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PROCEEDING
INTERNATIONAL CONFERENCE: NOT JUST EIGHT COUNTRIES USE BLACK SEA

Joint Operational Programme Black Sea Basin 2014 – 2020

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Constanța, Romania

Common borders. Common solutions

CROSS BORDER COOPERATION

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The project:

Leave your Environmentalist Spirit Online for the Black Sea Basin - Spirit BSB online

Association for the Protection of Human Being and the Environment for a Sustainable Development in the World-ECOM, Constanta, Romania - as Coordinator (LP)

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JOINT OPERATIONAL PROGRAMME BLACK SEA BASIN 2014-2020

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Contents

22. Using instream pins in order to monitor soil erosion, sediment deposition and water degradation on the river courses of the Black Sea Basin.

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Abstract

Sediment yield originating from the erosional and depositional process along streambanks plays an important role in the non-point source pollution assessment of water resources (Zaimes et al., 2019). Suspended sediment includes and can adsorb other pollutants (especially heavy metals e.g., Cr, Cd, Hg, Cu, Fe, Zn, Pb and As) from the flowing water in streams and rivers and deposit them onto the streambed, streambanks or other final recipients e.g., lake or sea (Yujun, 2008). Excessive erosion rates as a consequence of urban and agricultural expansion, deforestation and wildfires can intensify the sediments' volumes into the normally clean-water environments (Koutalakis et al., 2019). This can result to increased water pollution; it can produce negative effects on the fish and even humans through the food chain and can degrade the environmental status of the water resource and the adjacent areas (Bat et al., 2019). Land use is an influential factor in river sediment pollution (Liu et al., 2017). Consequently, the areas of this study were selected based on characteristics such as dominant land use, soil type and slope category in order to install the erosion pins and the monitoring plots to identify the pollution sources at the entire Aggitis watershed. Specifically, 400 erosion pins were placed in 40 erosion pin plots (Figure 1). Aggitis watershed, which is the Greek pilot area, is located at Eastern Macedonia in Northern Greece.

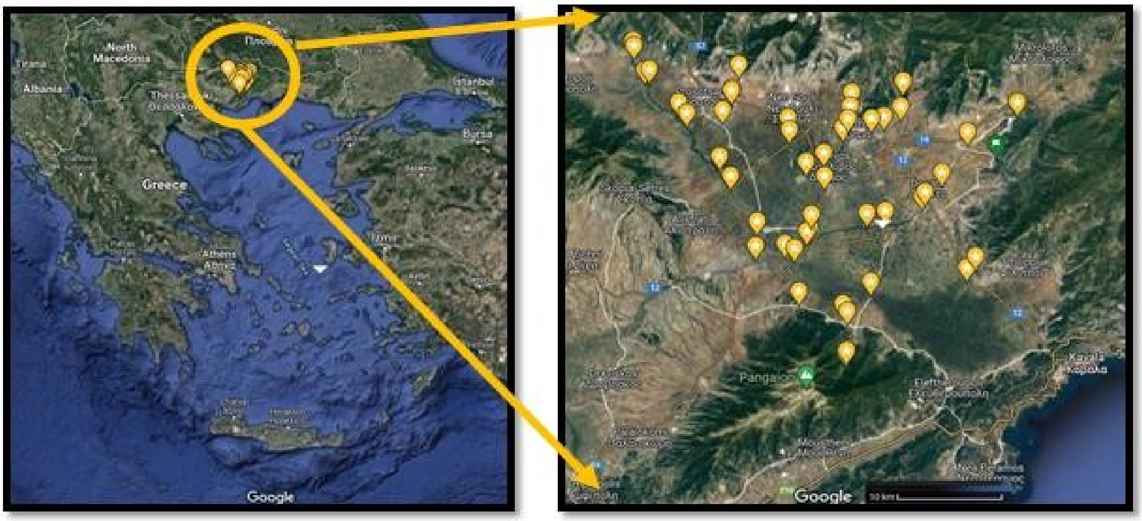

Figure 1. The location of erosion pins: left) compared to Greece and right) compared to Drama Basin.

Aggitis River is the main water course which end in the Strymonas River that finally discharges to Strymonikos Gulf in the North Aegean Sea (Koutalakis, 2019). The Aggitis watershed is surrounded by the mountain Menoikio at the west, the mountain Falakro at the east and from the Ori Lekanis and Paggeo Mountains at the southeast and southwest borders of the watershed, respectively (Pennos et al., 2016). The lower mountainous slopes are covered by stony lithosols with discontinuous Mediterranean shrublands (Phrygane). Alluvial Pleistocene fans (gravelly reddish-brown soils) and the calcium magnesium soils of the Neogene cover the central part of the watershed, cultivated for cereals such as wheat and barley, and maize further downstream (Lespez, 2003). The distal parts of these fans are covered by vertisols and the landcover are agricultural crops;maize and cotton. The southeast part of the watershed is covered by the sediment deposits of the Xiropotamos-Doxato stream (Gakis, 2002) which is dominated by the peaty and marshy Holocene deposits which correspond to the old Marsh of Philippi that was drained in 1932 (Glais et al, 2017).

The erosion pin method (Figure 2) was used due to its practicability for short time-scale investigations and its promising results with high accuracy (Zaimes et al., 2009). Resolution can be as high as 5 mm (Simon et al., 1999). Ninety percent of the pin was pounded in the stream bank to not to get lost during a major erosion event (Hooke, 1979). The length of the pins used was 80 cm, because erosion rates of up to 50 cm per erosion event had been witnessed in similar size streams (Zaimes et al., 2004). In addition, pins did not exceed 80 cm in length, to minimize the interference with streambank erosion processes. A diameter of 1 mm was selected because it was small enough to cause minimum disturbance to the banks but large enough to not bend under most high discharge events (Lawler, 1993).

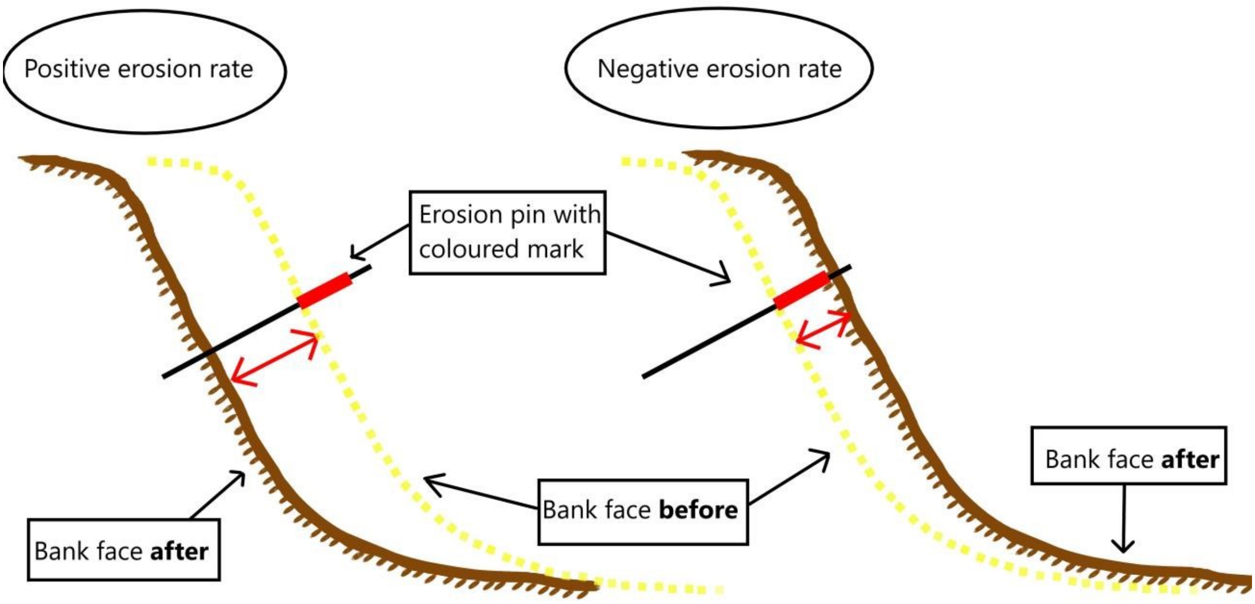

Figure 2. Erosion pins installed and measurement after erosion (left) and deposition (right) events.

Each erosion pin plot included two horizontal rows of five pins each. Pins within these rows were placed 1 m apart for a total length of 4 m. The streambank heights of the pin plots across all reaches varied from 1.3 to 2.2 m. To consistently place the pins in similar bank positions among the streambanks, the horizontal rows were placed at 1/3 and 2/3 of the height of the bank. This would to investigate better stream bank erosion processes (Zaimes et al., 2009). A representative eroding bank from the section of the Xiropotamos-Doxato stream is showcased in Figure 3. The specific section includes three erosion pin plots (A, B and C in Table 1) in different places of the stream (≈10 m apart). The measurement period covered, concerns the last winter (setting of erosion pin was finished in the end of October 2022 and the field measurements were performed during the end of March 2022).

Figure 3. A representative stream bank of the Xiropotamos-Doxato stream were pin were installed.

In erosion pin plot "A" (Table 1) the results showcased that on the bottom part of the streambank (1/3) in all five points was limited with the erosion ranging from 0 to 8 cm. On the upper part of the streambank (2/3), we noticed that it was similar to the bottom part and the maximum erosion was only 8 cm. In erosion pin plot "B" (Table 1), on the bottom part, we noticed that in four of the five pins the erosion was only 3 cm. On the upper part the maximum erosion in four of the five pins was only 5 cm. In contrast, there were two pins one in bottom part and one in upper part that recorded sediment deposition; thus, the minus "-" indicator. In erosion pin plot "C" (Table 1), on the bottom part, we noticed that the erosion was substantially higher (ranged from 28 to 48 cm) than the other two erosion pin plots. Also, there were two (2) pins in the bottom part of the streambank that could not be found (probably lost during high stream flows) corresponding to severe erosion (>50cm). On the upper part, two pins showcased high erosion (ranging from 20 to 40 cm) and the rest three also recorded erosion from 0 to 4 cm. The three erosion pin plots showcased the high spatial variability of streambank erosion even within one erosion plot and among erosion plots.

Currently, another sampling phase is in progress that will analyze in the laboratory the different chemical compounds found in the soil, stream bed and banks and water. The final goal is to implement the fingerprinting method. Sediment and pollutant fingerprinting has been developed over the past three decades for watershed sediment transport research (Mahoney et al., 2019). Sediment fingerprinting is a method to allocate sediment nonpoint source pollutants in a watershed through the use of natural tracers' technology with a combination of field data collection, laboratory analyses of sediments, and statistical modeling techniques (Davis et al., 2009). Furthermore, we have implemented terrestrial laser scanning (TLS) and Unmanned Aerial Vehicle (UAV) with different cameras in order to monitor and analyze the geomorphological changes via high-detailed point clouds, orthophotos and digital models. Future activities include further field erosion monitoring through time (different rainfall events) and the incorporation of all results from the other methodologies described above for an overall estimation of the non-point pollutant sources in the watershed.

Table 1. The recorded measurements of erosion/deposition at the 3 erosion pin plots of the Xiropotamos-Doxato stream.

LAND USE	PINS' PLACEMENT	PIN #	EROSION PIN PLOTS (cm)		
			A	B	C
		1	0	2	40
Grassland - Pasture	Upper streambank	2	1	5	4
		3	3	4	0
		4	3	0	0
		5	8	-2	22
		1	0	3	5
		2	8	-4	24
Grassland - Pasture	Lower streambank	3	2	3	48
		4	2	2	>50
		5	0	2	>50

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