

Using data products and models to inform GI planning

Prof. Laurence Jones - UK Centre for Ecology & Hydrology, LJ@ceh.ac.uk

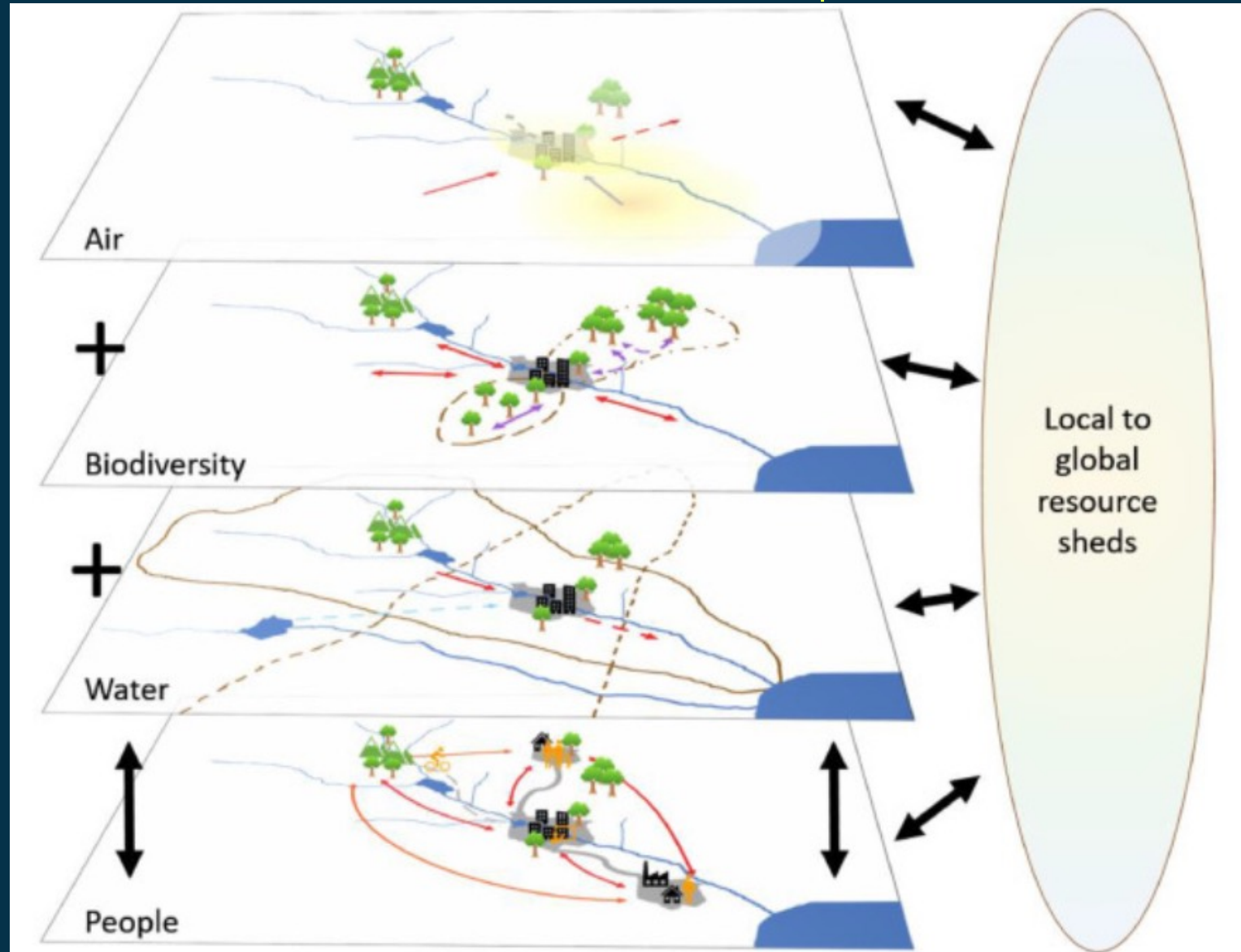
Ms Nieves Peña - TECHNALIA, nieves.pena@tecnalia.com

On behalf of GDA Climate Adaptation and Finance consortium



Where do the benefits happen ?

- Differs for every ecosystem service (both in scale & directions)
- Benefits are location-specific
- Models can quantify these benefits



Jones et al. (2022) Nature-based Solutions 2, 100040

Dakar, Senegal - Modelling PM_{2.5} removal by urban trees



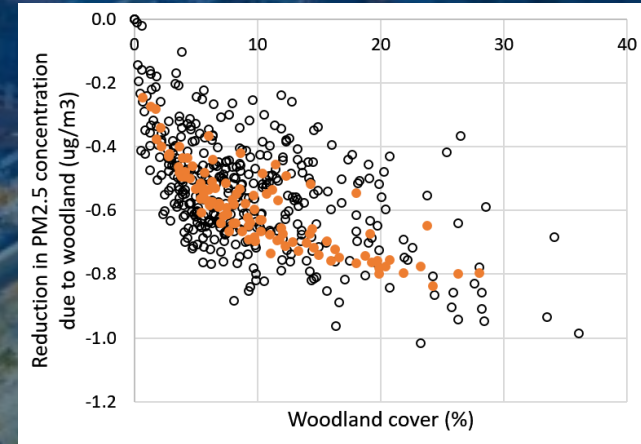
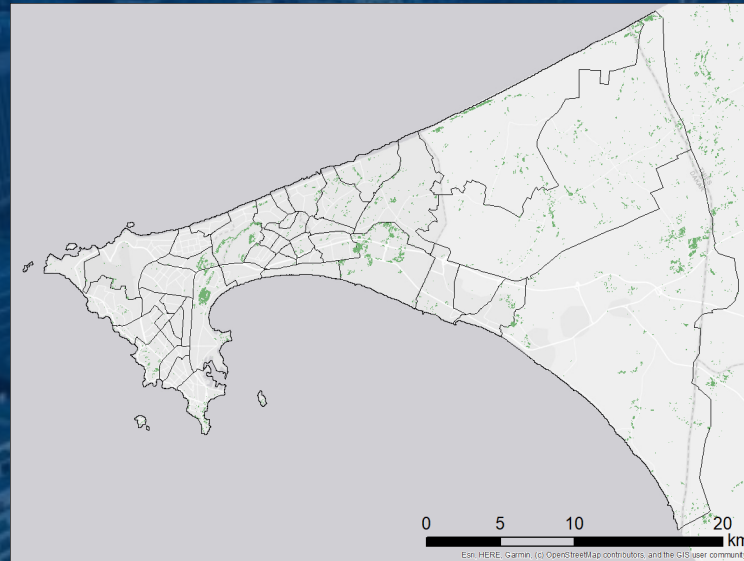
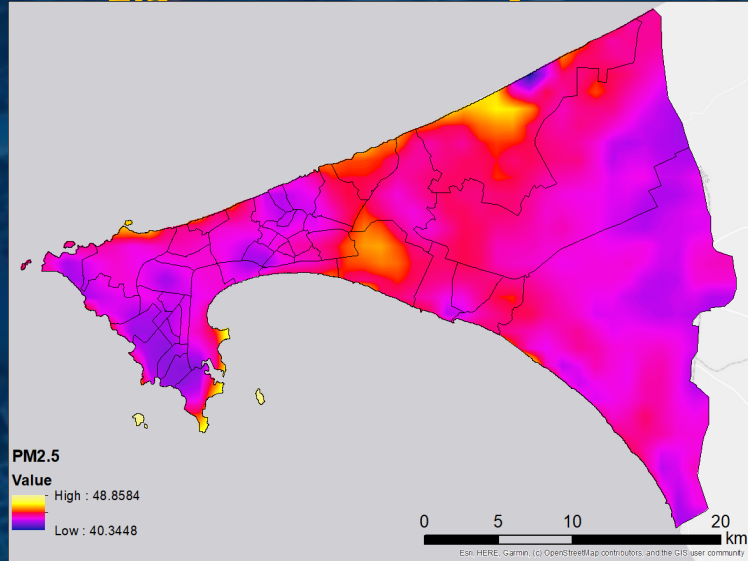
African Population and Health Research Center



UKCEH
Our planet. Decoded.



LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

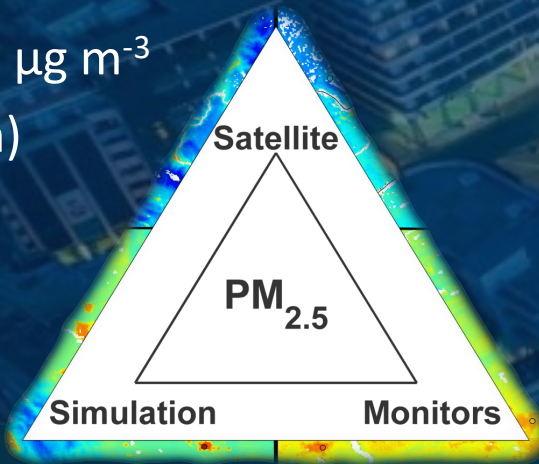


Meta-model derived from HPC air quality model (EMEP)

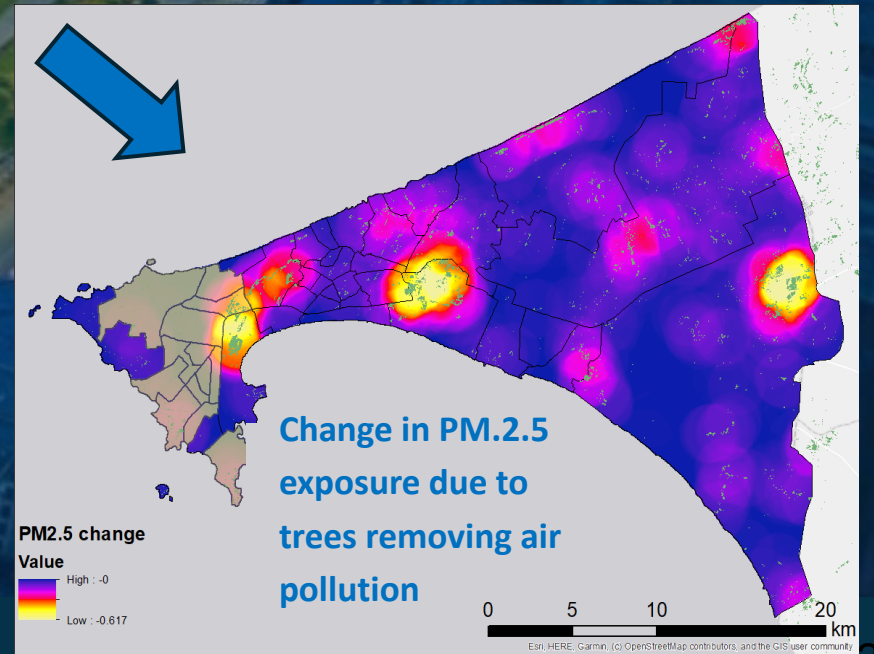
<https://sites.wustl.edu/acag/surface-pm2-5>

<https://esa-worldcover.org/en>

PM_{2.5} $\mu\text{g m}^{-3}$
(1 km)



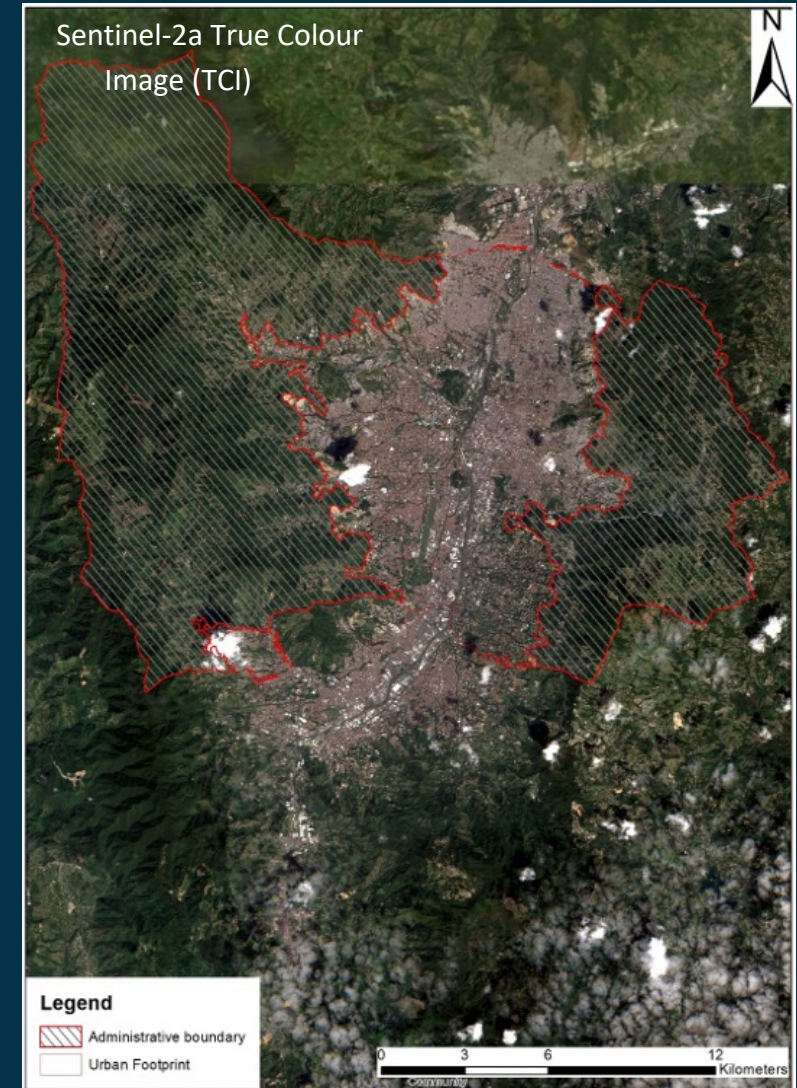
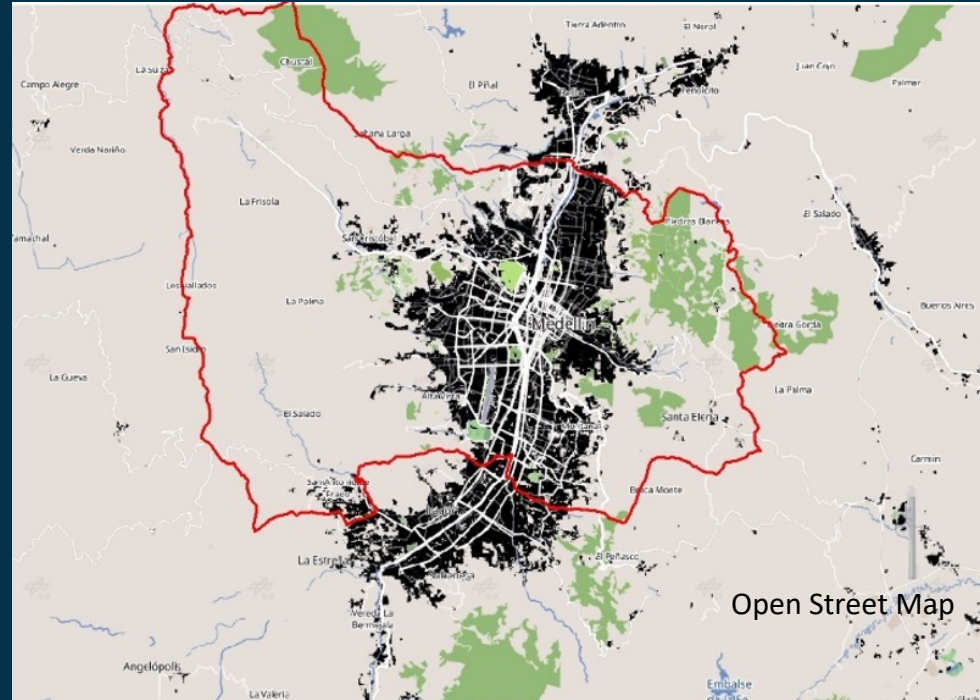
Tree cover
(10 m)



Medellín – Assessing GI benefits through a vulnerability lens

Considerations

- Who benefits ?
- What do we mean by urban ?
 - administrative boundaries
 - morphology



Models used:

- Air pollution removal by trees¹
- Aggregate cooling at city level by green and blue infrastructure^{1,2}
- Accessible greenspace¹

¹ Fletcher et al. (2020) Demand mapping for urban green infrastructure.

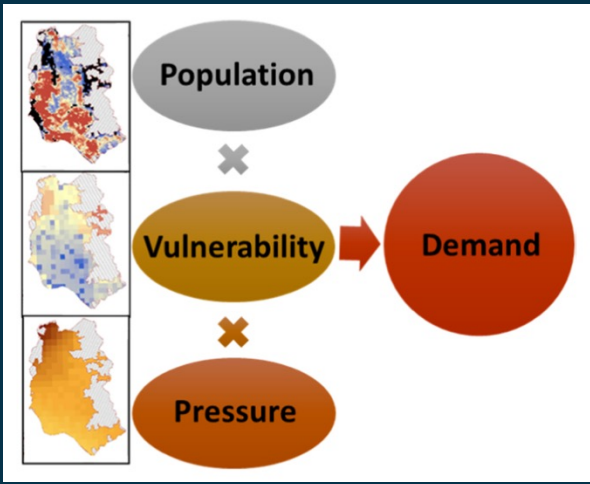
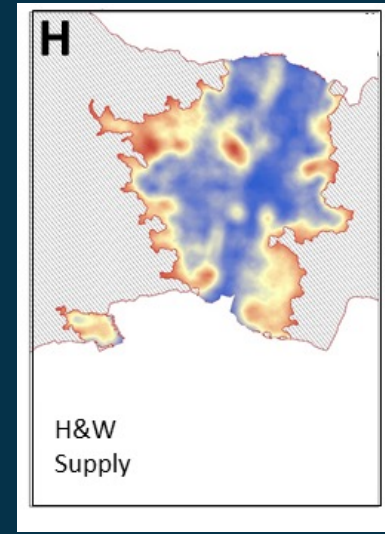
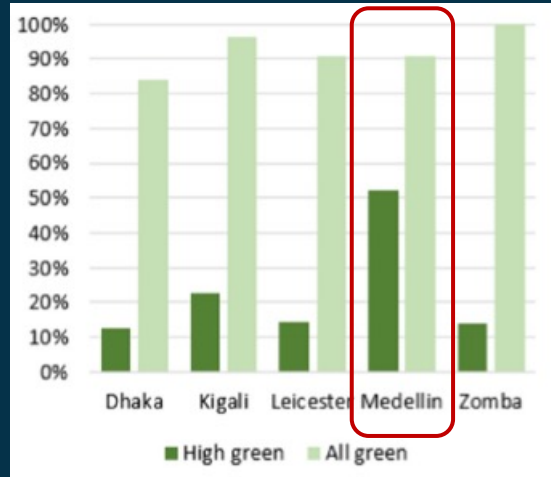
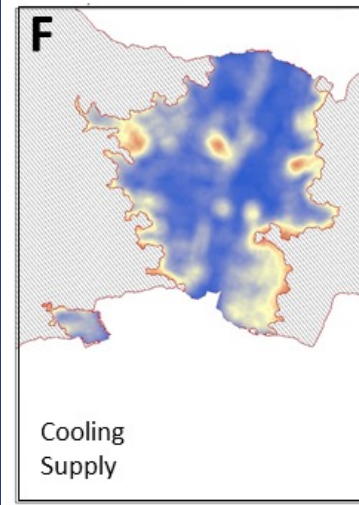
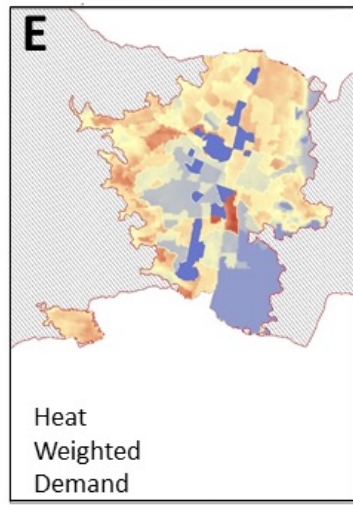
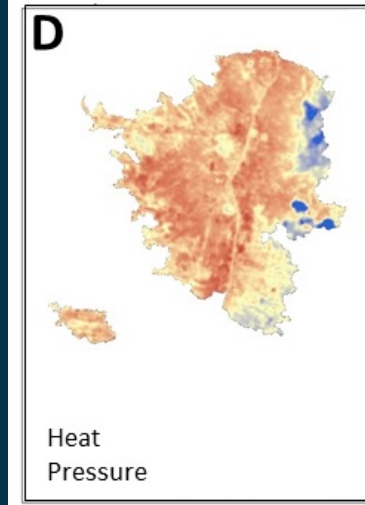
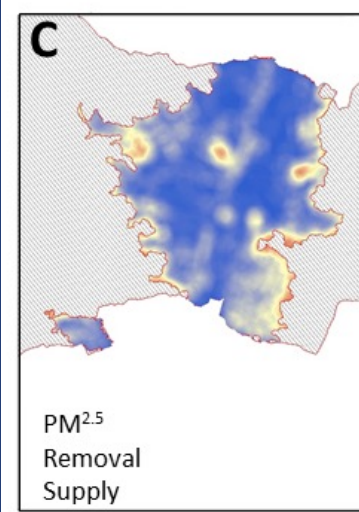
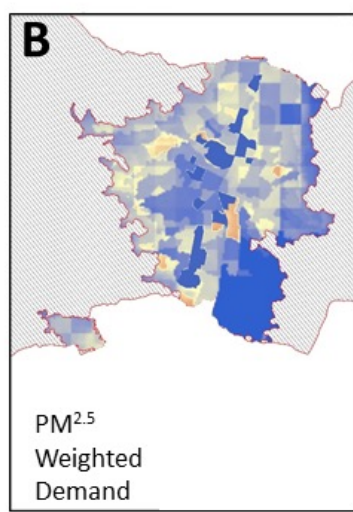
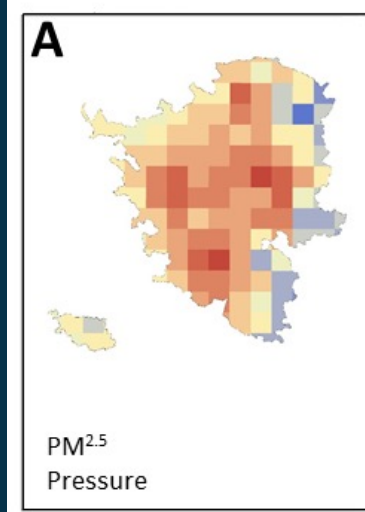
<https://doi.org/10.1016/j.scitotenv.2021.147238>

² Jones et al. (2025) Economic value of hot-day cooling provided by urban GI.

<https://doi.org/10.1016/j.ufug.2024.128212>

Medellín – Findings

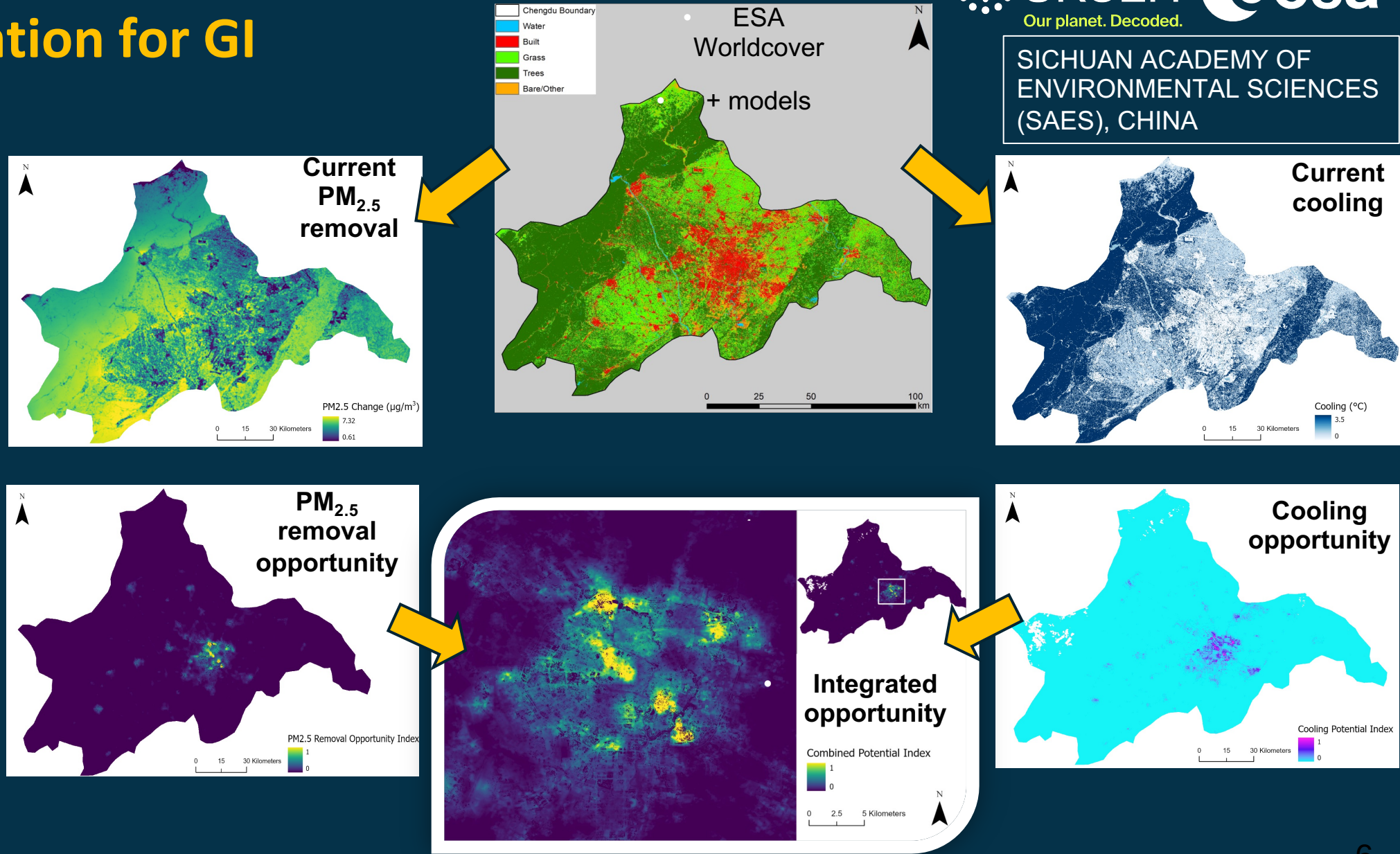
- Importance of location within a city
- Patterns of demand can be very different
- Existing greenspace serves populations in different ways



Chengdu – Spatial prioritisation for GI

SICHUAN ACADEMY OF ENVIRONMENTAL SCIENCES (SAES), CHINA

- Satellite data combined with population and ES models
- Calculate current benefits
- Assess areas of maximum opportunity
- Informs spatial prioritisation



Land Surface Temperature map

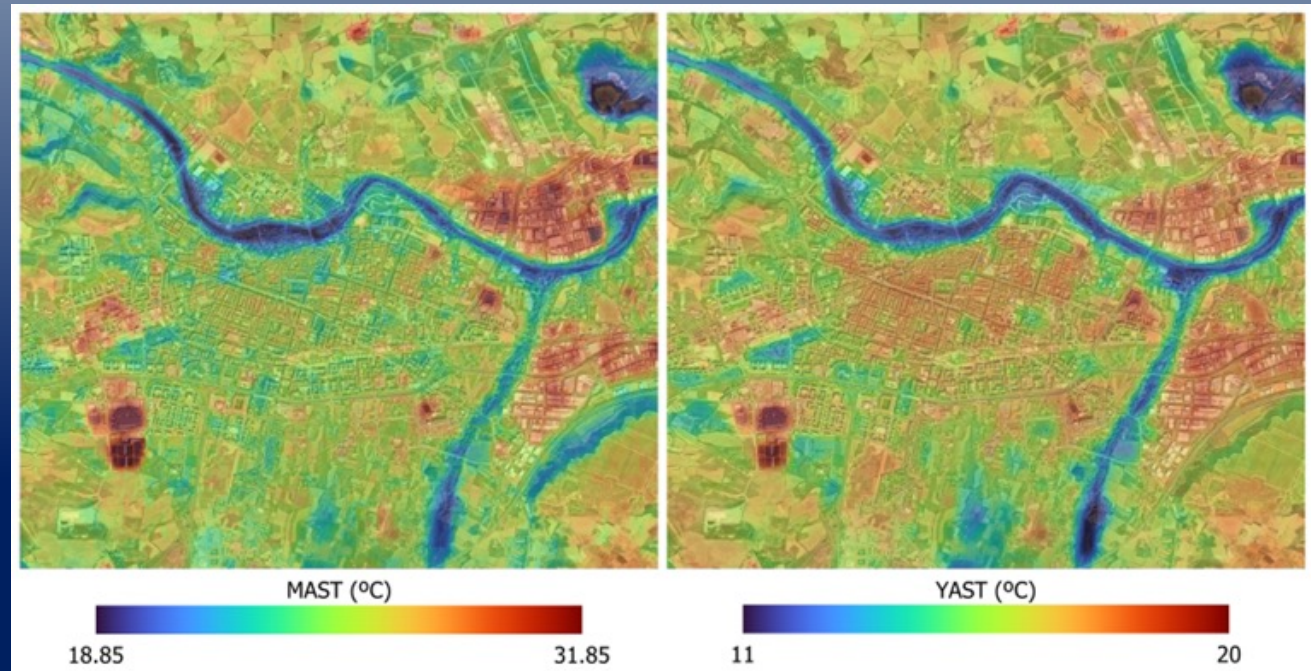
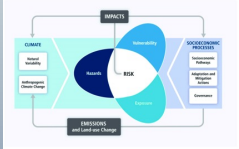
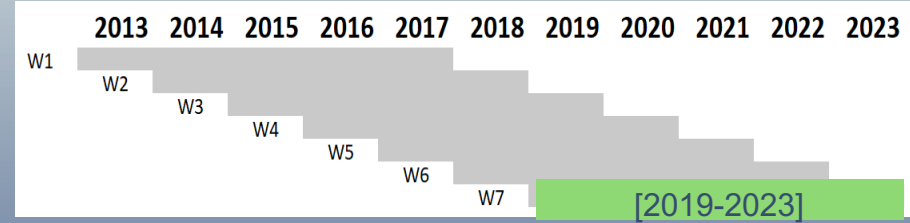
Logroño, Spain

Simple – straightforward approach

Images are downloaded from **Landsat 8 satellite** and processed to characterise the current (2019-2023) thermal behaviour of the city as well as its evolution over time, using seven 5-year windows.

This information allows to spatially characterize areas with **higher surface temperatures (hazard)**

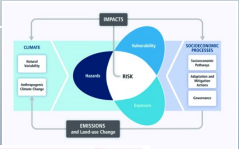
Bechtel, B. (2012). Robustness of Annual Cycle Parameters to Characterize the Urban Thermal Landscapes. *IEEE Geoscience and Remote Sensing Letters*, 9(5), 876-880. <https://doi.org/10.1109/LGRS.2012.2185034>



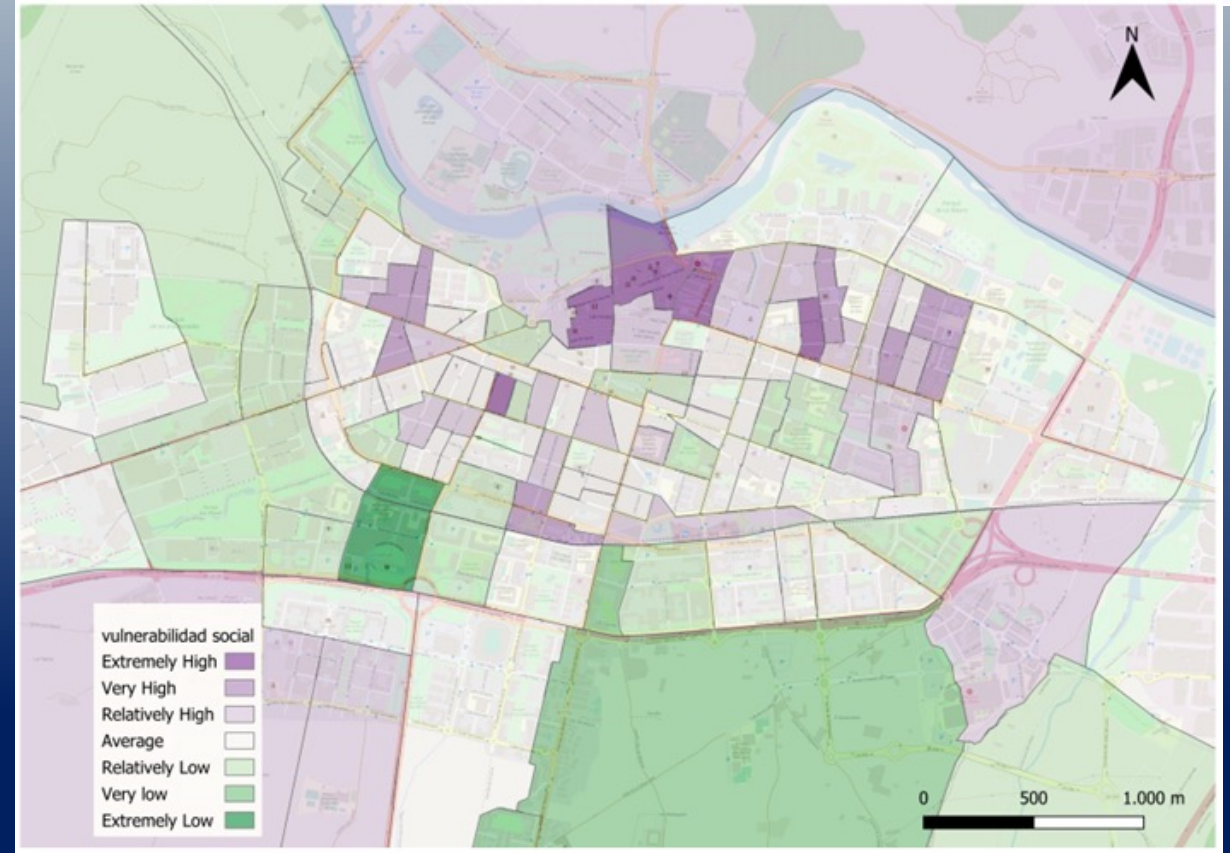
Social Vulnerability map

Logroño, Spain

Social vulnerability is defined as “the propensity or predisposition of a population to be adversely affected by climate hazards.



Indicator_2021-Census	Domain	Dimension
Boys under 5 years of age	Age	Sensitivity
Girls under 5 years of age	Age	Sensitivity
Men over 75 years of age	Age	Sensitivity
Women over 75 years of age	Age	Sensitivity
People with a disability preventing work	Health	Sensitivity
Dependants Rate	Mobility	Adaptive Capacity
Children per family	Mobility	Adaptive Capacity
Built-up surface fraction	Urban morphology	Adaptive Capacity
Buildings height	Urban morphology	Adaptive Capacity
Building-street aspect ratio	Urban morphology	Adaptive Capacity
Impervious	Physical environment	Adaptive Capacity
Water bodies	Physical environment	Adaptive Capacity
Tree canopy fraction	Green infrastructure	Adaptive Capacity
Grass fraction	Green infrastructure	Adaptive Capacity

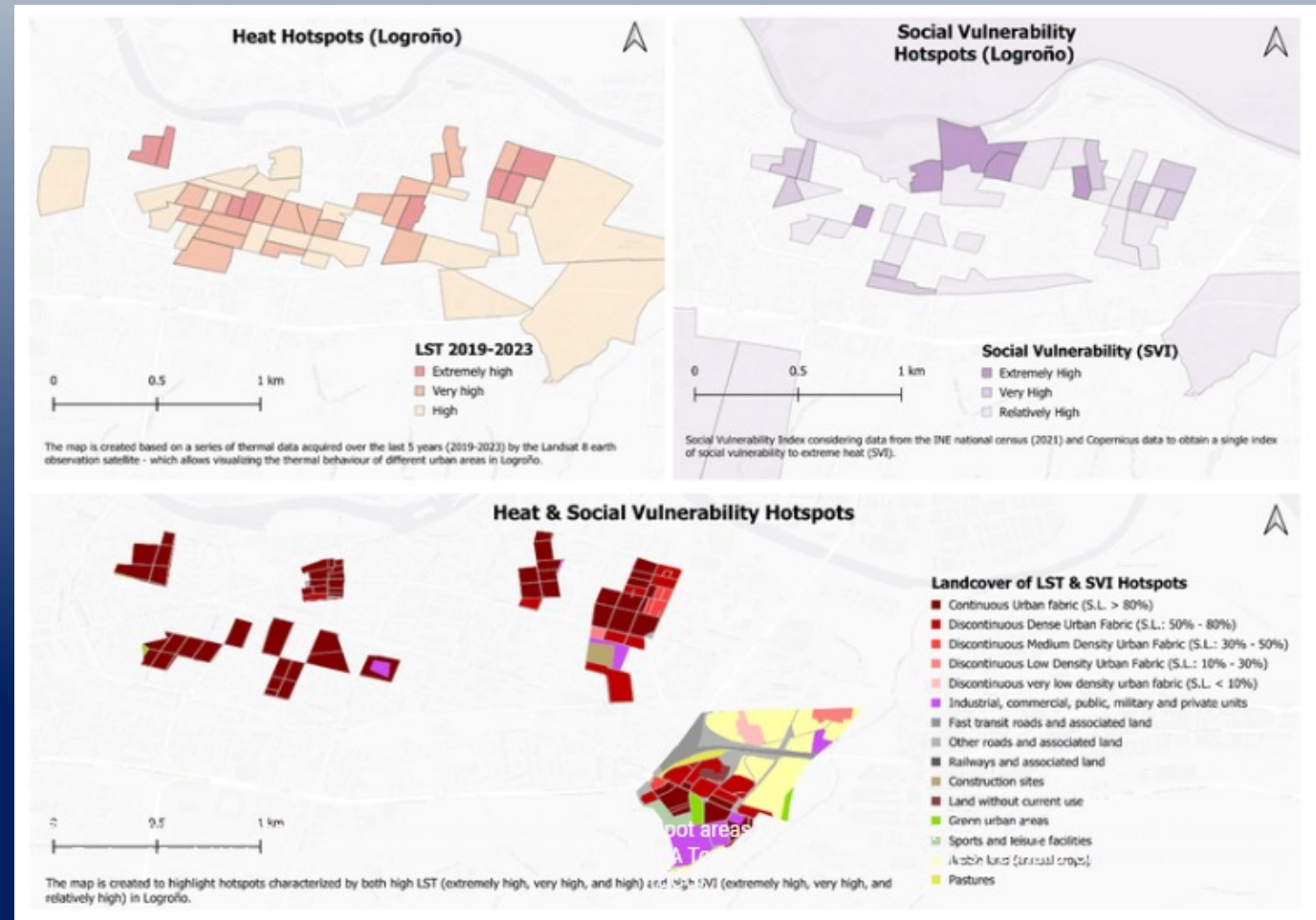


Integration of heat & vulnerability assessments

Logroño, Spain

The Logroño City Council activates a **strategic heat plan** to combat heat waves with a preventive protocol and investments to create 'climate islands' starting in 2025.

- Increasing urban canopy through new tree planting
- Sun protection for recreational spaces in the city
- Water misting in pedestrian areas
- Water infrastructure such as fountains, water features, water sheets, and water curtains
- Creation of new parks

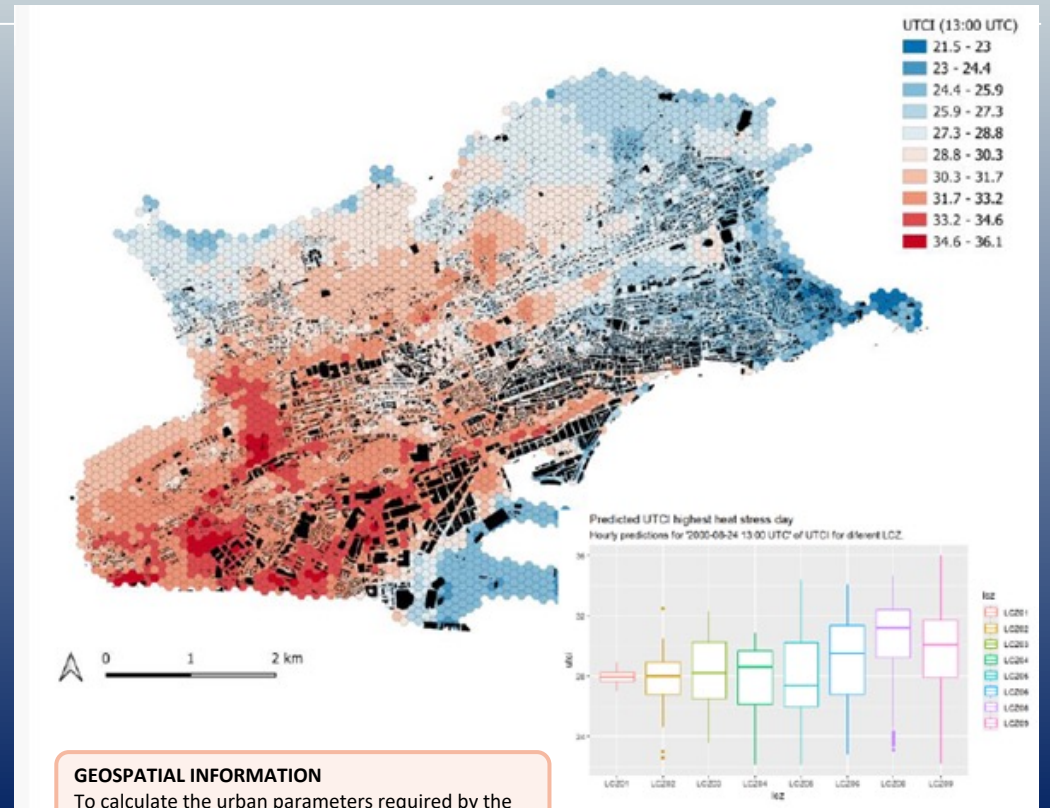
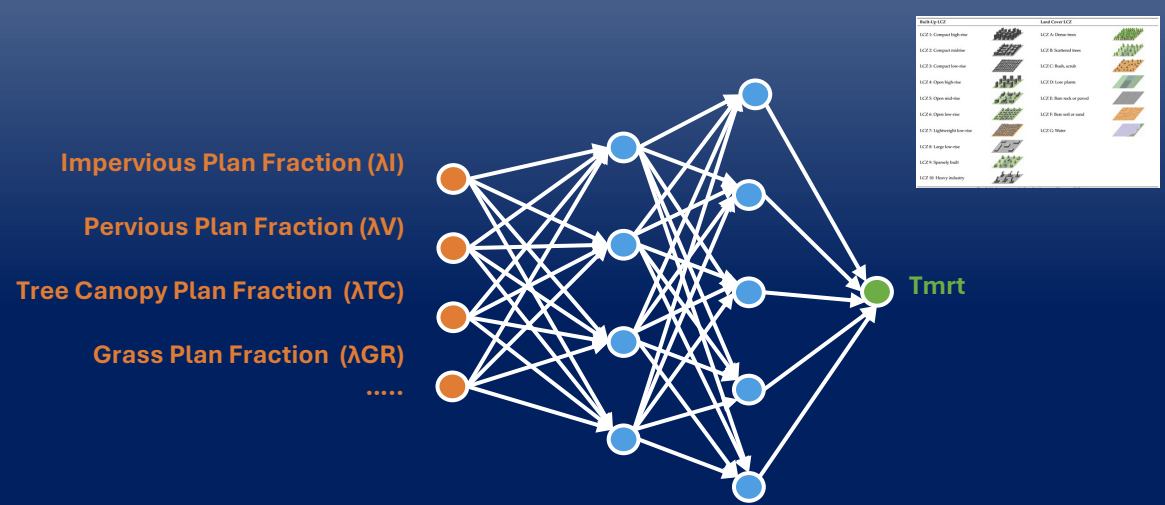


Thermal Comfort maps

Santander, Spain

More complex approach - AI based

Thermal comfort mapping based on a hybrid framework that integrates mesoscale modelling with an artificial intelligence (AI)-based emulator of Tmrt to efficiently produce high-resolution UTCI- maps.



GEOSPATIAL INFORMATION
To calculate the urban parameters required by the AI model

Green infrastructure

DEM DSM CDSM CORINE -landcover

URBAN MORPHOLOGY METRICS
Cell-level urban form descriptors derived from authoritative geospatial datasets

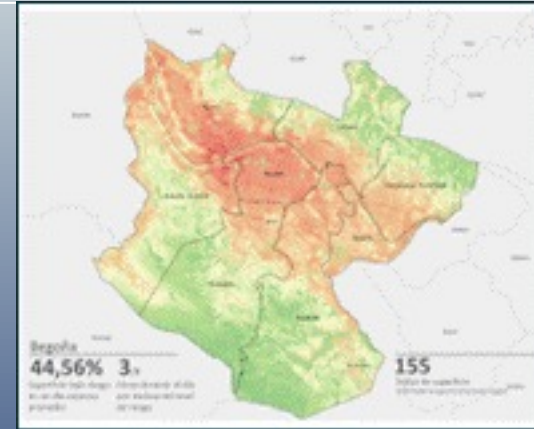
100 m

T4. CALCULATE HEAT STRESS
The Tmrt values are calculated for each cell for the 24 hours based on the trained AI model and the UTCI distribution based on of air temperature, relative humidity, wind speed, and Tmrt as inputs

Identification of shelters to combat high temperatures

Thermal Comfort
(**CURRENT**
PRESSURE)

Number of hours of thermal
discomfort (based on UTCI)



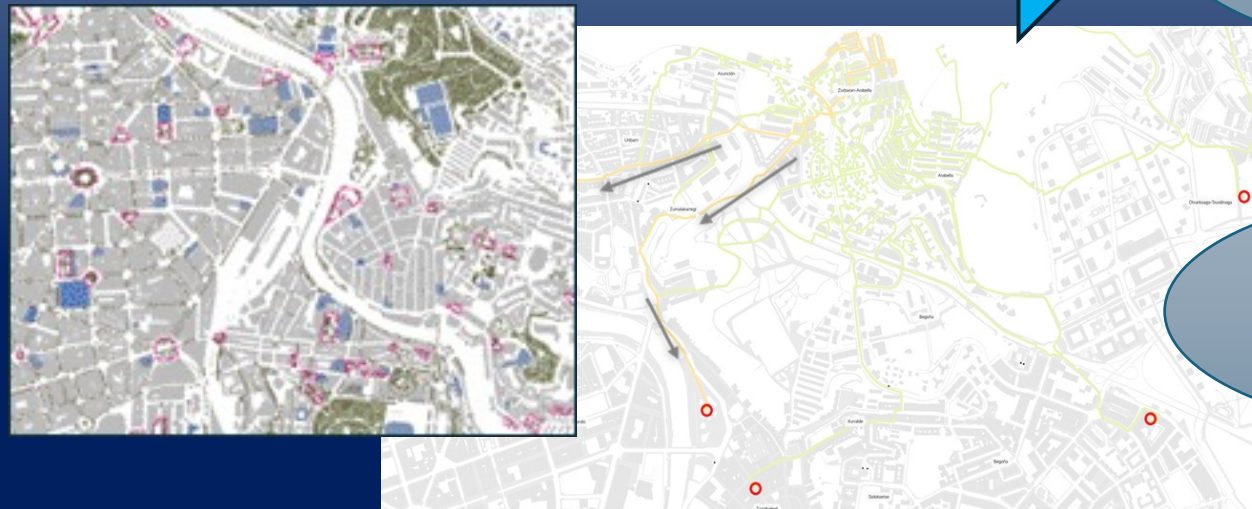
Thermal Comfort
(**FUTURE** PRESSURE)

CURRENT OFFER
(urban capacity to
offer comfort spaces)

Opportunity Map

FUTURE OFFER

CURRENT DEMAND
(Vulnerable population/
critical buildings)



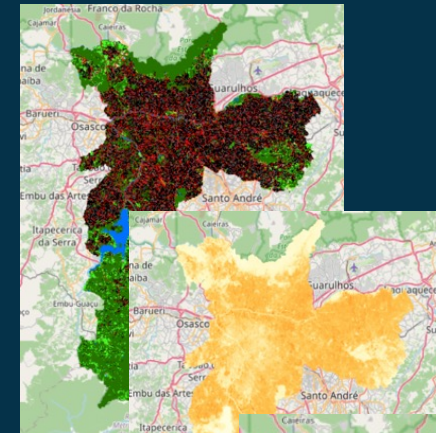
FUTURE DEMAND

Advantages of incorporating data products into models

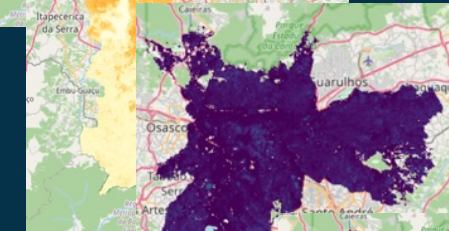


- Mapping of pressures (heat etc.)
- Model the services provided by GI
- Run scenarios – the future look
- Social & equity assessment
- Can feed into economic valuation
- Bespoke analysis
- **Better spatial prioritisation and decision-making**

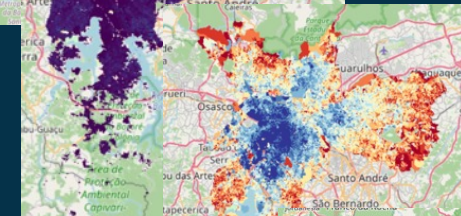
Land cover



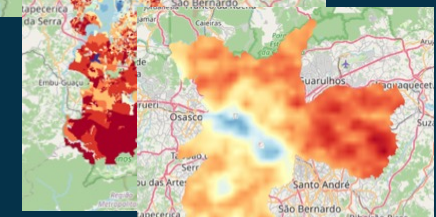
Heat



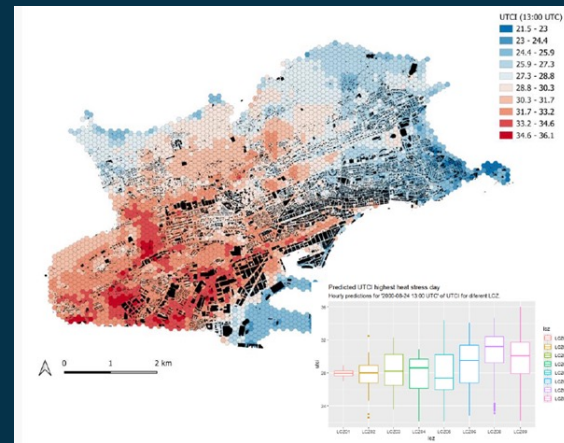
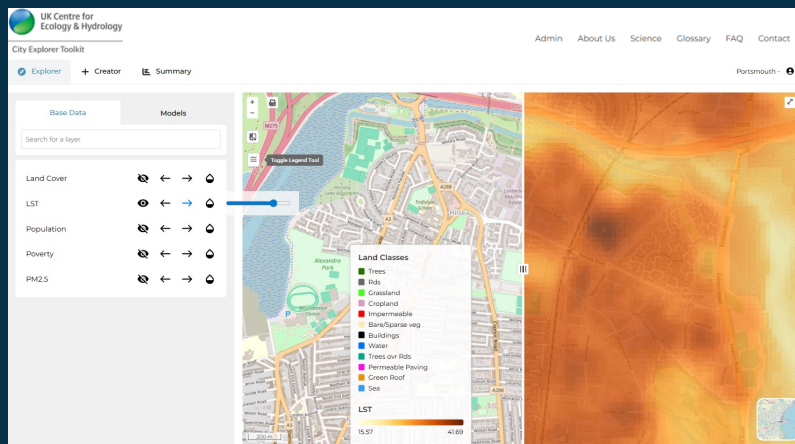
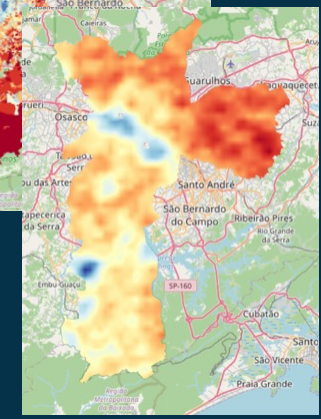
Population



Poverty



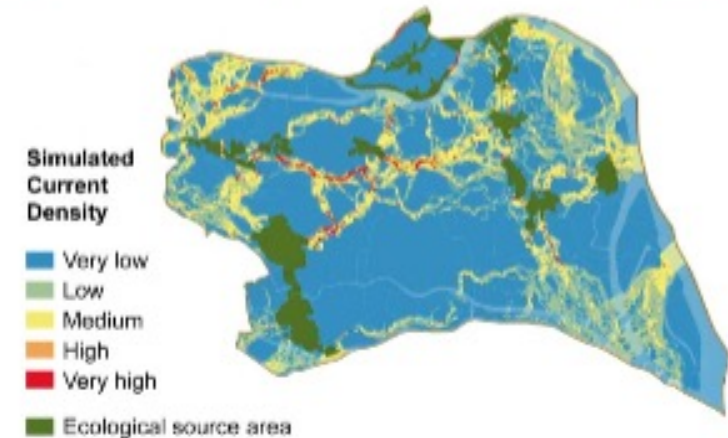
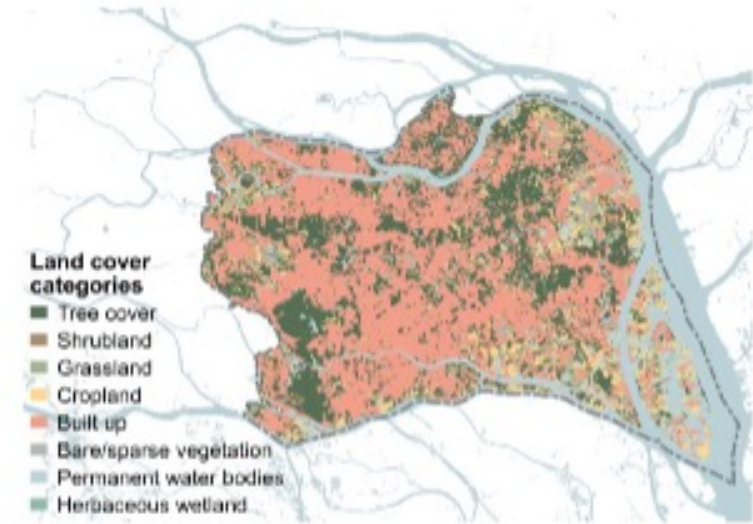
Air pollution



Useful data sources

- Geology
- Hydrology
- Climate
- Land cover and land use
- Ecology
- Socio-economic development
- Mobility and recreation

Methods for mapping and assessment



Handbook on Green Infrastructure Planning

Rehwaldt Landscape Architects

Draft



An offer of help ...

We are offering geospatial analytics and modelling support for the implementation of a GI Master Plan with one or two cities, following guidelines in the GI Planning Handbook

Please contact us if you are interested to be part of this pilot

Alex ChUNET alex.ChUNET@esa.int ; Laurence Jones LJ@ceh.ac.uk