

ChemPack Allocation for Nerve Gas Response in North Carolina

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ChemPack Distribution



Example of Nerve Agent Antidote Delivery Kit

http://www.semp.us/_images/bio/ts/Biot171PhotoE.jpg

- ChemPacks are large containers of antidote provided by the federal government
- Used in the event of mass exposure to a chemical weapon, nerve agent, or organophosphate
- North Carolina currently has 57 ChemPacks located in 43 hospital emergency departments
- State officials want to locate them so that every resident in NC is within 50 miles of a ChemPack

ChemPack Location Project

- Evaluate the optimal or nearly optimal location of ChemPacks for emergency response in North Carolina using the greedy algorithm for the p-median location problem
- Determine the best achievable coverage of the population within a 50 mile radius of ChemPacks



Storage of ChemPacks in
a Health Facility

<http://www.co.el-dorado.ca.us/ems/images/Chempack.jpg>

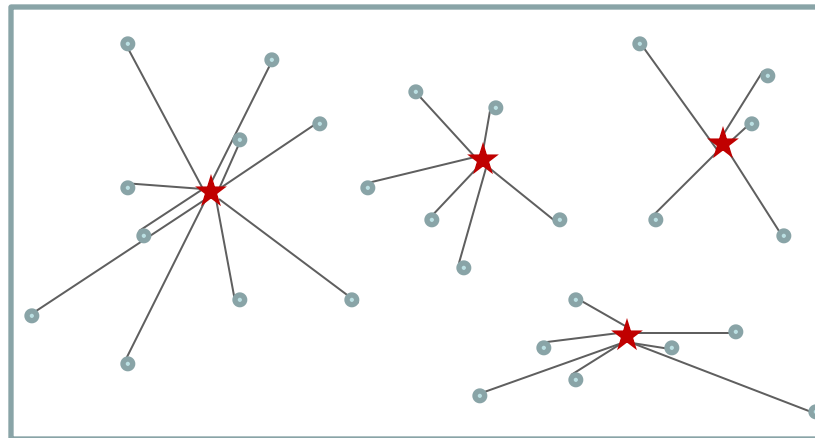
Data Collection



- Locations of populations and hospital emergency departments were calculated at the zip code level using data from the 2000 U.S. Census
- Hospital emergency department locations were collected using NC DETECT
- Distances between zip codes were computed using Matlab functions developed by Dr. Michael Kay that measure geographical distance; distances are multiplied by 1.2 to estimate road distances

p-Median Model

- The p-Median Problem is a type of facility location model that locates a fixed number (p) facilities out of a greater set of preselected possible locations
- People are served by the nearest facility with the goal of minimizing the total distance of the system weighted by the demand of n population centers



p-Median Model

$$\text{Let } y_j = \begin{cases} 1, & \text{if a facility is located at site } j \\ 0, & \text{otherwise} \end{cases}$$

$$x_{ij} = \begin{cases} 1, & \text{if population } i \text{ is served by a facility at site } j \\ 0, & \text{otherwise} \end{cases}$$

$$d_{ij} = \text{distance traveled by population } i \text{ to site } j$$

for $i \in n$ and $j \in m$

$$\min \sum_{i \in n} \sum_{j \in m} w_i d_{ij} x_{ij}$$

$$\text{s.t. } \sum_{j \in m} x_{ij} = 1, \quad \forall i \in n$$

$$\sum_{j \in m} y_j = p$$

$$x_{ij} \leq y_j, \quad \forall i \in n, j \in m$$

$$x_{ij}, y_j \in \{0,1\}, \quad \forall i \in n, j \in m$$

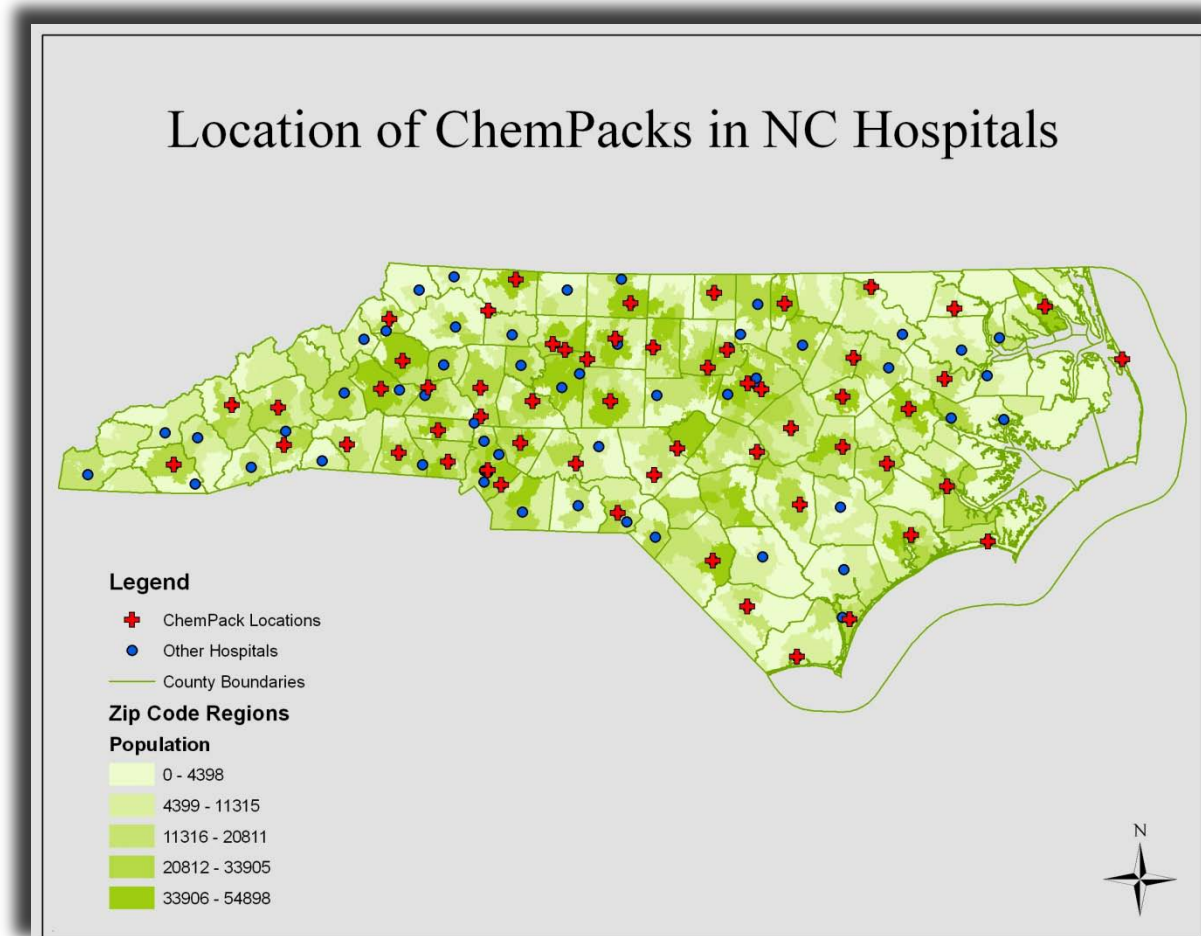


Greedy Algorithm

- The first location is found so that the total weighted distance (**wd**) traveled by all the populations is minimized and then additional facilities are located one at a time so that each time the minimum total weighted distance (Δ_l) is achieved

$$\Delta_l = \sum_{i=1}^n w_i \min \left\{ \min_{j \in \text{located}} \{d_{ij}\}; d_{ij} \right\} \quad \forall l \notin \text{located}$$

Results



Results (Cont.)

First Hospital Located	Last Hospital Located
Randolph Hospital, Asheboro 27203	Rutherford Hospital, Rutherfordton 28139

Sample of Hospitals with ChemPacks	City	Zip Code
Cape Fear Valley Medical Center	Wilmington	28403
Rowan Regional Medical Center	Salisbury	28144
Rex Hospital	Raleigh	27607
Pitt County Memorial Hospital	Greenville	27834
Presbyterian Hospital	Charlotte	28204
Craven Regional Medical Center	New Bern	28561
Annie Penn Hospital	Reidsville	27320
Durham Regional Hospital	Durham	27704
North Carolina Baptist Hospital	Winston Salem	27157
Mission St. Joseph's Hospital	Asheville	28801
Forsyth Memorial Hospital	Winston Salem	27103
Margaret R. Pardee Memorial Hospital	Hendersonville	28791
University of NC Hospital	Chapel Hill	27514
WakeMed	Raleigh	27610
Watauga Medical Center	Boone	28607
Wesley Long Community Hospital	Greensboro	27402
High Point Regional Health System	High Point	27262
Lenoir Memorial Hospital	Kinston	28501

