GT 04 - 648 - O

SOIL FORMATION FROM DREDGED SEDIMENT: EVOLUTION OF BIOCHEMICAL AND PHYSICAL PROPERTIES

GT 04. SOIL BIOLOGY / GT 10. SOIL CARBON DYNAMICS AND STABILIZATION

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Using dredged material from ports and waterways in agriculture, forestry, and construction (e.g., dike building, habitat restoration) is gaining interest. For such applications, organic matter (OM) must be stable, which can be achieved through soil ripening—a process that transforms waterlogged, anoxic sediment into aerated, soil-like material via drainage and oxidation.

This study examines the ripening of mechanically dewatered dredged sediment from the Elbe River around the port of Hamburg, deposited into nine stockpiles (1,000–2,200 m³) managed under different turning frequencies (none, 2×/year, 4×/year) and vegetation management (removed before turning or not). OM stability and microbial activity were assessed over two years using soil respiration, the Tea Bag Index (TBI), and Rock-Eval pyrolysis (RE7S). Proctor compaction tests were performed to ascertain the compactibility of the soil, and shrink-swell behavior was assessed using the Coefficient of Linear Extensibility (COLE). Samples from several decades' old locations ('historical sediment'), where dredged sediment had been applied for soil amendment, served to benchmark ripened material.

Carbon release and decomposition rates (k) decreased over time (Fig. 1, left), whereas the stabilization factor (S) increased. These trends reflect the depletion of labile OM and a shift toward recalcitrant ones. Respiration in the top layers of stockpiled sediment was higher than in lower layers, reflecting enhanced exposition to atmospheric air, enabling advanced stages of soil ripening. Rock-Eval pyrolysis detected a relative increase in recalcitrant carbon and the Oxygen Index (OI), while the Hydrogen Index (HI), reflecting labile OM, decreased (Fig. 1, middle).

Also, the soil physical parameters indicated significant changes in the material over the course of ripening. Proctor density (Fig. 1, right) increased by 13.64% in the control stockpile (SP4) from 1.10 g/cm³ in the initial material (HIP) to 1.25 g/cm³, and higher turning frequencies of the stockpiles led to higher compactibility. COLE values significantly decreased in all stockpiles to values below 0.14 at the latter part of the monitoring period, indicating progressively decreasing shrink–swell behavior.

These findings reveal how the combined biological breakdown of organic matter (OM) and mechanical processing enhances the structural and functional properties of dredged sediment for use as an earthen construction material.

ACKNOWLEDGEMENTS

This research is carried out within the project Sediment-to-Soil (S2S), supported by the Dutch National Science Foundation under the grant no. 18937, and by Hamburg Port Authority, Deltares, Rijkswaterstaat, Boskalis, Van Oord, HKV and STOWA.

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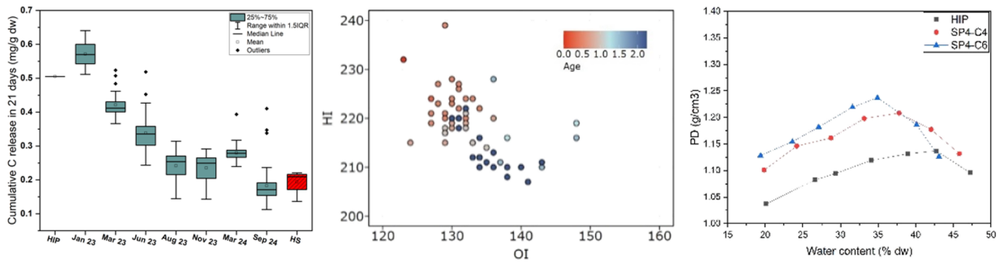

Respiration (left), HI and OI indices (middle) and Proctor curves (right) over time of soil ripening.