Umwelt Bundesamt

German Environment Agency
8. June 2022

# Prevention of land take[1]

## 1 Measure definition

Land take can be defined as the destruction or covering of soils by housing, services, recreation, industrial and commercial sites, constructions sites, transport networks and infrastructure as well as mines, quarries and waste dumpsites (Stolte et al. 2016). It involves the removal of top soil (scalping) and adding anthropogenic material such as tarmac or concrete and other substances, thus sealing the soil. The prevention of land take combines all measure to prevent the transformation of natural, semi-natural and agricultural areas into sealed soil (Colsaet et al 2018). This can be achieved through e.g., legally binding land take targets, strengthening of inner urban development, reuse of brownfields, protection of agricultural soils and valuable landscapes.

According to the European Environment Agency (EEA) (2019), the main drivers of land take in Europe during 2000-2018 were the increasing demand for land due to population and income growth, as well as the development of transport infrastructure and automobile use. In total in this period 14,049 km² land was lost to land take, with 78% of the land take affecting agricultural areas, i. e. arable lands and pastures, and mosaic farmlands (European Environment Agency 2019). Between 2012 and 2018 one-fifth of the functional urban area[2] that became sealed was of high productivity potential (around 2/3 of medium productivity potential) in EU-27 + UK (Tóth et al. 2022).

With land take, soil as a finite natural resource is lost and the process is often irreversible. The unsealing, redevelopment or renaturation of soils is associated with high costs and the same soil quality cannot be achieved. Moreover, recultivation is very limited as eleven times more land is taken than recultivated, with new land take often affecting the most fertile soil (Burghardt 2015).

**Geographical and biophysical applicability**

- **Suitability to different biophysical conditions:** Due to historical development, the most productive soils can be found in sub-urban areas or close to urban areas. Prevention of land take, maintaining and conserving the soil in these areas has the highest potential to mitigate negative effects.
- **Suitability in EU/German conditions:** In 2018, 2.3% of the European and 5.1% of German territory was sealed. Germany has the highest share of area sealed (EEA 2018). Given the current high rates of soil sealing, there is a high potential for the prevention of land take within the EU and its Member States.

### Fit with NbS definition

Since preventing soil sealing enables soils to maintain their ability to perform soil functions and deliver ecosystem services, prevention of soil sealing is aligned with the definition of nature-

[1] This factsheet was developed as part of the research project "Naturbasierte Lösungen (NbS) im Klimaschutz: Marktanreize zur Förderung klimaschonender Bodennutzung" (FKZ 3721 42 502 0) and is also published as part of the Annex to the UBA report "Role of soils in climate change mitigation", see www.umweltbundesamt.de/publikationen/Role-of-soils-in-climate-change-mitigation.

[2] A functional urban area (FUA) consists of a city and its commuting zone.

based solutions as defined in the working definition for this research project in Reise et al. (2022) provided that the original land use and management which is maintained are aligned with this definition as well.

# 2 Mitigation Potential

## 2.1 Carbon sequestration

Land take and soil sealing can lead to a significant reduction of soil carbon stocks. At the same time, soils have a significant potential for additional sequestration if they are not sealed. Land take can result in a loss of soil organic carbon from 10% to 66% of total stock present in the soils that are affected (Lorenz and Lal 2017; Verzandvoort et al. 2010). Between 2012 and 2018 the increase of sealed surface caused a loss of carbon sequestration potential estimated at around 4 million tons (approximate distribution among ecosystem types: urban ecosystems: 50%, cropland: 34%, grassland: 12%, others: 4%) in EU-27 + UK (Tóth et al. 2022).

## 2.2 Total climate effect

Land take, on the one hand, can lead to GHG emissions due to the destruction of soil profile and the loss of existing SOC stocks and on the other hand, reduces the area available for future carbon sequestration.

Sealing of organic and mineral soil leads to an increase of GHG emissions, because soil sealing is usually preceded by a destruction of the soil profile and scalping. The disturbance of soil causes mineralization especially of peat soils and thus a release of GHGs to the atmosphere (Stolte et al. 2016). The projections on SOC losses due to soil sealing have been reduced for the period 2000-2030 compared to the 1990-2000 period by a factor three due to regulations, restrictions and more compact urban growth (Verzandvoort et al. 2010). The most recent emissions resulting from conversion to settlement as reported under the UNFCC were 43 Mt $CO_2$e for the EU in 2018, and 2.5 Mt $CO_2$e for Germany in 2019.

## 2.3 Limitations on the mitigation potential

The loss of carbon sequestration potential and the loss of soil organic carbon stocks is highly dependent on the soil type, previous land use (e.g., grassland, peatland, agricultural land) and the type of sealing (total surface sealing, partial sealing, subsurface sealing covered by a soil layer). There is little knowledge on the effects of soil sealing in urban environments.

# 3 Adaptation and co-benefits

- **Yields:** Unsealed soils can be productive land used as agricultural area, grassland or forest positively impacting food sovereignty and food security.
- **Food and biomass production:** Due to historical development, the most productive soils can be found in sub-urban areas or close to urban areas to ease the access to crop markets and agricultural production. Maintaining and conserving productive soil delivers access to agricultural products to urban and sub-urban areas (Stolte et al. 2016). Studies show that between 1990 and 2006, 19 EU countries lost 1% of their potential agricultural production capability due to land take (Gardi et al. 2014). For the period 2000 to 2030 a similar loss was projected.

- **Micro climate:** Unsealed and green surfaces have a lower temperature compared to sealed surfaces and have the potential to better regulate the micro climate without artificially alteration (prevention of "urban heat island effects"). Surface temperature surveys from the cities of Budapest (Hungary) and Zaragoza (Spain) showed that temperatures in highly sealed areas can be up to 20°C higher compared to green shaded surfaces (Prokop et al. 2011).
- **Storing, filtering, buffering:** Soil and its organisms have the potential to filter, degrade, immobilize and detoxify organic and inorganic pollutants. Some of these pollutants are degraded by microorganisms and transformed into less harmful forms or held in the soil preventing them from contamination of air and water (Stolte et al. 2016). Sealed soil is withdrawn from these filter functions.
- **Ecosystem** soil**:** Soil and soil systems permanently interact with other ecologic compartments such as the biosphere, atmosphere, hydrosphere, and pedosphere. Sealing the soil interrupts these exchange processes.
- **Biodiversity:** Unsealed land and less fragmented landscapes usually provide a higher soil biodiversity and functioning as habitat for animal and plant species. Soil sealing leads to local extinction processes, elimination of native species or their displacement while soil biodiversity is practically lost due to limited soil function and interaction. From 2000 to 2030 a decrease of biodiversity of up to 35% due to sealing is expected in all EU27 Member States (Verzandvoort et al. 2010).
- **Water services:** Compared to urban land, unsealed land has a better water retention and storage, decreases water run-off and mitigates flood risks. Between 2012 and 2018 the estimated loss of potential water storage due to soil sealing in EU-27 + UK is estimated at 670 million $m^3$ (Tóth et al. 2022). From 2000 to 2030 a reduced water retention of 0.8% is projected in the EU due to sealing (Verzandvoort et al. 2010).

# 4 Trade offs

Prevention of land take is a no-regret option.

# 5 Implementation challenges

The EU27 population is expected to increase to a peak of 449.3 million in 2026 (+0.6%) and then gradually decrease to 416.1 million in 2100 (EUROSTAT 2020). With this expected population increase in the upcoming years the prevention of land take faces fundamental challenges. At the same time, the increased demand for living space per person, increased mobility and growth of transport infrastructure will potentially lead to a continuous demand for land and will be a fundamental driving force for soil sealing even if the population in Europe is decreasing in the future.

There are some relevant policies at EU level, however, none of them offer binding targets, incentives and measures to prevent land take aggravating the ambitions on the prevention of land take. The European Commission's Roadmap to a Resource Efficient Europe

(COM(2011)571)[3] introduces a 'no net land take by 2050' initiative that would imply that all new urbanisation will either occur on brownfields or that any new land take will need to be compensated by reclamation of artificial land. However, this initiative is not legally binding.

Some EU Member States introduced national policies, which partly address this issue. The German national sustainability strategy set the target of limiting the increase in settlement and transport area to 30 ha per day by 2020, which, however, was not achieved. The recent Coalition Agreement of the new German government stresses the need to achieve the 30 ha target by 2030.

Therefore, one of the main challenges with regard to the prevention of land take is the absence or insufficient political willingness and the lack of legally binding targets. At the same time, there are EU funding schemes that support soil consumption, for example, the Trans European Transport Network (TEN-T), the EU Structural and Investment Funds and the European Investment Bank (Prokop 2011).

# 6 References


Aksoy, E., Gregor, M., Schröder, C., Löhnertz, M., Louwagie, G. (2017): Assessing and analysing the impact of land take pressures on arable land. In: Solid Earth 8, p. 683–695. https://doi.org/10.5194/se-8-683-2017.

Burghardt, W. (2006): Soil sealing and soil properties related to sealing. In: Geological Society, London, Special Publications, 266(1), p. 117–124. https://doi.org/10.1144/GSL.SP.2006.266.01.09-

Colsaet, A., Laurans, Y., Levrel, H. (2018): What drives land take and urban land expansion? A systematic review. In: Land Use Policy 79, p. 339–349. https://doi.org/10.1016/j.landusepol.2018.08.017.

European Environment Agency (EEA) (2018): Soil sealing and ecosystem impacts. https://www.eea.europa.eu/data-and-maps/dashboards/soil-sealing-and-ecosystem-impacts.

European Environment Agency (2019) Land take in Europe. https://www.eea.europa.eu/data-and-maps/indicators/land-take-3/assessment.

Eurostat (2020): Population projections in the EU. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=People_in_the_EU_-population_projections&oldid=497115#Population_projections.

Gardi, C., Panagos, P., Van Liedekerke, M., Bosco, C., & De Brogniez, D. (2015): Land take and food security: Assessment of land take on the agricultural production in Europe. In: Journal of Environmental Planning and Management, 58(5), p. 898–912. https://doi.org/10.1080/09640568.2014.899490.

Lorenz, K., Lal, R., (2017): Impacts of land take and soil sealing on soil carbon, in: Gardi, C. (Ed.): Urban Expansion, Land Cover and Soil Ecosystem Services. 1st ed. Routledge. https://doi.org/10.4324/9781315715674.

O'Riordan, R., Davies, J., Stevens, C., & Quinton, J. N. (2021): The effects of sealing on urban soil carbon and nutrients. In: SOIL, 7(2), p. 661–675. https://doi.org/10.5194/soil-7-661-2021.

Prokop, G., Jobstmann, H., Schönbauer, A., European Commission, & Directorate-General for the Environment. (2011): Overview of best practices for limiting soil sealing or mitigating its effects in EU-27: Final report. Publications Office. http://dx.publications.europa.eu/10.2779/15146.

Reise, J., Siemons, A., Böttcher, Herold, A. Urrutia, C., Schneider, L., Iwaszuk, E., McDonald, H., Frelih-Larsen,A., Duin, L. Davis, M. (2022): Nature-Based Solutions and Global Climate Protection. Assessment of their global


[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571

mitigation potential and recommendations for international climate policy. Climate Change 01/2022. German Environment Agency, Dessau-Roßlau.

Stolte, J., Tesfai, M., Oygarden, L., Kvaerno, S., Keizer, J., Verheijen, F., Panagos, P., Ballabio, C., & Hessel, R. (2016): Soil threats in Europe: status, methods, drivers and effects on ecosystem services: deliverable 2.1 RECARE project. (98673 ed.) (JRC Technical reports). European Commission DG Joint Research Centre. https://doi.org/10.2788/488054.

Tóth, G., Ivits, E., Prokop, G., Gregor, M., Fons-Esteve, J., Agras, R.M., Mancosu, E. (2022): Impact of Soil Sealing on Soil Carbon Sequestration, Water Storage Potentials and Biomass Productivity in Functional Urban Areas of the European Union and the United Kingdom. Land. 2022; 11(6):840. https://doi.org/10.3390/land11060840.

Verzandvoort, Simone & Heidema, A.H. & Lesschen, Jan Peter & Bowyer, C. (2010): Soil sealing: Trends, projections, policy instruments and likely impacts on land service.

## Imprint

**Publisher**

Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
buergerservice@uba.de
Internet: www.umweltbundesamt.de
/umweltbundesamt.de
/umweltbundesamt

**Completion:** June 2022

**Authors**

Aaron Scheid, Dr. Ana Frelih-Larsen, Antonia Riedel, Rachael Oluwatoyin Akinyede, Ecologic Institute

Prof. Dr. Andreas Gattinger, Dr. Wiebke Niether, Justus-Liebig-Universität Giessen