TECH BRIEF

NCRST
NATIONAL CONSORTIUM ON REMOTE SENSING IN TRANSPORTATION
INFRASTRUCTURE

Critical Infrastructure

RESILIENT TRANSPORTATION NETWORKS

PROBLEM

Security planners face an ongoing challenge of finding ways to protect everything, everywhere, always, with finite funds. Clearly it is necessary to identify critical locations and infrastructure, that are high priorities for fortification and protection. Defensive measures are most easily justified if they apply to natural and accidental threats as well as deliberate attacks.

The logistical effectiveness of civilian transportation systems is invariably impacted by disasters. Some infrastructure elements are more critical than others. For example, one link of a transmission system may be a key in providing power to an area, and alternate routes may not have the capacity to replace it. The loss of that link could be devastating.

Our focus is on developing decision support systems to identify critical elements of transportation infrastructure: to identify bottlenecks, to calculate the impact of the loss of specific system components, and to help design plans for protection, or mitigation in the event of a loss.

SOLUTION

The most critical facilities are those which, when removed, produce the greatest impact on system operations. For example consider Figure 1, depicting a system of 5 facilities providing services to a region of demand. A simple measure of efficiency of this system is weighted distance (i.e. number of trips × distance) of travel. Each demand point is assigned to the nearest of the 5 facilities, and the assignment is marked by a connecting line. The pattern depicted here is the optimal configuration. If 2 facilities were compromised, the worst case scenario produces the configuration given in Figure 2, with a weighted distance more than 100% greater. This shows that an accident or attack could lead to substantial loss of efficiency, which translates to transportation congestion, delays in the delivery of critical services, and lives lost in the aftermath.

This type of analysis can be used:

- to understand which facilities are most critical and in need of fortification, based not only on size and capacity but also on location, service area and the accessibility of adjacent facilities;
- to plan backup and relief in the event of loss of those facilities;
- to design more resilient systems for future transportation and critical service delivery, in which such vulnerabilities are minimized;
- in maintenance planning, to ensure that facilities are not closed in combinations that leave the system vulnerable.

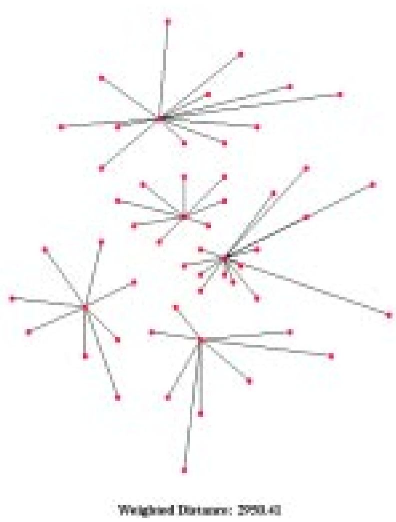

Figure 1. Five operating facilities

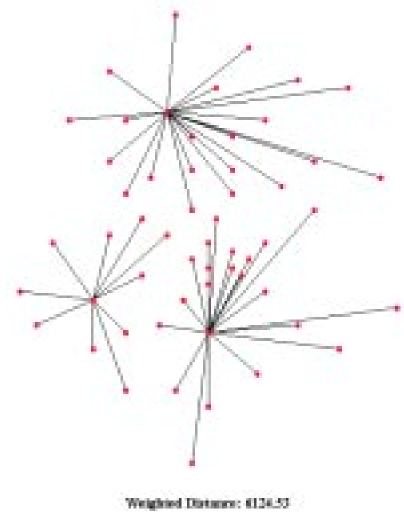

Figure 2. Disaster reduces system to three operating facilities. Transportation requirements increase more than 100%

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