Soil sealing and restoration

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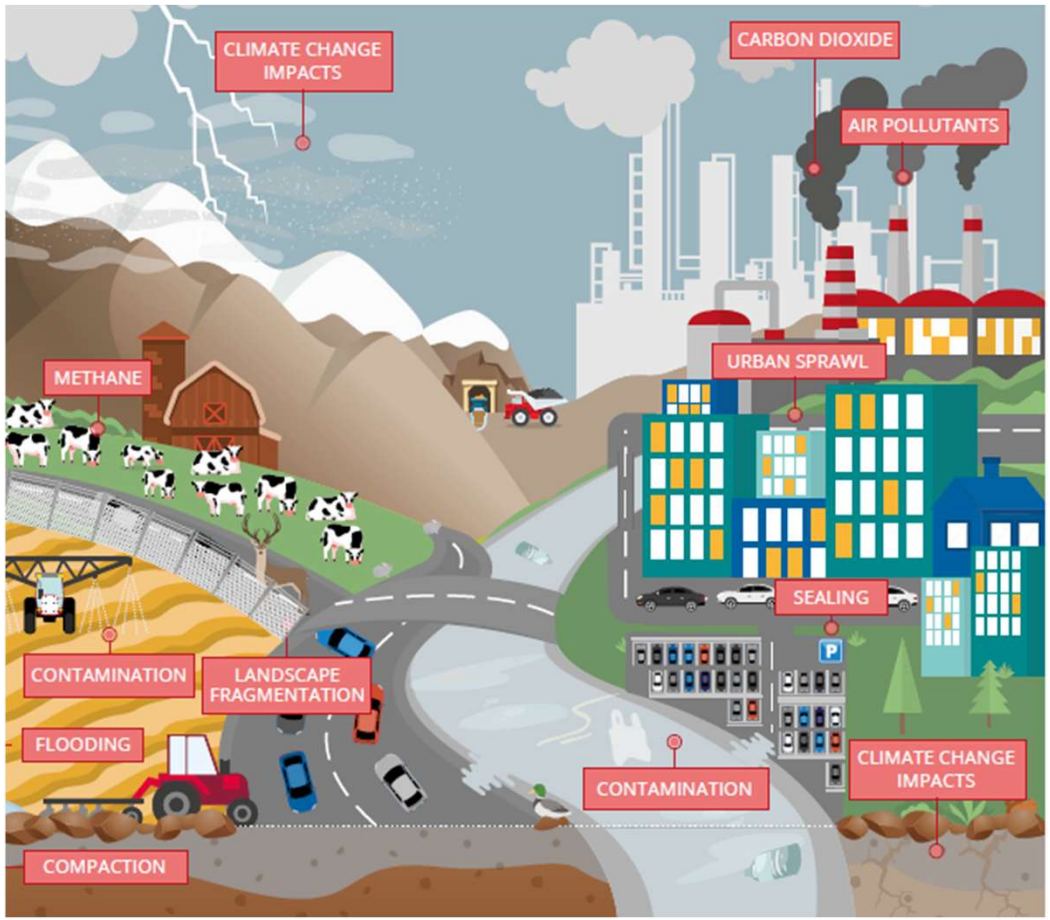
Soil sealing in the EU



- Europe is one of the most urbanised continents in the world
- Soil sealing is one of the main causes of soil degradation in the EU
- Soil sealing is considered to be the most intense form of land take
- Soil sealing is the covering of the soil by an impermeable material
- 4.2% of the EU territory has been artificialized by land take

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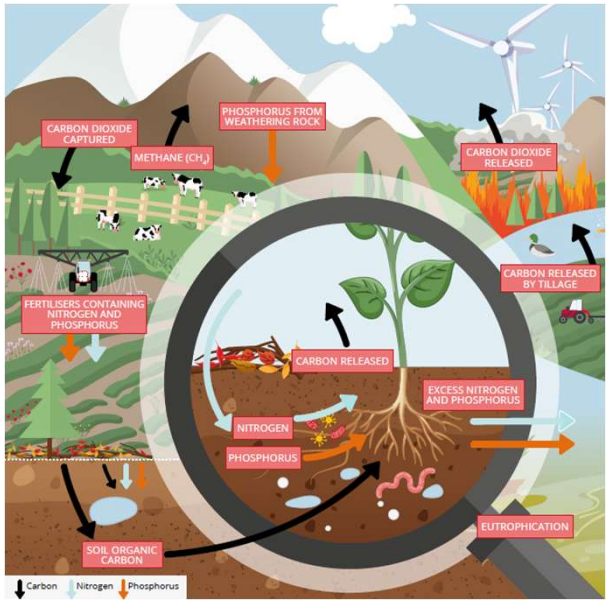
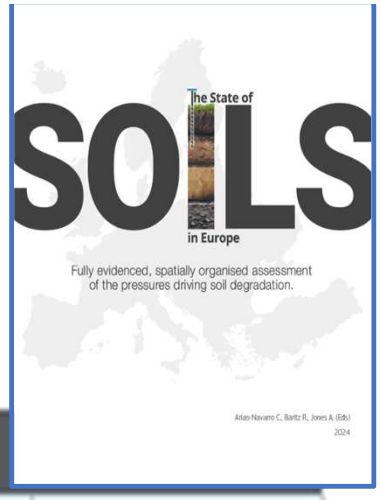
Soil sealing and ecosystem services



- Sealed soils prolong the duration of high temperatures during heat waves and have less capacity to act as a sink for pollutants.
- For an average city in France, the energy bill for households (for cooling) would have been reduced by 10% without the urban spreading of the last 20 years
- Loss of carbon sequestration capacity: 1 ha urban expansion corresponds to emission of 190-290 tCO2'yr
- Flood resilience: run-off due to increases in sealing doubled over a 63-year period in Leipzig; 12% increase in run-off with a 12.6% increase in sealing (Leeds)
- Sealing and soil waste: soil makes up 20% of the waste (underestimated: only 50 % of excavated soils is monitored)
- Food security: 1990-2006, 19 Member States lost through sealing a potential agricultural production capacity equivalent to 6.1 million tonnes of wheat

The state of soils in Europe 2024



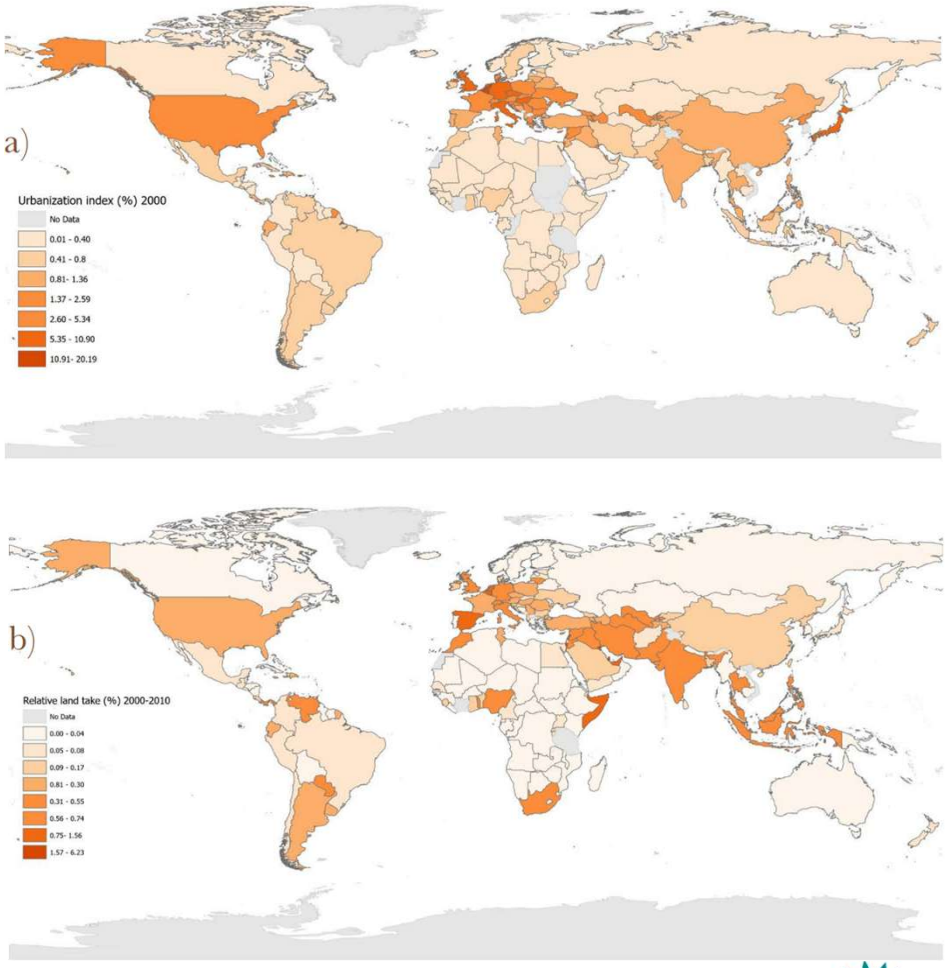
- Knowledge base about the impact of soil sealing seems well-developed; however, key societal benefit areas (economics, health social impact) are less investigated

	NEGATIVE IMPACTS						
	Climate change	Food and biomass production	Economic impact	Human health	Cultural and recreational value / social impact	Water	Biodiversity
Sealing	●	●	●	●	●	●	●

CONFIDENCE SCALE (BASED ON EVIDENCE AND AGREEMENT)	
● High agreement, robust evidence	● Low agreement, robust evidence
● High agreement, limited evidence	● Limited evidence

Soil sealing globally

- Urbanized land (*Schneider et al. 2009*):
  0.2 – 2.4% of total terrestrial surface
- EO-based estimates:
  - Global impervious surface 2000/01 (= land cover) (*Elvidge et al. 2007*): **579,703 km²** (i.e. 0.43%)
  - Global urban footprint (*Liu et al. 2020*): **1.1 Mio. km²** (i.e. 0.74%)
- *FAO (2022)*:
  - *Gardi et al. (2021):*
    Urban/artificial land (= land use):
    2000: 630,000 km² →
    2014: +143,000 km² (i.e. +23%)



(FAO 2022)

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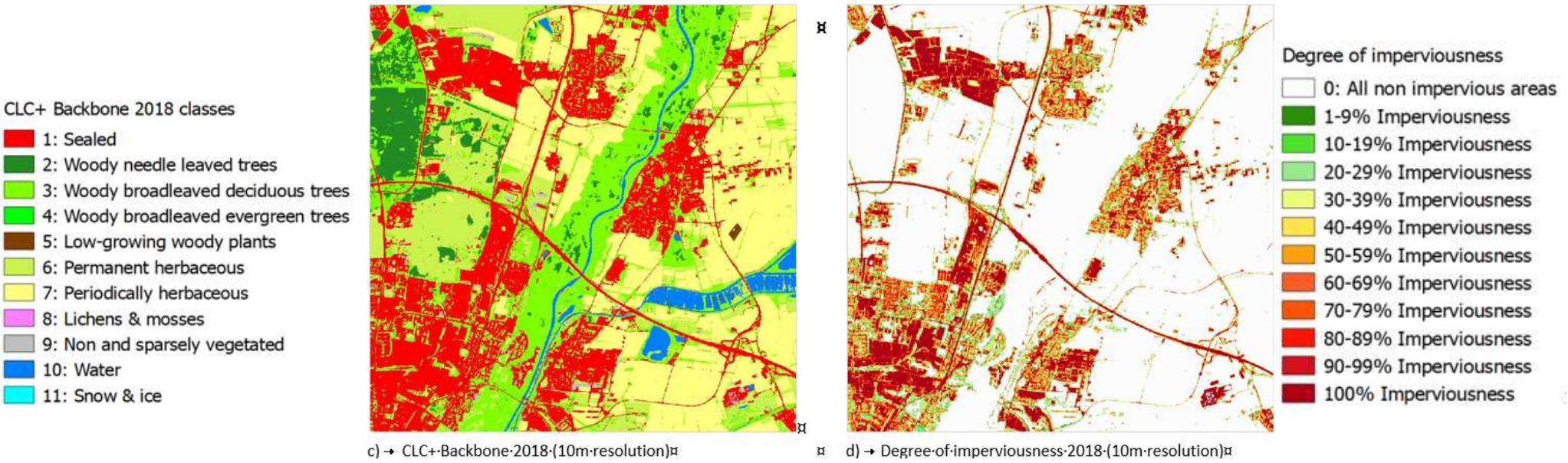
How the EU monitors soil sealing

- Copernicus Land Monitoring Service (CLMS): Imperviousness and Imperviousness change
- Spatial resolution: 3-yr cycles, until 2015: 20 m; 10m since 2018



c) → CLC+·Backbone·2018·(10m·resolution)¤ ¤ d) → Degree·of·imperviousness·2018·(10m·resolution)¤

Maucha et al. 2023

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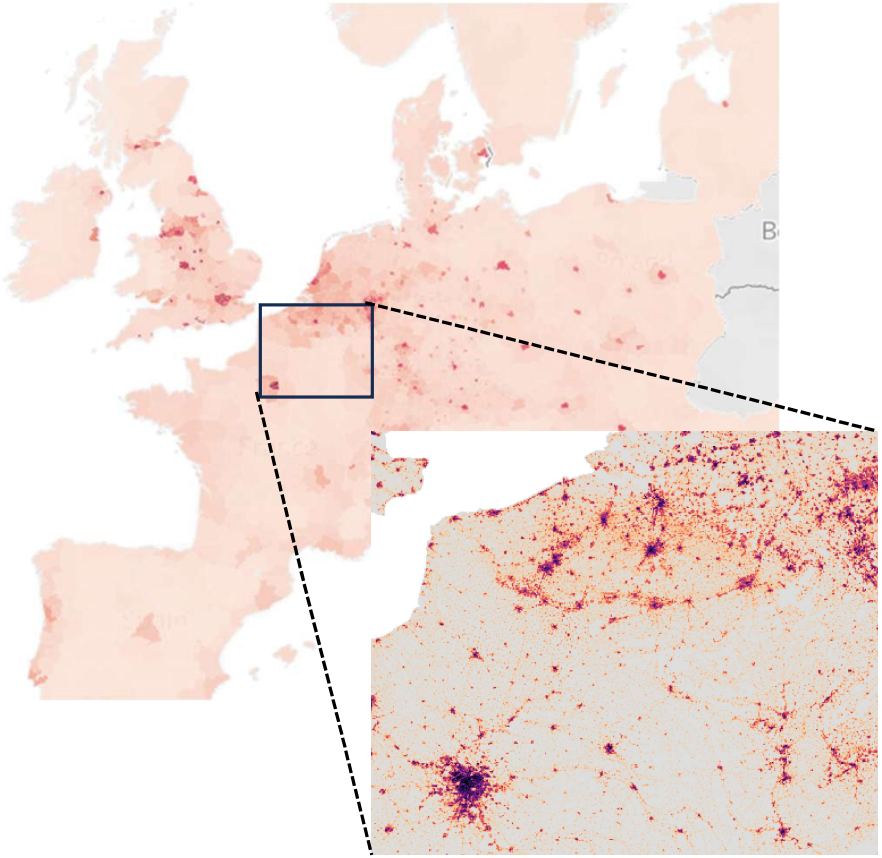
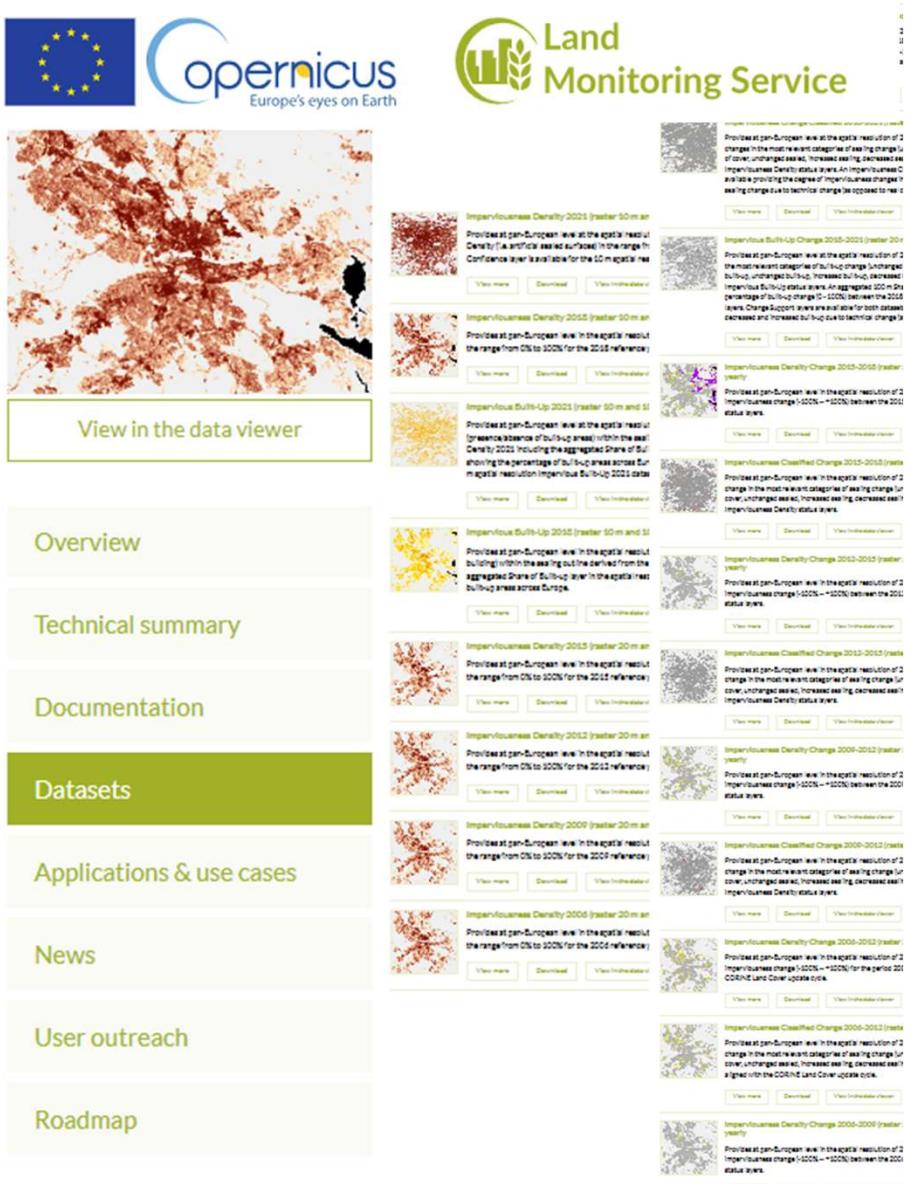
Definitions

- **Imperviousness:** covering of the soil surface with impermeable materials. Such areas are then incapable of being penetrated by air and water. In practice, soil sealing and imperviousness are used synonymously
- **Soil sealing is the covering of soil with completely or partially impermeable material.** It includes the destruction or covering of soil by buildings, other constructions and layers of impermeable artificial material (asphalt, concrete, etc.). Sealed land is a subset of **land take**, and represents the most intense form of land take; it is essentially **irreversible**
- **Land take** (syn. land consumption, artificialisation) can be defined as the increase in artificial areas over time and represents an increase in settlement areas
- **Land recycling** is the reuse of abandoned, vacant or underused land for redevelopment

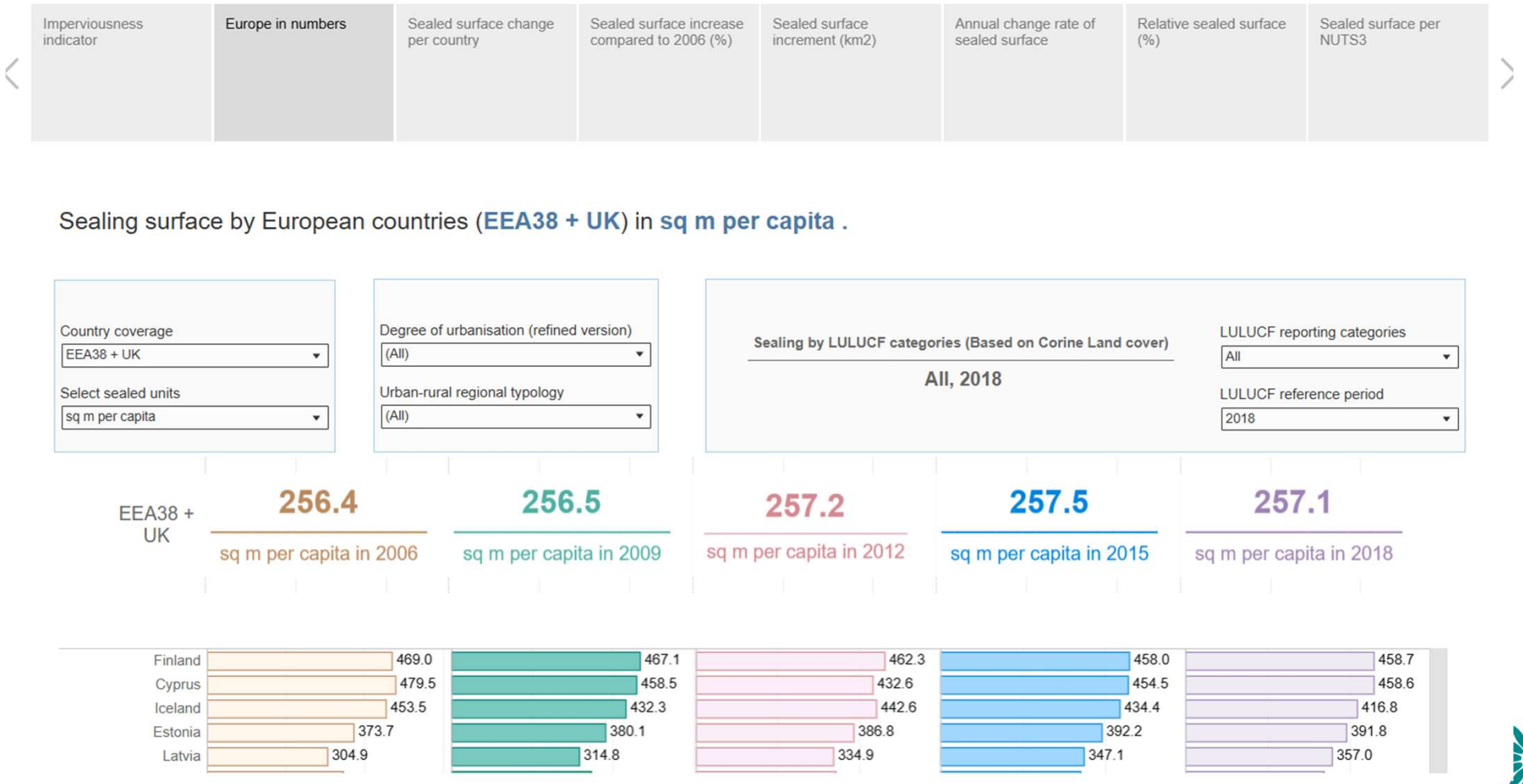
Soil sealing the EU

- CLMS portal
- Data services





Soil sealing the EU: indicator dashboard



https://www.eea.europa.eu/en/analysis/maps-and-charts/imperviousness-in-europe

Soil sealing the EU: statistics

- **2.82 %** of the EU-27+UK is sealed, totalling 122,273 km^2 (2018) (out of ca. 4.2 Mio km^2).

- In certain densely populated countries with dense infrastructure, such as Belgium and the Netherlands, almost 4 % of the national territory is sealed
- 2006-2018: **total surface area** of sealed EU soils has increased by 3,581 km^2 (1,467 km^2 2012-2018)
- **Annual rate** of soil sealing for the EU (km2):

2006-2009	2009-2012	2012-2015	2015-2018	2018-2021	2021-2024
362,6	385,3	189,1	274,9	upcoming 2026	
20m	20m	20m	10m		
Spatial harmonization (resolution): applied from 2018 onwards					

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National case studies

- Land take in Belgium: +30% (1985-2009)
- Soil sealing in Brussels: from 18% (1950) to 37% (2006)
- Italy
  - minimum values for the extension of permeable urban green: 15% in the town centre, 35% in residential areas (Brescia)
  - 'surface permeability' thresholds: 30-40% permeability in residential areas, 70% for parking areas and 90% for green public areas (Padua); 75% for private gardens, 15-50% for commercial areas (Parma)
- Switzerland:
  - 7.5% of the national territory is artificialized, of that, 4.7% is sealed (+29% 1985-2009)

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Copernicus monitoring vs national approaches

		Soil sealing (area, %)			
Country	Country size	National method		EEA/Copernicus	
Belgium (Flanders)	13,625km²	1,935km²	14.2%	1,212km²	8.9%
Austria	83,882km²	2,298km²	2.7%	1,475km²	1.8%
Luxembourg	2,593km²	176km² (a)	6.8% (a)	49km²	1.9%

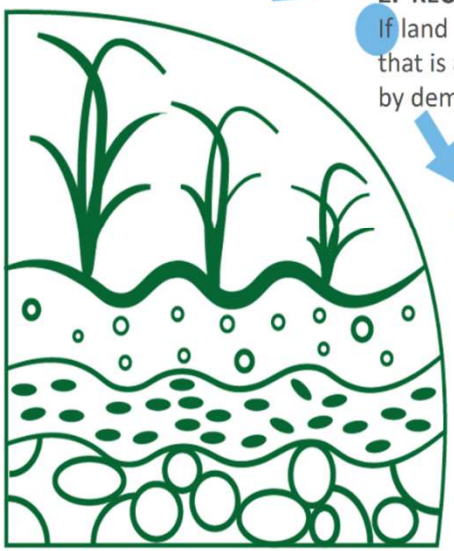
- National approaches with higher resolution EO and/or cadastral data reveal higher sealing area
- CLMS provides comparable estimates across all countries including valid trend

Land take the EU

- The settlement area (reported under LULUCF) in the EU-27 has increased by about 13% (2005-2023)
- EU land used for urban development (1990-2006) increased by 1.5 mio ha = half of Belgium
- 'Net Land take in cities and commuting zones for EEA-39': 450 km2/year between 2012 and 2018 (EU-28: 440 km²/year); 80 % of land consumption has occurred in commuting zones
- 80 % of land was taken at the expense of arable land: permanent crops (50 %) and pastures and mosaic farmlands (almost 30 %)
- Land take was highest in Malta, the United Kingdom, Cyprus, Luxembourg and the Netherlands

Management of sealing/sealed surface

- Land recycling: construction in or rehabilitating already previously built-up areas accounted for only 13.5% of urban developments in the EU (2006-2012)
- Some Member States: land recycling rates 50–80 %. Sustainable land recycling is possible!
- To combat soil sealing, and in order to achieve Healthy Soils by 2050, the EU has introduced the **Land take hierarchy**



1. **AVOID**
   Avoid additional land take and sealing as much as possible.

2. **REUSE**
   If land take or sealing cannot be avoided, then it is better to reuse land that is already taken or sealed (for a different or the same land use), e.g. by demolishing buildings, soil remediation, de-sealing or densification.

3. **MINIMISE**
   If it is not possible to avoid land take and sealing, and to reuse land, then land should be taken or sealed that is in already less favourable condition (e.g. no healthy forest or fertile agricultural land).

4. **COMPENSATE**
   If land is taken or sealed, mitigation and compensation measures should be applied to minimize the loss of ecosystem services (e.g. infiltration and rainwater collection for water absorbtion, green roofs for water retention and biodiversity; green buildings for cooling; urban farms and gardens for biomass production).

Spatial planning strategies at national/regional/local scales

Intensification rather than expansion/sprawl

Concentrate land take on less productive or already degraded soils

Land take hierarchy

EC 2012: Guidelines on best practice to limit, mitigate or compensate soil sealing

Currently being updated

Integrated measures

	Instruments	Activities
Avoid	Legal instrument	Building law with a soil conservation article Rules for new constructions (minimum green; convert undeveloped building land back to urban green
	Targets	Planning law: recognise the value of soils; redevelop brownfield sites
	Educational campaigns and data	Increase the awareness about the importance of agricultural land Monitoring databases for land take trends and underused land Online platform to advise on reducing land take Maps for planners: urban de-sealing potential
	Stakeholders	Partnerships, e.g., on Land Use and Nature Based Solutions
Re-use	Financial incentives	Land recycling funds (land re-use of vacant properties) Eco-accounts and financial compensation systems Subsidies for urban greening and to avoid sealing areas or porous surfaces Economic price-based instruments: tax on sealed areas Market-based initiatives (e.g. tradable certificates for ecosystem services)
Minimise	Spatial planning	Urban planning; land planning; environmental impact assessments Plan hierarchy: local building plans for high quality and climate-friendly building densities Soil rating (soil quality) for all soil functions
	Taxation	Land/urban planning: property tax to discourage land take
	Innovation	e.g. new surfacing materials and improved architectural design
Compensation	Construction	E.g.,-houses: ground floor covers a smaller area than the floors above it
	Eco-accounts	Land trading system: “surface credits” for de-sealing/regeneration of urban green space
	Project planning/approval	Compensate carbon stocks contained in the destroyed soil and vegetation Compensate soil functions for projects above a certain size Monitoring ES of (partially) sealed soils

Land take hierarchy: challenges

1. Property rights
2. Financial resources: compensation payments
3. Political consensus
4. Stakeholder involvement/feedback/implementation

Land take hierarchy: degree of implementation

- Many localized solutions in EU member states (ca. 450 published sources)
- Land take and soil sealing proceed

Land-related EU policies

To solve the challenge, various sectoral approaches are needed in combination:

- **Roadmap to a resource efficient Europe** established the commitment to **achieve no net land take by 2050** (EC 2011)
- **EU Soil Strategy 2030**: Member States are suggested to take appropriate measures to limit sealing; to achieve **healthy soils by 2050**
- **Soil monitoring Law** (SML): Target: avoid or reduce as much as possible the loss of the capacity of the soil to provide multiple ecosystem services; mandatory and optional indicators to monitor soil losses and land recycling
- **Nature Restoration Regulation**: targets for all ecosystems, monitoring of status and trend of ecosystem indicators (3-yr intervals), areas subject to restoration measures
  Targets urban: no net loss of green urban space and tree cover by 2030, and a steady increase in their total area from 2030
- **Regulation on environmental economic accounts** (2021): MS report on ecosystem extent accounts, ecosystem services accounts and ecosystem condition accounts
- National/regional policies
- Sources: EU Soil Wiki → GSP Soil Lex

Research needs

10 Thinktanks for soil research and innovation

10 Research roadmaps

Soils for Europe

Scoping paper:

Outlook on the knowledge gaps to reduce soil sealing and increase the reuse of urban soil

- Best practices to promote the reuse of urban soils from construction sites
- Effectiveness of de-sealing interventions
- **Socio-economic impacts** of no net soil sealing policies
- Minimum unsealed soil per person to ensure biodiversity and human health in urban areas
- Drivers of soil sealing from individual decisions to sectoral policies
- Typologies of soil sealing and their **impact on soil functions and services**
- Acceptability and legitimacy of no net soil sealing policies
- Links between soil sealing and land take

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Conclusions

- Soil sealing and land take are well-established indicators (EU SDG indicator set and **headline indicator** set in the EU's Environmental Action Programme, EU Soil Monitoring Law (*preliminarily accepted 2025)*
- Regular European **data surveys exist at high resolution** for both land take and soil sealing
- The **awareness** for land use efficiency is increasing, and soil sealing seems to slow down
- The EU Soil Monitoring Law offers a **common European vision** to further mitigate land and soil sealing, towards the (non-binding) target "no net land take until 2050"
- Initiatives and experiences with the **land take hierarchy** exist and need to be mainstreamed at national/regional/ local levels

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Thank you

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