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# TOOLS FOR SUSTAINABLE AND SMART LAND USE: SLOVENIAN APPROACH FOR LAND REGENERATION SUPPORT

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ABSTRACT
***Tools for sustainable and smart land use: Slovenian approach for land regeneration support***
*Functionally degraded areas (FDAs) refer to not fully utilized or abandoned land with visible effects of previous use, and of lower utility value. Such areas may have potential for new development and ecological enhancement. In Slovenia, the first database of FDAs was created in 2017, where we developed a completely new spatial data layer in addition to the typology of FDAs and a methodological approach for systematic monitoring. In 2020, we updated the database in collaboration with spatial planners from all 212 Slovenian municipalities. To enable collaboration and to monitor changes in FDAs, we developed a custom application using the ArcGIS Online platform. The presented tools, a new database and an online application, can play an important role in the process of planning and decision making at different spatial levels. They could stop the expansion of built-up areas, contribute to more rational land use according to the principle of "no net land take", support the transition to a carbon-free society and enable active regeneration of degraded areas.*

KEY WORDS
*functionally degraded areas, spatial planning, sustainable development, spatial database, zero land take, land recycling, participatory GIS, Slovenia*

## 1.Introduction

Land is a limited and non-renewable natural resource that is constantly under pressure from various human activities, often associated with serious problems such as irreversible ecosystem changes and inefficient land use (Barbosa et al. 2016). For this reason, efforts to reduce the pressure of human activities on land are increasing worldwide. Concepts such as "recycling - land re-use", "smart shrinkage", pursuing the goal of "no net land take" etc. are being invoked and implemented in policy and planning documents.

Sustainable (spatial) management and land use is one of the priorities of sustainable development and is even recognised by the United Nations through its 11th Sustainable Development Goal which focuses on inclusive, safe, resilient and sustainable cities and covers the spatial aspect of urbanisation with the indicator of land consumption (Marquard et al., 2020). Agricultural and forest land are recognised as non-renewable natural resources, especially when it comes to land consumption. Between 2000 and 2018, 78 % of land take in the EU-28 affected agricultural areas (i.e. arable land, pastures and mosaic farmlands ) (Land take in Europe, 2019). Locating activities on already developed land (e.g. land recycling) reduces the pressure to expand activities on agricultural and forestry land (e.g. greenfield development) and thus makes an important contribution to achieving the goals of sustainable spatial development, "no net land take" by 2050 (Science for Environment Policy, 2016), rational and effective spatial development (Strategija prostorskega razvoja … 2020; Land recycling in Europe, 2016) and green growth (Towards Green Growth, 2011), while it is also relevant in the context of the European Green Deal (A European Green Deal, 2019).

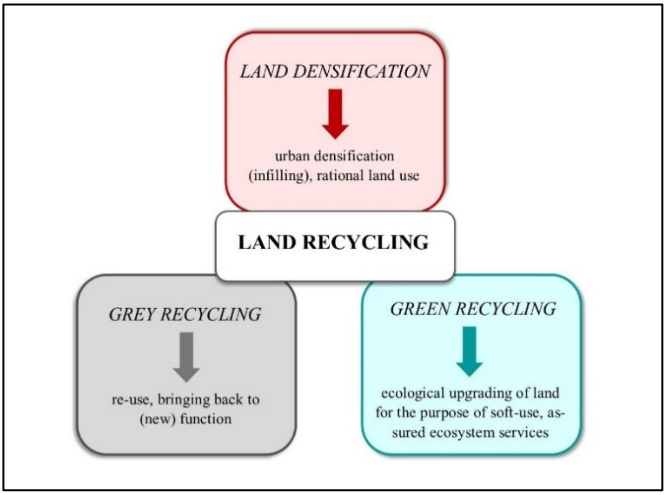


*Figure 1: The land recycling approach as a response to the ongoing pressures to the land resources.*

The loss of agricultural land, especially arable land, is particularly harmful for Slovenia, as we have a very modest amount of agricultural land. Among 38 European Environmental Agency countries Slovenia ranks among the countries with the lowest percentage of agricultural land in use (less than 35%), while it is in an even less favourable position when it comes to the amount of arable land per capita. Decoville and Schneider (2015) noted that "the ambitious political EU objective to stop net land take by 2050 can hardly be systematically monitored in a relevant way with a single tool". They pointed out that the targets and strategies of a given country are often influenced by its different cultural, historical and economic contexts. Therefore, there is a great need for the development of tools and instruments for monitoring dynamics and changes in space that take into account the specificities of countries, as they can more efficiently influence their own land management and planning policies (Decoville and Schneider, 2015; Kušar and Lampič, 2017).

In Slovenia, despite the recommendations and established approaches in the field of sustainable spatial development and soil protection, spatial changes are still intense and reflected in the loss of agricultural land. The current economic development and the establishment of new activities/investments follow new approaches and development opportunities on already developed land only to a limited extent. The strong and increasing dynamics lead to different types of degradation, especially in the physical deterioration of space.

The goal of this paper is to provide an insight into the development of the (geographical) methodological approach to identifying (typology and criteria) and recording functionally degraded areas (FDAs) in Slovenia, carried out between 2015 and 2020. The latest results of the updated FDAs inventory (September 2020) provide data on unused potential of land for redevelopment.

Based on the latest findings, developed practises and tools, the final goal is to present opportunities for their further use. All in all, our systematic monitoring and the datasets obtained have provided important drivers and blockers for brownfield regeneration that could be in the future included in all relevant documents and strategies, and in that way contribute to sustainable and smart land use.

## 1.1 Recognising functionally degraded areas in Slovenia

The definition of degraded area varies and is often associated with soil and/or water contamination. Usually countries have their own definitions, which are strongly linked to specific research, their objectives and methodological approaches. Brownfields are important from a sustainable development and planning perspective, and as the CABERNET Network Report noted, there are difficulties in identifying comparative data due to the lack of national datasets and the differences in definitions (Environmental Liability Transfer in Europe: Divestment of Contaminated Land for Brownfield Regeneration, 2011). Due to the lack of appropriate data, the first comprehensive FDA inventory was produced in September 2017 and was conducted between 2015 and 2017. The FDA database included the clear definition of FDA, the creation of the FDAs typology, and the identification and recording of FDAs (Lampič et al., 2017; Kušar and Lampič, 2017).

We defined functionally degraded areas as underused, partially or completely abandoned areas that show a visible impact of previous use and a diminished value, but at the same time represent a potential for new development (Lampič et al., 2017). Two main criteria were used for their identification - the size of the FDA (more than 5,000 $m^2$) and its degree of abandonment (completely or partially abandoned). Based on the literature review and the obtained data, a typology was developed classifying FDAs according to previous use at these sites. Nine main types were recognised - FDA of agricultural activities, FDA of service activities, FDA of tourist and sports activities, FDA of industrial activities, FDA of defence, protection and rescue services, FDA of mineral extraction, FDA of infrastructures, FDA of transitional use, and FDA for housing (Lampič et al., 2017). Some of these types also have subtypes and it is important to emphasise that the current classification remains open for further upgrading and additional expansion. The database was created as part of funding from the Ministry of Economic Development and Technology, which primarily sought to acquire sites for new investment on previously developed land.

## 2. Methods

The establishment of the first FDA database was accompanied by extensive preparations for fieldwork: direct field visits and interviews with municipal representatives, coordination of meetings, visits, and collection of data on all discovered FDAs. During 2019-2020, we conducted an update and upgrade of the existing database, resulting in a new spatial layer and a new web mapping application. Unlike the establishment of the database, the upgrade was carried out with a participatory approach of the Slovenian municipalities, who could make the perceived changes to the web application themselves. All their entries were reviewed centrally and later, where necessary, field visits and interviews were conducted with the municipalities. There are several reasons for the change in working methods. We had a lot of time and financial resources to build the first base in 2015 to 2017, as this was part of the research project. We also decided to use the traditional geographic method of data collection because the data collection methodology had just been established and greater accuracy and control was needed in establishing the database. In contrast, when updating the database in 2019/20 we had more experience and knowledge, but time and financial resources were much more limited. Our goal was to strengthen contacts and collaboration with regional development agencies and municipalities to generate their interest in the topic. As municipal spatial planners are familiar with their local environment and are best placed to identify changes, this proved to be crucial for the final results.

A different approach became possible due to the rapid development and availability of (GIS) software and hardware in recent years (Veenendaal et.al., 2017; Bobovnik and Potočnik Slavič, 2019). Web mapping was introduced quickly after the creation of the World Wide Web in 1989, with the first web-based map in 1993, and has undergone rapid development since 2004 (Veenendaal et al., 2017). In 2012, ESRI ArcGIS Online was launched as one of the first cloud mapping services, enabling much wider use of web mapping by researchers and users by providing a simple online interface to create, visualize, manipulate, and customize maps not only for specialized users but also for the general public (Veenendaal et al., 2017; González et al., 2019; ArcGIS Online, 2020).

The increasing availability of web mapping services has led to the proliferation of online interactive mapping, participatory GIS, public-participation GIS (PPGIS), collaborative mapping, and similar practices (González et al., 2019). These new collaborative and participatory (mapping) approaches are also finding their way into spatial planning and decision-making through concepts such as participatory spatial planning (PSP) or collaborative planning (McCall and Dunn, 2012). Key to our approach was the transformation of conventional mapping and GIS tools into participatory GIS (PGIS), which enabled the gathering of local knowledge (from municipality level) through user-friendly applications of geospatial technologies.

Based on the experience of setting up the database and some other researches (Bobovnik and Potočnik Slavič, 2019), we designed a working environment and process that was simple, fast and friendly, but at the same time efficient. Above all, we wanted to adapt it to users (e.g. municipal representatives), with the desire to prepare a tool that would allow quick changes, adding photos and other documents, while allowing us to constantly monitor changes. We designed the cloud web mapping application in the ArcGIS Online environment, which does not require installation of any program to operate and can be easily accessed online with a designated username and password (Figure 2). Users thus had an overview of the inventoried FDAs (from the 2017 database) in their municipality and could check the changes on each plot that occurred between 2017 and 2020. The application also allowed them to easily enter newly identified FDA locations and add new photos if there was a major change in the area. The application also allowed users to modify the basemap, query by various search fields (from FDAs variables to municipalities and addresses), print each FDAs and its data, and navigate to FDAs. The application was also fully functional for use on mobile devices, which proved especially crucial during our field visits.

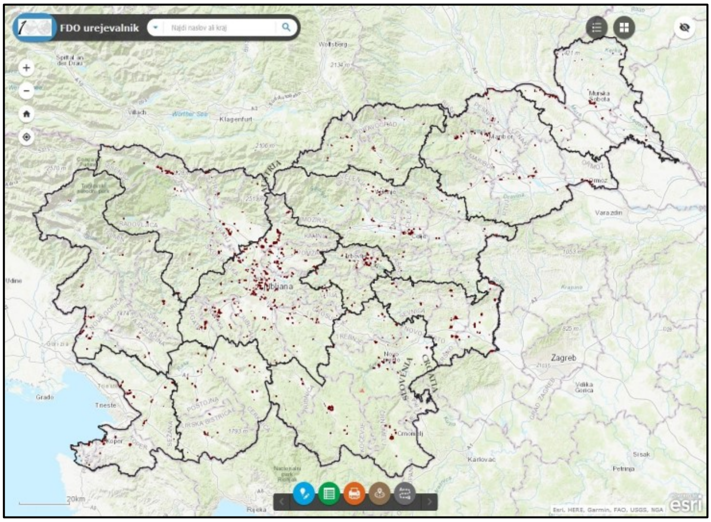


*Figure 2: Editor in ArcGIS Online for entering new locations or changes on FDAs.*

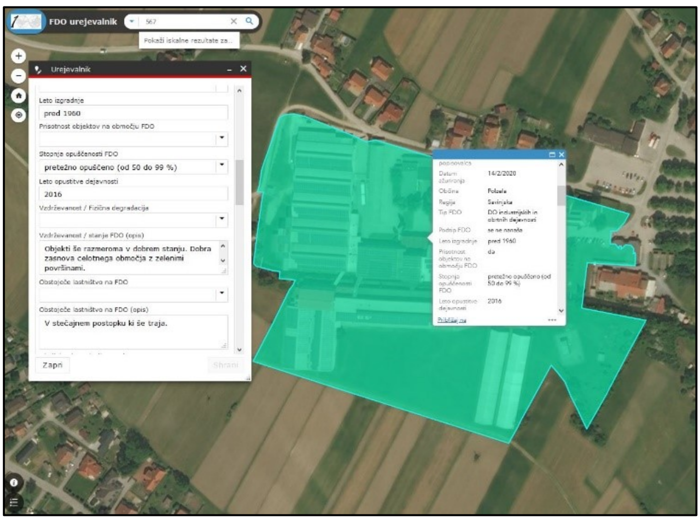


*Figure 3: Pop-up window for entering data and changes to the application.*

Along with the Editor for collecting data, we also prepared an online Dashboard for monitoring the collected data, basic analytics and better communication (Figure 4).

Dashboard was also prepared in the ArcGIS Online environment and was directly connected to the Editor, allowing on-the-fly analyses of the collected/updated data. This approach, with ongoing technical support throughout the project and constant communication with municipalities, regions and other stakeholders, resulted in a high response rate. Not only did we receive data from all 212 Slovenian municipalities, but we also saved time, manpower, materials and finances. The tools generated a lot of interest in the topic among local stakeholders, which allowed us to achieve good project results. In addition, we provided spatial planners at the local level with new knowledge related to sustainable planning principles.

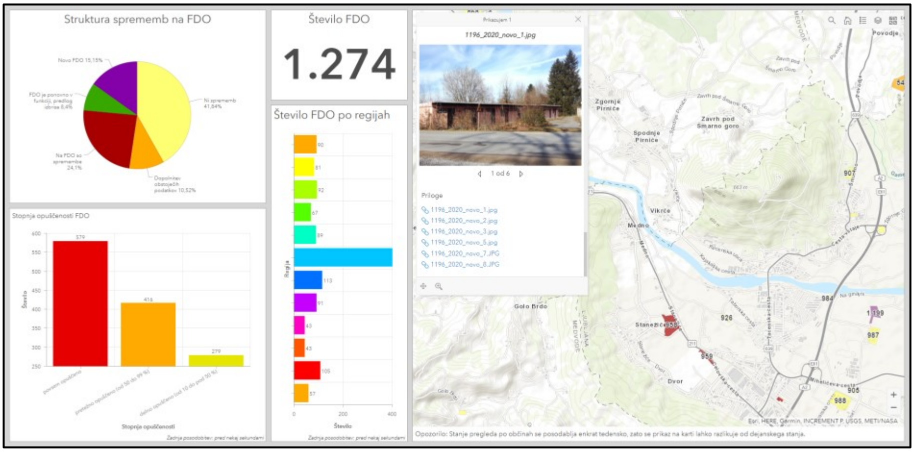


*Figure 4: For monitoring, basic analytics and better communication we created Dashboard in ArcGIS Online.*

## 3. Processes and changes on functionally degraded areas in Slovenia

With the first evidence of FDAs in 2017 and its further update in 2020, Slovenia has extensive and high-quality data on the extent of previously developed unoccupied land potential. In 2020, 1,167 functionally degraded areas with a total area of 3,747 ha were recorded. The inventory showed that by number and total area (ha), FDAs of industrial activities predominate (216; Table 1), followed by FDAs of service activities (191) and FDAs of mineral extraction (182). By area, FDAs of industrial activities (1,119 ha), FDAs of mineral extraction (781 ha), and FDAs of infrastructure (524.2 ha) follow. From the perspective of revitalization, this is important information because most of these areas can have a great impact on environmental pollution due to their past activities and therefore we need a different approach for their revitalization.

*Table 1: Number and total area of functionally degraded areas by their type in Slovenia.*

| FDA type | Number of FDAs | FDA area (ha) |
|---|---|---|
| FDA of industrial activities | 216 | 1,119.0 |
| FDA of infrastructure | 164 | 524.2 |
| FDA of agricultural activities | 85 | 252.8 |
| FDA of defence, protection and rescue services | 35 | 165.1 |
| FDA of transitional use | 140 | 306.0 |
| FDA of mineral extraction | 182 | 781.0 |
| FDA of service activities | 191 | 362.6 |
| FDA of tourist and sports activities | 68 | 133.8 |
| FDA for housing | 86 | 102.3 |
| **Total FDAs** | **1,167** | **3,746.8** |

*Source: Department of geography, Faculty of Arts …, 2020.*

Because we were updating an existing database (from 2017), we focused on the changes to FDAs that were identified during the three-year period. The total number of FDAs increased slightly to 1,167 (from 1,081 in 2017). Completely new FDAs were identified (193), and some were revitalised and are back in function. The total area increased from 3,422 ha (in 2017) to 3,747 ha. Nevertheless, it is important to understand that the changes are multi-faceted. New activities occurred at 107 locations, meaning these areas were revitalised and are excluded from our database, while 193 completely new FDAs were registered. More than half of the FDAs (667 FDAs covering 1,982 ha) had no changes in the three-year period between our recordings (Figure 5).

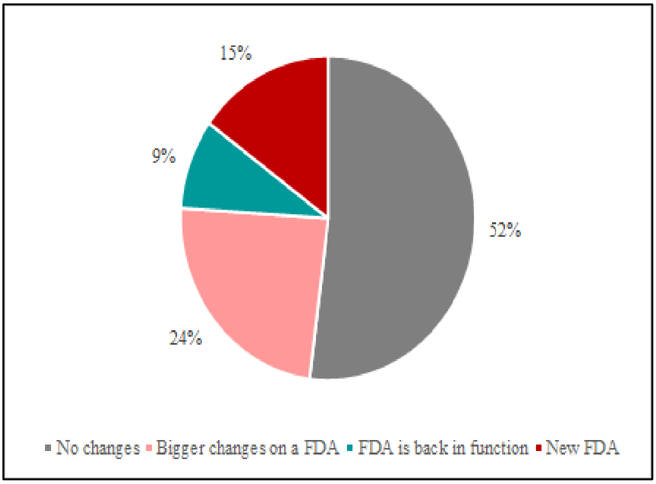


*Figure 5: Monitored changes on functionally degraded areas in Slovenia between 2017 and 2020.*
*Source: Department of geography, Faculty of Arts …, 2020.*

The main reasons for the inactivity of more than half of the FDAs include ownership problems, lack of owner interest in returning degraded land to functional use, old environmental burdens, and financial barriers. However, significant changes were recorded in 307 FDAs (1,155 ha). Some changes were positive as the rehabilitation processes began or revitalization of abandoned building sites and revitalization of industrial and service areas started, while others were negative - e.g. physical conditions continued to deteriorate, buildings were dilapidated, the state of degradation had worsened.

The spatial distribution shows that FDAs occur throughout Slovenia, but there are some differences between regions and between regional centres and the hinterland (Figure 6). When analysing the spatial distribution, it is also important to consider the size of the recorded areas, as it can play a key role in terms of site selection for placement of new development projects. Our analysis showed that FDAs in Slovenia are generally quite small, as the average FDA size is 3.11 ha and only 24 areas in our database are larger than 20 ha.

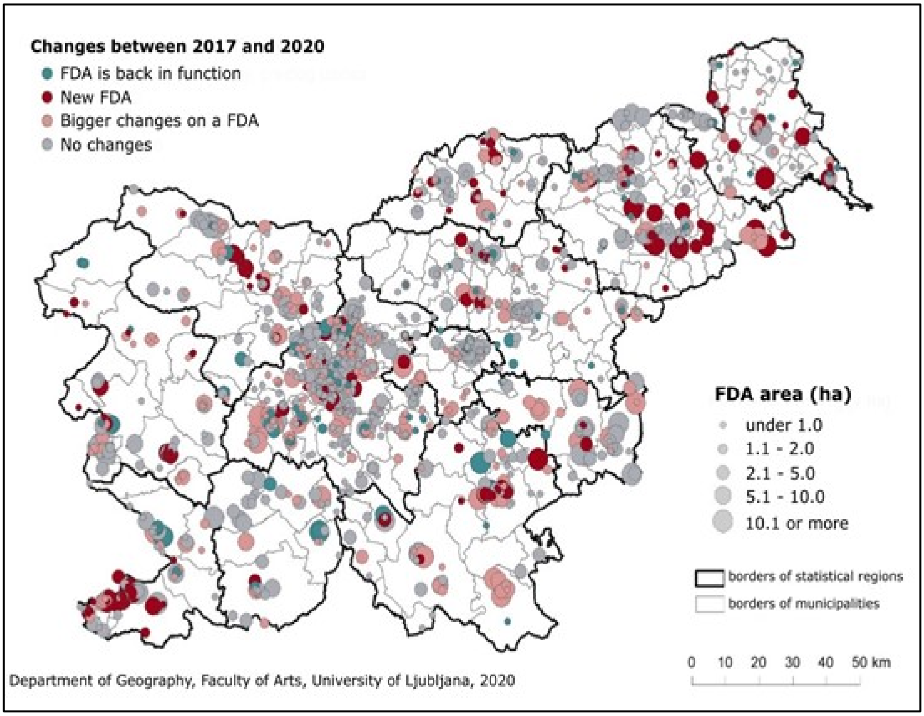


*Figure 6: Spatial distribution, size and changes (2017-2020) of all recorded functionally degraded areas in Slovenia.*

As part of the data collection process we also chacked regeneration plans for each FDA by municipality. In Slovenia, municipal development plans are usually defined by Municipal Detailed Spatial Plan (OPPN). Our inventory showed that there are specific plans for only 22% of the FDAs, while for almost the same number of FDAs (21%) there are no development plans and no options for their revitalisation (according to the municipality responses).

The lack of plans can often also be related to the lack of knowledge and unfamiliarity of the municipalities - they do not know what the private owner is planning for the area. On the other hand, sometimes they have plans and ideas for a particular FDA but cannot implement them due to lack of finances, ownership (e.g. 57% of FDAs are privately owned and ownership is often very fragmented), environmental pollution, etc. The spatial distribution also shows a difference between statistical regions; municipalities from Obalno-kraška and Primorsko-notranjska statistical regions (Western Slovenia) have a large number of defined plans, on the other hand, Pomurska and Podravska statistical regions (Eastern Slovenia) struggle the most (Figure 7). If we look at the development plans by FDA type, we can see that most plans exist for FDAs of mineral extraction and FDAs of transitional use, while for the areas of abandoned agricultural activities and tourism and sports activities the plans remain most uncertain (Figure 8).

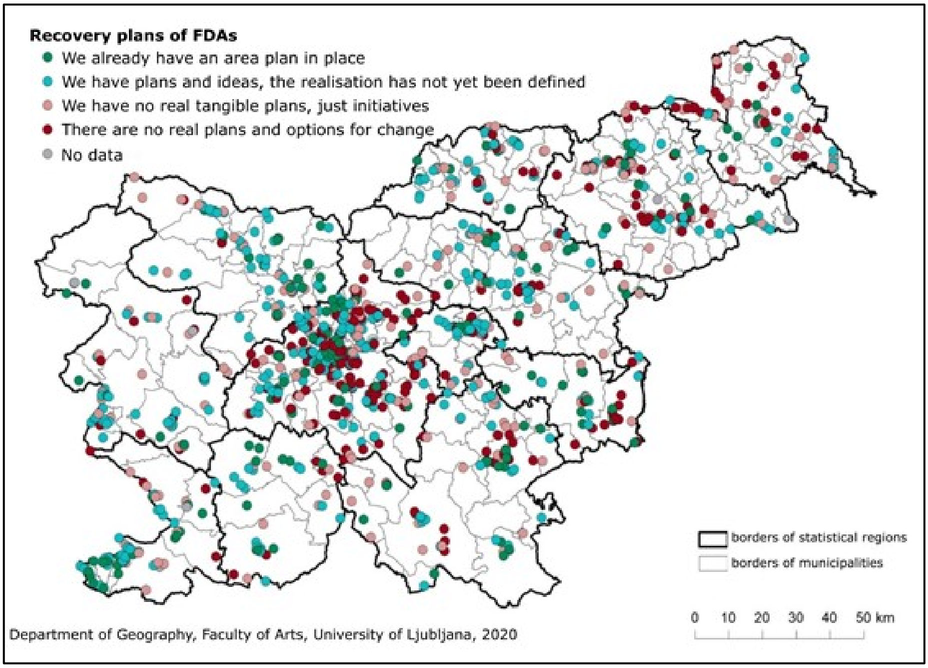


*Figure 7: The recovery plans of functionally degraded areas.*

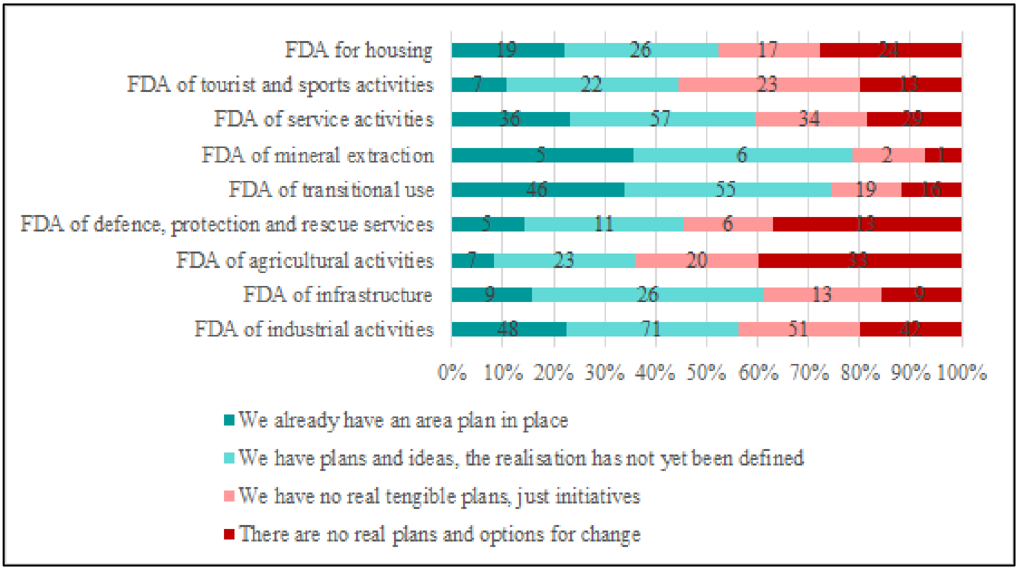


*Figure 8: Plans of regeneration by the type of functionally degraded area.*
*Source: Department of geography, Faculty of Arts …, 2020.*

Most often we can find the reasons for successful or unsuccessful regeneration in the financial investment required, ownership structure, municipal and national spatial documents, lack of public infrastructure and legislation. The newly recorded FDAs from 2020 were mostly related to illegal dumping and transitional land use, which means that new types of degraded land are forming. Nevertheless, we also came across some very positive examples of FDA revitalisation, which in some ways can be case studies for other revitalisation projects and for future planning strategies (Figure 9 and Figure 10).

*Figure 9: The disused construction site was recorded in 2017 (a). In 2019 the investment to new apartments was completely finished (b).*
*Source: Department of geography, Faculty of Arts …, 2020.*

*Figure 10: An example of green recycling: abandoned military area in Novo mesto municipality (a) was transformed into a The Equestrian Sport School Centre (b). Source: Department of geography, Faculty of Arts …, 2020.*

## 4. Conclusions

In this paper we present two different tools developed by geographers that have the potential to be used directly in the spatial planning process. They facilitate sustainable and smart land use. The first tool - an updated inventory (database) of FDAs was realised in 2020 (however, the first database was created in 2017). The second tool - the web mapping application (online) was developed in 2019 and enabled the implementation of latest approaches and practises with participatory spatial planning and participatory GIS. Both tools offer multiple benefits in terms of data collection, data analysis, communication with stakeholders and offer many different ways of implementation in spatial planning.

The developed approach was successful as we received high quality and up-to-date information from all 212 Slovenian municipalities, we also saved time, manpower and finances. Properly developed tools also strengthen communication and cooperation with regional development agencies and municipalities and stimulate public awareness. The new spatial layer (database) and participatory approach also contribute to the preparation of municipal spatial plans. The reasons for the successful implementation lie mainly in the simplicity of the tools used and the constant support and communication with stakeholders.

Table 2: Recognised benefits of developed tools.

| **Tool 1: Updated FDAs database** | **Tool 2: Online application** | |
|---|---|---|
| | **Editor functions** | **Dashboard functions** |
| • New data: precise location (based on cadastre), size, previous activity, ownership structure, environmental burdens, years of abandonment, etc.<br>• Evidence of land availability – facilitate planning of land recycling.<br>• Monitoring of degraded areas regeneration on different spatial levels.<br>• Development of strategic documents - quantitative policy targets.<br>• Possibility of monitoring changes - development of different indicators. | • Permanent data collection assured.<br>• Collaborative spatial planning approach.<br>• Raising stakeholders awareness and knowledge transfer.<br>• Enhanced data-manipulation capabilities.<br>Data querying and map exploration. | • Monitoring data updates.<br>• Communication with different stakeholders.<br>• Communication with public.<br>• Raising public awareness.<br>• Better visualisation. |

The analysis of the updated database confirmed a great dynamic in the FDAs in the period 2017-2020. Certain areas are reactivated faster than others, but only a more detailed analysis of the FDAs can identify the key factors that influence the possibility of their revitalisation. The process of change and the rate of its success is subject to various factors, such as size, degree of abandonment, ownership, existing infrastructure and its physical deterioration, environmental pressures, etc. (Kušar and Lampič, 2017).

In Slovenia, both presented tools have high potential for future sustainable spatial planning and land management. The adoption and importance of our five-year research and applicative work is reflected in the implementation of FDAs in Slovenian Development Strategy 2030 (Slovenian development … 2018), the official environmental indicator (included in the system of Slovenian Environmental Agency) and the use of the FDAs database in the preparation of regional development plans (for the period from 2021 to 2027). Nevertheless, we see further potential of the tools developed and the current FDAs database obtained - primarily for comprehensive preparation of policies that would contribute to more efficient and systematic redevelopment of previously developed land. There is also potential for the use of similar participatory GIS tools for different spatial planning and decision-making applications.

## 5. References

A European Green Deal. 2019. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (7.12.2020).

ArcGIS Online. 2020. https://www.esri.com/en-us/arcgis/products/arcgis-online/overview (11.12.2020).

Barbosa, A. L., Vallecillo, S., Baranzelli, C., Jacobs-Crisioni, C., Silva, F., Perpiñá Castillo, C., Lavalle, C., & Maes, J. 2016: Modelling built-up land take in Europe to 2020: an assessment of the Resource Efficiency Roadmap measure on land. *Journal of Environmental Planning and Management,* 60, 8, 1439–1463. DOI: 10.1080/09640568.2016.1221801.

Bobovnik, N., Potočnik Slavič, I. 2019: (Ne)privlačnost z vidika življenja in dela na podeželju: Terensko evidentiranje z metodo sodelovalnega kartiranja. *Dela,* 51, 27-50. DOI: 10.4312/dela.51.27–50.

Decoville, A., & Schneider, M. 2016: Can the 2050 zero land take objective of the EU be reliably monitored? A comparative study. *Journal of Land Use Science,* 11, 3, 331–349. DOI: 10.1080/1747423X.2014.994567.

Departmet of Geography, Faculty of Arts, University of Ljubljana. 2020. Archive od FDAs database.

Environmental Liability Transfer in Europe: Divestment of Contaminated Land for Brownfield Regeneration. NICOLE Brownfield Working Group. 2011. https://nicole.org/uploadedfiles/2011-wg-brownfields-finalreport.pdf (8.12.2020).

González, A., Kelly, C., Rymszewicz A. 2019: Advancements in web-mapping tools for land use and marine spatial planning. *Transactions in GIS*, 24, 253–267. DOI: 10.1111/tgis.12603.

Kušar, S. & Lampič, B. 2017: Opredelitev prednostnih območij za reaktivacijo funkcionalno neizkoriščenega prostora. *Urbani izziv, strokovna izdaja*, 7, 19–26. https://urbaniizziv.uirs.si/Portals/urbaniizziv/Clanki/2017/Opredelitev%20prednostnih%20obmo%C4%8Dij.pdf (12.12.2020).

Land recycling in Europe. Approaches to measuring extent and impacts, EEA Report. No. 31. 2016. https://www.eea.europa.eu/publications/land-recycling-in-europe (10.12.2020).

Land take in Europe. Indicator assessment. 2019. https://www.eea.europa.eu/data-and-maps/indicators/land-take-3/assessment (10.12.2020).

Lampič, B., Kušar, S., & Zavodnik Lamovšek, A. 2017: A model of comprehensive assessment of derelict land as a support for sustainable spatial and development planning in Slovenia. *Dela*, 48, 33–59. DOI: 10.4312/dela.48.2.5–59.

Marquard, E., Bartke, S., Gifreu, J., Humer, A., Jonkman, A., Jürgenson, E., Marot, N., Poelmans, L., Repe, B., Rybski, R., Schröter-Schlaack, C., Sobocká, J., Sørensen, M., Vejchodská, E., Yiannakou, A., & Bovet, J.

2020: Land Consumption and Land Take: Enhancing Conceptual Clarity for Evaluating Spatial Governance in the EU Context. *Sustainability,* 12, 8269. DOI: 10.3390/su12198269.

McCall, M. K. & Dunn C. E. 2012: Geo-information tools for participatory spatial planning: Fulfilling the criteria for 'good' governance? *Geoforum*, 43, 1, 81–94. DOI: 10.1016/j.geoforum.2011.07.007.

Science for Environment Policy. No net land take by 2050? Future Brief 14. 2016. Bristol, European Commission DG Environment by the Science Communication Unit. https://ec.europa.eu/environment/integration/research/newsalert/pdf/no_net_land_take_by_2050_FB14_en.pdf (10.12.2020).

Slovenian Development Strategy 2030. 2018. https://www.gov.si/assets/vladne-sluzbe/SVRK/Agenda-2030/Implementing_the_Agenda2030_update_2018.pdf (14.12.2020).

Strategija prostorskega razvoja Slovenije 2050. Osnutek dokumenta v javni razpravi. 2020. Ljubljana, Ministrstvo za okolje in prostor RS, 85 pp. https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Prostorski-razvoj/SPRS/SPRS-2050_gradivo-za-javno-razpravo.pdf (11.12.2020).

Towards Green Growth. A summary for policy makers. May 2011. OECD. 2011. https://www.oecd.org/greengrowth/48012345.pdf (8.12.2020).

Veenendaal, B., Brovelli, M. A., Li, S., 2017: Review of Web Mapping: Eras, Trends and Directions. *International Journal of Geo-information*, 6, 317. DOI: 10.3390/ijgi6100317.