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Annex 2: DPS Replications List

DALIA-DANUBE.eu

List of potential replications

DPS 1: SZIGETKÖZ Hungary

DPS 1 propose only one non-physical replication:

Non-physical replication:

Designing guidelines for putting principles into practice when designing the rehabilitation of water bodies

Problem: Economic pressures have modified the water bodies in Szigetköz in the last century, changing the water, ecological and environmental conditions in the regions to the detriment of biodiversity and significant wildlife species.

Recommended for replication: Designing guidelines for putting principles into practice when designing the rehabilitation of water bodies are recommended for replication. These guidelines help to apply an open-design approach by involving stakeholders in order to resolve existing conflicts, create compromises, and achieve a consensus.

Further innovative elements of planning and operating a rehabilitation policy and system:

1. **Design:**
   a. Technical solutions for nature-based rehabilitation of water bodies
   b. Design guidelines for wildlife habitat reconstruction and fish passes
2. **Operation:**
   a. Integrating the dynamics of natural waterflow patterns into the operation policy, applying Nature Based Solutions
   b. Artificial habitat development and artificial flooding
3. **Policy and Decision-making:**
   a. Stakeholder involvement practices during planning and operation (Szigetkoz Operating Committee)

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Figure 1: Fish crossing.

DPS 2: Ingolstadt (Germany)

Problem: Heavily modified water bodies (HMWB) due to River Regulation, Floodplain reduction, Riverbed incision, Hydropower Plant (transversal structure) and Lost of longitudinal and lateral connectivity.

Solution - Physical replication

Floodplain re-connection by technical re-establishment of hydrologic dynamics and restoring of ecological functions:

1) Construction of a (controlled) bypass stream to restore the longitudinal and lateral connectivity
2) Controlled small floods to mimic natural floodplain dynamics (sluice gates for controlled ecological flooding)
3) Groundwater lowering to increase groundwater fluctuations (Stop Logs)

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Monitoring - Non-physical replication

Abiotic: Hydrological monitoring (groundwater level, discharge, soil moisture), Erosion monitoring (remote sense data)

Biotic: Vegetation monitoring (macrophytes, riverbank vegetation, forest vegetation), Seed monitoring, Amphibian monitoring

DPS 3: Dyje sub-catchment, Czech Republic

DPS 3 propose one physical replication (equipment) and one non-physical replication:

Physical replication (equipment): Floating evaporimeter station(s)

Problem: Needs for precise measurement of water evaporation from the water body.

Solution: Purchase, installation and use of the **floating evaporimeter station(s)** to be placed at the site in order to improve the precision of water evaporation from the water body.

The purchase of a floating evaporimeter costs up to 20,000 Euros in the Czech Republic. The floating evaporimeter consists of a mechanical structure, which includes a measuring vessel with a diameter of 620 mm, floats and breakwaters. Powered by a battery charged by 2 solar panels (each 20W). Completed with a two-way pump that fills/drains water into/from the evaporative container in the event of a level change from the reference value by 5 cm. It can monitor following meteorological quantities**:** evaporation [mm], precipitation [mm], solar radiation [W/m2], air temperature [°C], water temperature in the evaporimeter [°C], water temperature at depths 0.5-1-1.5-2- 2.5 m [°C], wind speed [m/s], instantaneous wind speed [m/s], wind direction [0-360°], relative humidity [%].

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Figure 2: Floating evaporimeter station.

Non-physical replication: Reservoir Balance calculaTor: (ReBaTor)

The **ReBaTor** application serves as a basic assessment tool for the behavior of a small water reservoir (SWR) and its impact on the total outflow. The calculation of the reservoir balance includes not only inflow, minimum residual flow below the reservoir (MRF), and withdrawal but also evaporation from the surface and precipitation onto the surface. Users can view time series of individual variables and the operation of the reservoir volume depending on the balance. Additional information includes: the average time to fill the reservoir, the probability that the reservoir can secure the MRF and the required withdrawal, the aridity index, m-day flows for the reservoir profile, recommended MRF based on the MEF calculator, the average long-term balance of the reservoir, and the long-term average flow for the reservoir profile. The inputs to the application are outputs from the hydrological model (which ReBaTor contains and requires climatic data: precipitation and evaporation (potential evapotranspiration)) or observed/derived flow data. To perform the calculation, the user only needs to know the basic characteristics of the reservoir and the area where the reservoir will be located. All other data and calculations are handled by the application. Results can be viewed in the form of graphs and tables. The graphs are interactive and can be downloaded as a PNG image. Tables can be downloaded in CSV format.

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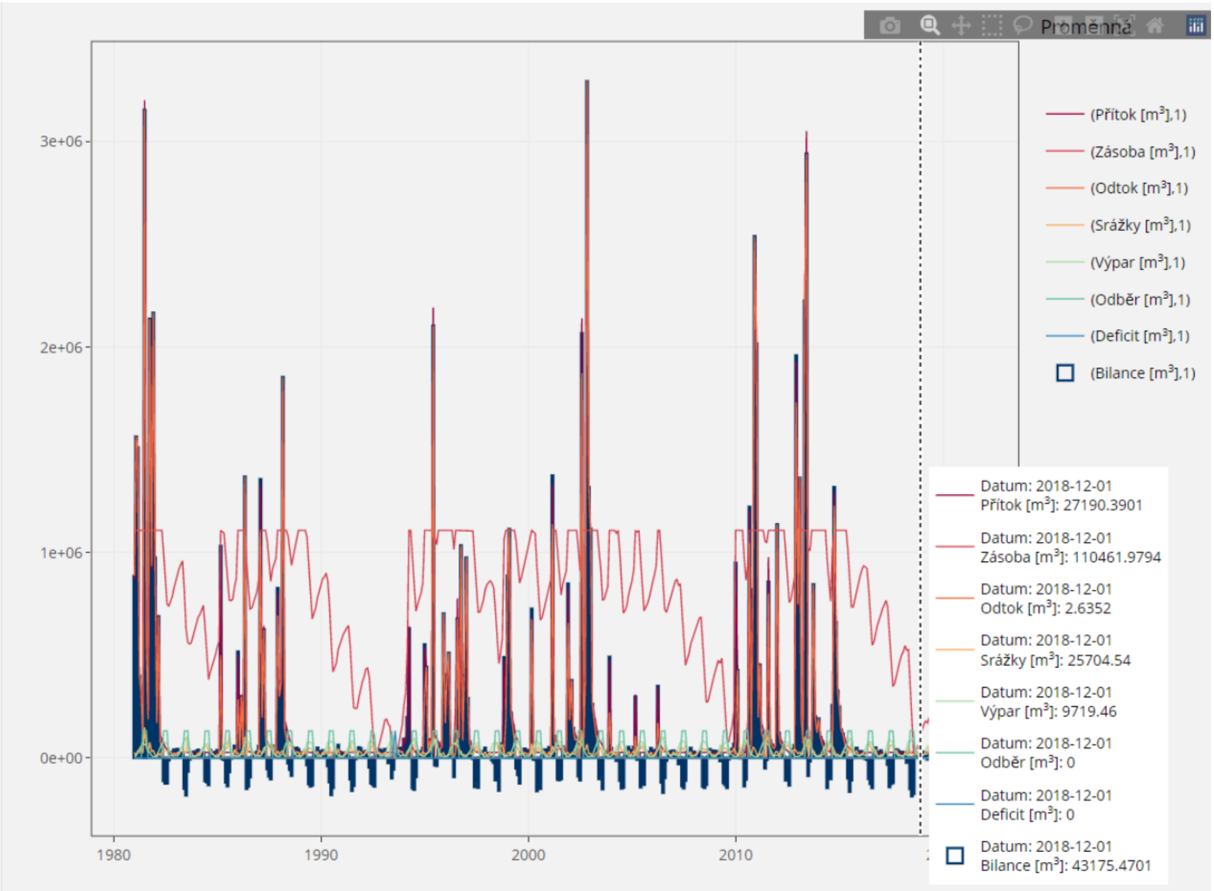

Figure 3: Example of outputs from small basin within the Thaya catchment.

Přítok [m³,1]: Inflow [m³,1]

Zásoba [m³,1]: Storage [m³,1]

Odtok [m³,1]: Outflow [m³,1]

Srážky [m³,1]: Precipitation [m³,1]

Výpar [m³,1]: Evaporation [m³,1]

Odběr [m³,1]: Withdrawal [m³,1]

Deficit [m³,1]: Deficit [m³,1]

Bilance [m³,1]: Balance [m³,1]

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DPS 4: Springs Reborn, Slovakia

DPS 4 propose one physical replication and one non-physical replication (methodology):

Physical Replication:

RESTORATION OF WATER SOURCES, SPRINGS AND INCREASE OF GROUNDWATER LEVELS, DECREASE FLASH FLOODS

THE PROBLEM: The initial onset of drainage areas in the spring regions of Europe record the drying up of spring regions and small watercourses.

SLOVAK CASE STUDY: The Slovak experiment documents the impact of the landscape structure revitalization nature-based measures with retention capacity increase on improving water resources and moderating flash flood risks.

OBJECTIVE: To gain knowledge on how the restoration of the damaged landscape is increasing the retention capacity through simple nature/based solutions on the restoration of ecosystem principles contributes to the restoration of water resources through monitoring devices that continuously monitor precipitation and flows from drainage areas and quantify the impact of the volume of retained rainwater and the reduction of flood flows. Flow rates in times of drought.

DPS REPLICATION: Nature-based water retention measures to slow down rainfall runoff and increase water infiltration. These measures will increase water flows during droughts, decrease culminations of flash floods, mitigation of forest fires, improve thermoregulation, and support biodiversity. In the damaged drainage area of 25-50 hectares, implement water retention measures to collect rainwater, which will strengthen percolation into the soil and will supplement the replenishment of soil and groundwater supplies with the subsequent restoration of the depleted groundwater sources of springs. The expected volume of nature-based water retention measures built for periodical retention of rainwater is 5-10 thousand m^3. Estimated increase of water source in drought periods is 1-2 l/s.

How far can EUR 100,000 go? It depends on many factors, mainly **the local labor costs**. Generally, they should be able to cover (EU averages) approximately **78 hectares with NBS measures,** retaining 4,600 cubic meters of water on forest land. Agricultural land requires a much higher measure density so the replication would cover 12 hectares of arable land or 23 hectares of meadows.

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Non-Physical replication:

USE OF THE METHODOLOGY FOR CREATING A PLAN OF INTEGRATED HOLISTIC RESTORATION OF WATER RESOURCES IN THE BASIN

PROBLEM: Despite the validity of the EU Water Framework Directive, plans for the integrated management of basins, which would deal with the prevention of floods and droughts, mitigate some of the negative effects of climate change, and improve soil fertility and biodiversity, are failing. Apparently, this is because in the management of the landscape we apply public policies based on the sectoral principle, which fail to connect the connections between water, soil and the state of ecosystem damage in the landscape's structures.

SLOVAK CASE STUDY: In the Kysúca river basin at the level of two districts (Čadca and Kysucké Nové Mesto), we are working on an integrated rainwater management plan in the basin, which can quantify the relationships between the economic use of the lands, the sustainable regeneration of natural resources (soil, water, biodiversity) with climate recovery. The output will be a rainwater management plan for all cadastral territories of the Kysuca river basin, which will propose a way to contribute to the restoration of water resources in the basin so that there are no flood extremes on the river, the risks of drought are avoided, biodiversity is strengthened, the overheating of the land is mitigated, the soil fertility by storing carbon in agroforestry landscapes.

OBJECTIVE: To create a network of partners in EU countries who would start the implementation of the methodology of integrated rainwater management in order to connect the needs of water, soil, ecosystem and climate protection in entire basins. The goal is to include the integrated rainwater management in the plans of integrated management of river basins, so that rainwater, which currently brings risks, becomes a co-creator of increasing

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economic benefits in the river basin in accordance with the need for permanent regeneration of water resources and soil, strengthening biodiversity and healing the climate.

DPS REPLICATION: Apply the methodological procedure for the development of the Integrated Rainwater Management Plan of the Kysuce River Basin with an area of 1,053 km^2. It follows from the preparation of the plan for the Kysúca River that it is possible to stop the growth of floods by implementing the entire network of the natural based solutions (NBS), to strengthen the abundance of water resources in the territories, to improve the hydrology of water courses, to improve the fertility of the forestry and agricultural landscape by depositing carbon in ecosystems and soil, to eliminate heat islands over an urbanized landscape, to reduce health risks from overheating the landscape.

DPS 5: Begečka jama, Serbia

DPS 5 proposes only physical replication.

Physical replication: Constructed Wetland System

Problem: Water quality issues caused by wastewater

Replication: Constructed Wetland System (CWS) for wastewater treatment

They are engineering methods that are designed and built using natural and regular processes that include active ingredients such as vegetation, soils, plant extracts, algae extracts, fungi, and bacteria that are effective in the wetland to assist with wastewater treatment.

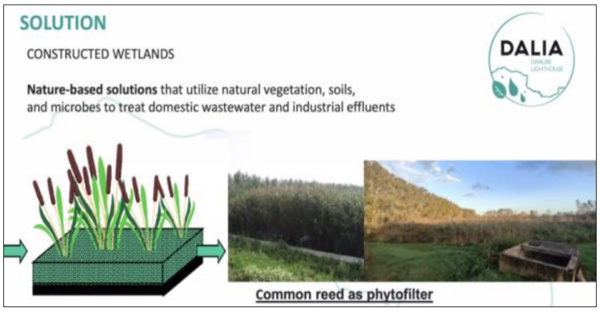

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Figure 4: Figure. Constructed Wetland System (CWS).

DPS 7: DANUBE DELTA

DPS 7 proposes one physical replication (equipment) and one non-physical replication (**developed technology-forecasting models**).

Physical replication (equipment):

Installation of the proposed continuous monitoring system for different rivers

Objectives: Improvement of monitoring system and knowledge of sediment load:

Potential replication:

- Installation of the proposed continuous monitoring system for different rivers
- **Monitoring the amount of suspended sediments** transited in the Sulina canal
- High temporal resolution (e.g. 15 min) measurements of suspended sediment concentration (SSC) at one point in the cross-section using o**ptical or acoustic backscatter sensors**.

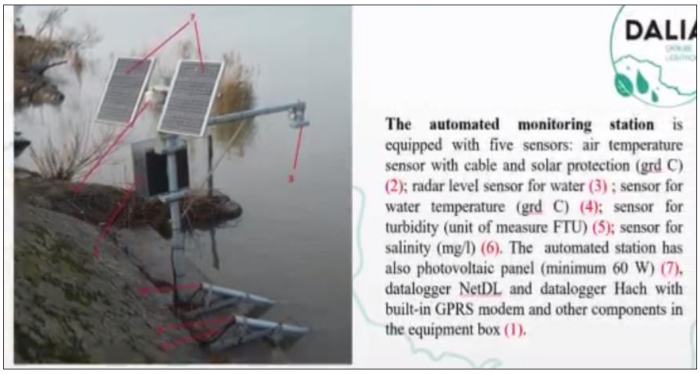

Figure 5: DPS7 Replication monitoring system.

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Non-Physical replication (equipment): developed technology-forecasting models).

Monitoring the pollution of **sediments** and biota by **developing different models**:

- **prediction models** related to water quality matrix and sediments
- **forecasting models** based on water quality and sediments **time series data**
- **a deep learning-based** framework, capable of **identifying the water quality status** as well as **sediments presence** and accumulation degree.

Developed technology (**forecasting models**) and results of the DPS7 could be extended in other riverine countries

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DPS 8: Bodrog river, Hungary

DPS 8 proposes three physical replications and three non-physical replications in the form of the **Riversaver Replication Pack.**

Problem: Plastic pollution of rivers

Based on the 10+ years' experience of Plastic Cup, the Riversaver Replication Pack consists of know-how and protocols about organizing river monitoring, cleanups and awareness raising. Among others, based on our know-how and support, monitoring and cleanups have been successfully organized in Slovakia, Ukraine, Romania, Serbia and Bulgaria.

Grounded in the fundamental principles of Ocean- and River Literacy and using educational tools developed in connection with River Lit(t)eracy, the River Saver Replication Pack is structured upon three primary pillars: **pollution management, awareness raising,** and **data management**, aiming to maximize opportunities for adaptation, replication, and transformation. This adaptability holds significant importance, considering the substantial variations in hydrological, economic, and cultural conditions, which differ significantly even among the countries within the Danube River Basin, let alone in the broader international context.

Physical Replication

1. Management of transnational riverine litter (plastic) pollution

The inventory of **physical tools** and equipment allocated for pollution management comprises River Litter Skimmers and workboats (low cost and high-tech solutions). Experience shows that, in addition to community river cleanups,

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professional river cleanup efforts can also yield substantial results. Plastic Cup Society offers for replication the first open access blueprints of the well tested fast-response river cleanup workboat, aiming to enhance our ability to swiftly address pollution incidents in river environments.

The River Litter Skimmer is based on the application of long, rigid, modular booms. The boom skims the water surface to create a series of whirlpools on the downstream side of the boom. The suction force generated by the series of whirlpools diverts floating riverine litter particles towards the collection zone for retrieval.

Figure 6: The Fast Response River Cleanup Workboat in action on the Bodrog River

2. Awareness raising (incl. communication and education) about plastic pollution in rivers

The inventory of **physical tools** and equipment allocated for awareness raising purposes comprises the River Litter Lab, the mini–River Litter Lab, toolkits for River Adoption, books and printed hand guides as per request.

The **River Litter Lab** is a mobile co-working and workshop space designed to resemble a pirate ship, both on the inside and outside. Upon stepping aboard, visitors are greeted by trained people who guide them through an immersive experience. Here, individuals become acquainted with the origins, formation, and composition of riverine litter. They gain hands-on knowledge on how to sort these materials and breathe new life into them. Visitors engage in activities such as grinding, melting, and molding, using recycled plastics to craft fresh, useful objects. In the process, they learn effortlessly while having a great time. The River Litter Lab ensures that no one leaves empty-handed. Every child

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departs with tangible mementos and a wealth of knowledge. This knowledge not only empowers individuals to contribute to river cleanups but also equips them to effectively manage household waste.

Figure 7: The River Litter Lab on the shore of the Bodrog, in the historical city of Sárospatak.

3. Data collection and management (harmonized plastic pollution monitoring in rivers)

The inventory of **physical tools** and equipment allocated for data collection / research purposes comprises the GPS bottle and remote sensing. The hardware set is supported by a monitoring and research protocol as part of the non-physical replication, the Aquatic Plastic book and the Riversavers' handbook.

The Plastic Cup initiative has introduced the GPS bottle—a specially designed technology that seamlessly integrates into a standard wide-mouthed commercial plastic bottle. This innovative system serves as a location tracker equipped with GPS and a cellular communication unit utilizing narrowband IoT network technology.

Plastic Cup's preliminary data shows that floating riverine litter accumulations that are not covered by vegetation are detectable from the air and from space alike. Remote sensing of the formation of floating waste accumulations was tested using Sentinel-2 and PLANETSCOPE satellite imagery and machine learning. An automated evaluator for waste monitoring and change detection was developed as part of the research. The application downloads satellite images from the mentioned sources on a daily basis (given that a new image is available for the selected area) and compares the amount of waste covered surface to previous images.

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Non-Physical replication

The effectiveness of DPS8's replication measures, such as managing plastic pollution on rivers, relies on the combination of the above physical tools and the associated expertise (intellectual tools, know-how). Adequate training and adaptable knowledge are essential for the effective management of riverine litter and the proficient utilization of these tools. The intellectual tools, which are non-physical in nature, center around the Riversaver concept and methodology.

1. Management of transnational riverine litter (plastic) pollution

The **intellectual** (non-physical) **tools** provided for effective river pollution management include **textual materials like handguides** (Aquatic Plastic, Riversavers's **Handbook); protocols (collection, selection, recycling of riverine litter); policy and recommendation papers**. The intellectual tools also include tutorial videos and audiovisual content available in English and most Danube languages. The distinct intellectual tools of pollution management are as follows:

a. Online Riversaver training (basic information about Plastic Cup and other river cleanup initiatives, basic principles of Ocean and River Literacy, and Lit(t)eracy).
b. Helpdesk and remote support for approved Riversavers to prepare and implement community river cleanup actions.
c. Personal support on a community river cleanup by two trained Riversavers from the Plastic Cup Society to provide expertise during cleanup, and the management of the collected riverine litter.
d. Helpdesk and remote support for qualified and professional water engineering experts and water authority personnel to prepare and implement professional river cleanup actions.
e. Personal support on a professional river cleanup action by two trained Riversaver from the Plastic Cup Society to provide expertise during cleanup, and the management of the collected riverine litter.
f. Remote support and documentation to set up Riversaver locations (adopter river sections, Riversaver centers, anchor points, community areas, Riversaver schools, etc.)
g. Online workshop on circular solutions methodologies considering the recycling and upcycling of collected plastics and other forms of environmental waste.

Additionally, users receive comprehensive support, including both on-site and remote assistance, along with user manuals and personalized training sessions upon installation, facilitating proficient use of these tools.

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2. Awareness raising (incl. communication and education) about plastic pollution in rivers

The **intellectual** (non-physical) **tools** provided for awareness raising purposes include textual materials like handguides (Clean Tisza Textbook Series, River Litter Lab); protocols (River Adoption, Roundtable Discussion organization, Waste Reduction Toolkit, Clean Tisza site). The intellectual tools also include tutorial videos and audiovisual content available in English and most Danube languages. The distinct intellectual tools of pollution management are as follows:

a. Online Riversaver training for schools, teachers and schoolchildren.
b. Online training and Q&A session for the replication of the Riversavers's Handbook and the River Litter Lab Book.
c. Online training and Q&A session for the replication of River Adoption procedures.
d. Online workshop for teachers and motivational talks to stakeholders in the education area about the potential measures for school kids to learn about re- and upcycling, the Riversaver School Network.
e. Personal visit and participatory workshops with the River Litter Lab (tbc)
f. Online training on how to organize effective workshops and roundtable discussions on regional, national and international level.

Additionally, users receive comprehensive support, including both on-site and remote assistance, along with user manuals and personalized training sessions upon installation, facilitating proficient use of these tools.

3. Data collection and management (harmonized plastic pollution monitoring of rivers)

The **intellectual** (non-physical) **tools** provided for data collection related to plastic pollution in rivers include textual materials like handguides (Aquatic Plastic, Riversavers's Handbook); protocols (citizen science protocols for monitoring macro- and microplastic pollution along ECSA principles, protocols for data collection and management along FAIR principles); applications and softwares (TrashOut, Riversaver Map, remote sensing machine learning algorithms, etc.). The intellectual tools also include tutorial videos and audiovisual content available in English and most Danube languages. The distinct intellectual tools of pollution management are as follows:

a. Online training and Q&A session as well as follow-ups with using the Riversaver map concept for visualization of plastic pollution in rivers.
b. Online training and Q&A session for applying citizen science methods in monitoring coastal riverine litter accumulations (on land pollution monitoring).

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c. Online training and Q&A session for applying citizen science methods in monitoring floating riverine litter accumulations (floating, drifting pollution monitoring based on bottle tagging, GPS tagging and remote sensing technologies).
d. River monitoring on the field with potential personal support (tbc)
e. Online wrap-up session and follow-ups with using the Riversaver map (protocols for shore adoption, etc.)

Additionally, users receive comprehensive support, including both on-site and remote assistance, along with user manuals and personalized training sessions upon installation, facilitating proficient use of these tools.

The overarching goal of transferring this knowledge is to actively involve local communities, fostering a sense of ownership and responsibility towards their rivers. This dual objective serves to ensure proficient management and operation of the physical assets involved in replication, while also sustaining long-term engagement. By empowering individuals to become Riversavers through comprehensive training, we aim to establish enduring commitment rather than viewing replication as a one-time endeavor. This approach ensures the protection of local organizations' own brands, cultivates a culture of responsible action and collaboration with the Plastic Cup initiative, thereby promoting ongoing utilization and updates of the Riversaver map, now extended across the entire Danube Region. Drawing from our past experiences, we believe that education and training in River Literacy as well as Lit(t)eracy, will inspire people and catalyze positive change, leading to cleaner rivers.

DPS 9: Crisuri Water Basin Administration, Romania

DPS 9 propose one physical replication and one non-physical replications:

Physical Replication: Litter traps for managing water pollution with PET bottles and other floating waste

Problem: Water pollution with PET bottles

Solution: DPS 9 proposed to implement at the basin scale 3 intervention sections for waste management and cleaning of water courses by placing 3 litter traps, in order to reduce the massive pollution with PET bottles and other floating waste in the cross-border zone on 3 main streams.

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One of these intervention sections may be replicated and fit into the budget of 100.000 euros.

The **technical solution** is composed of:

- Creation of a **platform** where the floats will be collected
- Construction of an **access road** to the platform where the floats will be picked up
- Installation of the **litter trap system** for collecting floaters

Figure 8: DPS8 Replication technical solution.

Non-Physical replication: A study, media materials

A non-physical replication of our DPS could contain the following:

A study about some (or all) rivers situated in a given hydrographic basin (or more) **to identify problems related to floating waste and such other materials** that end up in their respective riverbeds and could possibly transfer to other countries and/or territories, or even in seas and oceans. This study could **branch and go in-depth**, considering aspects like **where/what/why/how** and in the end should offer **at least two physical or non-physical solutions, a proposed methodology for further implementation (if needed)**, regarding a way of **reducing** or even **denying floating waste disposal** in the studied rivers, considering the legislation of that country.

Media materials about the positive and negative effects (health, visual, tourism, etc.) of water pollution, presented especially in schools and even for the general audience.

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