**Project PN23300102: Development and Technological Advancement of Methods for Assessing, Monitoring, and Mitigating Pollution with Plastic Objects and Particles in the Coastal and Shelf Areas of the Black Sea**

**Phase 4: Assessment of Macro-Waste and Microplastic Pollution in the Coastal and Inner Shelf Areas During Spring**

The activities within Phase 4 include:

**Activity 4.1**: Organization and preparation for field activities and analytical methods, along with dissemination of results.

**Activity 4.2**: Conducting fieldwork in the coastal and inner shelf areas.

**Activity 4.3**: Laboratory analysis of samples and generation of quantitative and qualitative data.

**Activity 4.4**: Interpretation of the obtained data, integration into the monitoring system, and preparation of the phase report.

Phase 4 resulted in a seasonal description of plastic material pollution on beaches and monitoring of microplastic (MP) pollution in water, sediment, and fauna samples. High concentrations of macroplastics were identified on Mangalia Beach (up to 8.6 objects/m²), moderate concentrations on Sulina and Sf. Gheorghe beaches, and low concentrations on beaches at Mamaia, Constanța, Eforie, Neptun, and Vama Veche.

For sediment MP abundance (Fig. 1), the maximum concentrations were found in the southern coastal areas, particularly at Neptun and Vama Veche beaches, with significant percentages also observed in sediments from Sf. Gheorghe.

*Fig. 1. Microplastic concentrations in beach sediments (SW – Swash Zone, LVF – Storm Wave Limit, Lim Veg – Vegetation Limit, 2nd Berm) and aquatic sediments (S); total particles identified in 0.5 kg.*

Quantitative visual investigations of water samples revealed that marine water pollution levels were low in areas adjacent to Sulina, Sf. Gheorghe, Constanța (Modern Beach), and Eforie but high in areas near Mamaia. Surface water samples showed an average MP concentration of 0.58 MPs/m³. Low concentrations (<0.5 MPs/m³) were recorded near Sulina, Sf. Gheorghe, Constanța, and Eforie, whereas high concentrations (7 MPs/m³) were identified near Mamaia.

**Phase 5: Development of Theoretical and Experimental Models for Technological Equipment**

Activities undertaken in Phase 5:

**Activity 5.1**: Continued development and refinement of theoretical models.

**Activity 5.2**: Development of equipment, including assembly and pre-testing in controlled environments.

**Activity 5.3**: Identification of required experimental adjustments to the prototypes and preparation of the phase report.

Three technological directions were pursued to address plastic pollution in natural areas as pattent applications or theoretical advancing:

1. **Innovative Gyroscopically Stabilized Crane Arm System for Deep-Sea Applications** (OSIM Patent Application No. 342 / 27.05.2024).
2. **Equipment and Method for Detecting Macroplastic Waste in Subaquatic Environments** (OSIM Patent Application No. 596 / 03.09.2024).
3. An **Autonomous Device for Collecting Plastics and Microplastics from Beach Sediments**, currently under further development with modern technologies and multiple enhancements, aiming for submission to OSIM and later to the European Patent Office (EPO).

Prototype testing occurred in controlled environments (e.g., electrostatic separators for microplastics) and field settings (various sonar systems for detecting macroplastics in aquatic environments). These efforts have supported the evaluation and monitoring of plastic waste (macro and microplastics) in key areas of interest within the coastal and shelf zones and facilitated the creation of innovative technologies for identification and sampling / collection of macro-/microplastics.

**Phase 6: Assessment of Macro-Waste and Microplastic Pollution in the Coastal and Inner Shelf Areas During Autumn**

The activities in Phase 6 include:

**Activity 6.1**: Organization and preparation for field and analytical methods.

**Activity 6.2**: Conducting fieldwork in the coastal and inner shelf areas.

**Activity 6.3**: Laboratory analysis of samples to obtain quantitative and qualitative data.

**Activity 6.4**: Interpretation of data and integration into the monitoring system.

**Activity 6.5**: Dissemination of results and preparation of the phase report.

Phase 6 extended the monitoring program to examine macro-waste and microplastic pollution in beach sediments, shelf sediments (5–10 m depth), surface seawater (approximately 20 cm depth), and 10 specimens of gibel carp (*Carassius gibelio*), focusing on digestive tracts and gills.

Macro-waste pollution was assessed similarly to the spring campaign. Sulina and Constanța beaches showed high pollution levels (15–25 objects/10 m²), while Mangalia reached critical levels (64 objects/10 m²). Sf. Gheorghe, Eforie Nord, and Tuzla exhibited low pollution levels (0–2 objects/10 m²), with moderate pollution in Mamaia and Neptun (1–10 objects/m²). Observations revealed significant inter-beach variability influenced by recent cleaning activities and proximity to the shoreline.

Across all phases, the project successfully conducted field, laboratory, and office activities, contributing to scientific understanding and raising awareness of anthropogenic pollution impacts through publications and outreach activities.

**Key Publications and Outreach for Phase 4-6 (2024)**

1. **Pojar et al. (2024)**: *Microplastic occurrence in coastal waters and aquatic faunas of the Western Black Sea.* EGU General Assembly Conference Abstracts.
2. **Pojar et al. (2024)**: *Microplastic Evaluation in Water and Sediments of a Dam Reservoir–Riverine System in the Eastern Carpathians, Romania.* *Sustainability*, 16(11), 4541.
3. **Suvaila et al. (2024)**: *Methodology for Regularity Studies by Precision Environmental Gamma Ray Spectrometry.* *International Journal of Environmental Science and Technology.*

Outreach the pollution acknowledging efforts also included educational events, such as a session with students from “Delta Dunării” Economic College in Tulcea (September 26, 2024), where technical data on pollution measurements and analyses were presented.