



## TFM-ext tool for the groundwater vulnerability assessment within a Geospatial Decision Support System (LandSupport project)

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# Presentation outline

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5. The Filtering capacity tool
6. Two case studies (Valle Telesina, IT and Marchfeld area, AU)
7. The operative use of the tool
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# The groundwater vulnerability assessment

Through the EU, high concentrations of nitrates and pesticides represent one of the main risky sources of the pollution for the groundwater resources and have potential long-term impacts on the environment and human health. Consequently, it is important to develop tools which enable us to map the most vulnerable zones with respect to specific land uses.





# The scope of the work

The scope of this work is to present the implementation of the extended Transfer Function Model (TFM-ext) as an operative tool for the groundwater vulnerability assessment within the larger S-DSS developed for LandSupport H2020 project (<https://www.landsupport.eu>).





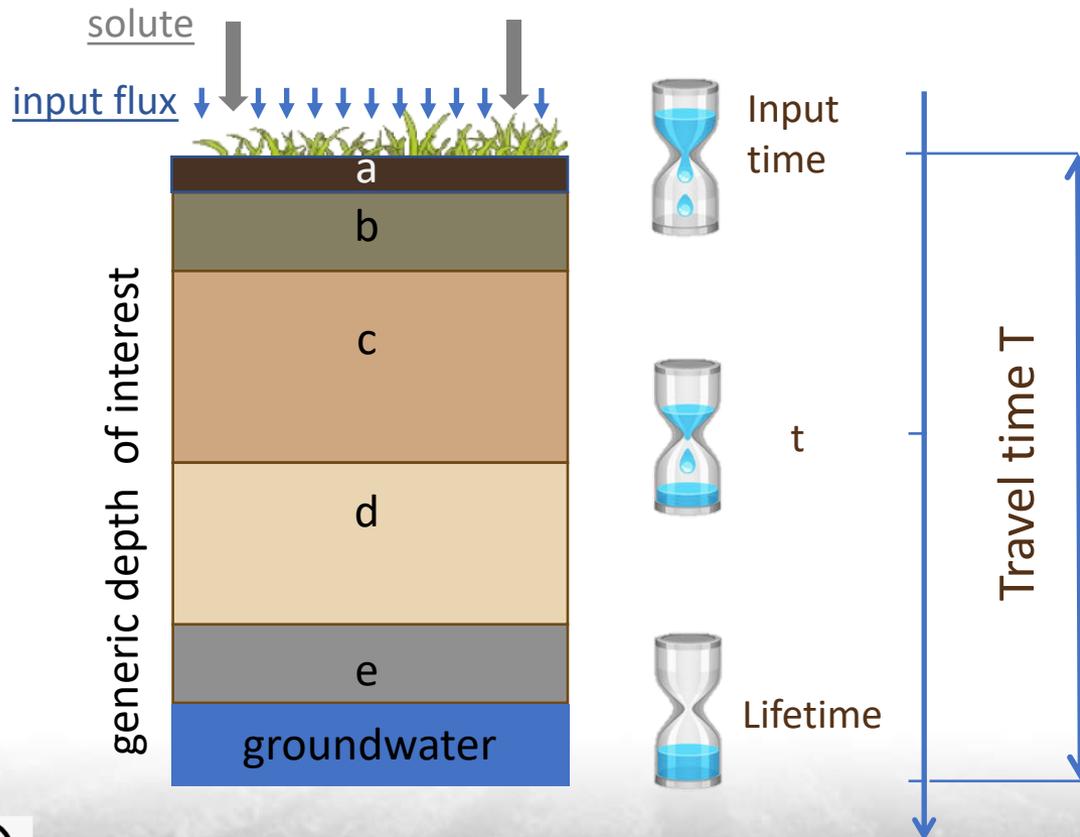
# The scope of the tool

This tool is aimed at helping Public Authorities (Administrative Regions) and Agriculture cooperatives and consortia who need instruments to better relate agricultural activities to groundwater preservation, analysing the natural filtering capacity of the soils under different land use conditions in order to protect the precious groundwater resource.



# The TFM-ext

The TFM-ext is based on the definition of a probability density function for the *travel times* of a solute particles moving in a field soil, (Jury, 1982). For more details, see the Abstract EGU2020-3819.





# The Filtering capacity tool

The values of mean travel times are associated to the filtering capacity of the soil, which is classified according to the percentage of input mass arrived at the depth of interest after one year, as:

- A **high filtering capacity** is associated to long travel times and to a small amount of mass arrived at  $z$  after one year;
- A **low filtering capacity** is associated to short travel times and to a big amount of mass arrived at  $z$  after one year.





# Two case studies

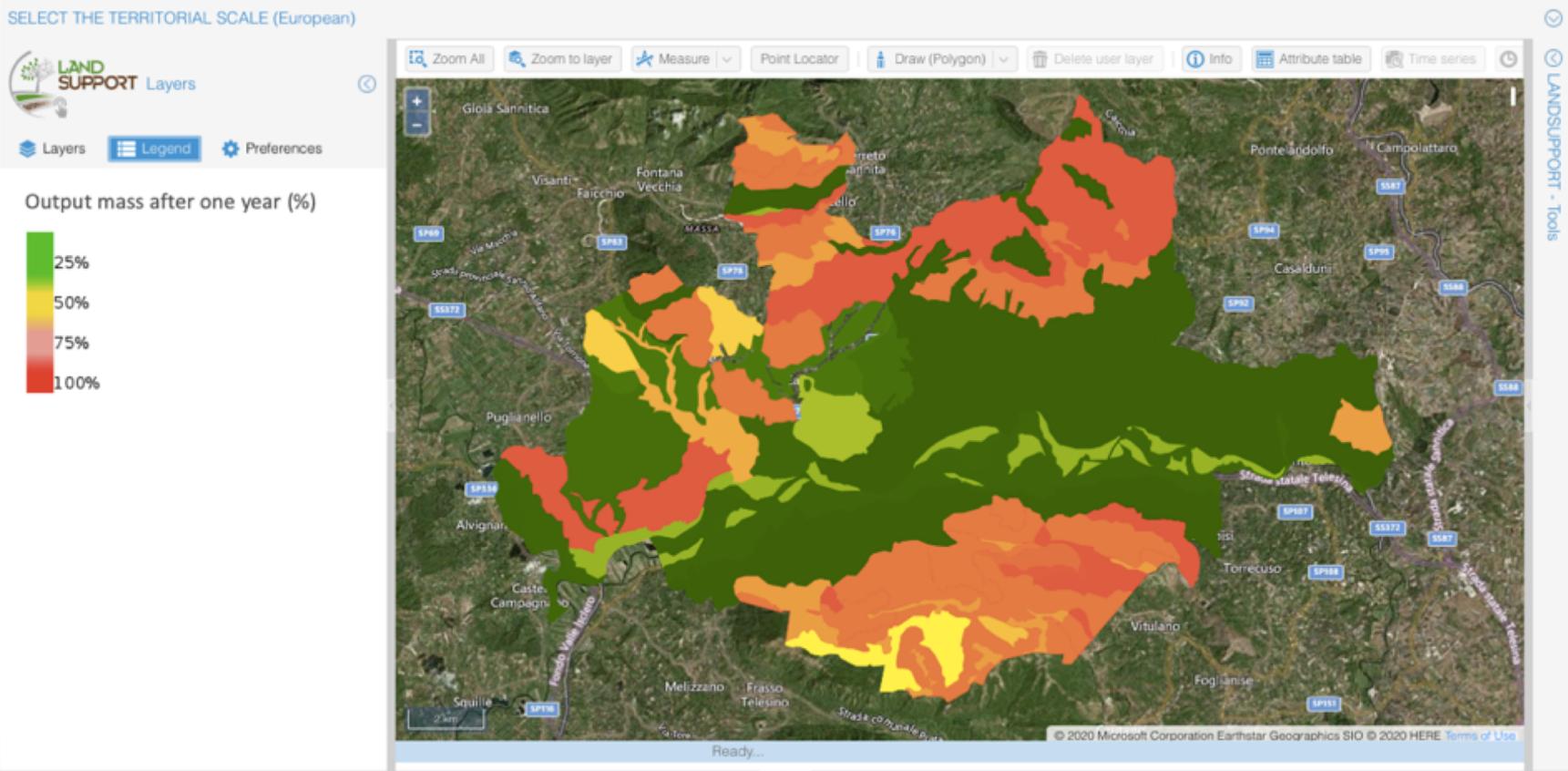
Two applications of the TFM-ext model, considering non-reactive solutes, were done:

- Valle Telesina, a hilly area of 200 km<sup>2</sup> in Southern Italy
- Marchfeld area, a region of around 1000 km<sup>2</sup> in eastern Austria



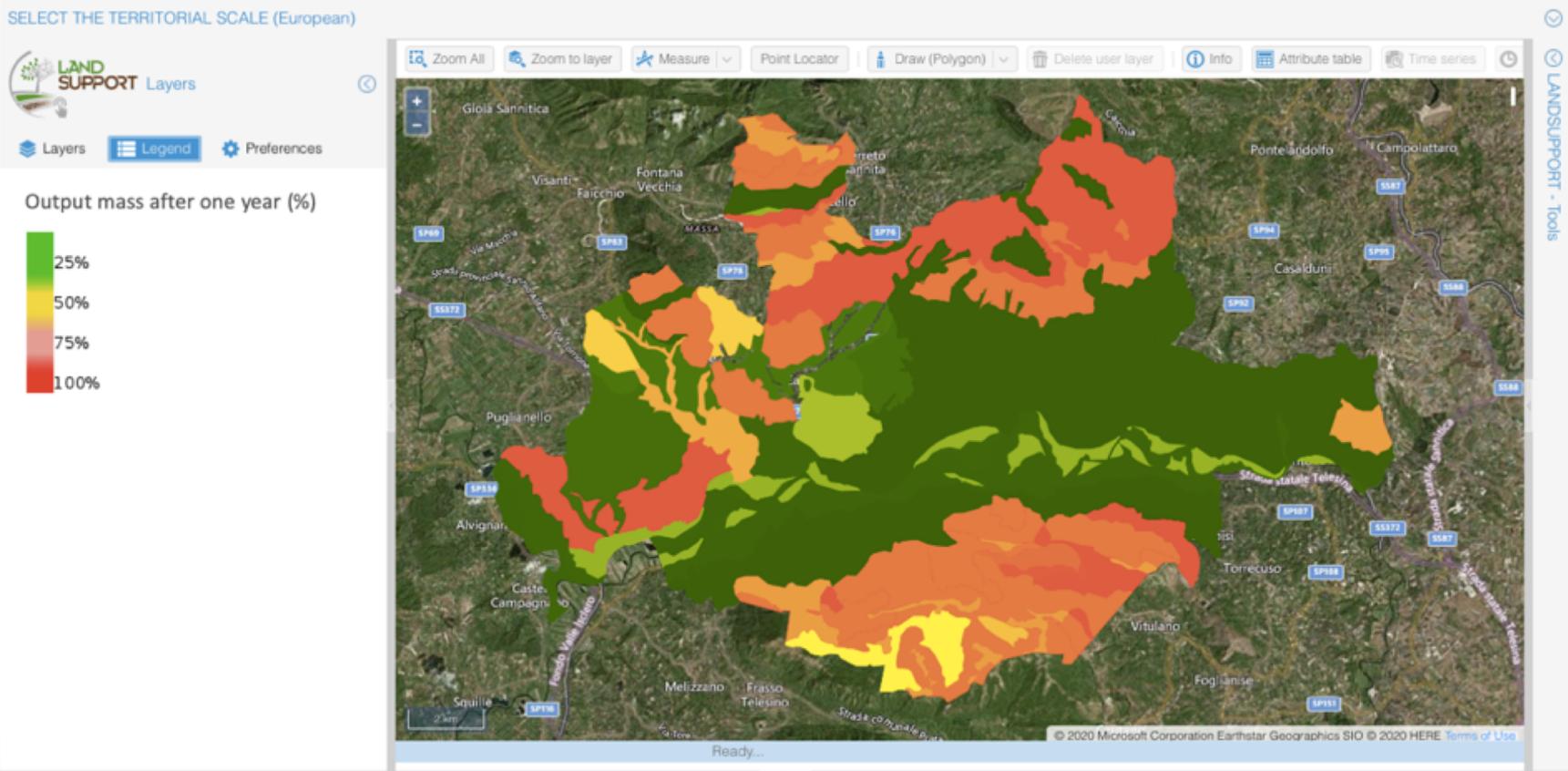
# Valle Telesina, Italy

From the regional handbook and regulations for farmers, 6 different crop scenarios, bare soil, alpha-alpha, maize, vine, olive and wheat, and the related fertilization management were considered for the Telesina Valley. Figure shows the results for a preliminary application considering the maize scenario.



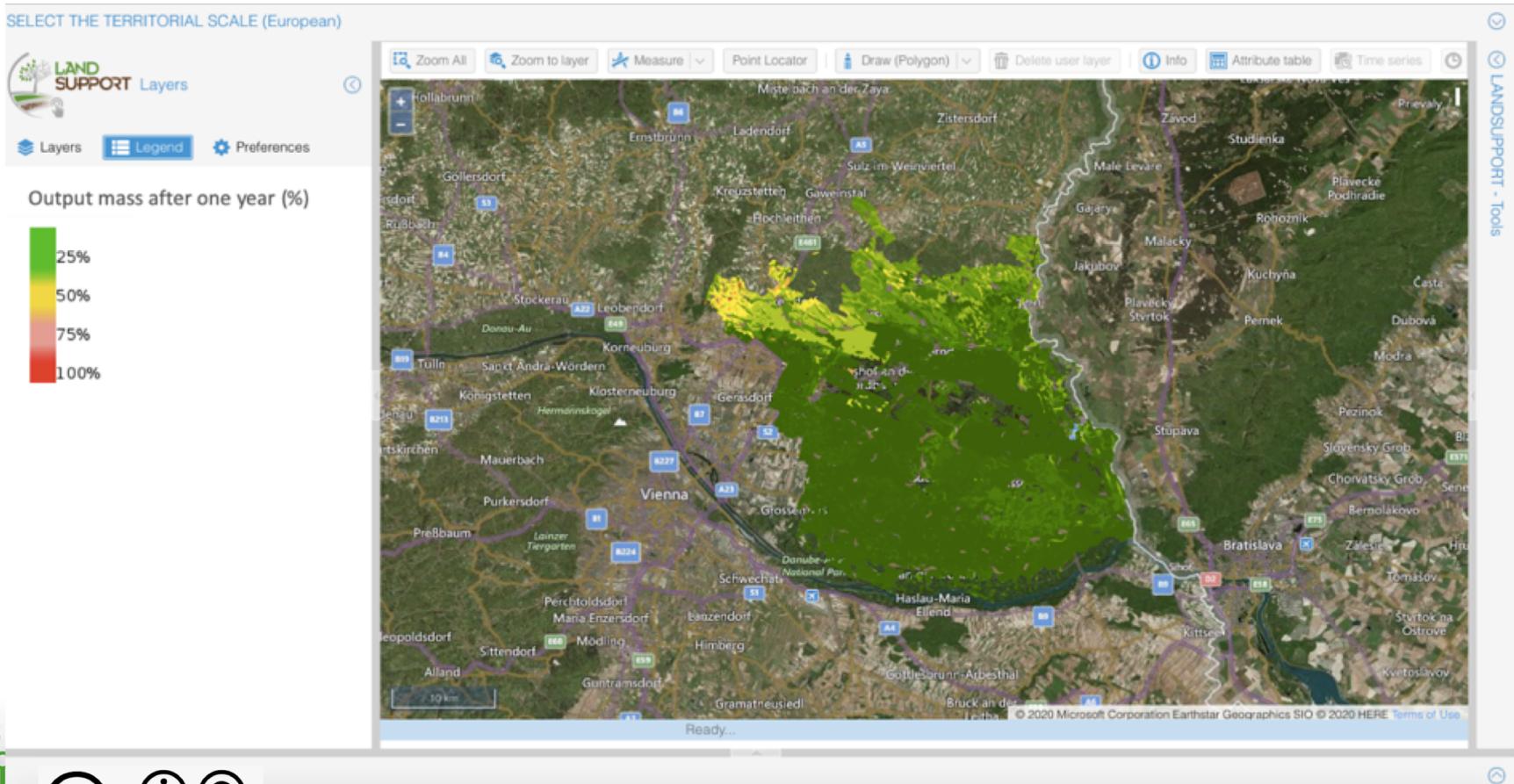
# Valle Telesina, Italy

Most of the soil units have mean travel times above 200 days, which means that the majority of the soils have a good filtering capacity. The different colours are mainly due the different depth considered in the computation, which, for the mountain and hilly parts are the depths of the soil profiles, i.e., 150 cm, and not the groundwater depths.



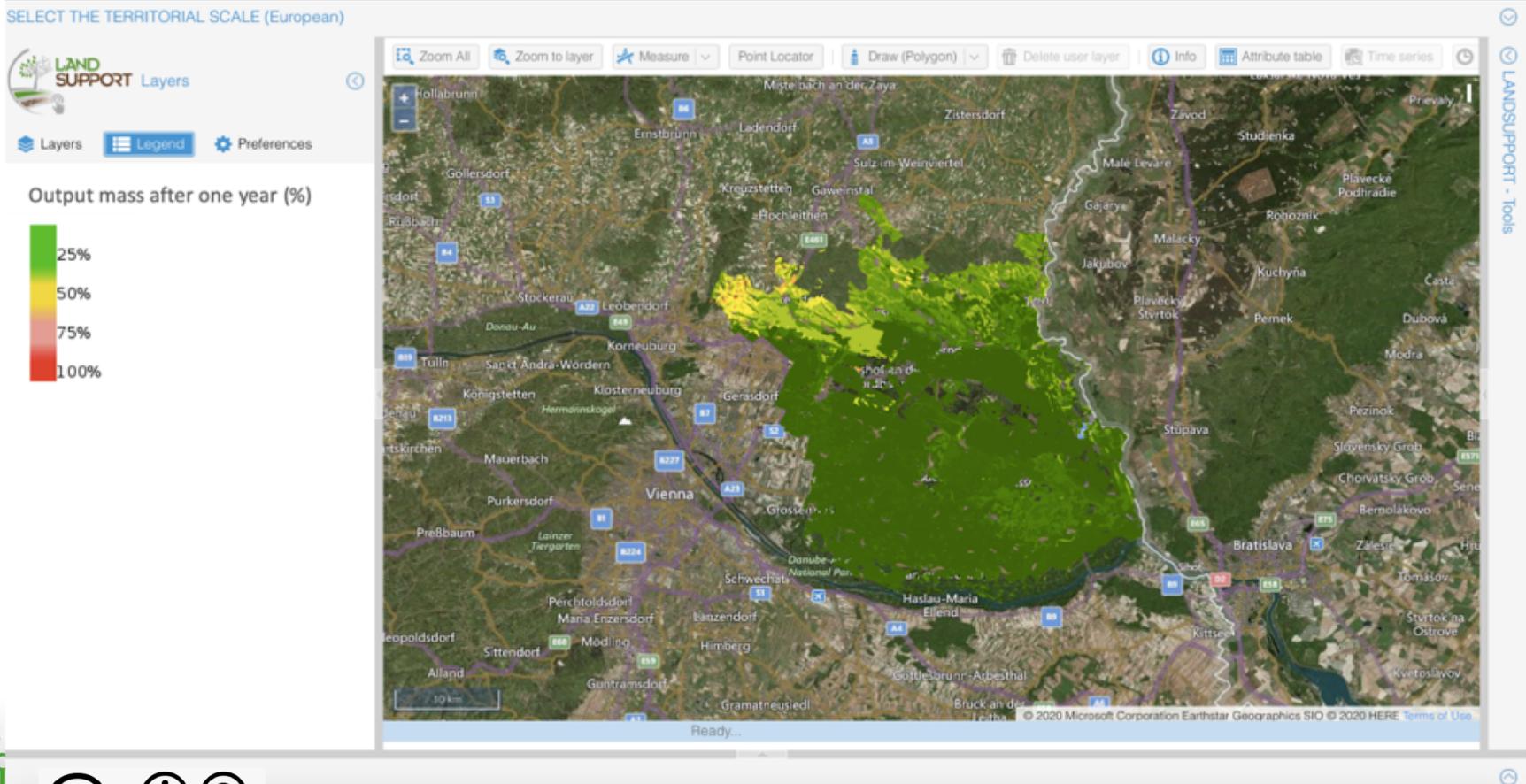
# Marchfeld, Austria

An analogous application was done for the Marchfeld case study, where the regional handbook and regulations for farmers suggested to consider potatoes, sunflowers, soy, maize, wheat and bare soils and the related fertilization management.



# Marchfeld, Austria

Results reported in Figure show that the Marchfeld soils have, in general, a high filtering capacity, with very long mean travel times, around 300 days. Some yellow to red spots are present in the North-Western part of the area, where the depths of the soil profiles, i.e., 200 cm, was considered.





# The operative use of the tool (1/8)

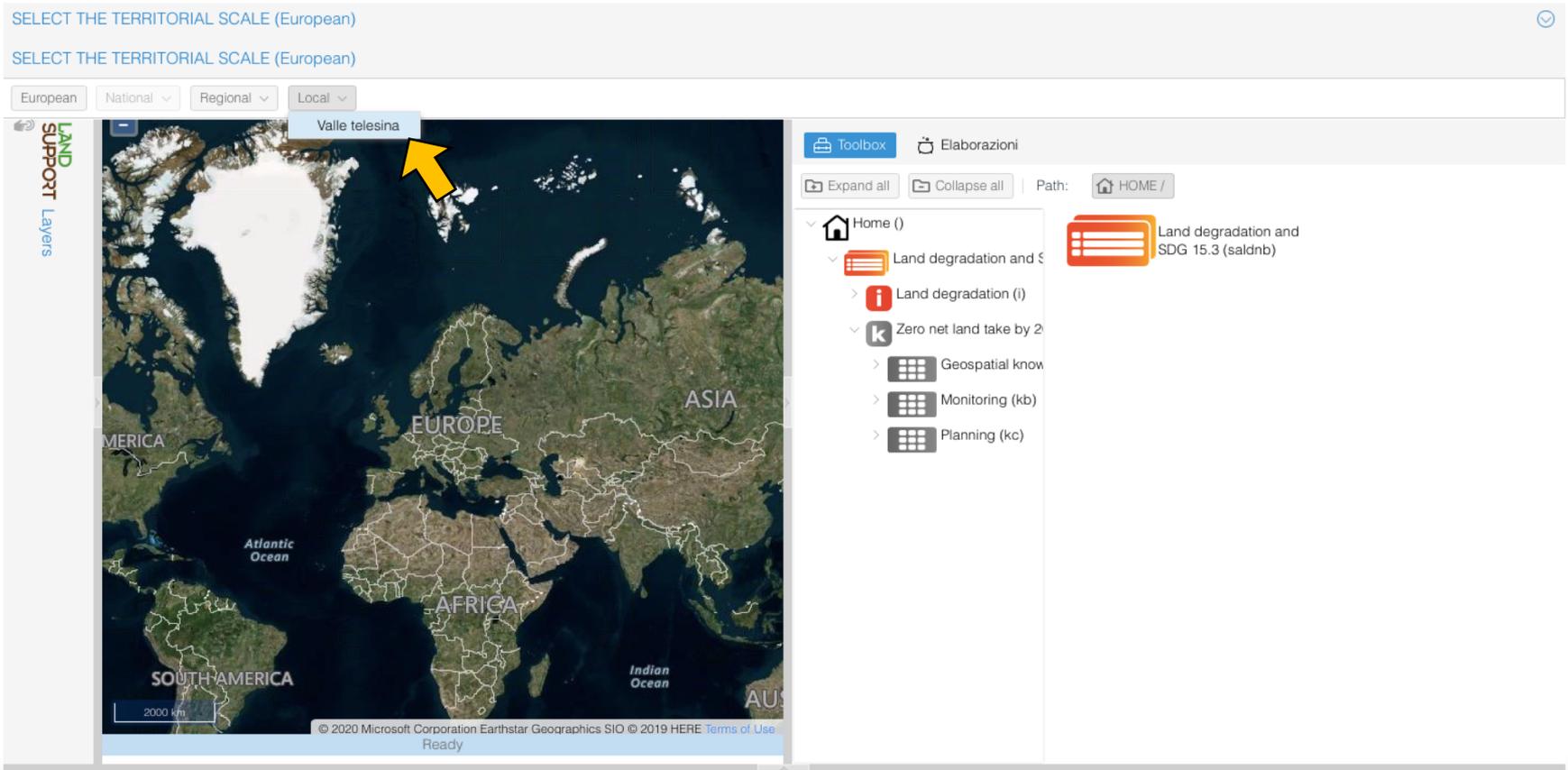
Operatively, the end-user can evaluate the filtering capacity of the soils, by:

- ➔ Defining the Region Of Interest (ROI);
- ➔ Choosing between different land use scenarios.



# The operative use of the tool (2/8)

Select the territorial scale: *Local* for the Valle Telesina, Italy or *Regional* for the Marchfeld area, Austria.



The screenshot displays the LAND SUPPORT web application interface. At the top, there are two dropdown menus for selecting the territorial scale, both currently set to "European". Below these are buttons for "European", "National", "Regional", and "Local". The main map area shows a world map with a yellow arrow pointing to the Valle Telesina region in Italy. The map includes labels for continents (AMERICA, EUROPE, ASIA, AFRICA, SOUTH AMERICA, AUSTRALIA) and oceans (Atlantic Ocean, Indian Ocean). A scale bar indicates 2000 km. The bottom of the map shows copyright information: "© 2020 Microsoft Corporation Earthstar Geographics SIO © 2019 HERE Terms of Use. Ready".

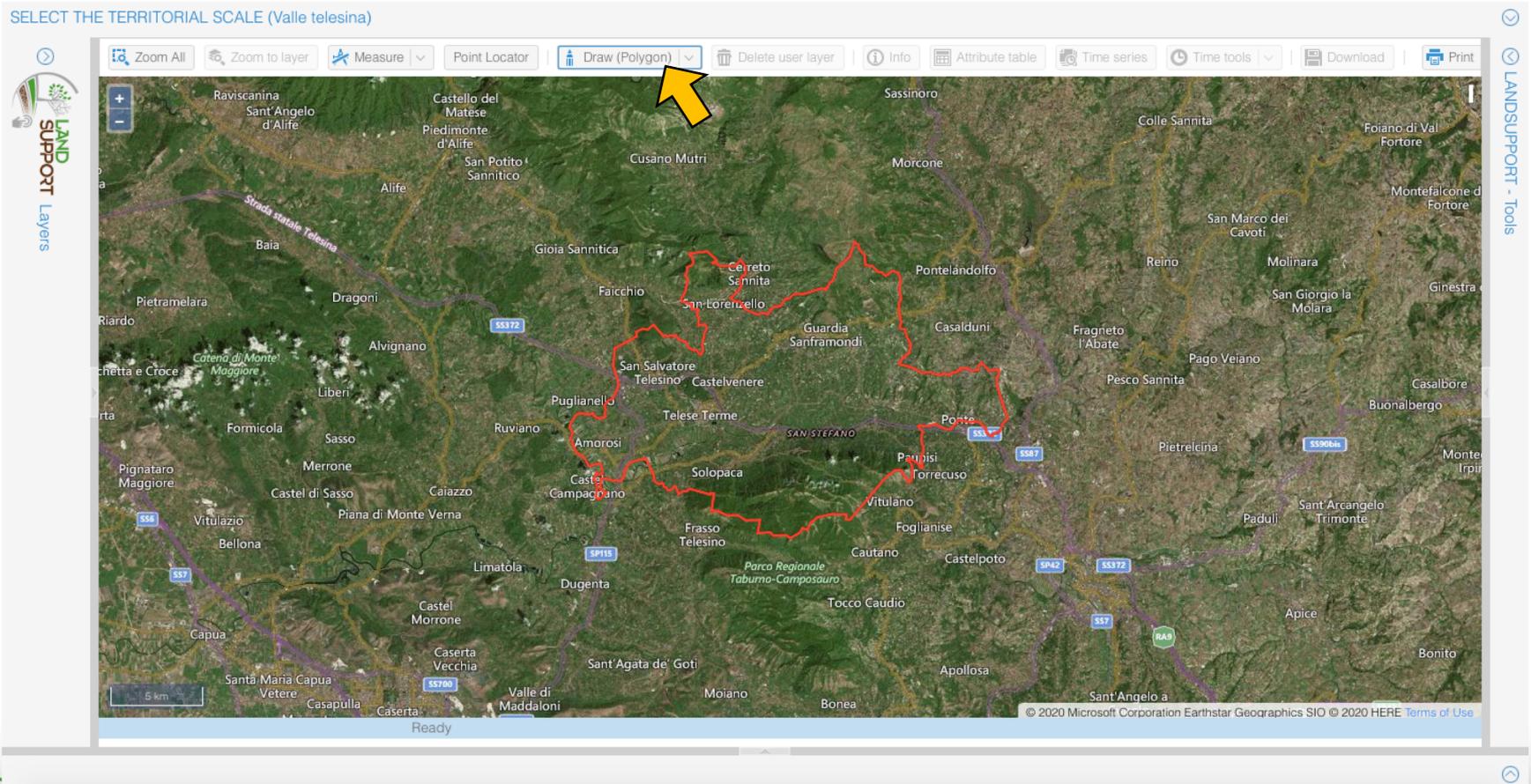
On the right side, there is a "Toolbox" and "Elaborazioni" section. The "Toolbox" contains buttons for "Expand all" and "Collapse all", and a "Path" field showing "HOME /". The "Elaborazioni" section shows a list of layers under "Home ()":

- Land degradation and SDG 15.3 (saldnb)
- Land degradation (i)
- Zero net land take by 2030 (k)
  - Geospatial know
  - Monitoring (kb)
  - Planning (kc)



# The operative use of the tool (3/8)

Click on the "Draw (Polygon)" button on the top bar and draw the desired area (ROI). It is also possible to assign it a name and a value (e.g., a number). Use the "Save" button to store the ROI in the memory of the system.

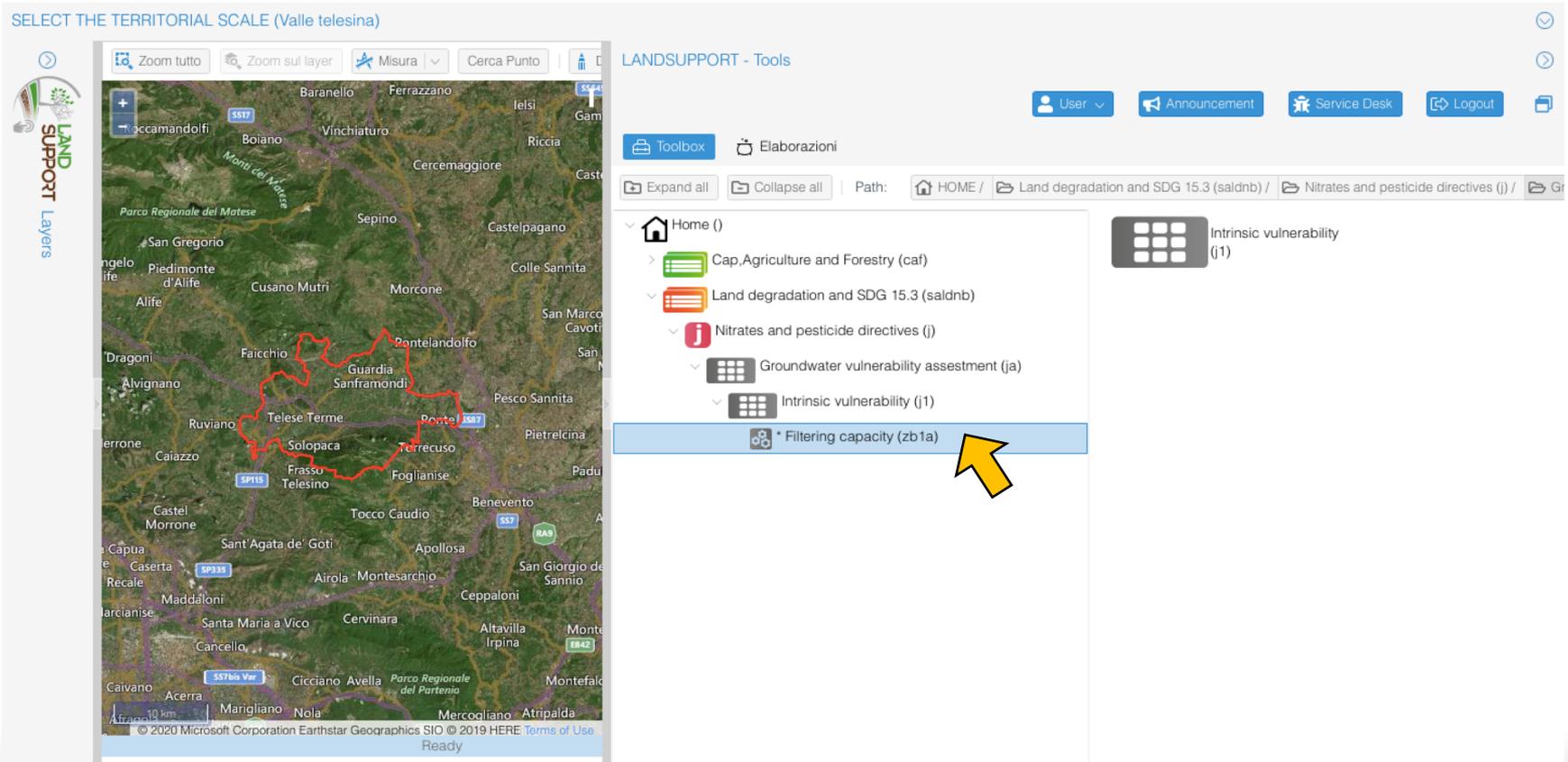


The screenshot displays the LAND SUPPORT web application interface. At the top, a navigation bar includes a search icon, a home icon, and the text "SELECT THE TERRITORIAL SCALE (Valle telesina)". Below this is a toolbar with various tools: "Zoom All", "Zoom to layer", "Measure", "Point Locator", "Draw (Polygon)" (highlighted with a yellow arrow), "Delete user layer", "Info", "Attribute table", "Time series", "Time tools", "Download", and "Print". The main area is a satellite map of the Valle Telesina region in Italy, with a red polygon drawn over a central area. The map is labeled with numerous towns and geographical features. On the left side, there is a vertical sidebar with the LAND SUPPORT logo and the text "Layers". On the right side, there is a vertical sidebar with the text "LANDSUPPORT - Tools". At the bottom of the map, there is a scale bar (5 km) and a copyright notice: "© 2020 Microsoft Corporation Earthstar Geographics SIO © 2020 HERE Terms of Use".



# The operative use of the tool (4/8)

Among the Groundwater vulnerability assessment tools, in the Land degradation and Sustainable Development Goals 15.3 (<https://sustainabledevelopment.un.org/?menu=1300>), select the Filtering capacity tool.

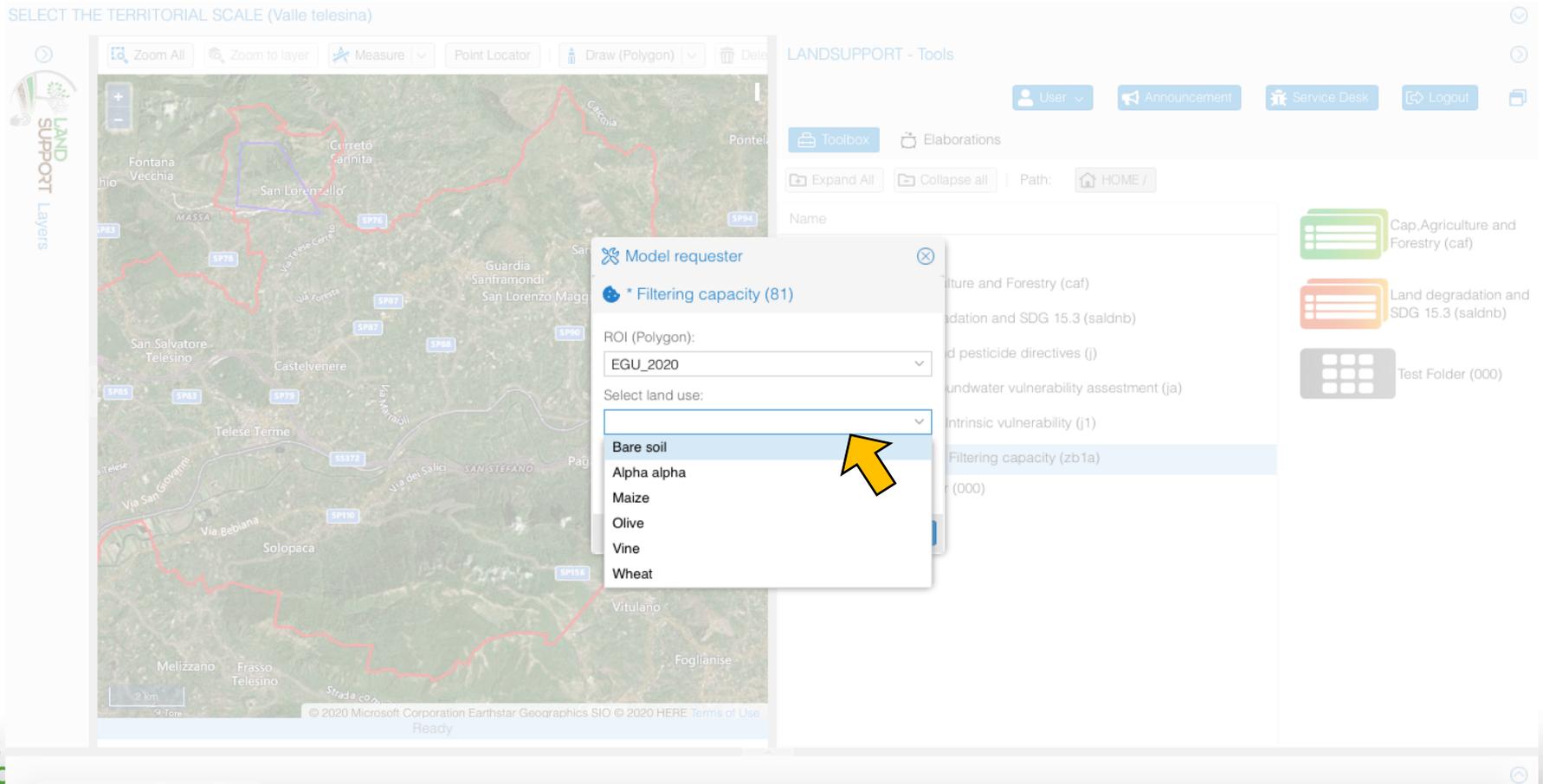


The screenshot shows the LANDSUPPORT - Tools interface. On the left, a map of Valle Telesina is displayed with a red outline indicating the selected territorial scale. The map includes various geographical features and labels. On the right, the 'LANDSUPPORT - Tools' panel is visible, showing a hierarchical list of tools. The 'Filtering capacity (zb1a)' tool is highlighted in blue, and a yellow arrow points to it. The tool selection menu includes the following items:

- Home ()
- Cap, Agriculture and Forestry (caf)
- Land degradation and SDG 15.3 (saldnb)
  - Nitrates and pesticide directives (j)
    - Groundwater vulnerability assessment (ja)
      - Intrinsic vulnerability (j1)
        - \* Filtering capacity (zb1a)

# The operative use of the tool (5/8)

In the pop-up window, select the ROI and the land use, between the already available in the menu.



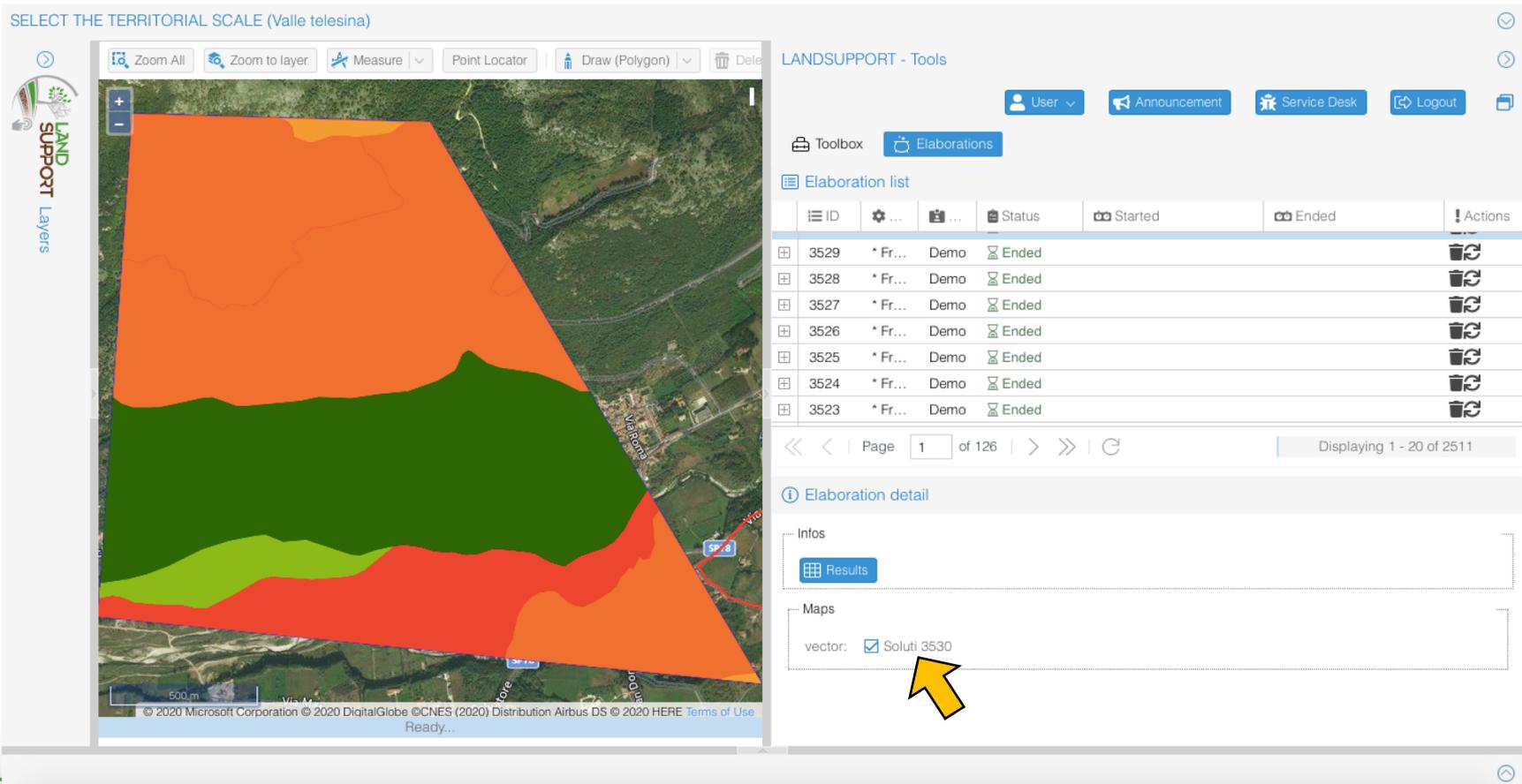
The screenshot displays the LANDSUPPORT web application interface. On the left, a map shows a geographical area with a red boundary and a blue polygon. The map includes labels for various locations like Fontana Vecchia, San Lorenzo, and Castelvenere. On the right, a sidebar contains navigation options like 'User', 'Announcement', 'Service Desk', and 'Logout'. A 'Model requester' pop-up window is open in the center, showing a dropdown menu for 'ROI (Polygon)' with 'EGU\_2020' selected, and another dropdown menu for 'Select land use:' with 'Bare soil' selected. A yellow arrow points to the 'Bare soil' option. The pop-up window also shows a list of models, with 'Filtering capacity (zb1a)' highlighted.



# The operative use of the tool (6/8)

In the Elaboration results panel, after selecting the run, the user can visualize both the summary and the map with the results.

SELECT THE TERRITORIAL SCALE (Valle telesina)



The screenshot displays the LANDSUPPORT web interface. On the left, a map shows a terrain with several colored overlays: orange, green, light green, and red. The map includes a scale bar (500m) and copyright information for Microsoft, DigitalGlobe, CNES, Airbus, and HERE. On the right, the 'LANDSUPPORT - Tools' panel is visible, featuring a user menu, announcement, service desk, and logout buttons. Below these is a 'Toolbox' with 'Elaborations' selected. An 'Elaboration list' table is shown with the following data:

ID	Fr...	Demo	Status	Started	Ended	Actions
3529	* Fr...	Demo	Ended			[Icons]
3528	* Fr...	Demo	Ended			[Icons]
3527	* Fr...	Demo	Ended			[Icons]
3526	* Fr...	Demo	Ended			[Icons]
3525	* Fr...	Demo	Ended			[Icons]
3524	* Fr...	Demo	Ended			[Icons]
3523	* Fr...	Demo	Ended			[Icons]

Below the table, the 'Elaboration detail' section is visible, showing 'Infos' and 'Maps' tabs. Under 'Maps', the 'vector' section has a checked checkbox for 'Soluti 3530', which is highlighted by a yellow arrow.



# The operative use of the tool (7/8)

The summary results table shows, for each soil polygon within the ROI, the classification, the area and the percent output mass after one year of simulation.

SELECT THE TERRITORIAL SCALE (Valle telesina)

**Results**

Soil	Class USDA	Area [...]	Area %	Out. mass after 1 year...
Consociazione dei su...	Typic Hapludands	77.33	26.76	72.30
Associazione dei suoli...	Typic Melanudands e ...	2.15	0.74	98.00
Associazione dei suoli...	Typic Melanudands e ...	2.15	0.74	63.50
Associazione dei suoli...	Lithic Hapludands e T...	41.26	14.28	98.00
Associazione dei suoli...	Lithic Hapludands e T...	41.26	14.28	72.30
Associazione dei suoli...	Lithic Hapludands e T...	0.82	0.28	98.00
Associazione dei suoli...	Lithic Hapludands e T...	0.82	0.28	72.30
Consociazione dei su...	Typic Haplustands	43.52	15.06	0.00
Consociazione dei su...	Alfic Haplustands	52.90	18.31	0.00
Consociazione dei su...	Typic Ustifluvents	36.33	12.57	97.90
Consociazione dei su...	Humic Ustivitrands	22.71	7.86	70.80
Consociazione dei su...	Typic Ustivitrands	0.28	0.10	60.50
Consociazione dei su...	Fluventic Haplustepts	11.71	4.05	22.00

LANDSUPPORT - Tools

User v | Announcement | Service Desk | Logout

Toolbox | Elaborations

Elaboration list

ID	...	Status	Started	Ended	Actions
3529	* Fr... Demo	Ended			
3528	* Fr... Demo	Ended			
3527	* Fr... Demo	Ended			
3526	* Fr... Demo	Ended			
3525	* Fr... Demo	Ended			
3524	* Fr... Demo	Ended			
3523	* Fr... Demo	Ended			

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Elaboration detail

Infos

Results

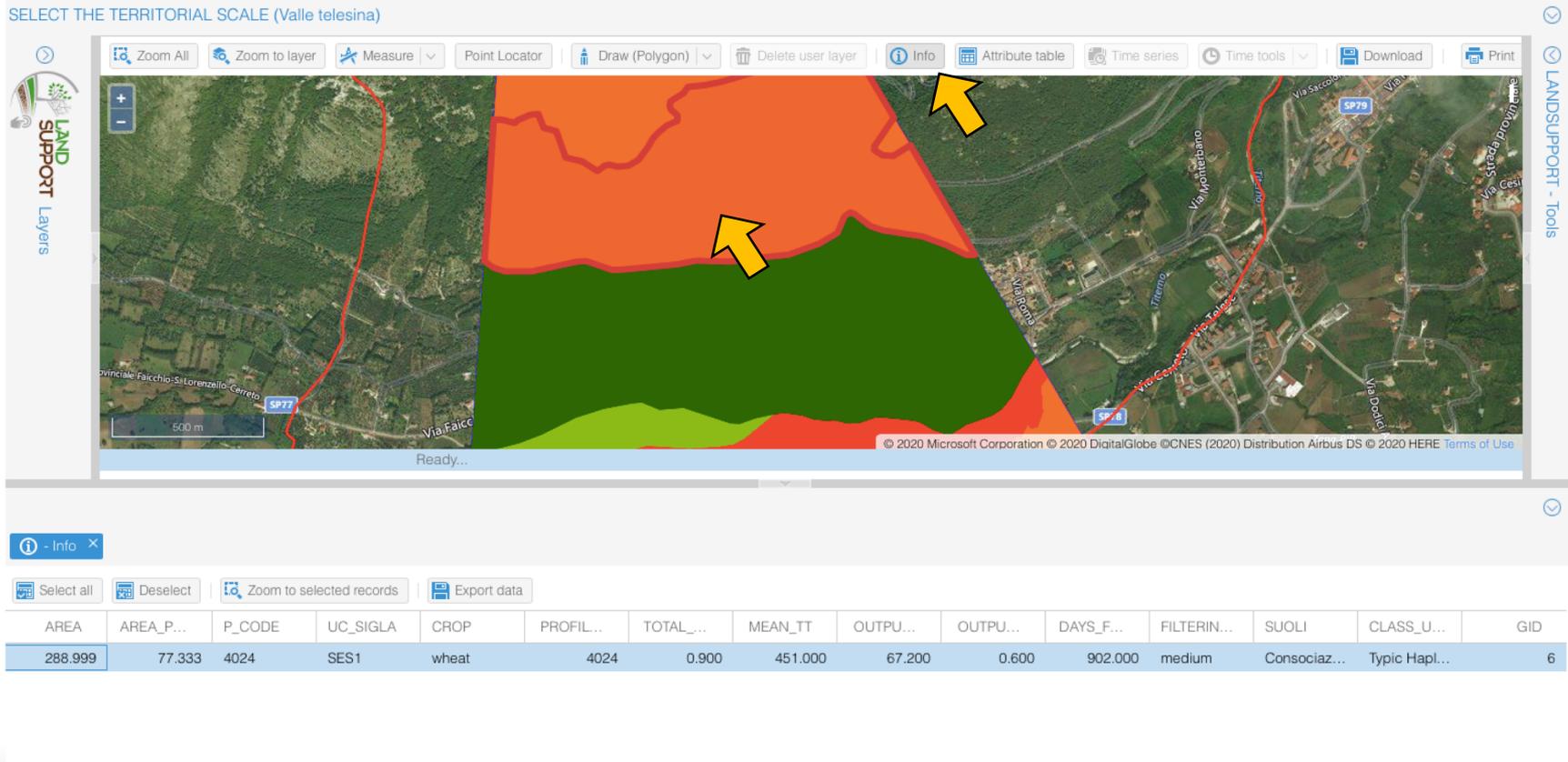
Maps

vector:  Soluti 3530

# The operative use of the tool (8/8)

To get more information, it is possible to click on a specific point on the map and see the results for that soil polygon.

SELECT THE TERRITORIAL SCALE (Valle telesina)



LAND SUPPORT Layers

LANDSUPP... - Tools

Ready...

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Info

Select all Deselect Zoom to selected records Export data

AREA	AREA_P...	P_CODE	UC_SIGLA	CROP	PROFIL...	TOTAL_...	MEAN_TT	OUTPU...	OUTPU...	DAYS_F...	FILTERIN...	SUOLI	CLASS_U...	GID
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# Upcoming improvements and features

- Integration of the reactive solutes (pesticides and fertilizers);
- End-User defined concentration scenarios;
- End-User defined period of simulation;
- End-User defined depth of simulation;
- Post processing of the results: amount of solute arrived at the investigated depth after every year of simulation and cumulative output percent over the entire period;
- Integration within the best practice tool in support for the evaluation of the ecosystem services within LandSupport project;
- Integration with other LandSupport tools, e.g., crop growth model.





# Principal references

- Bancheri, M., Coppola, A. & Basile, A. (2020), Estimating solute travel times in layered soils using an extended transfer function model, manuscript submitted to Water Resources Research.
- Basile, A., Buttafuoco, G., Mele, G., & Tedeschi, A. (2012). Complementary techniques to assess physical properties of a fine soil irrigated with saline water. *Environmental Earth Sciences*, 66(7), 1797-1807
- Jury, W. A. (1982). Simulation of solute transport using a transfer function model. *Water Resources Research*, 18(2), 363-368.
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**THANK YOU**

