

**Policy**

Europe: COM (2011) 571 final (roadmap to a Resource Efficient Europe)ⁱ; COM (2013) 249 final (green infrastructures); SEC (2006) 16 (them. strategy urban environment), EU Soil Strategy for 2030 COM(2021) 699 final;

Italy: dlgs 152/06; (Codice Ambiente DDL 2039 on Land Take; dlgs 31/03/1998, 112 (Bassanini)

First draft

TOOLS ZERO NET LAND TAKE, GREEN INFRASTRUCTURES

Territorial Scale: Italy

WHY

Soil consumption is a complex phenomenon which is defined in several ways. The European Environmental Agency defines “land take” as the amount of agricultural, forest, natural and semi-natural soils, wetlands and water bodies consumed by the growth of urban areas or other artificial surfacesⁱ. The phenomenon of “soil sealing”, closely linked to “land take”, is, instead, the process of ground covering with waterproof surfaces.

More generally, soil consumption (also “land consumption”) can be considered the change from a non-artificial land cover to an artificial land cover of the ground, with the distinction between permanent consumption (due to permanent artificial cover) and no-permanent consumption (due to a reversible artificial cover).

In Italy, the National Institute for Environmental Protection and Research (ISPRA) and the National Environmental Protection System (SNPA) monitors soil consumption producing national maps with a spatial resolution of 10 m updated every yearⁱⁱ. ISPRA-SNPA products consider also other artificial surfaces contributing to soil depletion such as unpaved parking, dumps, quarries, and railways lines.

Soil consumption and soil sealing processes have serious environmental consequences. According to The European Commission, soil sealing is the main cause of soil degradation as it increases the risk of flooding, contributes to water depletion and global warming and threatens biodiversity and soil ecosystem functions, resulting in the loss of fertile agricultural soilsⁱⁱⁱ.

Tool K - “Land take” allows users to perform analyses regarding the land consumption generated by recent urban expansion and urban and spatial planning choices. In addition to quantifying the loss of ecosystem services, the tool allows for analysis based on a “what if” logic, simulating reality to orientate urban planning choices towards greater environmental sustainability. The tool is composed of several features, numbered from k1 to k10 and grouped into three “families” (ka, kb, bc):

Ka – Geospatial knowledge <ul style="list-style-type: none"> • Environmental report (k2) • Fragmentation (k3) • Edge density (k4) • Urban SPRAWL (k6) • LCPI (k7) • RMPS (k8) 	Kb – Monitoring <ul style="list-style-type: none"> • Land take monitoring (k1)
	Kc – Planning <ul style="list-style-type: none"> • New urban development (k5) • Model of urban development (k9)
	m. Green infrastructures <ul style="list-style-type: none"> • New green corridor – Gain of ecosystem services and Design your green corridor

FOR WHOM

The “Land take” and “Green infrastructures” tools are aimed at professionals in the field of urban and territorial planning, public administrations and researchers.

HOW – if you want to select your *Region Of Interest* (ROI)^{iv}

The tool allows the free selection of a region of interest ROI by following a very simple procedure:

Operational procedure

The first step is selection of the area of interest. This can be performed in two ways:

- By selecting the territory of interest according to the NUTS statistical classification, which classifies the administrative units of the 28 European Union countries and of 6 extra-union countries (Iceland, Liechtenstein, North Macedonia, Norway, Switzerland, Turkey). Individual units or groups of units can be selected from the municipal level (NUTS 4) to the national level (NUTS 1).
- By defining a polygon using the “Draw” Tool. It is also possible to assign a name to this ROI^v. Once saved, the polygon can be used as a region of interest.

TOOL GEOSPATIAL KNOWLEDGE	HOW – if you want to select “ENVIRONMENTAL REPORT”
	Operational procedure
	By users’ clicking on icon k2, the “model requester” appears, allowing users to choose the region of interest (by selecting the administrative units). Click on the “evaluate” button and calculation starts. The system will automatically open the “Results” sub-folder; by clicking the last elaboration performed, in the “Elaboration detail” folder the users can view - and download - the processing result, as a .pdf report.
	What for

The k2 “Environmental report” tool provides information on the main environmental features of the ROI. The tool produces a .pdf report containing the following information:

- Surface water bodies (rivers and lakes)
- Areas subject to environmental protection (EU protected sites, Natura 2000 sites)
- Population data (10-year historical series 1961-2011, annual data 2015-2018)
- Information on the morphology of the territory (altitude, slope, exposure of slopes)
- Lithology / Agricultural productivity of soil / land uses (historical series 1990-2018)
- Climate data
- Potential ecosystem services (calculated through the MAES approach)

The .pdf report contains final remarks on methodology and data sources.

The tool is currently under development and some data and information in the report are missing or may not be correct.

HOW – if you want to select “FRAGMENTATION”

Operational procedure

By users' clicking on icon k3, the “model requester” appears, allowing users to:

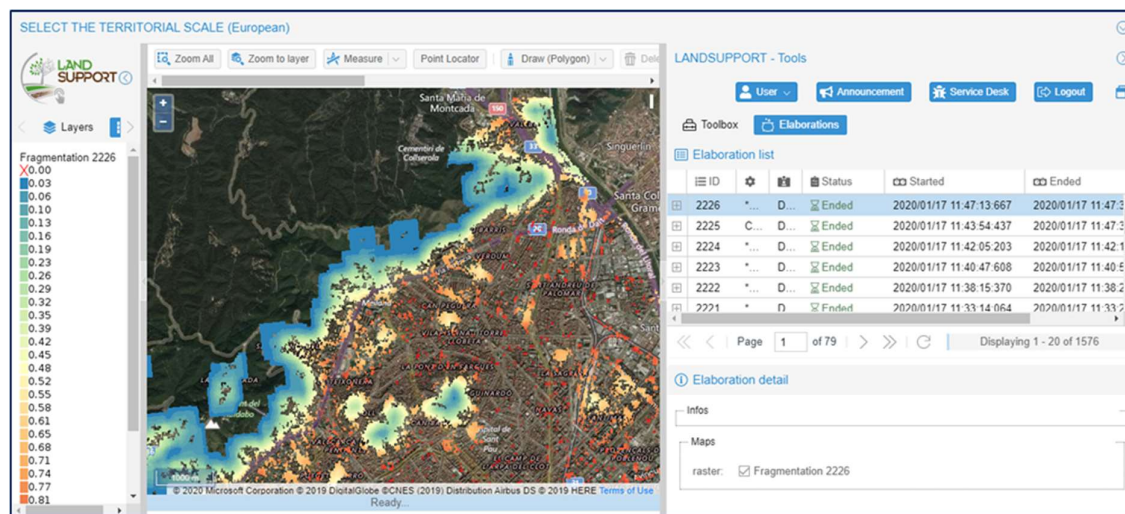
- choose the region of interest (by selecting the administrative units or a previously defined ROI)
- select the fragmentation radius (from 0 to 1500 metres)
- select the reference dates for evaluation (start and end date)
- perform the evaluation in “Timeseries mode”, thus obtaining time series
- choose the calculation target: urban or rural

By clicking on the “evaluate” button, the calculation procedure starts.

The system will automatically open the “Results” sub-folder; by clicking the last elaboration performed, in the “Elaboration detail” folder the users can view - and download - the processing result, as a .pdf report or visualize the map (figure below).

What for

The k3 “Fragmentation” tool allows users to obtain a raster layer, at each pixel (rural or urban, depending on the initial choice) of which a fragmentation value, influenced by the radius value, is assigned. The raster layer can be viewed on the platform.



HOW – if you aim to: k4 “EDGE DENSITY”- k6 “URBAN SPRAWL” - k7 “LCPI”- k8 “RMPS”**Operational procedure**

By users' clicking on the icon tool (figure below), the “model requester” appears, allowing users to:

k4

- choose the region of interest (by selecting the administrative units or a previously defined region of interest)
- select the reference dates to be evaluated (start and end date – years 2012-2015-2016-2017-2018-2019 can be chosen)

k6

- choose the region – or the regions – of interest (by selecting the administrative units or a previously defined region of interest)
- select the reference dates to be evaluated (years 2012-2015-2016-2017-2018-2019 can be chosen)

k7

- choose the region – or the regions – of interest (by selecting the administrative units)
- select the reference dates to be evaluated (years -2012-2015-2016-2017-2018-2019 can be chosen)

k8

- choose the region – or the regions – of interest (by selecting the administrative units)
- select the reference dates to be evaluated (years 2012-2015-2016-2017-2018-2019 can be chosen)

All tools

By clicking on the “evaluate” button, the calculation procedure starts.

The system will automatically open the “Results” sub-folder; by clicking the last elaboration performed, in the “Elaboration detail” folder the users can view - and download - the processing result, as a .pdf report.

What for

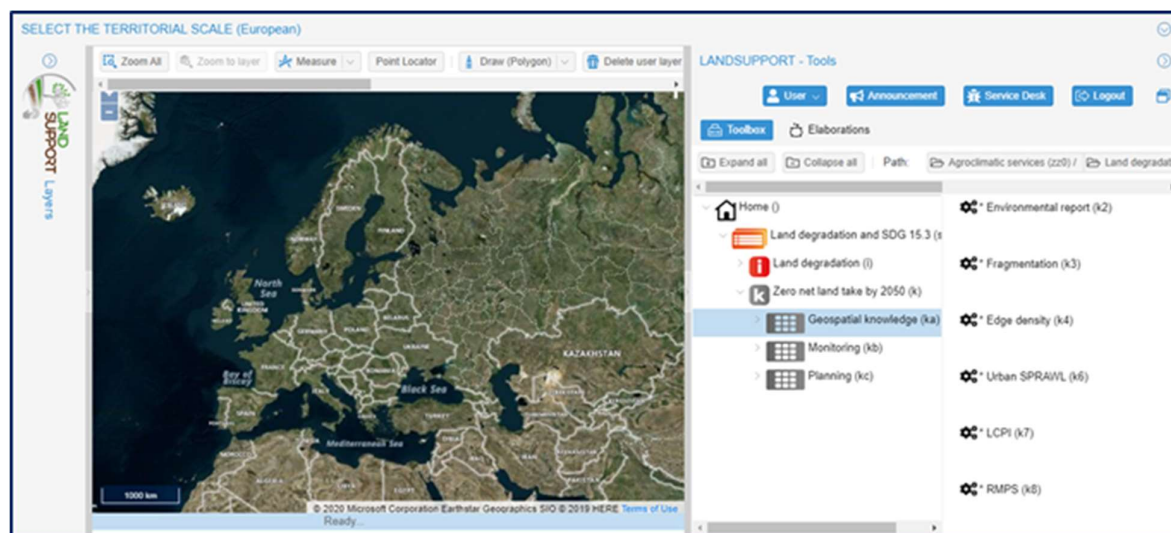
The k4 “Edge density” tool calculates the value of the “density of urban margins”, which is an indicator of urban dispersion.

The k6 “Urban sprawl” tool allows evaluation of the dispersion of urbanized areas (from 0 to 100 %), producing a value in numerical format and in the form of a bar chart, which allows us to compare the different areas of interest.

The k7 “LCPI” tool allows evaluation of the degree of compactness of urbanized areas, by calculating the “largest class patch index” and returning the value in numerical format and in the form of a bar chart, which allows comparison of the different areas of interest.

The k8 “RMPS” tool allows evaluation of the degree of compactness of urbanized areas, by calculating the “residual mean patch size” index and returning the value in numerical format and in the form of a bar chart, which allows comparison of different areas of interest.

The indices of all tools cited are based on scientific research.^{vi}



HOW – if you want to select “LAND TAKE MONITORING (kb)”

Operational procedure

By users' clicking on icon k1, the “model requester” appears, allowing users to:

- choose the region of interest (by selecting the administrative units or a previously defined area)
- select the reference dates to be evaluated (start and end date – years 2012-2015-2016-2017-2018-2019 can be chosen)
- perform the evaluation in “Timeseries mode”, thus obtaining time series.

By clicking on the “evaluate” button, the calculation procedure starts.

The system will automatically open the “Results” sub-folder; by clicking the last elaboration performed, in the “Elaboration detail” folder the users can view - and download - the processing result, as .pdf reports, or as layers to add to the map (figure below).

What for

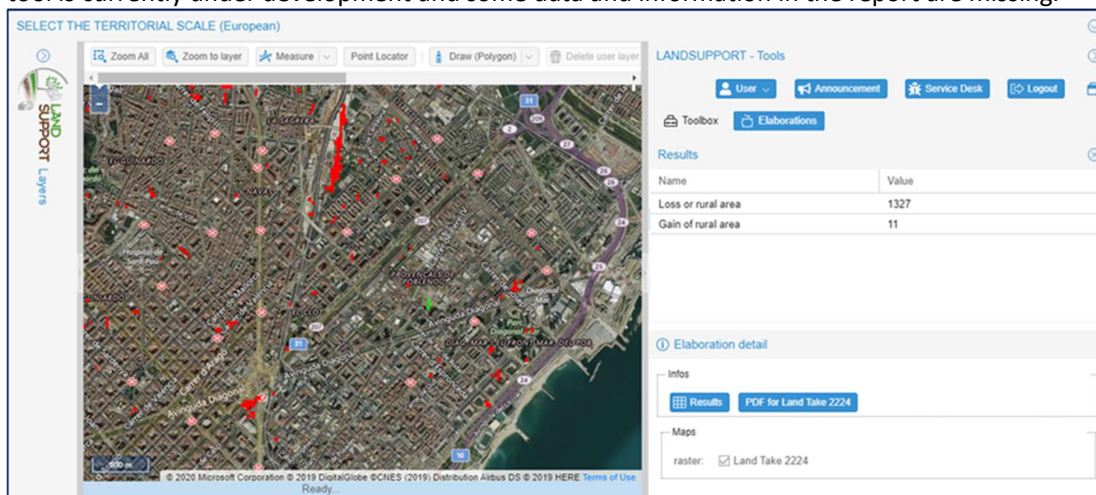
The k1 “Land take monitoring” tool provides information on land consumption in the selected time period in terms of “loss of rural area”, “gain of rural area” and loss of soil agricultural productivity.

The tool gives the numerical values of “loss of rural area”, “gain of rural area” and a .pdf report - downloadable - containing the following information about the area of interest:

- Short description of the area of interest (name, surface, location)
- Selected parameters for the analysis (start and end date of monitoring)
- “Loss of rural area” and “gain of rural area” (loss/increase of agricultural and natural areas in the time period considered)
- Loss of soil productivity (productivity class – from 1 to 10)

The .pdf report also contains final remarks about methodology and data sources.

The tool is currently under development and some data and information in the report are missing.



HOW – if you want to select “NEW URBAN DEVELOPMENT”

Operational procedure

By users' clicking on icon k5, the “model requester” appears, allowing users to:

- choose the region of interest (by selecting a previously defined region of interest)
- select the coverage percentage (from 0 to 100%)

By clicking on the “evaluate” button, the calculation procedure starts.

What for

The k5 “New urban development” tool allows users to simulate the impact of new urban developments in terms of potential loss of ecosystem services. The tool produces a .pdf report - downloadable - including the following information about the area of interest:

- Short description of the area of interest (name, surface, location)
- Summary of parameters used (previously selected coverage percentage)
- Potential loss of potential ecosystem services (calculated through the MAES approach)
- Potential loss of organic carbon (soil organic carbon)

The .pdf report also contains final remarks about methodology and data sources.

TOOL PLANNING	<p>HOW – if you want to select “MODEL OF URBAN DEVELOPMENT”</p> <p>Operational procedure By users’ clicking on the icon k9, the “model requester” appears, allowing users to:</p> <ul style="list-style-type: none"> • choose the region – or the regions – of interest (by selecting the administrative units) • select the reference dates to be evaluated (years 2012-2015-2016-2017-2018-2019 can be chosen) <p>By clicking on the “evaluate” button, the calculation procedure starts.</p> <p>What for The k9 “Model of urban development” tool synthesizes the degree of compactness of an urbanized area by combining the k4 (edge density), k7 (LCPI), k8 (RMPS) tools within a single instrument. The results are given in numerical and bar graph format, thus easing comparison.</p>
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TOOLS m. GREEN INFRASTRUCTURES	<p>HOW – if you want to select “NEW GREEN CORRIDOR”: “Gain of ecosystem services” or “Design your green corridor”</p> <p>Operational procedure By users’ clicking on the “Gain of ecosystem services” tool, the “model requester” appears, allowing users to choose the region of interest (by selecting a previously defined region of interest) and percentage of coverage. By clicking on the “evaluate” button, the calculation procedure starts and a .pdf file with the potential gain of ecosystem services is created. If you are interested in “Design your green corridor” just click on the respective button and select your region of interest; you will see high resolution data (European Settlement Map 2,5m spatial resolution - https://land.copernicus.eu/pan-european/GHSL/european-settlement-map - processed within LANDSUPPORT). This map will enable the user to better draw the outline of the new green corridor.</p> <p>What for The “m. Green infrastructure” tools allow simulation of the impact of re-naturalization and/or the establishment of new green corridors.</p>
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LIMITATIONS

The user should be aware that tool k “Land take” has some limits:

- some tools/outputs may be incomplete, with some data sources and information, namely .pdf reports produced by tools k2, missing or having low accuracy. Of course, environmental data inherit the limitation of the original dataset. Please check in corresponding metadata.
- there may be miss-classifications of some features due to both bad performance of the classifier and limited resolution (10 metres) of the “ISPRA-SNPA Land Consumption Map”, which is used as an elaboration base layer.
- Rural fragmentation maps are very useful but – for some inherited limitation of the employed algorithm - pixels values closed to the ROI outer boundary must be treated with caution.

FUTURE DEVELOPMENT

The following future developments are expected:

- tool k10 “New green corridor” is to be completed;
- new tool for the Italian territory using ISPRA soil sealing dataset (HRL- imperviousness corrected version)
- an additional algorithm for rural fragmentation (in agreement with ISPRA and EEA standard)
- new tools developed upon request from stakeholders and users
- users will be enabled to upload/download their own files (.shp or similar format) in order to perform analyses.

ⁱ European Commission (2016). *Science for Environment Policy. No net land take by 2050? Future Brief 14*. Produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol. Available at: <http://ec.europa.eu/science-environment-policy>

ⁱⁱ Munafò, M. (ed.) (2020). Consumo di suolo, dinamiche territoriali e servizi ecosistemici. Edizione 2020. Report SNPA 15/20. <https://www.snambiente.it/2020/07/22/consumo-di-suolo-dinamiche-territoriali-e-servizi-ecosistemici-edizione-2020/>

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- Strollo A., Smiraglia D., Bruno R., Assennato F., Congedo L., De Fioravante P., Giuliani C., Marinosci I., Riitano N., Munafò M. (2020), A Map of Land Consumption in Italy, *Journal of Maps*, 16:1, 113-123, <https://doi.org/10.1080/17445647.2020.1758808>
- ⁱⁱⁱ European Commission (2012). *Guidelines on best practice to limit, mitigate or compensate soil sealing*. Available at https://ec.europa.eu/environment/soil/pdf/guidelines/pub/soil_en.pdf
- ^{iv} Special care is required when user draws/select the Region of Interest. In fact LANDSUPPORT is a multi-scale decision support system. Each of the 15 available tools is designed for a specific application and for a specific scale. Furthermore, the databases using specific standards required for that specific scale. The users of LANDSUPPORT web platform must therefore be well aware of the limitation embedded in the different maps that they require for their specific application. The users must be expert on their specific problem and must understand if the input data offered by the platform are suitable for their problem. In light of the above, the system provides very reliable results only if used appropriately.
- ^v It is also possible to draw a ROI with numerous polygons. In this case, it is possible to assign different values (eg numbers) to each of the drawn polygons.
- ^{vi} Langella, G., Basile, A., Giannecchini, S., Moccia, F.D., Munafò, M., & Terribile, F. (2017, April). Soil Monitor: an advanced and freely accessible platform to challenge soil sealing in Italy. In *EGU General Assembly Conference Abstracts* (Vol. 19, p. 8418). Manna, P., Basile, A., Bonfante, A., D'Antonio, A., De Michele, C., Iamarino, M., ... & Terribile, F. (2017). Soil Sealing: Quantifying Impacts on Soil Functions by a Geospatial Decision Support System. *Land degradation & development*, 28(8), 2513-2526.