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MAPPING TEXTILE WASTE FLOWS IN SERBIA BASED ON OFFICIAL REGISTRY DATA

Research paper

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Abstract: Textile waste represents a growing environmental challenge, yet reliable data on its generation and management in Serbia remains limited. This study maps and analyzes reported textile waste flows in Serbia using data from the National Registry of Pollution Sources (NRIZ) GIS portal and Serbian Environmental Protection Agency (SEPA) official reports from 2020. The analysis focuses on waste index numbers related to the textile, leather, and fur industries, primarily Waste index number 04 02 22 (waste from processed textile fibers). The findings reveal a strong regional concentration of industrial waste generation, with landfill disposal being the dominant management method, accounting for approximately 63% of the tracked waste. Treatment and export volumes are minimal, while no recorded cases of incineration with energy recovery were identified. Crucially, the registry captures only the industrial and commercial segment of the waste chain. Household textile waste remains invisible in official statistics due to legal reporting exemptions, creating a significant blind spot. Linking this data gap through direct household assessments and localized tracking is essential for developing effective recycling infrastructure and circular economy policies in Serbia.
Key words: Textile waste, Circular economy, Serbia, Waste

INTRODUCTION

The textile production industry has one of the most complex value chains in manufacturing, involving various sectors, including agriculture, chemical fiber production, textiles and apparel, retail and services. (Beton et al., 2014). The textile value chain generates significant amounts of waste, largely associated with the rapid growth of fast fashion, while also contributing to greenhouse gas emissions and high-water use (Mitsigiorgi et al., 2025). These impacts are expected to increase further, with textile production projected to generate 62% more waste, use 50% more water, and emit 63% more carbon dioxide by 2030 than in 2015 (Dragović et al., 2023).

In Serbia, textile waste generation was estimated at approximately 1 kg per person in 2022 (Kokeza et al., 2026), accounting for around 4% of municipal waste and approximately 100,000t annually (Milosevic et al., 2023). Textile waste is generated throughout the textile value chain, including both industrial processes and the post-consumer stage. Industrial textile waste arises from the production of fibers, textiles, clothing, and other textile products, while post-consumer textile waste is generated when textile products are discarded by consumers.

However, the domestic textile and clothing industry has decreased in recent years, with the largest reductions recorded in textile production in 2021 (6.5%) and clothing production in 2020 (6.9%). Leather production, in contrast, increased in 2021 and 2022 before falling by nearly 15% in 2023 (Kokeza et al., 2026)

According to Article 75 of the Law on Waste Management applicable during the 2011–2024 reporting period, households are exempt from the obligation to report waste generation, while reporting is required for legal entities, entrepreneurs, and other waste holders (Republic of Serbia, 2009). Within this reporting framework, the National Registry of Pollution Sources (NRIZ) and its GIS portal contain records covering several waste categories related to the textile sector. These include waste from textile, fur, and leather industries, classified with Waste **index number** under group 04 covering the:

- 04 02 09 (waste from mixed materials, including impregnated textiles, elastomers, and plastomers),
- 04 02 21 (waste from unprocessed textile fibers), and

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- 04 02 22 (waste from processed textile fibers)

The registry also includes Waste index number **20 01 11**, referring to textiles from municipal sources, including household and similar commercial waste and separately collected fractions. The aim of this study is to examine what the available official data show about textile waste flows in Serbia, including where textile waste is generated and how it is managed, and to identify data gaps that limit a complete understanding of textile waste flows, particularly at the household level.To achieve this, the study analyzes the spatial distribution of reported textile waste generation and the main management pathways, including treatment, disposal, and export.

MATERIAL AND METHODS

The analysis was based on secondary data from official Serbian waste management sources. The primary source was the National Registry of Pollution Sources (NRIZ), specifically its GIS portal for waste management, supplemented by annual Waste Management Reports published by the Serbian Environmental Protection Agency (SEPA) and other available national strategic documents. Official data were accessed from the NRIZ GIS portal in August 2026. The records in the registry date from 2020, representing the most recent information available in the database at the time of the study (SEPA, 2026)
The data were extracted and filtered to include waste categories related to the textile sector and analyzed at the municipality level. The analysis covered waste generation, incineration with energy recovery, disposal treatment, and export, with the results summarized and presented in tables, charts, and maps. It is important to note that the datasets on waste generation, treatment, and disposal are not directly linked at the level of individual waste streams. Data on waste generation refer to reporting entities, while treatment and disposal data refer to waste management facilities receiving the waste. Therefore, these datasets were analyzed separately and were not used to trace individual waste streams from specific generators to specific management facilities.

RESULTS AND DISCUSSION

Based on the accessed NRIZ data, the analysis included 19 reporting companies located across 17 cities in Serbia, which generated textile waste classified under the waste index numbers identified in the registry. The majority of these companies, 13 in total, generated waste under waste index number 04 02 22, while five companies generated waste under 04 02 09 and one company under 04 02 21. Therefore, waste index number 04 02 22 represents the most widely generated and reported category among the identified textile waste streams and provides the most substantial basis for further spatial and quantitative analysis.
No records were identified for waste index number 20 01 11, corresponding to textiles from municipal sources. This absence is particularly relevant when interpreting the available data, as it indicates that no municipal textile waste was recorded in the NRIZ dataset for the period covered by the analysis.
In 2020, the total reported amount of waste generated under index number 04 02 22 (waste from processed textile fibers) was approximately 1,579 t. The largest share of waste was generated in Odžaci (759.23 t), linked to the manufacturing of automotive seating. Significant quantities were also recorded in Loznica (283.72 t), where textile waste is associated with the production of technical fabrics, and Bačka Palanka (192.82 t), where the reported activity includes the production of large industrial bags. Other cities with reported textile waste generation include Prokuplje, where activities include the production and processing of filters and the production of felt; Vranje, where activities include textile fibre preparation and spinning, as well as cut-and-sew apparel production; Prijepolje, where the main activity is the production and processing of workwear; Leskovac, where textile production includes the manufacture of hosiery, primarily stockings and socks; Niš, where the predominant activity is clothing

production; Majdanpek, where textile waste is associated with the production of upholstered furniture; and Babušnica, where garment production is recorded.
Regarding waste management, the data clearly indicate that landfill disposal remains the dominant method for handling this industrial waste. For example, the entire waste stream generated in Odžaci, as well as a large portion of waste from Prokuplje, ends up in landfills. Waste treatment (which includes recycling and other forms of recovery) is recorded in Bačka Palanka and Leskovac. Storage was recorded in several cities (Loznica, Majdanpek, Niš, Babušnica), but this represents only a temporary solution rather than a final management method. Export of textile waste is negligible, with only Prijepolje recording exports, amounting to 31.2 t. Finally, the data shows no recorded examples of this waste being directed to incineration with energy recovery, indicating that this management route is currently not utilized for processed textile waste in Serbia.
To visually map these complex flows, Figure 1 presents a Sankey diagram illustrating the movement of waste from the generation points to their final management destinations. This visualization highlights the macro-level distribution of the total tracked waste, where disposal represents the primary management route, receiving 993.17 t (approximately 63% of the total), while storage accounts for 416.71 t. Treatment captures only 60.48 t, and export remains minimal at 31.20 t. Additionally, 77.93 t are recorded as not documented, further emphasizing the tracking gaps mentioned above. The diagram also visually confirms that incineration with energy recovery is entirely absent from the management routes for this waste.

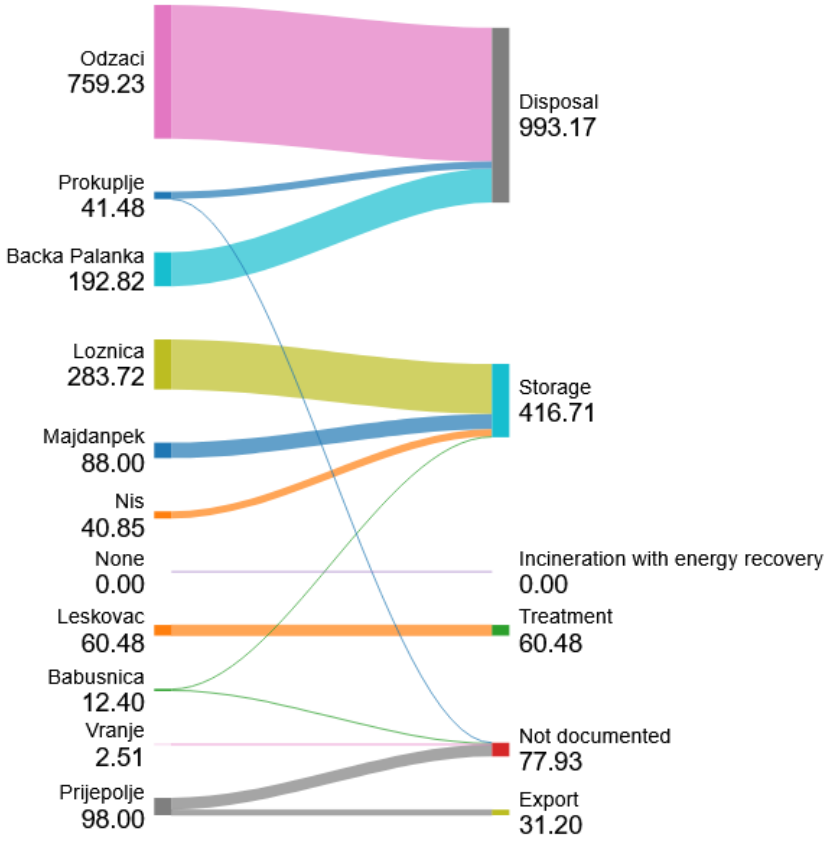


Fig. 1. *Sankey diagram of waste flows from processed textile fibers (04 02 22) from generation sites to management destinations in 2020.*

The geographical distribution of the reported textile waste generators and the corresponding quantities of generated waste is presented in Figure 2.

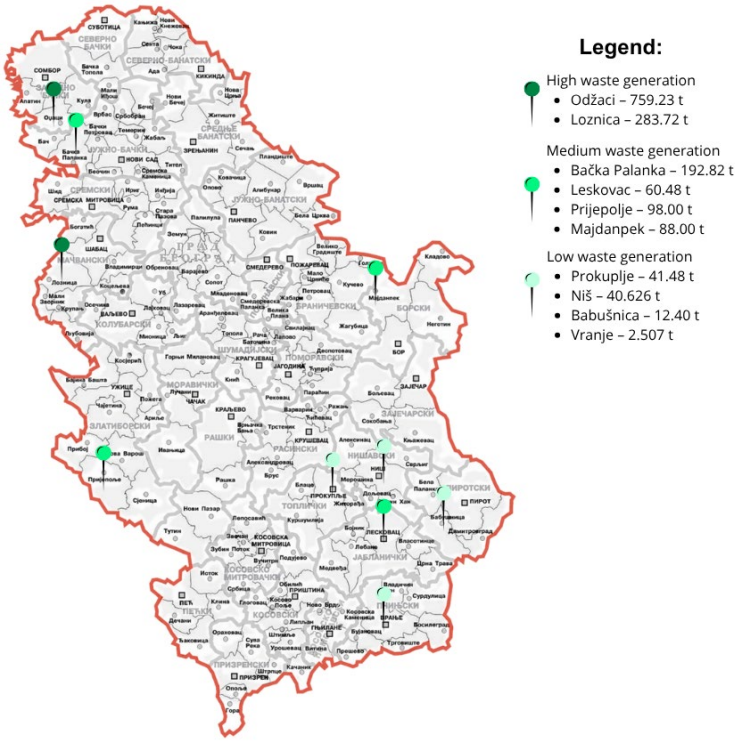


Fig. 2. *Geographical distribution of the reported textile waste generators and the corresponding quantities of generated waste*

For the **disposal** phase, the analysis will similarly focus on Waste index number 04 02 22 (waste from processed textile fibers). The data for this category are summarized and visually represented in Figure 3. In 2020, disposal of processed textile fibers was recorded at four landfill sites: Leskovac received the largest quantity (364.52 t), followed by Lapovo (253.65 t), Jagodina (101.51 t), and Kikinda (63.54 t). Beyond processed textile fibers, these landfills demonstrate varying capacities for accepting other textile waste streams. The Kikinda landfill, for instance, accepts a broader range of waste categories, including substantial quantities of mixed material waste (04 02 09), other textile wastes (04 02 99), and municipal textile waste (20 01 11). Lapovo also receives unprocessed textile fibers (04 02 21), while Pirot recorded disposal of sorted mixed material waste (19 12 08). This diversity indicates that certain facilities function as regional centralized receiving facilities for multiple waste categories, while others maintain a more specialized focus. It should be noted that the disposal data presented here are not directly linked to the previously identified waste generators, as the reporting system records quantities received at landfill facilities rather than tracing individual waste streams from their origin.

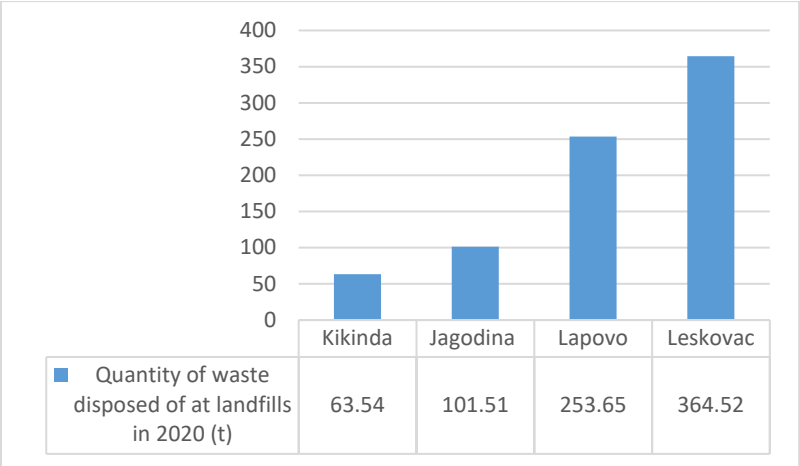


Fig. 3. *Disposal of waste from processed textile fibers (04 02 22) by landfill site in 2020*

Figure 4 presents the geographical distribution of landfill sites receiving waste from processed textile fibers (04 02 22) in 2020, with colour intensity indicating the quantity of waste received.

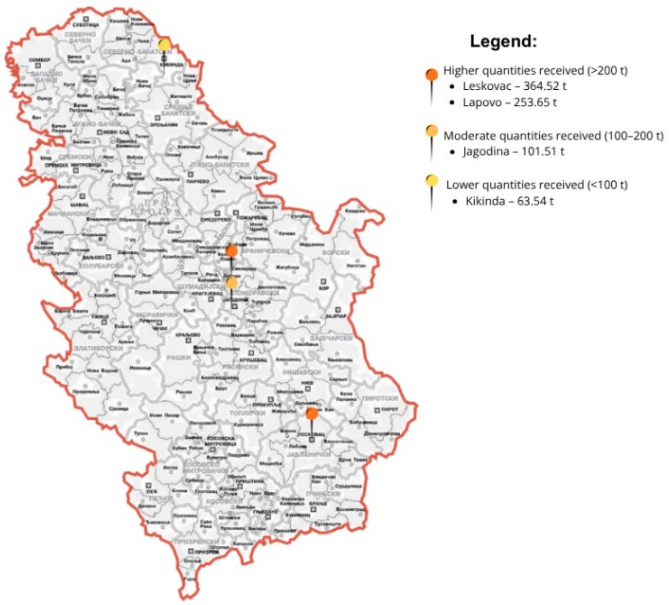


Fig. 4. *Geographical distribution of landfill sites receiving waste from processed textile fibers (04 02 22) in Serbia in 2020*

In contrast to disposal, **treatment** activities for processed textile fibers (04 02 22) are distributed across a larger number of locations, though the total quantities remain modest. The total amount of waste treated in 2020 was approximately 488.89 t. Ada recorded the highest treatment quantity (120.42 t), followed by Pančevo (80 t) and Bečej (71.79 t). Other locations with notable treatment activities include Bačka Palanka (64.1 t), Beočin (55.06 t), and Paraćin (53.12 t). Smaller quantities were treated in Varvarin (29 t) and Novi Sad (15.4 t), as illustrated in Figure 5. Importantly, the treatment data reflect the total quantities processed at each facility, which may include waste from multiple sources beyond those identified in the generation data, since the registry does not track waste streams from generator to treatment site.

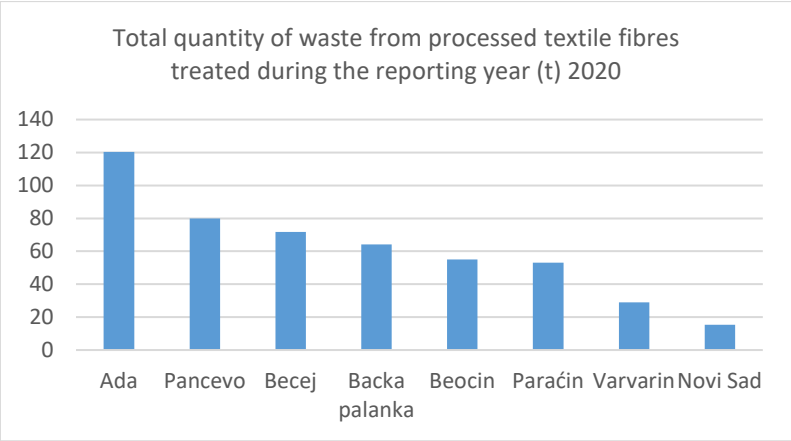


Fig. 5. *Quantities of waste from processed textile fibers (04 02 22) treated by city in 2020*

The geographical distribution of locations treating waste from processed textile fibers is presented in Figure 6, with colour intensity indicating the quantity of waste treated.

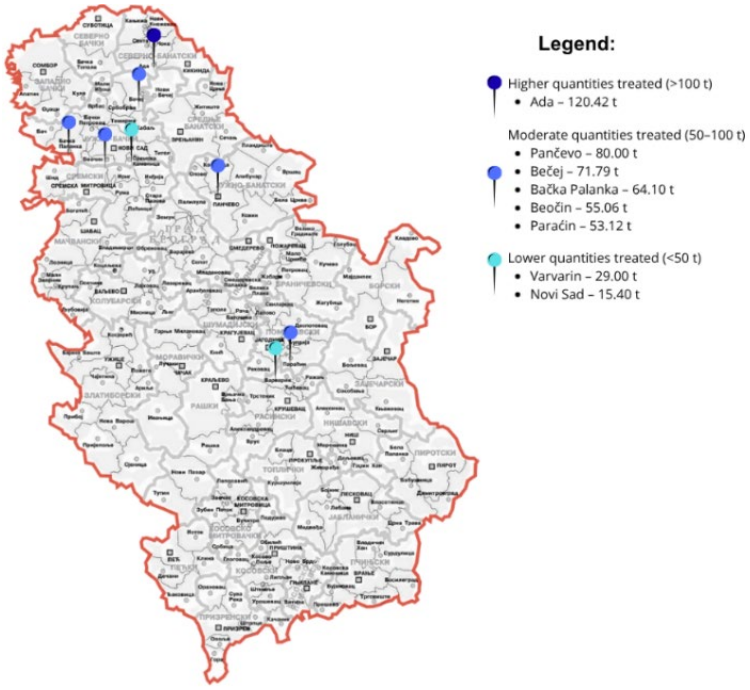


Fig. 6*. Geographical distribution of locations treating waste from processed textile fibers (04 02 22) in Serbia in 2020*

Export of processed textile fibers (04 02 22) was reported by three entities. The highest export quantity was reported in Zemun (116.834 t), with waste directed to Italy. Smaller quantities were exported from Apatin to the Czech Republic (14.58 t) and from Prijepolje to North Macedonia (31.24 t). Despite these exports, the overall volume remains minimal compared to the total waste generated, indicating that export plays a marginal role in the management of textile waste in Serbia. It should also be noted that export records identify the entities and destination countries, but do not directly trace the exported waste back to specific generators, as the system tracks these separately.

These findings indicate a significant gap in Serbia's waste tracking system, as household textile waste is not separately recorded in official statistics. Since households are not required to report textile waste, discarded textiles are generally included within mixed municipal waste, making the actual quantities difficult to determine. This lack of reliable data presents a

challenge for the planning and development of effective textile waste management and recycling systems.

CONCLUSION

Although landfill disposal accounts for the largest share, particularly for waste index number 04 02 22, some companies also use storage and treatment, while export plays only a minor role. No recorded cases of incineration with energy recovery were identified, indicating that this option for energy recovery from textile waste is currently not represented in the available data. These findings show that alternative management practices are already present, although they are used to a smaller degree, while landfill disposal remains the dominant management route. At the same time, the available data do not provide a complete picture of textile waste management in Serbia. Household textile waste is not separately recorded because households are not required to report it, and consequently, the actual amount of textile waste generated by households remains unknown. This, together with the absence of recorded incineration with energy recovery, highlights the limitations of the current waste tracking system and the need for more complete data on textile waste flows and management options in Serbia. Improving textile waste management therefore requires not only better data on industrial waste, but also suitable systems for the separate collection and monitoring of household textile waste. Future research should focus on collecting primary data on household textile waste, improving the tracking of waste flows from generation to final treatment, and assessing opportunities for textile waste recycling and reuse in Serbia. Such research could provide a more complete basis for improving textile waste management and supporting the development of circular economy practices.

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