ECOLOPES

ECOlogical building enveLOPES

1st Interregional Thematic Workshop RE-ACT Schools

26 June 2025

ECOLOPES: ecological building envelopes

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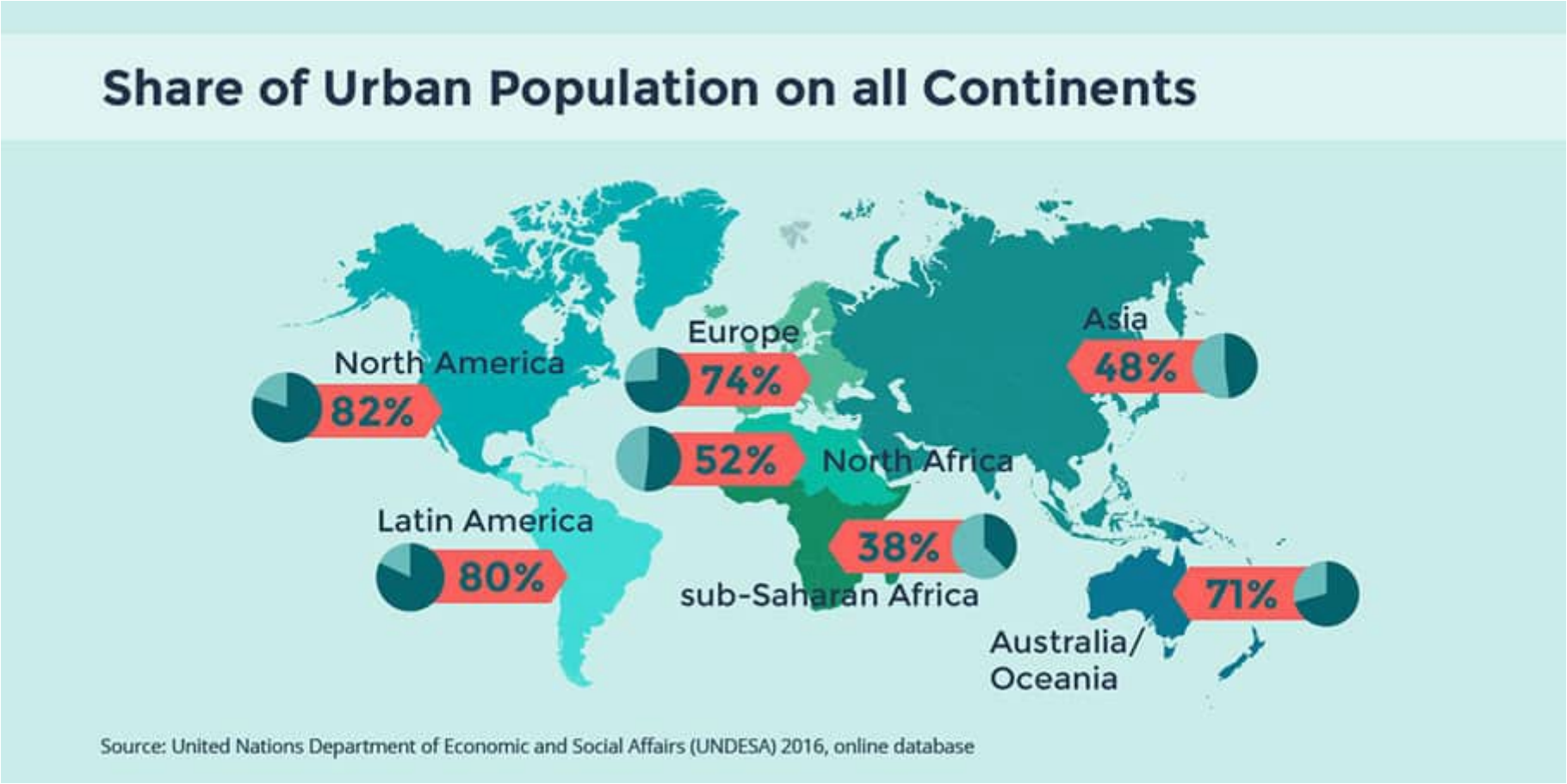
Università degli Studi di Genova - DAD

To design *in* an environment is to design *an* environment.

Busbea, L. 2019. Foreword: Maldonado's Environment. In Maldonado T. (2019 [1972]) Design, Nature & Revolution - Toward a Critical Ecology. University of Minnesota Press, Minneapolis, pp. vii-xiii.

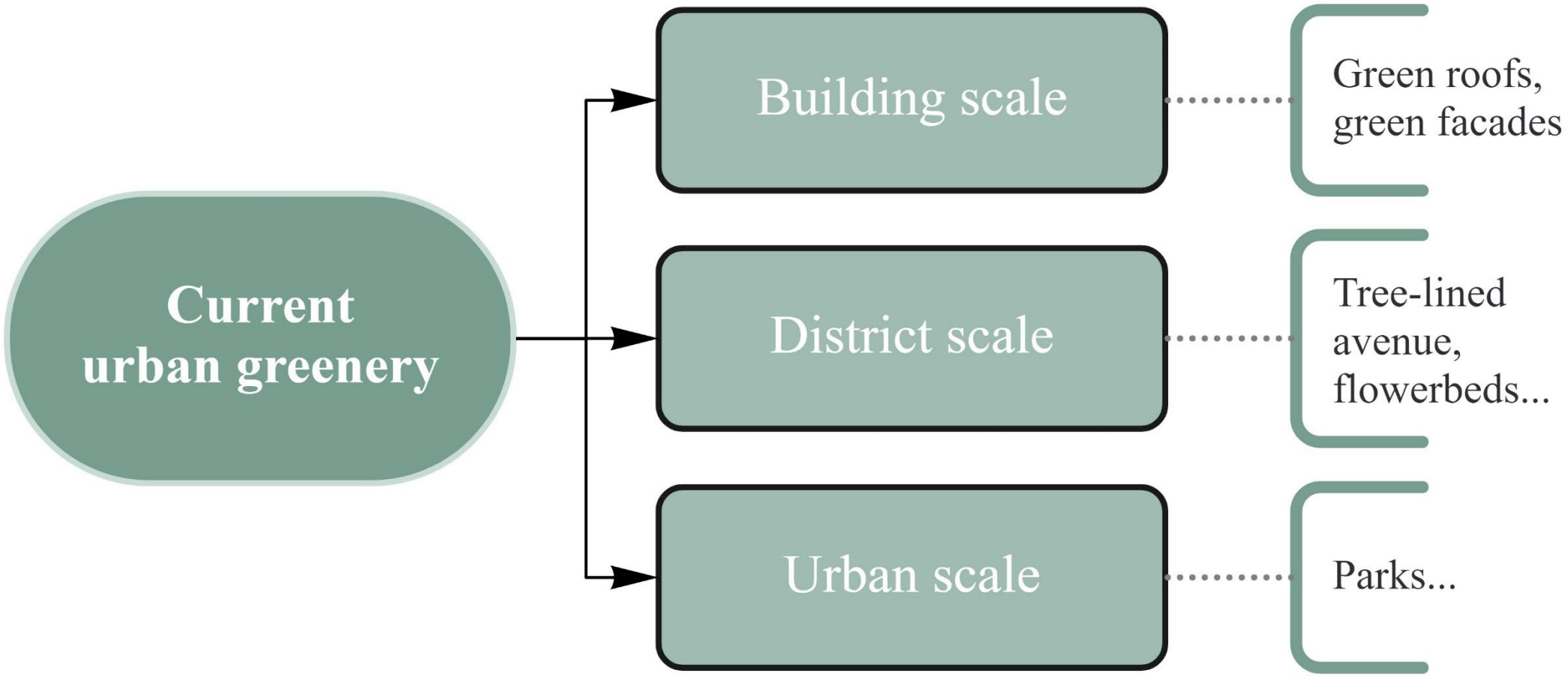
Background


Share of Urban Population on all Continents
North America
82%
Europe
74%
Asia
48%
52%
North Africa
Latin America
80%
38%
sub-Saharan Africa
71%
Australia/
Oceania
Source: United Nations Department of Economic and Social Affairs (UNDESA) 2016, online database

Background

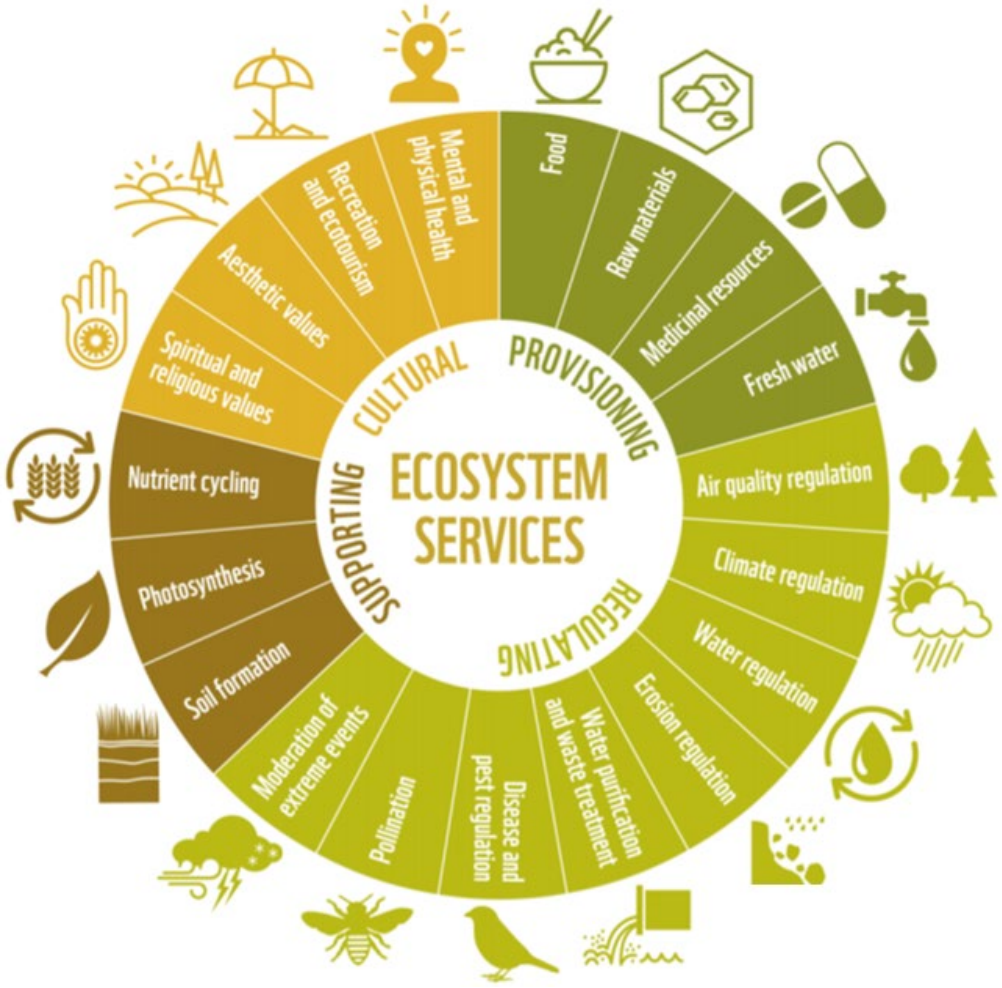
Examples from Copenhagen, Porto, Munich, in Katia Perini, Francesca Mosca, 2025. Nature-Based Cities: Performance-Driven Design Approaches for Climate Change Adaptation. https://link.springer.com/book/10.1007/978-3-031-94612-7

Background



Canepa, Maria, Francesca Mosca, Shany Barath, Alexandre Changenet, and Thomas E. Hauck. 2022. “Ecolopes, beyond greening. A multi-species approach for urban design.” Agathòn 11, 238. https://doi.org/10.19229/2464-9309/11212022.

Background

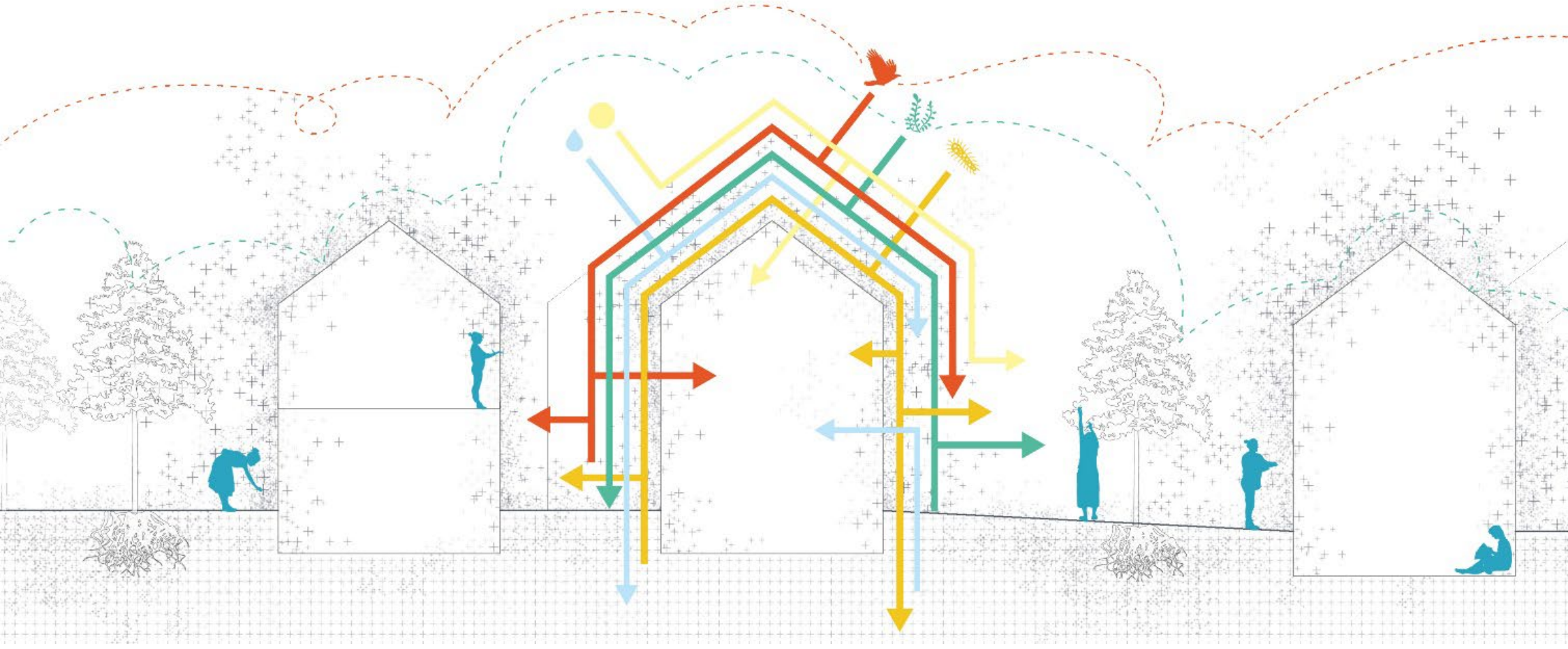


Range of ecosystem services provided by nature to humans
(WWF Living Planet Report, 2016)

Background

Grobman, Weisser, Shwartz, Ludwig, Kozlovsky, Ferdman, Perini, Hauck, Selvan, Saroglou, Barath, Schloter, Windorfer, 2023. Architectural Multispecies Building Design: Concepts, Challenges, and Design Process. Sustainability 2023, 15(21), 15480; https://doi.org/10.3390/su152115480

Aim of ECOLOPES



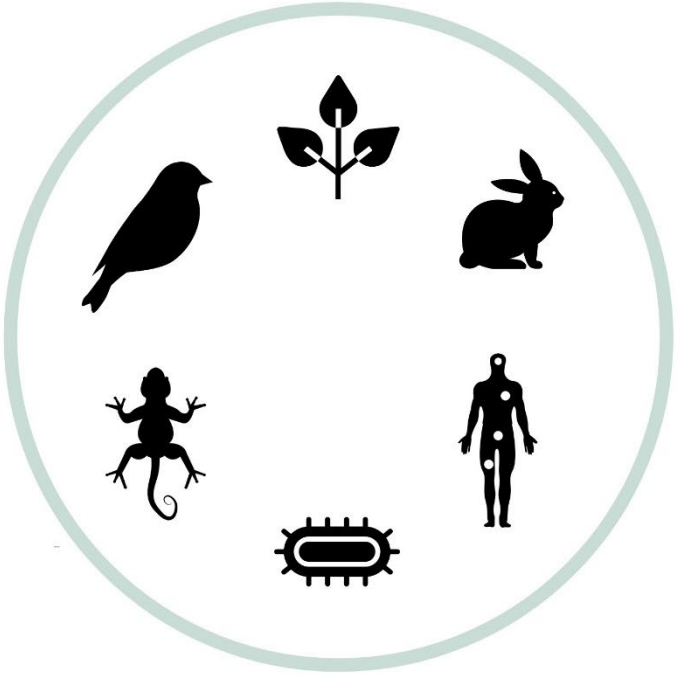
We propose a data-driven design recommendation system to assist architects and planners in the design of *ecolopes*, a multi-species living space for four types of inhabitants: humans, plants, animals, and microbiota

https://ecolopes.org/

Aim of ECOLOPES

Human-centered perspective

Nonhuman perspective

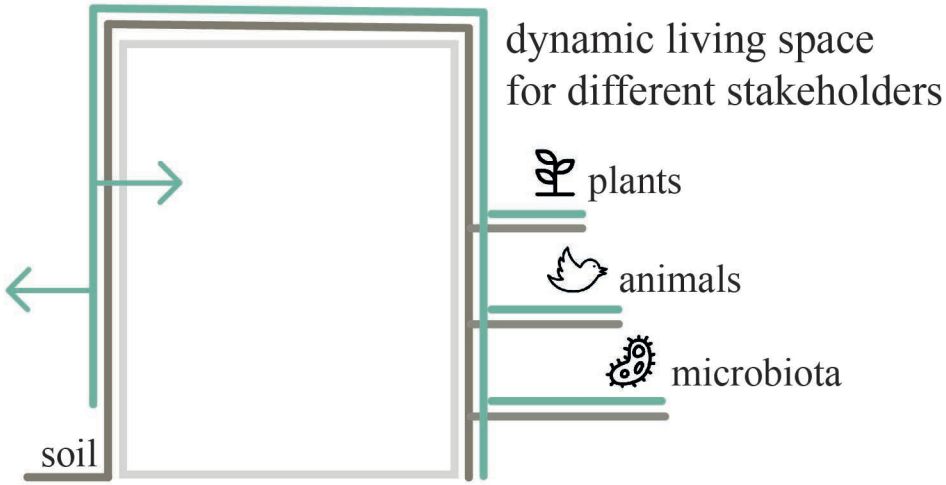


Canepa, Maria, Francesca Mosca, Shany Barath, Alexandre Changenet, and Thomas E. Hauck. 2022. “Ecolopes, beyond greening. A multi-species approach for urban design.” Agathòn 11, 238. https://doi.org/10.19229/2464-9309/11212022.

Aim of ECOLOPES

Green roof

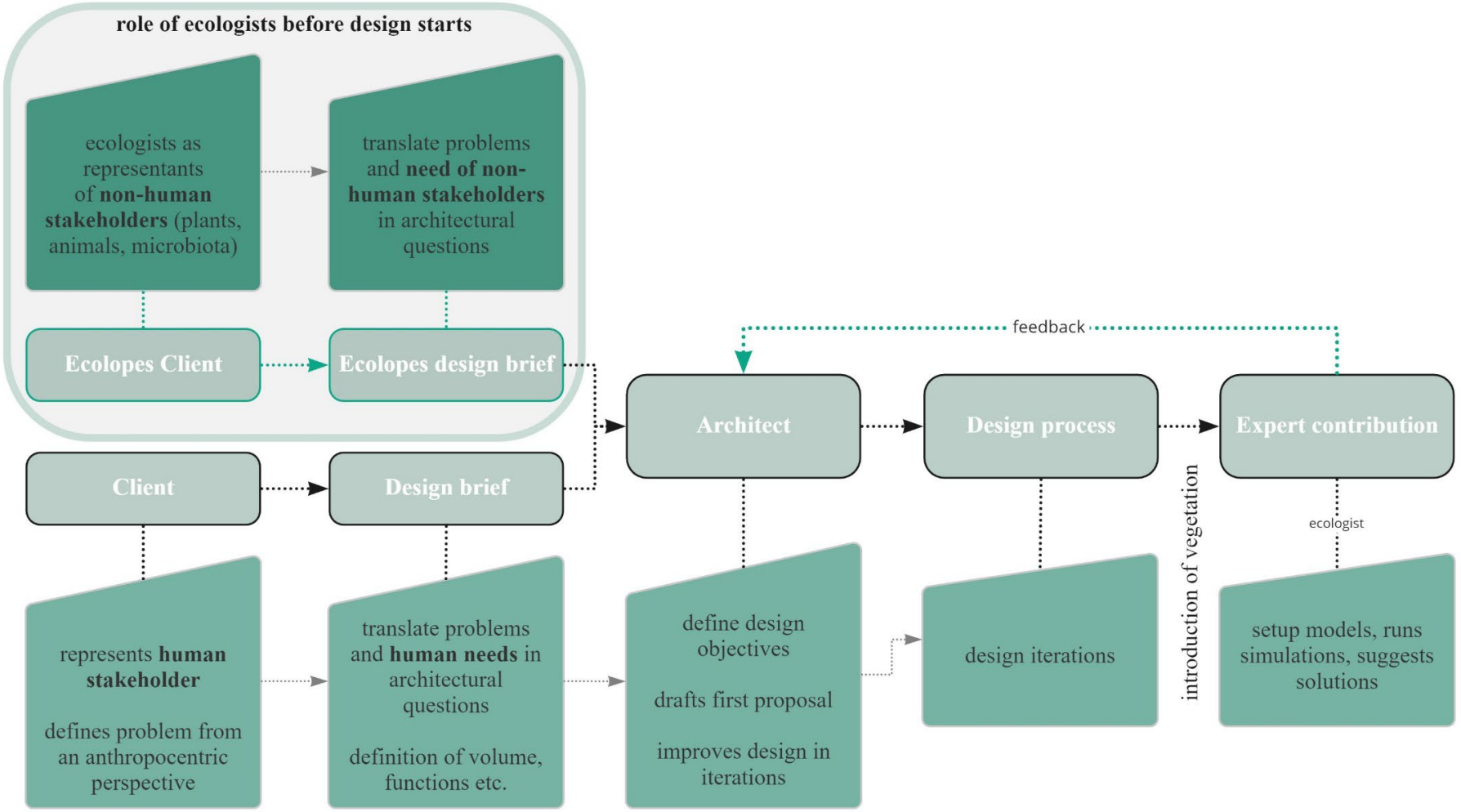
Green facade



Ecological envelope

Canepa, Maria, Francesca Mosca, Shany Barath, Alexandre Changenet, and Thomas E. Hauck. 2022. “Ecolopes, beyond greening. A multi-species approach for urban design.” Agathòn 11, 238. https://doi.org/10.19229/2464-9309/11212022.

ECOLOPES design workflow



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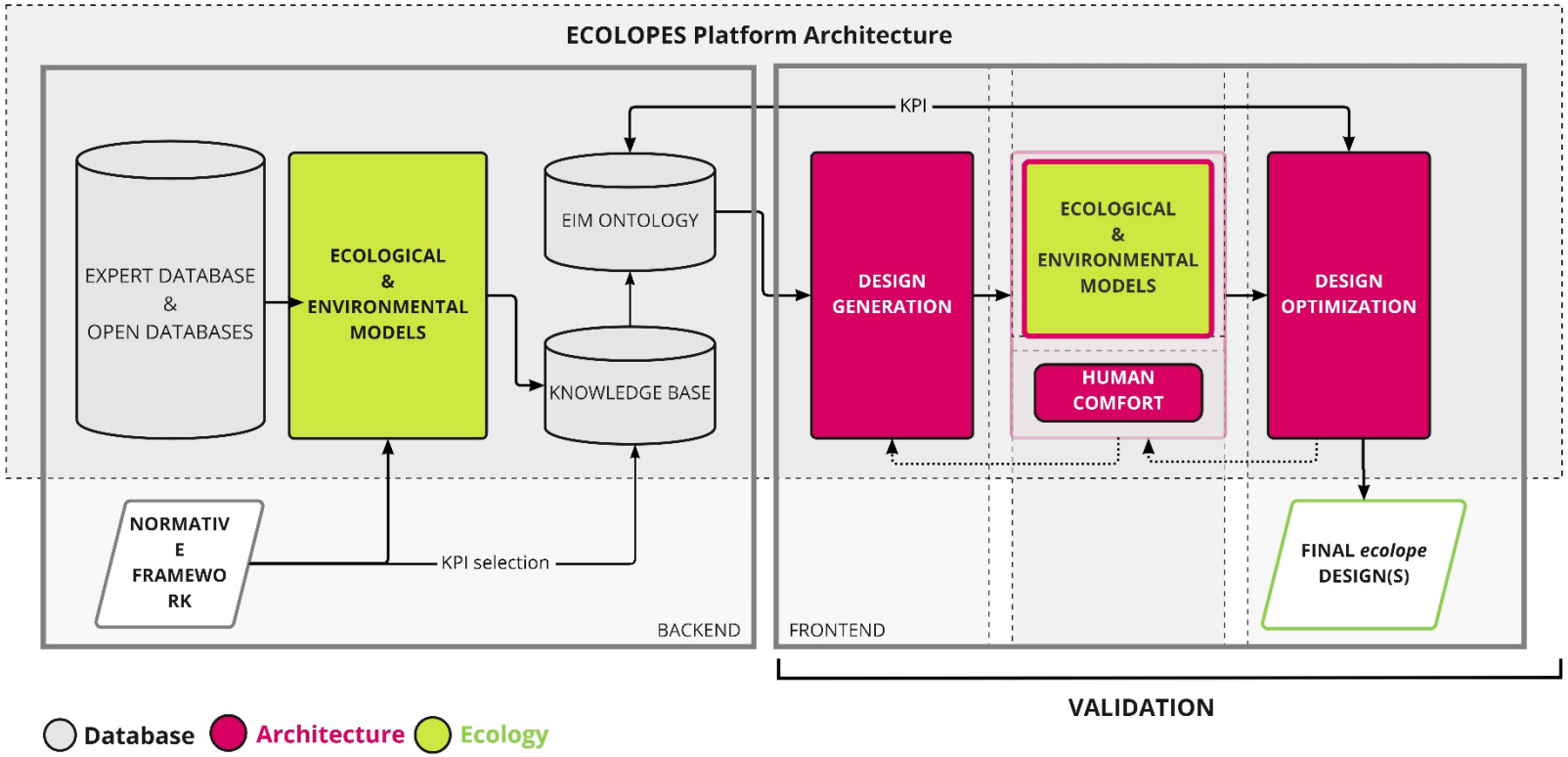
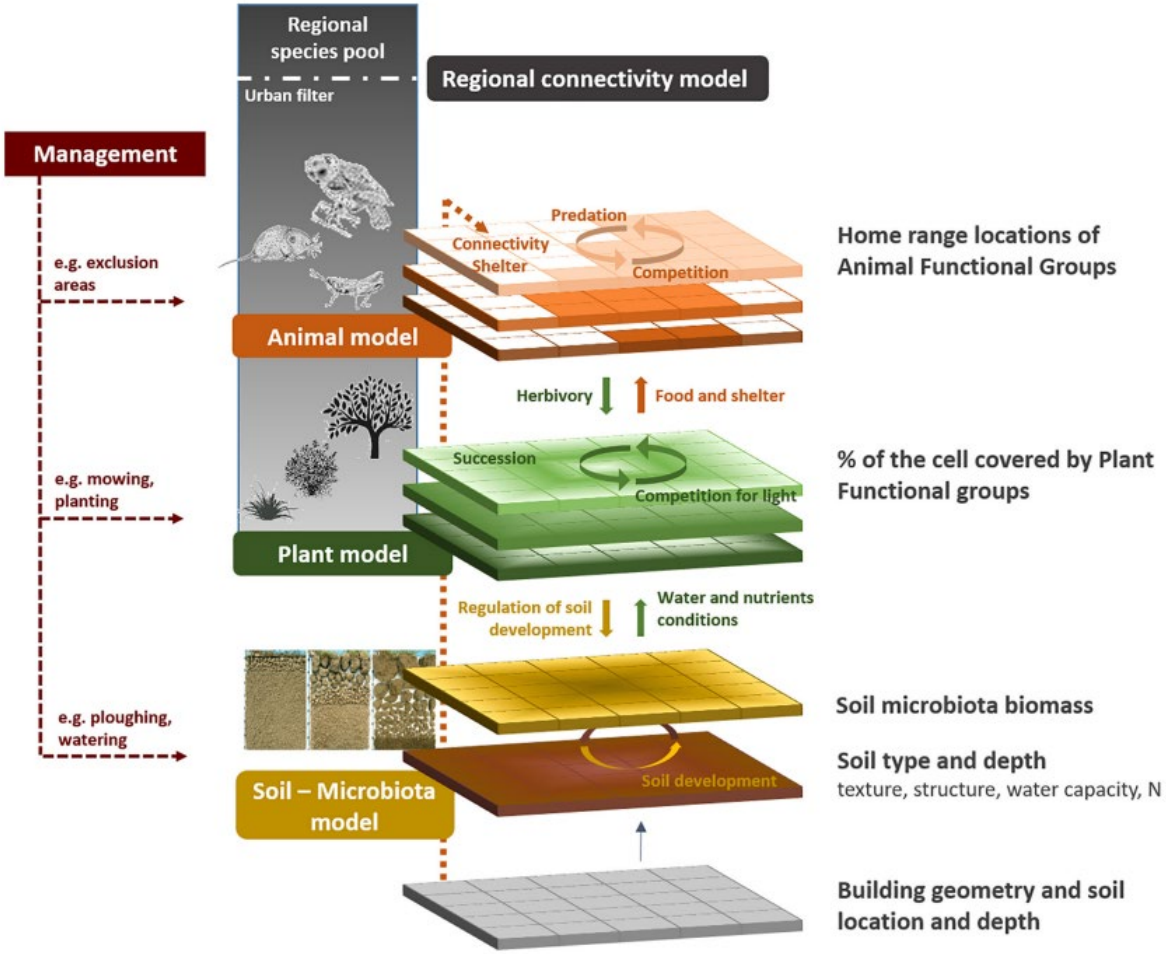
ECOLOPES computational framework



Weisser, Hensel, Barath, Culshaw, Grobman, Hauck, Joschinski, Ludwig, Mimet, Perini, Roccotiello, Schloter, Shwartz, Sunguroğlu Hensel, Vogler 2023. Creating ecologically sound buildings by integrating ecology, architecture and computational design. People Nat. 5, 4–20. https://doi.org/10.1002/pan3.10411

Integration of environmental and ecological models

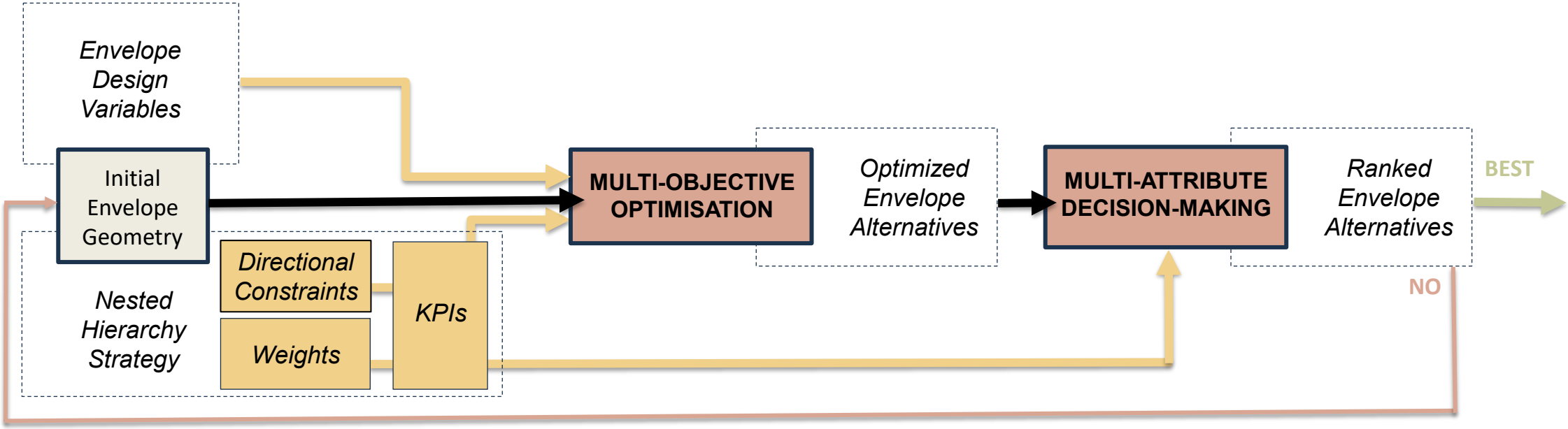


ECOLOPES ecosystem model includes a number of models and elements

Weisser, Hensel, Barath, Culshaw, Grobman, Hauck, Joschinski, Ludwig, Mimet, Perini, Roccotiello, Schloter, Shwartz, Sunguroğlu Hensel, Vogler 2023. Creating ecologically sound buildings by integrating ecology, architecture and computational design. People Nat. 5, 4–20. https://doi.org/10.1002/pan3.10411

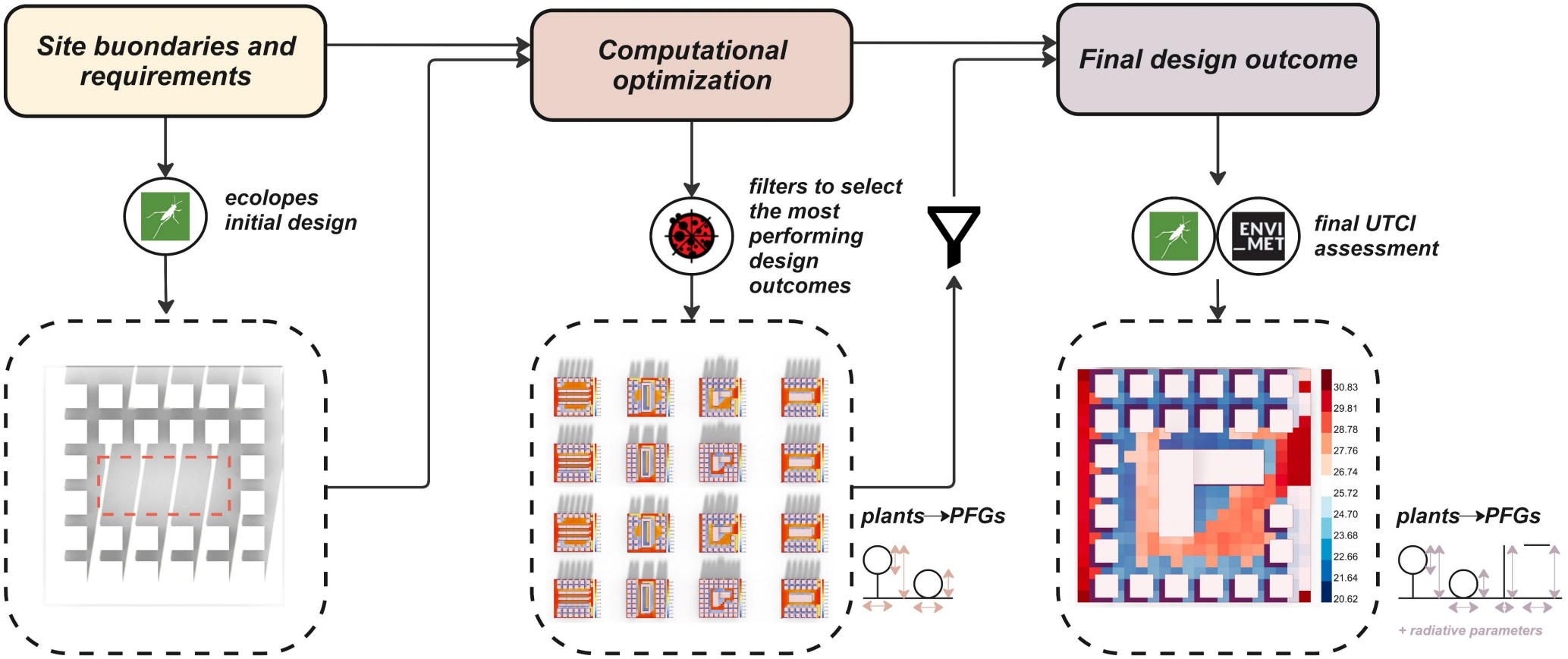
ECOLOPES optimization

Phase 1: Criteria Consolidation | **Phase 2** : Multi-objective Decision-making | **Phase 3**: Multi-attribute Decision-making



D6.3 – ECOLOPES Design Cases per Site (Barath et al.2024)

Integration of environmental and ecological models

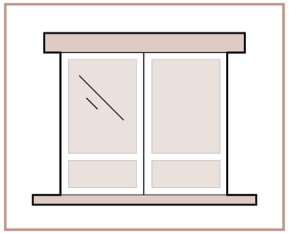


Human thermal comfort assessment process in the ECOLOPES approach

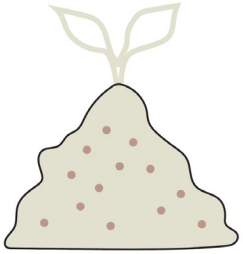
Based on Mosca, Francesca, Mariasole Calbi, Enrica Roccotiello, and Katia Perini. 2025. “A Computational Approach to Assess the Effects of Ecological Building Envelopes on Outdoor Thermal Comfort.” Sustainable Cities and Society, January, 106170. https://doi.org/10.1016/j.scs.2025.106170.

ECOLOPES optimization: current computable KPIs

Window to wall ratio – **ARCH**

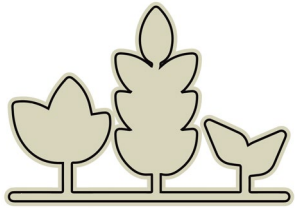


Soil volume – **ARCH** + **ECO**

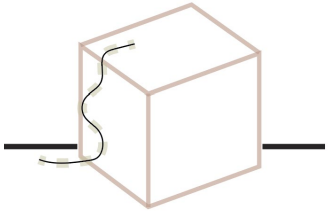


Solar Radiation – **ARCH** + **ECO**

Local Plant Richness – **ECO**

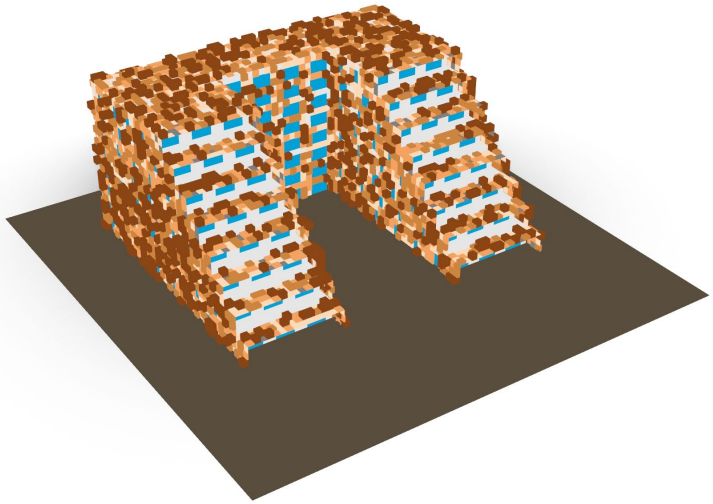


Climbing Animal Connectivity – **ECO**



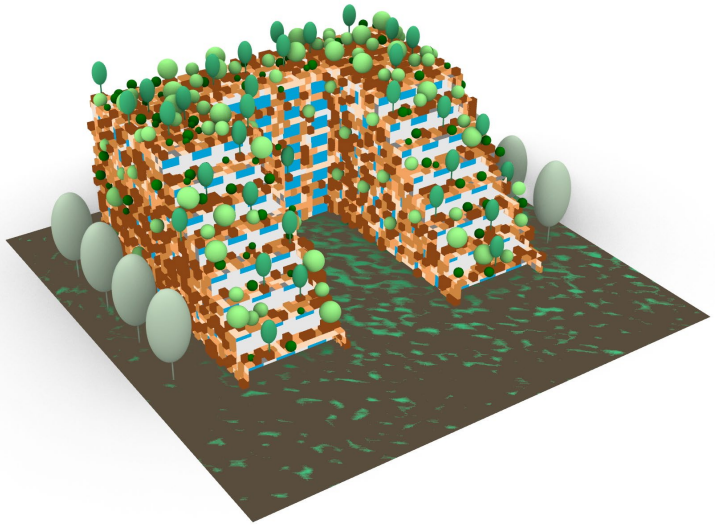
Based on Surayyn Uthaya, Laura Windorfer, Soultana Tanya Saroglou, Mariasole Calbi, Victoria Culshaw, Enrica Roccotiello, Jacob Yasha Grobman, and Shany Barath. 2025. "Multispecies Design Decision-Making: A Hybrid Computational Model for Ecological Building Envelope Optimization and Evaluation." Journal of Building Engineering 108 (August):112565. https://doi.org/10.1016/j.jobe.2025.112565.

ECOLOPES thermal comfort



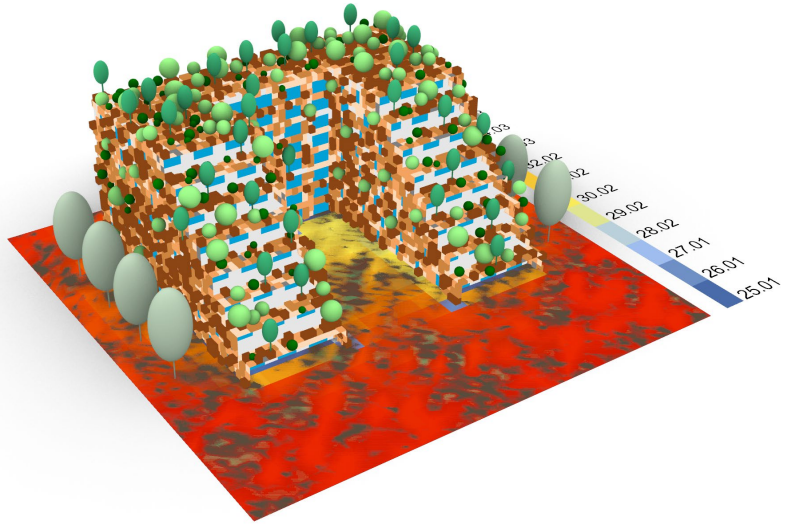
Optimized geometry with soil depth distribution

0,1-0,25-0,5-1 m ranges



PFGs distribution based on soil depth distribution

Es. shrub_trees13 (Abies alba, Abies_cephalonica…)

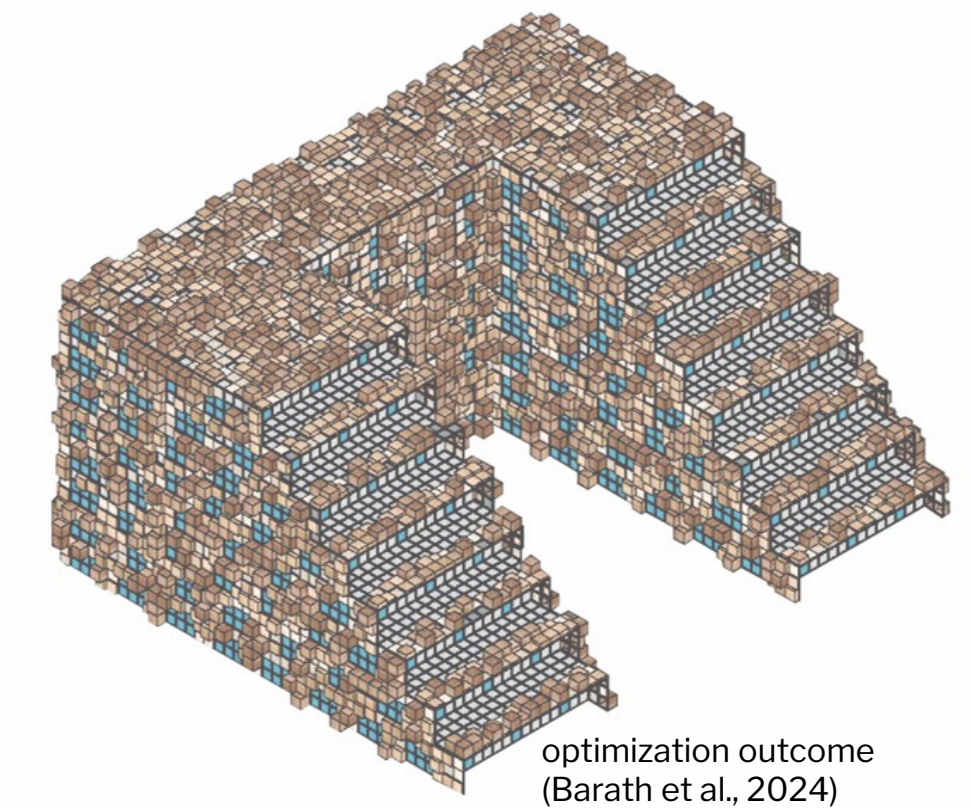


CFD simulation on outdoor thermal comfort considering PFGs

UTCI from 25.01 °C to 31,51 °C

D7.3 – ECOLOPES Report on the best design outcomes (Perini et al., 2025)

ECOLOPES design development



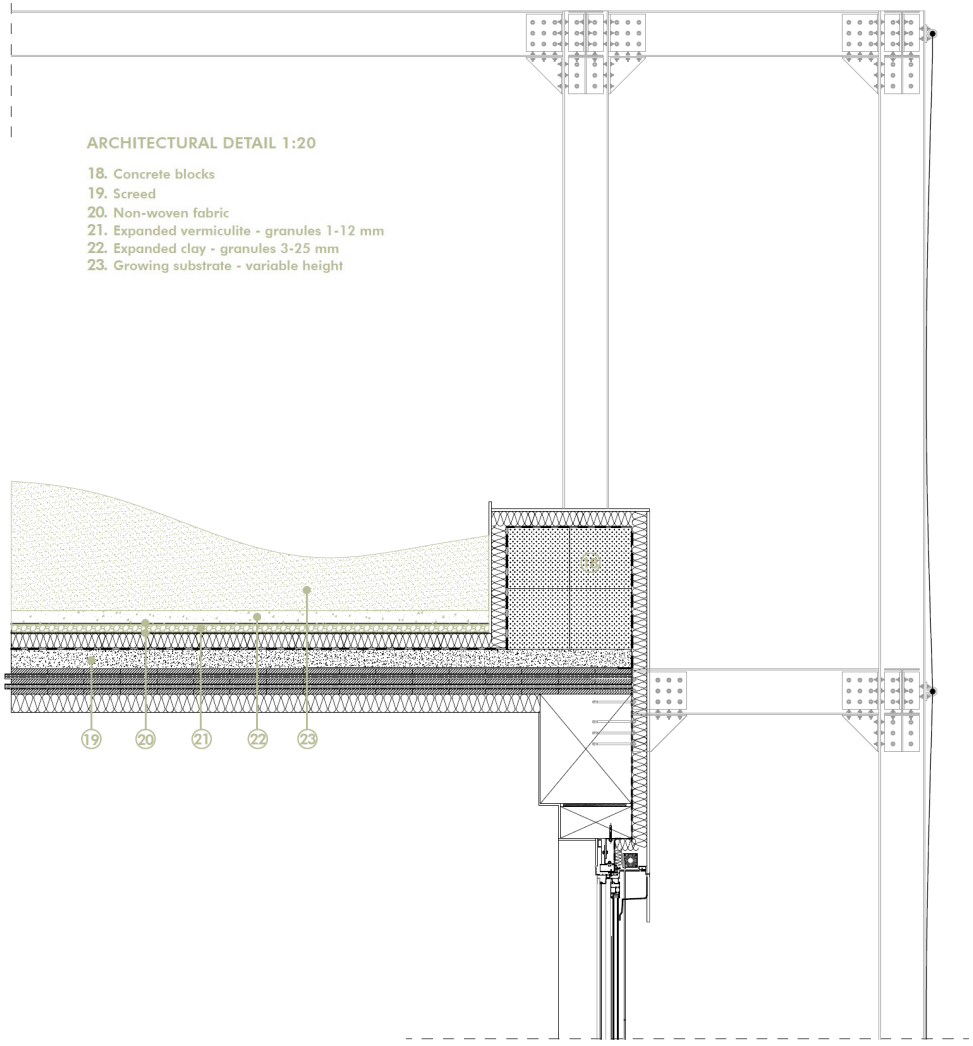
optimization outcome
(Barath et al., 2024)

Genoa
Via Maddaloni

Design development
(Perini et al., 2025)

Elisa Sini's master thesis, University of Genoa (supervision: Canepa, Mosca, Perini)

ECOLOPES design development



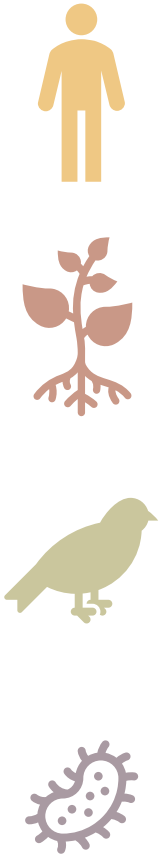
Genoa
Via Maddaloni

Design development (D7.3)

Elisa Sini's master thesis, University of Genoa (supervision: Canepa, Mosca, Perini)

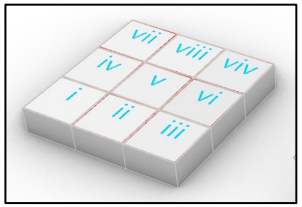
ECOLOPES multi-trophic interactions

	HUMANS	PLANTS	ANIMALS	MICROBIOTA
HUMANS		Pruning/irrigation/ fertilization	Eating; disturbing/repelling	Soil movement; fertilizing
PLANTS	Air quality; shading; allergies		Provide food; provide habitat;	Promote microbiota habitat
ANIMALS	Pests; wellbeing	Eat/kill; animals trophic net can give stability to the plant community		Biomass release
MICROBIOTA	Reduce maintenance needs and related costs; proximity and accessibility promote nature experience	Ph	Kill; soil class diversity support animals	

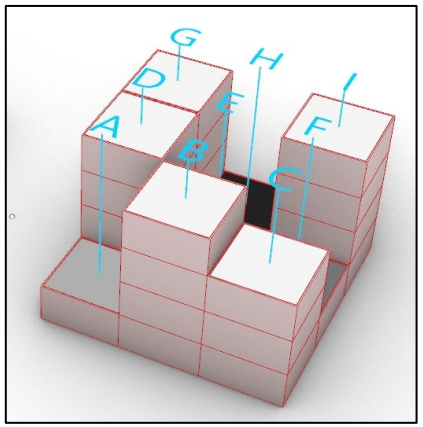


D7.3 – ECOLOPES Report on the best design outcomes (Perini et al., 2025)

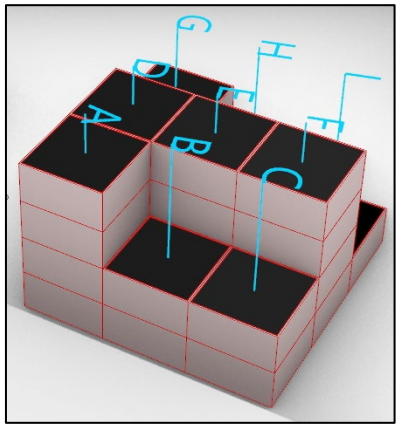
ECOLOPES building blocks



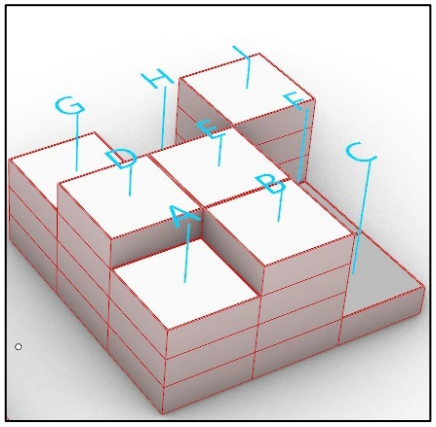
Reference



Munich

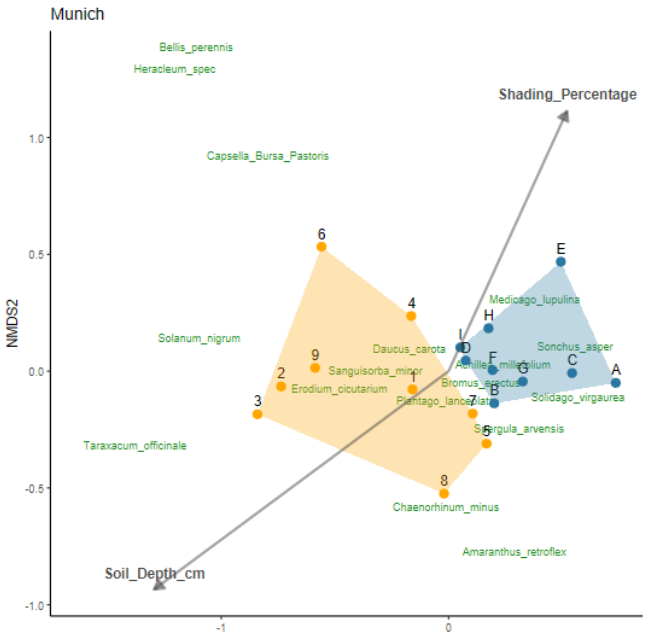


Genoa



Haifa

Building blocks optimized for variability in **Shading** and **Soil Depth** to test of if these KPI affect plant communities as expected



- Both shading and soil depth strongly affect plant community composition, in all sites.
- Experiment is run beyond the project to test which plant species win the competition

D7.3 – ECOLOPES Report on the best design outcomes (Perini et al., 2025)

Katia Perini, Francesca Mosca UNIGE

The project

ECOLOPES - ECOlogical building enveLOPES: a game-changing design approach for regenerative urban ecosystems

H2020 FET OPEN

2021-2025

Università di Genova

TECHNISCHE UNIVERSITÄT WIEN

TECHNION Israel Institute of Technology

Studio Animal-Aided Design

European Commission

Horizon 2020
European Union funding
for Research & Innovation

Thank you!

https://ecolopes.org/
https://www.youtube.com/@ecolope