

# Biodiversity as the basis for the provision of Ecosystem Services in the urban context

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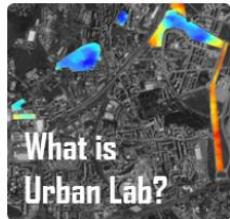
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## URBAN LAB

A VIRTUAL RESEARCH INFRASTRUCTURE IN URBAN ECOLOGY



What is  
Urban Lab?



Our  
Projects



Our  
Training



Our  
Outreach



News  
and Events

## OUR RESEARCH AREAS



Biodiversity as the key to  
support ecosystem  
services

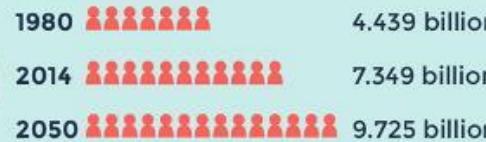


Adapt cities to the future

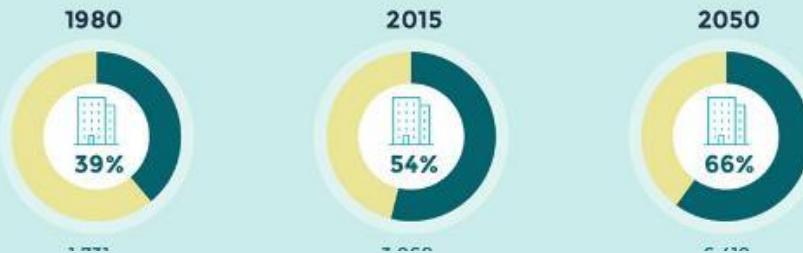


Stakeholders engagement  
and support

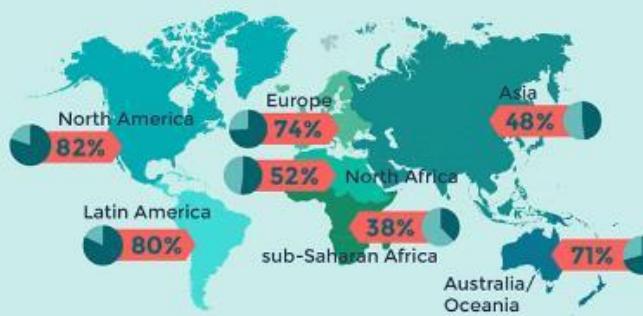
### World Population



### Share of the Urban Population Worldwide



### Share of Urban Population on all Continents



Source: United Nations Department of Economic and Social Affairs (UNDESA) 2016, online database

# NEW URBAN AGENDA





## SUSTAINABLE DEVELOPMENT KNOWLEDGE PLATFORM

# SUSTAINABLE DEVELOPMENT GOAL 11

Make cities and human settlements inclusive, safe, resilient and sustainable



11.a Support links urban,  
peri-urban & rural areas

11.b Increase adoption city  
integrated policies

11.7 Provide access green  
public spaces

11.c Support LDCs building  
resilient buildings

11.6 Reduce per capita city  
environmental impact

11.1 Ensure access safe  
housing/services

11.5 Reduce deaths, losses  
due to disasters

11.2 Provide access  
sustainable transport

11.4 Protect/safeguard  
cultural & natural heritage

11.3 Enhance inclusive &  
sustainable urbanization

11

SUSTAINABLE CITIES  
AND COMMUNITIES



11 SUSTAINABLE CITIES  
AND COMMUNITIESSustainable cities  
and communities

## Challenges

The **RAPID** and often **UNPLANNED URBANIZATION** witnessed worldwide has led to **INCREASED PRESSURE ON THE ENVIRONMENT**



Our cities account for up to **80% OF ENERGY CONSUMPTION** as well as **75% OF GLOBAL WASTE AND CARBON EMISSIONS**



Due to the high concentration of people, infrastructure, housing and economic activities, **CITIES ARE PARTICULARLY VULNERABLE** to climate change and natural disasters



## Solutions



**PROMOTE SOUND URBAN PLANNING**, sustainable building, low-carbon transports, green spaces and sustainable lifestyles

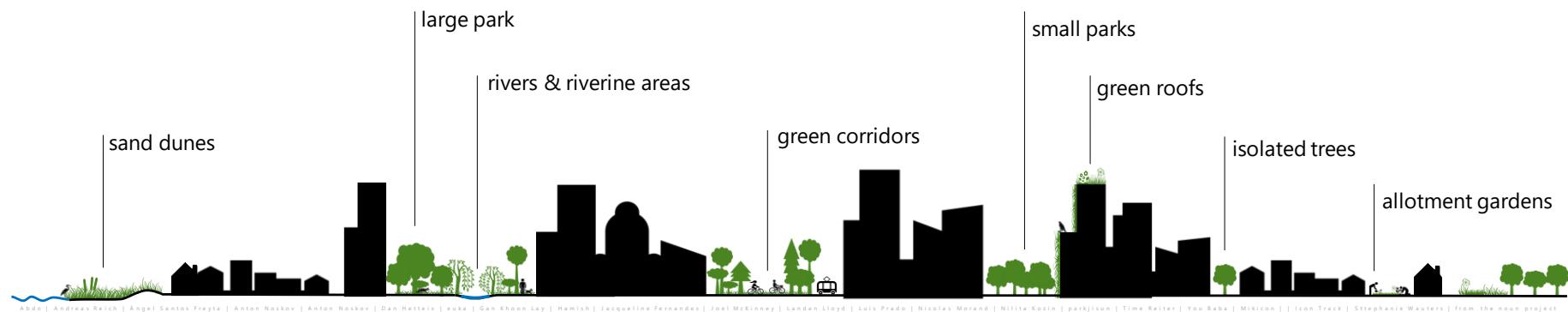


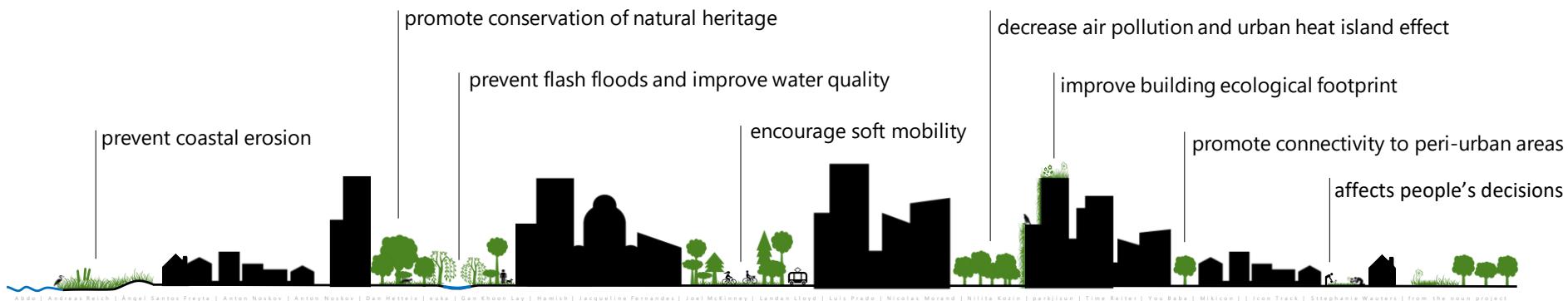
**INVEST IN RENEWABLE ENERGY**, waste management, sustainable and green infrastructure



**PROTECT CITIES** - which are important social, cultural and economic centres - from environmental and climate threats

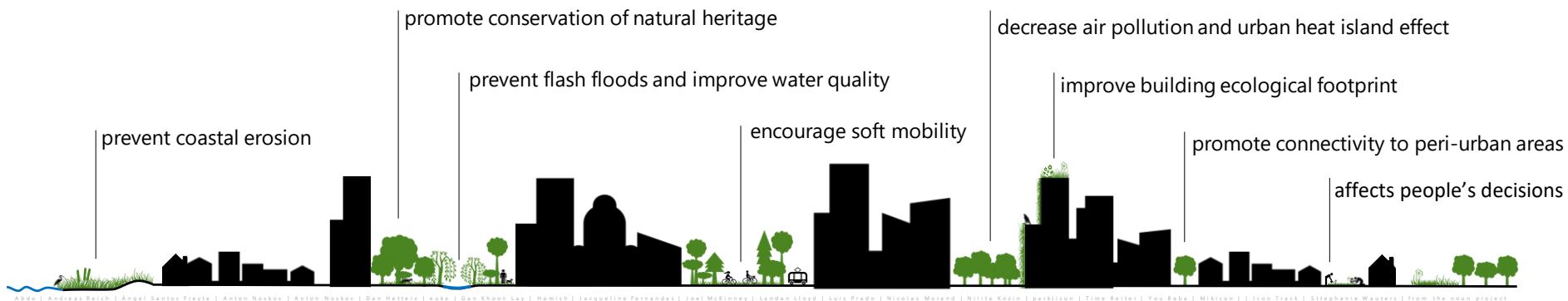
## cities green and blue infrastructure



**restoring or reclaiming land to promote ecosystem services in urban areas to fulfil SDG 11 targets**

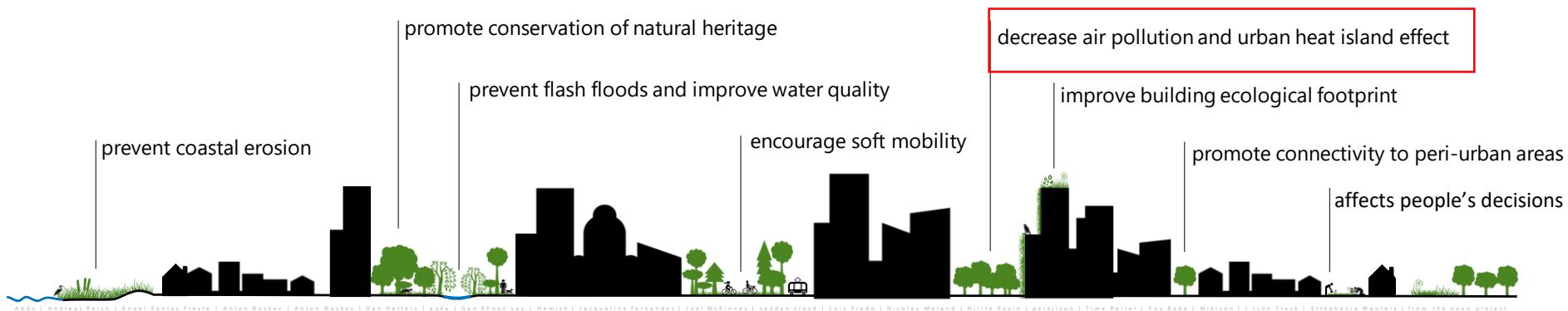
1. green areas promote microclimate regulation
2. green areas promote air quality
3. green areas affect people's decisions
4. green areas promote connectivity in urban areas
5. green areas planning must account trade-offs in ES

**restoring or reclaiming land to promote ecosystem services in urban areas to fulfil SDG 11 targets**



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## urban heat-island effect

### higher temperature in city center

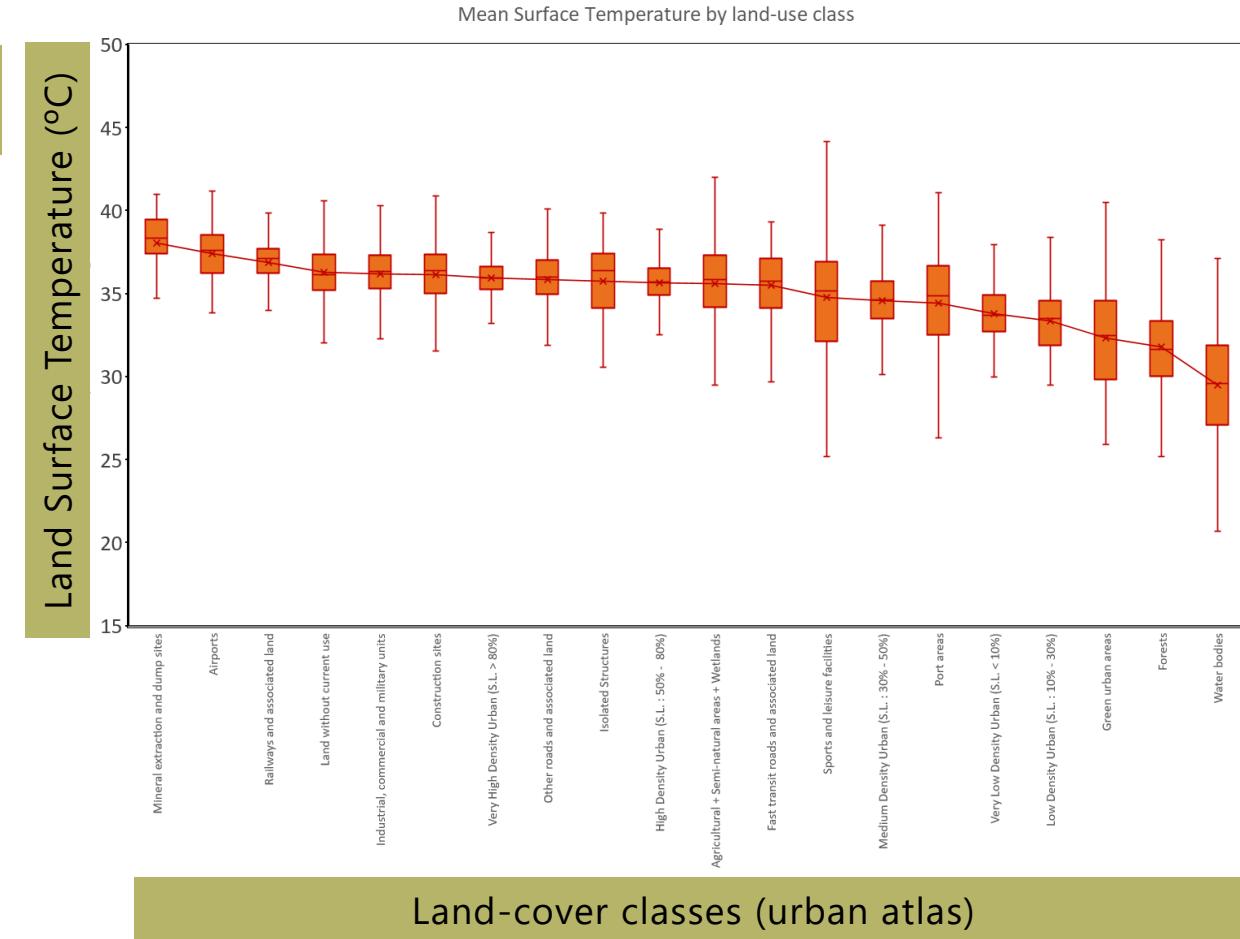
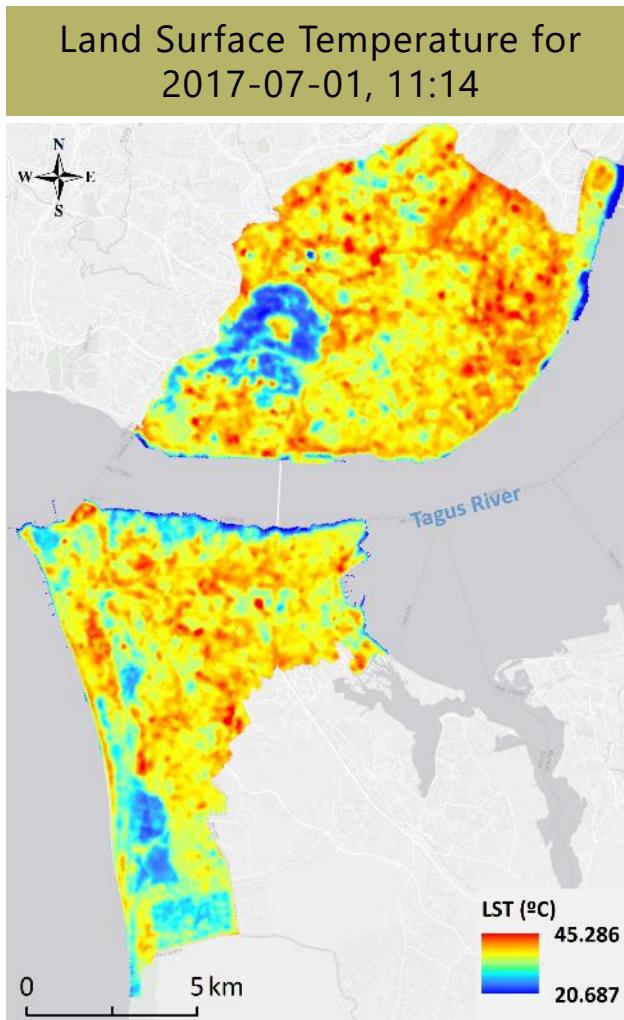




- how do green areas control local microclimate?
- are green areas cooler and moisture than nearby built-up areas?
- can we model that effect to create more liveable cities?

# green areas promote microclimate regulation

## Lisbon Metropolitan Area

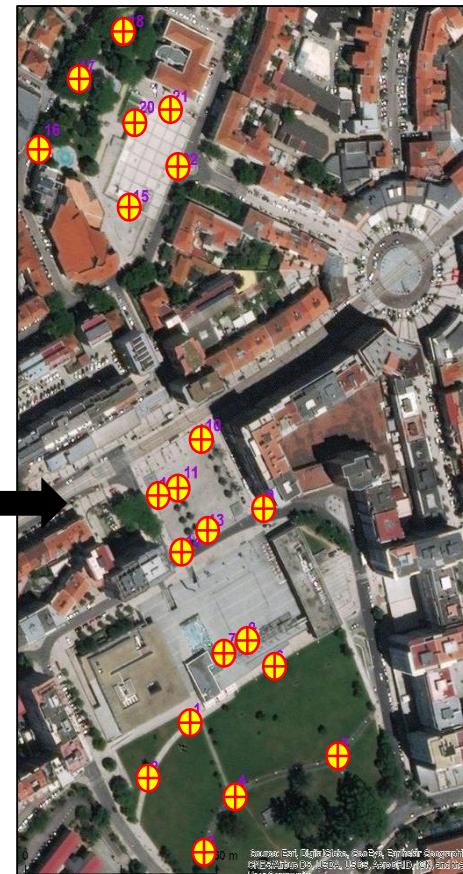
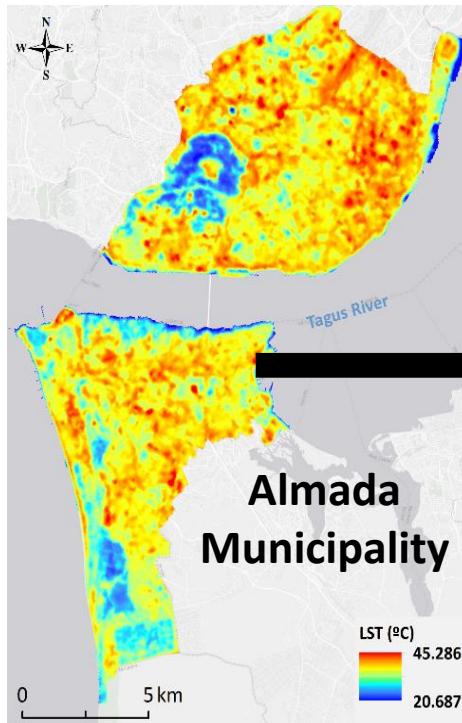


## Land-cover classes (urban atlas)



# measuring temperature and relative humidity

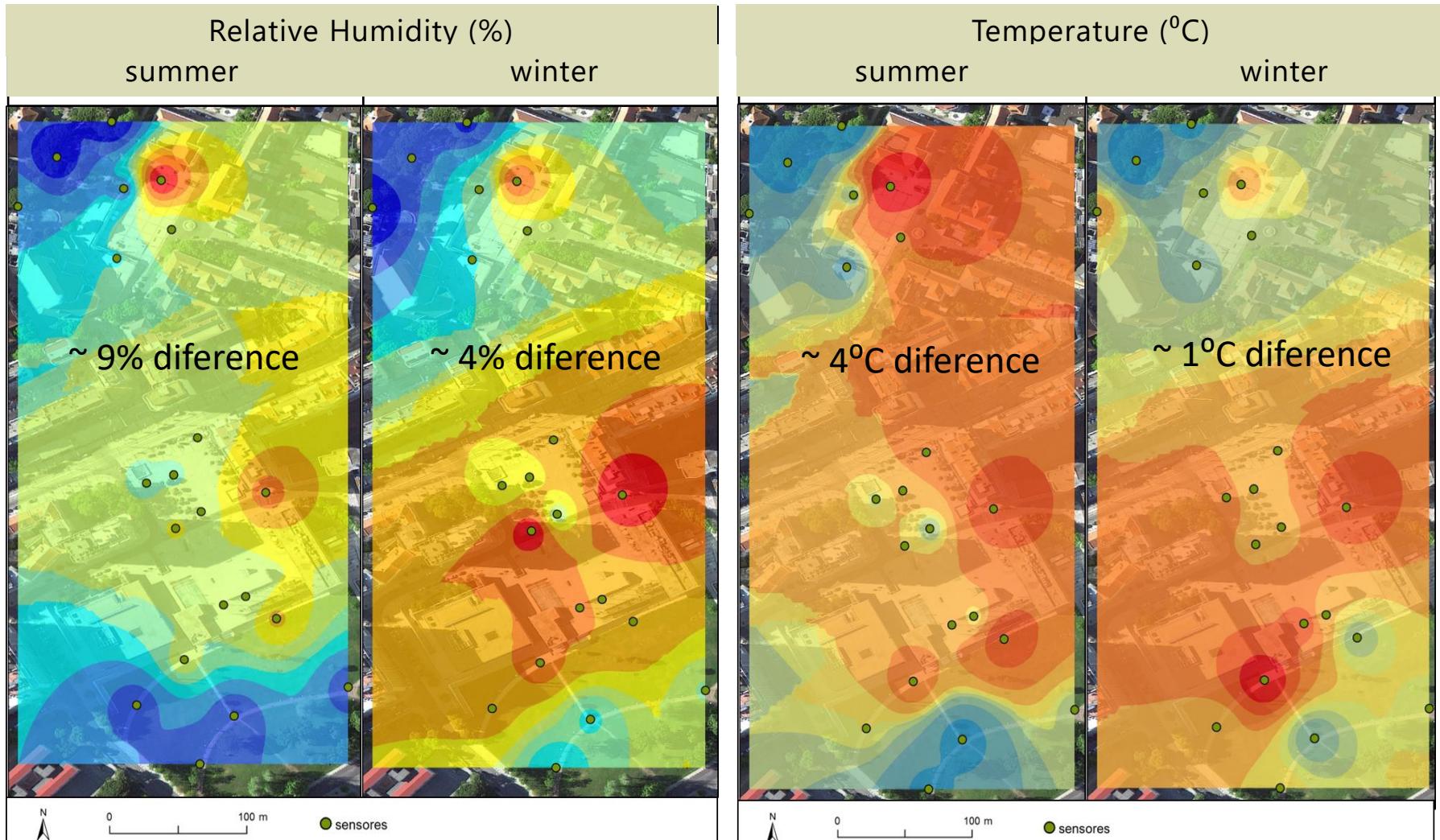
## Land Surface Temperature



Sensores  
iButton



## forest as provider of climate regulation



■ 53.2193732 – 54.7284802  
■ 54.7284802 – 55.9397306  
■ 55.9397306 – 56.9119132  
■ 56.9119132 – 57.6922134  
■ 57.6922134 – 58.3185036  
■ 58.3185036 – 58.8211811  
■ 58.8211811 – 59.4474713  
■ 59.4474713 – 60.2277715  
■ 60.2277715 – 61.199954  
■ 61.199954 – 62.4112044

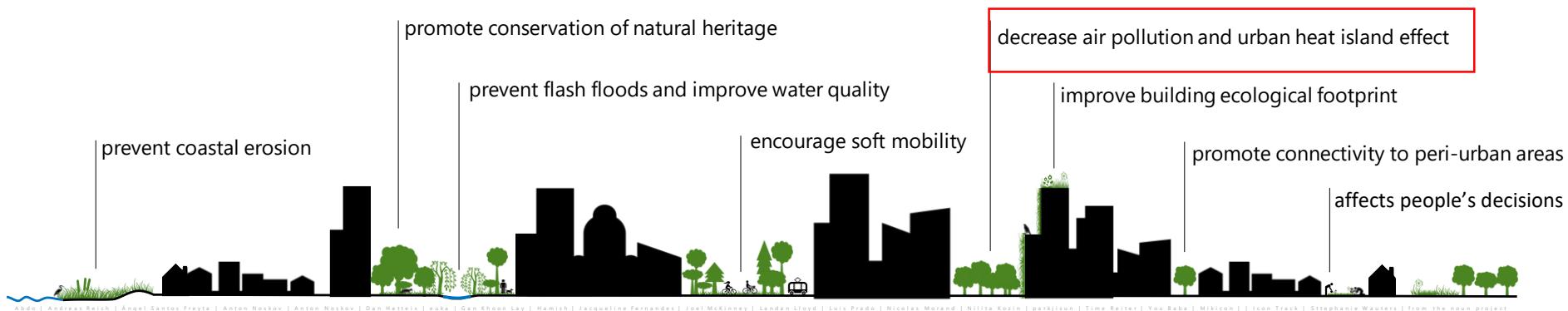
■ 77.0080566 – 77.6818136  
■ 77.6818136 – 78.2013979  
■ 78.2013979 – 78.6020882  
■ 78.6020882 – 78.9110904  
■ 78.9110904 – 79.1493851  
■ 79.1493851 – 79.4583873  
■ 79.4583873 – 79.8590776  
■ 79.8590776 – 80.3786619  
■ 80.3786619 – 81.0524189  
■ 81.0524189 – 81.926095

■ 21.8703017 – 22.63577  
■ 22.63577 – 22.9730763  
■ 22.9730763 – 23.1217115  
■ 23.1217115 – 23.1872081  
■ 23.1872081 – 23.2160695  
■ 23.2160695 – 23.2815661  
■ 23.2815661 – 23.4302013  
■ 23.4302013 – 23.7675076  
■ 23.7675076 – 24.5329759  
■ 24.5329759 – 26.2700967

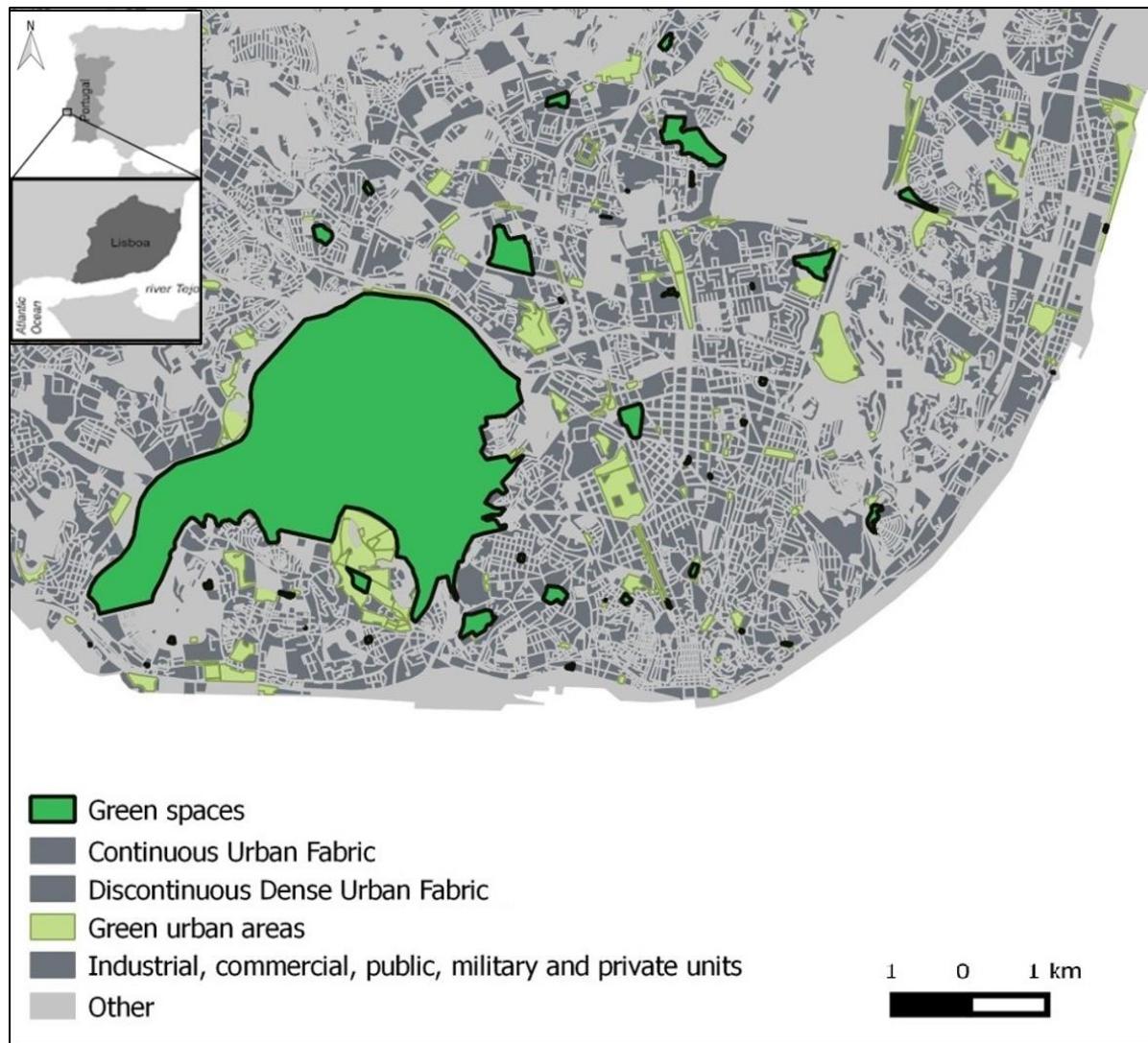
■ 12.1697041 – 12.4207479  
■ 12.4207479 – 12.5994708  
■ 12.5994708 – 12.726707  
■ 12.726707 – 12.8172888  
■ 12.8172888 – 12.8817757  
■ 12.8817757 – 12.9462627  
■ 12.9462627 – 13.0368445  
■ 13.0368445 – 13.1640807  
■ 13.1640807 – 13.3428036  
■ 13.3428036 – 13.5938474

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restoring or reclaiming land to promote ecosystem services in urban areas to fulfil SDG 11 targets



# functional diversity: from drivers to effects

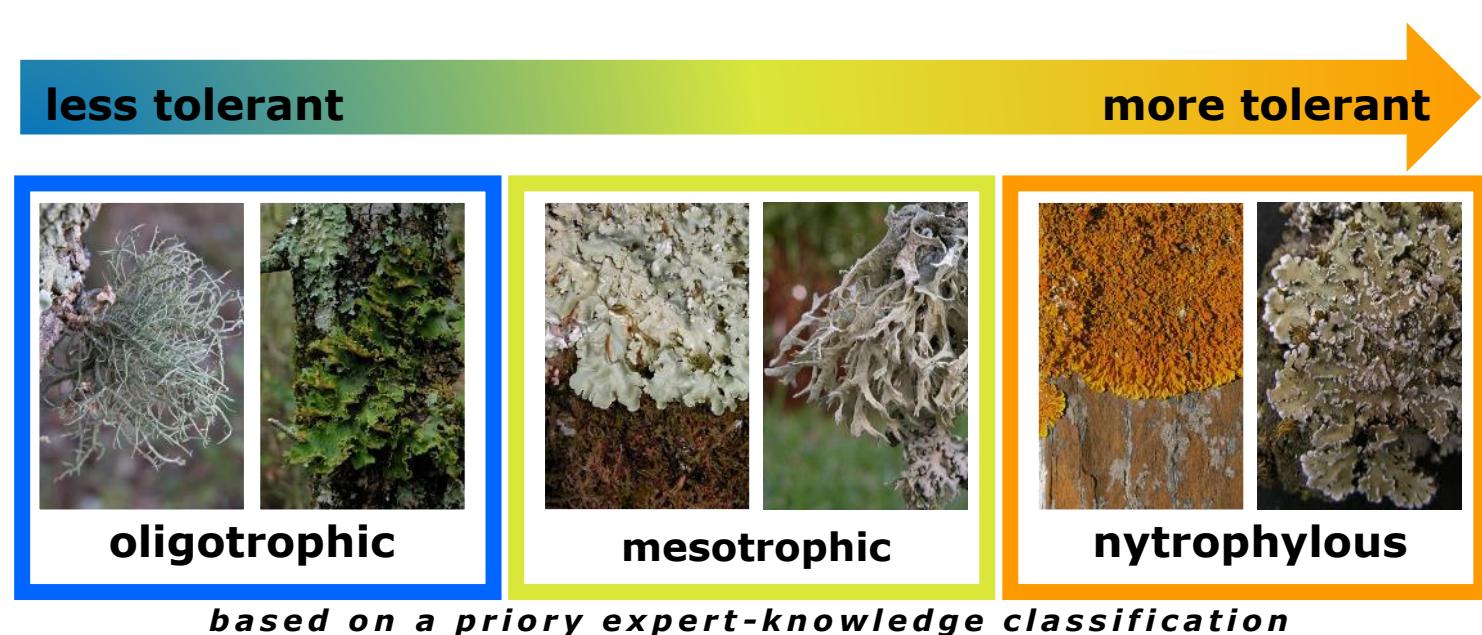


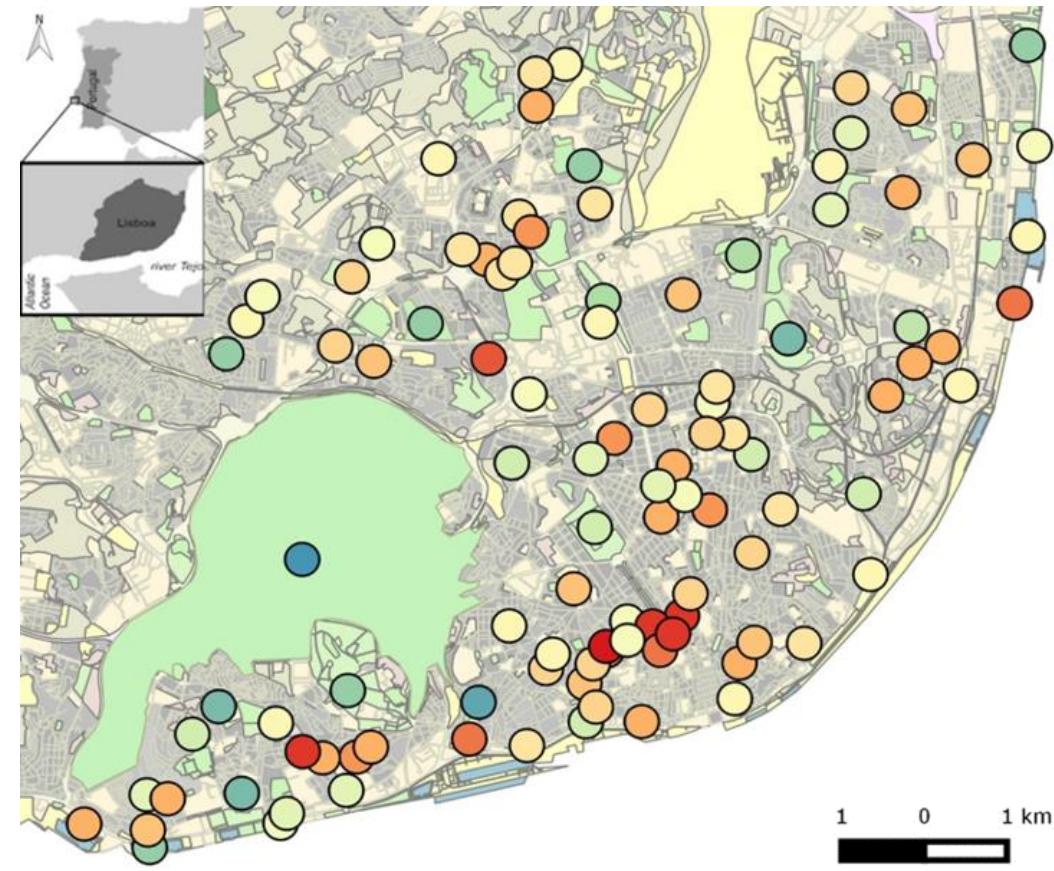
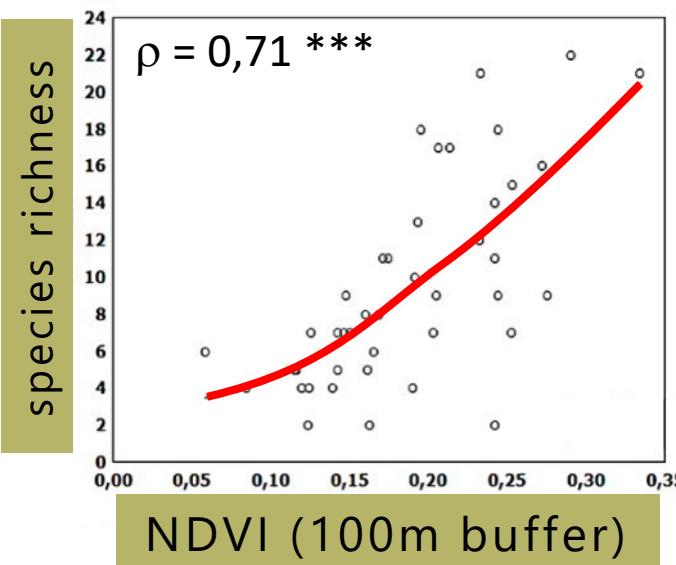
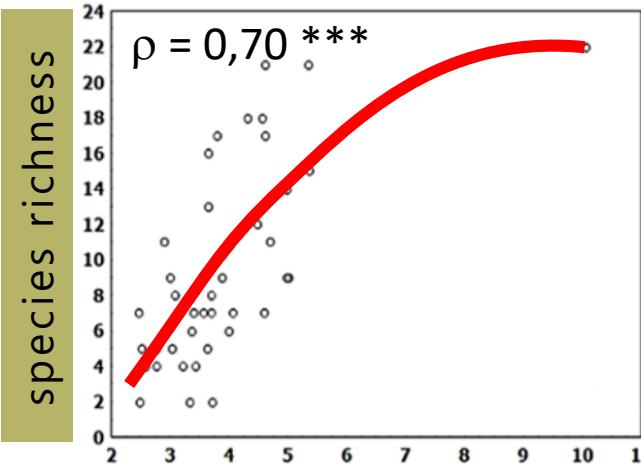
- Lisbon metropolitan area:  
~3 000 000 inhabitants  
(~500 000 in the city of Lisbon)
- random stratified sampling for location and size (n=60 urban parks)
- lichens as bioindicators of air pollution ( $PM_{10}$  particles)





## Lichens as bioindicators of air quality

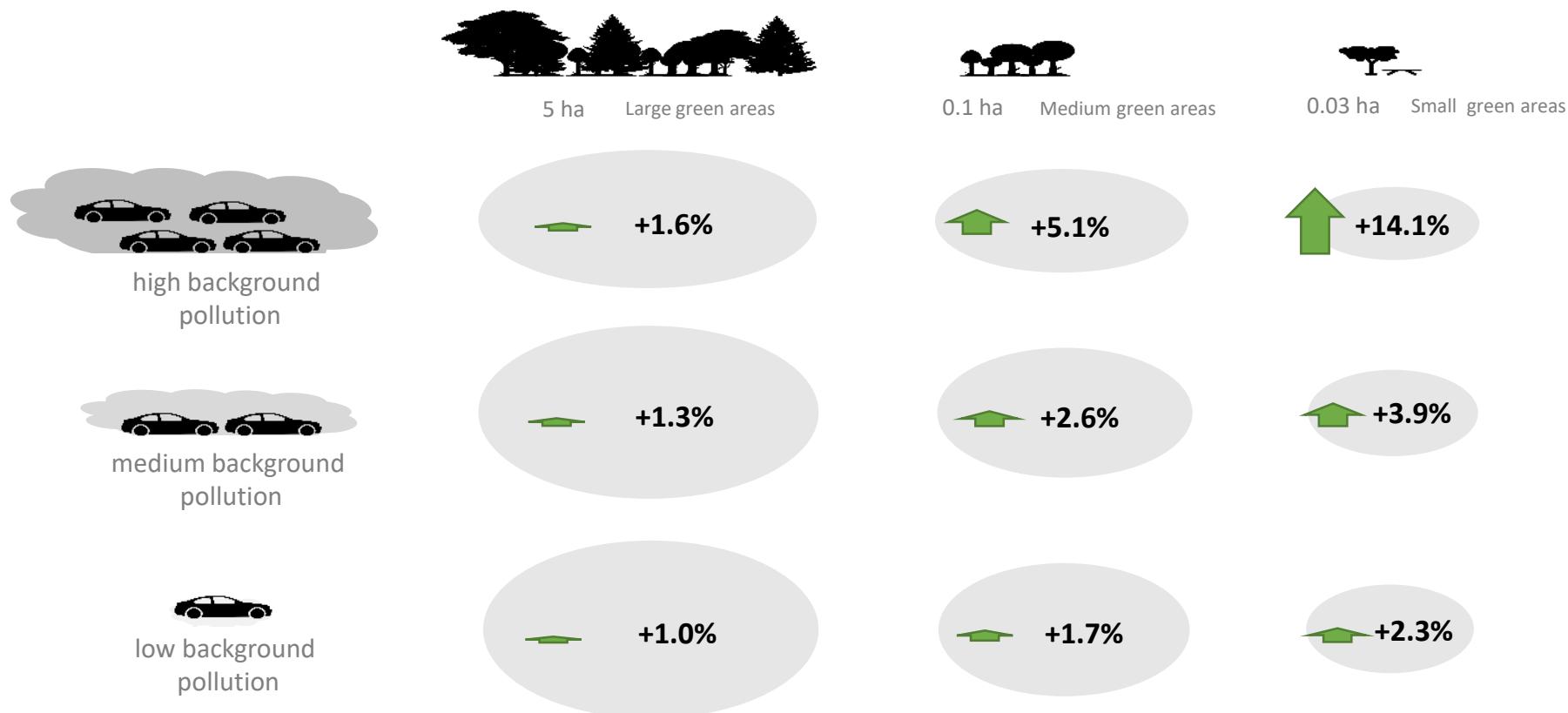




lichen species richness (air quality)

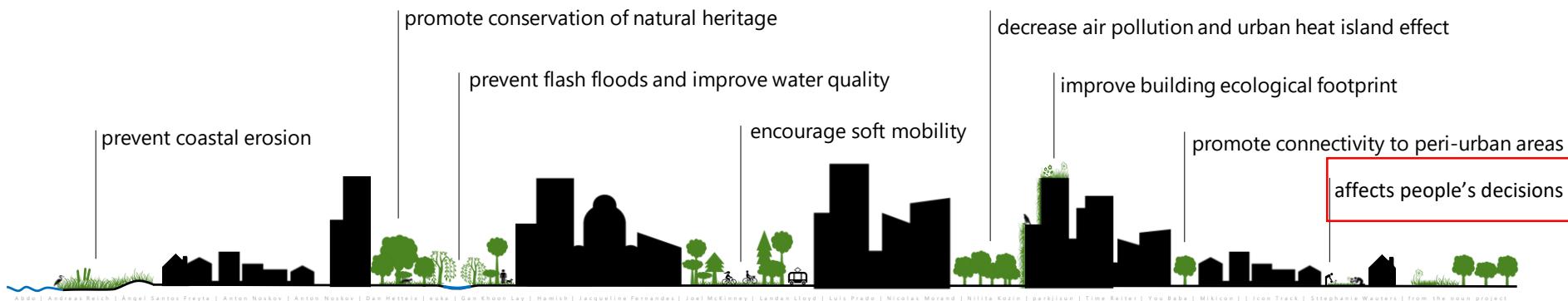
= Vegetation density

# green areas promote air quality



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# P Tem dez minutos para avaliar os espaços verdes de Lisboa?

A câmara de Lisboa quer saber a opinião dos seus munícipes sobre os jardins e parques da cidade. Quais os preferidos dos lisboetas? Há um inquérito online, disponível até dia 21 de Abril.

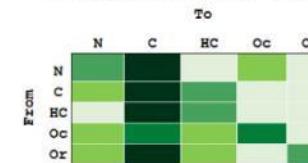


→ to here

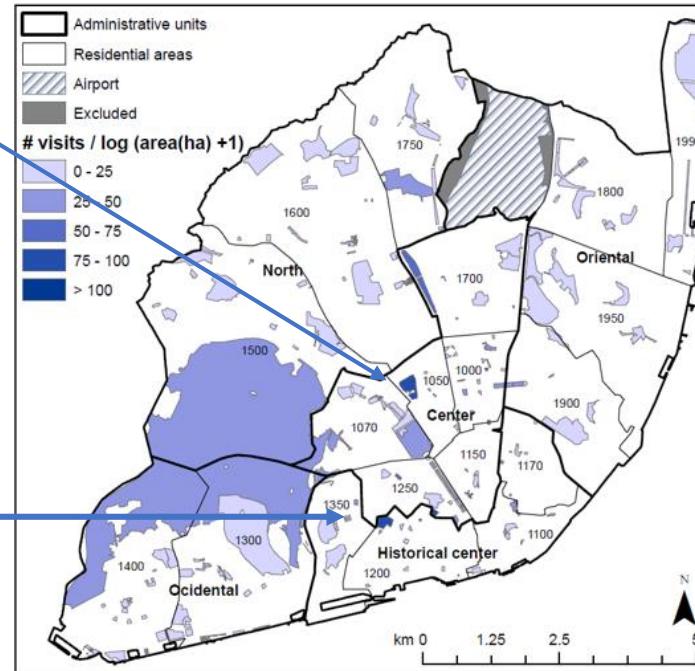
A. Aggregated fluxes at the zip level



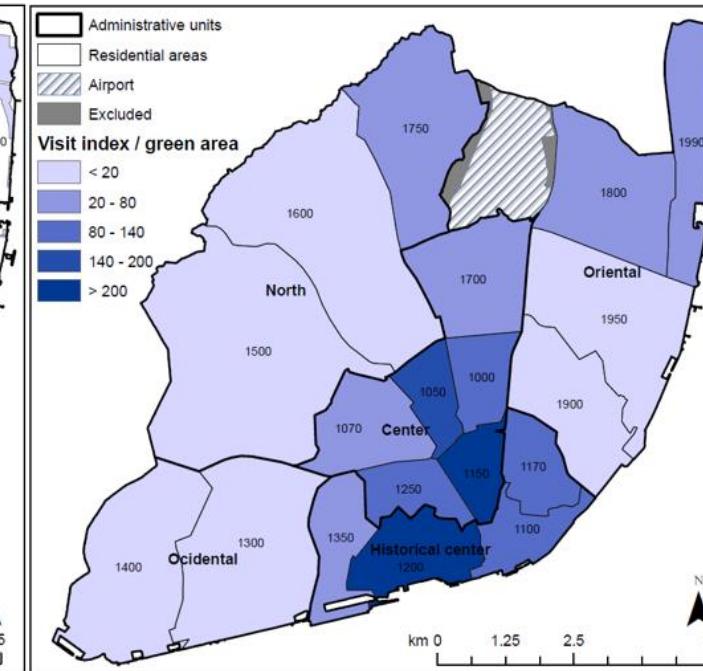
B. Aggregated fluxes at the UTI level

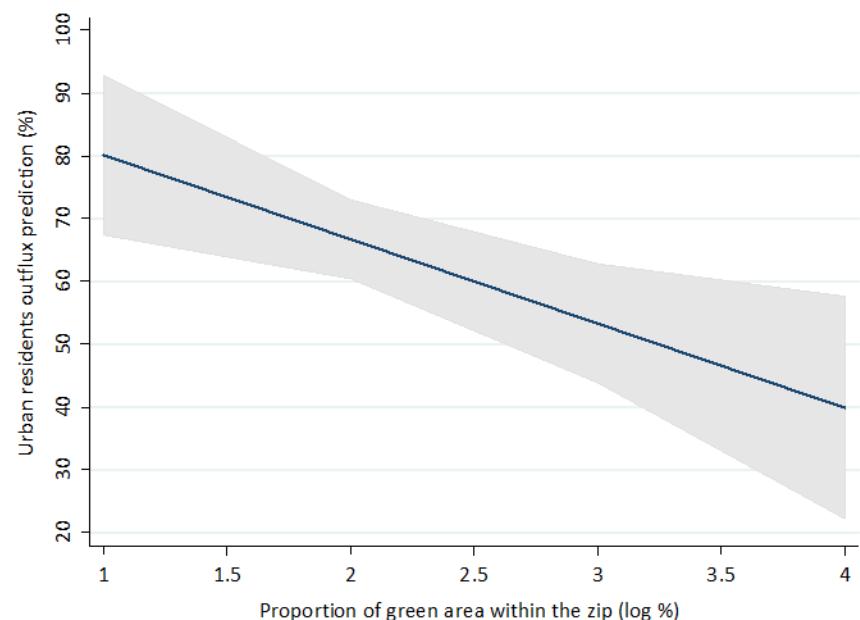
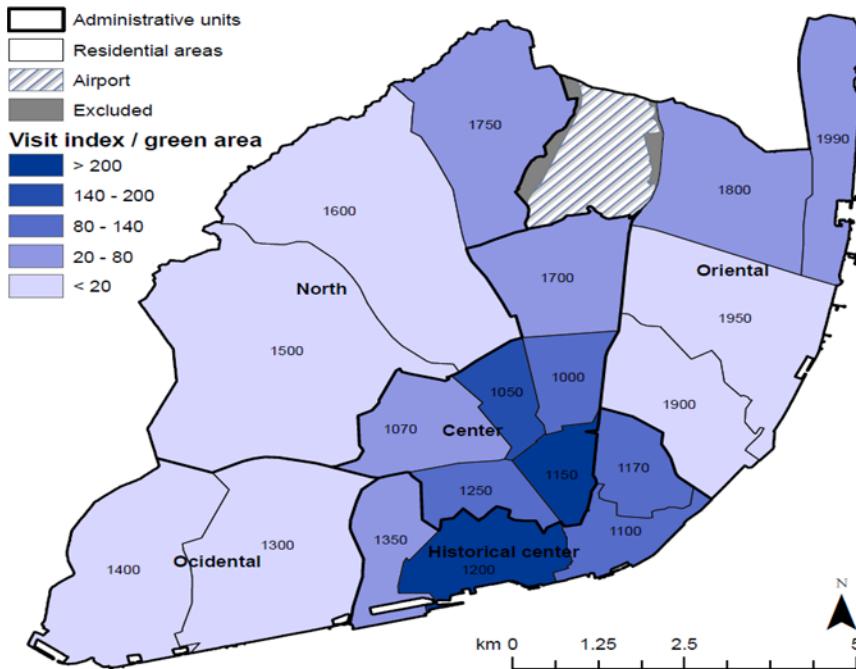
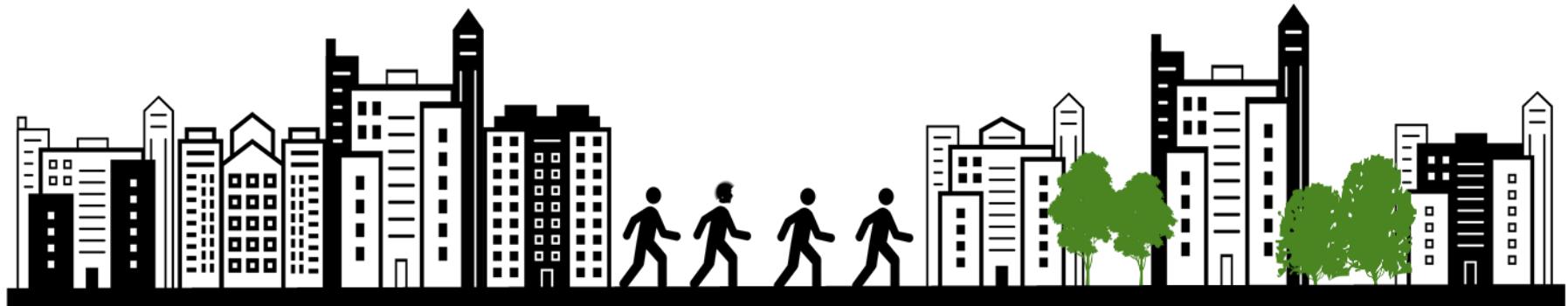


A. Saturation level per UGS



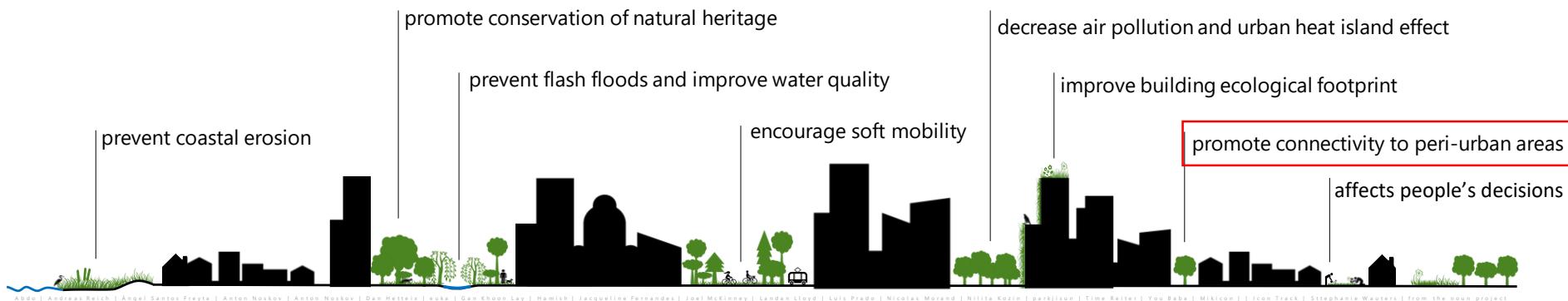
B. Saturation level per zip



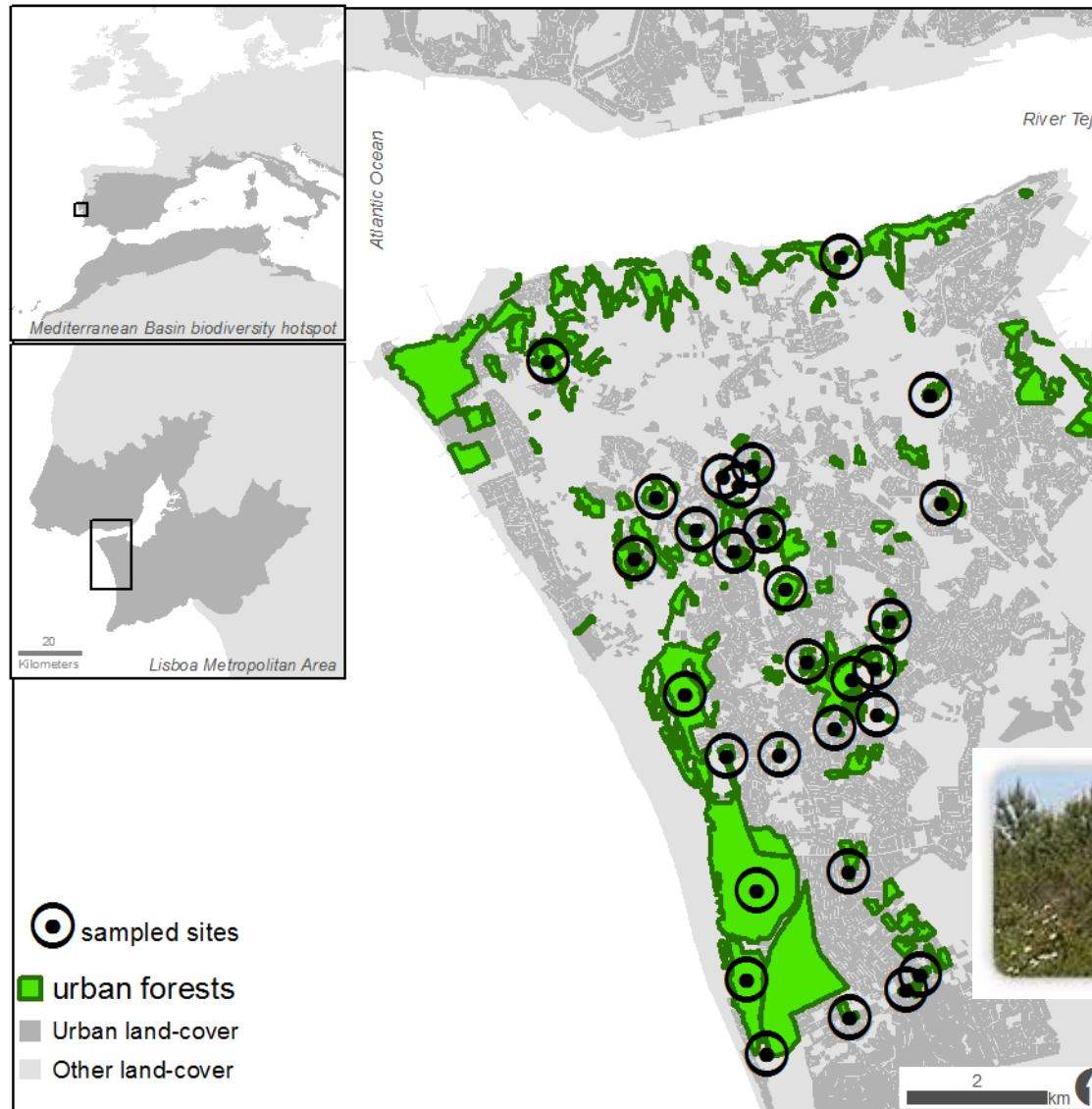


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# the use of functional diversity in large urban areas



- ▶ Almada municipality: 170 000 habitants living in 70 km<sup>2</sup>
- ▶ urban forest: 13% of municipality area surrounded by low and high density urban areas, agriculture and semi-natural areas
- ▶ random stratified sampling for location and size (n=46 urban forest fragments)



Mata dos Medos

# the use of functional diversity in large urban areas

lichens

**65 species**



butterflies

**20 species**



other-invertebrates

**18 orders**



birds

**47 species**



mammals

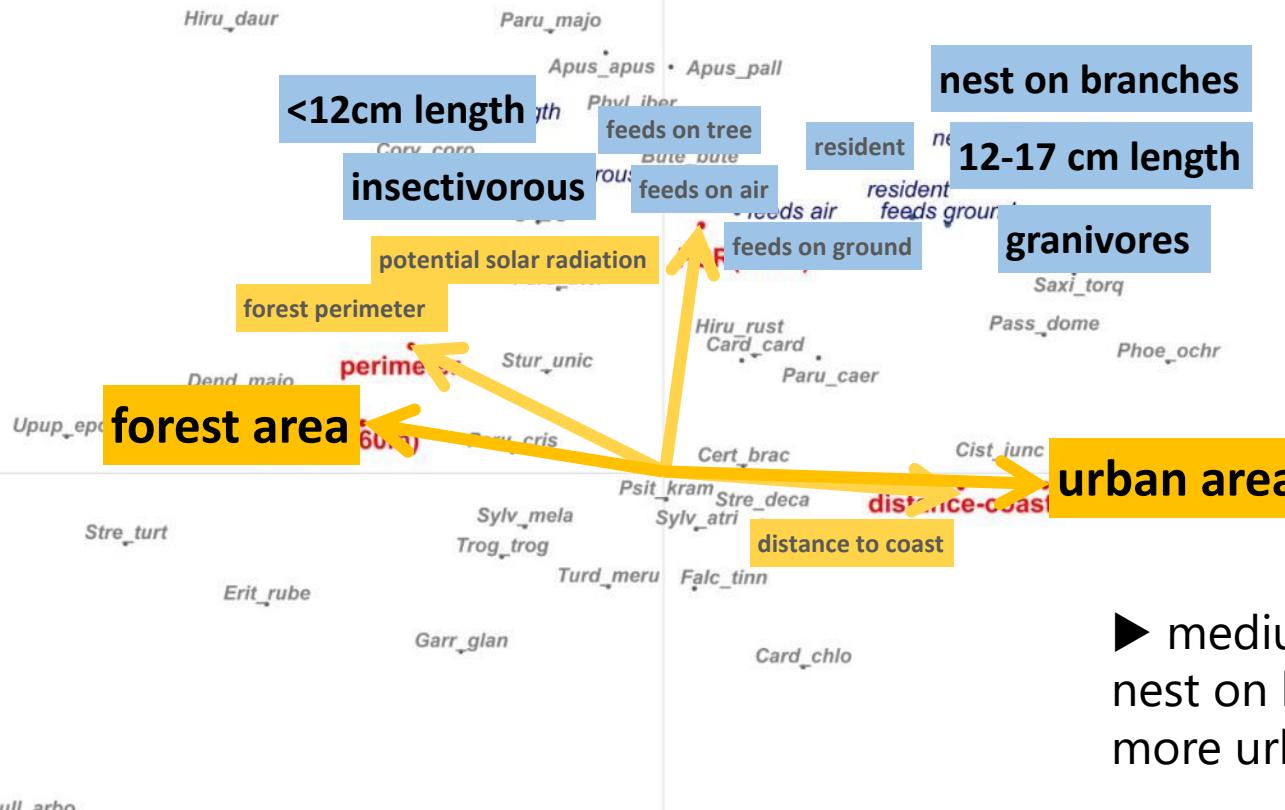
**4 species**



- ▶ total of 136 species of lichens, butterflies, birds and mammals and 18 orders of other-invertebrates

## the use of functional diversity in large urban areas

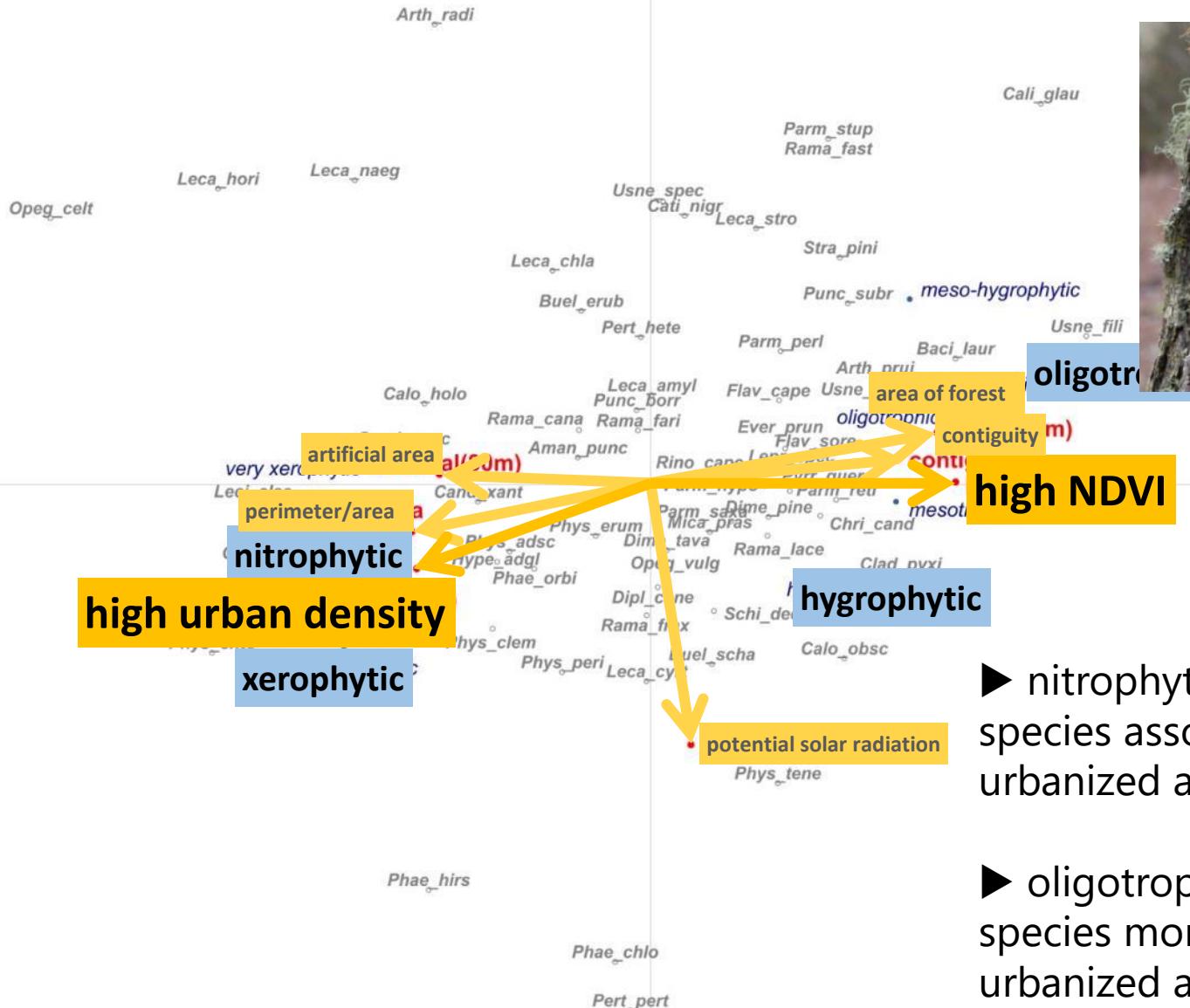
Colu\_palu



Henry Mühlfordt

- medium size granivores that nest on branches associated to more urbanized areas
- small size insectivorous birds associated to more forested areas

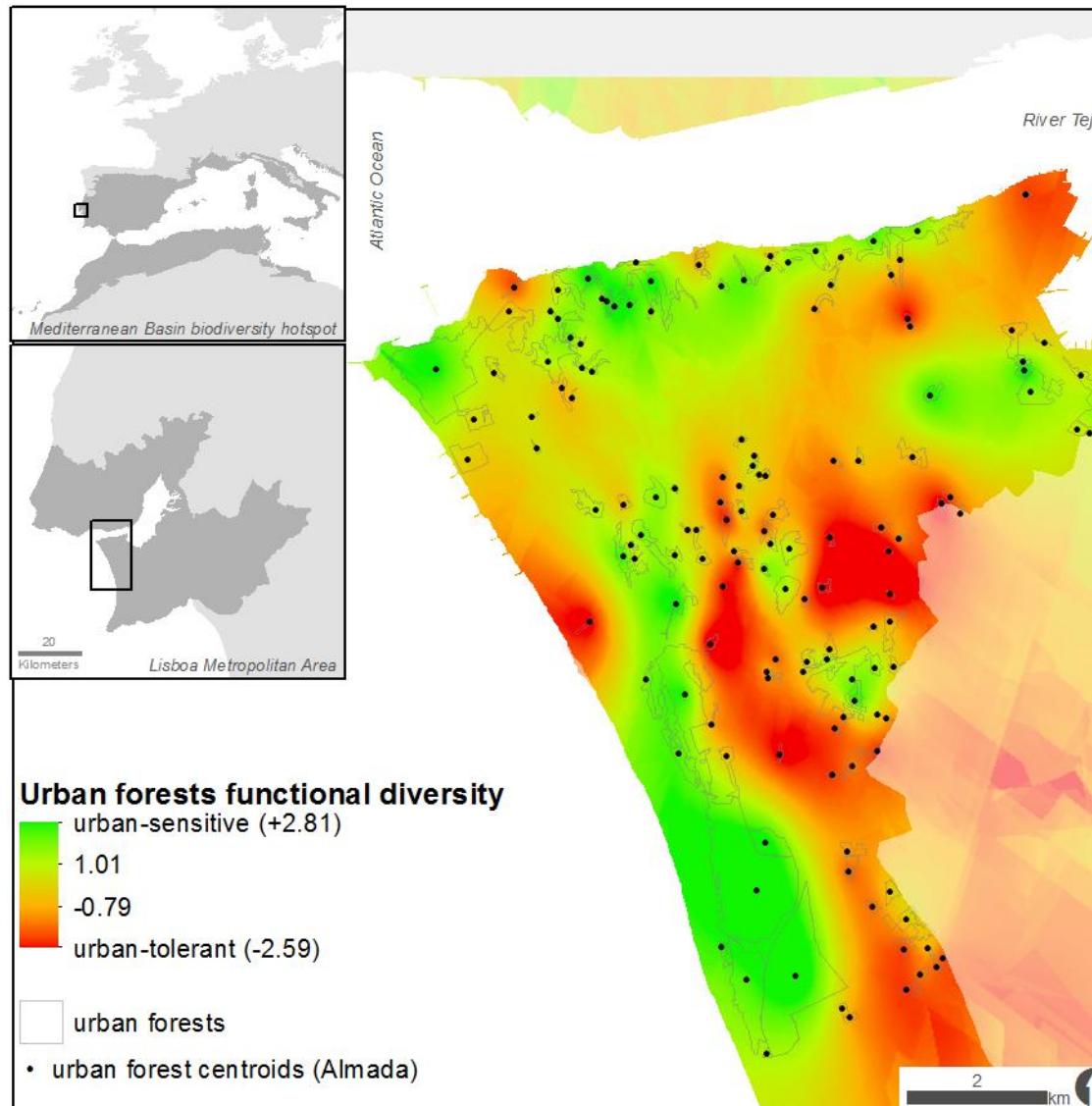
Colu\_livi



► nitrophytic and xerophytic species associated to more urbanized areas

► oligotrophic and hygrophytic species more associated to less urbanized areas

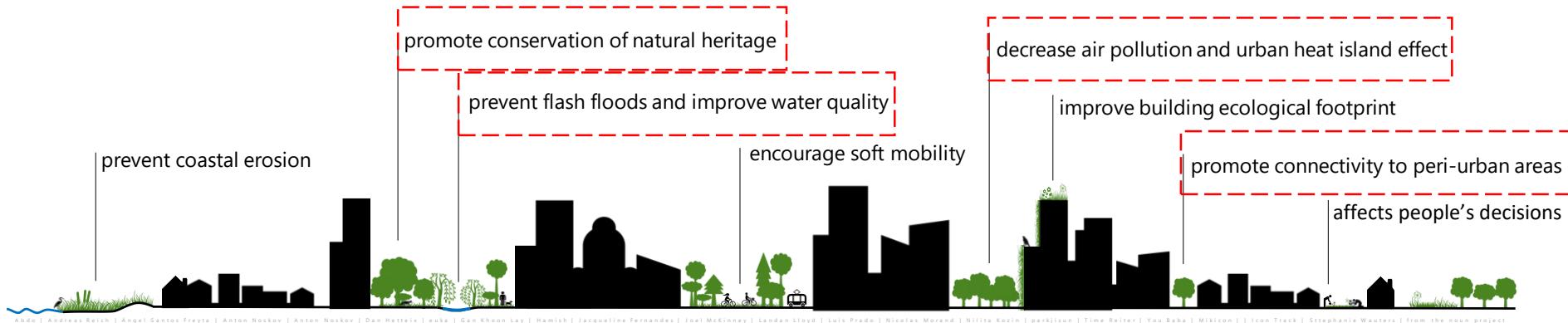
# the use of functional diversity in large urban areas



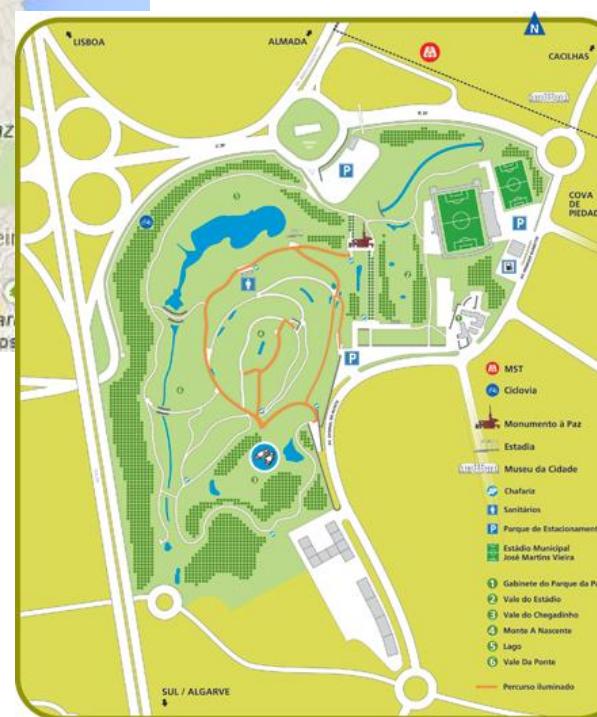
- ▶ index of urban diversity can be interpolated and mapped for all municipality
- ▶ it highlights the area with more a biodiversity more close to the “forest” type, and the gaps between those forests
- ▶ it provides a view on how to make green infrastructure more functional

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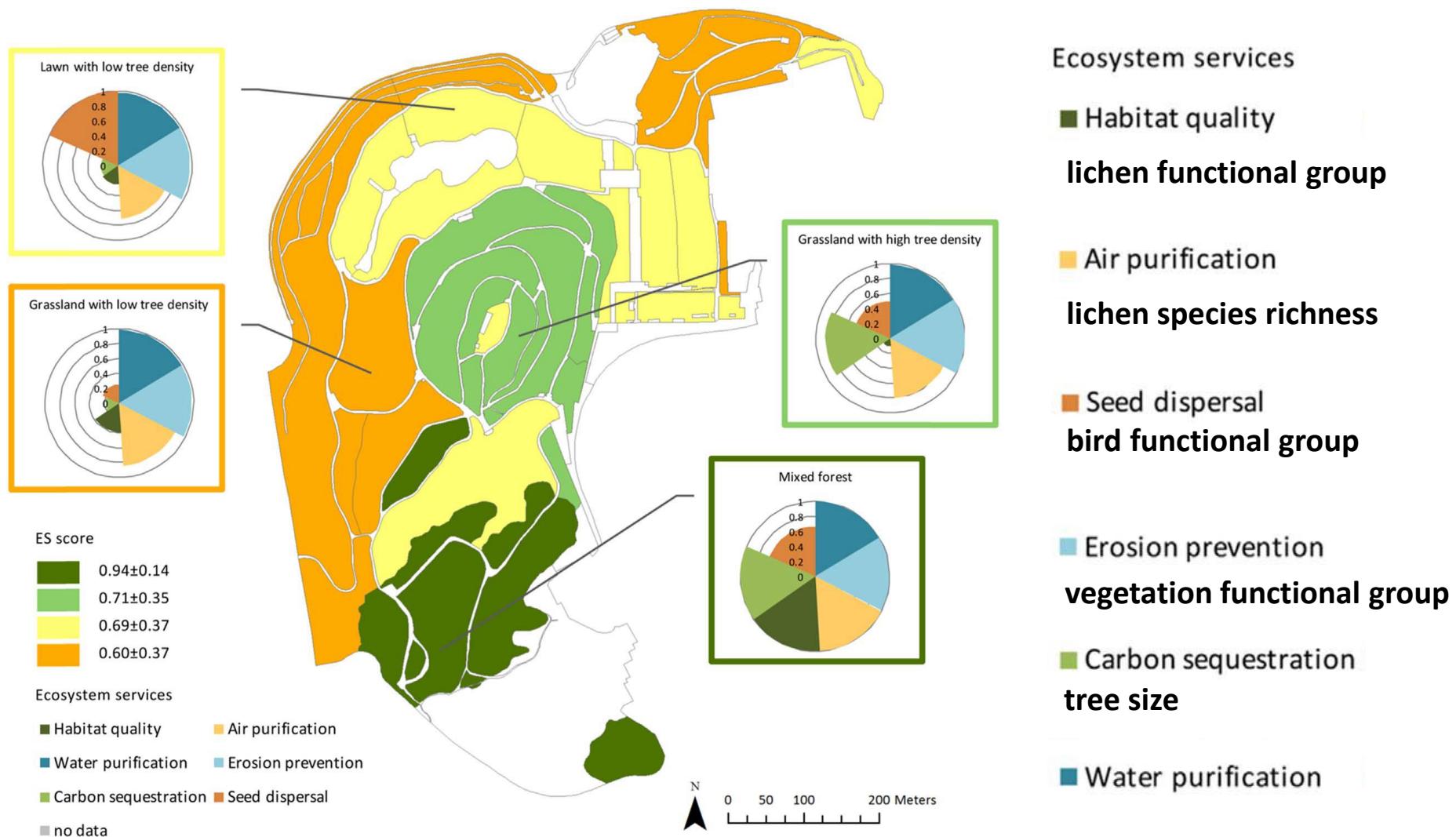
# trade-offs in ecosystem services



- ▶ Almada urban park
- ▶ considered the 'heart' of the city
- ▶ 60 ha
- ▶ includes lawns, grasslands with varied tree density, mixed forest, rest areas, paths and lakes



## trade-offs in ecosystem services



Mexia T, Vieira J, Príncipe A, Anjos A, Silva P, Lopes N, Freitas C, Santos -Reis M, Correia O, Branquinho C, Pinho P. 2018. Ecosystem services in urban parks under magnifying lens. Environmental Research 160: 469–478 [link](#)

Vieira J, Matos P, Mexia T, Silva P, Lopes N, Freitas C, Correia O, Santos-Reis M, Branquinho C, Pinho P. 2018. Green spaces are not all the same for the provision of ecosystem services: the case of air purification and climate regulation. Environmental Research 160: 306-313 [link](#)

↑ air purification and microclimate regulation



↑ management intensity

vegetation structure and management matters to the provision of ecosystem services in urban green areas

*“... Previous work maps the supply and demand for services, assesses threats to them, and estimates economic values, but does not measure the underlying role of biodiversity in providing services. In contrast, experimental studies of biodiversity–function examine communities whose structures often differ markedly from those providing services in real landscapes. A bridge is needed between these two approaches...”*



Luz AC, Buijs M, Aleixo C, Metelo I, Grilo F, Branquinho C, Santos-Reis M, Pinho P. 2019. Should I stay or Should I go? Modelling the fluxes of urban residents to visit green spaces. *Urban Forestry & Urban Greening* 40, 195-203. [link](#)

Llop E, Pinho P, Matos P, Pereira MJ, Branquinho C. 2012. The use of lichen functional groups as indicators of air quality in a Mediterranean urban environment. *Ecological Indicators* 13: 215-221. [link](#)

Llop E, Pinho P, Ribeiro MC, João-Pereira M, Branquinho C. 2017. Traffic represents the main source of pollution in small Mediterranean urban areas as seen by lichen functional groups. *Environmental Science and Pollution Research*. [link](#)

Santos A, Pinho P, Munzi S, Botelho MJ, Palma-Oliveira J, Branquinho C. 2017. The role of forest in mitigating the impact of atmospheric dust pollution in a mixed landscape. *Environmental Science and Pollution Research* 24: 12038-12048 [link](#)

Pinho P, Correia O, Lecoq M, Munzi S, Vasconcelos S, Gonçalves P, Rebelo R, Antunes C, Silva P, Freitas C, Lopes N, Santos-Reis M, Branquinho C. 2016. Evaluating green infrastructure in urban environments using a multi-taxa and functional diversity approach. *Environmental Research*. 147: 601–610 [link](#)

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Munzi S, Correia O, Silva P, Lopes N, Freitas C, Branquinho C, Pinho P. 2014. Lichens as ecological indicators in urban areas: beyond the effects of pollutants. *Journal of Applied Ecology* 51: 1750–1757 [link](#)