Numerical Modelling of Backfill Patterns of Borrow Pit in Osaka Bay

Muhammad Ali Hafeez[a, *], Tetsunori Inoue[a,b]

[a]Marine Pollution Management Group, Port and Airport Research Institute
(Nagase 3-1-1, Yokosuka, Kanagawa 239–0826, Japan)
[b]Estuary Research Center, Shimane University
(1060 Nishikawatsu-cho, Matsue-shi, Shimane 690-8504, Japan)
E-mail: engrali.uet@gmail.com; inoue-t@p.mpat.go.jp
* Corresponding author. E-mail address: engrali.uet@gmail.com (Muhammad Ali Hafeez)

Abstract

Osaka Bay, a semi-enclosed aquatic system, is currently facing degradation in water quality, a consequence of numerous borrow pits excavated during the industrial revolution. Addressing this issue, backfilling has been proposed as a remedial strategy. The evaluation of backfilling's efficacy necessitates precise numerical simulations of the aquatic environment, a task complicated by the challenge of accurately modelling the hydrodynamics and ecosystems within borrow pits. This study employs a sophisticated non-hydrostatic 3D hydro environmental model EcoPARI, aiming to assess the effectiveness of various backfilling scenarios through detailed comparison of hydrodynamics and ecosystem responses. Utilizing a high-resolution mesh configuration (100 m x 100 m), the research designs and tests multiple area-specific backfilling strategies to identify the most effective approach. Given the prolonged timeline required for backfill completion, the study focuses on area-wise backfilling as a pragmatic solution. Case 1, with its strategic east-side refilling, emerges as the most effective approach for improving water quality parameters such as salinity, temperature, and dissolved oxygen (DO) in a borrow pit. This method ensures a quicker and more uniform distribution of seawater, even to the pit's deeper west side, enhancing the efficiency of seawater exchange under varying flow directions. The dynamics observed, including salinity stabilization and temperature uniformity, underscore the critical role of refilling location and hydrodynamic conditions in achieving optimal water quality, with significant implications for environmental management and restoration practices. This approach allows for a nuanced understanding of which backfilling scenarios offer substantial mitigative effects on the bay's environmental health.

Keywords: Osaka Bay, Borrow Pit, Backfilling, Hydro Environmental Modelling.