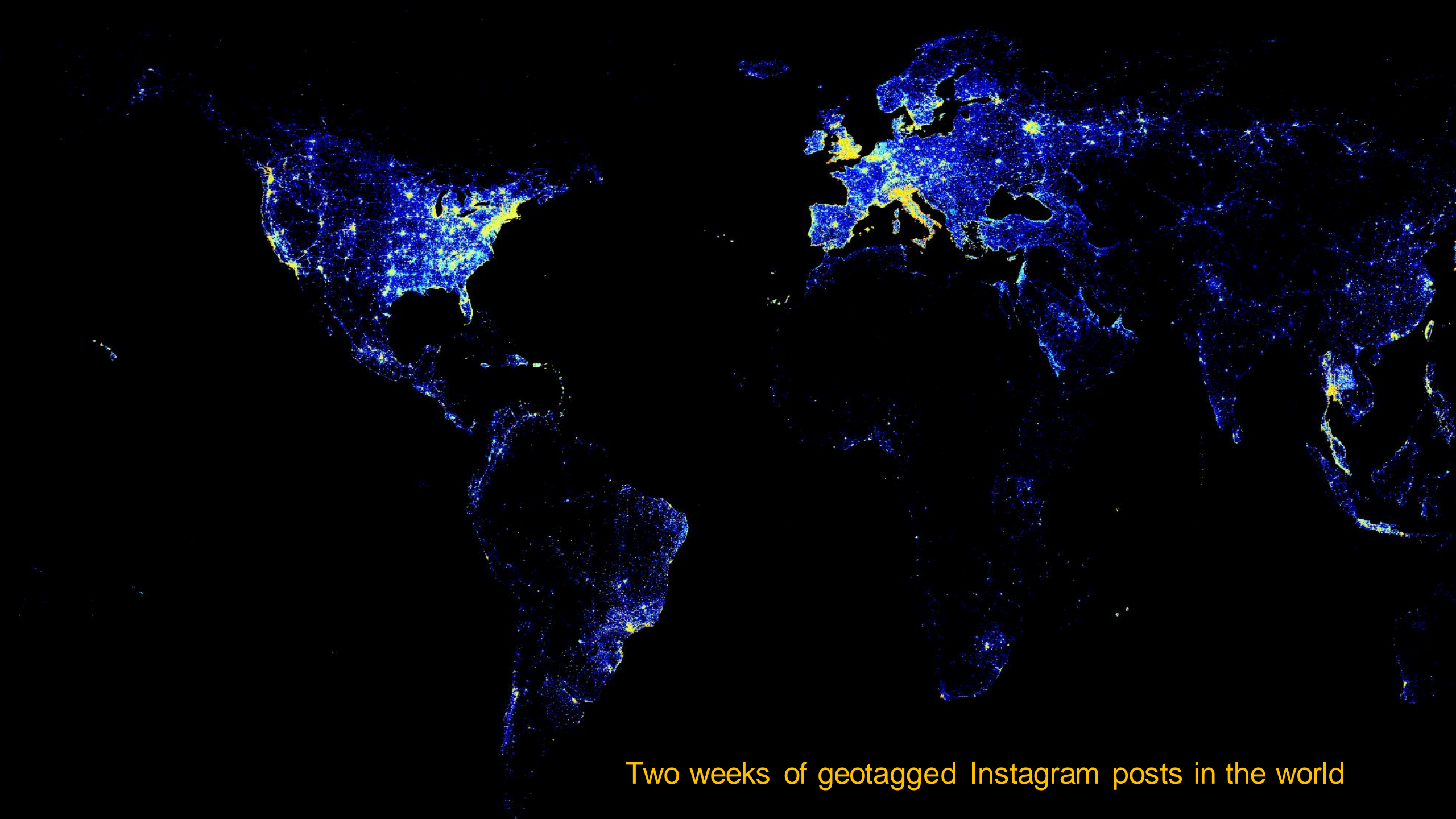


# CLIMATE CHANGE, SUSTAINABILITY AND CITIES

## (MOBILE BIG) DATA PERSPECTIVE

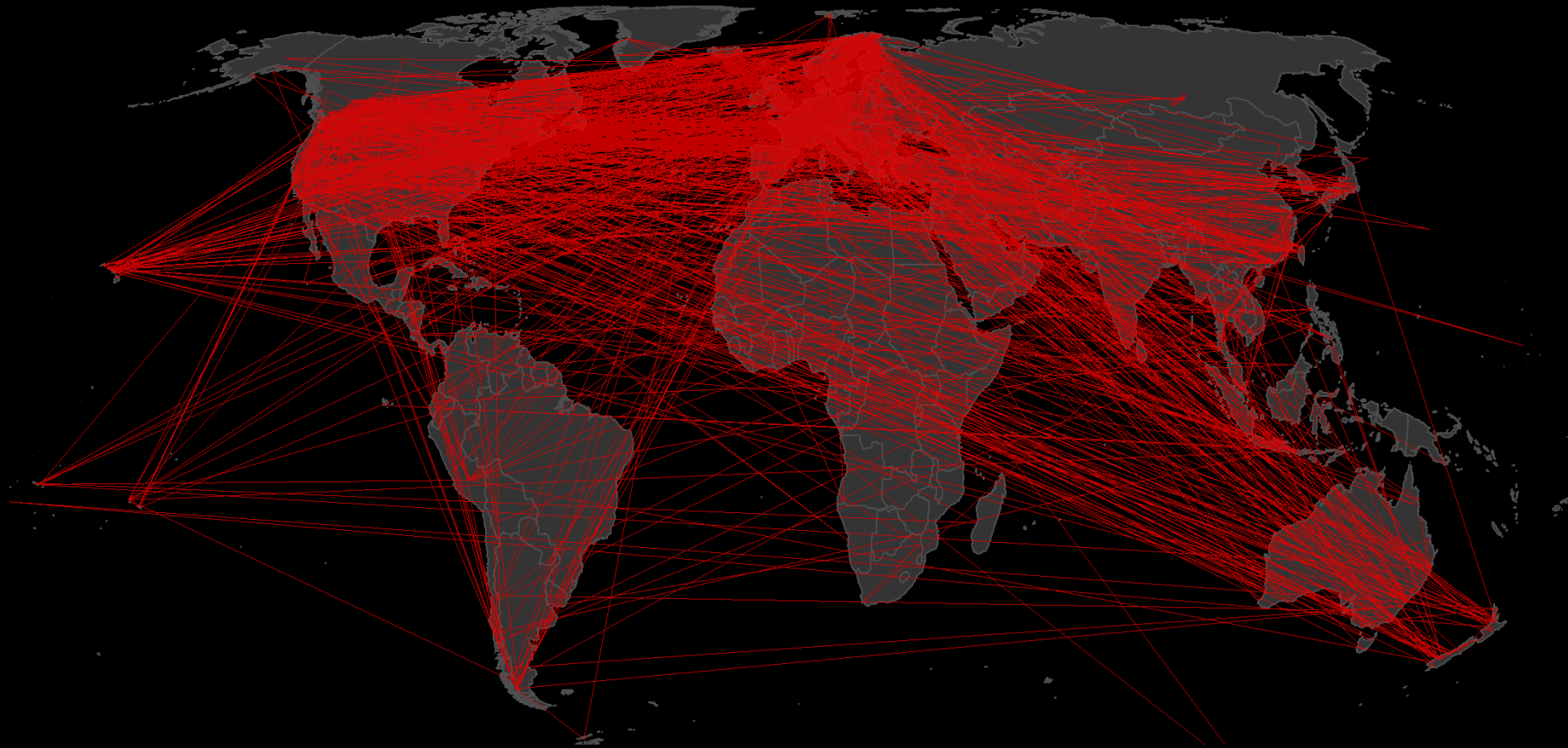
### TUULI TOIVONEN





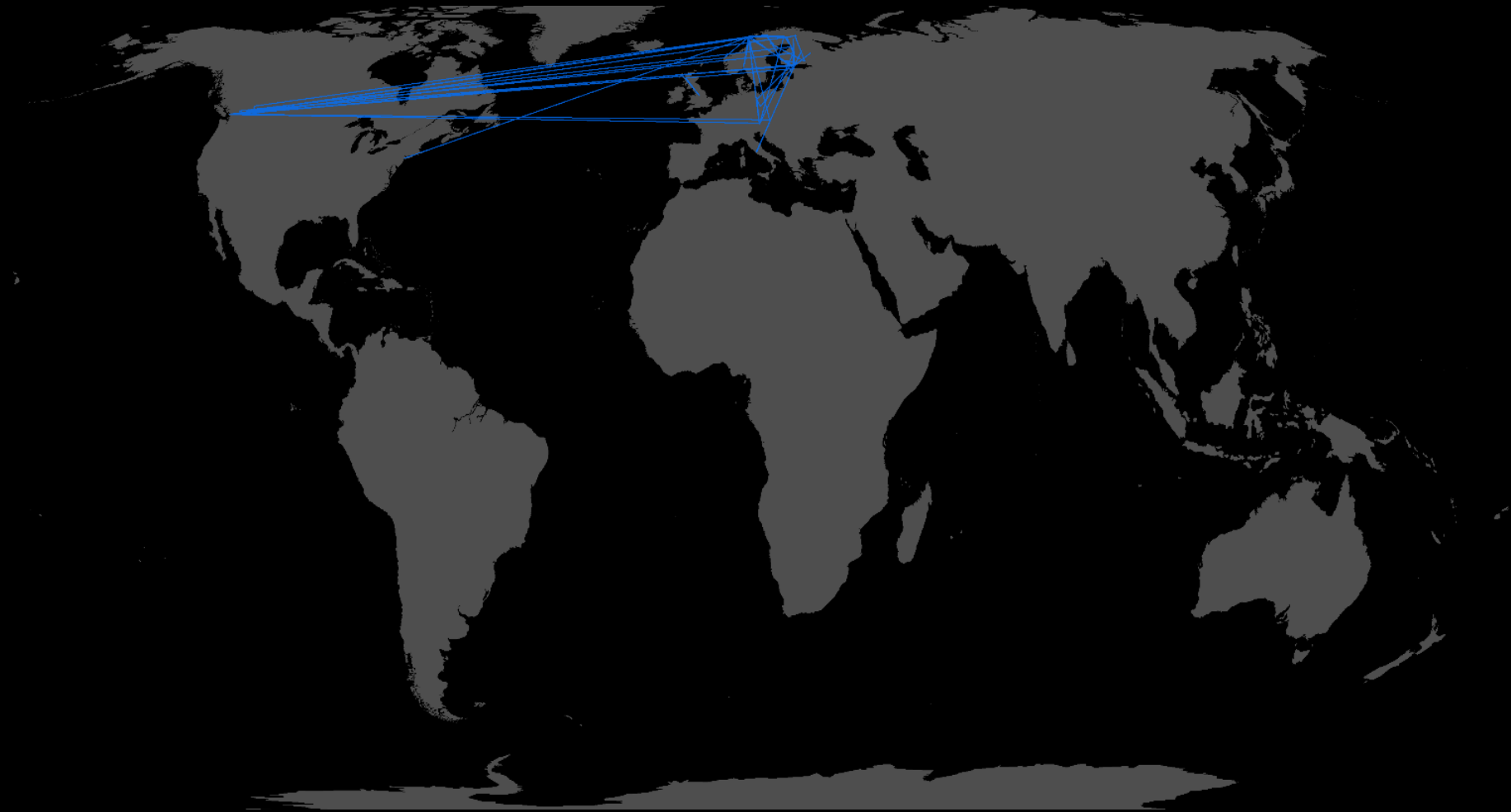
Two weeks of geotagged Instagram posts in the world

# GLOBAL MOBILITY PATTERNS



Toivonen, T., Heikinheimo, V., Fink, C., Hausmann, A., Hiippala, T., Järvi, O., Tenkanen, H., & Di Minin, E. (2019). Social media data for conservation science: A methodological overview. *Biological Conservation*, 233, 298-315. <https://doi.org/10.1016/j.biocon.2019.01.023>

# INDIVIDUAL ACTIVITY SPACES

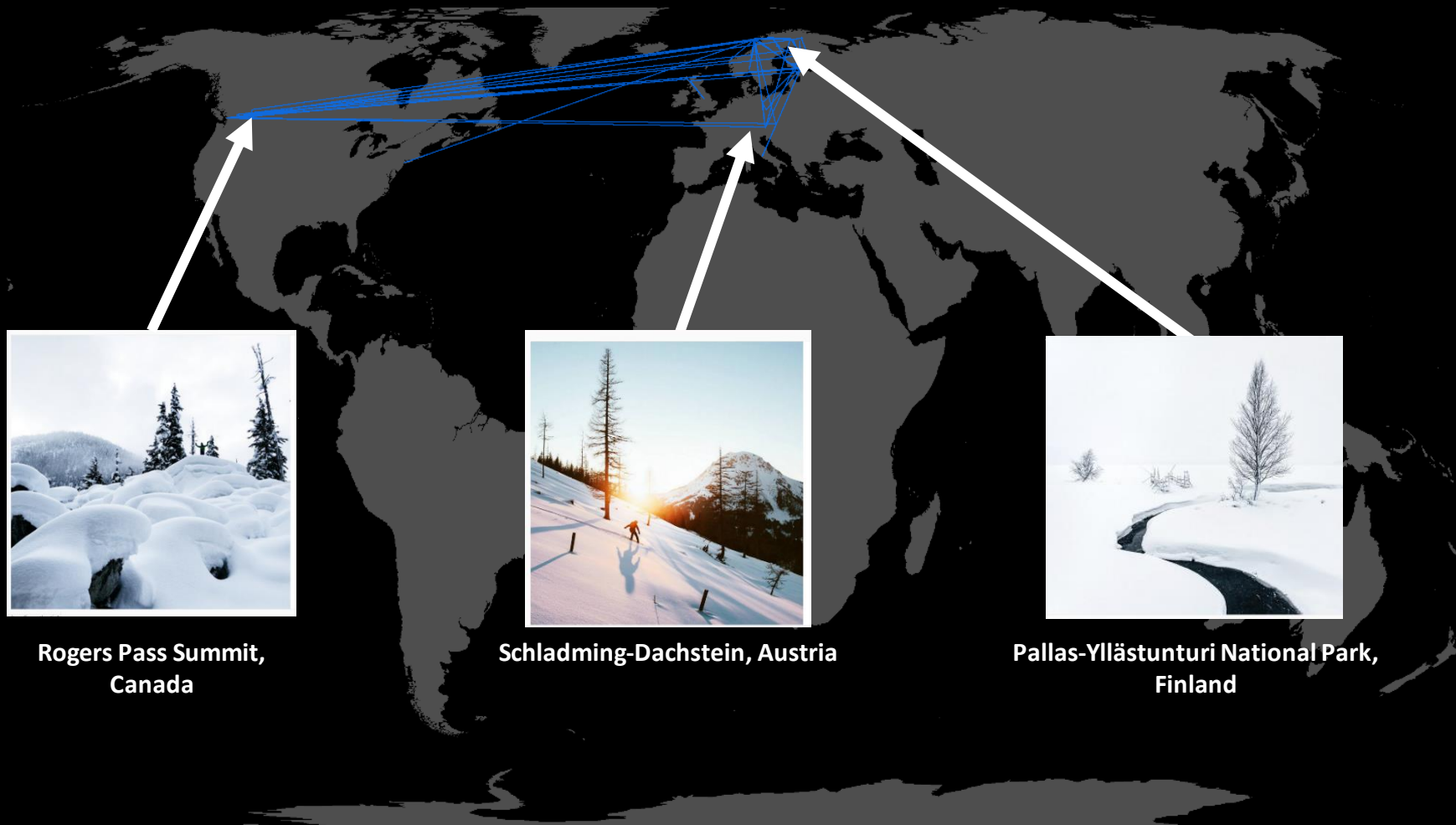


Toivonen, T., Heikinheimo, V., Fink, C., Hausmann, A., Hiippala, T., Järvi, O., Tenkanen, H., & Di Minin, E. (2019). Social media data for conservation science: A methodological overview. *Biological Conservation*, 233, 298-315. <https://doi.org/10.1016/j.biocon.2019.01.023>

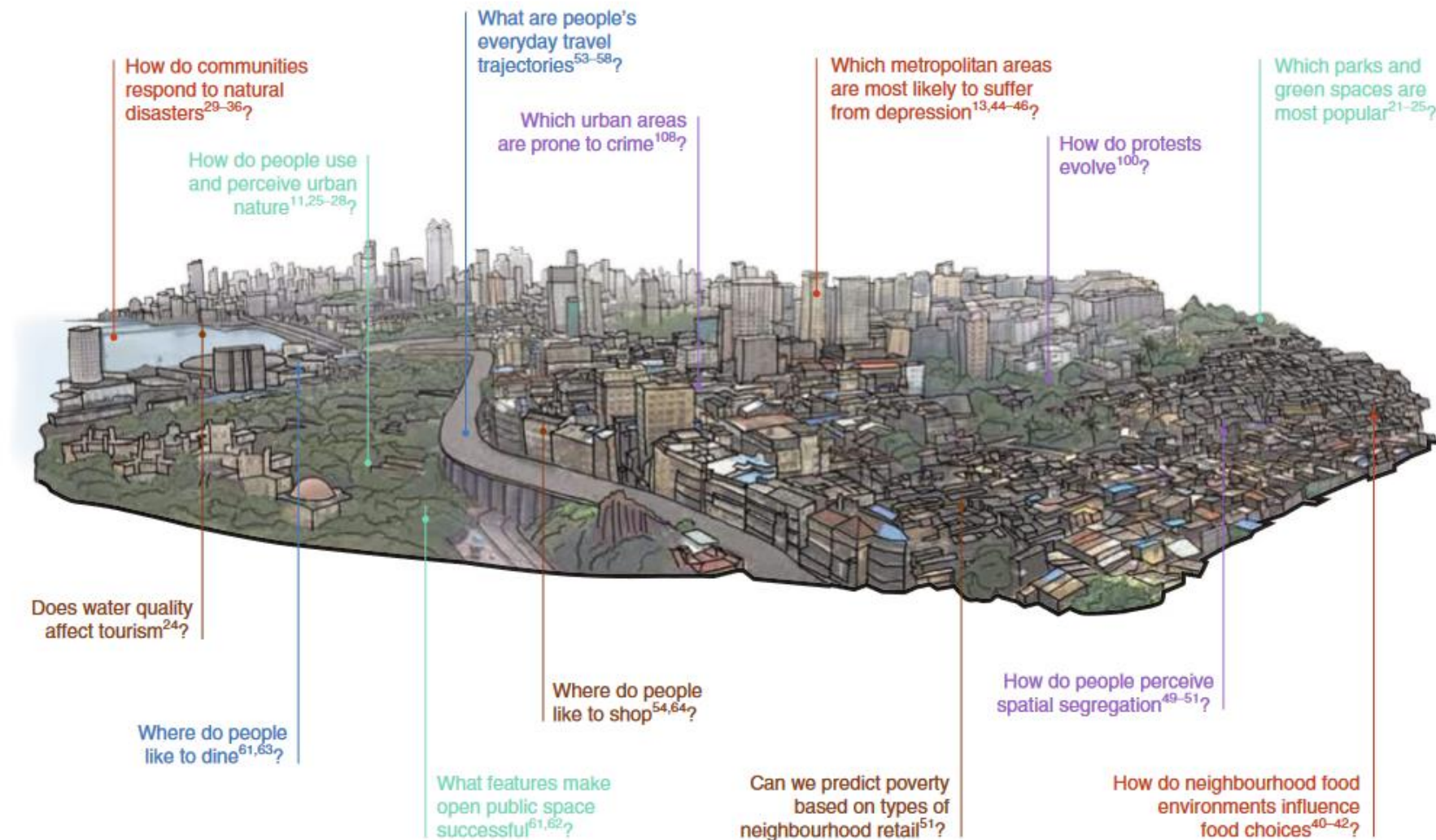
Posts from a Finnish Instagram-user. 107 posts in total.



# PREFERENCES / OPINIONS / SENTIMENTS



Toivonen, T., Heikinheimo, V., Fink, C., Hausmann, A., Hiippala, T., Järv, O., Tenkanen, H., & Di Minin, E. (2019). Social media data for conservation science: A methodological overview. *Biological Conservation*, 233, 298-315. <https://doi.org/10.1016/j.biocon.2019.01.023>  
Posts from a Finnish Instagram-user. 107 posts in total.



**Fig. 1 | The wide range of emerging opportunities for urban-sustainability research provided by big data from social media.** Evidence points to the promise of social-media data (SMD) for addressing key questions in five established domains of sustainability research: environmental sustainability (questions in green), public health (questions in orange), social equity (questions in violet), mobility (questions in blue), and economic development (questions in red). Large-scale, publicly available SMD on how people navigate, perceive, and respond to man-made and natural landscapes allows the investigation of human-environmental relationships in greater depth. SMD provide researchers and decision-makers with fresh insights into what makes open public spaces successful (refs <sup>61,62</sup>), what travel trajectories people pursue every day (refs <sup>53-58</sup>), how communities respond to natural disasters (refs <sup>29-36</sup>), which metropolitan areas are more prone to depression (refs <sup>13,44-46</sup>), and how neighbourhood environments influence food choices (refs <sup>40-42</sup>), among other consequential topics for sustainability planning discussed in the text. Image credit: Taylor Drake.

**Ilieva &  
McPhearson  
(2018)**

**Social-media  
data for urban  
sustainability.  
*Nature  
Sustainability*,  
<https://doi.org/10.1038/s41893-018-0153>**





# **68% OF THE WORLD POPULATION PROJECTED TO LIVE IN URBAN AREAS BY 2050**

UN 2018: <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>



# CITIES ARE IN KEY POSITION WHEN FIGHTING THE CLIMATE CHANGE

- “Climate change is a global phenomenon that largely impacts urban life. Rising global temperatures causes sea levels to rise, increases the number of extreme weather events such as floods, droughts and storms, and increases the spread of tropical diseases. All these have costly impacts on cities' basic services, infrastructure, housing, human livelihoods and health.
- At the same time, cities are a key contributor to climate change, as urban activities are major sources of greenhouse gas emissions. Estimates suggest that cities are responsible for 75 percent of global CO<sub>2</sub> emissions, with transport and buildings being among the largest contributors.”

UNEP <https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/cities-and-climate-change>



# TOWARDS 24-HOUR SOCIETY



Järv, O., Tenkanen, H. T. O., Salonen, M. P., Ahas, R., & Toivonen, T. K. (2018). Dynamic cities: Location-based accessibility modelling as a function of time. *Applied Geography*, 95, 101-110.  
<https://doi.org/10.1016/j.apgeog.2018.04.009>



# TOWARDS 24-HOUR SOCIETY

You can count on  
**SALLY** for Melbourne  
**CAPP**

teamcapp.com

Authorised by Sally Capp, 55 Victoria Harbour Promenade, Docklands, 3008

## MEDIA RELEASE

### A Night Mayor for Melbourne

Music entrepreneur and after dark advocate, James Young, will become Melbourne's first Night Mayor, if Sally Capp is returned as Lord Mayor.

"If he's elected as part of Team Capp, I want James to use his deep experience to help drive the revitalisation of our city's world famous and economically valuable night time economy,"

**The stuff of night mayors: Amsterdam pioneers new way to run cities after dark**

? What we do

In my area

MAYOR OF LONDON

Get involved

LONDONASSEMBLY

About us

Search...

Talk London

Media centre

### Night Czar

Amy Lamé was appointed Night Czar in 2016, and was tasked with ensuring London thrives as a 24-hour city. Amy's role involves championing London's nightlife both in the UK and internationally, including safeguarding venues across the city. This vital work is driven by working in partnership with the night time industries, local authorities, the Metropolitan Police, Transport for London and the public.

### Night Time Champions

Every London borough has a Night Time Champion. They meet with the Night Czar four times a year to share best practice.

**LONDON**



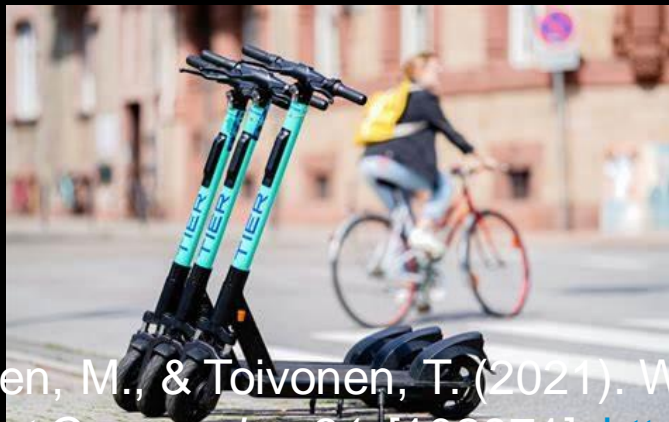
# TOWARDS MULTILOCAL LIVING AND HYBRID WORK



Raun, J., Järv, O., Okkonen, P. O., Rantanen, M., Hyryläinen, T., Ryynänen, T., & Toivonen, T. (2022). New avenues for second home tourism research using big data: prospects and challenges. *Current Issues in Tourism*, 26(6), 90–902.  
<https://doi.org/10.1080/13683500.2022.2138282>



# TOWARDS NEW MOBILITY NEEDS AND MOBILITY OPTIONS



Willberg, E., Salonen, M., & Toivonen, T. (2021). What do trip data reveal about bike-sharing system users? *Journal of Transport Geography*, 91, [102971]. <https://doi.org/10.1016/j.jtrangeo.2021.102971>



# TOWARDS GREENER & HEALTHIER CITIES, FOR PEOPLE AND THE PLANET



Poom, A., Willberg, E., & Toivonen, T. (2021). Environmental exposure during travel: A research review and suggestions forward. *Health & Place*, 70, [102584].  
<https://doi.org/10.1016/j.healthplace.2021.102584>



# TOWARDS EQUITABLE AND ACCESSIBLE CITIES



Willberg, E., Fink, C., & Toivonen, T. (2023). The 15-minute city for all? – Measuring individual and temporal variations in walking accessibility. *Journal of Transport Geography*, 106, [1032521].

<https://doi.org/10.1016/j.jtrangeo.2022.103521>





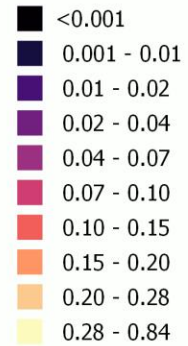
# TOWARDS MORE SUSTAINABLE CITIES





# Urban pulse on a 24-hour cycle in Helsinki region

Relative share of population  
in a 250 m grid square [%]



00:00-01:00

0 5 10 15 km

Bergroth, C., Järvi, O., Tenkanen, H., Manninen, M., & Toivonen, T. (2022). A 24-hour population distribution dataset based on mobile phone data from Helsinki Metropolitan Area, Finland. *Scientific data*, 9, [39]. <https://doi.org/10.1038/s41597-021-01113-4>

## PERSPECTIVE OPEN



# Harnessing sensing systems towards urban sustainability transformation

Adrienne Grêt-Regamey <sup>1✉</sup>, Michal Switalski <sup>1</sup>, Nora Fagerholm <sup>2</sup>, Silviya Korpilo <sup>3,4</sup>, Sirkku Juhola<sup>3,4</sup>, Marketta Kyttä <sup>5</sup>, Niina Käyhkö<sup>2</sup>, Timon McPhearson <sup>6,7,8</sup>, Markus Nollert <sup>9</sup>, Tiina Rinne<sup>5</sup>, Niko Soininen <sup>10</sup>, Tuuli Toivonen<sup>3,11</sup>, Aleksi Räsänen<sup>3,4</sup>, Elias Willberg <sup>3,11</sup> and Christopher M. Raymond <sup>3,4,12,13</sup>

Recent years have seen a massive development of geospatial sensing systems informing the use of space. However, rarely do these sensing systems inform transformation towards urban sustainability. Drawing on four global urban case examples, we conceptualize how passive and active sensing systems should be harnessed to secure an inclusive, sustainable and resilient urban transformation. We derive principles for stakeholders highlighting the need for an iterative dialogue along a sensing loop, new modes of governance enabling direct feeding of sensed information, an account for data biases in the sensing processes and a commitment to high ethical standards, including open access data sharing.

*npj Urban Sustainability* (2021)1:40; <https://doi.org/10.1038/s42949-021-00042-w>

## INTRODUCTION

Rapid urban growth and related pressures on the global environment are challenging the governance and planning of cities<sup>1–3</sup>. Recent frameworks suggest various levers to bring about

triggering transformation<sup>21</sup>. For example, geographic information observatories now provide the potential to combine data about human preferences and behaviour data with biophysical data streams such as traffic counters, public transit, weather stations,



PERSPECTIVE OPEN

# Harnessing sensing systems towards urban sustainability transformation

Adrienne Grêt-Regamey <sup>1</sup>✉, Michal Switalski <sup>1</sup>, Nora Fagerholm <sup>2</sup>, Silviya Korpilo <sup>3,4</sup>, Sirkku Juhola <sup>3,4</sup>, M. Niina Käyhkö<sup>2</sup>, Timon McPhearson <sup>6,7,8</sup>, Markus Nollert <sup>9</sup>, Tiina Rinne<sup>5</sup>, Niko Soininen <sup>10</sup>, Tuuli Toivonen<sup>3</sup>, Elias Willberg <sup>3,11</sup> and Christopher M. Raymond <sup>3,4,12,13</sup>

Recent years have seen a massive development of geospatial sensing systems informing the use of space. How sensing systems inform transformation towards urban sustainability. Drawing on four global urban case examples, we conceptualize how passive and active sensing systems should be harnessed to secure an inclusive, sustainable urban transformation. We derive principles for stakeholders highlighting the need for an iterative dialogue along various modes of governance enabling direct feeding of sensed information, an account for data biases in the sensing systems, and a commitment to high ethical standards, including open access data sharing.

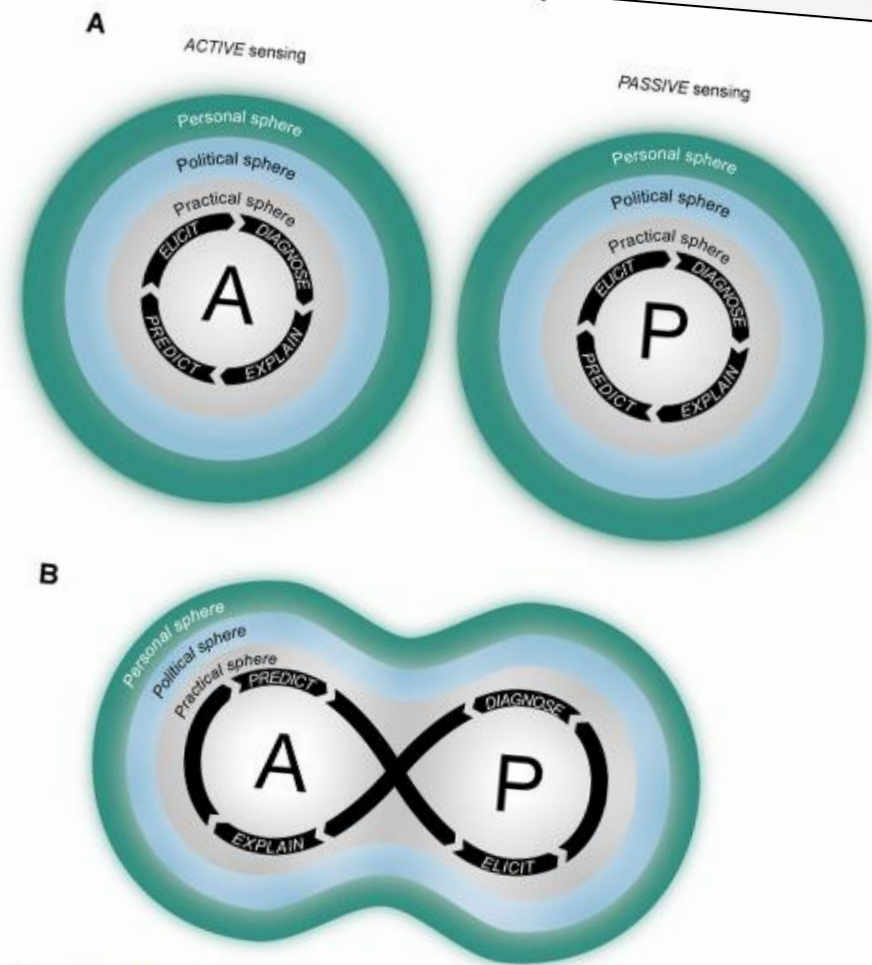
npj Urban Sustainability (2021)1:40; <https://doi.org/10.1038/s42949-021-00042-w>

## INTRODUCTION

Rapid urban growth and related pressures on the global environment are challenging the governance and planning of cities<sup>1–3</sup>. Recent frameworks suggest various levers to bring about urban transformation towards sustainability<sup>4–9</sup>. However, urban planners and decision-makers struggle to implement the transformation processes in complex, real-world settings<sup>9,10</sup>. Effectively directing urban development towards more inclusive, resilient and sustainable urban systems<sup>11,12</sup> requires multi-dimensional and radical changes<sup>13,14</sup>. Latest debates have pointed to the oversight of the ‘inner world’ of sustainability in these systemic views of transformation, including the emotions, thoughts, identities and beliefs of individuals driving human behaviour, otherwise referred to as a ‘deep leverage point’<sup>15–17</sup>. At the same time, there is a proliferation of data generated by massive ubiquitous sensing

triggering transformation<sup>21</sup>. For example, urban observatories now provide the potential to capture human preferences and behaviour through streams such as traffic counters, public transport, news portals and air quality monitoring. Building technologies increasingly integrated into everyday objects<sup>23</sup>, and digital twins connected to real-time data sources to allow for simulation. Integrated sensing systems can help to provide a picture of places, regions or the environment through observation, experimentation and analysis of processes and structures forming the city, and their changes.

Here, we investigate the different forms of sensing systems and their role in urban sustainability transformation. We conceptualize the interactions between various types of sensing systems and



**Fig. 1** Combinations of active and passive sensing to inform urban sustainability transformation. **A** The active and passive sensing in isolation; **B** how active and passive sensing can be combined across the spheres of transformation (practical, political, and personal) through the actions of eliciting, diagnosing, explaining, and predicting.





Do people use  
the urban  
environment as  
planners  
assume?



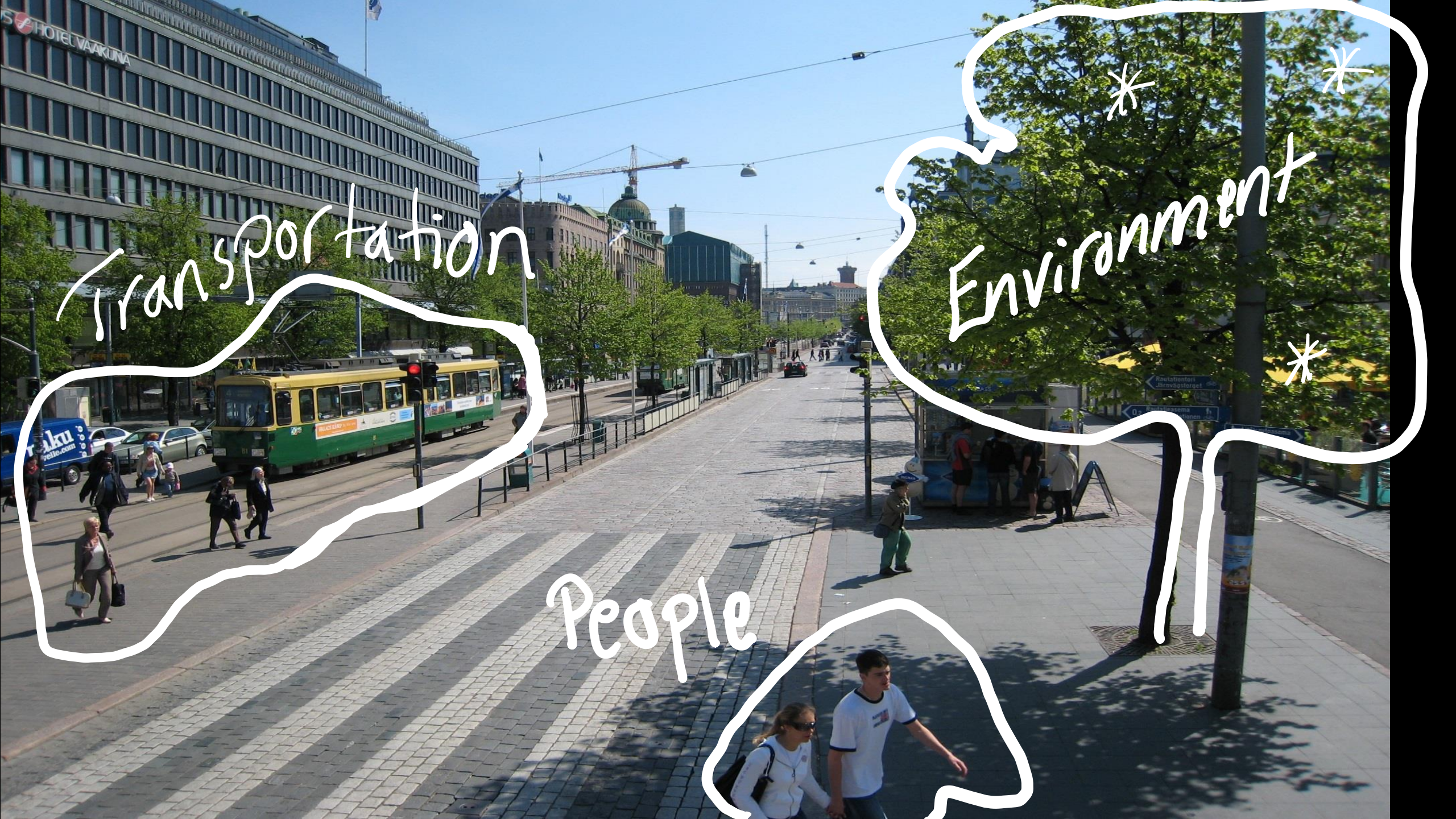




Who is impacted  
by climate  
change, where  
and when?







Transportation

Environment

People



The background of the book cover is a detailed illustration of a city integrated with nature. On the left, a person in a yellow shirt and green headwrap sits on a ledge, looking through a magnifying glass at a small green insect. Below them, a street lamp stands next to a large, leafy tree. In the bottom left, a person is riding a bicycle on a path. On the right, a multi-story building is shown with a green roof and a person standing on it. Above the building, a dragonfly is depicted. The entire scene is rendered in a sketchy, hand-drawn style with a color palette of greens, yellows, and browns.

EDITED BY  
**Timon McPhearson**  
**Nadja Kabisch**  
**Niki Frantzeskaki**

---

# Nature-Based Solutions for Cities

**EE**  
Elgar



Who can choose better routes?

125 min  
9.4 km

Greenery Quietness Fresh air

148 min  
11.1 km

Greenery Quietness Fresh air

148 min  
11.1 km

Greenery Quietness Fresh air

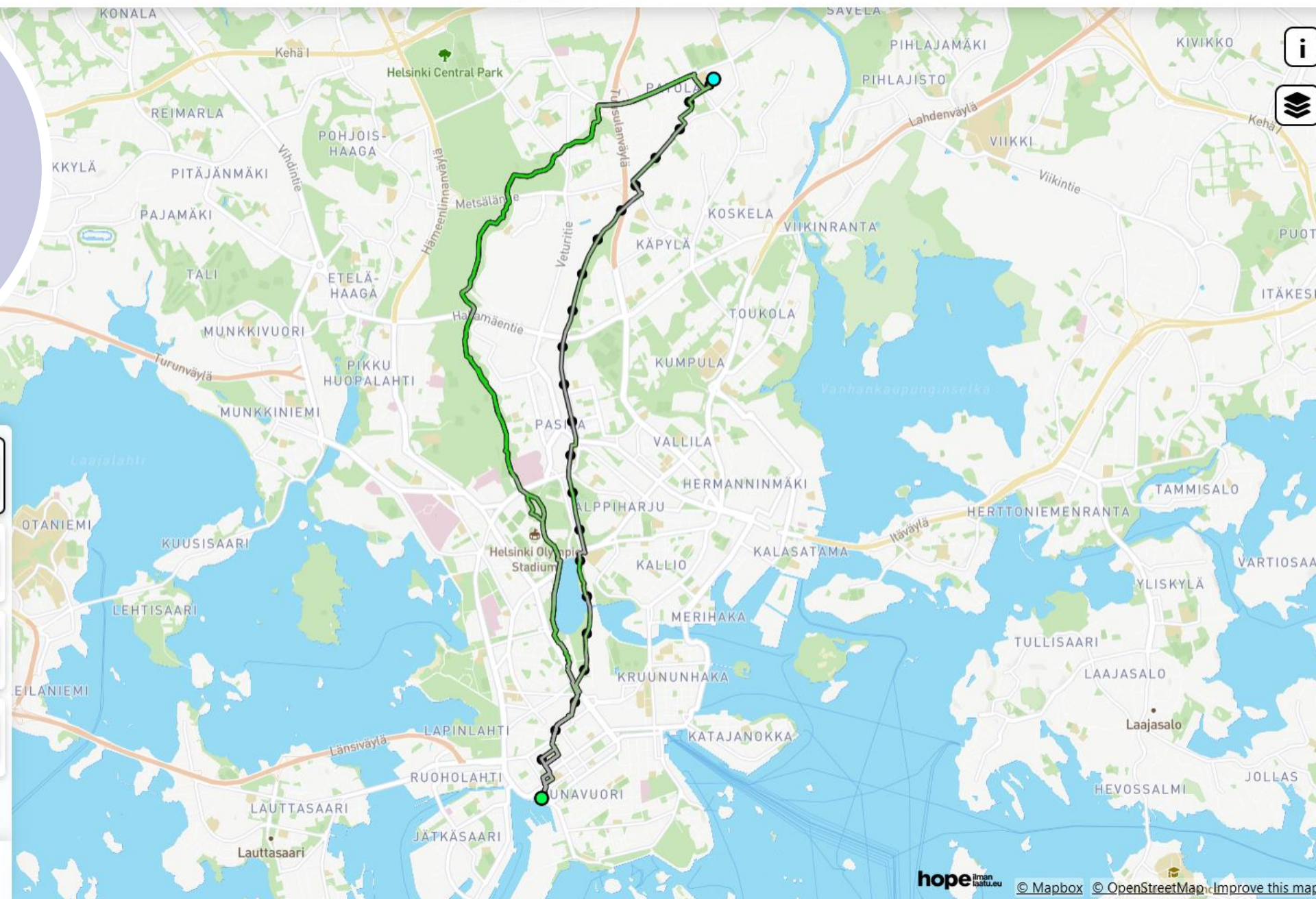
149 min  
11.1 km

Greenery Quietness Fresh air

Compare to car: duration & CO2

4/4

Show quiet paths





Who has access to  
good environment  
during daily  
mobilities?

**GREENTRAVEL  
PROJECT  
2023-2027**



Willberg et al.  
*International Journal of Health Geographics* (2023) 22:5  
<https://doi.org/10.1186/s12942-023-00326-7>

International Journal of  
Health Geographics

**RESEARCH**

**Open Access**



# Cyclists' exposure to air pollution, noise, and greenery: a population-level spatial analysis approach

Elias Willberg<sup>1,3\*</sup>, Age Poom<sup>1,2,3</sup>, Joose Helle<sup>1</sup> and Tuuli Toivonen<sup>1,3</sup>

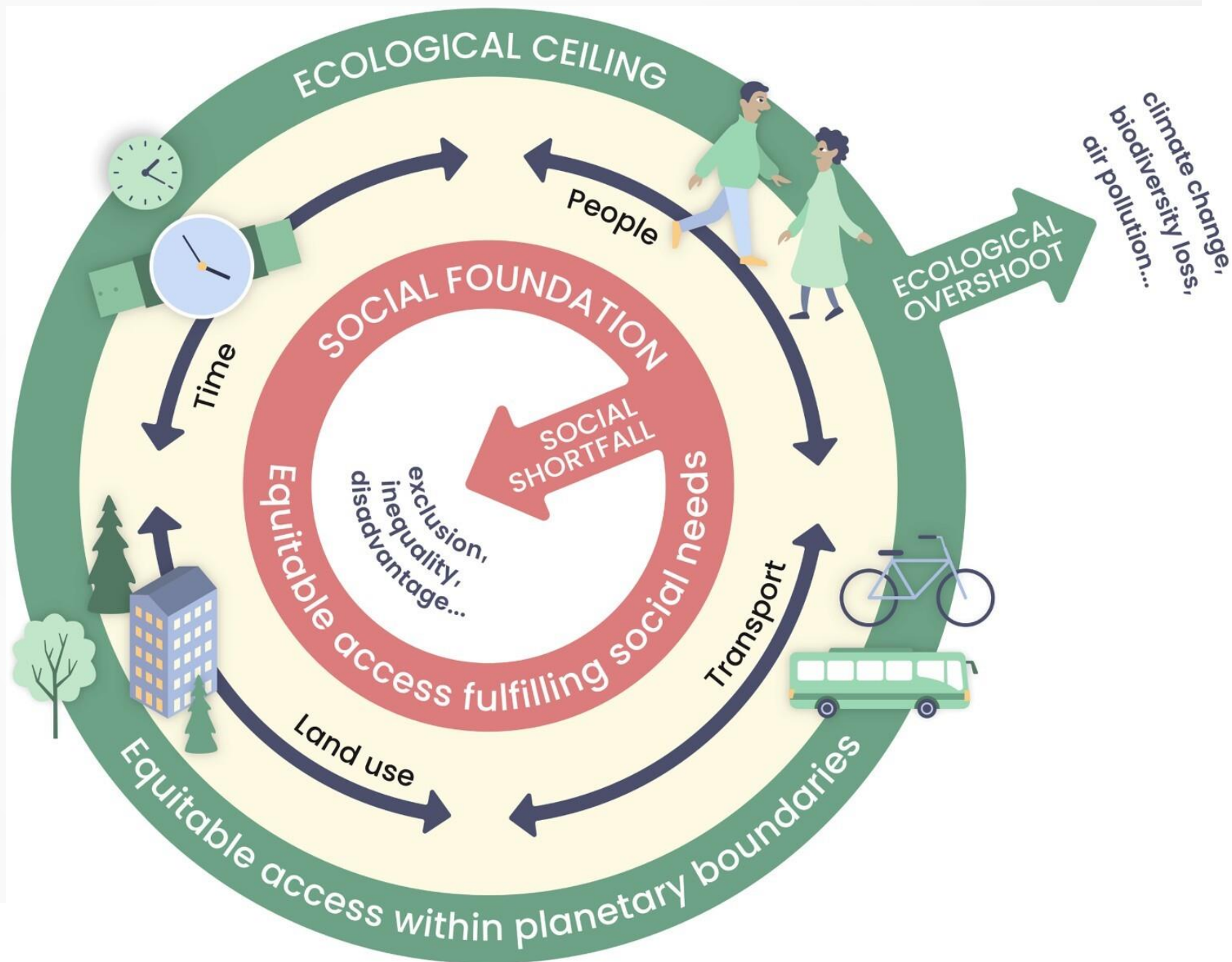
## Abstract

Urban travel exposes people to a range of environmental qualities with significant health and wellbeing impacts. Nevertheless, the understanding of travel-related environmental exposure has remained limited. Here, we present a novel approach for population-level assessment of multiple environmental exposure for active travel. It enables analyses





Willberg, E., Tenkanen, H.,  
Miller, H. J., Pereira, R. H.  
M., & Toivonen, T. (2023).  
Measuring just accessibility  
within planetary boundaries.  
*Transport Reviews*,  
[<https://doi.org/10.1080/01441647.2023.2240958>].  
<https://doi.org/10.1080/01441647.2023.2240958>







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HELSINKI INSTITUTE OF  
URBAN AND REGIONAL  
STUDIES

# MANY THANKS!

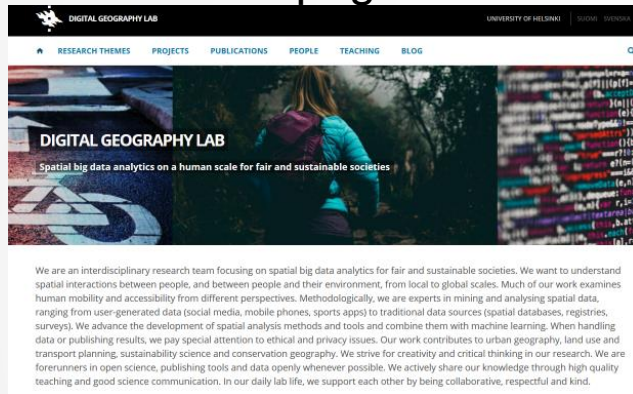
HELSINGIN YLIOPISTO  
HELSINGFORS UNIVERSITET  
UNIVERSITY OF HELSINKI





# HOW TO FOLLOW OUR WORK?

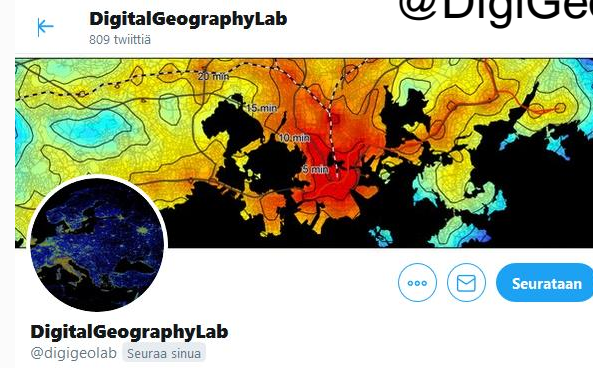
## Web pages



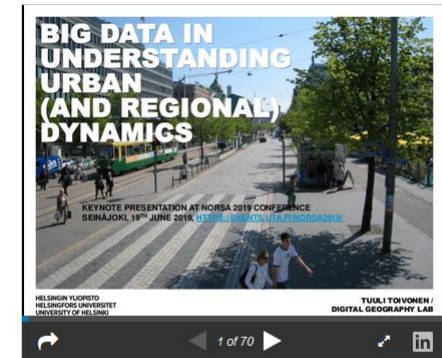
<http://www.helsinki.fi/digital-geography>

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UNIVERSITY OF HELSINKI

@DigiGeoLab, @TuuliToivonen



## Presentations



NoRSA 2019 Keynote: Tuuli Toivonen – Big Data for Analysing Urban Dynamics from University of Helsinki / Digital Geography Lab

## Blog

### Digiyeolab blog

**New paper out: Spatial prioritization for accessibility of urban parks** 7.10.2020

In our recent paper published in Applied Geography, we combine travel time modeling with spatial conservation prioritization to identify green areas that best serve the recreational use. We consider equitable access between urban dwellers, the need for various types of parks, and the use of various transport modes. The paper puts together approaches from conservation ... Continue reading "New paper out: Spatial prioritization for accessibility of urban parks"

**Reflections on the 8th Nordic-Baltic Migration Conference** 6.10.2020

Olle Järvi from the Digital Geography Lab attended as an expert panellist in the Nordic-Baltic Migration Conference "Cross-border Mobility in the Nordic-Baltic Region" organized by the Nordic Council of Ministers' Office in Tallinn, Estonia on September 18, 2020. Olle participated in the second panel "New Challenges in Cross-Border Mobility, Nordic-Baltic Region" together with Uffe Palludan ... Continue reading "Reflections on the 8th Nordic-Baltic Migration Conference"

**Green Paths -reittiopas edistää terveellistä ja aktiivista matkustamista** 24.9.2020

Age Poom, Joose Helle, Tuuli Toivonen Uusi Green Paths -reittiopas auttaa valitsemaan hiljaisemman ja ilmanlaadultaan parhaan pyöräily- ja kävelyreitin. Pääkaupunkiseudulla toimivan reittiyökalun suositukset perustuvat reaaliaikaiseen tietoon ilmanlaadusta sekä kaupungilla tehtyihin melutasomittauksiin. Sovelluksen avulla liikkuja välttää vilkkaasti liikennöidyt kadut, mutta pääsee silti perille kohtuullisessa ajassa. Helsingin yliopiston Digital Geography Lab -tutkimusryhmä on kehittänyt Green Paths -reittiyökalun ... Continue reading "Green Paths -reittiopas edistää terveellistä ja aktiivista matkustamista"

**Green Paths routing tool encourages healthy and active travelling** 24.9.2020

Authors: Age Poom, Joose Helle, Tuuli Toivonen The new Green Paths routing tool helps pedestrians and cyclists to choose urban commuting routes with less air and noise pollution. The tool is a proof of concept of exposure-optimised routing. It functions in the Helsinki capital region where the necessary environmental data is available. The novel routing ... Continue reading "Green Paths routing tool encourages healthy and active travelling"





# CLIMATE CHANGE, SUSTAINABILITY AND CITIES

## PERSPECTIVE OF DATA AND PEOPLE

TIMON MCPHEARSON &  
TUULI TOIVONEN