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Ecological and Biogeochemical Consequences of Changes in Sediment Supply Patterns to Tanafjord

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1. INTRODUCTION

Every sub climate change in the Arctic, including accelerated thawing of permafrost, rising air temperatures, and increasing intensity and variability of precipitation, is driving profound transformations in sediment supply dynamics to Arctic seas, including the coastal zones of the Arctic Ocean (Syvitski 2002). In northern Norway, one of the key river systems shaping the sedimentary and biogeochemical balance of coastal environments is the Tana River (Tenojoki). This river, extending over 360 km, discharges into Tanafjord—a fjord approximately 65 km long and 8–12 km wide (Dankers 2002)—whose estuary represents an important transitional zone between fluvial and sub-Arctic shelf environments. The fjord, together with the delta and estuary of the Tana River, functions as an active interface where freshwater and marine waters mix and where intense sedimentary processes occur.

Changes in sediment supply patterns, particularly with respect to fine-grained suspended sediments (SSC – Suspended Sediment Concentration), have important ecological and biogeochemical implications. These sediments act as carriers of biogenic compounds (e.g., nitrogen and phosphorus) and organic matter, thereby influencing primary productivity and the trophic structure of coastal waters. The aim of this study is to evaluate the ecological and biogeochemical consequences of changes in sediment supply to the Tanafjord estuary, with particular emphasis on the seasonal fluxes of fine-grained suspended sediments and their impact on the equilibrium of the fjord ecosystem and the sub-Arctic Barents Sea shelf.

2. METHODS

Based on the research infrastructure of the Kevo Subarctic Research Institute (University of Turku), a cyclic monitoring program of water quality is conducted in selected tributaries of the Tana River. The research program includes regular water sampling and the measurement of physicochemical and morphometric parameters in the lower reaches of the studied streams.

Collected material is subjected to detailed laboratory analyses, including determination of total suspended sediment concentration (SSC), concentrations of biogenic substances (nitrogen, phosphorus), dissolved organic matter (DOM), as well as parameters indicative of mineralization degree and eutrophication potential. These data form the basis for assessing seasonal and interannual variability in sediment and chemical loads delivered to the Tanafjord estuary and the Barents Sea shelf.

3. RESULTS

A two-year monitoring program conducted in 2024–2025 in selected catchments of the Tana River showed clear temporal variability in sediment transport. The largest suspended sediment loads occur during spring snowmelt and ice breakup, generating short-lived but intense pulses of suspended material. These episodic events lead to transient enrichment of the estuary with nutrients and a temporary increase in turbidity, which in turn affect both phytoplankton dynamics and the deposition of organic matter on the fjord floor.

The findings suggest that intensification of sediment delivery to Tanafjord—an integral component of the larger Barents Sea system—may trigger a range of adverse ecological processes. Enhanced fluxes of biogenic substances and organic matter foster eutrophication of local marine ecosystems, disrupt carbon cycling, and drive shifts in the composition of plankton communities and benthic microbiomes. At the same time, increased availability of dissolved organic matter (DOM) may stimulate seasonal phytoplankton blooms, altering energy and matter transfer within food webs and impacting biodiversity and the stability of coastal ecosystems. Such changes may exert long-lasting and cascading effects, influencing not only local but also regional biogeochemical processes across the Arctic shelf zone.

4. CONCLUSIONS

The study highlights the necessity of long-term, integrated monitoring of sediment and biogenic matter transport. It is recommended that both field-based approaches (e.g., flow measurements, suspended sediment sampling, chemical analyses) and remote sensing tools (e.g., Sentinel-2, Landsat, MODIS data) be employed to capture process dynamics across multiple temporal and spatial scales. A deeper understanding of these phenomena is essential for assessing the impacts of climate change on Arctic coastal ecosystems and for developing future strategies for their protection and sustainable management.

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