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# Organic Matter Decomposition During Sediment Ripening

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**Introduction**: Dredging produces large sediment volumes with organic matter (OM) from natural and industrial sources, which even in small amounts, can significantly affect sediment properties [1]. For beneficial use of dredged sediment, OM stability is paramount. Sediment ripening aims to reducing and stabilizing the organic fractions [2], [3]. This study examines OM degradation in mechanically dewatered dredged sediment (METHA plant, Hamburg, Germany) during ripening, analyzing sediment respiration and the Tea Bag Index [4]. Together, these methods provide a comprehensive understanding of the dynamics of organic matter transformation during biological ripening of dredged sediment.

**Methods:** The dewatered sediment originating from Elbe river in the area of the port of Hamburg was deposited into 9 stockpiles of 1,000-2,200 $m^3$. OM stability and the decomposition activity of the microbial community were investigated over a 2-year period by measuring $CO_2$ evolution and $O_2$ consumption during soil respiration using a gas chromatograph, and by determining the Tea Bag Index (TBI), a standardized approach to assess breakdown of labile and recalcitrant OM. Data from the ripening stockpiles are compared to the properties of ~60 years old historical sediment used as soil amendment (HS).

**Results**: The original material (high-intensity press, HIP) showed the highest cumulative carbon release, steadily declining from March to November 2023, reaching ~33% of the highest value within the first year of ripening (Fig. 1, left). A slight increase in March 2024 was followed by a sharp drop in September 2024 to below the "HS" sample level. The top layer consistently released more carbon than the bottom layer (Fig. 1, right), but appeared to become more similar to the bottom layer over time. The stabilization factor (S) increased during the early ripening phase (March to November 2023), then slightly decreased in March and September 2024 (Fig. 2, left), with the "HS" sample displaying less stabilization. The decomposition rate (k) decreased steadily throughout the ripening process, (Fig. 2, right). Complementary to the stabilization factor, k values of HS samples were higher than for ripening material.

**Discussion:** Ripening begins with drainage and ingress of atmospheric air, where oxygen enters the sediment, triggering chemical reactions and initiating OM mineralization [2, 3, 5]. Cumulative C release steadily declined, reflecting the depletion of labile organic matter as ripening progressed. Increased C release indicates a higher share of degradable OM and suggests environmental changes, such as higher precipitation [6, 8] or input of carbon by the vegetation [7]. The top layer, receiving more oxygen than the bottom, showed enhanced OM decomposition, especially in the beginning [9]. The decomposition rate (k) decreases over ripening, indicating labile OM depletion, while the stabilization factor (S) increases as recalcitrant OM becomes more dominant [4, 9].

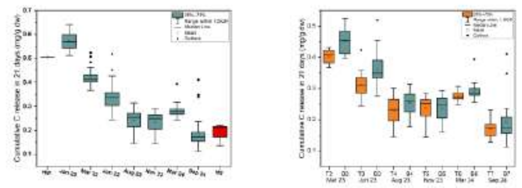

**Fig. 1:** Cumulative carbon release (left) and differentiation by top (T) and bottom (B) stockpile layers (right) over 21 days.

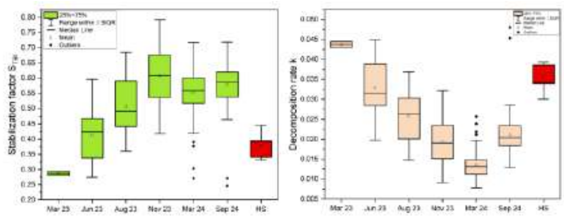

**Fig. 2:** Left: Stabilization factor (left) and decomposition rate (right) for tea bags incubated for 21-days.

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