ASSESSMENT OF THE EFFICIENCY OF SUPPORT TO ENVIRONMENTAL RESEARCH
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From the standpoint of our society, care for the environment is a priority of overall significance.

An integrated research framework was created through macro regional strategies to address common challenges and environmental issues within European Union member states and other countries in the region, which can be supported by European structural and investment funds. The area of environmental protection has for decades also been much researched in Serbia, however, not all aspects of this area are equally represented and developed. The European Union sees the environment as an area requiring large investments so that our country can achieve its environmental standards, and during the past several years, Serbia has adopted systemic environmental laws.

Environmental protection research is conducted via numerous Calls for Proposals published by the Ministry of Education, Science and Technological Development, Ministry of Environmental Protection, Ministry of Agriculture, Forestry and Water Management, and other ministries, as well as other national institutions (Science Fund, Innovation Fund), through co-operation of researchers from Serbia with researchers from other countries worldwide (bilateral, multilateral projects) and international calls (HORIZON 2002, EUREKA, COST, etc.), the business sector, local governments, as well as co-operation among researchers established through personal contacts.

Different results have been generated by the implementation of these projects, most often in the form of papers published in national and international journals, as well as presentations at national and international conferences and congresses, followed by technical solutions, patents, studies, reports, etc.

For the purposes of this study, data on the implementation of 274 scientific and/or research projects in the area of environmental protection were collected from 40 scientific and research organisations and processed. These scientific and research organisations submitted data on the number and sex structure of environmental projects, type of research and source of funding, as well as their thoughts and suggestions about the implementation of said projects.

The results of this research show that the majority of examined projects covered the topics of sustainable development, followed by biodiversity conservation, water and air protection, and the least with noise and vibration protection and forest protection. The analysed projects involved more men as researchers, particularly when it comes to the managers of these projects. Comparing the engagement of men and women within different research topics, it can be seen that a higher percentage of women were engaged in projects on water protection, biodiversity conservation, soil health and protection, and of men in projects related to sustainable development.

Based on the results of this study, general conclusions are the following: environmental protection is certainly one of the priority areas of research, and includes higher research quality and knowledge and technology transfer; researchers in Serbia are up-to-date with the latest developments in the area of environmental protection and mutually co-operate at the national and international levels; the highest percentage of research funds are provided from the Republic of Serbia Budget; researchers involved in the analysed projects participate to a certain extent in the development of national regulations in the area of environmental protection; and there is great need for human resources.
In the future, environmental research should focus on maintaining and enhancing existing co-operation with university-level education institutions and scientific institutes worldwide, and on promoting the establishment of new co-operation. As many young researchers should be involved as possible; burning issues and best ways to address them should be identified by involving all stakeholders in the chain; the implementation of the results that are directly implementable in practice should be continued; strategic documents in the area of environmental protection should be enforced; co-operation should be promoted at all levels and the role and participation of researchers in forming policies and making final decisions strengthened. Investments in scientific and research projects in the area of environmental protection should be increased.
ACRONYMS

BAT  Best Available Technology
BSS  Basic Safety Standards
BTI  Bacillus thurigensis israelensis
CAPRI Common Agricultural Policy Regionalized Impact
CfP  Call for Proposals
DHC  District heating system
DNA  Deoxyribonucleic acid
EC   European Commission
EU   European Union
GIS  Geographic Information System
HTC  Hydrothermal Carbonization
ICT  Information and Communication Technologies
IED  Industrial Emissions Directive
IPA  Instrument for Pre-Accession Assistance
IPPC Integrated Pollution Prevention and Control
ITNMS Institute for Technology of Nuclear and Other Mineral Raw Materials
MAFWM Ministry of Agriculture, Forestry and Water Management
MESTD Ministry of Education, Science and Technological Development
MOF  Metal-organic framework
PANDA Pan-Balkan Alliance of Natural Products and Drug Discovery Association
Rapid-E Real-Time Airborne Particle Identifier
RES  Renewable energy sources
RIS  Regional Strategy for Research and Innovation for Smart Specialisation
RNA  Ribonucleic acid
SRO  Scientific and research organisations
S4   Smart Specialisation Strategy Serbia
WWTS Waste water treatment system
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Introduction
1. Introduction

A healthy environment is the foundation for the preservation of human existence and for the development of the society. When talking about the environment we talk about the nature surrounding us, but also about human creations, using science and technology, to meet own needs. With the development of technology, humans’ needs keep growing and changing. As the human society is becoming more and more numerous, the needs become greater, the resources to meet human needs grow scarcer while, simultaneously, the negative impact on the environment keeps growing.

Environmental protection includes a set of different procedures and measures to prevent threats to the environment, with the aim to preserve the biological balance.

Environmental protection entails the preservation and protection of the health of people, entirety, diversity and quality of ecosystems, animal and plant genetic resources, soil fertility, natural attractions and landscapes, cultural heritage and man-made resources. It also entails ensuring conditions for limited, sensible and sustainable management of animate and inanimate nature; preserving the ecological stability of nature, amount and quality of natural resources; as well as preventing hazards and risks to the environment.

Ecological defence is multi-disciplinary and should be a continuous obligation of all members of the society. Its multi-disciplinary nature comes from the fact that health, environment and societal conditions represent a complex of areas and issues in continuous interaction. From the standpoint of our society, care for the environment is a priority of overall significance. A healthy environment is the foundation for the preservation of human existence and healthy societal development.

An integrated research framework was created through macro regional strategies to address common challenges and environmental issues within European Union member states and other countries in the region, which can be supported by European structural and investment funds. The development and advancement of regional co-operation in the area of environmental protection, contributing to the achievement of economic, social and territorial cohesion, can be realised with the help of four macro-regional EU strategies: EU Strategy for the Baltic Sea Region (2009), EU Strategy for the Danube Region (2010), EU Strategy for the Adriatic-Ionian Region (2014) and EU Strategy for the Alpine Region (2015). Serbia is actively participating in the implementation of the following two strategies: EU Strategy for the Danube Region (EUSDR) and EU Strategy for the Adriatic-Ionian Region (EUSAIR). Macroregional strategies are important because they represent a solid framework for the development of specific policies in RIS3 (Regional Strategy for Research and Innovation for Smart Specialisation) area, especially when it comes to value chain integration and co-operation in research and development at the regional level (S4 – Smart, Specialisation, Strategy, Serbia).1

The area of environmental protection has for decades also been much researched in Serbia. However, industry based on green technologies, water and soil treatment or waste recycling have not been equally represented. The EU sees the environment as an area requiring large investments so that Serbia can achieve its environmental standards. Environmental projects in the domain of water protection and treatment are particularly important in the Danube region countries. The interest of European institutions can also be seen in the series of programmes already at the disposal of researchers and companies, which could redirect co-operation to sustainable develop-

ment and ecological innovations, such as the IPA (Instrument for Pre-Accession Assistance) cross-border programmes or green innovation vouchers. Despite that economic results in the areas of green energy sources, recycling, reducing the amounts of exhaust gases or preserving the quality of the environment are not significant, the area of ecological innovations is, in the long term, sustainable development priority (S4).

Over the last several years, the following systemic environmental laws have been adopted in Serbia: the Law on Environmental Protection,2 the Law on Environmental Impact Assessment,3 the Law on Strategic Environmental Impact Assessment, and the Law on Integrated Prevention and Control of Environmental Pollution.4

The Law on Environmental Protection regulates the integral environmental protection system, ensuring access to the rights to life and development in a healthy environment and balance between economic development and environment in Serbia.5

The environmental protection system consists of measures, requirements and instruments for:

- Sustainable management, preservation of natural balance, entirety, diversity and quality of natural resources and conditions for the survival of all living beings; and
- Prevention, control, reduction and rehabilitation of all forms of environmental pollution.6

This law is implemented through research within scientific, development and innovation projects.

An analysis of the strategic framework in the area of environmental protection with comparative overview of compliance with the EU strategic framework, international conventions, and the UN Sustainable Development Agenda 2030 has been prepared, as basis for comprehensive review of the strategic environmental protection framework (smart specialisation).7

Environmental protection research is conducted via numerous Calls for Proposals published by the Ministry of Education, Science and Technological Development, Ministry of Environmental Protection, Ministry of Agriculture, Forestry and Water Management, and other ministries, as well as other national institutions (Science Fund, Innovation Fund), through co-operation of researchers from Serbia with researchers from other countries worldwide (bilateral, multilateral projects) and international calls (HORIZON 2002, EUREKA, COST, etc.), the business sector, local governments, as well as co-operation among researchers established through personal contacts.

The implementation of these projects has yielded various results, mainly in the form of papers published in nationally and internationally acclaimed journals, as well as presentations at national and international conferences and congresses.

Figure 1. shows an overview of the number of scientific results in Serbia in the area of environmental protection for the period 2018-2020.

Figure 1. Number of scientific results in the area of environmental protection for the period 2018-2020

![Figure 1. Number of scientific results in the area of environmental protection for the period 2018-2020](source: WOS, SCOPUS)

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6 Ibid, Art 2.
7 Smart specialisation, available at: https://pametnapacijalizacija.mp.gov.rs/
2. Methodology

The methodology for the development of this study included:

1. Data collection
2. Data analysis and processing and
3. Statistical analyses

Data collection

Data on the implementation of 274 scientific and/ or research projects in the area of environmental protection were collected from 40 scientific and research organisations. The organisations surveyed submitted data on the number and sex structure of environmental protection projects, types of research and sources of funding.

Data analysis and processing

In line with data received, projects were grouped under two categories – per institutions issuing calls for proposals or contracts to scientific and research organisations; and per sources of project funding. After this, project descriptions were compiled, followed by their analysis. Based on the results of the analysis, these results, i.e. data, were processed.

A survey was conducted with the studied scientific and research organisations, and its results helped make conclusions and provide recommendations within this study.

Statistical analyses

Based on the data received, statistical analyses were performed, related to the sex structure of studied projects, the structure of results received from analysed projects, as well as the percentages in which research topics in the area of environmental protection were presented.
Project Description and Analysis
3. Project Description and Analysis

3.1. Projects supported by the Ministry of Environmental Protection under Green Fund 2018

On 30 August 2018, the Ministry of Environmental Protection (MEP) published a Call for Proposals under the Green Fund, to support educational, research and development studies and projects in the area of environmental protection in 2018. The aim of this CfP was the promotion and protection of the environment by supporting studies and projects in the area of education, development and research, in line with the objectives defined in Serbian strategic documents.

According to the law regulating scientific activity, institutions officially registered as scientific and research organisations (SRO) were eligible to apply for the funds within this CfP. One project could be implemented by several SROs, with only one SRO responsible for the project, while others would be participating organisations. The CfP provided that funds be awarded to selected studies and projects finalised by November 2018 and reported on by December 2018.

Total available funds for the implementation of studies and projects within this CfP amounted to 50,000,000.00 RSD, with the maximum amount of 5,000,000.00 RSD and the minimum amount of 500,000.00 RSD per project. Funds received for the implementation of projects could be used for: remuneration to persons engaged on project implementation, travel costs, accommodation costs for experts abroad and their per diems, experiment costs, training and lectures costs, dissemination of results, printing of materials, informing the public and overhead costs.

A total of 102 applications were submitted, 52 of which were ranked and evaluated, having entered the preliminary ranking list, while 50 applications did not meet the eligibility criteria. After reviewing submitted projects and studies and evaluating them according to pre-defined criteria, and in line with the amount of funds available, the final ranking list for co-funding with the Green Fund included 22 projects, as presented below in Table 1 (Decision – Final Ranking of Studies and Projects for Co-Funding).
### Table 1. Final ranking of projects for co-funding with the Green Fund

<table>
<thead>
<tr>
<th>Rank</th>
<th>Institution</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Faculty of Electrical Engineering, University of Belgrade</td>
<td>Feasibility study for the implementation of the national network for continuous and automated monitoring of significant environmental protection parameters</td>
</tr>
<tr>
<td>2.</td>
<td>Faculty of Electrical Engineering, University of Belgrade</td>
<td>Creating conditions to improve the quality of the environment in buildings in the domain of noise protection</td>
</tr>
<tr>
<td>3.</td>
<td>Vinča Institute of Nuclear Sciences, University of Belgrade</td>
<td>Improving the technical solution for transforming toxic waste materials produced in galvanisation processes into non-toxic products with potentially commercial application</td>
</tr>
<tr>
<td>4.</td>
<td>Faculty of Technology and Metallurgy, University of Belgrade</td>
<td>Technical and technological solution for the treatment of sludge deposited from primary iron and steel production</td>
</tr>
<tr>
<td>5.</td>
<td>Institute for Technology of Nuclear and Other Mineral Raw Materials (ITNMS), Belgrade</td>
<td>Industrial waste – technogenic raw materials for the treatment of mining waters and production of environmentally friendly materials</td>
</tr>
<tr>
<td>6.</td>
<td>Faculty of Technology and Metallurgy, University of Belgrade</td>
<td>Cost–benefit analysis for BAT application in Serbia</td>
</tr>
<tr>
<td>7.</td>
<td>Institute Mihajlo Pupin, Belgrade</td>
<td>Expert and technological support to the establishment of the educational centre for students and professionals on renewable energy and energy efficiency in the Technical High School Mihajlo Pupin in Kula</td>
</tr>
<tr>
<td>8.</td>
<td>Faculty of Mining and Geology, University of Belgrade</td>
<td>Exploring the possibilities to reduce the emissions of pollutants and mitigate impact on climate change by changing the district heating system in Serbia</td>
</tr>
<tr>
<td>9.</td>
<td>Faculty of Technology and Metallurgy, University of Belgrade</td>
<td>Development of technical and technological solution for sustainable management of waste with high mercury content</td>
</tr>
<tr>
<td>10.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>Guidelines for sustainable planning and management of catchment areas for mini hydropower plants in protected natural areas</td>
</tr>
<tr>
<td>11.</td>
<td>Institute for Technology of Nuclear and Other Mineral Raw Materials (ITNMS), Belgrade</td>
<td>Improving the quality of the environment through sustainable management of waste biomass by turning it into solid biofuels using hydrothermal conversion</td>
</tr>
<tr>
<td>12.</td>
<td>Technical Sciences Faculty – Department for Environmental Engineering and Work Protection, University of Novi Sad</td>
<td>Analysis and improvement of composting biodegradable organic waste and defining the parameters for process management</td>
</tr>
<tr>
<td>13.</td>
<td>Fruit Research Institute, Čačak</td>
<td>Healthy soil for healthy life</td>
</tr>
<tr>
<td>14.</td>
<td>Veterinary Medicine Faculty, University of Belgrade</td>
<td>Development of a new floating biological larvicide based on Bacillus thuringiensis israelensis (BTI)</td>
</tr>
<tr>
<td>15.</td>
<td>Faculty of Chemistry, University of Belgrade</td>
<td>Seminar and workshop: environmental protection – prevention, monitoring and remediation – international and local experiences</td>
</tr>
<tr>
<td></td>
<td>University Business Academy, Novi Sad</td>
<td>Research into potential liquids packaging deposit systems applicable in the Republic of Serbia</td>
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<tr>
<td>16</td>
<td>Vinča Institute of Nuclear Sciences, University of Belgrade</td>
<td>Time variations and space characteristics of the presence of volatile organic compounds and atmospheric particles in the Belgrade metro area – campaign for stationary and mobile collection of data during the heating season using analytical minute resolution instruments</td>
</tr>
<tr>
<td>17</td>
<td>Institute of Forestry, Belgrade</td>
<td>Developing and opportunities for implementing adaptation measures with the aim to increase the resilience of natural ecosystems to climate change in national parks and other protected natural areas</td>
</tr>
<tr>
<td>18</td>
<td>Institute of General and Physical Chemistry, Belgrade</td>
<td>Study: Improving the efficiency of CONDUST products aimed to prevent landfill dusting from thermal power plants operations and mine dumps</td>
</tr>
<tr>
<td>19</td>
<td>Institute of Physics, University of Belgrade</td>
<td>Mapping the sources of toxic, mutagenic and cancerogenic volatile organic compounds on the territory of the City of Belgrade</td>
</tr>
<tr>
<td>20</td>
<td>Institute of Chemistry, Technology and Metallurgy, University of Belgrade</td>
<td>New technology for the treatment of water contaminated by oil pollutants using microbiological procedures on modified aluminosilicate minerals</td>
</tr>
<tr>
<td>21</td>
<td>Faculty of Technology and Metallurgy, University of Belgrade</td>
<td>Preliminary examination of the environmental impact of leachate from the Vinča Landfill</td>
</tr>
</tbody>
</table>
3.1.1. Vinča Institute of Nuclear Sciences, University of Belgrade

The project ‘Time variations and space characteristics of the presence of volatile organic compounds and atmospheric particles in the Belgrade metro area – campaign for stationary and mobile collection of data during the heating season using analytical minute resolution instruments’ was awarded 4.65 million RSD.

The aim of the project was to fill in the database on the presence of specific pollutants in the Belgrade metropolitan area on a stationary location and by mobile monitoring. The measurements were performed with the aim to establish the concentrations of respirable particles by using mobile monitoring stations (vehicle on the move) and creating a map to provide data to citizens on the exposure on routes for walking, recreation and transport on the territory of the City of Belgrade.

The results of the proposed project activities included data collection helping assess the air quality situation in Belgrade and the impact of various sources of pollution. In the long term, these data can be used as input parameters for:

- Plans and strategies focusing on quality control and environmental protection
- Epidemiological studies and health analyses of Belgrade residents
- Analysing housing quality in certain parts of the city, urban planning and use analysis of specific locations (for housing, industrial purposes, etc.) and
- Studies regarding the improvement of traffic, expanding green areas and maintaining pedestrian zones in Belgrade

The scientific contribution of the research results is very significant, because the analysis of a large number of pollutants in the air and meteorological parameters, collected at stationary and mobile measuring sites, provides a better insight into the complexity of factors that influence air quality in urban environments.

Another result of this project implementation was a 30-minute television programme, broadcasted within Radio Television of Serbia’s (RTS) Science Programme.

The project ‘Improving the technical solution for transforming toxic waste materials produced in galvanisation processes into non-toxic products with potentially commercial application’ received 0.8 million RSD.

The aim of the project was to improve the technical solution for using waste sludge from Ni/Cr (nickel-chrome) plants as raw material for non-organic pigments, and it was demonstrated that it is possible to convert the hazardous liquid waste left over after the galvanising process into a solid non-toxic product with potential commercial application (non-organic pigments).

The technological procedure was designed in such a way to extract solid products from the liquid sludge by applying relatively simple, cheap and environmentally-friendly methods. The value of the technical solution provided does not lie only in the fact that the products obtained are far less toxic compared to the initial liquid waste sludge, but also that these products are of far lower mass/volume compared to the initial liquid sludge.

Working on this project, waste sludge left over after the galvanising process in the company PPT – TMO AD from Trstenik was used as the baseline raw material for synthesising non-organic pigments, the same one used during the development of the above-mentioned technical solution.

3.1.2. Institute Mihajlo Pupin Belgrade

The project ‘Expert and technological support to the establishment of the educational centre for students and professionals on renewable energy and energy efficiency in the Technical High School Mihajlo Pupin in Kula’ was awarded 4.64 million RSD.

The aim of the project was to increase the level of knowledge and awareness of the public regarding the use of renewable energy sources and advanced technologies in agriculture and bring their economic and environmental sustainability closer by implementing in practice an experimental facility on the selected agricultural holding.

The main result of this project was the development of a detailed design, which includes planning and development of technical documentation for three different types of devices for using renewable energy sources (RES) – sun, wind and water. Based on the design solution, the purchase of appropriate materials and specialised equipment, needed for the construction of these three mini-experimental systems will be made, to be used in education and practical
work of the future Regional RES Centre in Kula. According to the project implementation plan, it will be implemented in the three following phases:

1. Development of the main design, specification and purchase of materials and specialised equipment necessary for building an experimental RES laboratory, and expert support organised through consultations and training of teaching staff in the school, to operate the new equipment;

2. Construction of a pilot facility, i.e. experimental installation of RES on the premises of the Technical High School Mihajlo Pupin in Kula, by installing the following individual devices:
   - Mobile automated solar power generator
   - Mini wind turbine with foldable pole and
   - Mini Pelton hydro 1200 W turbine

3. Implementation of an experimental laboratory on the school premises within the accredited educational programme for the profile “Renewable energy engineering technician” in the Technical High School Mihajlo Pupin in Kula. The implementation of all three phases of the project was completed.

3.1.3. Fruit Research Institute, Čačak

The project ‘Healthy Soil for Healthy Life’ was allocated 4.4 million RSD.

The aim of the project was to strengthen the capacities and improve the situation of the environment through targeted research, education on sustainable land use and raising environmental awareness of the population through the exchange of information between scientific and research institutions and higher education institutions on one hand, and employees in pre-school institutions, primary and high schools, agricultural producers and civil society from the territory of Čačak on the other.

All planned activities were successfully implemented, and the results of project implementation were the following:

- The situation of soil on the territory of Čačak, exposed to different forms of degradation, detected, and measures to overcome potential problems proposed
- Awareness of the population on the importance of implementing activities on environmental protection raised by organising two public debates and one workshop
- Broader access to the results of targeted research by the public enabled via the Internet on the Čačak Environmental Portal8

Total value of the project was 6,311,893.7 RSD, and the amount of funds approved by the Ministry was 4,386,820.60 RSD.

3.1.4. Veterinary Medicine Faculty, University of Belgrade

The project ‘Development of a new floating biological larvicide based on Bacillus thurigensis israelensis (BTI)’ received 4.1 million RSD.

The aim of the project was to develop a new product, biological larvicide in the form of floating pellets, which represents a completely new product, projected for broad use both for general and as biocide for professional use.

The project was designed to be implemented in two phases.

The first phase of the project was implemented through the development of a prototype machine for the production of floating pellets based on biological larvicides, with initial quantities produced in the process of developing the prototype equipment and research conducted in laboratory settings.

The second phase of the project was planned for implementation during 2020, however, because of the epidemiological situation, as well as the fact that there was no call published by the Ministry of Environmental Protection, the Faculty postponed the implementation of the second phase of the project for the following year.

All funds received from the Ministry were spent to develop the prototype equipment, which also contains new technical solutions enabling the production of floating larvicide in the form of pellets. The project is expected to be co-funded in the future through phase two, with the aim to organise field research to confirm laboratory results. The research within this project is also serving as a doctoral dissertation for a project team member.

8 Čačak Environmental Portal, available at: https://ekologija.cacak.rs
3.1.5. Faculty of Forestry, University of Belgrade

The project ‘Guidelines for sustainable planning and management of catchment areas for mini hydropower plants in protected natural areas’ received 3.8 million RSD.

The main topic of the project related to the effects of the construction of mini hydropower plants in Serbia, in terms of highly destructive impacts on aquatic and coastal ecosystems, biodiversity degradation, hydrological regime disturbances, as well as threatening the interests of the local population and its fragmentation. Research was primarily focused on protected areas.

The project was implemented within the given framework, and based on research results obtained, recommendations and suggestions were made regarding the concept of mini hydropower plants in Serbia, as well as guidelines for their sustainable planning and management of catchment areas for mini hydropower plants in protected natural areas.

3.1.6. Faculty of Electrical Engineering, University of Belgrade

The project ‘Feasibility study for the implementation of the national network for continuous and automated monitoring of significant environmental protection parameters’ received 3.5 million RSD.

This project was implemented in co-operation with two more SROs: Institute of Physics – institute of national importance for the Republic of Serbia and the Vinča Institute of Nuclear Sciences – institute of national importance for the Republic of Serbia. The aim of the project was to draft a technical solution with an analysis of economic and social validity for building an integrated national system for continuous monitoring of environmental parameters for the purposes of environmental protection.

The result of the project is a design solution defining an economically efficient and long-term sustainable development of a system for monitoring the environment from an environmental perspective (ionising and non-ionising radiation, air and water pollution, allergen levels, etc.) based on the application of modern information and communication technologies (ICT) on networking and control of measurement devices, including collection, transfer, storage and analysis of environmental parameters. The integration and improvement of existing specialised networks for monitoring certain pollution types should reduce the costs of construction and maintenance, and considerably broaden and increase the quality of coverage and possibilities of these systems, but also support monitoring of the parameters that are currently not monitored.

Implementing a considerably denser sensor network will enable comprehensive time-space monitoring of the situation in the environment, with detection, localisation and prediction of pollution. The system should enable sharing timely and full information with the public by applying modern ICTs.

The project ‘Creating conditions to improve the quality of the environment in buildings in the domain of noise protection’ had a budget of 1.28 million RSD.

The aim of this project was to create conditions for improving the quality of the environment in residential buildings from the aspect of noise pollution. To improve this aspect, the project proposed two-pronged action. The first was to develop the text for modern regulatory documents for soundproofing in buildings, and the second was to provide additional education to designers in the area of noise protection, which does not exist today within their university education.

The project was implemented. As a result of project activities, the Rulebook on sound comfort in buildings was drafted and several workshops were held for architects, with the aim to educate them in the area of soundproofing in buildings.

3.1.7. Faculty of Technology and Metallurgy, University of Belgrade

The project ‘Preliminary examination of the environmental impact of leachate from the Vinča Landfill’ received 3.39 million RSD.

The project was implemented within the provided timeframe (by December 2018).

Project aim was to determine the quality of leachate waters on the Vinča landfill, the soil in the vicinity of the landfill, Danube riverbank sediments and selected plant species, by monitoring the concentration of a number of heavy metals.

Project results were described in a report. Upon their analysis the following conclusion was reached: determining the quality of leachate waters on the Vinča landfill, the soil in the vicinity of the landfill, Danube riverbank sediments and selected plant species, monitoring the concentration of a number of heavy
metals – showed that there were potential connections and impacts of leachate from the landfill on the surrounding environment, which was demonstrated by monitoring the concentration of 10 elements, and based on the concentration of lead isotopes in soil samples, sediments and biota. In all samples, a highly increased concentration of aluminium was also identified. The distribution of pollutants in the water/soil system, and sediment/water indicated that the metals are mobile, moving from one environment to the other, but also that sampled plant species migrate.

The project ‘Cost–benefit analysis of BAT application in Serbia’ received 2.32 million RSD.

The aim of the project was to provide support to IPPC (Integrated Pollution Prevention and Control) operators and competent authorities in Serbia to assess the validity of derogations from specific requirements in the Industrial Emissions Directive (IED) 2010/75/EU, regarding defining conditions in the integrated permit according to the IED, based on appropriate criteria in line with Article 15(4) and assessed economic impact and profit made from BAT (Best Available Technology) applications. The plan is to identify the most important IPPC sectors, based on representative economic indicators and environmental protection indicators, for which it will be strategically important to conduct a detailed cost–benefit analysis of the IED.

The achieved results and outputs include:
- Methodology to determine derogations in IED Article 15(4) in Serbia defined
- Model for cost–benefit analysis of the impact of BAT developed and
- Analysis of the IED sector directed at identifying priority sectors with regards to their economic significance and impact on the environment conducted

The project ‘Development of technical and technological solution for sustainable management of waste with high mercury content’ received 1.3 million RSD.

The aim of the implementation of the proposed project was to develop a technical and technological solution for the treatment of waste with high mercury content which will, in accordance with the Waste Management Strategy for the period 2010–20199; the national legislation, the Minamata Convention and provisions in European Union Regulation No. 1102/2008 on the banning of exports of metallic mercury and certain mercury compounds and mixtures and the safe storage of metallic mercury, enable to obtain a fully inertised solidified matter and, through final encapsulation in specially controlled box, enable its durable disposal and reliable solution which does not pose a threat to the environment, which will considerably contribute to improving hazardous waste management in a way that does not pose a threat to the health of people and the environment in Serbia.

The project was fully implemented, and the application of the defined technical and technological solution for sustainable waste management with high mercury content was tested in larger laboratory settings of the Yuniris ltd company from Belgrade, and the technical solution was also verified by the Ministry of Education, Science and Technological Development of the Republic of Serbia. Based on the results of testing of the pilot facility in laboratory settings, the conditions were defined for the transfer of technology into real industrial settings of the above-mentioned company.

The results of project implementation include: defined technical and technological solution for sustainable management of waste with high mercury content, pilot facility for the treatment of waste with high mercury content and defined conditions for the transfer of technology to real industrial settings.

The achieved and measurable project result, or the phase for which support was requested, includes developed technical and technological solutions in accordance with BATs defined in relevant reference documents and optimised parameters of the developed technical and technological solution.

The project ‘Technical and technological solution for the treatment of sludge deposited from primary iron and steel production’ had a budget of 1.28 million RSD.

Project aim was to define the technological procedure for the treatment of waste sludge deposited from primary iron and steel production, at laboratory level. Baseline laboratory tests showed good results. It was planned that project results be used for semi-industrial testing, which would make it possible to introduce the process into regular industrial practice and rehabilitate landfills with 1,500,000 tonnes of deposited hazardous waste, consisted of blast furnace and converter sludge. Simultaneously, the new hazardous waste would be treated, which would eliminate the need for depositing it and further polluting the environment.

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Industrial application of the technical and technological solution would also lead to economic benefits regarding the return material suitable for sintering and return to the blast furnace, but also the production of zinc-rich dust, which has market value.

Negotiations are underway with the waste generator that provided samples of raw materials to the research team to perform laboratory tests about a possible new project and continuation of the Green Fund project at semi-industrial level.

The results have not been published so far, because of the plans to protect intellectual property rights.

3.1.8. Faculty of Chemistry, University of Belgrade

The project ‘Seminar and workshop: environmental protection – prevention, monitoring and remediation – international and local experiences’ received 2.69 million RSD.

The Faculty of Chemistry implemented this project in co-operation with the Vinča Institute of Nuclear Sciences – institute of national importance for the Republic of Serbia and the Institute for Chemistry, Technology and Metallurgy – institute of national importance for the Republic of Serbia, University of Belgrade. The aim of the project was to conduct workshops and seminars to act and call on prevention, but also perform continuous monitoring, followed by remediation, with the aim to improve the health of nature. This is the only way to enable the much-desired sustainable development of the human society and to reduce threats to generations to come. The results of the project include the workshop and seminar held, under the title: Environmental Protection – Prevention, Monitoring and Remediation – International and Local Experiences.

During the two-day seminar, lectures were held by experts from Europe and Asia, presenting important and latest world topics in the area of environmental chemistry. The seminar was aimed at researchers, students, economic and civil sectors.

A three-day workshop was held on modern techniques for environmental monitoring, forensics and bioremediation studies, aimed at selected researchers and doctoral students. The selected researchers and doctoral students were on this occasion trained in all segments of the bioremediation process – from sampling, chemical and microbiological analyses, to multiplying zymogenous microbial consortia and performing bioremediation studies using Micro-Oxymax respirometer. Finally, the metabolic activity of microorganisms and environmental forensics were tested by using comprehensive 2-D gas chromatography with mass spectrometry (GCxGC/MS), as well as fourier-transform infrared spectroscopy (FTIR). The workshop was organised in groups in two laboratories, and applications were made by filling out the questionnaire.

3.1.9. Institute for Technology of Nuclear and Other Mineral Raw Materials (ITNMS), Belgrade

The project ‘Industrial waste – technogenic raw materials for the treatment of mining waters and production of environmentally friendly materials’ received 2.6 million RSD.

ITNMS implemented this project in co-operation with the Institute of Chemistry, Technology and Metallurgy – institute of national importance for the Republic of Serbia, University of Belgrade, Faculty of Technology and Metallurgy, University of Belgrade and the Faculty of Civil Engineering, University of Belgrade.

The project idea was to address complex environmental issues from different areas of industry; fly ash from thermal power plants, waste sulphur from oil refineries and heavy metals from acidic mine waters. The research so far was conceived on micronized ash. However, starting from the fact that fly ash is dangerous because it contains heavy metals and soluble salts, which are washed by rain from landfills, entering water streams, but also technogenic raw materials – efficient sorbent for removing metallic ions from acidic waste waters and in the production of environmentally friendly construction materials – sulphur concrete, research was extended to the application of pelletised ash for the design of sulphur concrete, immobilising toxic matters into environmentally safe and chemically inert materials.

The project was implemented, and the results include four statements from international events, printed in full.

The project ‘Improving the quality of the environment through sustainable management of waste biomass by turning it into solid biofuels using hydrothermal conversion’ received 1.6 million RSD.

ITNMS implemented this project in co-operation with the Faculty of Natural Sciences and Mathematics, University of Novi Sad and Faculty of Chemistry, University of Belgrade.
The aims of the project include introducing new technologies of hydrothermal carbonisation with low environmental impact, and more economic production of solid fuels from renewable sources, with simultaneous valorisation process for wet waste lignocellulosic biomass. An additional aim of the project is to promote scientific excellence in this area and disseminate the results achieved among key stakeholders in the industry and the economy, including waste biomass generators. Outputs will enable to assess the potentials for application of different waste biomass (grape husks, corn cobs, horse manure, Miscanthus, Paulownia, etc.) and the optimisation of the HTC (Hydrothermal Carbonisation) process, by setting the most important burning characteristics of the received products – hydrocarbon black. The scientific impact of this project should have long-term effects on the transformation of Serbian and regional industry and economy towards waste biomass from agricultural production, as a good starting point for the development of a regional bioeconomy. Potential advantages of primary hydrothermal carbonisation in Serbia are numerous, especially in industries based on agricultural production, animal husbandry and bioenergy. This means primarily the improvement of traditional production processes with energy or chemical savings, development of sustainable solutions for reducing impact on the environment, designing new systems for more efficient transformation of wet waste into fuels, energy and other products of high practical value.

The implementation of the HTC technology would also influence long-term solutions to the problem of open landfills, local waste biomass dumps, the first of its kind in Serbia and the region. Through this project, the agricultural sector can increase the potential not only for becoming an important player in biofuel production, but also for developing and procuring new biorefinery technologies at local and global levels, with considerable reduction in carbon dioxide emissions. The new biorefinery concept with HTC applications would expand the existing value chains, which would result in new business opportunities in various areas. Increased share of biofuel in the energy sector is one of the most important goals of current EU policy. The scientific result of this project will contribute to developing new environmentally acceptable processes in the lignocellulosic processing and production industries and the agricultural sector, in which waste materials generate value-added products.

The following project results were published:
One paper in the national journal of international importance; one statement from an international event, printed in full; four statements from international events printed in excerpt; one statement from a national event printed in full; one technical solution (non-commercialised).

3.1.10. Technical Sciences Faculty – Department for Environmental Engineering and Work Protection, University of Novi Sad

The project ‘Analysis and improvement of composting biodegradable organic waste and defining the parameters for process management’ received 2.54 million RSD.

The aim of the project was to identify the minimum number of parameters for monitoring optimum composting process and receiving useful product from organic waste treatment, with the aim to reduce the costs of monitoring processes and simplify monitoring processes by a number of operators in the waste management area expected in the future.

The conclusion of research conducted indicates that, in addition to numerous other parameters, the temperature and moisture in the compost heap are absolutely the primary parameters, which need to be constantly monitored at the sufficient number of points (samples), with the aim to receive relevant results. The pH value parameter, which is often stated in literature as one of the most important ones, in the conducted experiments on real examples, turned out to be unreliable during the process itself, but also necessary to determine the quality of the final product at the end of the composting process. The impact of the density of the compost material in the compost heap based on the laboratory part of the tests indicates that optimum density, depending on the type of compost material ranges from 280 to 500 kg/m3, while the carbon to nitrogen (C/N) ratio shows allowed oscillations of up to 22% compared to referenced literature, which indicate optimum ratio as 30:1.

In line with expectations, it was confirmed that the types of material, granulation, as well as operational measures bear significance, i.e. the issue whether fresh material would be added during the process. Active aeration of the compost heap is singled out as the measure contributing the most to accelerating the process and shortening the period of treatment of organic waste.

A report with research results and recommendations was submitted.
3.1.11. University Business Academy, Novi Sad

The project ‘Research into potential liquids packaging deposit systems applicable in the Republic of Serbia’ received 2.5 million RSD.

A final study was developed as project output, representing the basis for initiating national dialogue on this topic. The Faculty of Economy and Engineering Management, with its economists, also participated in the development of the study, and an international consultant was also hired, dealing with deposit systems in Estonia.

Baseline values used include available data from government authorities and organisations on the total amount of packaging placed by producers on the Serbian market, as well as data on the amounts of recycled packaging waste.

The aim of the study, inter alia, was to reach the most responsible institutions in the Republic of Serbia and show that it is high time to use the opportunities for better quality and more sustainable packaging waste management.

The implementers of this project emphasise the importance of the fact that thus far in practice it has not occurred that a ministry would ‘entrust’ this type of task to a private university.

3.1.12. Institute of Forestry, Belgrade

The project ‘Development and opportunities for implementing adaptation measures with the aim to increase the resilience of natural ecosystems to climate change in national parks and other protected natural areas’ received 2.38 million RSD.

The project is based on relevant strategic documents and its implementation included nine activities.

Project results comply with numerous international agreements, ratified multilateral treaties and conventions, environmental protection laws, regulations and policies currently implemented in the EU, as well as legal and institutional environmental protection framework and policy in Serbia.

The proposed adaptation measures are harmonised with international agreements, ratified multilateral treaties and conventions, strategic documents at the European level. Project results are also in line with Serbian laws and regulations.

The aims and results of the research project based on said strategic documents will provide practical solutions to define environmental stability and apply adaptive measures in spatially defined forest ecosystems.

3.1.13. Institute of Physics, University of Belgrade

The project ‘Mapping the sources of toxic, mutagenic and cancerogenic volatile organic compounds on the territory of the City of Belgrade’ received 1.64 million RSD.

The Institute of Physics implemented this project in co-operation with the Faculty of Electrical Engineering, University of Belgrade and the Singidunum University. The project focuses on mapping, characterisation of sources and prognosis of concentration dynamics of toxic, mutagenic and cancerogenic volatile organic compounds in the central core of Belgrade, based on measurements from only one measuring station within the City Institute for Public Health’s monitoring network. The aim of this project was to develop an innovative technology based on artificial intelligence algorithms, implemented through machine learning methods, with the potential to provide the foundation for a unified, sustainable system for identifying pollution sources, as well as to assess and predict the concentration of different types of pollutants in Belgrade, but also in other areas, without additional investments in the monitoring equipment. In this way, this project contributes to raising the level of awareness of citizens, protecting the health of vulnerable population categories and establishes a system for information sharing with the public about the episodes of increased air pollution, and project results will be useful to both the citizens and the city and national legislative structures aiming to develop strategies for systematic air pollution control and reduction throughout the territory of Serbia. The results of this project also have significant scientific contribution, by enabling better understanding of the impacts of environmental factors and processes (meteorological factors, topographic characteristics, natural and anthropogenic emission sources, etc.), which are relevant for the concentrations of pollutants in the air and their evolution in time and space.

It is important to mention that, although additional analyses surpass the scope and aims of this project, the interactive clustering method used can be applied with all existing hybrid receptor models (e.g. function of potential source contributions, concentration weighted trajectories, concentration weight-
ed planetary boundary layer), and can also be used in place of the method of constructing regular and irregular grids, the so-called gridding. Also, the analysis of presented spatial data can be additionally improved by applying the interpolation method (inserting values in-between existing values) within each individual cluster, which includes learning algorithms in the form of random forests, kriging, etc. By using the methodology developed within this project it is possible to ensure adequate spatial coverage with data on BTEX concentrations (benzene, toluene, ethylbenzene, xylene) in the parts of the city where routine measurements are not conducted, based on measurement results on a single measuring location.


The project ‘Study: Improving the efficiency of CONDUST products aimed to prevent landfill dusting from thermal power plants operations and mine dumps’ received 1.58 million RSD.

The project was implemented in co-operation between the Institute of General and Physical Chemistry and Aquastatin, specialised company dealing with development, production and application of chemicals with the aim of total fire and harmful dust protection.

Project aim was to formulate a chemical that is absolutely efficient for preventing dusting from mining or coal ash dumps. In case of expected improvement of efficiency of CONDUST, landfills and mine dumps in Serbia could be quickly and easily treated with a domestic solution, at prices tailored to the Serbian market.

Project result is product improvement, which helped achieve the goal of using better products under the same technological production settings, at unchanged price.

3.1.15. Faculty of Mining and Geology, University of Belgrade

The project ‘Exploring the possibilities to reduce the emissions of pollutants and mitigate impact on climate change by changing the district heating system in Serbia’ received 1.5 million RSD.

The project explores the possibility for complete energy usage from waste water treatment systems (WWTS) within district heating systems (DHS) in Serbia. In addition, the project also explores the possibility to implement different types of heat pumps for valorising treated water temperature. The project established correlation between WWTS size and nominal operation parameters and its total energetic potential (amount of produced biogas, treated water flow and temperature), and proposed different conceptual solutions for valorising this potential in DHS. In relation to the existing DHS, the possibility for reducing pollutant emissions (nitrogen-oxide - NOx, sulphur-oxide - SOx, particles etc. and carbon-dioxide). A case study was developed in Šabac. For other towns in Serbia, the results served as basis for approximating energy potentials and environmental benefits. A workshop presenting project results was organised for awareness-raising and education purposes.

Project results:

- Study: Exploring the possibilities to reduce the emissions of pollutants and mitigate impact on climate change by changing the district heating system in Serbia:
  > Analysis of district heating systems in Serbia;
  > Waste water treatment systems in Serbia;
  > Using biogas and waste heat from waste water treatment facilities in the district heating system in Šabac; and
  > Projections of energy and emissions balances after integrating heat pumps using as a source the heat from treated waters.

- Workshop on exploring the opportunities to reduce the emissions of pollutants and mitigate impact on climate change by changing the district heating system in Serbia, held in Krupanj on 27 November 2018. The workshop was attended by 51 participants and it consisted of three panels with introductory presentations:
  > Waste water treatment systems
  > Heat pumps
  > Energy and emissions balances

- Brochures:
  > Heat Pumps in District Heating Systems
  > Energy and Emissions Balances from Energy Consumption in District Heating Systems in Serbia
3.1.16. Institute of Chemistry, Technology and Metallurgy, University of Belgrade

The project ‘New technology for the treatment of water contaminated by oil pollutants using microbiological procedures on modified aluminosilicate minerals’, was allocated 0.85 million RSD.

The main aim of the project is to improve water treatment systems by applying microbiological procedures on aluminosilicate minerals (organic minerals). The project proposal provides the design of a technological approach for the treatment of waters contaminated by oil pollutants. The procedure is based on adsorption of organic pollutants on organic minerals, followed by bioremediation of adsorbed contaminants with adsorbent regeneration. The proposed procedure will improve approaches for addressing the issue of waters polluted by oil substances. Considering that the procedure uses cost-effective raw materials without generating additional waste, as such it can considerably contribute to higher inclusion of the industry and public utility companies in addressing the issue of waste water treatment, which is currently, based on quoted reports, one of the burning environmental issues in the Republic of Serbia. It should be kept in mind that polluted waters also pollute the soil, and thereby food, which puts them among the top priorities for efficient treatment.

The majority of reports of examined projects co-funded by the Green Fund state that their implementation was to an extent impeded by reduced amounts of funds available to them, and particularly the short timeframe for project implementation.
3.2. Other projects supported by the Ministry of Environmental Protection

In the period 2018-2020, the Ministry of Environmental Protection awarded funds to co-fund or fund scientific and/or research projects directly or indirectly related to environmental protection. The implementation of some of these projects has been completed, and of some is under way or has only just begun. In addition to the Green Fund projects, these are mainly studies and research projects implemented based on contracts with the Ministry of Environmental Protection, as well as projects under the Nature Protection Programme.

### 3.2.1. Studies and research projects based on contracts with the Ministry of Environmental Protection

The projects are presented in Table 2 below.

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>University of Belgrade, Institute for Multidisciplinary Research</td>
<td>Research into the presence of European eel in the fishing waters of Serbia</td>
</tr>
<tr>
<td>2.</td>
<td>University of Belgrade, Faculty of Biology</td>
<td>Operational monitoring of surface and ground waters in the Republic of Serbia, Lot 1: Operational monitoring of surface waters</td>
</tr>
<tr>
<td>3.</td>
<td>University of Belgrade, Faculty of Biology</td>
<td>Reporting services for the Emerald Network for 2019</td>
</tr>
<tr>
<td>4.</td>
<td>University of Belgrade, Faculty of Biology</td>
<td>Inventory and mapping of habitats in the area of the Tara National Park</td>
</tr>
<tr>
<td>5.</td>
<td>University of Belgrade, Faculty of Biology</td>
<td>Monitoring flora on the territory of the Tara National Park</td>
</tr>
<tr>
<td>6.</td>
<td>University of Belgrade, Faculty of Biology</td>
<td>Revitalising the Cardamine serbica on the territory of the Tara National Park</td>
</tr>
<tr>
<td>7.</td>
<td>University of Belgrade, Institute for Biological Research Siniša Stanković</td>
<td>Determining the natural fn of certain harmful and hazardous matters in the soil</td>
</tr>
<tr>
<td>8.</td>
<td>University of Belgrade, Institute for Biological Research Siniša Stanković</td>
<td>The level of erosion-related threats to agricultural land in the Jablanica Administrative District</td>
</tr>
<tr>
<td>9.</td>
<td>University of Belgrade, Institute for Biological Research Siniša Stanković</td>
<td>Data acquisition and other services with the aim to continue with the establishment of the environmental network in the Republic of Serbia</td>
</tr>
<tr>
<td>10.</td>
<td>Institute for Soil Science</td>
<td>Determining the natural fn of certain harmful and hazardous matters in the soil on the territory of Eastern Serbia</td>
</tr>
</tbody>
</table>
3.2.2. Projects under the Nature Protection Programme

The projects are presented in Table 3 below.

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Natural History Museum, Belgrade</td>
<td>Status and situation review and determination of stocks and genetic diversity of the three-toed woodpecker in the population of the steppe polecat (Mustela eversmanni) in Serbia</td>
</tr>
<tr>
<td>2.</td>
<td>Natural History Museum, Belgrade</td>
<td>Monitoring bat populations and shelters in Serbia</td>
</tr>
<tr>
<td>3.</td>
<td>Natural History Museum, Belgrade</td>
<td>Status and situation review of the steppe polecat (Mustela eversmanni) populations in Serbia</td>
</tr>
<tr>
<td>4.</td>
<td>Natural History Museum, Belgrade</td>
<td>Atlas of migratory birds and bats of Serbia</td>
</tr>
<tr>
<td>5.</td>
<td>Natural History Museum, Belgrade</td>
<td>Monitoring migration of birds and bats by permanent marking using aluminium and coloured markers (rings)</td>
</tr>
</tbody>
</table>

The results of the implementation of these projects were mainly in the form of studies, or reports providing recommendations for next steps. Some institutions also reported that the results could serve to plan activities of competent government authorities, related to the tasks that coincided with the topics of respective projects.

3.2.3. Projects in relation to the establishment of the NATURA 2000 network

The implementation of projects in the area of nature protection in relation to the establishment of the Natura 2000 network is monitored by the Ministry of Environmental Protection and the Institute for Nature Protection of Serbia, as well as the Provincial Nature Protection Institute of Vojvodina, against EU directives related to nature protection and the improvement of technical and administrative capacities for the implementation of the Law on Nature Protection (Table 4). Research funding comes from EU donations. In the period 2018-2020, some of the projects mentioned above were under implementation phase, some were completed, and some had only just started with implementation.

The aims and results of these projects related to the implementation of the necessary activities for setting up the platform for the NATURA 2000 network. In general, these included:

- Incorporate existing data on important species and habitats into key activities on active biodiversity protection in Serbia, as well as into documents required for successful realisation and closing of Chapter 27 – Environment, necessary for the completion of the process of Serbia’s accession to the European Union and
- Collection, verification, informatic organisation and centralisation of existing information on important species and habitats.

The reports on project results, the implementation of which is completed, have been submitted to the Institute for Nature Conservation of Serbia.
Table 4. Projects in relation to the establishment of the NATURA 2000 network

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Establishment of the NATURA 2000 network</td>
</tr>
<tr>
<td>2.</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Data acquisition and other services with the aim to continue with the establishment of the environmental network in the Republic of Serbia – JNOP 01/2018</td>
</tr>
<tr>
<td>3.</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Data acquisition and other services with the aim to continue with the development of the Red Lists of individual groups of flora, fauna and mushroom organisms in the Republic of Serbia – JNOP 05/2018</td>
</tr>
<tr>
<td>4.</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Analysis and study of species and natural habitats subject to reporting under Article 17 of the Habitats Directive and Article 12 of the Birds Directive</td>
</tr>
<tr>
<td>5.</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Data acquisition and other services with the aim to establish environmental networks in the Republic of Serbia – JOP 01/2018</td>
</tr>
<tr>
<td>6.</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Data acquisition and other services with the aim to establish European Union NATURA 2000 environmental networks as part of the Republic of Serbia environmental networks – JNOP 02/2019</td>
</tr>
<tr>
<td>7.</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Continued support to implementation of Chapter 27 in the area of nature protection (NATURA 2000) – EuropeAid/139336/DH/SER/RS</td>
</tr>
<tr>
<td>8.</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Natura 2000 habitats mapping at Skadar lake, conservation and sustainable use of biodiversity at lakes Prespa, Ohrid and Shkodra/Skadar</td>
</tr>
<tr>
<td>9.</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Habitat and species mapping for the identification of the Natura 2000 site in Montenegro</td>
</tr>
</tbody>
</table>
3.3. Innovation Fund projects

In the period 2018-2020, the Innovation Fund of the Republic of Serbia funded the implementation of the below projects that are directly or indirectly linked with environmental protection.

3.3.1. Under the Technology Transfer Programme

Project: ‘New catalyst for freon dehalogenation’ implemented by the Innovations Centre of the Faculty of Technology and Metallurgy, University of Belgrade, financial support amount: 19,800 EUR. Project duration 2017-2018.

Project aim was to eliminate freon emissions into the environment, considering that organohalogen compounds, such as freons, are released from cooling systems, fire extinguishing systems and polyurethane foams for thermal insulation and are extremely harmful to the ozone layer. The Innovations Centre of the Faculty of Technology and Metallurgy developed a new catalyst that can easily be adjusted to user needs and produced in different forms. The new catalyst does not require to use precious metals in its active layer which makes it cheaper than existing catalysts, providing 95.5% efficiency and simple to adapt to end user needs. A facility for decomposing freon from electronic waste was made.

The Innovations Fund supported the development of the catalyst and got involved in searching for commercial partners for licensing and development at the industry level.

In addition to the above-mentioned, a project result is also patent application.

Project: ‘Technological procedure for industrial production of multi-purpose gluten-free flour using apple leftovers with high content of diet fibres, antioxidant and antidiabetic effects’, implemented by the Institute of General and Physical Chemistry and Faculty of Chemistry and Faculty of Agriculture, University of Belgrade

Project duration was one year, implemented in 2018. Project aim was to develop a procedure to use by-products from making juice by squeezing/pressing apples, currently disposed on landfills in Serbia, which is a source of pollution due to high organic matter content.

Project results are: developed procedure for industrial production of multi-purpose gluten-free flour using apple leftovers; submitted and published international patent application; study developed showing cost-effectiveness and sustainability of the proposed procedure through a technical and economic study, market analysis and marketing activities.

3.3.2. Under the Early Development Programme

Project ‘Solagro Smart Recycler 2.0’, implemented by the company Solagro Smart Recycler from Kraljevo, project value: 72,356 EUR, with the Fund contribution of 61,501 EUR. The project lasted for one year and was implemented during 2018.

This company develops the mobile recycling machine for public use, with an improved can pressing mechanism (up to 90% of compression) with innovative controls and advanced recycled waste analytics, as well as modern user interface solutions enabling user interactions. Recycling would be stimulated by offering various prizes.

Project result is the development of a new recycling machine with improved can pressing mechanism. The product has been commercialised and is generating profit.

3.3.3. Under the Business and Science Cooperation Programme

Project ‘Drone surveying of noise sources and implementing in GIS’, implemented by the GeoGis Consortium, Belgrade, and the main partner Institute of Physics, Belgrade, with additional two partners: the Dirigent Acoustic Company, Belgrade and Mihajlo Pupin Institute, Belgrade. Project budget was 334,955 EUR, and Fund contribution 234,000 EUR. The project was implemented in the period 2017-2019.

The focus of the project, under commercial name GRAMACA, was the development of a device for air surveying and automatic recording of sound sources, which is the first device of this sort in the world. Data received from the application of this device, recorded in GIS, can be used for acoustic mapping and zoning purposes, designing noise protection in the environment, and also with the implementation of modern sustainable environment concepts, such as smart cities, healthy cities, or the so-called Blue Green Dream.

This technology raises noise mapping to a higher level, as it represents the most advanced automated solution for noise mapping, which will considerably
reduce human resource and time-related costs and increase the quality of measurements. The mapping of noise sources using the new technology will have significant impacts on the industry of environmental protection and smart city technology development, which will increase the quality of life in cities and settlements in the vicinity of major noise sources (roads, railroads, airports and industry). Two prototypes of ultra-light acoustic cameras were developed, and MEMS microphones with light graphene membrane were raised to a higher technological level and are expected to be an integral part of the next generation of devices.

The product is available on the market, generating income.

3.3.4. Under Proof of Concept

Project ‘Degradable, multifunctional filter for removing SO2, NOx and CO from flue gases’, implemented by the SRO Vinča Institute of Nuclear Sciences, University of Belgrade, project value: 1,618,600 RSD. Project implementation is under way.

Period of implementation is 2019-2020.

Project aim was to produce materials for filters that would be cheap and to develop the technology to apply these filters in chimneys, where they would reduce and eliminate polluters such as SO2 (sulphur dioxide), NOx (sodium oxides) and CO (carbon oxides) from flue gases. The elimination of first SO2 as one of the most dangerous polluters, followed by NOx and CO, cleans the air, thus contributing to improving air quality and healthier environment, not only in Serbia but also globally.

Project result will be the gas adsorption filter.

Project ‘Turning natural clay pyrophyllite (Parsovidi) into an electrochemical sensor to detect traces of pesticides in food and water’, implemented by the SRO Vinča Institute of Nuclear Sciences, University of Belgrade, project value: 2,399,994 RSD. The project is ongoing, approved in February 2020.

The aim of the project is to develop new electrocatalysts, highly important for the implementation of sensor structures suitable for quantitative determination of some chemical species, such as pesticide, medicine or dye traces in water and food, both in situ and ex-situ. The use of pyrophyllite (natural clay) was proposed, as active electrocatalyst because of its low price, abundance, simple crystalline structure and no need for dissolvents. Such a material provides the opportunity to develop an electrode for electrocatalytic degradation of organic pollutants in water, for controlling their concentration and motility in the environment (pesticides, medicines and industrial textile dye), and sensors to detect traces in water and food.

The result of the project would be a sensor for detecting pesticides in food and water.

Project ‘Reservoir design to store solid hydrogen with stationary stable power sources use’, implemented by the SRO Vinča Institute of Nuclear Sciences, University of Belgrade, project value: 2,393,100 RSD.

Project is ongoing, approved in February 2020.

Project aim is to design and construct a reservoir for solid hydrogen. The reservoir will be part of a stationary system for stable power supply, envisaged as a combination of conventional renewable sources and fuel cell technologies. Such a system can produce and store energy in 24-hour cycles. A typical role of such systems would be to supply mobile telecommunication base stations, but the same principle can be also applied to isolated households in urban or rural areas.

Project aim will be achieved through several steps including the synthesis of materials for storing hydrogen with desired qualities, optimising packaging and sequencing materials, making a reservoir using an acid-resistant alloy, followed by detailed packaging performance and capacity tests in repeated fill and empty cycles. A safe and reliable solution is expected to be provided for storing hydrogen, with the possibility to perform a large number of filling and emptying cycles, without significant performance losses. Project result would be the reservoir for hydrogen storage.
3.4. Projects under the Science Fund of the Republic of Serbia

Starting in 2019, the Science Fund of the Republic of Serbia published several public calls for project funding.

The implementation of projects approved for funding was initiated during 2020, so having in mind that the implementation period has just started, there are still no research results available.

Among the projects directly or indirectly related to environmental protection, the Science Fund is financing the following projects:

3.4.1. Under the Programme for Excellent Projects by Young Researchers – PROMIS

The Project: ‘Detecting and quantifying bioaerosols of importance for human and plant health in real time (BREATHE)’, implemented by the BioSens Institute, alongside the partner scientific and research organisation Institute for Multidisciplinary Research, University of Belgrade. The total budget provided is 20,185,611 RSD for the project implementation of 24 months.

The aim of the BREATHE project is to set the foundations for advanced atmospheric diagnostics in real time in Serbia, using information technologies.

This project will expand the knowledge needed for automatising aerobiological research. The research team is planning to resolve problems related to comparisons with classic Hirst-type volume measurements and the use of complex data received by the method of flow cytometry.

In addition to the development of advanced classification models by using artificial intelligence, research during project implementation will focus on explaining the models themselves, for full understanding of the impact of all data input. It is expected that the use of domain knowledge in database models will result in better and more precise classification. Special attention will be directed at knowledge transfer and the possibility to apply the model for bioaerosol classification, which will be developed within the BREATHE project, on measurements received using other devices of the same type. Advanced tools for image reconstruction will be tested with the aim to represent the dispersed signal measurement in a new way. Also, the impact of age and degree of moisture of selected bioaerosols on their fluorescent emission will be examined, by using Rapid-E (Real-Time Airborne Particle Identifier), flow cytometer and spectrofluorometer.

During the implementation of the BREATHE project, data collection is planned in Novi Sad using the Rapid-E device produced by Plair SA, Hirst-type device and automatic meteorological station. The approach including comparison with the standard method (EN16868:2019) enables easier promotion of results among end users in the aerobiological community, including support to new users for automatic bioaerosol monitoring.

Project ‘Carbon Capture By Self-Drying Schiff Base MOFs (CASCH-MOF)’ implemented by the Faculty of Natural Science and Mathematics, University of Novi Sad. Total budget provided is 22,844,969.92 RSD for project implementation of 24 months (2020-2022).

Project description: CO₂ emissions in the atmosphere and the corresponding greenhouse effect represent the main anthropogenic factor related to climate change, and this is why resolving the CO₂ issue is one of the burning issues of today. Currently, the metal-organic framework (MOF) represents one of the main candidates for exhaust gas CO₂ adsorption. Still, the main obstacle preventing their practical implementation is their sensitivity to moisture. Therefore, reaching resistance to moisture with selective CO₂ adsorption also in the presence of water steam currently represents a challenge in MOF chemistry, which has still not been successfully resolved. For the first time, this project proposes a unique approach to preventing water adsorption on MOF, based on the idea that the priority should be water adsorption, contrary to the attempts to additionally boost CO₂ adsorption.

The aim of this project is to introduce Schiff base in MOF structure, which would transform the adsorbed water molecules into harmless and low adsorbing molecules, that would further desorb by preserving MOF structure and its ability for CO2 adsorption.
Project ‘Waste Water Treatment Reinforcement – Advanced Processes Using Green and Cost-Effective Materials (Waste Water Force)’ implemented by the Faculty of Natural Science and Mathematics, University of Novi Sad. Total budget provided is 19,500,029.82 RSD for project implementation of 24 months (2020-2022).

Key project aims are research and development of progressive waste water treatment processes by using alternative and environmentally acceptable new generation materials, as well as knowledge integration in the area. The Waste Water Force project has a multi-layer structure consisted of several key points, ranging from synthesis and characterisation of materials to their application in selected waste water treatment processes, with emphasis on those using renewable energy sources.

The aim is to develop a form of HUB, as unique platform for scientific and broader audience to cover scientific targets in the area of waste water treatment, providing expertise, improving data exchange and accelerating co-operation. The HUB would serve as the meeting point of all stakeholders with the aim to improve the waste water sector. In this way, the Waste Water Force will have an impact also after the official end of the project. The green concept has in recent years become the necessary approach to choosing technologies and technological solutions. Waste Water Force will help to integrate and strengthen this concept in the area of waste water treatment, starting from material development, through treatment processes, to awareness-raising about its importance.

The project is multi-disciplinary, linking together environmental chemistry with information technologies, so as to overcome the boundaries of experimental work and raise the level of awareness, overcome barriers and use all the opportunities in this sector. Waste Water Force will represent an instrument to shift action focus to environmentally-friendly and positive aspects, by promoting the green and sustainable approach to waste waters.

3.4.2. Under the Programme of Cooperation of Serbian Science with Diaspora – knowledge exchange vouchers

Project ‘Application of Hydroinformatics in Water Resource Management to Improve Arsenic Risk Assessment and Remediation Approaches for Serbian Water Sources (HYDRA)’ is implemented by the Faculty of Natural Science and Mathematics, University of Novi Sad. KWR Water Research Institute, Netherlands is also a project partner.

Implementation period 2020-2021.

The HIDRA project will establish new cooperation between the Environmental Protection Research Group with the Faculty of Natural Science and Mathematics, University of Novi Sad and group of researchers from the KWR Institute (Netherlands). Both groups are working on issues related to ensuring safe drinking water. In a series of training visits, the researchers from diaspora will present to the Environmental Research Group with the Faculty of Natural Science and Mathematics, University of Novi Sad knowledge on the use of hydroinformatic tools for simplifying the risk management processes in water systems that are negatively influenced by arsenic pollution.

In order to establish long-term and productive co-operation between the Novi Sad Faculty and the KWR, the specific objectives of the HIDRA project are to:

- Share and exchange scientific knowledge about arsenic research and hydroinformatics among the scientists of the two teams, by strengthening Serbian links with diaspora members, broadening the Serbian network of international partners
- Develop hydroinformatics in the Environmental Protection Research Group, where for the first time in Serbia these tools will be used to improve water supply solutions for drinking water sources polluted by arsenic
- Implement joint research activities and submit scientific papers for publishing in international journals
- Disseminate the results of the HIDRA project in the scientific community and
- Identify future calls under different funding instruments, local and international, and draft joint project proposals
3.4.3. Under the Programme for the Development of Artificial Intelligence Projects

Project ‘Artificial Intelligence Applications in Innovative Energy Management Services’ implemented by the Mihajlo Pupin Institute, University of Belgrade, was provided the total budget of 23,588,459.60 RSD for project duration of 24 months.

The project is dealing with the development of analytical tools using artificial intelligence, with the aim of maximising prosumer (professional+consumer) management efficiency in smart grid contexts. These tools will be integrated in a unique application repository, which will provide advanced analytical services in various application scenarios, ranging from individual households, blocks of buildings, to section of distribution grid. These services will predominantly rely on the application of the latest technologies and concepts in the domain of artificial intelligence, like machine learning based on artificial neural networks, linear and non-linear optimisation, and application of linked data and knowledge graphs.

3.5. Ministry of Agriculture, Forestry and Water Management Projects

The Ministry of Agriculture, Forestry and Water Management (MAFWM) of the Republic of Serbia, particularly under their integral units: National Waters Directorate, Forests Directorate, Agricultural Land Directorate and Directorate for Agrarian Payments, has implemented a number of study and research projects directly or indirectly related to environmental protection (Tables 5-8).

Funds for the implementation of these projects were provided by the above-mentioned Ministry.

Table 5. MAFWM Projects – National Waters Directorate

<table>
<thead>
<tr>
<th>No</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Faculty of Biology, University of Belgrade</td>
<td>Research monitoring of biological, physical-chemical and hydrometeorological parameters to define referential sites on the territory of the Republic of Serbia</td>
</tr>
<tr>
<td>2</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Fourth Joint Danube Survey</td>
</tr>
<tr>
<td>3</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Environmental risk and status assessment for watercourses over 4,000 km² in the Danube river basin and for watercourses over 1,000 km² in the Sava river basin</td>
</tr>
<tr>
<td>4</td>
<td>Institute for Biological Research Siniša Stanković</td>
<td>Biological monitoring of waters, collection of materials and identification – macroinvertebrates, phytobenthos and macrophytes</td>
</tr>
</tbody>
</table>

The objectives of these projects were to:

- Identify reference conditions for all types of surface water bodies, excluding artificial ones, according to the Rulebook on reference conditions for surface water types¹⁰ and

- Collect comparable data alongside the Danube river – biological, physical-chemical, chemical, hydromorphological degradation, microplastics, genotoxicity, e-DNA

¹⁰ Rulebook on reference conditions for surface water types, Official Gazette RS, No. 67/11.
The results of the above-mentioned projects were also included in the reports with recommendations for next steps.

**Table 6. MAFWM projects – Directorate for Agrarian Payments**

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mihajlo Pupin Institute</td>
<td>New technology applications with the aim of smart management of vegetable growing in protected spaces</td>
</tr>
<tr>
<td>2.</td>
<td>Mihajlo Pupin Institute</td>
<td>Design, construction and delivery of mobile solar electrogenerator for irrigation</td>
</tr>
<tr>
<td>3.</td>
<td>Mihajlo Pupin Institute</td>
<td>Natural wind and water resources aiming to improve the agro-technical irrigation measure: green technology applications for sustainable rural development of Serbia</td>
</tr>
</tbody>
</table>

The project ‘New technology applications with the aim of smart management of vegetable growing in protected spaces’ included the application of new technologies with the aim of smart vegetable-growing processes in glasshouses and greenhouses, using renewable energy as primary sources (sun, wind), which can establish a sustainable system and achieve an increase in the energy efficiency of the entire system.

The project ‘Design, construction and delivery of mobile solar electrogenerator for irrigation’ realised a solar plant for irrigation of vegetable crops on private land in the village Belegiš.

The aims of the project ‘Natural wind and water resources aiming to improve the agro-technical irrigation measure: green technology applications for sustainable rural development of Serbia’ were to explore the opportunities for applying renewable energy sources in the process of plant irrigation, as well as for transferring knowledge to agricultural producers about the opportunities, methods and cost-effectiveness of the application of these energy sources in agriculture.

**Table 7. MAFWM projects – Agricultural Land Directorate**

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Institute of Field and Vegetable Crops</td>
<td>Global assessment of field and vegetable crops tolerance to hazardous and harmful substances in agricultural land and water for irrigation</td>
</tr>
<tr>
<td>2.</td>
<td>Institute for Soil Science</td>
<td>The content of hazardous and harmful substances in agricultural land and cultivated crops in Vranjska Kotlina (structural basin)</td>
</tr>
<tr>
<td>3.</td>
<td>Institute for Soil Science</td>
<td>Hazardous and harmful substances in agricultural land, irrigation water and cultivated crops in Prokuplje municipality, aiming for products safe to health</td>
</tr>
<tr>
<td>4.</td>
<td>Institute for Soil Science</td>
<td>Assessment of irrigation norms of certain agricultural crops in the area of Topica, focusing on irrigation water quality and chemical and physical soil properties</td>
</tr>
<tr>
<td>5.</td>
<td>Forestry Institute</td>
<td>Control of soil fertility and determining the content of hazardous and harmful substances in the soil in Petrovac na Mlavi and Požarevac municipalities</td>
</tr>
<tr>
<td>6.</td>
<td>Forestry Institute</td>
<td>Fertility status of agricultural land, content of toxic elements, nutritional elements and soil erosion on the territory of Topola municipality</td>
</tr>
</tbody>
</table>

The aim of the project ‘Global assessment of field and vegetable crops tolerance to hazardous and harmful substances in agricultural land and water for irrigation’ is to contribute to the protection and sustainable use of agricultural land in the Republic of Serbia, followed by the need to use detailed field and laboratory activity to assess the tolerance of selected field and vegetable crops to hazardous and harmful substances (of organic and inorganic origin) in soil and water used for irrigation. The results of this project so far have been listed in the reports and recommendations for next steps have been provided.

Based on research results from the projects implemented by the Institute for Soil Science and Forestry Institute, studies have been developed and submitted to the competent Ministry.
### Table 8. MAFWM projects – Forests Directorate

<table>
<thead>
<tr>
<th>No.</th>
<th>INSTITUTION</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>Works on forest fire protection in 2019</td>
</tr>
<tr>
<td>2.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>Prognosis of hazards and early detection of fires in the area of East Serbia – support to the development of forest management plans</td>
</tr>
<tr>
<td>3.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>Defining economically sustainable and environmentally-friendly operation systems and methods for developing wood products under different operation conditions (pilot project)</td>
</tr>
<tr>
<td>4.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>The impact of torrential floods on physical and chemical soil degradation in the area of East Serbia</td>
</tr>
<tr>
<td>5.</td>
<td>Faculty of Forestry, University of Belgrade</td>
<td>Identifying the situation and potential of soils in non-covered forest and abandoned agricultural areas in the mountainous areas of West Serbia</td>
</tr>
<tr>
<td>6.</td>
<td>Institute of Forestry</td>
<td>Mapping seed facilities in GIS</td>
</tr>
</tbody>
</table>

Based on research results from the above-mentioned projects of the Institute of Forestry and Faculty of Forestry, University of Belgrade, reports and studies have been developed and submitted to the competent ministry.

### 3.6. Projects under bilateral and multilateral co-operation of the Ministry of Education, Science and Technological Development

In the period 2018-2020 there were a total of 45 bilateral co-operation projects in the area of environmental protection under the Ministry of Education, Science and Technological Development (MESTD), which were finalised or are ongoing, with:

- Republic of Serbia and Montenegro – 12 projects;
- Republic of Serbia and Slovenia – 5 projects;
- Republic of Serbia and Austria – 2 projects;
- Republic of Serbia and Croatia – 7 projects;
- Republic of Serbia and Slovakia – 1 project;
- Republic of Serbia and Germany – 1 project;
- Republic of Serbia and China – 1 project;
- Republic of Serbia and Hungary – 1 project; and
- Republic of Serbia and Portugal – 1 project.

Under the Multilateral Scientific and Technological Co-Operation Programme in the Danube Region with Austria, Slovenia and Portugal, 10 projects were finalised or are ongoing.

Under the Multilateral Scientific and Technological Co-Operation Programme with Belarus and China, three projects were finalised or are ongoing.

Analysis shows that the results of the above-mentioned projects include:

- Joint scientific papers published in renowned national and international professional journals, including also at meeting events and conferences
- Knowledge transferred among research groups, primarily young researchers, through training and lectures held at both teams’ institutions
- Young researchers promoted, with the aim to adopt certain methodologies and achieve results to be included in their doctoral theses
- Doctoral dissertations developed
- Participation in important strategic international projects on specific issues
• Application for longer period of doctoral student education, as well as for funding for the visits of professors and researchers
• Handbooks developed to help students acquire specific techniques in laboratories
• Sample collections created and data bases expanded;
• Knowledge improved
• Risk assessment conducted

Co-operation with China is of particular importance, through the Pan-Balkan Alliance of Natural Products and Drug Discovery Association (PANDA), formally established on 26 September 2019 in Shanghai, China. Inspired by the Belt and Road initiative, researchers from the People’s Republic of China and the Republic of Serbia formed a platform for researching biodiversity and natural products, and discovering new medicines / functional foods, within co-operation between China and Balkan countries, with Serbia in the centre. This co-operation includes scientists in research organisations, at universities, in companies, scientific associations, through exchange, scientific and research co-operation and nurturing talents among the members of institutions within the alliance. The mission of the alliance is to promote mutual development and biodiversity conservation of plants and mushrooms of all members, natural products and ability to detect medicines and research healthy foods in China and the Pan-Balkan region. PANDA office was established with the Institute for Biological Research Siniša Stanković – institute of national importance for the Republic of Serbia, University of Belgrade.

It is important to mention that the majority of scientific and research organisations reported the following main results of project implementation:

• Results received will serve as foundation for further co-operation between institutions
• Both partners will be provided the opportunity to participate in the EU Horizon 2020 programme
• Co-operation will be used to establish a team of experts to participate in joint applications for new projects and research; also, the co-operation will focus on the opportunities for teacher and student mobility, through Erasmus+ funds and
• National monitoring strategy planning

3.7. Projects supported by the EU and Horizon 2020 projects

3.7.1. BioSens Institute

Project ‘Value chain of urban waste transformation into valuable products’ in urban areas focuses on converting bio-waste into valuable products to a circular economy. The project aims to establish new value chains for urban bio-waste utilisation to produce higher value products, including food and feed ingredients through a multi-stakeholder approach. The project is set to showcase a rash of new products produced from urban bio-waste-to-bio-based processes. In its implementation, the project will develop citizens’ awareness of their own contribution to urban bio-waste collection.

The project aims is to demonstrate the way in which a new chain of urban waste flow towards the production of resources with new and higher value, including nature-based products – food and feed. The project takes different types of waste as initial raw materials, such as fish and meat waste, spent coffee grounds, household source separated biowaste, used cooking oils, cellulosic waste derived from municipal wastewater and waste treatment plants and sewage sludge. Pilot demonstration will take place in several European cities. The process will lead to the production of food and additives for the production of new food, bioethanol, bioplastics, organic chemistry derivatives, bio-oil. End-product characterisation and safety assessment will be implemented. The project will develop and implement a behavioural change in terms of both disposal of biological waste and the classification of waste and bio-waste, and acceptance of derived products. new profitable business models will be developed preparing market entry, and finally, the project will provide guidance for city managers on adopting new organisational models supporting the valorisation of urban biowaste, as well as evidence-based EU level policy recommendations for decision makers.

Project duration: September 2019 – February 2023; no results have been achieved so far.
Project ‘Behavioural, Ecological and Socio-Economic Tools for Modelling Agricultural Policy’ deals with European economic policy redesigning. Sustainable and resilient agricultural systems are needed to feed and fuel Europe’s population in the long term. The main issues standing in the way of these objectives and the development of the agricultural ecosystems are climate change and intensified land use. There is a need to reorganise agricultural areas and policies covering them legally. This project is fully funded by the EU, developing frameworks to connect economic modelling with farms, lots, which have business agents. The project will quantitatively model, map and monitor co-designed policy scenarios’ impacts on the environment, climate system, delivery of ecosystem services, as well as socio-economic metrics (e.g. jobs). Using online policy dashboard, workshops and training, to help build capacity for EU policy makers, at the national and local levels, the project will support the European Green Deal and enable changes in the EU agricultural sector after 2020.

Although nearly one-half of the EU is under arable agricultural land, environmental services are threatened by processes such as intensified land exploitation and climate change. Therefore, European, national and local organisers must re-organise and design policy to improve the sustainability of agricultural areas, ensuring farmers’ livelihood. However, impact assessment models used by the European Commission (EC) neglect the complexity of farmers’ decision making and can lead to inadequate projections of policy organisers. They are focused on a narrow economic aspect – income, neglecting policy impact on rural, social and cultural heritage. The project will develop the new planning framework, using knowledge in behavioural theory, connecting existing economic modelling of individual farms with organisation representatives.

Although nearly one-half of the European Union (EU) land area is agricultural the ecosystem services (ESS) are threatened by processes such as land-use intensification and changing climate. European, national and regional policy makers must hence rethink and redesign rural policy to enhance the sustainability of agricultural landscapes while ensuring farmers’ livelihoods at the same time. However, the policy impact assessment models currently used by the European Commission (EC) ignore the complexity of farmers’ decision making, potentially leading to incorrect predictions of policy outcomes. They focus on narrow aspects of agricultural economics (e.g. income), ignoring policy impacts on rural natural, social and cultural assets. The project will develop a new modelling framework using insights from behavioural theory, linking existing economic modelling with individual-farm Agent-Based Models. Using these new modular and customizable tools the project will quantitatively model, map and monitor co-designed policy scenarios’ impacts on the environment, climate system, delivery of ESS, as well as socio-economic metrics (e.g. jobs). The outputs will improve and contribute to existing tools used by the EC such as the Modular Applied General Equilibrium Tool (MAGNET) and Common Agricultural Policy Regionalised Impact model (CAPRI). The project will improve communication and expand the methods, including online policy dashboard, workshops and training, to help build capacity for EC staff and policy makers at EU institutions, national, regional and local decision makers and expert personnel, as well as other researchers.

Project duration: September 2019 – February 2023; no results have been achieved so far.

Project ‘Integration of paper-based nucleic acid testing methods in microfluidic devices for increased bio-sensitivity application’ explores the opportunities for removing obstacles in diagnostics. Nucleic acids found in all beings are tested by using amplification test and are used widely for enabling the discovery of DNA and RNA of bacteria, viruses and other pathogens, even in small doses. This research is very complex and expensive for wider use during rapid diagnostics on the patient’s location. The IPANEMA project has formed a large network of multidisciplinary skills for rapid paper-based microfluidic base opportunities. With its global partners, the project is working on several different technologies, which can be unified using smart phones for fine and simple but expensive analyses in patients.

Team members bring together scientific and industrial knowledge, as well as partners from selected countries, in order to: unify knowledge-base and experiences of entrepreneurs and end users from the multi-disciplinary bio-sensor testing on the location of the user; develop a bottom-up approach to produce a cheap device and include paper-based nucleic testing; promote implementation in three priority sectors – health, food agriculture and environmental monitoring. Research and development activities will focus on the development of cheap tests, their inclusion in microfluidic testing and optimised use in tissue engineering, detecting pathogens in agricultural food and detecting cyanobacteria in fresh water. Redistribution and training will enable researchers to acquire technical skills in connecting scientific knowledge and ideas with products and services.
This project also includes participation of multiple countries – France, Serbia, Israel, Portugal and the United States of America.

Project duration: January - September 2020; one paper has been published and another is under review so far.

3.7.2. Vinča Institute for Nuclear Sciences, University of Belgrade

‘Metrology for radon monitoring’ is a project under EC Directive 2013/59/EURATOM (EU-BSS) covering monitoring radon levels in Europe. For the first time, radon exposure will be part of legal metrology in Europe. Since EU member states require the amount of radon not to exceed 300 Bq/m3, new procedures were established for existing devices for radon monitoring with their past measurement data.

The new measurement method will enable harmonised measurement implementation and the composition of partners will contribute to the establishment of infrastructure for radon metrology in Europe, for the EC radon action plan. It has been estimated that radon leads to lung cancer in 3% to 14% of the population, depending on the levels in the country of measurement. At the European level, this concerns 15,000 to 20,000 people. The aim of the legislation under formation is to establish a solid base for radon protection. This is one of the main EU-BSS (Basic Safety Standards) objectives.


Results: Develop technology and coordinated metrology infrastructure to end users (legislators, regulatory bodies and politicians), organisations developing standards and those providing measurements (accredited laboratories, instrument manufacturers) H115, as well as after a nuclear or radiological event, competent bodies for radiation protection and other decision makers require urgent and accurate information, based on reliable radiological data for covered areas. Still, large areas and risks for humans in the surroundings probably require difficult and challenging measures to be achieved.

Project ‘Metrology for mobile detection of ionising radiation following a nuclear or radiological incident’ will develop new measurement techniques using data collected by unmanned aerial vehicles, and for radioactivity in air measurements using transportable air-sampling systems. This will support timely, effective reaction that protects the people and the environment against the effects of ionising radiation in the aftermath of nuclear and radiological emergencies. The project will also ensure that new instrumentation and procedures are taken up by nuclear regulatory bodies, environmental agencies and international standards organisations.


3.7.3. Faculty of Biology, University of Belgrade

The ‘EcoStack’ project will provide European farmers with the knowledge and solutions required to maximise ecosystem services for crop production, minimising harmful impacts of agriculture on the environment and ensuring profitability of agricultural production. These objectives will be achieved through a combination of ecosystem services in order to increase effective synergistic interaction among the providers of ecosystem services. Past attempts on this plane were ineffective due to insufficient knowledge of the exchange of natural enemies of pests and pollinators among different crop types and surrounding natural and semi-natural habitats, as well as due to unwillingness of agricultural producers to establish refugee habitats for these functionally important organisms. The EcoStack project will focus on managing useful organisms within the crop, rather than manipulating surrounding habitats. The use of progress in accumulated knowledge in the interactions between trophic levels (microorganisms – plants – herbivores – natural enemies/pollinators) will be maximised, the contribution of functional biodiversity on different levels (within and among species, crops, areas) assessed, achieved positive effects managed and combined for increasing their usefulness to farmers, but also to improve system resilience. The research will include: conventional and organic systems; agricultural, horticultural and permanent cultures; pastoral and mixed systems; all pedo-climatic conditions in the European production zone. The research will focus on rapeseed, wheat, potato, tomato, orchards (olives, fruits) and vineyards, as well as meadows/pastures. Advanced molecular and other techniques and tools will be used to establish population sources of useful organisms, as well as to monitor and record their movements and interactions. One comprehensive work package will be dedicated to relevant socio-economic issues, including acceptability of innovative approaches for farmers, and specific tools will be developed based on precise agricultural data, so that farmers can connect input (functional biodiversity) and output (maps of yields) parameters based on data from their personal production areas alone. For the purposes of implementation and results demonstration, access to
a comprehensive farm network covering entire Eu-
rope will be ensured.

Project duration: September 2018 – September 2023. Project result is the establishment of a network to cover entire Europe.

3.7.4. Institute for Biological Research Siniša Stanković, University of Belgrade

Project ‘Managing the effects of multiple stress-
ors on aquatic ecosystems under water scarcity, GLOBALAQUA’ has gathered together a multidisci-
plinary team, with the intent to examine the mutual effects of a number of stressors, with special focus on water resources. Focusing on six river basins, which encompass a rich set of socio-ecological conditions and a wide geographic coverage and focus on a spe-
cific set of stressors to illustrate different manage-
ment scenarios.

The project aims to improve the scientific knowledge regarding the relationships between multiple stress-
ors so as to identify potentially synergistic linkag-
es, and to assess how these interactions determine changes in the chemical and ecological status of wa-
ter bodies.

Special attention will be given to the role of water scarcity and to the relationships between biota and stressors in this condition. An integrative approach to effects on water quality, organisms and ecosys-
tems function and services will be used. Moreover, the project aims to establish cause–effect relation-
ships between multiple levels through the use of integrative modelling. The alteration of ecosystem services related to the effects on socio-economic development will also be investigated. The project will contribute to improving water management practices and policies by taking into account the in-
fluence of multiple stressors. An analysis of current policies will be carried out as well as the definition of scenarios of alternative management practices and policies, such as e.g. the EU Water Framework Direc-
tive (2000/60/ EC).

Project was implemented in the period February 2014 – January 2019.

The results were published in more than 200 papers in top international journals and presented in a num-
ber of conferences.

The purpose of the project ‘Strengthening the ca-
pacities for the implementation of the Water Framework Directive in Montenegro’ is to enable the Ministry of Agriculture and Rural Development and other beneficiaries to prepare the grounds for introducing the EU Water Framework Directive, and all directives related to water, through a designation of an operative and efficient monitoring network and preparation for organisational management plans for Adriatic and Danube basins.

Project duration is February 2017 – February 2020.

3.7.5. Institute of Mining and Metallurgy

‘Mining Waste Cadastre of the Republic of Serbia’ is a project which aims to further develop and improve mining waste management in Serbia, by developing an inventory – cadastre of mining waste. It is envis-
aged that the cadastre should be developed in the form if an Internet application and book, containing risk assessment, characterisation and classification of mining waste.

Serbia produces approximately 150 million cubic metres of solid mining waste, around 15.5 million tonnes of flotation waste and around 35,000 tonnes of oil sludge per year.

According to the preliminary projections of the Min-
istry of Mining and Energy, Serbia has around 200 active mines and approximately 250 abandoned, in-
activated or unlisted mining waste landfills. The Law on Mining and Geological Research provides that active and inactive mining waste management is the responsibility of the company exploiting the ore.11 Companies have the obligation to submit annual re-
ports on production, including waste production, to the Ministry of Mining and Energy.

Project beneficiary is the Ministry of Mining and En-
ergy of the Republic of Serbia. This is one of the first projects within the so-called decentralised manage-
ment system, which means that the project is imple-
mented by Serbian institutions, in co-operation with EU Delegation in Serbia.

The overall project goal is to provide assistance to Serbia in harmonising its legislation with EU envi-
ronmental and climate change regulations, through environmental institution building and infrastruc-
tural improvements. Specific objectives include the development and improvement of mining waste management system.

The project is implemented from February 2017 until January 2021.

Expected results are:

- Strengthened capacities of the Sector for Geology and Mining, Ministry of Mining and Energy, for control and monitoring of mining waste, by developing a cadastre in the form of Internet application and book
- Strengthened capacities of the Ministry of Mining and Energy to manage mining waste, with the aim of environmental protection, through case studies on the topic of soil rehabilitation and re-cultivation
- Improved level of knowledge in the field of inspection control of waste management within the Ministry of Mining and Energy, by drafting a handbook for inspectors and
- Improved overall capacities of Ministry of Mining and Energy staff to manage mining waste, through training and study visits

‘Classification and Sorting of Radium-rich Phosphogypsum Tailings’. In the past certain European countries produced phosphogypsum, most commonly originating from Africa, which led to phosphogypsum deposits after use.

PFIC (Greece), Agropolychim (Bulgaria) and Elixir Prahovo (Serbia) are among the leading Phosphogypsum manufacturers with the largest storage facilities compared to RIS countries, which is why end users will be connected and tested within the (raPHOSafe) project.

The result of the project in the area of East and South-East Europe is the mutual advantage in which phosphogypsum manufacturers may use recycling without waste and remediate the phosphogypsum dumps in the regions, with potential application worldwide. This will considerably reduce harm to human health and the environment and allow for reuse of phosphogypsum dumps for other income, in areas such as agriculture or tourism.

The technology used is patented radionuclide classification and separation system allows to classify, sort and separate non-radioactive from radioactive material. This will enable re-use of the non-radioactive phosphogypsum into construction material, whereas the radioactive phosphogypsum provides a highly sought-after resource for further processing into radiopharmaceutical applications for cancer medication.

Project implementation period is February 2018 – December 2020, and the result is a study.

‘Integrated innovative metallurgical system to benefit efficiently polymetallic, complex and low-grade ores and concentrates – INTMET’ represents a unique technological breakthrough to overcome the limitations related to difficult low-grade and complex ores to achieve highly efficient recovery of valuable metals. Main objective of the project is applying on-site mine-to-metal hydrometallurgical processes of the produced concentrates enhancing substantially raw materials efficiency thanks to increase copper, zinc and lead recovery over 60% vs. existing selective flotation. Three innovative hydrometallurgical processes and novel more effective metal extraction techniques will be developed and tested at relevant environment sites aiming to maximise metal recovery yield and minimise energy consumption and environmental footprint. Additionally, secondary materials, like tailings and metallurgical wastes, will be tested as well for metal recovery and sulphur valorisation. The technical, environmental and economic feasibility of the entire approach will be evaluated to ensure a real business solution of the entire process.

The project will be economically viable due to the diversification of products, high-profitable solution, with lower operation and environmental costs and allowing mine-life extension developing a new business-model concept based on highly efficient recovery of complex ores that will ensure EU mining industry competitiveness and employment. The project is fully aligned with EIP-RM (European Innovation Partnership on Raw Materials) and other associations monitoring the situation in mines.


Results: Semi-industrial facility for bioleaching and bioreactor for continuous treatment of minerals with the capacity of 1 l/day and 20 l/day of leached pulp.

‘Industrially Contaminated Sites and Health Network’. In Europe, earlier industrialization and poor environmental management practices have left a legacy of thousands of contaminated sites. Past and current industrial activities can cause local and diffuse contamination, to such an extent that it might threaten human health of resident populations, especially in vulnerable subgroups. The project is centred on developing a common European framework for research and response on environmental health issues in industrially contaminated sites and establish a European network of experts and institutions involved in assessing health impacts and managing remediation and response.
Specific research into the impact of contaminated places on health have provided significant evidence. Although the material is diffused and random, the assessment has lead to the division of goals and methods. Therefore, there is need for urgent organisation and co-operation between researchers and environmental impact assessment managers, so that strategies can be identified at European level, to systematically address this issue.

The network has defined gaps in knowledge and priorities of researchers, supported the collection of significant data and information, stimulated the development of a harmonised methodology, promoted the co-operation among researchers and developed leadership and sources for risk management, governance and communication.


3.7.6. Faculty of Chemistry, University of Belgrade

The aim of the Faculty of Chemistry, University of Belgrade project ‘Co-operation Activities for Cross-Border Research in the Area of Food, Nutrition and Ecology’, is to create network co-operation between the Faculty of Chemistry in Belgrade and Centre of Excellence for Molecular Food Sciences and four renowned institutions in the EU. This would confirm the unique opportunity for the Faculty of Chemistry, University of Belgrade and its partners to increase research excellence and visibility and technical innovation capacities, enabling cross-research in the areas of food, agriculture, nutrition and environmental protection, by linking different technological disciplines – proteomics, lipidomics, transcriptomics and metallomics.

Project will focus on key co-operation actions in research by networking, training and lectures on the way to future co-operations; organisation of three summer schools; networking of internal and external collaborators – experts, led by workshops and meetings of science and industry; and finally, bringing the EuroFood 2021 (European Food Conference 2021) to the Faculty of Chemistry in Belgrade, to increase the visibility of science in Serbia in the field of food and food science.

Special topics are dedicated to great challenges in the area of environmental pollution impacts on food that we eat on the molecular level, which is why the project will have significant social impact. Information sharing about the project will lead to the interest of the broader public, ranging from experts, through the social scientific community and production organisers, to interested non-professionals. This will lead to more presentation in science of environmental impacts through the food we eat, its nutrition value and environmental protection.

The project is ongoing, it started in September 2018.

3.7.7. Mihajlo Pupin Institute

Project ‘ICT-Enabled Behavioural Change towards Energy Efficient Lifestyles (InBETWEEN)’ deals with the development and application of advanced ICT tools to increase household energy efficiency. The developed tools enable energy savings, primarily of the part consumed unnecessarily, but also better integration of renewable energy sources, which, in addition to economic, achieve also significant environmental effects. InBetween went beyond the currently available ICT technologies used for inducing the end user behaviour change towards more energy efficient lifestyles by simultaneously assisting users to identify energy wastes, learn how they can conserve energy and motivate them to act. In addition to providing opportunities for energy savings and offering incentives for user behavioural change, a big part of the motivation is joined with the opportunity provided and actions through the project design. The aim of the technologies is to deliver a cost-effective solution generating added value, without considerable disruptions of day-to-day activities through the project platform, offering advanced energy services. It allows Users to integrate their building’s connected devices and systems with advanced energy analytics and optimisation services to create a comprehensive recommendation and feedback solution which will facilitate further the behaviour change towards more energy and cost-effective daily routines. A significant demonstration activity in a range of real-life pilot locations in the EU with diverse public set-ups, which differ in terms of size, type, climate and patterns of use, will offer the necessary technological validation.

Project ‘Innovative Design and Integration of Renewable Energy Sources Systems integrated in Building Envelopes’ works on the development of technologies to increase renewable energy sources efficiency and energy storage, integrated into buildings. In addition to improving individual sources, additional efficiency is achieved by integrated management and control, with the aim to minimise harmful environmental effects of conventional sources, but also providing economically sustainable solutions for reliable renewable energy supply.
New light receptors and geometric concentrators increase the amount of solar energy collected. Organic material for phase shift will provide heat when the building is cold and cold air when the building is too warm. The specially developed heat pump will best use the energy collected for supplying heating under the roof and hot water and thermal energy storage. These energy components are monitored using a rapid response smart system. For flat users, public and commercial managers, the operation can be monitored in real time, enabling simple and maximum efficiency.

‘Integrated Demand Response Solution towards Energy Positive Neighbourhoods – RESPOND’ applies and presents interoperable, cheap, user-centred solutions. The solution uses energy automation, control and monitoring tools to integrate a cooperative demand response programme into legacy energy management systems. To this end, RESPOND will use an integrated approach to optimise energy dispatching in real time, taking account both energy demand and supply while exploiting all available energy assets at each site.

The solution will be flexible, scalable and capable of delivering cooperative demand response at the building unit, building and district levels.

In order to provide seamless integration all DR-enabling elements and to ensure high replication potential, RESPOND will use open standards for interoperability with smart home devices and automation systems, smart grid connectivity integration potential with third party services.

Underpinned by smart energy monitoring infrastructure, the project will be able to perform reliable energy data analytics and forecasting in order to detect energy conservation opportunities. The solution will also adapt to different operational environments in real time.

Through interactions with end users in three different pilots, the project will raise awareness by delivering data-driven recommendations for energy demand reduction and influence end user behaviour to make users an active part of the DR loop. In order to demonstrate high replication potential, the project will be deployed in different types of residential buildings situated in different climate zones and population densities, each with different types of energy monitoring and resources available.


‘Digital Platform and Analytic Tools for Energy – PLATOON’ project offers methodology that deploys distributed/edge processing and data analytics technologies for optimised real-time energy system management in a simple way for energy domain experts. The project aims to develop and use the project reference architecture to build and deploy scalable and replicable energy management solutions that contribute to increased renewable energy consumption, smart grids management, increased energy efficiency and optimised energy asset management.

3.8. IPA Projects

IPA projects implemented at national and multilateral levels primarily focused on sustainable development, health and waters, and research was funded in the total amount of 3,825,750.93 EUR. The projects were organised in cooperation with surrounding countries. They have been implemented since 2017, and one of the projects is still active.

3.8.1. BioSens Consortium in Edukons

‘Real-time measurements and forecasting for successful prevention and management of seasonal allergies in Croatia-Serbia cross-border region’. Exposure to aeroallergens is associated with allergic rhinitis and asthma that significantly reduce quality of life and have a notable economic impact on society. Timely information on exposure risk is prerequisite for preventing symptoms and managing allergies. There is long-term awareness of the importance of aerobiological data in Europe, but applied methodology provides only past data (1–7 days old). Such data, from a public health point of view, can be used for observational retrospective analysis and strategy development only, but in order to be of use for improving the quality of life in pollen-sensitive population, they must be available in real time with suitable forecasts (such as the case is in meteorology).

A consortium consisted of BioSens Institute – Research Institute for Information Technologies in Biosystems (Serbia), University of Novi Sad Faculty of Sciences (Serbia), J. J. Strossmayer University of Osijek, Department of Mathematics (Croatia), and City of Osijek (Croatia), as Project Partners, has been established to implement RealForAll project with the main objective to enable public health system that fulfils a role in assisting successful prevention and management of seasonal allergies. To achieve this, RealForAll will enable real-time monitoring of airborne allergens, by developing models for predic-
tion exposure and by creating a joint platform for instantaneous dissemination of this information. In addition, the project will make an effort to educate end users on the benefits from using aerobiological information for prevention and daily management of seasonal allergies.

A network of devices for real-time measurements of airborne pollen concentrations is expected to have a notable impact on aerobiological research, not only regionally but also on a European scale.

The overall objective of the project is to strengthen the social, economic and territorial development of the cross-border area, by improving the quality of public social and health services in the programme area (Priority Axes 1 of the Interreg IPA Cross-border Cooperation Programme Croatia-Serbia 2014-2020). The total project budget is 624,220 EUR, using 85% funds of the Interreg IPA Cross-border Cooperation programme Croatia – Serbia 2014-2020 with the amount of 530,587 Euro. Public contribution to the project is 93,633 EUR, co-funded by the Republic of Serbia, Autonomous Province Vojvodina, Provincial Secretariat for Finance and the institutions implementing the project.


3.8.2. Institute of Field and Vegetable Crops

‘Implementation of cross-border joint actions toward environment protection in agriculture’. EU Member States have the obligation to comply with the strategies in the area of climate change mitigation, waters protection, environmental protection risks management and biodiversity and land quality conservation. To achieve the set goals, awareness needs to be raised about the pollutants reaching the environment from agriculture and knowledge gained on good agricultural practices in certain agricultural production industries (field and vegetable crops, animal breeding) for the purposes of environmental protection. Owing to climate and natural characteristics, the project area is traditionally also an agricultural area, and in recent years it has been facing natural disasters, floods and droughts. Monitoring changes at the national level and in cross-border areas is an important step for raising awareness and addressing issues in the area of environmental protection.

By analysing the current status of soil and water pollution by nitrates and pesticides; by checking the composition and quality of fodder and livestock keeping on farms; by assessing the wellbeing and health status of animals; by checking and analysing manure and ways to use manure and organic fertilisers on field crops – a surveillance, monitoring and management system will be established, from the aspect of optimising production and achieving well-being of animals and humans. One of the main issues today is the lack of knowledge and skills of agricultural producers for adequate soil and water management, as well as for new challenges in livestock production.

Preservation of the environment and the quality of life should not be limited to individuals or local self-governments or remain a national-level issue. Territorial co-operation in cross-border areas enables identification of joint problems and gaps, risk prevention and promotion of the importance of environmental preservation and of living in harmony with nature. In the long term, this contributes to overall regional co-operation development, strengthening international competitiveness and reducing social and economic inequalities.

Cross-border co-operation enables increased exchange of experiences and information between Croatian and Serbian partners in the area of agricultural production, environmentally-friendlier revitalisation based on analytical production methodology and technology, followed by joint implementation of solutions that must be better as results cannot be achieved by action only at the local and national levels. The joint cross-border initiative is planning to raise the level of awareness and interest of the community in agricultural production, environmental protection and revitalisation, as well as to improve food quality. In this respect, this project will provide a knowledge platform on the influence of sustainable agricultural production on the environment and the quality-of-life preservation. It will also educate relevant communities about sustainable agricultural production, through various scientific and expert educational materials.

The aim is to prevent the main problems of pollution from agriculture in the cross-border region, by raising awareness of target groups, educating producers and accepting good agricultural practices.

Supporting integrated cross-border organisation of surveillance/management of existing risks with the aim of environmental protection and biodiversity will lead to the following results:

- Established soil status in the project area;
- Established current chemical and quality water status in project area;
• Established livestock health status in order to optimise feeding with the aim of reducing the discharge of harmful substances in the environment;
• Established pollutant status and structure of vegetable and crop production
• Established status of invasive species, diseases and pests; and
• Developed framework agricultural production management plan in the cross-border area.

Project duration: June 2017 – June 2019.

Total project value: 570,255 EUR.

3.8.3. Technical Faculty Bor, University of Belgrade

IPA II Cross-Border Co-Operation Programme on Romania-Serbia Project: ‘Academic Environmental Protection Studies on Surface Water Quality in Significant Cross-Border Nature Reservations Đerdap / Iron Gate National Park and Carska Bara Special Nature Reserve, with Population Awareness-Raising Workshops’ was proposed for funding by the project management body. The lead partner is the Polytechnic University of Timisoara (Romania) and the partners are: Technical Faculty Bor (Serbia), Association Pro-Mehedinti (Romania) and Citizen’s Association Village (Serbia).

Research topic is the current environmental status in the cross-border area of Đerdap / Iron Gate National Park on Danube river banks. The surface waters will be tested in Danube and its tributaries from both countries. Special attention will be dedicated to analysing the quality of Pek and Mali Pek waters, Special Nature Reserve Carska Bara and Balta Nera. Young generations from both countries will be informed about the importance and necessity for urgent protection of natural resources and the awareness of the society about the sustainable use of natural resources and environmental protection.

A good level of development of infrastructure of both institutions will be achieved, through equipment for the analysis of parameters in order to ensure the fulfilment of future foals, which will provide the next generations of experts with significant information and knowledge.


Total project budget: 626,979.15 EUR, with 223,366.50 EUR by the Technical Faculty Bor.

3.8.4. Institute of Lowland Forestry and Environment

‘Resilient riparian forests as ecological corridors in the Mura-Drava-Danube Biosphere Reserve (REFOCuS)’. Riparian forests of the Mura-Drava-Danube Biosphere reserve constituting ecological corridors are in unfavourable condition and declining due to increasing incidence of pests and diseases, unsustainable human activities and lack of guidance on how to manage riparian forests, including where to find appropriate planting material, so that they can continue to persist and provide all ecosystem services.

REFOCuS project aims to counteract this decline by building resilience into riparian forests of the Mura-Drava-Dunav reserve by providing:
• Novel silvicultural methods for forest management and conservation and
• Increase availability of appropriate planting material to be used when natural regeneration fails

REFOCuS project consortium, led by the Slovenian Forestry Institute, consists of five project and six associated partners from Austria, Hungary, Slovenia, Croatia and Serbia, geographically covering the whole territory of the Mura-Drava-Dunav Biosphere reserve. The project includes four thematic working packages: 1) Interpreting knowledge, 2) Silviculture and conservation, 3) Planting material availability and 4) The policy interface, supported by project management and project communication packages. Expected results of the REFOCuS project are:
• Recommendations on tree species to use and promote,
• Spatial analysis of the riparian corridor,
• Management handbook for threatened riparian forests,
• Pests and diseases riparian forests information system and identification tool,
• Transnational seed transfer zones for seven riparian tree species,
• Database on planting material for riparian forests connected to transnational seed transfer zones,
• Common regional planting material transfer procedure,
• Planting material use and conservation guidelines,
• Whole region riparian species gene bank,
• Holistic strategy for resilient riparian forests all drafted by project partners with support of stakeholders,
• Installed demonstration sites for stakeholder education.

Project duration: June 2018 – May 2021.
Overall budget amount: 1,503,076.78 EUR, with IPA investment: 176,372.54 EUR.

'A new approach in rural ethno- and ecotourism: capacity and competence development'. The project aims to develop tourist capacities of the Ludaš Lake and incorporate the local community into tourist sector to make this location more attractive on the eco- and ethno-tourism map and make it suitable for the cross-border cooperation with Hungarian tourist centres. Furthermore, the project intends to document the traditional use of plants among the local population and educate the locals on how to implement green technology in production of plant-based souvenirs, as well as how to preserve the environment.

The project’s target groups are local community members, small independent entrepreneurs and tourism sector employees operating in the project’s target area.

The project will also contribute to the economy of the border region by bringing together local merchants, tourist agencies and other service providers.

Project duration: May 2018 – April 2020.
Total budget: 499,200 EUR.

3.9. Danube Region

3.9.1. Institute for Multidisciplinary Studies, University of Belgrade

‘Managing and restoring aquatic ecological corridors for migratory fish species in the Danube river basin’. MEASURES project aims to create ecological corridors by identifying key habitats and initiating protection measures along the Danube and its main tributaries. In this sense, sturgeons and other migratory fish species will act as flagship species in support of these goals, as they are indicators of the ecological status of its watercourses. Transnational management of these corridors and restoration actions, as well as restocking with indigenous species are essential.

Total budget: 2,512,931.08 EUR, with IPA contribution of 90,346.27 EUR.

'Developing an E-Learning Tool for Environmental Education for Primary and Secondary School in the Lower Danube Region'. The aim of the project is to develop e-learning tools and improve environmental education in the Lower Danube Region. The project develops innovative e-learning tools for children (6-15 years) and training materials to be used by school teachers. In this way, the project raises awareness of the importance of the aquatic ecosystems and contributes to the future protection of biodiversity in the region.

Project duration: throughout 2018.

3.9.2. Faculty of Mining and Geology, University of Belgrade

‘Sediment Quality Information, Monitoring and Assessment System to support transnational cooperation for joint Danube River Basin water management’. The Joint Danube Surveys characterized sediment quality in the Danube several years ago and concluded that contaminated sediment was a persisting problem in the Danube River Basin (DRB). DTP Countries did not have enough institutional capacity (information, guidelines and methods) to build transnational sediment monitoring networks for health and safety assessment.

The main objective of the project is to respond to the current demand for effective and comparable measurements and assessments of sediment quality
in surface waters in the DRB by delivering a ready-to-deploy Sediment Quality Information, Monitoring and Assessment System to support transnational cooperation for joint Danube River Basin water management.

The main result will be the improved, harmonized and coordinated sediment quality monitoring of water body status in the Danube River Basin. The project will also generate international cooperation between stakeholders concerning the monitoring of safety parameters and concentrations in water, in sediments, and in biota. The immediate and mid-term goal of the project will be a transparent method of monitoring support, that will encourage cooperation in transnational water management.

The project is the long-needed and timely response until the next quality assessment of the DRB due in 2021.

Project duration: June 2018 – May 2021.

Total budget amount: 1,749,152.38 EUR, with IPA contribution of 192,418.75 EUR.

3.9.3. Institute for Biological Research

Siniša Stanković, University of Belgrade

‘Environmental Aspects of Floods’. The lack of distribution of special knowledge and practical solutions on flood protection impedes the introduction of several directives and plans; harmonised flood protection is necessary.

Project aim is to develop a harmonised, international, post-graduate course in flood protection and risk assessment, encompassing all actors and involving the expertise of the professionals in the Danube River Basin in this process.

Project result is formed lectures package, with prepared Handbook (reading material).


Approximate budget: 97,000 EUR.

‘Joint Danube Survey (JDS4), International Committee for the Protection of Danube River’. The project represents one of the most comprehensive surface water surveys worldwide.

The key purpose is to collect information on carefully selected elements of water quality for the length of the Danube River, including its major tributaries. The project enables to harmonise water monitoring practices and procedures in accordance with the EU Water Framework Directive (WFD) committing member states to achieving good water quality.

The fourth survey cycle in 2019 (after 2001, 2007, and 2013) was conducted at 51 sampling sites and will inform the Directive in 2021.

Research results will be available by end 2020.

3.9.4. Mihajlo Pupin Institute

‘Mobilizing Institutional Learning for Better Exploitation of Research and Innovation for the Circular Economy – MOVECO’. Today’s economy that does recognise circulation needs the change initiated by this project. The research aims to close the loop of circular economy and set the goal of implementation of framework conditions and political instruments for environmental innovation and transition to circular economy, by adopting smart and sustainable – different principles of countries in the Danube River Basin.

Expected result will be the development of the economy and improved use of raw materials, new added values, comprehensive new way of work and business model with high level of co-operation and partnership.


Total budget of the Institute: 152,890 EUR, with IPA contribution of 129,956.5 EUR.

3.10. Other Projects

In addition to the above-mentioned and analysed projects, an additional 100 projects were identified, the research objectives of which were directly or indirectly linked with environmental protection, and their topics were mainly connected to sustainable development and health. Research funds on these projects were provided by the business sector, international foundations or agencies, local or regional governments.
Research Results of Analysed Projects
4. Research Results of Analysed Projects

4.1. Research Topics in the Area of Environmental Protection

The results of this research show that the highest number of examined projects covered the topics of sustainable development, followed by biodiversity conservation, water and air protection, and the lowest with the topics of noise and vibrations protection and forest protection (Figure 2).

Figure 2. Research topics of analysed projects in the area of environmental protection for the period 2018-2020, in %
4.2. Structure of Analysed Projects by Sex

Within this research, an analysis of the project structure by sex was made compared to the total number of researchers in all examined projects (Figure 3), as well as structures by sex, compared to the total number of project managers (Figure 4). Results have shown that in both cases there are more men, however, the discrepancies are higher when it comes to the managers of examined projects. Men are managers in 22% more projects compared to women, while there were by 14% more men researchers engaged in examined projects compared to women.

**Figure 3. Structure of analysed projects by sex compared to the total number of researchers**

- Men researchers: 57%
- Women researchers: 43%

**Figure 4. Structure of analysed projects by sex compared to the total number of project managers**

- Men project managers: 61%
- Women project managers: 39%
4.3. Structure of Researchers by Sex on Environmental Protection Research

The results of structure analysis of researchers by sex under various research topics in the area of environmental protection are presented in Figure 5.

Figure 5. Structure of researchers by research topics (A – women; B – men; C – women and men)
4.3. Structure of the Results of Analysed Projects

As can be seen in Figure 6, the highest percentage of research results within analysed projects cover reports with recommendations for follow-up, papers in nationally and internationally acclaimed journals, followed by conferences, congresses, statements and new and improved technical solutions.

Figure 6. Structure of the results of project implementation in the area of environmental protection
Conclusions and Recommendations
5. Conclusions and Recommendations

5.1. Conclusions

Environmental protection certainly is one of the priority areas for research identified in the Smart Specialisation Strategy (S4) in the Republic of Serbia for the period 2020-2027.

Based on the results of analysis of 274 scientific and/or research projects in the area of environmental protection implemented by 40 scientific and research organisations, covered by this study, the following may be concluded:

• Researchers in Serbia are up-to-date with the latest developments in the area of environmental protection.

• Scientific and research organisations co-operate amongst themselves but also with other institutions and organisations, domestic and foreign, in a high percentage; in addition, on around 50% of analysed projects, scientific and research organisations co-operated with the business sector.

• Scientific and research organisations regularly apply to calls for funding applications in the area of environmental protection, published by line ministries (Ministry of Environmental Protection, Ministry of Education, Science and Technological Development, Ministry of Agriculture, Forestry and Water Management, Ministry of Mining and Energy), Science Fund, Innovation Fund, European Commission, European Parliament, City of Belgrade Secretariat, Provincial Secretariat for Environmental Protection and Sustainable Development, Provincial Secretariat for Science, various public companies, users of protected natural areas, etc.

• Research funding in this area is largely (around 90%), provided from the Republic of Serbia budget, however, about one-half of analysed projects are reported to have acquired research funding from the business sector or other sources, while very few scientific and research organisations analysed in this study dispose of their own funds.

• One-half of the institutions whose projects have been analysed here reported their researchers contributed to developing legislation in the area of environmental protection, i.e. participated as stakeholders in the development of national regulations, laws and by-laws; also they emphasise that in the majority of cases the legislator did not take into account their suggestions and recommendations, especially when it comes to recommendations based on reports and situation analyses.

• Researchers in the area of environmental protection feel that for now research is supported and funded by government funds in Serbia, relying on strategic documents, while they identified no initiatives supporting the development of research and innovation in the area of environmental protection, i.e. certain segments of protection, in line with specific policies and thematic programmes at the national level. Also, Serbia is the signatory of most international agreements, implemented using precise regulatory mechanisms contributing to environmental protection.

• The majority of researchers use their own equipment for project implementation or co-operate with other scientific and research organisations on joint publications, while few use services provided by other institutions.

• The needs for human resources are great – the current number of employees at all levels and types of activities is insufficient for the implementation of infrastructural projects and for harmonisation with the European environmental protection legislation. Since long-term practical
experience is required after formal education, it is necessary to immediately intensify work on creating human resources. Young researchers are interested in research in this area, and occasionally employees in companies within the environmental protection sector report for research as part of doctoral studies. Scientific and research organisations educate young researchers through the development of master theses and doctoral dissertations, through co-operation with other university-level institutions, as well as through professional development in country and abroad.

- In Serbia, there are around 2,000 researchers per one million inhabitants, which is more than in other West Balkan countries, but less than in more developed EU countries in the neighbourhood. Officially, there are around 15,000 scientific researchers, and this number has been increasing in the past years. Out of the total number of researchers, 51% are women, which is much higher than the European average (S4). However, this research has reached the conclusion that there are more men engaged, and also more men managers in analysed projects. Women researchers engaged in analysed projects mostly work on research on the topic of water protection, and men of sustainable development, while both are the least engaged in projects on the topics of noise and vibration protection and forest protection. Researchers feel that all environmental protection segments must be equally developed as they are interconnected, as well as that it is required to support all research aspects in the area of environmental protection. Still, the results of analyses in this study have shown that there is need/interest in certain types of research in the area of environmental protection, which in their opinions are neglected or underdeveloped, some of them including: application of waste and different conditions of production of eco-brick, mortar and concrete, impacts/effects of forests on the environment and mitigation of the effects of climate change, monitoring of ground and surface waters, dumps, etc. There is particular interest in the following topics: innovative eco-friendly materials, research in energy efficiency, circular cities, sustainable cities, resilient cities, new planning and design methodologies with special focus on environmental principles, design theories from an environment and behaviour perspective, etc.

- Research results in this study have shown that researchers feel it is necessary to increase investments in scientific and research projects in the area of environmental protection, that co-operation among different research sectors in the area of environmental protection is needed, that co-operation on international level is more efficient than on the national. A unified database is required, with information from all environmental fields. Such a database should have broad applications in environmental management, but also in research, regional analyses, reporting on national commitments, developing strategic national documents, as well as developing legislation, especially relevant ordinances and rulebooks.
5.2. Recommendations

- Future research in the area of environmental protection should focus on maintaining and promoting existing co-operation with university-level education institutions and scientific institutes worldwide, and the establishment of new co-operation should be encouraged.

- Researcher activity in the area of environmental protection should focus on intensifying scientific networking with international laboratories, researcher groups and private sector entities to form project consortia with the aim to prepare and implement scientific, research and development projects funded from various national and international funds.

- Activity of scientific and research institutions should focus also on developing the capacities for the accreditation of excellence centres within organisational units, achieving the highest and internationally recognised scientific results, which also have developed international scientific co-operation in the area of environmental protection.

- Promoting the area of environmental protection can be established through primarily engaging young researchers on programmes of general interest in line with the Law on Science and Research, such as those supporting and funding scholarships for young, gifted scientists and researchers, programmes for developing human resources in scientific and research work, programmes for funding doctoral academic studies, and for programmes of the Republic of Serbia Science Fund.12

- Research clearly defined in strategic documents will enable directed training of young researchers in this area of general interest for the economy and the society.

- Improving international bilateral and multilateral co-operation will enable sharing and transferring experiences among partners. This kind of co-operation, particularly established through the mobility of researchers and exchange of experiences and results, also increases the level of expertise and knowledge of each of the partners in the area of environmental protection. Other advantages will include a comparison of established approaches and results, as well as scientific and technological comparison, that will reduce the differences among individual institutions and increase the usage of results. Research objectives of joint projects should meet the needs of selected scientific and industrial sectors and may also build on achieved results or be scaled up or further developed in future projects.

- It is necessary to continue with the implementation of results that are directly implementable in practice, which will have direct economic effects on participating institutions and their economic activation, as well as the society at large. In order to implement the results received in practice, it is necessary to connect all the factors, as well as to bring the results closer to end users through good marketing and placement, first of the research conducted, then also the results achieved.

- Identify burning issues and find the best solutions for addressing them by involving all stakeholders in the chain, making the foundation for further

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application of models in practice, which would be
the end goal of networking and co-operation, and
which would in perspective also bring the highest
added value for the community.

• Agriculture and Rural Development Strategy of
the Republic of Serbia for the period 2014–2024,
defines creating and transfer of competitive
knowledge and technologies in the area of envi-
rornmental protection\(^{13}\) as its priorities, which is
also identified as a priority area in the national
Smart Specialisation Strategy Serbia (S4), and
potentials for development of scientific and re-
search resources in this direction. This strategic
development document emphasised that efforts
need to be invested in the identification and de-
velopment of new areas of action. The Smart Spe-
cialisation Strategy (S4) mentions three cross-
cutting areas of research: energy and energy
efficiency, key development technologies and
environmental protection. Serbia does not have
particularly good economic indicators for these,
but they are globally acceptable, and achieved
results and potentials in the identified priority
areas can represent solid basis for exploiting po-
tentials in these propulsive industries. In the area
of environmental protection and energy efficien-
cy, based on the interviews conducted, S4 pro-
poses new specific areas – energy-efficient and
eco-smart solutions. Based on systematised data
received from the interviews conducted, a sub-
area was identified – eco-smart energy sources.
Within this sub-area, the following potentials,
requiring additional research, were identified:
biomass (pellet, bio-degradable waste); efficient
bacteria; leftovers from other processes – waste
treatment: dry farm leftovers (cows, cattle, pigs,
chickens); leftovers from meat industry – their
rehabilitation and further exploitation; munici-
pality waste treatment; geothermal energy and
solar energy. As general conclusion for the area of
environmental protection and energy efficiency,
S4 reports the existence of innovation and scien-
tific potentials. Due to the horizontal nature and
importance for the innovation system, this area
should be horizontally supported by the organi-
sation of numerous workshops on the above top-
ics. Horizontal networking of identified compa-
nies in this area with key stakeholders in the area
of machine industry and electroindustry, as well
as agriculture and food industry, will contribute
to successful application of the concept of smart
specialisation in the Republic of Serbia, as well
as the achievement of goals set in the area of en-
vironmental protection. Having in mind that the
area of environmental protection was not iden-
tified in the process of mapping economic, sci-
entific and innovation potential, more attention
should be paid in the future to environmental
protection in the Republic of Serbia (S4).

• To advance action in the area of environmental
protection, first of all strategic documents need
to be strengthened, links established among all
structures in the system, horizontally and verti-
cally, co-operation encouraged at all levels, and
the role and participation of researchers in form-
ing policies and making final decisions increased.
As part of the modern trends in creating scientific
and innovation policies, effort should be invested
in strengthening co-operation among decision
makers, the scientific community, academia and
the business sector and civil society – with the
aim to increase the competitiveness of the econ-
omy, economic growth and societal progress, by
interlinking research, industrial and innovation
strengths and resources.

• It is necessary to direct resources and research
to several priority areas, especially those exhibit-
ing issues with potentially significant effects on
the society and enable more efficient use of do-
monic but also international potentials for better
positioning in global, international institutions,
relevant to the area.

• By developing innovation, science and technolo-
gies in the area of environmental protection, con-
ditions are met for the preservation of our living
space and the protection of health of the envi-
ronment and the bio fund. This will help preserve
the health of people and provide potentials for
a healthy future of our children and generations
yet to come.

\(^{13}\) Internet, available at: http://www.minpolj.gov.rs/download/strate-
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ASSESSMENT OF THE EFFICIENCY OF SUPPORT TO ENVIRONMENTAL RESEARCH

2021