The Neretva River Delta: Distribution Pattern of Sediments and Characterization of Nanosized Mineral Phases

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Introduction

The Neretva River is the largest river on the Croatian part of the eastern Adriatic coast and the only one forming a deltaic system. At the river mouth, river discharges its water and sediment load into the Neretva Channel. The entire area was investigated in order to determine the transport of sediments as well as their spatial distribution pattern and to provide a detailed characterization of their inorganic component. Special emphasis was placed on the analysis of the finest fraction of sediment (<4μm) since it contains abundance of clay minerals which dominate the surface properties of sediments and regulate the distribution of pollutants.

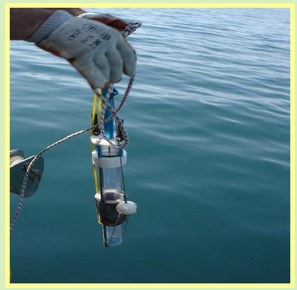


Fig.1. Map showing the Neretva River, the Neretva Channel and the surrounding area with sampling stations (left) and photographs of the sampling procedure (right).

Experimental

The sampling of sediments was conducted at 19 locations in the Neretva River system, and at 31 location in the Neretva Channel. Sediment cores up to 50 cm long were retrieved using gravity corer (Fig. 1). The sediment samples, as well as the extracted micron-sized fraction, were analyzed in order to characterize particle morphology and determine mineralogical composition. To estimate the reactivity of particles, specific surface area (SSA) and cation exchange capacity (CEC) were measured.

Results

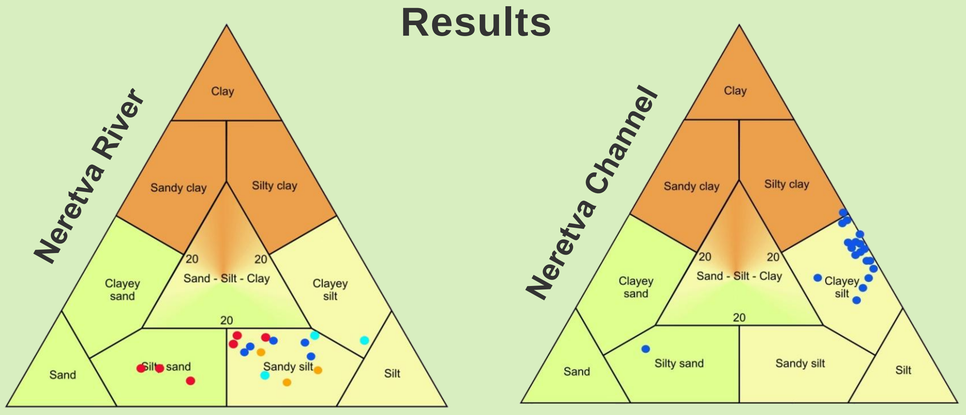


Fig.2. According to the ratios of different grain size fractions (sand/silt/clay, Shepard, 1954), sediments from the Neretva River system (left) were classified as sandy silts, while those from the Neretva Channel (right) were lacking the sand fraction and were all classified as clayey silts.

This distribution pattern of sediment fractions indicates that most of the fine-grained particles (clay fraction) are transported seaward.

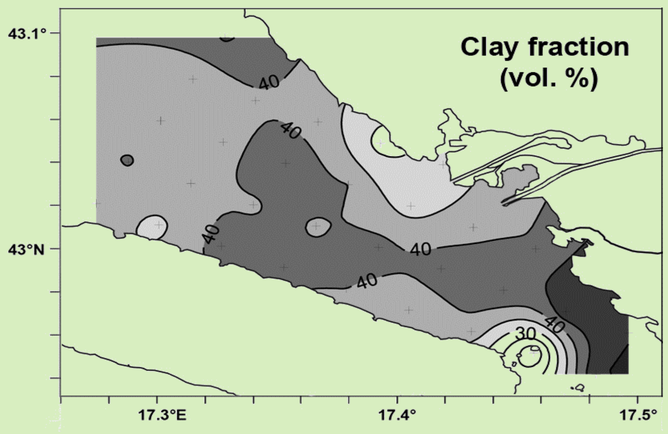
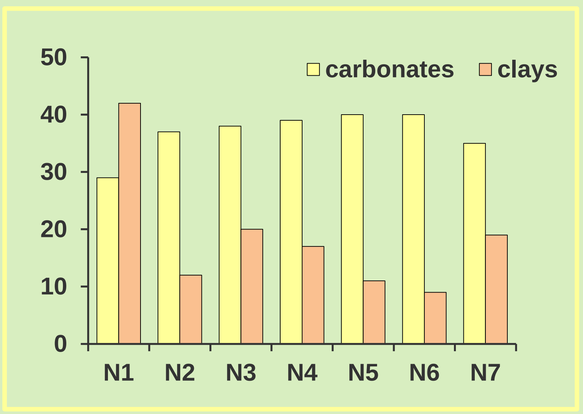


Fig.3. Spatial distribution of clay fraction (<4μm) in the Neretva Channel indicates that sedimentation dynamics is governed by aggregation and rapid deposition of fine-grained particles.

Most of the sediment brought by the river gets trapped inside the Neretva Channel.



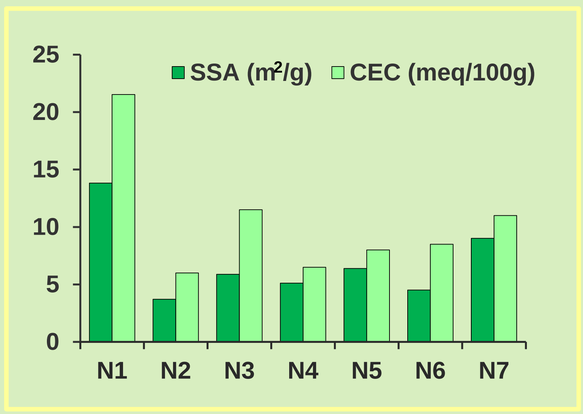


Fig.4. Lower carbonate and higher clay mineral content (left) correspond with an increase of specific surface area and cation exchange capacity (right).

Increase of SSA and CEC are responsible for an increased reactivity of particles and their higher affinity for pollutants.

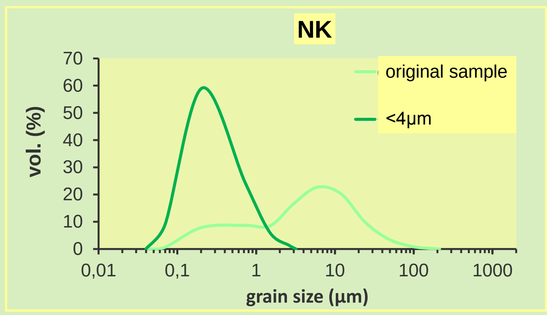


Fig.5. Grain size distribution of the original sediment from the central part of the Neretva Channel and the extracted clay sediment fraction.

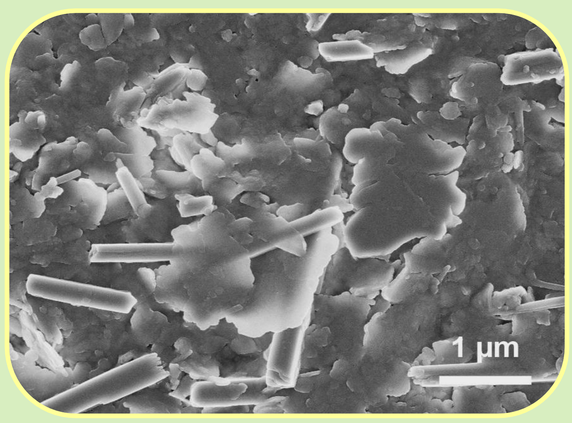


Fig.6. SEM image of the extracted clay sediment fraction (<4μm).

Morphological features of particles reveal predominance of clay minerals.

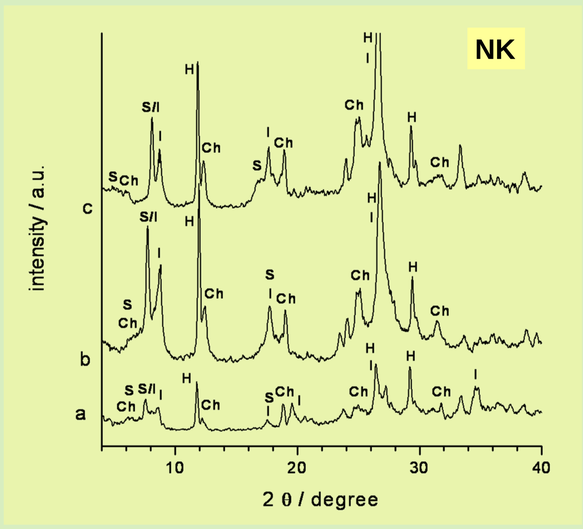


Fig.7. XRD pattern of: a) original sediment, b) clay fraction (<4μm), c) clay fraction treated with ethylene glycol. The mineralogical composition of clay fraction is dominated by illite, chlorite, smectites, interstratified smectite/illite and nanotubular halloysite.

The occurrence of halloysite indicates that sediment originates from the upper part of the Neretva River drainage area.

Conclusion

The granulometric and mineralogical analyses showed that the sediment load carried by the Neretva River originates from the upper part of the drainage area. The suspended sediment load is deposited from the river plume and is the main source of material found in the Neretva Channel.

The morphological features and the structural characteristics of the submicron-sized mineral phases mainly belong to a specific group of clay minerals. Clay minerals have high specific surface areas (SSA) and great capacities for cation exchange (CEC) that enable them to sorb, transport and regulate the distribution of trace metals. They are, therefore, an important factor to consider when studying pollution. Their significance is even greater in environments where mixing of fresh and sea-water occurs, because of aggregation processes that promote sedimentation of fine-grained particles and associated trace elements.

Shepard, F.P., 1954. Nomenclature based on sand-silt-clay ratios. J. Sediment. Petrol., 24: 151-158.