RESEARCH BRIEF

Dissuading Adversaries and Their RN Pathways:

Integrating Deterrence Theory and Analytics in the GNDA

OVERVIEW

The Dissuading Adversaries and their RN Pathways (DARNP) project expands upon several extant analytical and computational models and data collections of potential radiological or nuclear (RN) adversary behaviors that UWT-START researchers have previously developed, many for Department of Homeland Security Domestic Nuclear Detection Office (DNDO). The project uses cutting-edge non-state actor deterrence theory and game-theoretical approaches to combine these previous models, which themselves integrate deep qualitative and contextual empirical data on violent non-state actors with theoretical insights drawn from terrorism studies, organizational psychology, political science, criminology, sociology, and engineering.

PROJECT BACKGROUND

This interdisciplinary, multi-institutional project analyzes the dissuasive effects of Global Nuclear Detection Architecture (GNDA) investments on adversary behaviors. Using a Stackelberg game-theoretical model informed by behavioral models, in which the defender and adversaries are embedded in a geospatial network that exerts influence on both sets of actors' cost-benefit analyses, the project identifies optimal investment and communication strategy equilibria that simultaneously minimize the non-state adversary RN threat (risk, vulnerability and consequence) and implementation costs. The models variously assess: a) adversaries' likely interest in, means of acquiring, and ability to weaponize RN materials, and the success thereof; b) RN targeting preferences; c) RN weapon command-and-control preferences; and d) RN smuggling route preferences. Additional models currently under development use geospatial data and plume models to provide defender and adversary utility functions for successful attacks and (perceived) probabilities of transit success in order to assess the effects of information asymmetries and the variation in adversary preferences and risk tolerances.

APPLICATIONS

UWT-START has used the DARNP model to estimate possible adversary responses to RN detection countermeasures. One funder, the Defense Advanced Research Projects Agency (DARPA), sought to mobilize a network of portable radiation detectors (PRD) as a deterrent and preventative measure against radiological or nuclear attacks perpetrated by non-state actors against major U.S. cities. In furtherance of that effort, the START-UWT team assessed several configurations of PRD networks and urban coverage to estimate preferable deployment strategies. Moreover, the model has been used to analyze a range of other potential defensive strategies: increased border security, increased maritime security, targeted strikes against organization leadership, highway-located fixed radiation detectors, and outfitting highway patrol officers with PRDs.

Policy Scenario	Expected Casualties (Log)	Expected Costs	Cost Avoidance/Policy Cost Factor
Highway Detectors	**0.553210922**	$8,411,498,584	336
Maritime Interdiction Enhancement	0.632241054	$9,613,141,239	**1489**
Leadership Removal	1.164802875	$12,505,763,774	472
Tier 1 Cities PRD Network	1.023664706	**$3,547,342,799**	120
Universal PRDs	1.183380061	$16,800,528,791	157

*Note: **Bolded text** indicates the best outcome in each column.*

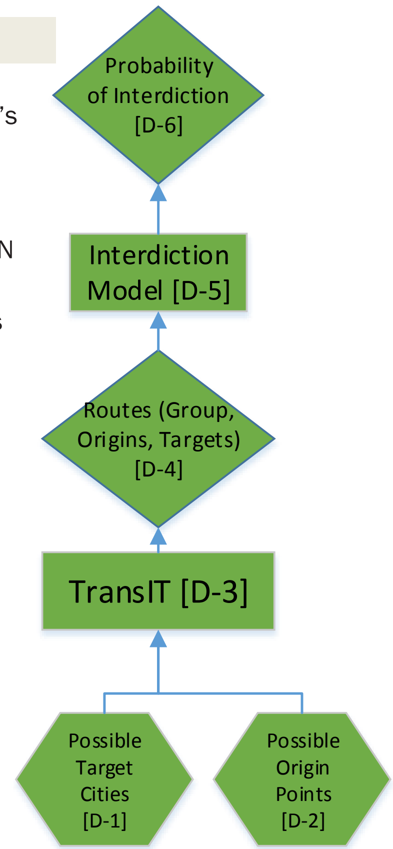
FINDINGS

UWT-START has used the Stackelberg component of the DARNP model to estimate optimal deterrent policies conditional on likely adversary responses to each policy. Thus far, the model has been used to assess several hypothetical government policies that might affect the likelihood of a non-state adversary deploying an RN weapon in the continental United States. Specifically, the model outputs indicate that the optimal deterrent policy, in terms of reduced probability of attack success, is a system in which small radiation detectors are installed adjacent to a subset of highway on-ramps and off-ramps in the continental United States. The outputs also indicate that enhanced maritime interdiction capability is the most cost-effective deterrent policy. Other policies in the testing sample included an operation to remove the leadership of a non-state adversary organization, a policy wherein highway patrol officers carry PRDs, and one in which a network of PRDs are deployed in Tier 1 cities.

METHODOLOGY

This project synthesizes a wide variety of methodologies and analytical approaches to develop and populate the game-theoretic model that informs cost-benefit estimates. Each of the model's component parts features one or more distinct methodologies:

- *Future Adversaries' Radiological & Nuclear Attacks (FARNA) Module:* This sub-model combines open-source research, expert elicitations, and Monte Carlo statistical simulations to estimate the probability that a given (actuated) adversary will acquire RN materials, weaponize those materials, and opt to deploy the completed RN weapon.
- *Transnational Illicit Trafficking (TransIT) Module:* The TransIT model was developed as part of a two-year multi-institutional START research project funded by DNDO's International Cooperation Office. The research team consisted of scholars and specialists in the areas of organized crime, terrorism, nonproliferation and RN materials. The DARNP project leverages existing TransIT data to link domestic multi-modal transportation networks with external networks in order to identify key routes and potential chokepoints at the Eastern and Southern maritime and land borders.
- *Cost-Consequence Module:* The project draws on the geospatial data previously collected for DNDO's CDF Mapping project and other efforts to produce highly detailed estimates of the cost/consequences of RN attacks on selected targets. These data enable the model to match the profiles of the targets to the adversary preferences generated in the FARNA targeting module. In addition, START has completed a consequence matrix that estimates casualties and financial costs resulting from each of the modeled RN weapons. This consequence matrix feeds into the defender's risk mitigation strategies. START identified 57 targets that will enable the project to analyze the differential effects of countermeasure investments, given the attributes of the various adversaries.



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START

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