2019-12

Understanding the Sources of Illicit Drug Bale Wash-up

Joseph, John; Radko, Timour; Margolina, Tetyana

Monterey, California: Naval Postgraduate School

http://hdl.handle.net/10945/70101

NPS NRP Executive Summary
Understanding the Sources of Illicit Drug Bale Wash-up
Report Date: 11/18/19 | Project Number: NPS-19-N355-A
Naval Postgraduate School, Graduate School of Engineering and Applied Sciences

NAVAL RESEARCH PROGRAM
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

UNDERSTANDING THE SOURCES OF ILLICIT DRUG BALE WASH-UP

Interim Executive Summary
Period of Performance: 06/01/2019–06/30/2020

Researchers:
Principal Investigator (PI): CDR John Joseph USN (ret.), GSEAS, Oceanography Department
Additional Researcher(s): Dr. Tetyana Margolina, GSEAS, Oceanography Department
Dr. Leonid Ivanov, GSEAS, Oceanography Department
Dr. Timour Radko, GSEAS, Oceanography Department

Student Participation: METOC Curriculum student to join effort in FY20

Prepared for:
Topic Sponsor Lead Organization: US Coast Guard Research and Development Center
Topic Sponsor Name: LT Anne Newton, USCG R&D Center
Topic Sponsor Contact Information: anne.f.newton@uscg.mil 860-271-2868

NPS NRP Executive Summary
Understanding the Sources of Illicit Drug Bale Wash-up
Report Date: 11/18/19 | Project Number: NPS-19-N355-A
Naval Postgraduate School, Graduate School of Engineering and Applied Sciences

EXECUTIVE SUMMARY

Project Summary
Counter-drug agencies have encountered many illicit bales of drugs wash up on shore of beaches around the Gulf of Mexico region, yet it is not clear where the packages originated or how long the packages had been drifting. This trend has almost quadrupled in the number of cases in the past few years. This study will apply high-resolution oceanographic modeling at NPS to provide a physics-based solution that narrows the likely origins of the drifting drug bales that have washed ashore and will shed light on their "patterns of life." The study will integrate critical intelligence information collected by the US Coast Guard, DEA, Navy and other drug enforcement agencies to help guide and constrain the model to produce statistically significant, realistic output. Results from the study will also provide insight on the methods used by drug smugglers to move their illegal cargo. At least two modeling approaches will be employed to statistically trace the past movement of the drug bales. One method uses a forward-motion approach that starts with a gridded distribution of simulated bales that are driven by the currents and wind stress derived from a high-resolution ocean model to assess where and when the bales would reach locations of known wash-ups. A second method uses an adjoint modeling approach that employs a time-reversal method; that is, simulated bales are backed-up along reversed tracks from their landing locations driven by time-reversed model physics. Information based on the insight of experienced "on-scene" enforcement personnel (made available via USCG and JIATF South) will provide constraints on how the model results will be interpreted. For example, washed-up bales known to be jettisoned from Go-Fast boats or airdropped at specific locations and times can be used to validate the model output. Ensembles of hundreds of model runs will be conducted to provide statistically valid results for the study.

Keywords: *counter drug, drug bale wash-up, adjoint ocean modeling*

Background
Counter-drug agencies have observed an increasing trend in illicit drugs packaged in bales washing up on shore of beaches in Florida, Texas, Louisiana, Alabama and Mississippi and the eastern shore of Mexico. However, determining from what country these bales originated has puzzled these agencies as no one has been able to dedicate the time or effort to research into the possible origins and ways these bales come to be floating in the sea. This trend has almost quadrupled in the number of cases in the past few years, but it is not known why. The counterdrug community can learn much from a study into the trends and patterns-of-life. For example, information about the packaging and marine growth on the package can provide insight into whether the packages were originally air-dropped or transported by boat. Markings on the packages can provide hints of their original source or if they are connected to interdictions at sea by USCG or DEA. Incorporating oceanographic models to help determine the drift patterns of the bales once released can help "connect" a bale's wash-up location to its potential release position and transport time. The USCG has documented geographic positions, dates, times, photos of each of these cases over the past 4-5 years. Combining this

information with realistic ocean physics from models is anticipated to paint a much clearer picture for counter-drug agencies on how bale wash-ups are directly related to their sources.

Findings and Conclusions

In the initial phase of the study, we applied a forward-motion modeling approach to help understand the physical mechanisms that determine the movement of drug bales that may originate from the Yucatan region in the Gulf of Mexico and Florida Bahamas flows, and to estimate their drift behavior quantitatively. Travel times were estimated for packages drifting along trajectories seeded in the Yucatan Channel, propagating into the Gulf of Mexico and then through the Florida Straits into the Florida and Bahamas coastal areas. Mean subsurface velocities applied to estimate the travel times were derived from the high resolution (3 km) RNCOM ocean model using a 10^{th} order wavelet decomposition (Ivanov and Chu, 2019). Possible mechanisms for trapping drifting packages within the Florida and Bahamas coastal areas are discussed. Preliminary calculations demonstrate that most passive drifters are transported to a Florida-Bahamas coast by tides. However, surface waves and winds also can play an important role in this process.

The general conclusions obtained by the project thus far are as follows:

1. The modeled circulation with the spatial resolution of 3 km allows us to estimate some mechanisms of motions of drug containers including influence of tides on these containers. Estimations of the travel times for passive drifters along several prevailing trajectories exceeded those estimated earlier (see, for example, Lugo-Fernandez, 2006).
2. The current work suggests that a basic mechanism for the Florida coast responsible for the beaching of drug containers is the classical tides. This mechanism is evident outside the Gulf Stream in the area with coordinates: 27–30°N between 79–81°W.
3. Real drug bales had different geometry than the one assumed in the initial modeling efforts (spheroidal "particles" of the size which was smaller than the spatial scale of the circulation). Preliminarily numerical experiments show that accounting for the container shape will result in higher degree of level of freedom and the container motions may change.
4. The meandering Florida current re-distributes the moving particles in the near coast areas where they can be subsequently moved onto the coast by wind (which is not resolved in the initial modelling efforts) or wind waves (which have not been accounted for in the model). These factors will be studied in more details.
5. Our numerical estimations demonstrated that the degree of turbulent intensity (especially in the Florida coastal area) plays an important role in pushing out free particles from the main jet and then in their transportation onto the coast. A strong particle drift can be found in the area with coordinates: 24–26°N between 78–82°W.

The current work is in the early stages of getting the model "up and running" and has provided useful preliminary results. One of the primary concerns is being able to represent the drug bales in the model in a realistic way so that the important physics that drive the drift is captured. For example, the density of bales can determine how the bales ride in the water which, in turn, influences how much the winds and

currents, which may not be in the same direction, control the net drift of the packages. Limits at which the model is no longer valid must also be considered. For instance, once the bales get very close to shore, there are likely to be small-scale physics that the model cannot resolve that may influence the transition of the bales from the sea to shore. Intelligence information received via the USCG District 8 and the dialogue with some of the on-scene counter-drug personnel has helped "tune" the model to provide realistic results. Location of landfall or at-sea intercept sites, images of recovered packages, descriptions of packaging and similar intelligence provide insight on how best to initialize the information in the model. Continued collaboration will enable the model to produce realistic scenarios and reduce uncertainty of the trajectory predictions.

Recommendations for Further Research

Our present investigation lays the foundation for further work on methods to improve estimations of how the drug bale are moved through the ocean by environmental factors and tend to wash up at some common locations. Continued efforts to incorporate intelligence information provided by drug enforcement agencies with physical oceanographic conditions derived from oceanographic modeling is needed. Validation of the performance of the model based on tracking of real and simulated drifting drug bales would allow adjustments that are likely to increase confidence in the results, thus providing law-enforcement personnel a reliable, efficient tool to meet their objectives.

References

Lugo-Fernández, A. 2006. Travel Times of Passive Drifters from the Western Caribbean to the Gulf of Mexico and Florida-Bahamas. Gulf of Mexico Science 24 (1), 61-67.

Ivanov, L.M., and P.C. Chu, 2019. Estimation of turbulent diffusion coefficients from decomposition of Lagrangian trajectories , Ocean Modelling, 137, 114-131.

Acronyms

Drug Enforcement Agency	DEA
Joint Interagency Task Force South	JIATF South
Naval Postgraduate School	NPS
Regional Navy Ocean Coastal Model	RNCOM
United States Coast Guard	USCG