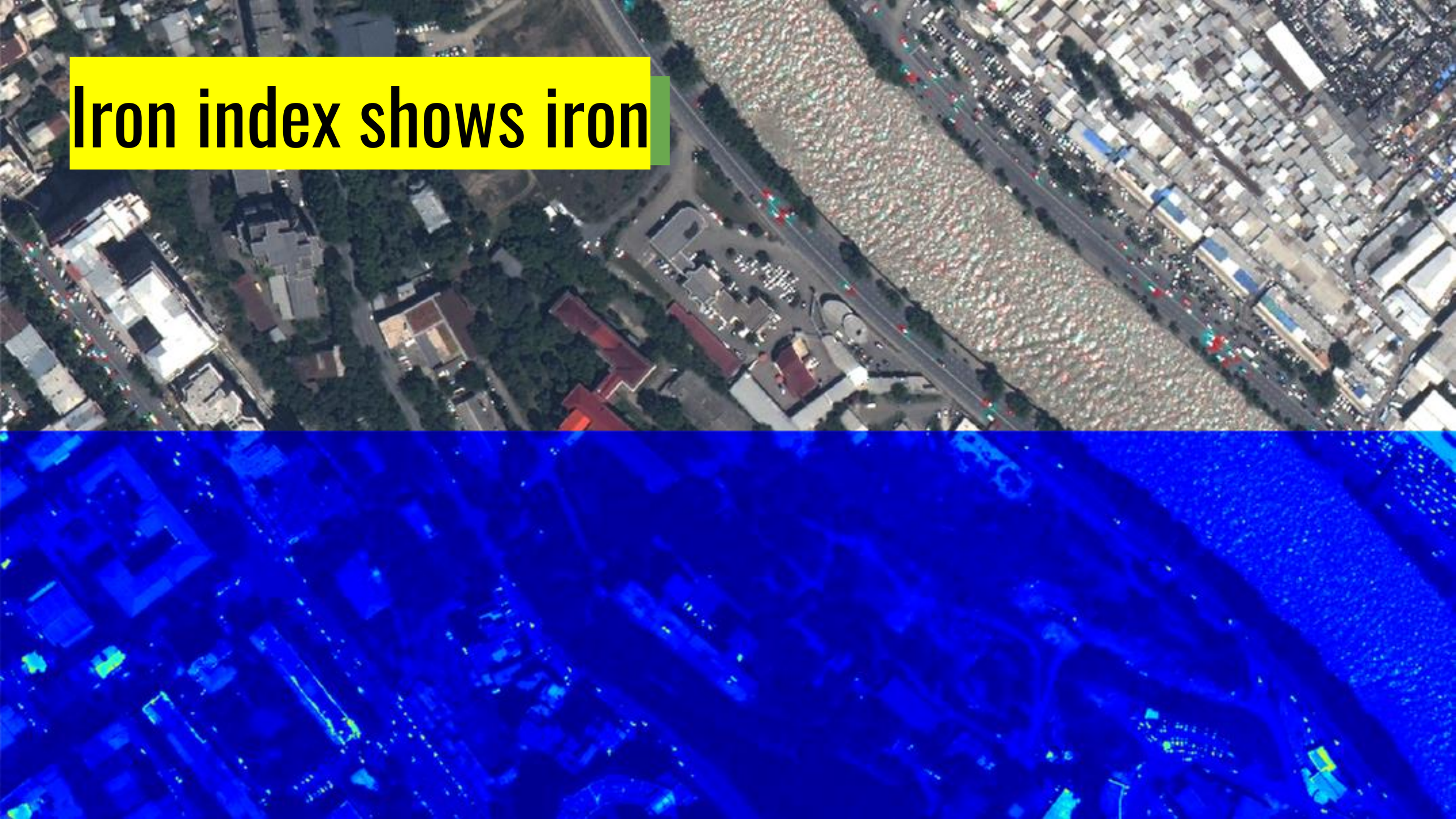
Tags

| | |
|---|---|
| landuse | grass |
| leisure | park |

Nodes

852480815
852480706
852480833
852480922
852480680
852480722
852480870
852480952
852480697
852480752
852480887
852480649

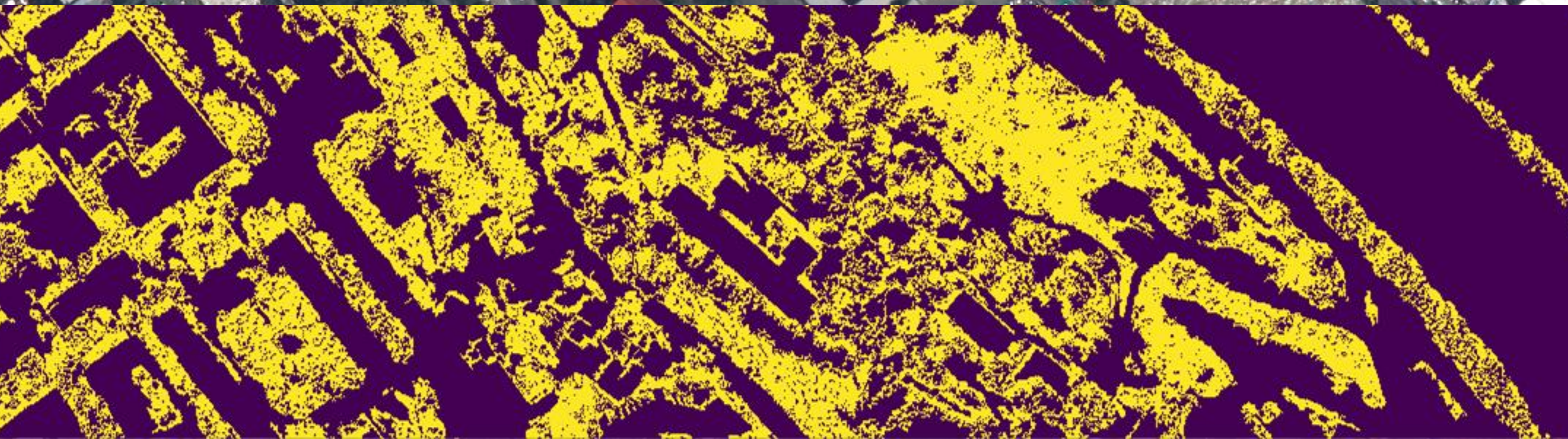
# NDVI can show trees


Iron index shows iron

# Classification of water bodies

# Classification of all buildings

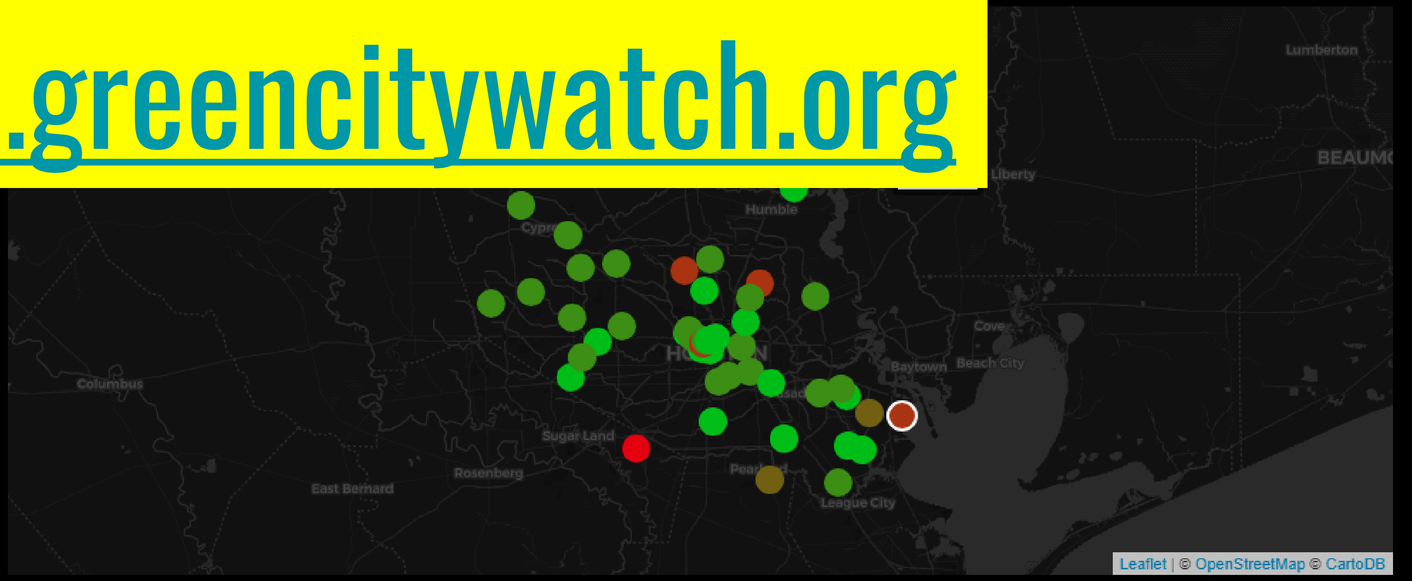
# Classification of green areas



# Demo at www.greencitywatch.org

City:

Houston




Use sliders to change importance of different score groups

**Social:** 40

**Ecology:** 30

**Economy:** 30

## Sylvan Beach Park

Social mean score: 2

| Social Indicators | Score |
|---|---|
| Amenities and recreational facillities | 1.00 |
| Gray vs Green | 1.00 |
| Greenness in winter | 4.00 |

Eco mean score: 1.8

| Ecological Indicators | Score |
|---|---|
| Green within a riparian zone | 1.00 |
| Width of blue space in a park | 5.00 |
| Impermeable surfaces | 1.00 |
| Stormwater Capture | 1.00 |

Monetary value: 0 $

| Economic indicator | $ |
|---|---|
| Economic value of ecosystem services | 0.00 |

# Next steps

Working with the World Bank Group to assess:

- Tbilisi, Georgia
- 26 cities across Indonesia (incl. Jakarta)
- Montreal, Canada

WORLD BANK GROUP