

Geohazards and coastal dynamic: a geo-engineering assessment of the southern Iraqi shore (Ras al-Bisha zone)

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Abstract

The coastal zone of Ras al-Bisha, located between the mouth of the Shatt al-Arab River and the eastern breakwater of the Grand Faw Port, exhibits complex interactions of tidal forces, sediment transport, and anthropogenic modifications. This study develops an engineering geological framework to assess sediment stability and geohazard potential under semi-diurnal tidal conditions. Field measurements, including in situ vane shear tests at 41 stations, were used to determine undrained shear strength and derive critical shear stress for surface sediments. Hydrological data provided ebb and flood current velocities and water levels. A dual factor of safety (FS) approach was introduced to evaluate sediment stability separately for ebb and flood tides, producing spatially explicit maps of stable ($FS > 1.5$), critical ($1.0 \leq FS \leq 1.5$), and unstable ($FS < 1.0$) zones. The results reveal an inland-to-seaward gradient in sediment strength and resistance, with very soft to soft sediments dominating the nearshore environment. Flood tides generate higher applied shear stresses than ebb tides, leading to expanded unstable zones along the shoreline front. Erosion rate analyses confirm greater sediment displacement during flood conditions, while ebb tides partially mitigate instability. The dual-FS hazard maps offer a refined way for prioritizing monitoring and mitigation efforts, directly informing coastal management and infrastructure planning in estuarine settings affected by bidirectional tidal dynamics.

Keywords

Iraqi shore; Geohazard mapping; Ebb and flood tide dynamics; Sediment stability; Coastal erosion risk

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List of abbreviations and acronyms

ASTM American Society for Testing and Materials
D2573 ASTM Standard D2573 (field vane shear test)
D422 ASTM Standard D422 (particle-size analysis of soils)
D4318 ASTM Standard D4318 (liquid/plastic limit tests)
FS factor of safety
FS_{ebb} Factor of safety under ebb-tide conditions
FS_{flood} Factor of safety under flood-tide conditions
GFP Grand Faw Port
GCPI General Company for Ports of Iraq
MSC Marine Science Centre

List of symbols

γ_w Unit weight of water (kN m^{-3})
 d Water height above midpoint (m)
 S Slope of the energy grade line (dimensionless)
 τ_a Applied fluid shear stress (Pa)
 τ_{aEbb} Applied fluid shear stress during ebb tide (Pa)
 τ_{aFlood} Applied fluid shear stress during flood tide (Pa)
 τ_c Critical shear stress of sediment (Pa)
 S_u Undrained shear strength of sediment (kPa)
 β Dimensionless constant (2.6×10^{-4})