

Monitoring Net Land Take in Europe

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Contributor: Rita Nicolau, Beatriz Condessa

Land as an environmental resource has gained increasing importance in European policies. The target of “no net land take” by 2050, set by the 2011 Roadmap to a Resource Efficient Europe, is also reinforced by the Soil Strategy of the European Union for 2030. Net land take evaluates, for a given period, the difference between land take and developed land re-naturalization. Its reduction is only feasible by increasing the re-naturalization of developed land, an intervention undertaken in specific and rare circumstances. Accordingly, reusing or recycling developed land is the only intervention that substantially prevents land take. The following defines the three processes for which monitoring is necessary to evaluate the achievement of this target. Then, the legal framework of the European goal is presented, as well as the interventions that can contribute to its pursuit and the actions already taken by some countries and regions in Europe towards this end.

Keywords: land consumption ; urbanization ; land re-naturalization ; developed land recycling ; urban land use efficiency

1. Introduction

The goal of “no net land take” by 2050 defined in the 2011 Roadmap to a Resource Efficient Europe ^[1] is part of the European Union’s 7th Environmental Action Program ^[2] and is also part of the Soil Strategy of the European Union for 2030 ^[3]. The strategy recommends that Member States set their own national, regional, and local targets by 2023 for net land take reduction by 2030 and report on their progress to make measurable contributions to the EU’s 2050 target. The strategy also proposes the application of “land take hierarchy” principles to increase land-use efficiency through more effective reuse or recycling of developed land, thereby promoting reductions in land take and soil sealing.

Land take is “the loss of undeveloped land to human-developed land” ^[4] (p. 4). It evaluates the loss of natural and semi-natural land to urban and other artificial land developments. Accordingly, it is also known as land consumption or land artificialization ^{[5][6]}. Land take comprises the development of both areas sealed by construction and urban infrastructure and unsealed areas, such as urban green parks and some sports and leisure facilities ^[7].

Land take leads to the loss of natural capital and landscape fragmentation ^{[7][8]}. Soil sealing is considered the most harmful expression of land take because it is a generally irreversible process that reduces habitat space and compromises the soil’s ability to provide ecosystem services, such as biomass supply, water and nutrient cycling, and organic carbon storage ^{[9][10]}. The loss of soil’s ecological functions triggers heat island effects and flooding, and can even increase soil, water, and air pollution ^{[7][11]}.

The main drivers of land take are population growth and economic development ^{[12][13]}. The former is mainly related to a need for more housing, public facilities, and transportation; the latter is related to new industrial and commercial sites, the competition between municipalities to attract more investment, and the prioritization of economic development over environmental sustainability, in a broad sense. Colsaet et al. ^[12] carried out an extensive literature review on this topic, concluding that urban expansion “is not a mere result of market forces but is also shaped by institutions and public policies” (p. 346), including land use regulation, the legal and fiscal framework, the lack of both vertical (between administrative levels) and horizontal (between municipalities) coordination, and the strong dependence of local governments on tax revenues (such as property taxes).

The reverse process of land take (the conversion of artificial land into non-artificial land) is generally known as the re-naturalization or restoration of developed land. It is also less commonly referred to as the re-cultivation of developed land ^[7]. An increase in vegetation cover provided by re-naturalization translates into an increase in soil carbon stocks ^[14].

Net land take evaluates, for a given period, the difference between land take and re-naturalization of developed land. The “no net land take” target aims to protect soils and safeguard the services they provide through more sustainable land use, which involves reducing the consumption of undeveloped land ^[15]. Meeting this target by the year 2050 calls for new construction to be carried out on abandoned or underutilized urban land and for the non-artificial land consumed by urbanization to be offset by the re-naturalization of an equivalent amount of artificial land, demanding significant investment in developed land recycling ^[7]. Recycling of developed land aims at increasing the density of buildings (densification or infilling), building on abandoned or underused land (gray recycling), or converting developed land into green urban areas (green recycling). Both densification and gray recycling allow nations to respond to the housing needs of a growing population and diversify economic activity in areas that are already part of the urban perimeter, maximizing

the use of existing infrastructure. Green recycling allows for preserving some of the natural soil functions that are vital to urban sustainability. Proper planning of green urban areas can contribute to green infrastructure development ^[7].

It is noteworthy that land designated herein as urban or developed refers to the Corine Land Cover (CLC) level 1 class known as artificial surfaces, and land designated as non-urban, undeveloped, or natural refers to the remaining CLC classes.

2. Framing the “No Net Land Take” Goal

Given the lack of a binding legal framework to achieve the goal of “no net land take” by 2050, the European Union has sought to raise awareness among the Member States on the issues of land take and recycling of developed land through the dissemination of various studies ^{[7][11][16][17]}, and more recently, through the inclusion of said issues in the Soil Strategy of the European Union for 2030 ^[3]. Over recent decades, most European countries have adopted strategic planning guidelines to promote the sustainable development of their territories ^[5], following the principles of the European Spatial Development Perspective ^[18], the Territorial Agendas of the European Union ^{[19][20][21]}, and the New Urban Agenda ^[22].

At the global level, the 2030 Agenda for Sustainable Development established 17 Sustainable Development Goals and 169 targets, which are to be achieved by 2030 by all countries ^[23]. Targets 11 and 15 deal with land consumption and land degradation, respectively, and both relate to net land take. Target 11.3 aims, among other things, to improve inclusive and sustainable urbanization in all countries. The indicator selected for monitoring this (11.3.1) is the “ratio of land consumption rate to population growth rate.” Since land take reflects the consumption of non-artificial land by urban development, it represents part of land consumption. The other part comprises the consumption of artificial land, which corresponds to developed land recycling and re-naturalization. Target 15.3 aims, among others, to combat desertification and restore degraded land. The proposed indicator for the monitoring thereof (15.3.1) measures the proportion of degraded land, which is also related to net land take. Land degradation can be assessed by the loss of ecosystem services provided by soil, such as a decrease in soil carbon stocks ^[24], and the re-cultivation of developed land usually increases these stocks ^[14].

3. Types of Interventions to Avoid, Reduce, or Offset Land Take

Based on the analysis of over 200 case studies from different European territorial contexts, the ESPON SUPER project (Sustainable Urbanization and Land Use Practices in European Regions) has identified the following types of interventions that can contribute to avoiding, reducing, and/or compensating for land take: densification, regeneration, urban containment, and governance and sectoral policies ^{[25][26]}.

Densification aims to increase the density of people living in built-up areas, usually by defining zones and quantitative thresholds for infilling urban areas. It can involve increasing the volume of buildings or the reorganizing the existing urban structure ^[26].

Regeneration aims at reusing and improving abandoned and problematic sites, such as brownfields. Brownfields are underutilized urban areas, such as former industrial sites, which may have contamination problems.

Containment initiatives aim to limit land development beyond a designated area, reduce urban sprawl and promote more rational land use (e.g., green belts and urban growth boundaries). Generally, these interventions foster the redevelopment and densification of urban neighborhoods and improve the green spaces in the rural-urban interface.

Governance approaches to reduce land take can encompass policy goal setting, spatial planning at different levels or sectors of action, financial incentives, and environmental assessments of plans and projects aimed at urban development ^[27]. According to the SUPER conclusions ^[26], interventions that address various sectoral policies (e.g., transportation, environment, and agriculture) and their potential impacts on land use tend to promote more sustainable development.

The types of interventions mentioned above can make use of more than one instrument, such as legislation (binding laws and regulations), zonal land-use regulations establishing mandatory principles, incentive and economic programs (policy packages aimed at a particular objective), and projects (e.g., those implemented under the URBACT III program) ^[25].

Given that strategies or visions are non-binding instruments, their success often depends on the existence of financial or binding instruments that make it possible to achieve targets. Accordingly, the adoption of strategies does not in itself guarantee successful interventions.

4. Data Sources Used at the European Level to Estimate Land Take, Re-Naturalization, and Recycling of Developed Land

Assessment of land cover/land use changes associated with the land take, re-naturalization, and recycling of developed land, can be achieved through a wide variety of data sources. The net land take indicators produced by the European Environment Agency (EEA) ^{[7][11]} for Europe resulted from CLC maps, which are inadequate for monitoring these

processes at the level of countries and their regions, as they do not make it possible to identify change areas of less than 5 ha ^[28]. The indicators for developed land recycling produced by the EEA resulted from the Urban Atlas ^[29], which has a higher spatial resolution than CLC but only covers medium to large cities and their functional areas, preventing the monitoring of the phenomenon in other areas of interest. Another data source available at the European level is the Land Use/Cover Area frame Survey, known as LUCAS ^[30]. As the estimates for land take provided by LUCAS result from sampled measurements, they are less accurate than those resulting from full coverage datasets. The high-resolution imperviousness layers produced by Copernicus ^[31] capture “the spatial distribution of artificially sealed areas, including the level of sealing of the soil per area unit.” Accordingly, they only make it possible to monitor the sealed land, i.e., permanent land take, but integration with other land cover or land use datasets may make it possible to estimate non-permanent land take. Given the limitations of European data sources, the evaluation in each member state of the above processes is often based on national data sources, generally more detailed than those available at the European level. The definitions of the processes and their assessment methodologies also vary substantially among countries and regions.

5. Approaching the “No Net Land Take” Goal

The definition of quantitative targets aimed at achieving national objectives, such as a reduction in net land take, and the monitoring of such targets, are the responsibility of central governments. However, as land-use planning decisions are mainly taken at the regional or municipal levels, to meet a national target, translation into regional or local targets is necessary ^[5].

Some European countries have already set national quantitative targets for reducing land take or increasing the recycling of developed land. Among these, one should highlight Luxembourg, which limited land take to 1 ha per day by the year 2020 in its National Sustainable Development Plan, designed in 2007 ^[5]. As a result, the land take dropped to 0.46 ha/day between 2007 and 2018 ^[32]. Although the Luxembourg Spatial Planning Program is currently under review, it envisions reducing the land take target to 0.25 ha/day by 2035 ^[32]. Assessment of the land take in Luxembourg is based on orthophotos ^[33].

In Austria, land take is estimated based on cadastral data. In 2002, the Austrian government set a threshold of 1 ha/day by 2010 for soil sealing ^[16]. The report on Land Take Reduction in Austria, presented on 8 October 2019, revealed a downward trend in land take since 2010 ^[34]. However, the land take was still 11.5 ha/day between 2018 and 2020, and soil sealing was also above the limit set for 2010 (>4.0 ha/day) ^[35]. Given this situation, the Austrian government's program for 2020–2024 has set a land take target of 2.5 ha/day by the year 2030.

In Flanders (a region of Belgium), land take monitoring relies on two data sources: the official federal cadastral statistics on built-up areas, available with annual updates since 1985, and the Flanders land use database ^[36], which has been accessible since 2013 and is updated every three years. In 2016, land take in Flanders amounted to 6 ha/day ^[37]. To reach the “no net land take” target by 2050, the Flemish Spatial Policy Plan aims to curb settlement growth so that it is zero by 2040. To meet this objective, the Flemish government intends to densify settlements, promote the multifunctional use of space, encourage management of contaminated sites, redevelop brownfield sites, and further dynamic landfill management ^[38].

In Wallonia (another region of Belgium), land take is also quantified based on cadastral data. The target of “no net land take” by 2050 is addressed by the 2018 Walloon Spatial Development Perspective (Schéma de Développement du Territoire), which limits land take to 1.6 ha/day by 2030 to meet the 2050 target. In 2020, the land taken in Wallonia doubled the 2030 target. The above document also states that by 2030, 50% of new housing and 30% of economic areas should be developed in brownfields ^[39].

Land take in Germany is quantified based on two datasets: the “Authoritative Real Estate Cadastre Information System” and the “Digital Basic Landscape Model of the Authoritative Topographic and Cartographic Information System” ^[40]. In Germany, the land take evaluates the conversion of non-artificial areas into settlements and transportation networks (excluding, for example, the creation of mining sites from undeveloped land). The first national target for curbing land take was set in 2002, to reduce it to 30 ha/day by 2020. To achieve this goal, the German government promoted the reuse of brownfields and the development of under-utilized urban areas ^[41]. In 2013, a legally binding priority for inner urban development came into effect, requiring settlements to consider inner urban potential before expanding into surrounding areas. In 2016, the German Sustainable Development Strategy was re-launched, and the land take target was reset to less than 30 ha/day by 2030. The monitoring of land consumption in Germany relies on combined quantification by three indicators: the surface area occupied by settlements and transportation networks, the density of settlements, and open urban space per capita. The goal is reducing land take at the expense of increasing settlement density without decreasing urban open space per capita ^[42]. Meeting these targets is supported by two territorial planning instruments: the land consumption reduction action plan and the land certificate trading scheme ^[26]. The latter was implemented in a pilot project led by the German Environment Agency, involving 87 municipalities. Each municipality received several certificates representing the area available for new development based on its population. Surplus or insufficient areas were tradeable between local governments through the sale or purchase of certificates. This project showed that the trading scheme

effectively reduces land take ^[43]. Despite the enormous importance given to land as an environmental resource by the instruments in place in Germany, undeveloped land consumed by built-up areas, open urban space, and transportation still amounted to 57.9 ha/day in 2020 ^[44].

Although the “no net land take” target was only introduced into French legislation in 2018, as a response to measure 1.3 of the Biodiversity Plan, which aims to limit the consumption of natural, agricultural, and forest areas ^[45], in 2010 the French Law on modernization of agriculture and fisheries had already set a target to halve the rate of agricultural land consumption by 2020 ^[5]. The French legislation is, however, silent on the deadline for achieving the “no net land take” target. The French land take observatory became operational in 2019. It reports that since 2016 there has been stagnation in the land take rate in France, and that the consumption of natural, agricultural, and forest areas amounted to 54.8 ha/day between 2019 and 2020 ^[46]. By 2020, the French government started funding private and public brownfield redevelopment operations ^[15]. The data sources used in France for assessing land take are the OCS GE reference database and the cadastral tax files (“fichiers fonciers”), which enable the detection of changes in land use, in particular, the conversion of natural, agricultural, or forest areas into built-up areas. By definition, cadastral files do not cover the land in the public domain, such as the road network.

In Italy, net land take is assessed annually from maps produced through photo-interpretation and the semiautomatic classification of remote sensing images (Sentinel-1 and Sentinel-2). In said assessment, land take covers changes from non-artificial to artificial areas (excluding the creation of green urban areas from agricultural areas) and the conversion of green urban areas into sealed areas. There is a clear distinction between permanent land take (land sealing) and reversible land take ^[47]. Italy also estimates the losses and gains due to land transformations based on the economic valuation of functions and ecosystems provided by different land uses. In Italy, the net land take was 14.2 ha/day between 2019 and 2020. In the same period, land re-naturalization amounted to 1.4 ha/day. The main difficulties experienced in controlling land take in Italy are the lack of a uniform policy framework at the national level and the absence of efficient regulatory measures in most of the country ^{[47][48]}.

Although the UK’s National Planning Policy Framework does not refer to the goal of “no net land take” ^[15], the re-use of previously developed land for housing has been an objective of English spatial policy since the late 1990s, intending to reduce urban sprawl and greenfield development and to densify urban areas ^[49]. The national target set in 1998 of having at least 60% of new housing built on brownfield land by 2008 was achieved and surpassed before 2008.

One should stress that the above summary has sought to depict how the objective of reducing land take is being addressed in some countries and regions in Europe without looking at the effectiveness of the measures adopted, as this would require an analysis of the political and social contexts, and how the initiatives described are implemented by the legal instruments in place.

This section revealed that the term “land take” has different meanings among member states, which prevents comparisons of its estimates across countries. Therefore, clarification of the land use changes that the term encompasses is urgently needed. Despite the ambiguity of land take’s definition, there is evidence that several countries are acting on the message delivered by the goal, which is the protection of soils, especially the most fertile and productive ones.

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