RESEARCH ON MIGRATION AND BURIAL OF TRAINING ORDNANCE ON THE BEACHES OF MARTHA'S VINEYARD

Peter Traykovski

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New England District > Missions > Projects/Topics > Martha's Vineyard ... www.nee.usace.army.mil/Massions/Projects/Topics/Matthas/Vineyard.RiFs/ + Mar11, 2016 - Marthaly Vineyard Remedial Investigation Feasibility Study ... conducting a Remedial Investigation/Feasibility Study (RI/FS) at three maritters ...

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Tracking Unexploded Munitions : Oceanus Magazine https://www.whoi.edu/oceanus/feature/tracking-uxos +



Woods Hole Oceanographic Institution



















DoD's STRATEGIC ENVIRONEMENTAL RESEARCH AND DEVELOPMENT PROGRAM

• Energy and Water • Environmental Restoration • Munitions Response • Resource Conservation and Resiliency

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Applied Ocean Physics & Engineering Dept. Woods Hole Oceanographic Institution

























 DOD • EPA • DOE
 SERDP funds ~ 10 PIs on burial & mobility. Far more on developing better detectors

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DISTRIBUTION OF FUDS WITH MUNITION CONTAMINATION

12 Million Acres, ~ 5 Million Underwater or Coastal. Does not include active sites



LONG POINT ONGOING REMEDIATION WORK







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JUNE 2015, USACE FEASIBILITY STUDY, TISBURY GREAT POND MUNITIONS RESPONSE AREA, MARTHA'S VINEYARD, MA



100 200 300 400 500 600 700 NOTES: gation Area 10/22/2014 Rev: FS.mxd Meters 2009 Aerial Data Source: amec MassGIS Intrusive Grid ID 600 1,200 1,800 2,400 Drawn: JBO Chk: DMS PROJ: 562910000 UXB Feet

Great

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http://www.nae.usace.army.mil/Portals/74/docs/Topics/MarthasVineyard/Tisbury/TisburyFeasibilityStudy.pdf

Shoreline retreat and UXO exposure



Woods Hole Oceanographic Research on Surf-Zone Mobility and Burial of UXO

Goals:

- To better understand which (if any) objects will migrate vs. bury
 - There is a wide range of different munitions in varying states of decay
- What wave conditions can cause objects to migrate or dunes to erode?
- Our research will help site managers decide what remediation actions are appropriate
 - How large an area needs to be surveyed?







Research Methods

- Explore a wide range of object parameter and forcing conditions.. e.g. big storms
- Focus on role of relative density (S_o), as not examined in previous research, using "realistic" objects

$$S_{o \ sand} = \frac{\rho_{UXO}}{\rho_{wet \ sand}} = 0.9, 1.1, 1.3 2.0$$

 $S_{o \ water} = \frac{\rho_{UXO}}{\rho_{water}} = 1.8, 2.2, 2.5, 4.0$
100 Lb. WW2 Bomb $S_{o \ water} \sim 4$
Photoflash Bomb





















Measured Migration Trajectories



- Migration vs Burial Strongly Dependent on Relative Density
 - Less Dense Objects Migrated Across Surf-zone
 - Little Along-shore Migration
- No sUXO made it to the beach. All ended ~ 50 m offshore in ~ 1.5 meters depth

Mobility Parametrized Modelling



- To understand our measurements use "college-level-101" fluid dynamics
- Basically F=MA, with fluid (wave¤t) forces and object mass & buoyancy
 - Solve torque balance based on a prescribed initial burial depth (b_d)
- This theory compares well to laboratory measurements for threshold of mobility
 - Lab measurements typically start with no waves, then the wave maker is turned on at full force
 - Very different from natural storms where waves increase over a few days and background wave and tidal flows are present

Results compared to theory



- Theory could not classify field measurements in a natural surf-zone based on a constant initial percent burial
- A time-dependent parametrized numerical model that accounts for slow burial of UXO was developed
- Introduced a new parameter: The rate of hydrodynamic energy change:
- Slowly increasing moderate waves sufficient for scour, but not object mobility -> BURIAL
- With waves increasing rapidly from a calm state, object is subjected to large waves before partial burial, -> MOBILITY

Results compared to the new theoretical approach

- Produces the same qualitative structure of a sharp transition in S_0 as measurements.
- The time dependent relation between U_{wave} and S for U increasing with realistic rates successfully classifies burial and mobility data.



Using A Numerical Surf Zone Hydrodynamics Models to simulate sUXO Migration

- Not college 101 level fluid dynamics! Many PhDs go into making these models.
- Complex models with many adjustable parameters and choices to make when running them.
- Need extensive testing & validation for a given environment or set of processes.



- Model results for final UXO location are sensitive to mobility threshold, but not to migration rate.
- Final resting location is determined by a balance between swell onshore forcing and reflected wave group energy offshore forcing

Preliminary Conclusions based on Ongoing Research

- Munition mobility tends to be restricted to less dense objects
- Most dangerous "live training" munitions are more dense than typical mobility thresholds
 - There are some exceptions with low density. e.g. photoflash bomb.
- Most migration tends to occur in across-shore direction in response to direct wave forcing
 - Spreading of dense UXO to adjacent beaches over long distances is unlikely
- Shoreline erosion and dune migration exposing contaminated areas behind current dunes is a significant concern.



There is always potential for "unexplained" appearance of UXO that fall from expected mean

