

Using Infrastructure Density for Resource Allocation Policy

This project incorporates new risk and policy analysis metrics and statistical and GIS-based tools to choose among policy options for the distribution of resources by geographic region and type of recipient based on the potential consequences of a terrorist attack on a vulnerable site on infrastructure near such sites.

Modeling Area: Risk Analysis and Risk Management

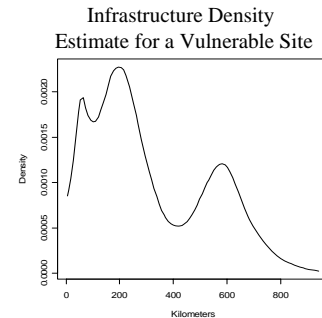
Case Studies Supported: Critical Infrastructure, Ports

Principal Investigator: Rae Zimmerman

Institution: New York University

Other Investigators: Jeffrey S. Simonoff (NYU),

Carlos E. Restrepo (NYU), Zvia Segal Naphtali (NYU)



Brief Description: Social and economic consequences of a terrorist attack on a vulnerable site can magnify impacts by indirectly damaging nearby critical infrastructure systems. Alternatively, an attack on an infrastructure facility can indirectly damage or disable a vulnerable site. New metrics and models are necessary to approach this problem. During Year 4 infrastructure density around vulnerable sites in California provided by CREATE was measured using probability density estimation, a type of smoothing method. High hazard dams were used as the infrastructure to test the methodology. Proposed Year 5 work will build on Year 4 research, and provide new tools based on critical infrastructure density estimates around vulnerable sites by including multiple infrastructure systems and ways to extend to other states. The research objective is to provide additional tools for policy analysis for the distribution of resources among counties or facilities for security. The work will also provide and analyze additional and alternative measures of proximity incorporating novel aspects such as functionality and connectedness for alternative metrics in policy analysis. The infrastructure density estimates support resource allocation decisions at facility or county levels by aggregating results. In addition to the problem of evaluating options to choose among counties for allocating resources, this research will also address risk analysis and resource allocation by examining infrastructure density around a large port, providing infrastructure density estimates for several vulnerable sites inside the port. Ports of LA, Long Beach and NY are candidate port sites.

Objectives: This research will enhance the ability of decision-makers to distribute resources for security by (a) developing new methodologies to estimate critical infrastructure densities around vulnerable sites as a basis for risk-based resource allocation; (b) developing novel metrics and indicators of proximity beyond simple distance measures using concepts of functionality and connectedness; (c) developing methodologies for combining different critical infrastructure systems in order to include them in the infrastructure density estimates; (d) performing comparisons of this methodology with other resource allocation methods for the protection of vulnerable sites at both the facility and county level; and (e) summarizing and evaluating the conceptual and practical soundness of critical infrastructure density estimates in two different settings: (1) multiple vulnerable sites and multiple infrastructure systems and (2) major port facilities and their multiple infrastructure facilities.

Interfaces to other Center Projects: This work will maintain a close interface with CREATE's risk analysis projects and port research; we will continue working with Henry Willis (RAND).

Interfaces to non-Center Projects: We plan to work with the California Office of Homeland Security to discuss the feasibility of using this methodology for policy analysis in the area of resource allocation for CA ports. For the NY-NJ port area, the director for the port security initiative at the Stevens Institute of Technology (part of the new DHS Center of Excellence, the Center for Maritime, Island and Port Security) is an enthusiastic collaborator. In addition, we have strong linkages to the Port Authority of NY and NJ (PANYNJ) and state OEMs.

Major Products and Customers: Project deliverables will be a report on risk-based policy analysis tools for resource allocation choices consisting of: (a) methodologies for including multiple infrastructure systems as part of infrastructure density estimates explored in our Year 4 risk-based resource allocation policy analysis by county; (b) alternative measures of proximity using functionality and connectedness to carry out sensitivity analyses and provide additional inputs to policy analysis in the area of risk-based resource allocation; and (c) evaluations of the conceptual and practical soundness of alternative risk-based resource allocation strategies based on critical infrastructure density estimates for the protection of vulnerable sites, including comparing methods developed by other CREATE research. *Customers:* DHS – Infrastructure / Geophysical; DHS – ORD; California OHS; MTA; PANYNJ. *Products:* A new tool that will consist of a function in the sophisticated freeware statistical software R that will allow users such as policy-makers to input a set of proximity measures between points of interest and obtain as output a set of density measures in numerical and graphical format. This tool will allow users to assess the relative vulnerability and risk of indirect consequences associated with an attack on a vulnerable site. The outputs of this tool can help users prioritize funding to counties or facilities based on proximity of critical infrastructure systems to vulnerable sites.

Technical Approach: GIS is used to obtain distances between vulnerable sites and critical infrastructure systems. Additional measures of proximity based on network theory will also be formulated as alternative measures for comparison. Estimates of the probability density of infrastructure proximities to the vulnerable site are then obtained. This takes as the underlying working model that infrastructure is placed randomly relative to the vulnerable site according to some underlying probability distribution that depends on both the vulnerable site and the infrastructure. The results can be visualized using figures such as the one above. Individual facilities can be ranked according to the summaries of the density of infrastructure around them, such as the probability of infrastructure being in the immediate vicinity. These summaries can be aggregated at the county level to provide valuable information to decision-makers allocating resources for security.

Major Milestones and Dates:

1. Develop methodologies for estimating infrastructure density around a vulnerable site to include multiple infrastructure systems: December 2008.
2. Apply the methodology to the states of CA and NY (for ports) using multiple infrastructure systems (such as major highways, transit stations, ports, rail-lines, etc.): April 2009.
3. Develop alternative proximity measures using functionality and connectedness: June 2009.
4. Conduct initial sensitivity analyses of resource allocation at the county level based on infrastructure density estimates from various measures of proximity: August 2009.
5. Conduct comparisons of resource allocation methodologies developed for this work with other allocation models; discuss implications for resource allocation policy; Produce R function to provide a tool for users to estimate infrastructure densities: September 2009.