Identifying the Sources and the Contributions of Inland Sediment and Litter Pollutants to Enhance the Black Sea Through Nature-Based Solutions

George N. Zaimes, Paschalis Koutalakis, Georgios Gkiatas, Valasia Iakovoglou, Mirela Marinescu, Oana Ristea, Andranik Ghulijanyan, Luiza Gevorgyan, Ecaterini Kuharuk, Ilya Trombitsky, Mustafa Tufekcioglu, Mehmet Yavuz, Aydin Tufekcioglu and Ahmet Duman

Abstract

The Black Sea is considered one of the most degraded regional seas. Efforts have been made to improve the conditions of the Black Sea, but little focus has been on the inland pollutants and litter, specifically from the rivers and streams that end in the Black Sea. Streams and rivers are significant sources of sediment and litter. This study aimed to identify the primary sources of sediment and litter and their contributions. This will help to suggest the optimal nature-based solutions to mitigate pollution sustainably. The study has five pilot areas in Greece, Romania, Armenia, Moldova, and Turkey. This will allow us to investigate different riverine ecosystems around the Black Sea and the implementation of different nature-based solutions. Surface and stream bank erosion methods are applied at different scales (plot and watershed) to estimate their contributions to the Black Sea. Traditional (runoff plots erosion pins) and innovative methods (laser scanning, unmanned aerial vehicles) are utilized. This way, areas with the highest erosion or litter will be targeted, and the optimal nature-based solutions based on the specific characteristics of these areas will be implemented.

Keywords

Non-point source pollutants · Surface erosion · Stream bank erosion · Nature-based solutions · Semi-enclosed sea

1 Introduction

The depollution of semi-enclosed seas is tricky because of the significantly slower water circulation, since water can only be exchanged through narrow straights. The Black Sea is a typical semi-enclosed sea that circulates its water with the Mediterranean through the Dardanelles, Bosporus straits, and Sea of Marmara of Turkey. Therefore, it is considered one of the most polluted regional seas (Stanev & Ricker, 2019). Major sources of pollution in the Black Sea are litter and non-point sources (e.g., sediment and nutrients) (Berov & Klayn, 2020; Cincinelli et al., 2021; Feldbacher et al., 2016; Lechner et al., 2014). As in most seas, mitigating such pollutants has focused on marine or coastal environments despite rivers and their tributaries being major contributors (Zaimes et al., 2019). Large rivers, such as the Danube, Dnieper, Southern Bug, Dniester, Don, Kuban, and Sakarya, contribute approximately

G. N. Zaimes (✉) · P. Koutalakis · G. Gkiatas · V. Iakovoglou
GERi Lab, Department of Forestry and Natural Environment Science, International Hellenic University, 1st km Drama-Microchoriou, PC 65404 Drama, Greece
e-mail: zaimesg@for.ihu.gr

M. Marinescu · O. Ristea
River Basin Management Plan Office, Buzau-Ialomita Water Administration Strada Bucegi 20, PC 120208 Buzau, Romania

A. Ghulijanyan · L. Gevorgyan
Young Foresters Union NGO, v. Koghb 4110, PC 0027 Yerevan, Armenia

E. Kuharuk · I. Trombitsky
Eco-TIRAS International Association of River Keepers, Teatrala 11A, PC 2012 Chisinau, Republic of Moldova

M. Tufekcioglu · M. Yavuz · A. Tufekcioglu · A. Duman
Faculty of Forestry, Artvin Çoruh University, Seyitler Yerleşkesi, Merkez 218A, PC 08100 Artvin, Turkey

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300 km^3 yr^{-1} of discharge to the Black Sea which is around 4–5 times the basin's surface area (Stanev & Ricker, 2019). These waters carry many pollutants and are one of the reasons the basin experiences extensive anthropogenic pressures (Stanev & Ricker, 2019). The project "Protecting streams for the clean Black Sea by reducing sediment and litter pollution with joint innovative monitoring and control tools and nature-based practices" with the acronym "Protect-Streams-4-Sea" will enhance environmental protection in the Black Sea by reducing its pollutants and litter. This will be accomplished by focusing on the inland pollutants and litter transported by the rivers to the Black Sea. In this paper, preliminary results are presented.

2 Study Areas

Parallel activities are being implemented in five Black Sea region countries. The pilot areas in each country are (a) the Aggitis River watershed in Greece, (b) the Buzau River watershed and Siriu reservoir in Romania, (c) Debed River watershed in Armenia, (d) Baltata River watershed in Moldova, and (e) Arhavi River watershed in Turkey (Fig. 1). The pilot areas have water bodies with different characteristics to test the project methodologies in different Black Sea environments.

3 Methodologies

The field methods utilized in this project measure surface and stream bank erosion. Specifically, at the plot scale, surface runoff plots and Gerlach traps are being utilized for surface runoff and erosion pins, cross-section surveys, and laser scanning for stream bank erosion (Vatandaşlar & Yavuz, 2017; Zaimes et al., 2011). To estimate surface and stream bank erosion at the watershed scale, remote sensing methodologies, geographic information systems, and hydrologic modeling are utilized (Koutalakis et al., 2020). Specific reaches will be targeted, and Unmanned Aerial Vehicles (UAVs) are being utilized to produce orthomosaics and enhance the analysis quality of these areas (Diaconu et al., 2023). Finally, "litter traps" have been placed in key "hot spots" to gather litter, while nature-based solutions will be suggested to reduce pollutants.

4 Preliminary Results

4.1 Aggitis River Watershed, Greece

The location of the field sampling for (a) water quality and quantity and (b) soil and bed material sampling has been finalized (Fig. 2). The sampling points are in different land uses and locations: forested areas with 15 points, natural

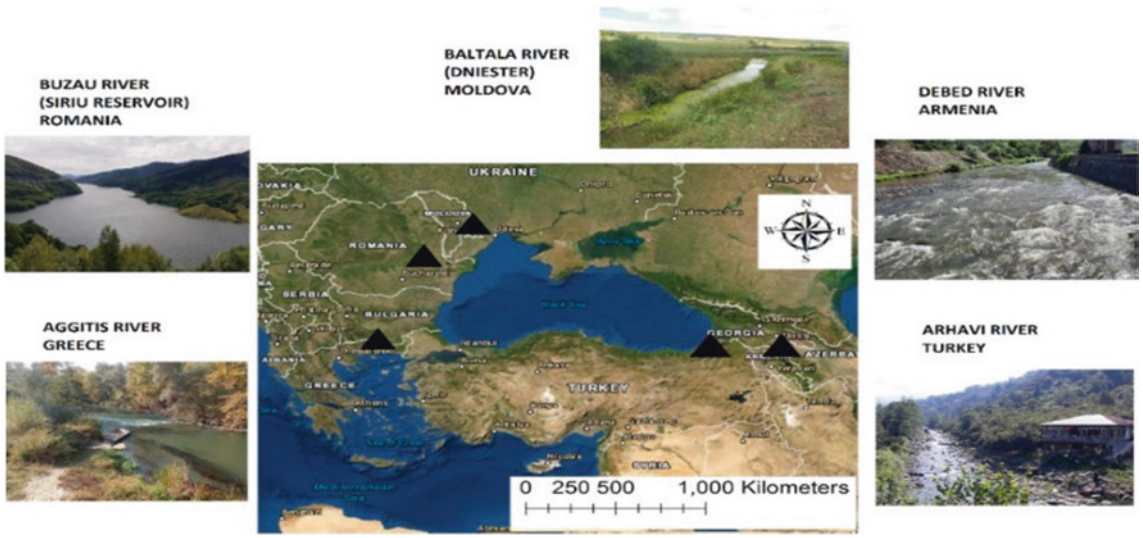

Fig. 1 The project's pilot areas: Aggitis River watershed in Greece, Buzau River watershed and Siriu reservoir in Romania, Debed River watershed in Armenia, Baltata River watershed in the Republic of Moldova, and Arhavi River watershed in Turkey

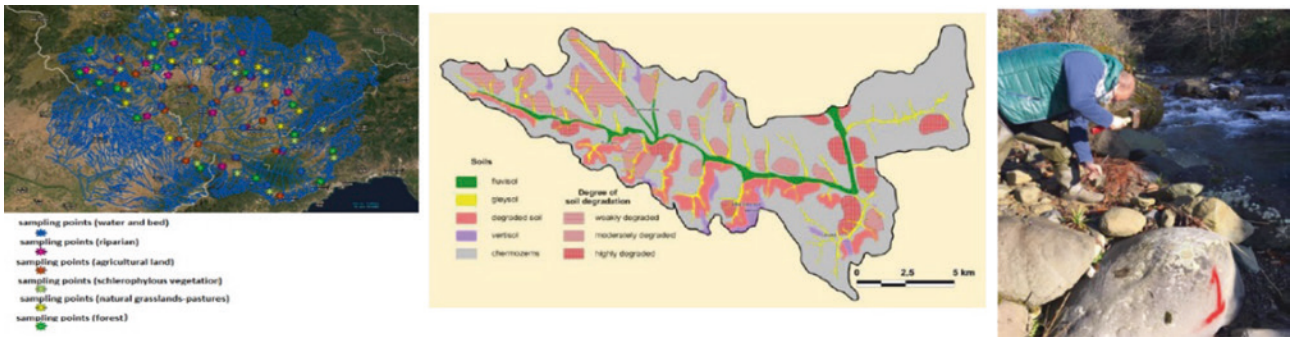

Fig. 2 The sample locations in Aggitis watershed (left), the soil types in Baltata watershed (middle), and the installation of erosion pins in Arhavi watershed

grasslands-pastures with 15 points, sclerophyllous vegetation with 15 points, agricultural areas with 15 points, stream banks with 20 points, and stream water and bed with 20 points.

4.2 Baltata River Watershed, Moldova

Different data layers have been developed for the Baltata River watershed, including soils, land uses, slopes, and stream network. The soils are diverse, with the majority being Chernozem (black soil) (70%) (Fig. 2).

4.3 Arhavi River Watershed, Turkey

Soil erosion measurements have taken place in Arhavi watershed. Specifically, channel cross-section measurements were completed, and erosion pins were placed to measure and spatial of erosion or deposition (Fig. 2).

5 Conclusion

Traditional and innovative methods identify sediment and litter origins in rivers and streams. Their identification will allow the targeted implementation of optimal nature-based solutions and reduce pollutants in the Black Sea.

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