

## Final Evaluation Report

---

Your Details	
Full Name	Maja Novković
Project Title	Toward Cost-Effective UAV-Assisted Multimetric System for Detection of Freshwater Patches of High Conservation Value within the Danube Floodplain in Serbia.
Application ID	28388-1
Grant Amount	£4668
Email Address	maja.novkovic@dbe.uns.ac.rs
Date of this Report	27.12.2020.

**1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.**

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Fieldwork activities				All planned fieldwork activities were completed. Thanks to the volunteer support, six additional biological parameters were sampled and processed.
Laboratory activities				All planned lab work activities were completed. We managed to process four additional parameters, while for the rest of parameters the work is still in progress.
Conservation assessment of the BAČ04 wetland area				Data collected for the wetland area No. BAČ04 were used to fulfil the conservation assessment (carried out by Institute for the Nature Conservation of Vojvodina Province) of this site as a candidate for Special Nature Reserve at national level.
Multimetric UAV (Unmanned Aerial Vehicle) system development				The multimetric index was developed. Due to the Covid-19 partial and total lockdown in Serbia, we had the delay in sample processing and subsequently in calibration of the multimetric index.
Stakeholders presentation, training and communication				We have managed to actively involve stakeholders in the field activities and to exchange the knowledge with them. Due the Covid-19 pandemic, the final presentation to stakeholders was carried out online, using the Zoom app. During this dissemination event, the project activities, outcomes and their potential use were discussed. The stakeholders expressed their interest for the further field testing and development of the method.
Website development				Website development was completed. <a href="https://www.uavwetlands.com/">https://www.uavwetlands.com/</a>
Dissemination activities				Dissemination activities were completed, but in slightly different manner due to public gatherings

				restrictions. Some activities were held online.
--	--	--	--	---

**2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.**

During 2020 we had significant and unexpected work delays due to the Covid-19 pandemic. There was the total lockdown at the national level from March-May 2020 during which we had no access to faculties and laboratories. Various epidemiological measures and recommendations partly restricted the public gatherings, which had affected field work and dissemination activities, including in-person training for stakeholders. Also, in the last phase of the project, we had some delays due the Covid-19 illness, quarantine and self-isolation period of some the project team members.

Due to the state of emergency in Serbia (Covid-19 pandemic) Faculty of Science, University of Novi Sad terminated all contracts with suppliers, so unfortunately the purchase of any goods was not possible. Shortly after the state of emergency ended, the new Law on Public Procurement of the Republic of Serbia took effect on July 1 of 2020, so Faculty of Sciences needed additional time to harmonise its regulations with the new Law. All of the above led to delays in some goods and equipment purchase.

After each interruption, project activities were resumed as soon as possible. The Rufford Foundation approved the extension of the deadline for the implementation of all project activities which enabled us to successfully finish them.

Due to the pandemic epidemiological measures and recommendations, some dissemination activities were conducted online instead of in person as initially planned.

**3. Briefly describe the three most important outcomes of your project.**

The one of the most important outcomes of the project was the establishment of the wetland research network and strengthening the collaboration among stakeholders, students, and researchers from several universities and institutions involved in aquatic conservation and freshwater management. Together with the Faculty of Sciences at University of Novi Sad and at University of Niš, the project was carried out and supported voluntarily by students and researchers from other universities and institutes: Josip Juraj Strossmayer University of Osijek (Croatia); Katholische Universität Eichstätt-Ingolstadt (Germany); Faculty of Natural Sciences, University of Kragujevac (Serbia); Institute for Nature Conservation of Vojvodina Province (Serbia); Masarysk University (Czech Republic); Institute for Biological Research "Siniša Stanković" (Serbia); and Jevremovac Botanical Garden of Faculty of Biology, University of Belgrade (Serbia) who actively participated in all phases of the project and contributed with their equipment and consumables. This joint action also included Kopački Rit Nature Park (Croatia) wetland area in the field work, which together with NR Gornje Podunavlje creates the largest wetland area in the middle Danube basin. Also, thanks to the volunteering work, additional set of biological parameters were

included into the development of the multimetric tool: fish, phytoplankton, molluscs, periphyton, epiphyton and amphibia.

The project resulted in creation of complex database of wetland aquatic habitats and biodiversity. The team acquired the data for four planned ecological quality elements: macrophytes, macroinvertebrates, water physico-chemical parameters, and hydro-morphological parameters, but also managed to sample additional biological community data for fish, phytoplankton, periphyton, epiphyton, molluscs, and amphibia (*Anura*). Beside this team managed to acquire a collection of UAV imagery. The multimetric system for assessment of conservation value of aquatic habitats within the floodplain landscape was proposed and will be further evaluated through the peer-review process of publishing scientific article.

#### **4. Briefly describe the involvement of local communities and how they have benefitted from the project.**

During the fieldwork of 2019 and 2020, members of local fishermen and local nature lovers' community participated in project activities by providing the project team with the fieldwork logistic and the local knowledge. Since the local community directly use ecosystem services of the wetlands' lakes and ponds, they were very interested in the ad hoc habitat ecological status assessment.

The fieldwork was conducted in collaboration with local stakeholders and water resources managers: Institute for Nature Conservation of Vojvodina Province, Novi Sad; "Vojvodinašume", Public Company, Petrovaradin: Special Nature Reserve "Gornje Podunavlje" - ŠG "Sombor"; Special Nature Reserve "Koviljsko-Petrovaradinski rit" - ŠG "Novi Sad"; Special Nature Reserve, Karadorđevo'' - Military Institution "Morovic"; Nature Park "Begečka jama" - DTD "Ribarstvo". Within each of protected areas, the ranger services supported the project team by field vehicles, boats and navigational support through the complex and challenging landscape of the wetlands. The final reports on ecological status of water bodies were sent to each protected area management in order to complement their habitat inventories.

Moreover, in the initial phase of the project, the project team members promoted the project among fellow freshwater researcher community, among some of them expressed their interest in participating in the project and suggested expanding the number of parameters that could be sampled in the field and could be later included in index development and calibration. They supervised the team members regarding standardised sampling techniques and offered their expertise in sample processing.

#### **5. Are there any plans to continue this work?**

We plan to continue the work on selected topics, as we believe it could significantly improve resolution and quality of aquatic vegetation and land cover monitoring in wetland areas and aquatic ecosystems in general. As we managed to obtain the essential equipment set through this grant, it will enable us to continue further testing and development of the methodology in different environmental conditions and

setups. The wetland stakeholders expressed interest in further development and improvement of the multimetric tool.

**6. How do you plan to share the results of your work with others?**

The results of the project and the project itself were presented to the regional scientific community and the wider community through the scientific conferences carried out by the team members as an oral and online presentations. We plan to continue this activity after the project end. Currently, two scientific papers presenting the project results are being prepared and will acknowledge the project. The first paper considering correlation between different habitat types and fish community composition is in the pre-submitting phase (the journal Ecological Engineering). The second manuscript, considering the UAV imagery analyses and different aquatic habitats detection and their conservation value is in the development phase.

Project web page was developed and include the complete project workflow, activities and the project results. We plan to continue web site maintenance and updating with all future activities (continued research) and project products.

Results of the project will be part of my PhD thesis titled: Monitoring of ecological groups of macrophytes in an anthropogenically multi stressed environment of the Danube River. The thesis title and the theme was approved by the Senate of the University of Novi Sad in September 2020.

**7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?**

The grant was used continuously during the project, in accordance with the project timetable and the national tendering procedures and the legislation.

**8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.**

Item	Budgeted Amount	Actual Amount	Difference	Comments
Printing of brochures and leaflets	150		-150	Brochures and leaflets weren't printed, considering that due to 2020 COVID19 pandemic, all of presentations and conferences were held online.
Printing of T-Shirts	450	240	-210	As suggested by the

				Foundation reviewers, we reduced the number of printed t-shirts.
Creation and maintenance of the website	200	80	-120	We created website ourselves and paid only maintenance on WIX platform in order to save up funds for equipment.
Promotional movie production	100		-100	We created and produced movie by ourselves in order to save up funds for equipment.
Biological data sampling fieldwork fuel costs (in 'Gornje Podunavlje', 'Koviljsko-Petrovaradinski Rit' and 'BAČ04' wetland area)	300	300		Additional funds were provided by Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad and University of Kragujevac (please, see the details below).
Biological data sampling fieldwork accommodation and food (in 'Gornje Podunavlje', 'Koviljsko-Petrovaradinski Rit' and 'BAČ04' wetland area)	1400	1430	+30	
UAV fieldwork fuel costs	300	196	-104	
UAV fieldwork costs (renting and purchase of additional equipment)	1000	1630	+630	In order to remain the project sustainability, in the second fieldwork year, we allocated some additional funds to obtain the UAV equipment.
GPS device	197	213	+16	The change of the equipment price.
External HDD drive for data storage	70	59	-11	The change of the equipment price.
Macrophyte grabblers	60		-60	We couldn't purchase the suitable grabbler type because of the lack of suppliers, so we made them personally with the help and material provided by my father ☺
Plankton Sampler Nets	47	20	-27	The change of the equipment price.
Plankton Sampler Frame	95	75	-20	The change of the equipment price.
Ethanol (96%) for sample preservation	168	110	-58	Due to high temperatures and high organic matter content of samples, we spent more ethanol for the sample preservation than it was

				planned.
Plastic sample containers	100	70	-30	
Alkalinity kit	31		31	Obtained by the project of the Ministry of education, science and technical development of the Republic of Serbia (No. 43002)
Conference travel and costs of stay (Montenegro, 2019)		210	+210	In order to present the project results to the wider scientific community we allocated some funds towards additional dissemination activity
Grant agreement translation		37	+37	According to the Faculty of Science rulebook we needed to pay transliteration of grant agreement in Serbian
<b>Total</b>	<b>4668</b>	<b>4670</b>	<b>+2</b>	<b>Exchange rate 1£=132din</b>

In order to support additional parameters sampling and increased number of team members we obtained some additional funds:

Faculty of Sciences, Novi Sad and Faculty of Natural Sciences, University of Kragujevac supported project by the two off-road vehicles and funded their amortisation and fuel costs (approximately £300).

In 2019 we needed to prepare the 96% ethanol for sample preservation in advance, so it was provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia research program (Grant No. OI 173030) (additional 80l - £100).

Expenses for the travel and costs of stay for the abroad team members were funded by Provincial Secretariat for Science and Technological Development of Autonomous Province of Vojvodina and the BAYHOST (Germany), the Bavarian Academic Center for Central, Eastern and South-eastern Europe (approximately £500).

Funds for travel and costs of stay for attendance on scientific conference in Heidelberg was funded by the grant for foreign teachers of the Katholische Universität Eichstätt-Ingolstadt (Germany) (approximately £400).

In 2020 UAV purchase was co-funded by the researchers' material funds provided by Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant No. 451-03-68/2020-14/200125) research program (£150).

In order to further continue the research of project objectives in 2020 additional multispectral UAV imagery acquiring was conducted. The multispectral UAV

equipment was obtained from the Department of Geography from the Faculty of Sciences, and flight engineer support was co-funded from our personal funds.

In the same manner in 2020 we managed to allocate some personal funds to repair and licence (old) dinghy and conduct additional fieldwork in wetland area Dubovački rit downstream the Danube. Also, in order to navigate the boats by ourselves I have managed to obtain boat operating licence (approximately £150).

#### **9. Looking ahead, what do you feel are the important next steps?**

In order to continue the research and develop comprehensive wetland monitoring methodology, the next steps will be processing, testing and integration of additional habitat parameters in order to increase the resolution of the index. Also, we believe that additional UAV image types (beside RGB photography) like infrared, near infrared and multispectral photography should be tested as it could enhance the quality of aerial imagery. Also, we believe that additional field testing and calibration of the index, in a variety of different environmental conditions, will improve its performances.

#### **10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?**

The Rufford Foundation logo was used on the promo materials (t-shirts, bags and pens), project website, project promotional video, scientific conferences power point presentations and abstract books, it was also used to mark the equipment bought from the grant funds.

The Rufford Foundation and the Project itself were presented on three international scientific conferences: 8th International Symposium of Ecologists, Montenegro (two presentations); Arbeitskreises Hydrologie der DGFG, Heidelberg Germany; 9th International Symposium of Ecologists, Montenegro). The fourth conference to which the project results abstract was submitted and accepted: 43rd IAD Conference: Rivers and Floodplains in the Anthropocene - Upcoming Challenges in the Danube River Basin is postponed to 9-10 June 2021 due to Covid-19 pandemic in 2020.

Through dissemination activities the foundation and the project were presented to the BSc Ecology and MSc Hydrobiology students from the Faculty of Sciences, University of Novi Sad. At the end of project activities an online presentation of the Rufford Foundation and project was held to the representatives of water management and conservation stakeholders in Vojvodina (Special Nature Reserve "Koviljsko-Petrovaradinski rit" - ŠG "Novi Sad"; Special Nature Reserve „Karadorđevo” - Military Institution "Morovic"; Public Water Management Company Vode Vojvodine, Novi Sad; "Vojvodinašume", Public Company, Petrovaradin), the presentation was also attended by members of Scientific and Research Society of Biology and Ecology Students "Josif Pančić", University of Novi Sad; NGO Zeleni Sad from Novi Sad; NGO Via naturae from Tuzla and also freshwater researchers from Faculty of Sciences, University of Novi Sad; Faculty of Sciences, University of Banja Luka, Faculty of Sciences, University of Tuzla, Faculty of Sciences, University of

Kragujevac, Faculty of Sciences, University of Nis, Faculty of Biology, University of Belgrade, The Institute for Plant Protection and Environment and the members of the ECOBIAS ERASMUS + project team (Development of Master Curricula in Ecological Monitoring and Aquatic Bioassessment for Western Balkan HEIs (ECOBIAS).

**11. Please provide a full list of all the members of your team and briefly what was their role in the project.**

*Faculty of Sciences, University of Novi Sad*  
Maja Novković (MN), Ecology PhD student  
Dušanka Cvijanović, PhD (DC)  
Bojan Damjanović, PhD (BD)  
Anđelka Šikić (AŠ), Ecology BSc student  
Kristina Purić (KP) Ecology BSc student  
Bojana Arifi (BA) Ecology BSc student  
Marko Orej (MO) Ecology BSc student

*Faculty of Sciences, University of Niš*  
Aleksandra Milovanović (AM) Ecology BSc student  
Olivera Stamenković (OS) Ecology PhD student  
Tijana Kostić (TK) Ecology BSc student  
Milica Stojković-Piperac, PhD (MSP)  
Jelka Crnobrnja Isailović, PhD (JCI)

*Katholische Universität Eichstätt-Ingolstadt (Germany)*  
Johanna Weidendorfer (JW), BSc student

*Josip Juraj Strossmayer University of Osijek (Croatia)*  
Dubravka Čerba, PhD (DČ)

*Institute for Nature Conservation of Vojvodina Province (Serbia)*  
Laslo Galamboš (LG) biologist

*Faculty of Natural Sciences, University of Kragujevac (Serbia)*  
Bojan Matejić (BM) biologist  
Marko Vljaković (MV) biologist

*Jevremovac Botanical Garden of Faculty of Biology, University of Belgrade (Serbia)*  
Branislav Vesković (BV),  
Nikola Lukičić (NL),  
Dragana Predojević, PhD (DP)

*Institute for Biological Research "Siniša Stanković" (Serbia)*  
Aleksandra Vesić (AV),  
Božica Vasiljević, PhD (BV)

*Masaryk University (Czech Republic)*  
Erika Lorencova (EL) Ecology PhD student

DC carried out the process of obtaining the licences for the scientific work in the protected areas.

DC, BD, JW and MN conducted on-site macrophyte assessment and subsequent calculation of macrophyte community metrics, ecological status and traits assessment. AV conducted the determination of *stoneworth* species.

MO, TK, AM, OS, MSP and DČ performed the sampling of macrozoobentos, subsequent lab samples processing and species determination as well as community metrics calculation, ecological status and traits assessment.

MN planned the UAV flight missions, while BV and NL operated the UAV and accrued aerial images. MN conducted subsequent UAV image processing, orthomapping products creation and GIS image classification and spatial analyses.

AŠ and JW performed on site measurements of basic water physico-chemical parameters, and collected the samples for additional lab measurements. KP, BA, AŠ, JW, MO, DČ, and MN performed additional water samples lab analyses.

BM and MV researchers from the Faculty of Natural Sciences, University of Kragujevac together with LG from Institute for Nature Conservation of Vojvodina Province joined the project team during the fieldwork activities in order to successfully sample and determine additional biological parameter of ecological status – fish. Together with MSP they conducted electrofishing on each sampling site, determined the fish species and measured chosen fish traits.

JCI and EL joined the team in order to assess the Anura and Mollusc groups (respectively) within the research area. DR and BV processed the phytoplankton and periphyton samples (respectively), which were acquired by AŠ, JW, MN and DČ.

MN, DC, AŠ, JW and DČ georeferenced all sampling sites. MN provided the research area and sampling sites maps.

MN (supervised by DC) created the project logo, website and promotional video.

MN and DC managed project activities and coordinated the team.

## **12. Any other comments?**

All project activities are presented on the project website. We plan to further update the website with every new product developed based on the data obtained through this grant and also to complement it with all with all future research. Please visit <https://www.uavwetlands.com/>