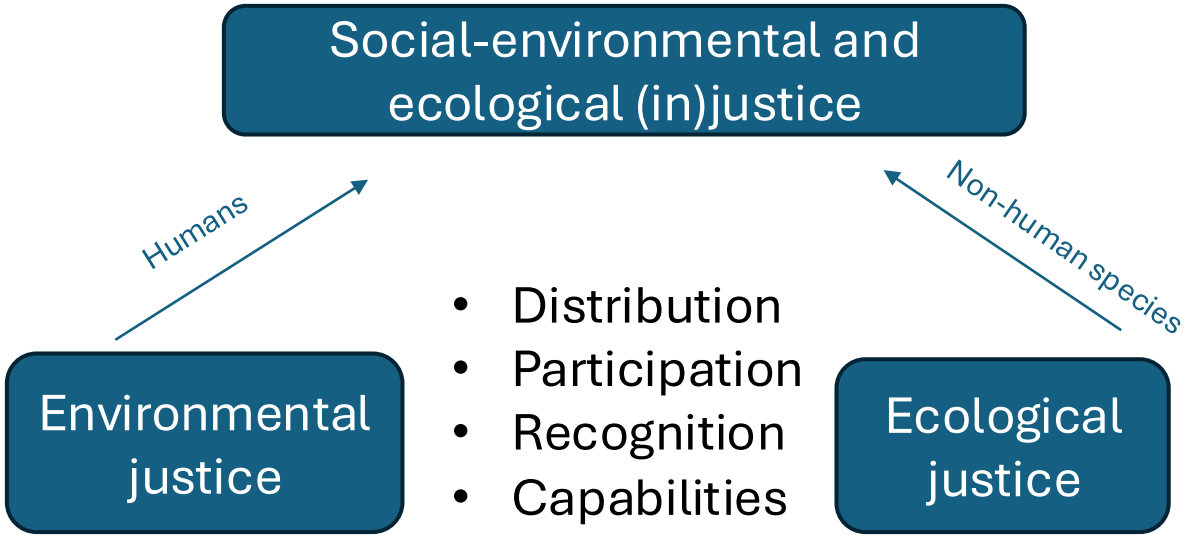
Potentials and limits of spatially explicit tools/data for mapping environmental and ecological justice in cities

A case study in Barcelona

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Based on research carried out with Amy Phillips (University of Manchester), Amalia Calderón-Argelich (UOC) and Elke Nys (VUB and KU Leuven)

SE3DS Seminar | ICTA-UAB – 2nd June 2026

Environmental justice and ecological justice



Based on the framework by Pineda-Pinto et al. (2021)

Environmental justice

- Justice for humans in relation to environmental benefits, harms and decision-making.
- Typical drivers: inequalities in access/exposure to air/water pollution, noise, heat, greenspace, housing and health vulnerabilities.

Ecological justice

- Justice for non-humans, ecosystems and ecological processes.
- Typical drivers: habitat quality, biodiversity, pollution burdens, recognition and representation of nature.

Important: the research maps the two “justices” separately, then compares them. It doesn’t treat "social-ecological justice" as one already-settled object.

Sources: Nys (2025), Pineda-Pinto et al. (2021), Schlosberg (2007)

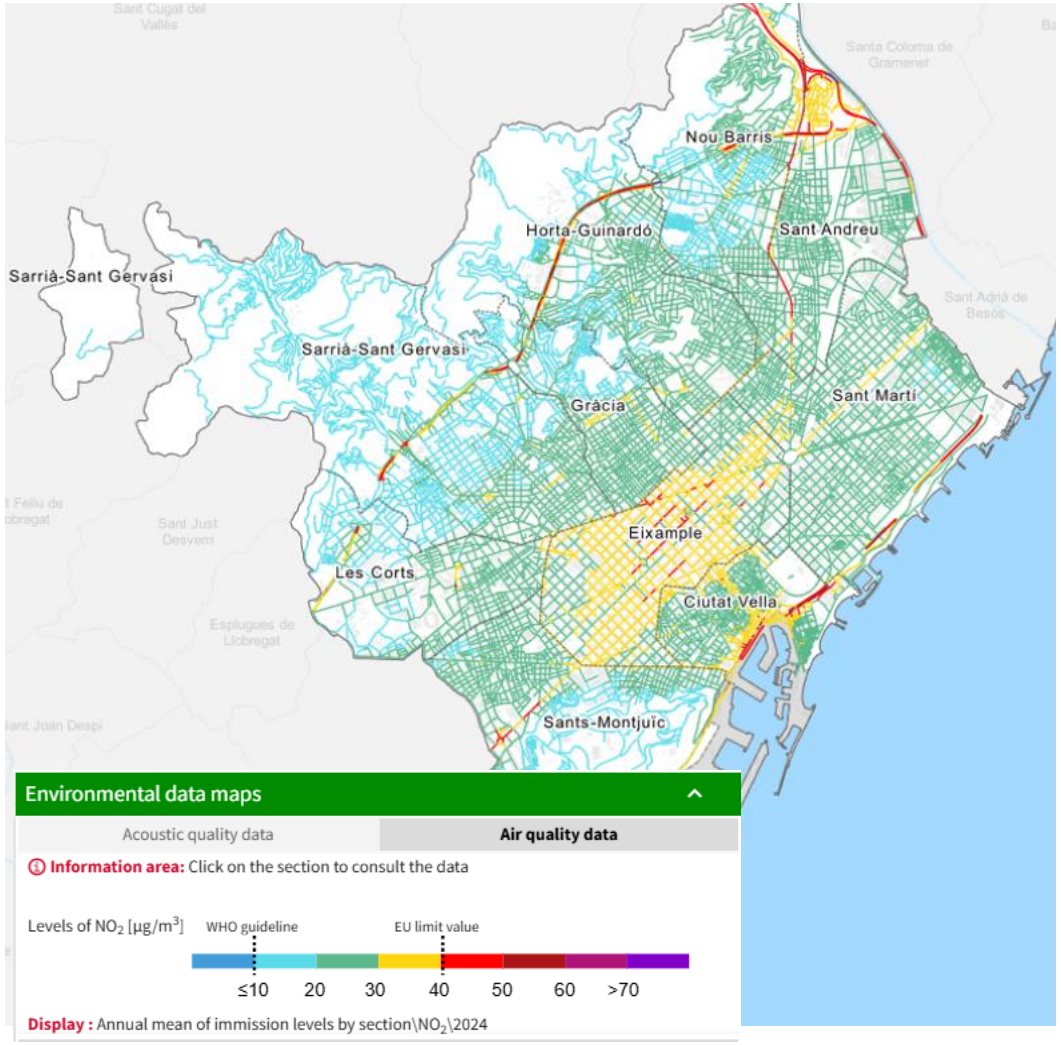
Four dimensions of justice: can we map them all?

Distribution	Participation / procedure	Recognition	Capabilities
Who gets environmental benefits and burdens?	Who has voice, influence and procedural fairness?	Whose identities, needs and values are acknowledged?	Who can flourish, adapt and live well?
Usually the easiest to map.	Often reduced to civic or electoral proxies.	Hard to represent with open (secondary data) spatial datasets.	Broad and often overlaps with other dimensions

Critical point: mapping participation, recognition and/or capabilities turns them back into distributional questions?

Conceptual basis: Schlosberg (2007); Pineda-Pinto et al. (2021)

Barcelona as a test bed



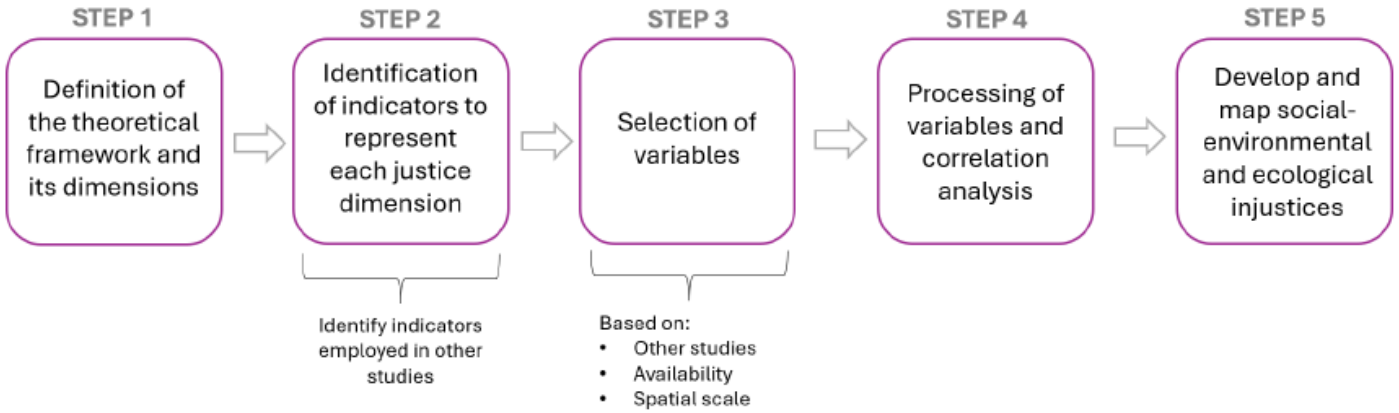
- Compact Mediterranean city with strong contrasts between the dense and compact center and greener peripheries.
- Known inequalities in exposure to air pollution, noise, heat and green-space access.
- Ambitious urban greening strategies, including superblocks, green axes and biodiversity conservation planning (Pla Natura).
- Extensive open/GIS datasets enables exploratory spatial analysis at census-tract scale.

Analytical unit

1,068 census tracts (aprox. 1500-2000 inhabitants each), with variables harmonized from multiple sources and spatial resolutions.

Sources: Nys (2025) and Barcelona City Council website

Mapping workflow: from concepts to spatial indicators/proxies



- Define justice dimensions and select indicators/proxies from the literature.
- Collect spatial variables from open data sources.
- Process variables to the census-tract level and standardize them.
- Reduce redundancy through correlation analysis.
- Average variables into dimension-specific and composite indices.

Methodological choice with major consequences:

Higher index values mean higher relative justice within Barcelona - not an absolute claim that a census tract is "just“ or “unjust”.

Source: Nys (2025), methodology adapted from Pineda-Pinto et al. (2021)

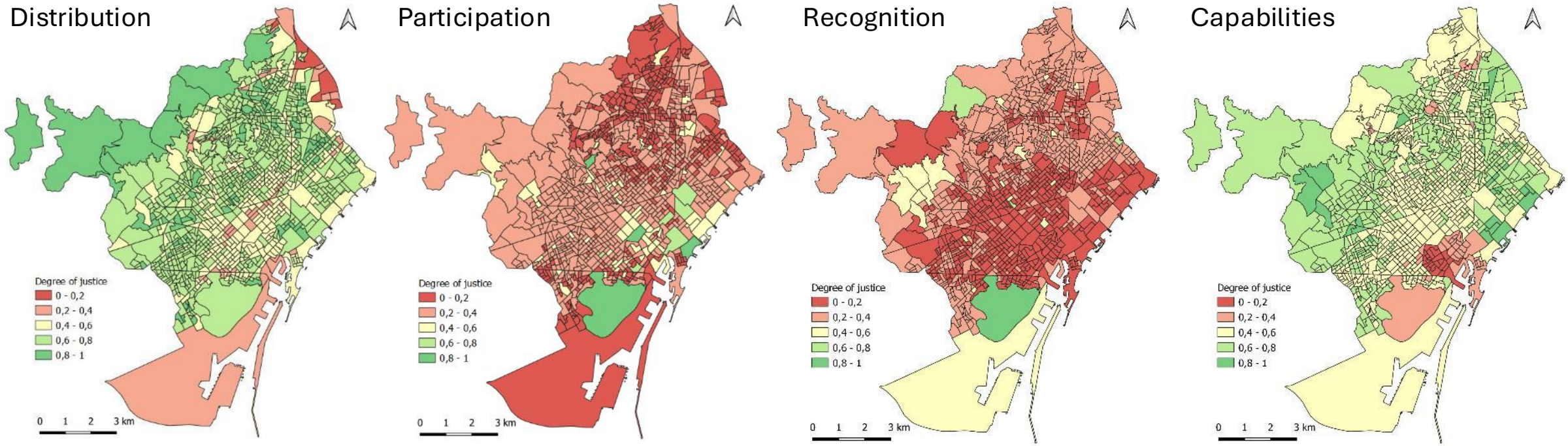
Mapping workflow: from concepts to spatial indicators/proxies

Indicator	Variable Barcelona
Social-Environmental Distributive Justice	
Air pollution exposure	PM2.5
	NO_2
Traffic volume	Traffic density between 5 and 6 PM
	Traffic density between 8 and 9 PM
Built environment	Proximity to public green spaces
	NDVI
	City areas with greater conditioning factors for everyda
Natural hazard risk	Thermal comfort levels
	Flammability
	Flooding return period of 500 years
Social-Environmental Participation Justice	
Civic engagement	Neighborhood associations and movements
	Virtual participation: Incidents, complaints, suggestions managed by the Barcelona City Council
Representation in government	Percentage of participation in the Barcelona Municipal (
Social-Environmental Recognition Justice	
Municipal inclusivity	List of social service equipment in the city of Barcelona
Touristic pressure	Effects due to the intensity of tourist activities in the cit
Social-Environmental Capabilities Justice	
Income	Average gross taxable income per person
Employment	Percentage of unemployed people above 16 years
Education	Percentage of the population aged 25-64 with higher ed
Housing	Average surface by inhabitant
	The proportion of main dwellings built up to 1980
	The proportion of main dwellings rented
	Energy behavior of buildings in the city of Barcelona
Health	Number of premature deaths
	Percentage of people who report having perceived poor health
Safety	Total number of criminal offenses known by the Policia de la Generalitat de Catalunya

Indicator	Variable Barcelona
Ecological Distributive Justice	
Air pollution exposure	PM2.5
	NO_2
Noise pollution	Noise 24h
	Noise nighttime
Light pollution	Lunar BRDF-Adjusted Nighttime Lights Yearly
Heat risk	Thermal comfort levels
Soil quality	Average of 4 heavy metals in the soil (Pb, As, Cd and Hg)
Ecological Participation Justice	
Engagement	Presence of environmental organizations
Representation in government	Percentage of people voting for Green parties during the European Parliament elections
Ecological Recognition Justice	
Legal status of green spaces	Level of protection of green spaces
Ecological Capabilities Justice	
Habitat provision	NDVI
	Singular biodiversity
Native species preservation	Number of birds, butterflies, and other vertebrates

Source: Nys (2025), methodology adapted from Pineda-Pinto et al. (2021)

Environmental justice: differentiated patterns

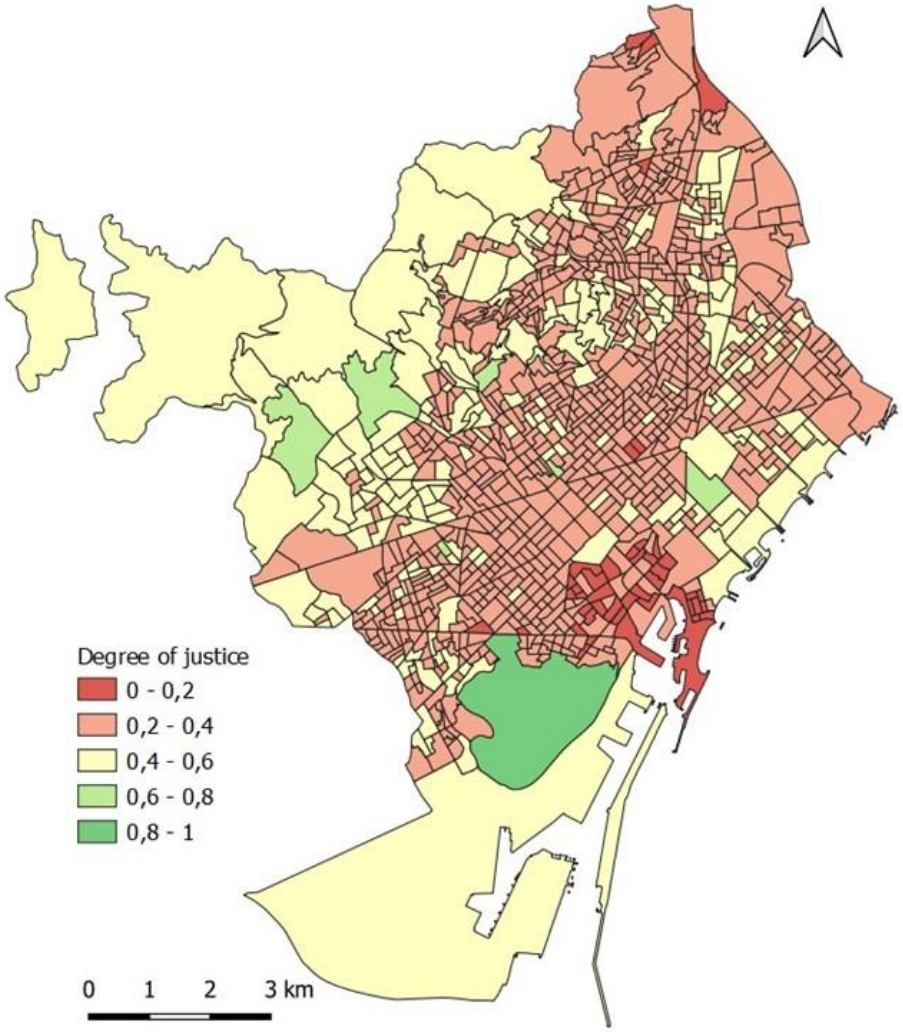


- Distribution: lower scores in dense and traffic-exposed areas; higher scores near greener peripheries.
- Participation: spatial pattern depends strongly on civic and electoral proxies.
- Recognition: tourism pressure and social-service proxies create a very specific reading of recognition.
- Capabilities: captures housing, income, health and safety-related vulnerability.

The maps are useful as diagnostic layers, but the meaning of each layer varies in robustness.

Source: Nys (2025), social-environmental justice maps

Composite environmental justice index

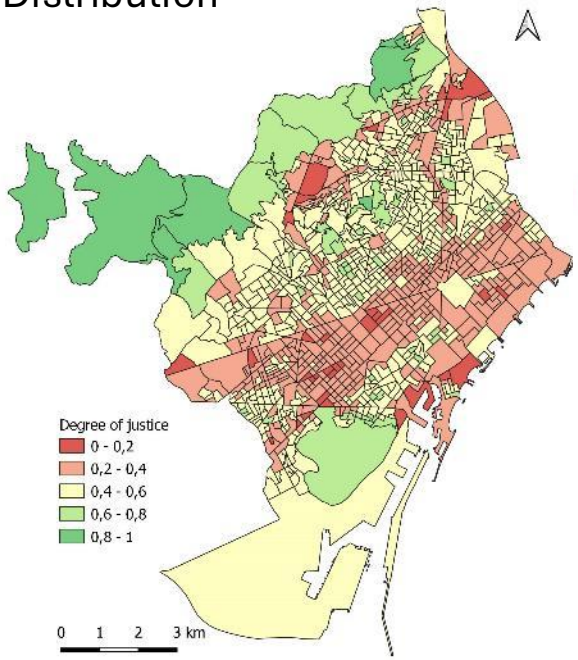


- Lower values cluster in central areas and parts of the northeast.
- Higher values appear in some northwestern and southern/coastal census tracts.
- Old town areas stand out through combined capability and recognition pressures.
- Interpretation must return to the components - the composite index alone is just a synthesis.

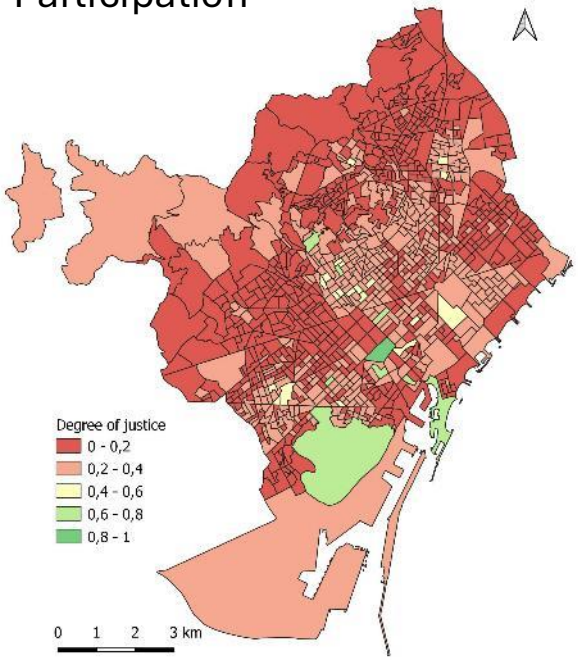
Source: Nys (2025), social-environmental justice index

Ecological justice: lower and more spatially concentrated

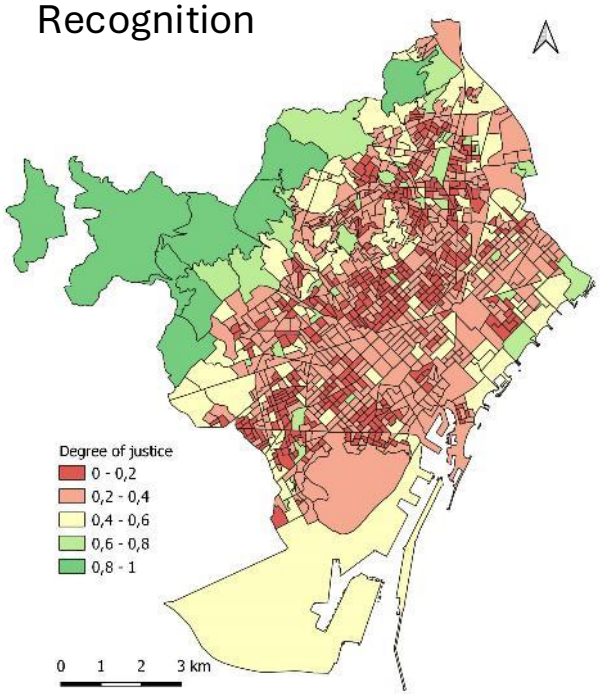
Distribution



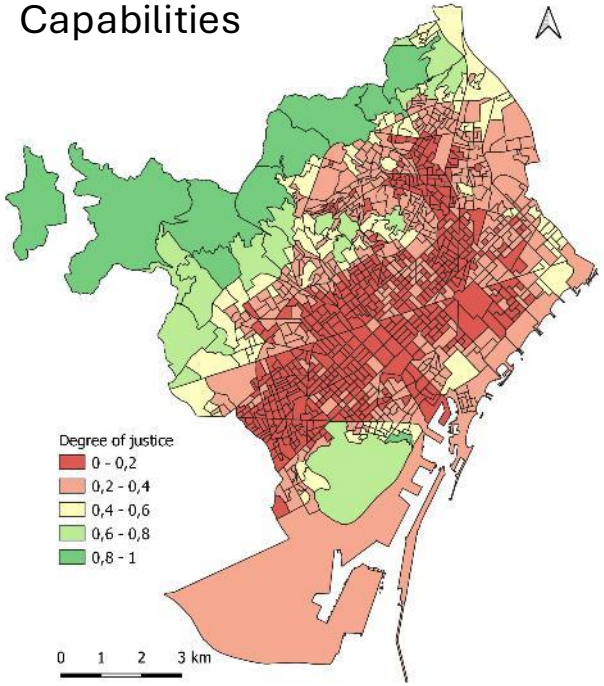
Participation



Recognition



Capabilities

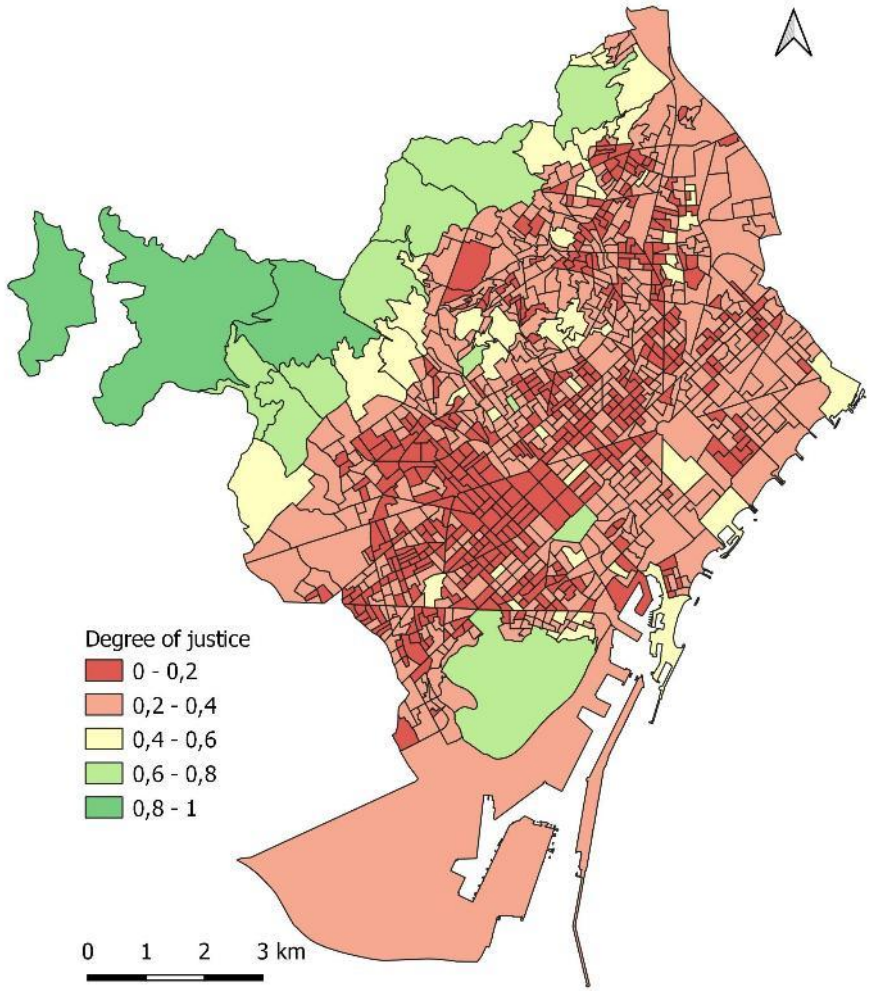


- Distribution: pollution, heat, light and soil burdens affect ecological conditions.
- Participation: environmental organizations and green-vote proxies could be highly contested.
- Recognition: legal protection of green spaces heavily privileges protected or formal green areas.
- Capabilities: biodiversity, NDVI and habitat indicators concentrate around larger green structures.

Ecological justice is not simply "more green" , it depends on which non-human species and processes are being considered.

Source: Nys (2025), ecological justice maps

Composite ecological justice index



- Highest scores appear around Collserola and other larger green areas.

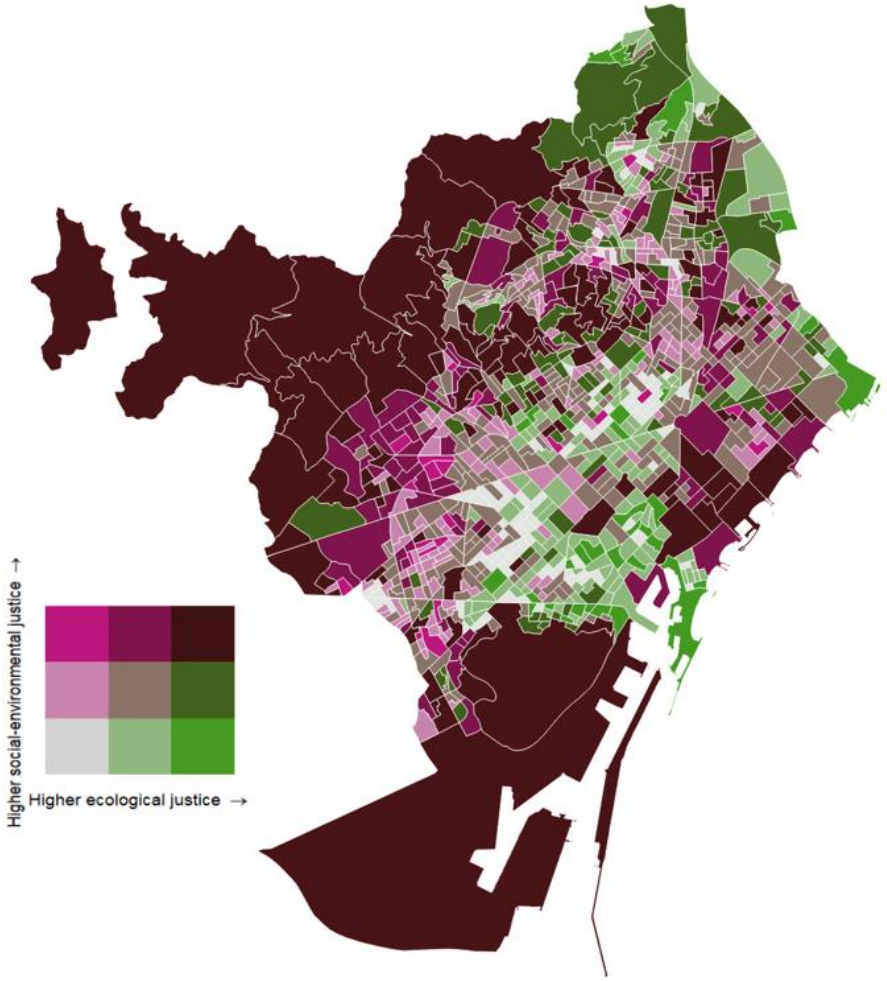
- Dense central, southern and eastern urban areas score lower.

- Ecological justice median is lower than the social-environmental index in the thesis results (0.23 vs 0.34).

- This suggests that ecological concerns remain less supported by urban conditions and data.

Source: Nys (2025), ecological justice index

Overlaying both justices: overlaps and mismatches



- High-high: mainly greener peripheral areas and some park-rich zones.
- Low-low: dense central and some eastern/northeastern areas.
- Lower environmental / higher ecological: areas where ecological assets do not automatically translate into human justice.
- Higher environmental / lower ecological: places where human conditions are relatively better but ecological conditions remain weak.

Reported correlation: weak-positive relationship, not equivalence.

Source: Nys (2025), bivariate map

What these maps can reveal

1. Pattern detection

They identify where multiple burdens or limited capabilities cluster.

2. Cross-lens comparison

They show that justice for humans and justice for non-humans do not always coincide.

3. Planning prioritization

They can support screening, monitoring and debate in urban greening strategies (e.g., designation of no human access areas?).

Best use: not as a final ranking of neighbourhoods, but as a boundary object for asking better questions in urban greening/sustainability planning.

Challenges: indicators are not the justice dimensions

- Inclusive participation is broader than attendance, complaints, associations or voting.
- Recognition cannot be fully captured by municipal social services, websites or formal legal categories.
- Green votes or environmental organizations may not (fully) represent "nature" or non-human agency.
- Some proxies may measure administrative visibility or available land rather than justice dimensions.
- Aggregating all the indicators into a single index masks the understanding of the underlying justice drivers (individual maps more useful/useable than indices).

If a proxy is too weak, "nothing" may be better than a misleading layer.

Implication: maps should display uncertainty and invite validation with qualitative, local and participatory evidence.

Challenges: ecological justice is especially hard to spatialize

Which non-humans?

Trees, birds, insects, soil organisms, mammals and urban-adapted species do not share the same needs or vulnerabilities.

Which scale?

Dense urbanization may look ecologically unjust locally yet it may allow larger peri-urban land conservation at a broader scale.

Which political claim?

Environmental justice is linked to movements and claims. Composite maps can blur who is making the claim and for what intervention.

- Do not aggregate "non-human lifes" without a clear ecological theory or species/process focus.
- Avoid interpreting relative maps as absolute justice statements.
- Complement GIS with field observation, ecological expertise and stakeholder deliberation. Do we need data that is explicitly collected for the purposes of mapping environmental/ecological justice?

Take-home message

1 **Mapping helps reveal spatial patterns of environmental and ecological (in)justice, but interpretation of what is “just” remains challenging.**

2 **Participation, recognition and ecological agency require more than GIS proxies.**

3 **The next step is mixed-method mapping: spatial diagnosis + local validation + explicit normative debate about what is just for humans and for non-humans.**

THANK YOU
QUESTIONS AND COMMENTS WELCOME

References:

- Pineda-Pinto, M., Nygaard, C. A., Chandrabose, M., & Frantzeskaki, N. (2021). Mapping social-ecological injustice in Melbourne, Australia: An innovative systematic methodology for planning just cities. Land use policy , 104 , 105361-.
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This activity is part of the grant RYC2023-042663-I funded by MICIU/AEI/10.13039/501100011033 and by ESF+

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