GREENLand

Funded by the European Union

PROGRESS REPORT M16

Reporting period: 01/01/2023 – 30/04/2024

PROJECT	
Project number:	[101079267]
Project acronym:	[GREENLand]
Project name:	[TWINNING MICROPLASTIC-FREE ENVIRONMENT]
Call:	HORIZON-WIDERA-2021-ACCESS-03-01: Twinning
Type of action:	CSA
Responsible service:	REA.C3 – Widening Participation
Project starting date:	[01/01/2023]
Project duration:	[36 months]
Period covered by the report:	from [01/01/2023] to [30/04/2024]

EXECUTIVE SUMMARY

This document presents the project management report for the period between M1-M16 (January 2023 to April 2024) and it embodies submitted deliverables. More specifically, this report identifies the goals of the project during the first period (M1–M16) and provides an in-depth overview of the progress that has been achieved so far, divided by work packages. Additionally, it reflects the Project Management activities, reports with outcomes and results, and the Milestones achieved.

The GREENLand project aims to strengthen Serbia's research and innovation capacity in the field of microplastics, while also enhancing educational resources, administrative efficiency, and collaboration with EU partners. Project is coordinating by Educons University (EDU) from Serbia as Widening country with prestigious institutions Alfred Wegener Institute (AWI) from Germany and University of Galway (UG) from Ireland.

Importantly, the project is supporting Serbian policymakers in gaining a better understanding of the risks associated with microplastics in the country and significant progress has been made across the project's five key objectives.

O1 - To develop science, innovation and technology (SIT) roadmaps of microplastics in soil, freshwater and microorganisms.
The scientific roadmap has been developed, and starting in month 19, the project consortium will begin formulating the technology roadmap. The innovation roadmap is currently in development. Comprehensive analyses of EU and Serbian regulations related to microplastics in food, water, waste, and soil were conducted to explore new research directions. As part of this initiative, an action plan for microplastics-free soil has already been written, and the consortium is working on a methodology for microplastics analysis in water and soil samples. Additionally, a cooperative initiative was established with the Environmental Protection Agency and the Department for Chemicals at the Ministry of Environmental Protection of the Republic of Serbia, to support and implement regulatory actions on microplastics. The results of this work package will generate new research avenues, advancing the understanding and management of microplastics in the environment.

O2 - To significantly improve education and administrative workflow by developed e-Tools.

Open Science System (OSS) and institutional repository, REDUN (Repository of EDUCONS University) and eLearning System (ELS) are established in order to accelerate virtual learning and widen the networking of the Educons University. Document Management System (DMS) and Cloud Based System (CBS) are established to accelerate administrative efficiency. These digital systems attract students and researchers around the globe by 15% and reduce the costs of administration by 20%.

O3 - To improve the capability to compete for EU funding

The Project Incubator Hub (PIH) was established at the beginning of the project to improve the capability to compete for EU funding. A total of 22 project proposals were prepared and submitted, and three of them were successfully evaluated. The Transfer Technology Hub (TTH) was established in month 15 of the project, under the Center for Innovation and Cooperation with the Real Sector. IP Strategy is developed as a guideline on how to proceed in the internal IP protection and commercialization process.

O4 - To build capacity through the new generation of highly-skilled staff

In total 17 different training courses of up to 5 days and 1 summer school were organised with the goals to build management and administrative capabilities, to promote knowledge, technology and innovations. This increased the efficiency of the institution in the preparation of project proposals, improved organisational flexibility and the effectiveness of decision implementation. Also, strategic networking and staff exchange of 13 researchers and 4 non-researcher staff were trained.

O5 - To significantly improve dissemination, exploitation and collaboration

Transfer Technology Hub was established in month 15 and requires further time to achieve collaboration agreements. By the end of the project, the knowledge and network that will be accumulated and achieved in the coming period will provide new institutional cooperation with industry and at least four collaboration agreements.

Explanation of the work carried out per WP

Research component

All research activities have been implemented in WP1 where 10 researchers from EDU spent 22 PMs out of the 44 PMs planned for the whole duration of the project. From other costs, the research component included chemicals, equipment maintenance, and LCA software exactly how it is planned by budget lines in justification of the purchase costs in part B. Partners from AWI included 2 researchers, and partners from UG included 3 researchers to WP1 in all activities of research. The whole budget for research is less than 30% and more than 70% of the budget is spent by EDU following the planned budget.
Research activities included scientific, innovative, and technology roadmap for microplastics which details are provided in work package 1. Hence all the results of the research components are included in WP1 to avoid repetitions.

Work package 1

Progress in WP1

Results achieved

Task 1.1. Scientific roadmap *(M1-M12)*

- EU Regulations: A comprehensive analysis was conducted on European Union regulations concerning microplastics in food, water, waste, and soil. This analysis focused on understanding current legislative frameworks and identifying gaps and opportunities for improvement.
- Serbian Regulations: A similar analysis was performed on Serbian regulations related to microplastics in food, water, waste, and soil. The aim was to assess national policies in relation to EU standards and highlight areas needing alignment or enhancement.
- Initiative for development of a national strategy for microplastics: This initiative involves cooperation with the Environmental Protection Agency and the Department for Chemicals at the Ministry of Environmental Protection. The Initiative focuses on implementing regulatory actions on microplastics intentionally added to products, raising awareness about the impacts of microplastics on health and the environment, seeking mutual support for these actions through collaboration with relevant stakeholders.
- New approach to microplastics consumption aims to effectively reduce the presence and impact of microplastics, ultimately contributing to a healthier environment and population involving

regulatory reforms, scientific advancements, technological innovations, consumer education, industry changes, and international cooperation. Workshop “Adoption of the legal acquisition of the European Union in the field of microplastics into the national legislation of the Republic of Serbia” was held on 01.11.2023 at EDU. The workshop contributed to the realisation of this goal by emphasising the initiative for changes in legislation by the Greenland project through the Initiative for a National Strategy for Microplastics, and at the same time educating the attendees about the current laws that regulate that area, as well as about the impact of microplastics and ways to reduce the amount of microplastics in environment.

Task 1.2. Innovative roadmap *(M13-36)*

- Soil Quality Analysis. An extensive analysis of soil quality in the Vojvodina region was conducted to identify a pilot area for microplastics analysis. This included evaluating various soil quality parameters to determine potential sites for detailed study. A thorough review and analysis of existing data obtained from our laboratory were performed. This included assessments of both organic and inorganic pollutants, with a special emphasis on phthalate esters. The historical data provided a crucial baseline for identifying trends and areas of concern related to microplastic contamination and its associated pollutants.
- Mapping Hot spots. Based on the results of the data analysis, locations with a high potential presence of microplastics were mapped, identifying "hot spots" for focused analysis based on historical pollutant levels. These areas are prioritised for further detailed study.
- Chemical and Equipment Inventory. A comprehensive list of required chemicals and equipment for microplastics analysis was created for the EDU laboratory. This ensures that all necessary resources are available for effective and accurate analysis. Part of the solvents, standards and other consumables needed for basic soil and water analyses was purchased in this period, and the rest related to the analysis of microplastics will be purchased in the period from M17 to M22.
- LCA Software. Life Cycle Assessment (LCA) software was acquired to support the analysis and evaluation of microplastics' environmental impacts. The primary goal of acquiring LCA software for our project is to predict and analyse the environmental influence of plastics, particularly microplastics. This tool will enable us to evaluate the overall environmental impact of microplastics from various sources and to identify critical stages

in the life cycle of plastics where interventions can significantly reduce environmental harm.

- Methodology for microplastics detection in soil (KPI 1.1) In collaboration with UG, AWI, and the University of Novi Sad, the development of laboratory procedures for the detection of microplastics in soil and water began. This included defining methodologies and ensuring consistency in detection practices across laboratories.
- Action plan for microplastics free soil. (KPI 1.2) The main objective of the Action Plan is to reduce the levels of microplastics in soil in the Republic of Serbia. The Action Plan is formulated to effectively strengthen prevention and control of microplastics soil pollution, and to gradually improve soil environmental quality.

Task 1.3. Technology roadmap *(M19-M36)*

- This task is scheduled to commence in month 19 of the project. Planned activities include developing and implementing technological solutions for detecting, analysing, and mitigating microplastics. This will involve integrating innovative technologies and methodologies developed in earlier tasks.

- The first version of Deliverable 1.4 – Report on initiative for development of a national strategy for microplastics is submitted and will be updated.

KPI OVERVIEW

KPI	Target by the end of the project	Achieved by M16
new research avenues	3	1*
action plans	3	1**
new approach to microplastics consumption	2	1***

*Working on methodology protocol for microplastic detection: in sediments, water, and soil

**Action plan for microplastics free soil is finished (Annex 2)

*** Workshop Adoption of the legal acquisition of the European Union in the field of microplastics into the national legislation of the Republic of Serbia 01.11.2023.

CONTRIBUTION PER PARTNER

EDU	Analysis of EU and Serbian legislation, review of international projects on microplastics with the participation of Serbian researchers, review of microplastics research and monitoring results in Serbia, writing a report of scientific roadmap, writing a report on Initiative for the national strategy for microplastics, analysis of soil quality, creating a map of hotspots, attending LCA software training, writing an Action plan for microplastics free soil.
AWI	Presented experiences in Germany regarding microplastic regulation, creating a list of required chemicals and equipment for microplastics analysis, and working on methodology for microplastics detection in soil.
UG	Presented experiences in Ireland regarding microplastic regulation, contribution to the report of the scientific roadmap, and working on methodology for microplastics detection in soil.

DELIVERABLES AND MILESTONES

DELIVERABLES SUBMITTED

D1.1 Report of Scientific Roadmap – M12
D1.4. Report on initiative for development of a national strategy for microplastics – M36

DELIVERABLES TO BE SUBMITTED

D1.2. Report of Innovative Roadmap – M20
D1.3. Report of Technology Roadmap – M30

ACHIEVED MILESTONES

1. Identification of hot spots potentially contaminated with microplastics - M1
2. Prediction of microplastics in the environment - Educated staff for LCA analysis - M2

RISKS AND MITIGATION MEASURES

Risk encountered	Mitigation applied
Extreme climatic conditions	Reorganized plan of sampling hot-spots.

WORK PACKAGE 2

PROGRESS IN WP2

RESULTS ACHIEVED

Task 2.1. Transformation to Cloud Based System (CBS) and eLearning System (ELS) *(M1-M24)*

Implemented and established CBS at Educons University which includes:

- Established and made operational Google Workspace (GWS) and related apps (supports secure data, information, and document management, supports eLearning and exchange of learning materials)
- Accounts for all employees are open and activated and every staff member has a 500GB minimum available storage
- Established Intranet as a private network within Educons University facilitating internal communication, collaboration, support, and information sharing among employees (still in the early phase in terms of use)
- Implemented and deployed FIS IS – eLearning and study supporting information system for student services that includes three modules (unified database for all modules):
    - eFaculty (eAdmin) - Module for undergraduate and postgraduate studies
    - eStudent – web service for students
    - eTeacher (Employee) – web service for teachers (including also services common for all employees)
- Implemented and deployed FIMES – a highly integrated and automated system intended for monitoring and organizing business processes. It includes modules for (i) personnel and general record management, (ii) financial and material accounting, and (iii) other financial and accounting records.
- Implemented FIMES-FIS integration and synchronization of DBs through the web application eEmployees (eZaposleni) for shared information related to employees, teaching, exams, and finances.
- Upgraded the computer network equipment and equipped the classrooms and labs with the new computers and other peripheral equipment to maximize the benefits of all listed activities and transition to the CBS.
- Provided training to all employees for all relevant newly implemented CBIS.
- Provides continuous daily support to all users of the new system.
- Held regular consultations with partners from AWI and especially from UG to understand operations and practices at their

institutions. Visited the University of Galway to gather best practices that could be adapted to meet the needs of Educons University to further improve the quality of work and optimize processes. Had several very informative face-to-face meetings with representatives of the following departments at UG: (1) Research Management (2) University Library (3) Career Development Centre (4) Equality, Diversity and Inclusion (5) Student Support (inc Students with Disabilities) (6) Information Systems and Solutions, (7) Centre for Excellence for Learning and Teaching. All this provided valuable insight into possibilities of enhancing the academic and administrative services which would improve the overall educational experience and facilitate achieving the set KPIs.

Task 2.2 Developing Document Management System (DMS) *(M1-M12)*

- Deployed a DMS system - a web-based application providing: (i) Document filing of electronic and digitized documents, (ii) an Electronic registry for document management, and (iii) an Electronic archive system.

Task 2.3 Establishing Open Science System (OSS) *(M1-M36)*

- Developed a data management plan that complies with the FAIR data principles.
- The institutional repository, REDUN (Repository of EDUCONS University), is deployed at https://redun.educons.edu.rs to provide open access to publications and other research outputs resulting from projects implemented by this institution.
- Educons University has joined the COBISS (Co-operative Online Bibliographic System and Services) system and started using it.

KPI OVERVIEW

KPI	Target by the end of the project	Achieved by M16
established software systems	4	4
attract more students	35%	15%
reduction the administration costs	50%	20%

CONTRIBUTION PER PARTNER

EDU	Digitalisation of Services, Deployment of Information Systems, Infrastructure Upgrade, Contribution to DMP and other Deliverables, Technical Support and Staff Training and Development, Monitoring and Evaluation
AWI	Active involvement in data management plans and monitoring of the process of selection and implementation of cloud based information systems at Educons university. Contributed to deliverables and provided feedback.
UG	Advisory and support role: presented best practices from UG that could be adapted to Educons University needs, specifically in the areas that enhance academic and administrative services. Research management: Offered guidance on effective research management practices to enhance research activities and outputs. Library management: Advised on library management and services to improve resource accessibility and use especially focusing on availability of digital resources and support of distant learning. Information Systems: Closely monitored the process of evaluating, selecting and implementing Cloud based information systems (eLearning system, business information system, open science system..) at Educons university; Career development: provided insights into process on career development programs to better support career readiness and success. Inclusion: Shared practices that support a more inclusive university environment and offered more concrete help in the process of implementation. Student support: Offered recommendations on student support services. Teaching and learning: Presented programme for innovative teaching and learning practices that improve educational quality and effectiveness. All these activities contribute towards attracting more new students by enhancing the quality of Educons university

DELIVERABLES AND MILESTONES

DELIVERABLES SUBMITTED

D2.1. Data Management Plan – M6

D2.2. Report on Cloud Based System – M10

D2.3. Report on eLearning System – M12

D2.4. Report on Established University Repository (UR) – M8

Deliverables to be submitted

D2.5. Final report on WP2 – M36

Achieved milestones

3. Established CBS – Created accounts on CBS – M10
4. Established University Repository – M8

Risks and mitigation measures

Encountered problems include: initial difficulties with the engagement of people/employees to accept planned changes and adopt the new way of working. The initial resistance has weakened with time and people are more willing to cooperate and get involved in the establishment of the new system. The benefits of having the new Cloud Based IS that integrates all main services at EDU (student, teacher, admin, personnel, finance, DMS) have already been visible (KPI results) although the optimisation process is still in process.

In spite of these initial difficulties, there have not been any delays from the planned activities in terms of system establishment and deployment.

Risk encountered	Mitigation applied
Server crash or hacker attack.	In order to avoid this, we place servers in the ETF center, where a team of data protection experts works.

Work package 3

WP3's main goals are to (i) develop and implement the Human Resource Strategy that will lead to a significant improvement of EDU capacities from a scientific and innovation standpoint; (ii) coordinate staff exchange activities to ensure knowledge transfer between UG, AWI, and EDU staff; (iii) set up the Project Incubator Hub and the Technology Transfer Hub to support EDU research ideas to be upgraded into innovation projects with market readiness level.
The first 16 months of the project were key to achieving most of the WP objectives. The next chapter explains in detail the progress for each task of WP3.

PROGRESS IN WP3

RESULTS ACHIEVED

Task 3.1. Developing Human Resource Strategy (M1-M6)

- The Human Resource Strategy (HRS) was developed early in the project by EDU with the support of colleagues at AWI and UG who leveraged their institutions' experience and structure to provide concrete examples and suggestions.
- The HRS is built around 6 key strategic priorities: (i) enhancing organizational efficiency; (ii) leadership and performance management development; (iii) HR attracting, recruiting, and retaining; (iv) training, skill enhancement, and career development; (v) equality, diversity, and inclusion; and (vi) strengthening the visibility and capacity of our human resources (HR) through intensifying partnership with the local and regional community.
- We sought to make the Strategy optimistic, realistic, detailed, feasible, measurable, and sustainable. At the same time, as a living document, it needs to be flexible and open to adaptation throughout the various implementation phases.
- The Strategy is supported by a detailed Action Plan, which clearly defines activities, responsible parties for the realisation of the activities, implementation deadlines, and indicators of success.
- The HRS was submitted as a sensitive deliverable at M6. The action plan has been implemented since M6 throughout the project and beyond the project activities too.

Task 3.2. Strategic Networking and staff exchange (M5-M36)

First researchers' and non-researchers staff exchange activities were carried out on 7 research exchange visits that were organised, lasting up to 13 days:

- 12.03.-25.03.2023. AWI, Germany (3 researchers)
- 19.06.-30.06.2023. UOG, Ireland (4 researchers)
- 11.06.-24.06.2023. AWI, Germany (3 researchers)
- 09-13.10.2023. AWI, Germany (2 researchers and 1 non-researcher)
- 14.12.2023. AWI, Germany (3 researchers and 2 non researchers)
- 21.04-01.05.2024. AWI, Germany (3 researchers)
- 21.04-27.04.2024. UOG, Ireland (5 researchers and 1 non-researcher)

In total 13 researchers (Vesna Teofilović, Snežana Štrbac, Danka Radić, Miroslav Vrvić, Mira Pucarević, Aleksandra Rankov, Ljiljana Ćurčić, Andrea Andrejević-Panić, Jelena Ješić, Dragana Linda Mitić, Nataša Stojić, Gordana Racić, Igor Vukelić) and 4 non-research staff (Galina Ćurčić, Jovana Kisin, Nemanja Brkljača, Suzana Kojić) were at partners'

institutions to acquire and exchange knowledge on methods for detection, extraction, and analysis of microplastics in soil, water, and microorganisms, digitalization, administrative and human resource workflow, establishment of project and transfer technology office as well as marketing promotion.

In order to successfully implement envisaged project activities focused on capacity building of the institution 17 training courses of up to 5 days were organised on the following topics:

- LCA software online training Sphera LINK
- Training on statistical analysis of data obtained from the analysis of soil polluted with microplastic-Aidasco LINK
- Data analysis for innovative roadmap creation (categories of data, analysis of diversity indices proportion indices of similarity and diversity) LINK
- Google Workspace and Google Classroom as new tools for eLearning LINK
- Repository of Educons University - REDUN LINK
- Seminar on Archiving and Digitization of Documents LINK
- Use of COBISS 3 software for library LINK
- Open Science and Research Data Management LINK
- Finance and Accounting course LINK
- Human resources training: communication, organisation, time management and leadership LINK
- The Social Media Alphabet: Key Components to Better Understanding Digital Marketing LINK
- Training for the preparation, writing, and management of Horizon Europe projects - European Training Academy LINK
- Training on Research Data Management and Open Science in Horizon Europe - European Training Academy LINK
- Training on writing Horizon Europe Twinning projects - European Training Academy LINK
- Horizon Europe writing proposal training: Introductory, work Programme, finding calls, finding consortium partners, budget preparation, SyGMa portal, hop-on and cascade calls LINK
- Knowledge transfer training – experience from Alfred-Wegener-Institute, Helgoland LINK
- Knowledge transfer training – experience from the University of Galway, Ireland LINK

Training organisation aligns with the Human Resources Strategy 2023-2025, developed in Year 1, whose action plan defines priorities of all 5 work packages in order to successfully relate project activities with University strategic development. All organised trainings was dedicated to all employees and working divisions of EDU.

GREENLand summer school on capacity building of Educons University was organised on 28 and 29 of September 2023, led by the director of the Adizes Southeast Europe Group. The summer school was attended by the University top management (Rector, Vice Rectors, Financial Manager, Executive Manager, coordinators of EDU developmental centres, Director of marketing) with the main idea to set up rules and build organisational flexibility and increase effectiveness of decision implementation. Starting point was to communicate with people working together to identify major issues and construct synergies among them. Summer school provided conceptual and practical tools that help EDU to achieve superior results.

Task 3.3. Transferring scientific ideas into the projects that will be implemented in practice (M13-M36)

The team has considered the establishment of the Project Incubator Hub (PIH) as a priority for the success of the project; hence the activities of this task were anticipated (upon formal communication with the project officer).

The PIH was established in the first 6 months of the project, assigning the leader of the office and developing a concrete implementation plan aligned with the HRS.

With the support of the PIH, EDU staff managed to submit 22 proposals for open calls under various EU-funded programmes such as Horizon Europe and ERASMUS+. Of these 22 submitted proposals, 3 were successfully evaluated, 7 were rejected, and the remaining ones are still under evaluation. This represents a drastic increase in EDUCONS performance concerning several submitted proposals for EU-funded calls.

Granted projects:

1. BEAMING Project number: 101137131
2. 2023-1-RS01-KA171-HED-000130436, Erasmus+
3. 2023-1-RS01-KA131-HED-000112988, Erasmus+

Transfer Technology Hub is established under the Center for Innovation and Cooperation with the Real Sector during the first Y of the project.
Primary goal of the TTO was to create an IP Strategy which is developed to be a guideline for researchers, students and associates on how to proceed in the internal IP protection and commercialization process.
Technology Transfer Office work is organised through 4 pillars: Knowledge Transfer, Technology Transfer, Building partnerships and international relations and Scientific-Industrial Cooperation. Transfer Technology Hub organisational work will be followed according to the

proposed Action Plan. First pillar is aimed at supporting mentoring programs, developing modern education concepts and sharing knowledge in the local communities. Second pillar will monitor the process of generating intellectual property within project activities and work on their protection, as well as activities of commercialization and licensing. Third pillar has the aim to deepen existing and create new connections with the economy at the domestic and international level. Fourth pillar is focused on Scientific-Industrial Cooperation. The strategy also defines the appearance of the documentation that will be used at the institutional level for evaluation and decision- making related to initiating the process of intellectual property protection or establishing a spin-off company.
Work on TTO establishment was supported by training and communication with partners UOG and AWI.
IP strategy was submitted as a sensitive deliverable at M15.

KPI OVERVIEW

KPI	Target by the end of the project	Achieved by M16
exchange researchers	15	13
exchange non-research	7	4
training courses organized	10	17
Summer/winter schools	3	1
number of submitted proposals	9	22
number of granted projects	3	3

CONTRIBUTION PER PARTNER

EDU	To build capacity related to activities of all WP (microplastic research activities, work of PIH and TTH, managerial, administrative and financial capacities, digitalisation, Open Science practices) and project objectives EDU organised 17 trainings, 1 summer school, established Project Incubator Hub and Transfer Technology Hub, submitted 22 project proposals.
AWI	Consultations regarding HRS and IP strategy, training on project administrative management at the institute and funding advice strategies including selection and support for writing mutual project proposals. Strategies for technology transfer work, IP and journal papers are discussed and set up. Development of teaching materials based on the performed training for the analysis of water, sediment and soil samples for future dissemination and outreach.
UG	Consultation regarding development and adoption of HRS, development of EDU IP strategy was based on discussions

	using UG as an example Institution and relies on UG Research and Innovation Strategy, training on project and administrative work of the University, strategy for writing mutual project proposals and journal papers are discussed and set up.

DELIVERABLES AND MILESTONES

DELIVERABLES SUBMITTED

D3.1. Human Resource Strategy (HRS) - M6

D3.3. IP Strategy - M15

DELIVERABLES TO BE SUBMITTED

D3.2. Report of a Project Incubator Hub (PIH) and Technology Transfer Hub (TTH) - M20

D3.4. Final report on WP3 – M36

ACHIEVED MILESTONES

5. Human Resource established - M6

6. Networking plan created and updated - M9

RISKS AND MITIGATION MEASURES

Risk encountered	Mitigation applied
Inadequate staff for the new strategy.	Employing professionals with the appropriate skills.
The organisation of exchange visits for 1 to 3 months has been proved to be complicated due to researchers' busy schedules and the impossibility of travelling for such a long period of time.	The exchange visits have been shortened to two weeks and made more frequent. Already 7 organised in the first 16 months for 13 EDU researchers.
Difficulty in identifying the right profile to lead the TTH at EDUCONS	Several months were spent selecting the right profile to lead the TTH. During this time, significant progress was made in establishing the TTH.

WORK PACKAGE 4

PROGRESS IN WP4

RESULTS ACHIEVED

Task 4.1. Development and implementation of a project management communication plan *(M1-M36)*

- The visual identity of the project is created (project logo, templates for different types of documents, the standard text for press releases, etc.).
- Templates for different types of documents are ready and in use.
- A clear target audience is defined to communicate project activities, information, and results to various stakeholders (D4.1).
- The website https://project-greenland.com/ has been launched with all the information about the project, and it is updated with different content such as news, announcements, event reviews, project results, activities, announcements, blog posts, etc. including papers and other relevant documents.
- On the project website, 61 articles have been created and published, covering all activities utilized for additional promotion and dissemination.
- Minor new functionality integrations and improvements have been made to the website. An SEO plugin (Search Engine Optimization) has been integrated for better search and visibility of the project on different web browsers, news has been featured chronologically on the Home Page, and the Gallery has been adapted to a better impress of photos and video material made.
- The "News" section is the media hub of the project, or project's place on the web and contains, in addition to the TV and e-Zine subcategories, Category Capacity building activities as well as Category Communication/Dissemination activities.
- Social media profiles are created: Twitter, LinkedIn, Facebook, and Instagram.
- The YouTube channel of the GREENLand project, in the meantime, was launched as one of the channels for the wider dissemination of the project's results. Promotion activities will be continuously updated following the interest of defined target groups.
- Development and maintenance of high-quality communication messages and outreach material: e.g. Content Strategy with relevant sources, facts, industry reports, illustrations, and infographics.
- Design of visuals with graphics that illustrate different types of content, communication messages, and thematic directions

including announcements of events, webinars, training, courses, facts and information to spread awareness of the microplastic's impact on the environment.
- The cooperation agreement was signed with the largest media company in Vojvodina, Radio Television Vojvodina.
- Announcements and media appearances with interviews were numerous. Appeared 4 times on National RTV Vojvodina and once on TV Novosadska in the programs: “Razglednice”, “Morning program” and in the news on Radio Television Vojvodina, as well as with an experienced well-known TV presenter Višeslav in the morning show on TV Novosadska.

WP4 tasks and activities with measurable indicators, channels, and platforms are prepared and created, results are monitored monthly via Monday - Project Management Tool for collaboration, document management and workflow processes.

NUMBER OF FOLLOWERS ON SOCIAL NETWORKS OF THE PROJECT

social networks	Target values by the end of the project	Followers
Facebook Project GREENLand	400	335
Instagram project_greenland	400	278
Twitter X @Proj_GREENLand	400	177
LinkedIn Project GREENLand	400	157
SUM	1600	947

The Communication and Dissemination Strategy developed in D4.1 (M6) aims to identify and organise all activities to maximise the project's impact and promote the exploitation direction of the project results. Therefore, the Strategy assessment has been performed, adapted and developed further, considering the target audience's journey, with channels, tactics, and campaigns (both online & offline) to bring GREENLand straight in front of diverse stakeholders and interested communities.

Considering the above mentioned, the consortium mapped and segmented all defined activities under two directions named: Capacity Building Activities and Communication/Dissemination Activities. These segmented activities can easily and concisely monitor the dissemination actions (e.g. workshops, training, webinars, presentations, lectures, knowledge transfer, visits, conferences, trade shows, fairs,

festivals, panel discussions, meetups etc.) of the project partners' regarding planned or achieved results, considering that all Work Packages correlate, interlaced and affiliated.

Task 4.2. Dissemination and outreach activities *(M1-M36)*

- 1000 glass bottles and 1000 cotton bags were made to replace plastic bottles and plastic bags. Glass bottles and cotton bags are used for dissemination.
- 2 roll-ups are designed and built for conferences, training, dissemination, and events.
- Design/production of printed promo material: brochure, flyer, notes, textile mask for the bottle with project branding and logos of all consortium partners.
- On the website, stakeholders can follow a brief report of the results, events, and activities of the project in E-zine. The e-zine is written as a report with a coverage of two months.
- Project GREENLand established cooperation with 2 sister projects so far.

Task 4.3. Knowledge transfer to industry and other stakeholders *(M29-M36)*

- Participation and organisation of specific events for increased and effective liaisons, dissemination of information, and engagement of key stakeholders in the social media ecosystem, activities were undertaken since the beginning of the project.
- Additionally, the GREENLand project continuously utilised project partner networks and social media channels to connect with all key target groups and spread awareness.

KPI OVERVIEW

KPI	Target values by the end of the project - cumulatively	Achieved by M16
Followers	1600	947
Posts	1200	669
Collaboration agreements	4	2
research papers	12	7
national and international conferences	9	7

The project was presented and disseminated at a total of 29 local, regional and international events so far (physical, online, hybrid), including several societal, scientific, and industrial public events, working groups, scientific conferences, etc.

KNOWLEDGE TRANSFER EVENTS IN DETAIL

Type of the event	Date	Country	Details
Workshops			
Adoption of the legal acquisition of the European Union in the field of microplastics into the national legislation of the Republic of Serbia	November 2023	Serbia	LINK
Seminars			
Joint Webinar: upPE-T, UPLIFT, PRESERVE and GREENLand projects: Solving the problem of microplastics through evolving recycling technology	November 2023	Online	LINK
Dissemination/Communication Activities and Events			
Fenseraj ukusa - Food festival	November 2023	Serbia	LINK
Round table: Global challenges and green transition of the Republic of Serbia	November 2023	Serbia	LINK
Workshop: CIRCULAR ECONOMY AS MODEL FOR AGRICULTURAL DEVELOPMENT OF THE REPUBLIC OF SERBIA in Rekovac	November 2023	Serbia	LINK
19th INTERNATIONAL ENVIRONMENT PROTECTION AND NATURAL RESOURCES FAIR – ECOFAIR	November 2023	Serbia	LINK
Knowledge transfer to industry and other stakeholders	December	Serbia	LINK
The second TwinSubDin workshop “Control of contamination in the application of organic soil amendments”	December 2023	Serbia	LINK

Faculty of Food Technology, Food Safety and Ecology of the University of Donja Gorica- Microplastics from creation to disappearance	December 2023	Montenegro	LINK
23rd European Meeting on Environmental Chemistry	December 2023	Montenegro	LINK
Central and Eastern Europe Symposium on Microbial Ecology (CEESME)	September 2023	Hungary	LINK
Knowledge transfer to local self-governments of APV – national legislative on microplastics – review and perspectives	February 2024	Serbia	LINK
Transnational project meeting (TPM) for Erasmus project C-ZERO SPORTS CLUBS in Sakarya	February 2024	Turkey	LINK
Presentation of the GREENLand project at the meeting of the Environment Protection Alliance at NALED	February 2024	Serbia	LINK
Bioeconomy changemakers festival	February 2024	Serbia	LINK
19th International Fair of Education “PUTOKAZI”	March 2024	Serbia	LINK
Working visit to Khazar University in Baku	April 2024	Azerbaijan	LINK
Knowledge transfer to the academic and research community from the region	April 2024	Serbia	LINK
Scientific club: New era of environmental protection	April 2024	Serbia	LINK
Kremenchuk International Scientific and Practical Conference of Young Scientists and Specialists	April 2024	Ukraine	LINK
Conference “Green transition in the economy – state and perspectives”	October 2023	Serbia	LINK
Fresh Water Net-clustering event	March 2024	Belgium	LINK

Congresses and Conferences			
EEM2023 - 8th International Congress "Engineering, Environment and Materials in Process Industry	March 2023	Bosnia and Herzegovina	LINK
1st European Green Conference, EGC 2023	May 2023	Croatia	LINK
RemTech Expo-European conference on remediation markets and technologies	September 2023	Italy	LINK
Conference "Green transition in economy – state and perspectives"	October 2023	Serbia	LINK
23rd European Meeting on Environmental Chemistry	December 2023	Montenegro	LINK
14th European Nutrition Conference FENS 2023	November 2023	Serbia	LINK
International Conference (Micro-nano) Plastics in Soil 2024	March 2024	The Netherlands	LINK

To promote knowledge, technology, and innovations with an emphasis on dissemination, communication, and exploitation activities, building capacity through the next generation of highly qualified employees will involve more than just developing scientific capacities.

CONTRIBUTION PER PARTNER

EDU	Preparation and printing dissemination and communication material, website management, social media management, organisation of external and internal events: training, courses, visits, presentations, webinars (physical, online, hybrid), media relations, networking and collaboration with stakeholders and target audiences following the defined activities and the Strategy.
AWI	Sharing accumulated knowledge and practical skills, including soft skills, with the aim of more productive and efficient execution of defined activities for wider dissemination & communication of the project, as well as coaching and mentoring to a broader audience, beyond the GREENLand core community.
UG	Providing a wide range of instructions to facilitate the information flow to better prepare WP actions and impact on target audience benefits, including knowledge sharing, mentoring, capacity building and potential of all team members.

Deliverables and milestones

Deliverables submitted

D4.1. Dissemination, Exploitation, and Communication Plan – M6

Deliverables to be submitted

D4.2. Report on all dissemination activities – M36

D4.3. Report on knowledge transfer activities – M36

D4.4. Final publishable report on WP5 – M36

Achieved milestones

There were no Milestones to reach M16 of the project regarding WP4.

Risks and mitigation measures

During the implementation and trying to increase the number of followers on the social networks, it took a lot of time to determine who the press release contact person was at one of the partners.

Risk encountered	Mitigation applied
Pandemic restriction on traveling.	Extended education or online some parts that could be done in this way.
Low interest in participating in events.	Online promotion on social networks.

WORK PACKAGE 5

PROGRESS IN WP5

RESULTS ACHIEVED

Task 5.1. Management of the consortium *(M1-M36)*

- The kick-off meeting was organised at the beginning of the project in Novi Sad, Serbia on January 24th, 2023, to ensure a common understanding of the project timeline and to discuss the first future steps.
- During this meeting Project Supervisory Board (PSB) was established at the Kick-off meeting, such as a plan for further PSB meetings which will be organised and conducted regularly in collaboration with the consortium partner that hosts the event (once a year in person and quarterly online).
- Online meetings of the PBS were organised as necessary for the preparation of deliverables and other important decisions.
- The Second PSB meeting was held on December 12-14, 2023, at Bremerhaven in Germany, as planned by the GREENLand project proposal. It was dedicated to the WP leader's plan for the next six months, based on what has been accomplished thus far.
- Consultations regarding all ongoing activities are organised online as necessary.

Task 5.2. Project administration and reporting *(M1-M36)*

- Good communication within the Consortium has been ensured by establishing effective internal communication channels (Teams and Monday).
- Establishing new digital services in WP2 t has greatly contributed to easier monitoring and management of documentation.
- The flow of documentation through the administrative services within the activities of the Project Incubator Hub has been established.

Task 5.3. Communication and coordination of reports for the Commission *(M1-M36)*

- All 10 deliverables have been submitted on time, and 6 milestones have been achieved.

KPI OVERVIEW

KPI	Target by the end of the project	Achieved by M16
project team meetings	5	3
Deliverables	15	10
Milestones	10	6

Contribution per partner

EDU	Organisation of kick-off and mid-term meetings, continuous reporting on the SyGMa portal, communication with project officer, coordination of partners
AWI	Organisation of PSB meeting in Bremenhaven, Consultations regarding all activities on project management
UG	Consultations regarding all activities on project management

Deliverables and milestones

Deliverables submitted

D5.1. Project start-up meeting minutes and report – M2

The first deliverable, the project start-up meeting minutes and report was delivered on time, however, the submit button wasn't used properly. The GL project officer at the time Nikolina Mijolović contacted the coordinator on 26. April 2023 and provided instructions on how to submit properly. The due date for this deliverable was 28. February 2023.

Deliverables to be submitted

D5.2. Project Management meeting minutes and Report – M36

D5.3. Progress report – M17 – *this deliverable*

Achieved milestones

There were no Milestones to reach M16 of the project regarding WP5.

Risks and mitigation measures

Risk encountered	Mitigation applied
Problem with illness, maternity leave.	change of participants and redistribution of responsibilities.

IMPACT

PROGRESS TOWARD THE EXPECTED IMPACTS AND OUTCOMES

(EO1) Boosting excellence capacity and resources in Serbia

The GREENLand project has positively impacted the level of excellence in Serbia in the field of microplastic. The project has produced a roadmap for research in the field of microplastics, setting the scene to increase the number of studies and research in the field, increasing public investments, and widening the number of researchers with key expertise.

Workshops and conferences have been organised to provide Serbian researchers, NGOs, and policymakers with a greater understanding of the problems and dangers related to microplastics.

Furthermore, more than 10 researchers from Serbia have been trained by international partners' experts on methods for the detection, extraction, and analysis of microplastics in soil, water, and microorganisms. The acquired knowledge will be leveraged to develop research and innovation projects, write research articles, likewise to further train young researchers in Serbia, and extend the number of academics with such expertise.

(EO2) Enhancing strategic networking activities

Over 30 EDU staff members leveraged GREENLand planned activities to participate in short-term staff exchanges, workshops, expert visits, and conferences. This granted the opportunity to significantly expand their international network, entering contact with over 300 scientists. The expansion of network activities also resulted in a drastic increase in several project proposals submitted over the last 16-month period, passing from 3 proposals per year to 22 proposals submitted in the last year and a half.

(EO3) Raising reputation, research profile, and attractiveness of MRI

The research roadmap developed in WP1 provided the path to guide EDU researchers to produce more scientific work related to microplastics. In collaboration with the project partners, and thanks to the methodological skills acquired during the project, 7 scientific articles were published focusing on microplastic-related topics, as well as presented results at 6 scientific conferences (Anex).

(EO4) Strengthening research management capacities and administrative skills

GREENLAND supported the skill-up process of EDU administrative and managerial staff. This was achieved through 2 short visits of 5 EDU staff members at the project partner institutions. The acquired knowledge was leveraged to kick-off and scale-up the project incubator hub, that has already provided very important results.

Moreover, the human research strategy developed at the beginning of the project addresses current weaknesses among the administrative staff, identifying new needed positions and correlated expertise, likewise a set of training that current employees should follow up. Some of the mentioned training has already taken place, such as the ones about Horizon Europe budgeting, project management, etc. These and future training and short international visits will transform EDU into a modern institution that can count on an up-to-date and highly skilled administrative and managerial staff. In turn, this will also provide an example for other local universities.

(EO5) Improving creativity supported by development of new approaches in R&I collaboration

EO5 requires further time to be achieved. To improve the creativity and new approaches in R&I collaboration, especially with the industry and young entrepreneurs, a systematic shift is needed. The project, though its networking activities with the project international partners is providing valuable information for EDU researchers to learn how collaboration in R&I in their countries takes place.
The project is currently developing the Technology Transfer Hub and the Labs of Innovation. Both tools will grant a closer and more constant collaboration among all the various regional innovation actors, including researchers, entrepreneurs, industry, policy makers, and civil society. They will connect research and innovation, supporting the development and market uptake of innovative solutions.

From Expected Outcomes to Wider Impacts

The EOs have been already partly achieved, beyond project expectations at this early phase. Hence the project will try to further improve, and potential achieve more than planned. In terms of Wider Impacts, there are dependent on the success of the Expected Outcomes. The project expects to significantly address of the Wider Impacts upond the achievement of its EOs.

MONITORING AND EVALUATION STRATEGY

The project is monthly monitoring all its KPIs for both objectives and expected outcomes. This allows us to have a clear picture of where we are standing and what improvements are needed to achieve the project's ambition. Methodologies of data collection vary depending on the type of KPI. Baselines are considered data before the beginning period of the GREENLand project.

OPEN SCIENCE

The GREENLand project has so far published 7 scientific articles. All 7 peer-reviewed scientific publications have been published via Gold Open Access to provide free access to the results of the project research component. Also, the project has shared on the website the map with hotspots with potential microplastics contamination. The map shows the geographical distribution of total phthalates on the territory of AP Vojvodina and illustrates the results of soil analysis conducted at Educons University. These data are available for policymakers, organisations, and other researchers to be used.

Finally, other early results were shared in presentations at conferences and workshops, both locally and internationally.

DEVIATIONS FROM ANNEX 1 AND ANNEX 2

TASK AND OBJECTIVES

Overall, the GREENLand project is being implemented in line with the implementation plan. The tracked KPIs per WP show that the progress has been significant towards the achievement of the objectives.

Nonetheless, some deviations that do not hamper the achievement of the objectives are important to be discussed:

- Task 3.2. Strategic networking and staff exchange: the researchers' visits have been reduced from 1 month initially planned to 2 weeks. In exchange, the number of visits have been increased to ensure that researchers spent the same amount of time as planned in the GA. This was done to adapt to researchers' agendas.
- Task 3.3. Transferring scientific ideas into the projects that will be implemented in practice: this task timeline was changed to better serve the project to achieve its objectives. Initially expected to start at M13, the task was kicked off in the first 6 months of the project.

USE OF RESOURCES

At the current status, no deviations in terms of resource use have been registered.

ANNEX 1

SCIENTIFIC PAPERS

1. Stojić, N.; Pezo, L.; Lončar, B.; Pucarević, M.; Filipović, V.; Prokić, D.; Ćurčić, L.; Štrbac, S. Prediction of the Impact of Land Use and Soil Type on Concentrations of Heavy Metals and Phthalates in Soil Based on Model Simulation. Toxics 2023, 11, 269. https://doi.org/10.3390/toxics11030269 published 15 March 2023
2. Racić, G.; Vukelić, I.; Kordić, B.; Radić, D.; Lazović, M.; Nešić, L.; Panković, D. Screening of Native Trichoderma Species for Nickel and Copper Bioremediation Potential Determined by FTIR and XRF. Microorganisms 2023, 11, 815. https://doi.org/10.3390/microorganisms11030815 published 22 March 2023
3. Vrvić, M. (2023). Technologies for Remediation of Polluted Environments: Between Classic Processes and the Challenges of New Approaches. In: Karabegovic, I., Kovačević, A., Mandzuka, S. (eds) New Technologies, Development and Application VI. NT 2023. Lecture Notes in Networks and Systems, vol 707. Springer, Cham. https://doi.org/10.1007/978-3-031-34721-4_23 published 30 May 2023
4. Rani, M.; Ducoli, S.; Depero, L.E.; Prica, M.; Tubić, A.; Ademovic, Z.; Morrison, L.; Federici, S. A Complete Guide to Extraction Methods of Microplastics from Complex Environmental Matrices. Molecules 2023, 28, 5710. https://doi.org/10.3390/molecules28155710 published 28 July 2023
5. Štrbac, S., Stojić, N., Lončar, B. et al. Heavy metal concentrations in the soil near illegal landfills in the vicinity of agricultural areas—artificial neural network approach. J Soils Sediments 24, 373–389 (2024). https://doi.org/10.1007/s11368-023-03637-1 published 19 September 2023
6. Bjelić, D., Markić, D.N., Prokić, D. et al. "Waste to energy" as a driver towards a sustainable and circular energy future for the Balkan countries. Energ Sustain Soc 14, 3 (2024). https://doi.org/10.1186/s13705-023-00435-y published 2 January 2024.
7. Lugonja, N.; Marinković, V.; Pucarević, M.; Miletić, S.; Stojić, N.; Crnković, D.; Vrvić, M. Human Milk—The Biofluid That Nourishes Infants from the First Day of Life. Foods 2024, 13, 1298. https://doi.org/10.3390/foods13091298 published 24 April 2024

SCIENTIFIC CONFERENCES

1. Stojić, N., Ćurčić, L., Prokić, D., Pucarević, M. (2023): Correlation between abundance of microplastics and concentration of phthalate esters, VIII International Congress "Engineering, Environment and Materials in Process Industry", Jahorina, March 20-23, 2023, Republic of Srpska, Bosnia and Herzegovina p. 139 ISBN: 978-99955-81-44-2 https://redun.educons.edu.rs/handle/123456789/525
2. Prokić, D., Pucarević, M., Ćurčić, L., Stojić, N., Sekulić, M. T., and Šperanda, M. (2023): Life cycle assessment (LCA) of microplastics in the environment, Book of abstracts, 1st European Green Conference, EGC 2023, International Association of Environmental Scientists and Professionals (IAESP), Osijek, Croatia, 23-26 May 2023, Vodice, Croatia, pp. 42 ISSN: 2991-5171 https://redun.educons.edu.rs/handle/123456789/568
3. Vidojević, D., Stojić, N., Pucarević, M., Prokić, D., Ćurćić, L., (2023): , Inadequate municipal solid waste management and occurrence of phthalate esters in soil in Serbia, RemTech Expo 2023, Ferrara (Italy) ISBN 978 88 8080 575 5 https://redun.educons.edu.rs/handle/123456789/566
4. Prokić D, Ćurčić Lj, Stojić N, Pucarević M, Panin B, Mitić D. L: (2023): Circular economy as a mechanism for reducing plastic waste, Proceedings from the scientific conference: Green transition in economy – state and perspectives'', Sremska Kamenica, Novi Sad, Serbia, 12. October 2023., p. 145-154. ISBN 978-86-82088-13-4 https://redun.educons.edu.rs/handle/123456789/627
5. Pucarević, M., Stojić, N., Vrvić, M. M. , Prokić, D., Ćurčić, Lj., Panin, B., Mitić, L. (2023): Instrumental Methods for the Microplastics Determination in the Environment, 23rd European Meeting on Environmental Chemistry, 3-6 December, 2023, Budva, Montenegro, ISBN 978-9940-9059-2-7 https://redun.educons.edu.rs/handle/123456789/626
6. Vrvić, M.M.; Lugonja, N.; Miletić, S.; Pucarević, M.; Mitić, D.-L.; Teofilović, V.; Stojić, N. (2023): A Brief Bibliometric Analysis of Microplastic and Nanoplastic Particles in Food. Proceedings 2023, 91, 257. https://redun.educons.edu.rs/handle/123456789/628
7. Stojić, N., Ćurčić, L., Prokić, D., Panin, B., Ćurčić, G., Pucarević, M. (2024): Strategic options for reducing microplastics, International Conference 2024 on (Micro-nano) Plastics in Soil, 13-14 March 2024 Utrecht, The Netherlands. https://redun.educons.edu.rs/handle/123456789/671

ANNEX 2

ACTION PLAN FOR MICROPLASTICS-FREE SOIL

Soils are a finite and non-renewable natural resource that store, filter and transform many substances including water, nutrients and carbon. Healthy soils are crucial for agricultural production and food security. Healthy soil is a service provider to the natural environment, economy, and health, and represents a stabilizing factor for the functionality of natural and managed ecosystems.

Given that plastics are produced, used and mostly discarded on land, soils represent a large sink for microplastics. Owing to the long-term persistence of plastics in the environment, their accumulation is one of the most widespread and long-lasting anthropogenic changes to the Earth's surface.

Soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems and that respect the boundaries our planet can cope with, thus creating a toxic-free environment.

The main objective of the Action Plan is to reduce the levels of microplastics in soil in the Republic of Serbia. The Action Plan is formulated to effectively strengthen prevention and control of microplastics soil pollution, and to gradually improve soil environmental quality.

The Action Plan outlines the following specific objectives:

1. to provide guidance and enhance knowledge on the prevention and reduction of microplastics and their impact on soil ecosystem services, public health and safety through coordinated actions;

2. to monitor the source of microplastics emission in soil in order to enhance knowledge and establish a mechanism to address the problem of excessive presence of microplastics in soil;

3. to serve as a guide in the management of microplastics in accordance with accepted international and regional standards and approaches;

4. to advocate for reduction of microplastics in soil to the largest extent possible.

The Action Plan aims to strengthen Serbian environmental leadership, whilst creating a healthier, socially fairer Serbia. The work plan for the preparation of the Action Plan for Microplastics-Free Soil reads as follows:

- Introduction
- Initial position analysis – state of soils in Serbia
- Policies that support microplastics use reduction in Serbia
- The challenge of managing microplastics emissions in soil
- Policy instruments to mitigate microplastics in soil
- Development of sustainable alternatives
- Awareness raising and behaviour change

INTRODUCTION

Soil hosts more than 25% of all biodiversity on the planet and is the foundation of the food chains nourishing humanity and above ground biodiversity. This fragile layer will be expected to feed and filter drinking water fit for consumption to a global population of nearly 10 billion people by 2050 [1]. The main problems for soils in the EU are irreversible losses due to increasing soil sealing and soil erosion, and continuing deterioration due to local contamination and diffuse contamination (acidification and heavy metals). The incremental loss and deterioration of Europe's soil resource will continue and will probably increase as a result of climate change, land-use changes and other human activities [2].

Soil degradation in the Republic of Serbia is at present dominantly driven by human factors (land conversion, abandonment of agricultural fields, overexploitation of soil in agriculture). Also, soil erosion is a major form of soil degradation in Serbia [3]. According to the Report on the state of land in the Republic of Serbia for 2018 and 2019 [4], the greatest pressures on soil in the Republic of Serbia are: erosion, occurrence of landslides, reduction of organic matter, pollution and change in land use. Given that plastics are produced, used and mostly discarded on land, soils represent a large sink for microplastics. For instance, microplastics have been found from high to low latitudes across a variety of terrestrial ecosystems such as agricultural lands, urban and industrial areas, and even in remote mountains [5]. Microplastics found in the soil are responsible for the destruction of the soil structure, for the reduction of infiltration capability of soil for rain and irrigation water, and have adverse impacts on the soil water holding capacity [6]. The condition of the soil on the territory of the Republic of Serbia is monitored by several institutions with the aim of assessing the

condition and defining programs for its protection. Unfortunately, systematic soil quality monitoring in the Republic of Serbia does not include determining the content of microplastics in soil.

Initial position analysis – state of soils in Serbia

The main processes connected with soil loss and degradation in Serbia are as follows [7] :

1. soil loss and damage due to industrial, mining, and power-producing activities;
2. loss of soil organic matter;
3. acidification and salinization of soil;
4. different forms of soil pollution (excessive use of agrochemicals, heavy metals, industrial pollution, etc.);
5. aeolian and water erosion;
6. compaction of agricultural soils.

The sources of soil pollution are predominantly a consequence of human activities and can basically be divided into three groups [8] :

1. **Wastewater as soil pollutants:** industrial wastewater; water contaminated by agricultural activities (burdened with nitrogen and phosphorus originating from fertilisers, pesticides, organic materials of different origin); wastewater from households and maintenance of settlement hygiene;
2. **Contaminants originating from the atmosphere, contaminating soil with dry or wet sedimentation:** emissions from industrial technological processes; emissions due to combustion of fossil fuel (industry, power plants, individual heating); emissions originating from motor vehicles (traffic); emissions during combustion of various organic materials;
3. **Solid waste of different origin:** municipal waste; industrial waste; waste from agriculture and others.

The most common soil pollutants in Serbia are heavy metals, persistent organic pollutants, pesticides, fertilisers and emerging pollutants, pesticides, fertilisers and emerging pollutants such as pharmaceuticals and personal care products [9].

According to a report from 2018 called Towards Soil Decontamination in the Republic of Serbia [10], 709 potentially contaminated sites and contaminated sites were identified and recorded on the territory of the Republic of Serbia, 557 of which are registered and 152 are estimated.

Although there is no specific data for the Republic of Serbia, growing evidence all over the world has demonstrated that microplastics are present in terrestrial ecosystems [11]. Microplastics enter soil via multiple sources (Figure 1), including landfills, soil amendments, land application of sewage sludge, wastewater-irrigation, compost and organic fertiliser, residues of agricultural mulching films, tire wear and tear, and atmospheric deposition etc. [12]. Municipal solid waste landfills may also represent point sources of microplastic pollution affecting the underlying soil and groundwater [13]. In the Republic of Serbia, over 140 non-sanitary landfills and dumpsites have been estimated to pose high risks to the environment. Leakage from these dumpsites poses a threat to groundwater, surface water and soil, due to the high content of organic matters and heavy metals [14]. The lack of facilities and equipment for pollution reduction (wastewater treatment facilities, electrostatic precipitators and flue gas desulphurization facilities) results in the emission of pollutants into the air, water and soil, generation of significant quantities of waste and inadequate disposal, i.e., negative impact on human health and environment.[15]

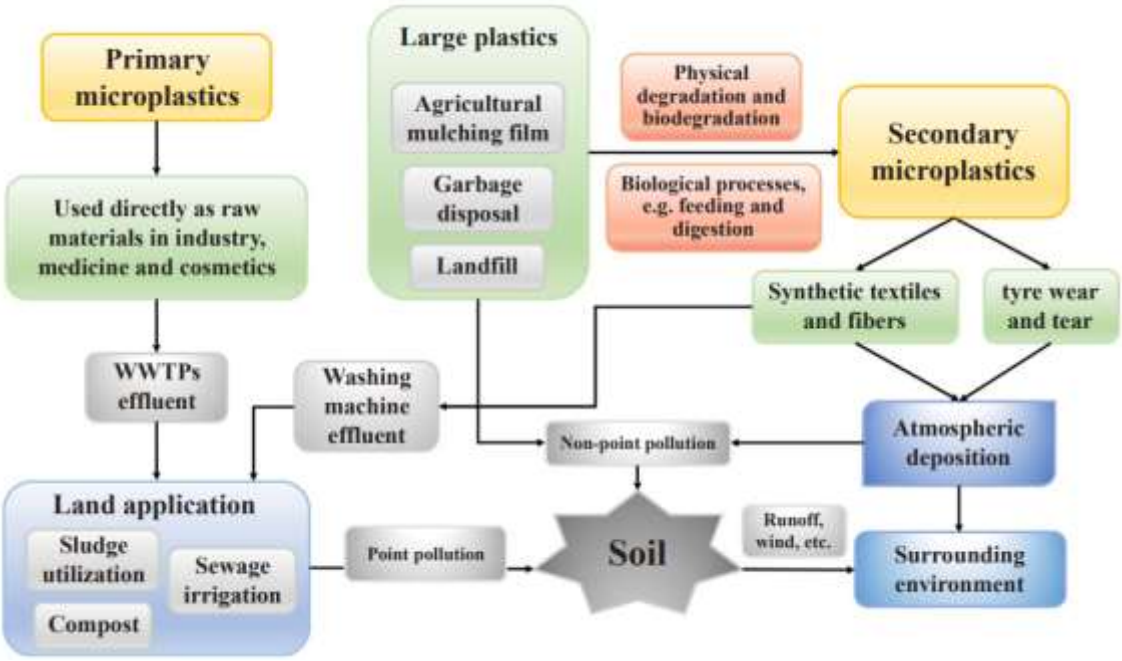

Figure 1. Sources of microplastics in soil. WWTPs indicates wastewater treatment plants [16].

Once in the soil, microplastics may persist, accumulate, and eventually reach high levels that can affect organisms and biodiversity. Additionally, microplastics can also act as a vector for the transfer of pollutants, either plastic additives or other toxicants absorbed from soil matrices, to soil biota and thus pose a hazard [17].

POLICIES THAT SUPPORT MICROPLASTICS USE REDUCTION IN SERBIA

Protection of soil in the Republic of Serbia is legally established in the following legislation [18] :

1. Law on Environmental Protection ("Official Gazette of RS" No. 135/2004, 36/2009, 36/2009 -other law, 72/2009 – other law and 43/2011 – Decision of SC and 14/2016, 76/2018, 95/2018 – other law and 95/2018 – other law);
2. Law on Soil Protection ("Official Gazette of RS", No. 112/2015);
3. Law on Agricultural Land ("Official Gazette of RS" No. 62/2006, 65/2008 – other law and 41/2009, 112/2015, 80/2017 and 95/2018 – other law).

A prerequisite for soil protection in the Republic of Serbia is systematic monitoring of soil quality, harmonised with the objectives defined in the national programs and strategies:

1. National Program of Environmental Protection ("Official Gazette of RS", No. 12/2010);
2. National Strategy of Sustainable Development of the Republic of Serbia ("Official Gazette of RS", No. 57/2008);
3. Action Plan for Implementation of the Sustainable Development Strategy ("Official Gazette of RS", No. 22/2009);
4. Strategy of Sustainable Urban Development until 2030 ("Official Gazette of RS", No. 47/19);
5. The Strategy for Agriculture and Rural Development of the Republic of Serbia 2014-2024 ("Official Gazette of RS", No. 85/14);
6. National Environmental Approximation Strategy for the Republic of Serbia ("Official Gazette of RS", No. 80/11), etc.

A strategic framework for circular economy in the Republic of Serbia started to be defined in 2019 with the creation of an ex-ante analysis of the effects of circular economy, which indicated that a separate policy document was needed for the field of circular economy. In accordance with the results of the analysis, the Ministry of Environmental Protection initiated the development of the Circular Economy Development Programme in the Republic of Serbia 2022-2024. The document covers most important fields of relevance for circular economy: waste management; water management; renewable energy sources and energy efficiency; chemicals management; green public procurement and voluntary instruments; economy policy; innovation and public awareness. Circular economy is recognized as an important strategic concept for green transition of the Republic of Serbia, which has been placed high on the list of priorities for the development of our society in recent years. Green transition is a process that includes economic, energy and investment transition based on sustainable use of resources

and energy, reduction of negative environmental impacts, application of innovation and digital tools, knowledge, added value and greater competitiveness of the economy [19].

By signing the Declaration on the Green Agenda for the Western Balkans at the Summit in Sofia on 10 November 2020, Serbia undertook to implement the recommended measures in five fields, including circular economy, with a special focus on waste, recycling, sustainable production and efficient use of resources, including soil [20].

Soil monitoring in the Republic of Serbia is legally defined in the Regulation on the Systematic Monitoring of the Condition and Quality of Soil [21] which has been harmonised with the recommendations provided in the Proposal for a Soil Framework Directive - COM(2006)232. Another legally binding document is the Regulation on Limit Values for Polluting, Harmful and Hazardous Substances in the Soil [22].

The Regulation on Establishing the Criteria for Determining the Status of Endangered Environment and Priorities for Rehabilitation and Remediation [23] applies to identification of the rehabilitation and remediation priorities, which are also regulated by the Rulebook on the Methodology for the Development of Rehabilitation and Remediation Projects [24].

The systematic monitoring of the soil quality is based on the use of indicators to determine the risks of soil degradation. These indicators are defined in the National List of Indicators [25] and they are used for reporting on the state of soil in the Republic of Serbia. The Serbian Environmental Protection Agency (SEPA) is the key national institution responsible for managing the integrated system for environmental monitoring and reporting. The process of reporting on the state of soil includes a collection of relevant information and data, followed by providing an update on the soil indicators to be used to inform decision-makers [26].

European legislation has recognized the need for monitoring of microplastics, which involves the establishment of monitoring programmes, enabling the assessment of the status of soil on a regular basis. Serbia continuously adopts and harmonises laws and regulations with the regulations of the European Union (EU). Unfortunately, microplastics are not yet the subject of Serbian Regulations [27].

THE CHALLENGE OF MANAGING MICROPLASTICS EMISSIONS IN SOIL

According to the European Strategy for Plastics in a Circular Economy (COM/2018/028), which encourages a circular approach that prioritises recycling of plastic packaging under the programme until 2030, the following key activities are identified for national and regional authorities and industry to mitigate emissions of plastics into the environment [28]:

1. **Improving the economics and quality of plastics recycling:**
   - improve design and support innovation to make plastics and plastic products easier to recycle;
   - expand and improve separate collection of plastic waste, to ensure quality inputs to the recycling industry;
   - expand and modernise the EU's sorting and recycling capacity;
   - create viable markets for recycled and renewable plastics.
2. **Curbing plastic waste and littering:**
   - preventing plastic waste in our environment;
   - establishing a clear regulatory framework for plastics with biodegradable properties;
   - more research is needed to improve our understanding of the sources and impacts of microplastics, including their effects on the environment and health, and to develop innovative solutions to prevent their dissemination.
3. **Driving innovation and investment towards circular solutions:**
   - Research and innovation can also make a difference in preventing plastic waste and microplastics pollution.
   - Further scientific research is needed to gauge the potential health impacts of microplastics and develop better monitoring tools.

Sources of microplastics to soil ecosystems are expected to continue increasing for many years to come because of increased production, extensive use scaling with the expanding population, their degradation resistant properties, and the substantial quantities that already exist. Therefore, potential control and remediation measures are urgently needed to attempt to mitigate microplastics pollution and alleviate the risks posed by microplastics [29].

Source reduction is perhaps the best method available to curtail further spread of microplastics pollution. This essentially requires further efforts in reducing plastic usage, increasing recycling, and engaging in public outreach to eliminate littering. In order to achieve a reduction in plastic usage, countries, including Serbia, are currently introducing regulations on most commonly used single-use plastic items, although the same effort has not yet been seen with regard to curtailing the use of plastics in packaging materials. Eliminating overuse of compost and fertiliser could help reduce soil contamination with microplastics as well [30].

There is a vital need to develop biodegradable and environmentally friendly mulches to replace conventional plastic film mulches in agricultural soil [31]. Use of plastics that are biodegradable, perhaps such as those made from starch, cellulose, or similar polymers, has been proposed and employed. However, biodegradable plastics entail other sustainability concerns, as the production process consumes a lot of water and land and most of these polymers are not recyclable after the first use [32]. The promotion of recycling is an effective strategy to mitigate microplastics pollution. Routine recycling processes, such as washing, mechanical shredding, and the production of granular particles, can lead to the fragmentation of larger plastics into smaller particles, ultimately contributing to the generation of microplastics. Innovation and advancements in recycling technologies are essential to enhance efficiency, minimise particle escape, and ultimately contribute to a significant reduction in microplastics pollution [33].

Directly addressing the issue at its source, i.e., reducing plastic waste, is a powerful and impactful approach to mitigate microplastic pollution. This comprehensive strategy starts at the community and industrial levels, supported by government policies aimed at eliminating the excessive use of plastic through legislation and financial investments [34]. Government of the Republic of Serbia can contribute to the reduction of soil microplastics pollution through the following efforts:

1. clarifying the responsibilities, and associated penalties, of government departments and businesses in the production, use, recycling, and disposal of plastics;
2. instituting polluter-pays and beneficiary-compensation as basic principles when designing environment taxes;
3. raising awareness about microplastics through education;
4. consulting the public, from individuals to non-profit environmental groups, improving public participation, and developing relevant feedback mechanisms [35].

The mutual relationship between science technology and policy developers can contribute to finding strategic solutions to mitigate the microplastics in the terrestrial environment. The recommendations for the stakeholders, policymakers, and environmentalists to reduce microplastics pollution in the terrestrial environment includes [36]:

1. eco-design;
2. implementation of strict rules and regulation for the production, dependency and utilisation of plastic products;
3. increase the demand of biodegradable plastics;
4. by reducing the use of non-biodegradable plastics;
5. use of microplastics for energy source;
6. improvements in the collection of solid waste;
7. strategic improvement in the recycling of e-waste etc.

POLICY INSTRUMENTS TO MITIGATE MICROPLASTICS IN SOIL

Mitigating microplastics in soil requires a multifaceted approach involving various policy instruments. Here are several strategies that policymakers could implement [37]:

1. **Regulations on plastic use:** Implement regulations to reduce the production and use of single-use plastics, which are a significant source of microplastics in soil. This could involve bans or restrictions on certain types of plastic products or packaging.
2. **Extended producer responsibility (EPR):** Implement EPR policies that make producers responsible for the entire lifecycle of their products, including proper disposal and recycling. This encourages manufacturers to design products that are easier to recycle and less likely to become microplastics.
3. **Waste management and recycling programs:** Strengthen waste management and recycling infrastructure to ensure proper disposal of plastic waste and prevent it from ending up in soil. This could include improving recycling facilities, implementing composting programs, and increasing public awareness about proper waste disposal.
4. **Funding for research and development:** Allocate funding for research and development into alternative materials that can replace plastics in various applications. This could include biodegradable plastics, bio-based materials, and other innovative solutions.
5. **Monitoring and reporting requirements:** Implement monitoring programs to track the levels of microplastics in soil and report findings to the public. This can help raise awareness about the issue and inform future policy decisions.
6. **Education and awareness campaigns:** Launch education and awareness campaigns to inform the public about the environmental impacts of microplastics in soil and encourage behaviour change. This could include educational programs in schools, public outreach campaigns, and media initiatives.
7. **Incentives for sustainable practices:** Provide incentives for businesses and individuals to adopt sustainable practices that reduce the use of plastics and prevent microplastics pollution. This could include tax incentives, grants, or subsidies for eco-friendly initiatives.
8. **International cooperation:** Collaborate with other countries and international organisations to develop coordinated strategies for mitigating microplastics pollution. Since microplastics can travel long distances through air and water, international cooperation is essential to address the problem effectively.

By implementing a combination of these policy instruments, policymakers can work towards reducing the presence of microplastics in soil and protecting ecosystems and human health.

DEVELOPMENT OF SUSTAINABLE ALTERNATIVES

Developing sustainable alternatives to microplastics in soil involves innovative approaches and materials that can fulfil similar functions without causing harm to the environment. Here are some strategies and examples:

1. **Biodegradable polymers**: Research and develop biodegradable polymers that can degrade into harmless compounds in soil over time. These polymers can be used in various applications such as mulches, agricultural films, and packaging materials. Examples include biodegradable plastics made from plant-based materials like cornstarch or sugarcane.
2. **Natural fibres**: Explore the use of natural fibres such as hemp, jute, or cotton as alternatives to synthetic fibres in products like textiles, geotextiles, and erosion control mats. These fibres are renewable, biodegradable, and less likely to accumulate in soil compared to synthetic fibres.
3. **Bio-based materials**: Investigate the use of bio-based materials derived from renewable resources such as algae, fungi, or agricultural waste. These materials can be used in a wide range of applications including packaging, construction materials, and consumer products. For example, mycelium-based materials can be used to replace polystyrene foam packaging.
4. **Mineral-based additives**: Develop mineral-based additives that can provide similar functions to microplastics in soil improvement and agriculture. For example, natural clays or zeolites can be used as soil conditioners or carriers for agricultural inputs, reducing the need for synthetic polymers.
5. **Nano-materials**: Explore the use of nano-materials such as nano-cellulose or nano-clay particles as alternatives to microplastics in applications where fine particles are needed, such as in cosmetics or industrial processes. These materials can offer similar functionalities while being biodegradable and less harmful to the environment.
6. **Circular economy models**: Promote circular economy models that focus on reducing waste and maximising resource efficiency. This involves designing products with reuse, recycling, and composting in mind, minimising the generation of waste materials that can end up as microplastics in soil.
7. **Green chemistry approaches**: Apply principles of green chemistry to develop alternative materials and processes that are environmentally friendly throughout their lifecycle. This includes minimising the use of hazardous chemicals, reducing energy consumption, and optimising resource efficiency.
8. **Collaborative research and innovation**: Encourage collaboration

between researchers, industry stakeholders, and government agencies to accelerate the development and adoption of sustainable alternatives to microplastics. This can involve funding research projects, supporting technology transfer initiatives, and fostering open innovation platforms. By focusing on these approaches and fostering innovation in materials science and engineering, we can develop sustainable alternatives to microplastics that protect soil health and ecosystem integrity.

AWARENESS RAISING AND BEHAVIOUR CHANGE

The goal of this part of the Action Plan is to establish a plan for the development of measures/programs/initiatives to raise awareness of the importance of reduction of microplastics in soil in Serbia (i.e. policy makers, general public, universities, schools, industry, etc.).
Further objectives are:

1. to identify which stakeholder groups/policy makers/age groups are not receiving suitable information;
2. to develop a resource base of publicly available educational material on the harmful impact of microplastics in soils and the importance of its reduction;
3. to coordinate, promote and provide support materials to microplastic free soil awareness activities across Serbia. For example, through communication and workshops with other networks and groups.

Measures to improve knowledge and exchange information and best practices are needed to fill this gap. The aim is to increase public understanding and shape community perceptions on the dangers of microplastic pollution of soil, thereby empowering more people and organisations to take action. To increase public awareness of the need to reduce microplastics in soil, there is need to foster initiatives such as:

1. training and information events;
2. distribution of materials regarding the harmful effect of microplastics in soil and the need for its reduction.

KEY GROUPS AND NETWORKS

Three key areas have been identified for target activities: education, policy awareness and public stakeholder groups.

- Ø Key Groups for targeted awareness and education outreach:
  1. Education
     - o Primary
     - o Secondary
     - o Tertiary Education (lifelong learning, summer schools, etc.)
  2. Policy awareness
     - o National agencies
     - o Ministry of Agriculture, Forest and Water Management
     - o Ministry of Environmental Protection
     - o Environmental Agency
  3. Public Stakeholder groups
     - o Agricultural producers
     - o Land based industries
     - o Land planners
     - o National parks

Networks:

1. Teacher associations
2. Soil Science Societies
3. Farmers associations
4. Ecology societies

Educational Material Development:

In order to promote microplastics-free soil there is a need to create informative materials, including brochures, posters, and digital content, explaining the environmental impact of microplastics pollution to soil and showcasing sustainable alternatives.

Awareness Campaigns:

Launch a multimedia awareness campaign utilising radio, television, social media, and community events to disseminate information about the Action Plan on Microplastics-Free Soil goals and benefits.

School Programs:

Collaboration with schools and universities to integrate microplastic waste reduction into programs and to organise awareness raising activities.

Plastic Waste Reduction Initiatives:

In order to reduce plastic waste in soil initiatives are needed, such as:

- Ø Conduct of plastic waste audits to understand types and sources of plastic waste and their harmful impact on soil;
- Ø Promotion of sustainable alternatives to single-use plastics.

LITERATURE

[1] EU Soil Strategy for 2030 Reaping the benefits of healthy soils for people, food, nature and climate; Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0699

[2] Environment in the European Union at the turn of the century: Soil degradation; European Environment Agency; Available at: https://www.eea.europa.eu/publications/92-9157-202-0/page306.html

[3] Soil Degradation and Climate Change in Serbia; Available at: https://www.undp.org/sites/g/files/zskgke326/files/2022-07/Soil_degradation_and_climate_change_in_Serbia_web.pdf

[4] Report on the state of land in the Republic of Serbia for 2018 and 2019; Environmental Protection Agency; Ministry of Environmental Protection; Republic of Serbia; Available at: http://www.sepa.gov.rs/download/Zemljiste_18_19.pdf

[5] Lin D, Yang G, Dou P, Qian S, Zhao L, Yang Y, Fanin N. 2020 Microplastics negatively affect soil fauna but stimulate microbial activity: insights from a field-based microplastic addition experiment. Proc. R. Soc. B 287: 20201268. http://dx.doi.org/10.1098/rspb.2020.1268

[6] Sajjad M, Huang Q, Khan S, Khan M. A, Liu Y, Wang J, Lian F, Wang Q, Guo G. 2022; Microplastics in the soil environment: A critical review. Environmental Technology & Innovation, Volume 27, 102408. https://doi.org/10.1016/j.eti.2022.102408

[7] Ličina V. et all. 2011; The Soils of Serbia and Their Degradation. Field Veg. Crop Res. 48, 285-290. Available at: https://scindeks-clanci.ceon.rs/data/pdf/1821-3944/2011/1821-39441102285L.pdf

[8] Filipović D, Obradović Arsić D. 2014; Quality of soil in the Republic of Serbia and the status of population's health. Collection of Papers - Faculty of Geography at the University of Belgrade 62, 39-60. Available at: https://scindeks-clanci.ceon.rs/data/pdf/1450-7552/2014/1450-75521462039F.pdf

[9] Towards soil decontamination in the Republic of Serbia; Available at: https://www.sepa.gov.rs/download/zemljiste/TowardsSoilDecontamination.pdf

[10] Towards soil decontamination in the Republic of Serbia; Available at: https://www.sepa.gov.rs/download/zemljiste/TowardsSoilDecontamination.pdf

[11] Guo J.J. et al. 2020; Source, migration and toxicology of microplastics in soil. Environment International, 137, 105263. https://doi.org/10.1016/j.envint.2019.105263

[12] Guo J.J. et al. 2020; Source, migration and toxicology of microplastics in soil. Environment International, 137, 105263. https://doi.org/10.1016/j.envint.2019.105263

[13] Qi R, Jones D. L, Li Z, Liu Q, Yan C. 2020; Behavior of microplastics and plastic film residues in the soil environment: A critical review. Science of the Total Environment, 703, 134722. https://doi.org/10.1016/j.scitotenv.2019.134722
[14] Scaling up residential clean energy (SURCE) project (P176770), Environmental and social management programme in the Republic of Serbia 2022-2024, Borrowing Agency, Belgrade, 2022. Available at: https://documents1.worldbank.org/curated/en/099910101202238465/pdf/ESMF0final0ENG.pdf
[15] Circular economy development programme in the Republic of Serbia 2022-2024 ("Official Gazette of RS" No. 137/2022-15); Available at: https://www.pravno-informacioni-sistem.rs/eli/rep/sgrs/vlada/drugiakt/2022/137/1
[16] Guo J.J. et al. 2020; Source, migration and toxicology of microplastics in soil. Environment International, 137, 105263. https://doi.org/10.1016/j.envint.2019.105263
[17] He D, Luo Y, Lu S, Liu M, Song Y, Lei L. 2018; Microplastics in soils: Analytical methods, pollution characteristics
and ecological risks. Trends in Analytical Chemistry, 109, 163 – 172. https://doi.org/10.1016/j.trac.2018.10.006
[18] Towards soil decontamination in the Republic of Serbia; Available at: https://www.sepa.gov.rs/download/zemljiste/TowardsSoilDecontamination.pdf
[19] Circular economy development programme in the Republic of Serbia 2022-2024 ("Official Gazette of RS" No. 137/2022-15); Available at: https://www.pravno-informacioni-sistem.rs/eli/rep/sgrs/vlada/drugiakt/2022/137/1
[20] Circular economy development programme in the Republic of Serbia 2022-2024 ("Official Gazette of RS" No. 137/2022-15); Available at: https://www.pravno-informacioni-sistem.rs/eli/rep/sgrs/vlada/drugiakt/2022/137/1
[21] "Official Gazette of RS", No. 88/2020
[22] "Official Gazette of RS", No. 30/2018 and 64/2019
[23] "Official Gazette of RS", No. 22/2010
[24] "Official Gazette of RS", No. 74/2015
[25] The Rulebook on the National List of Indicators of Environmental Protection ("Official Gazette of RS", No. 37/2011)
[26] Towards soil decontamination in the Republic of Serbia; Available at: https://www.sepa.gov.rs/download/zemljiste/TowardsSoilDecontamination.pdf
[27] Vesna T. et al. 2020; The necessity for monitoring of microplastics in Serbia. MICRO 2020. Fate and Impact of Microplastics: Knowledge and Responsibilities. 23-27 November, 95/999. Available at: https://cer.ihtm.bg.ac.rs/handle/123456789/6322?locale-attribute=en

[28] A European Strategy for Plastics in a Circular Economy; Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:2df5d1d2-fac7-11e7-b8f5-01aa75ed71a1.0001.02/DOC_1&format=PDF
[29] Guo J.J. et al. 2020; Source, migration and toxicology of microplastics in soil. Environment International, 137, 105263. https://doi.org/10.1016/j.envint.2019.105263
[30] Hettiarachchi H, Meegoda J. N. 2023. Microplastic Pollution Prevention: The Need for Robust Policy Interventions to Close the Loopholes in Current Waste Management Practices. Int. J. Environ. Res. Public Health 2023, 20, 6434. https://doi.org/10.3390/ijerph20146434
[31] Sajjad M, Huang Q, Khan S, Khan M. A, Liu Y, Wang J, Lian F, Wang Q, Guo G. 2022; Microplastics in the soil environment: A critical review. Environmental Technology & Innovation, Volume 27, 102408. https://doi.org/10.1016/j.eti.2022.102408
[32] Hettiarachchi H, Meegoda J. N. 2023. Microplastic Pollution Prevention: The Need for Robust Policy Interventions to Close the Loopholes in Current Waste Management Practices. Int. J. Environ. Res. Public Health 2023, 20, 6434. https://doi.org/10.3390/ijerph20146434
[33] Nikpay P, Toorchi Roodsari S. 2024. Crafting a Scientific Framework to Mitigate Microplastic Impact on Ecosystems. Microplastics, 3(1), 165-183; https://doi.org/10.3390/microplastics3010010
[34] Nikpay P, Toorchi Roodsari S. 2024. Crafting a Scientific Framework to Mitigate Microplastic Impact on Ecosystems. Microplastics, 3(1), 165-183; https://doi.org/10.3390/microplastics3010010
[35] Guo J.J. et al. 2020; Source, migration and toxicology of microplastics in soil. Environment International, 137, 105263. https://doi.org/10.1016/j.envint.2019.105263
[36] Kumar A. et al. 2023. Microplastics in terrestrial ecosystems: Un-ignorable impacts on soil characterises, nutrient storage and its cycling. Trends in Analytical Chemistry, 158, 116869. https://doi.org/10.1016/j.trac.2022.116869
[37] A European Strategy for Plastics in a Circular Economy; Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:2df5d1d2-fac7-11e7-b8f5-01aa75ed71a1.0001.02/DOC_1&format=PDF