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Underwater Unexploded Ordnance Burial Prediction

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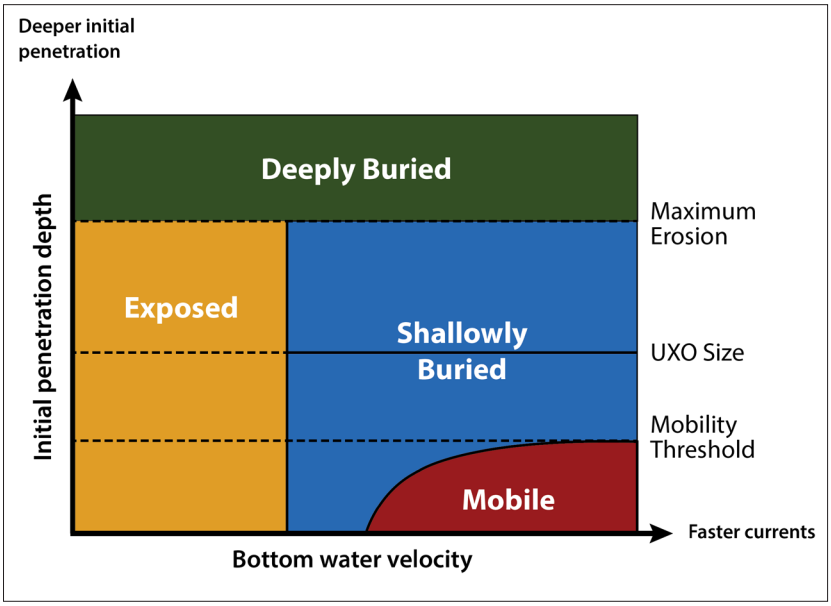
The Strategic Environmental Research and Development Program (SERDP) would like to predict how unexploded ordnance (UXO) on or under the ocean floor is moved and exposed by water and sediment motion to identify and prioritize UXO cleanup (*remediation*) locations. UXO movement and exposure depend on its initial sediment penetration depth. IDA performed a numerical analysis to explore the accuracy and precision (*fidelity*) of estimates from existing computational models for predicting initial sediment penetration depth of mines dropped into water to see if those models could be repurposed for UXO. We first explored what level of fidelity would be useful for predicting final burial depth or relocation of the UXO. Then we looked at what level of fidelity is already achievable given existing models. Finally, we considered how those models might be improved to make them more useful for underwater UXO remediation.

IDA's focus was on prediction of initial sediment penetration of UXO. Determining how much prediction fidelity would be useful required understanding the factors that influence subsequent burial, exposure, and motion of the UXO, including bottom water velocity, the washing away of sediment through erosion, and the addition of sediment through accretion. The initial sediment penetration depth is influenced by water depth, sediment characteristics, and munition type. To systematically account for these factors, **IDA developed an initial burial regime map that showed conditions leading to four ultimate fates of the UXO—exposure, deep burial, shallow burial, and mobility.** Although this map was based on a simplified characterization of water and sediment dynamics, it led to some broad conclusions. Notably, useful prediction fidelity of initial sediment penetration depth varies with both local conditions and burial depth. In particular, prediction fidelity of initial sediment penetration depth is useful only insofar as it aids in predicting the UXO's ultimate fate; additional fidelity would not meaningfully aid in remediation decisions.



Subsequent quantitative analyses connected useful fidelity to achievable fidelity to determine if and where additional fidelity would be useful. **This work resulted in specific recommendations for improving existing models and developing new models** for sandy and silty sediment penetration, consolidation and creep in clay sediment, scour burial in silt, and mobility of partly buried UXO in all sediment types.

Based on IDA NS D-8616, *UXO Burial Prediction Fidelity*, J. A. Teichman, S. M. Cazares, and Y. Macheret, July 2017; IDA NS D-8617, *UXO Burial Prediction Fidelity: A Summary*, J. A. Teichman, J. Macheret, and S. M. Cazares, July 2017; and follow-on work. Research sponsored by SERDP and the Environmental Security Technology Certification Program.

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