Controlling Epidemics

Dr. Catherine Dibble

Department of Geography

University of Maryland

Funded by the Office of Naval Research

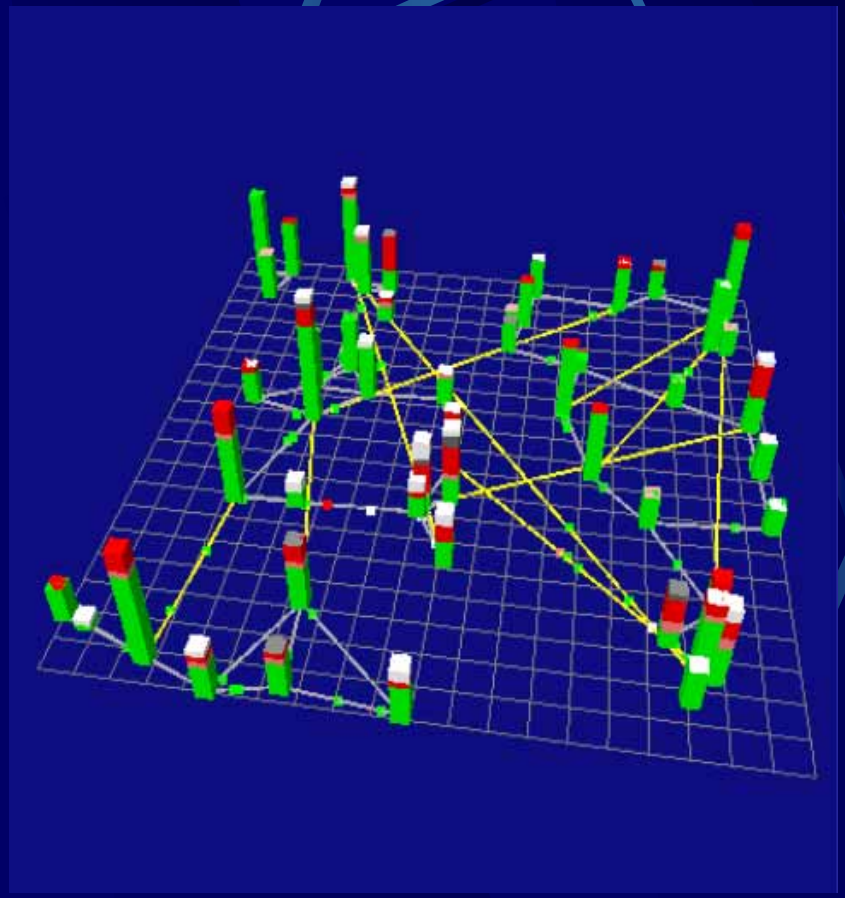
Epidemic Costs and Damages

- Epidemics (pandemics) of infectious diseases:
  - SARS
  - smallpox
  - killer influenzas such as 1918 (or Bird Flu?)
- Extremely high mortality rates > 30%
- Severe social and economic disruption
- Limited resources for intervention and control
- ⇒ **Where to target interventions?**

Key Questions

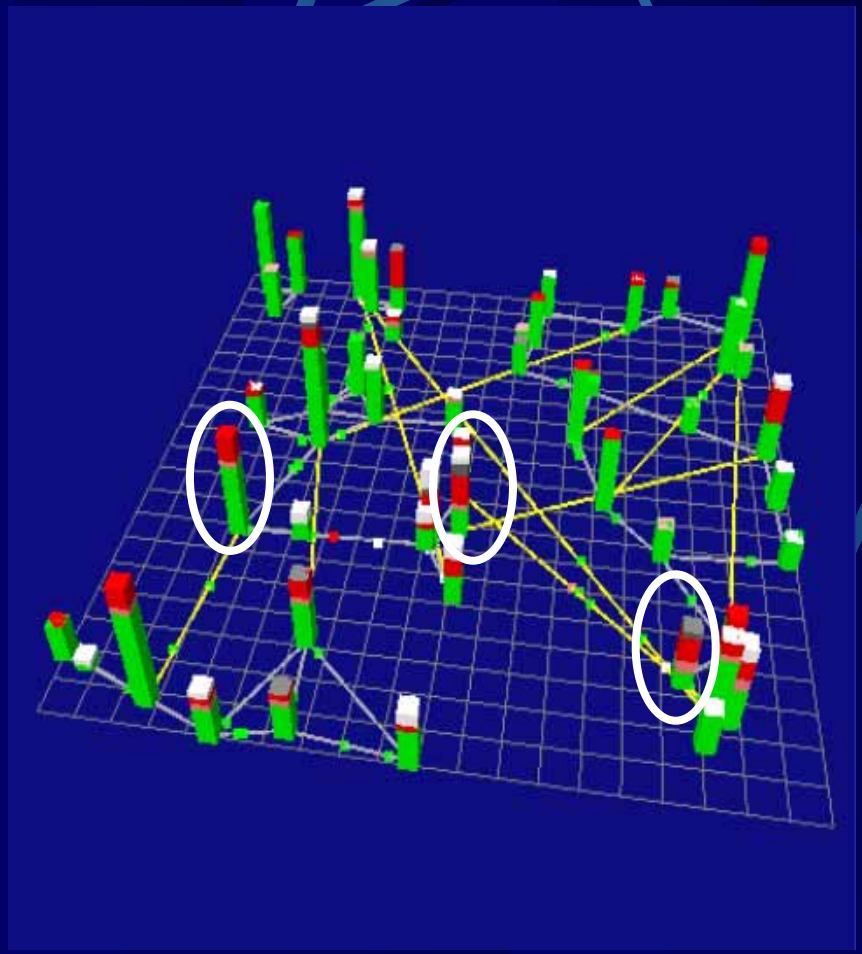
1. **Which cities are at greatest risk?**
2. **Which cities can serve as effective "firebreaks" to protect the entire country?**
3. **Which airline flights, train routes, or highways should be blocked?**

GeoGraph Epidemic Models



- Colored bars are cities
- People travel between cities, spreading the disease
- Bar charts show health status:
  - Green – healthy
  - Pink – infected
  - Red – infectious (usually sick)
  - White – recovered (immune)
  - Gray – dead
- Links are roads and air routes

1. High-Risk Cities



- **Run large numbers of different simulations**
- **Each with its own random history and initial conditions**
- **Which cities are consistently at higher risk for greater levels of infection than other cities?**
- **Laboratory landscapes here**

Optimizing Interventions

Genetic Algorithm

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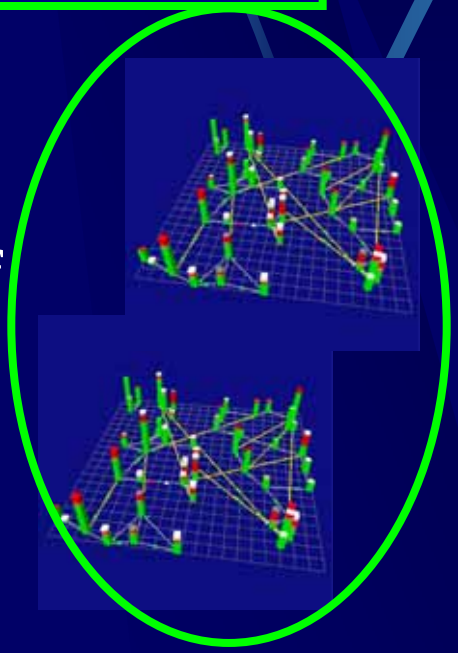
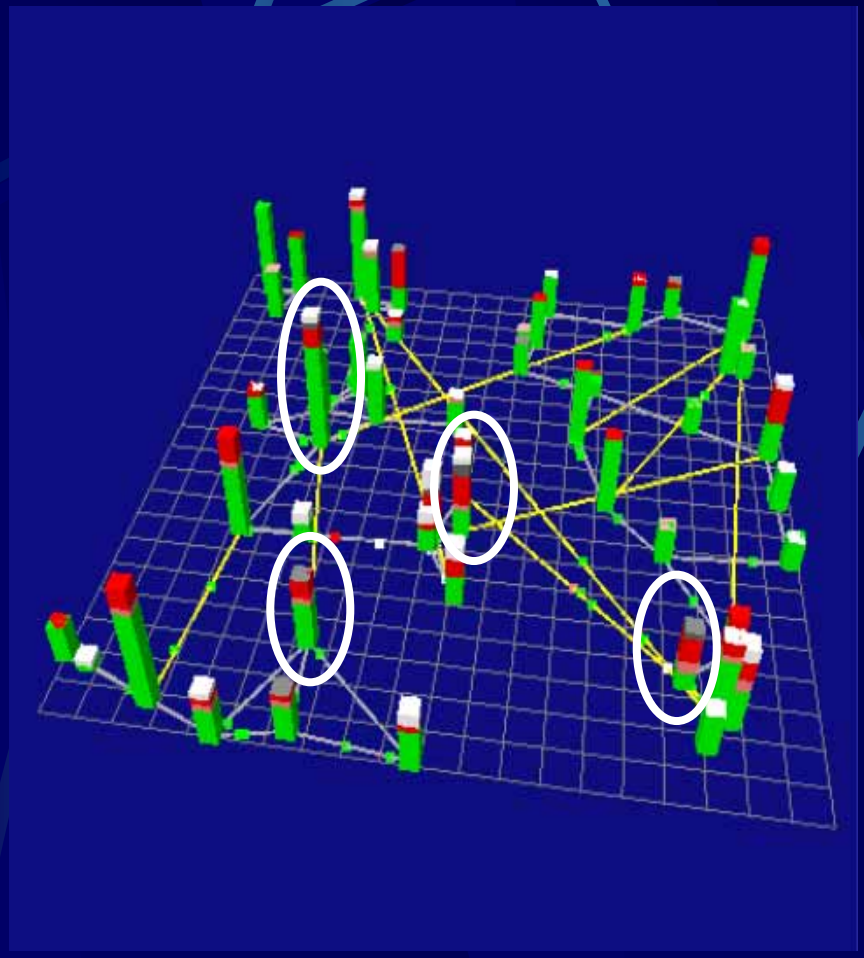
Intervention – List of Transportation Links to Block or of Cities to Re-enforce



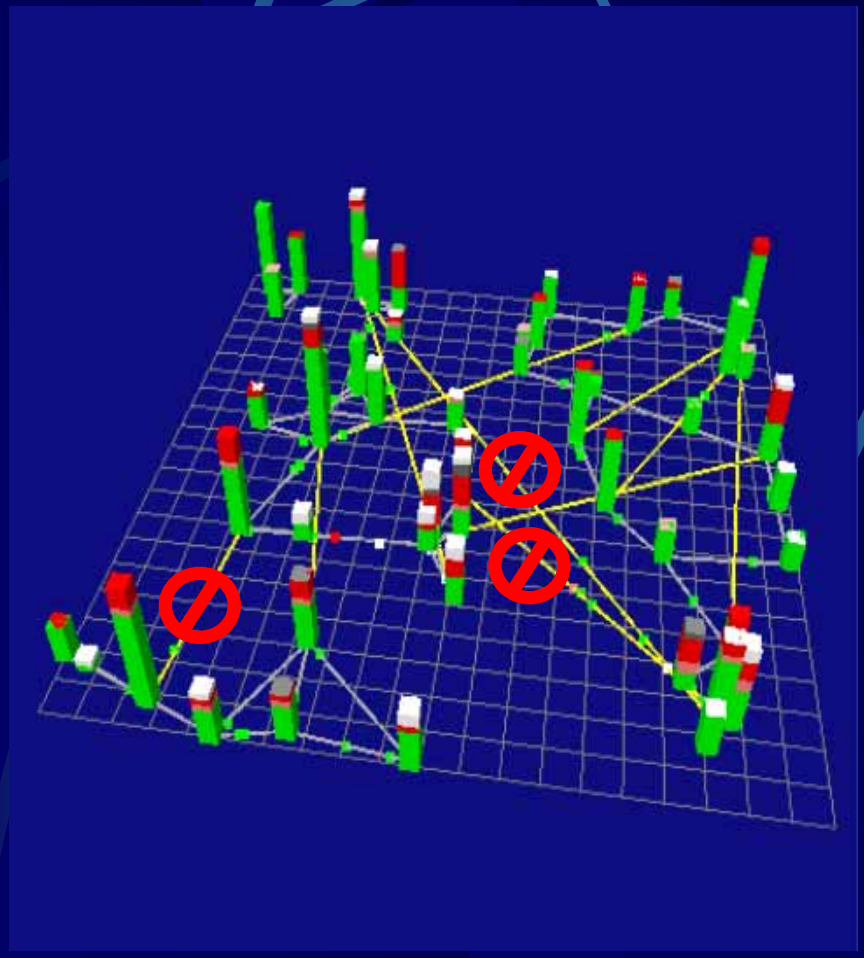
- **Run many GeoGraph simulations ("epidemic histories") to evaluate each intervention.**
- **A Genetic Algorithm designs optimal interventions, based on simulation results.**

2. City Interventions



- **Select specific cities to receive additional resources to control the epidemic.**
- **Run the simulation many times to evaluate each intervention.**
- **Genetic Algorithm optimizes interventions.**

3. Transportation Interventions



- **Select specific transportation links (e.g. airline flights) to monitor or to block.**
- **Run the simulation many times to evaluate each intervention.**
- **Genetic Algorithm optimizes interventions.**

Highly Cost Effective

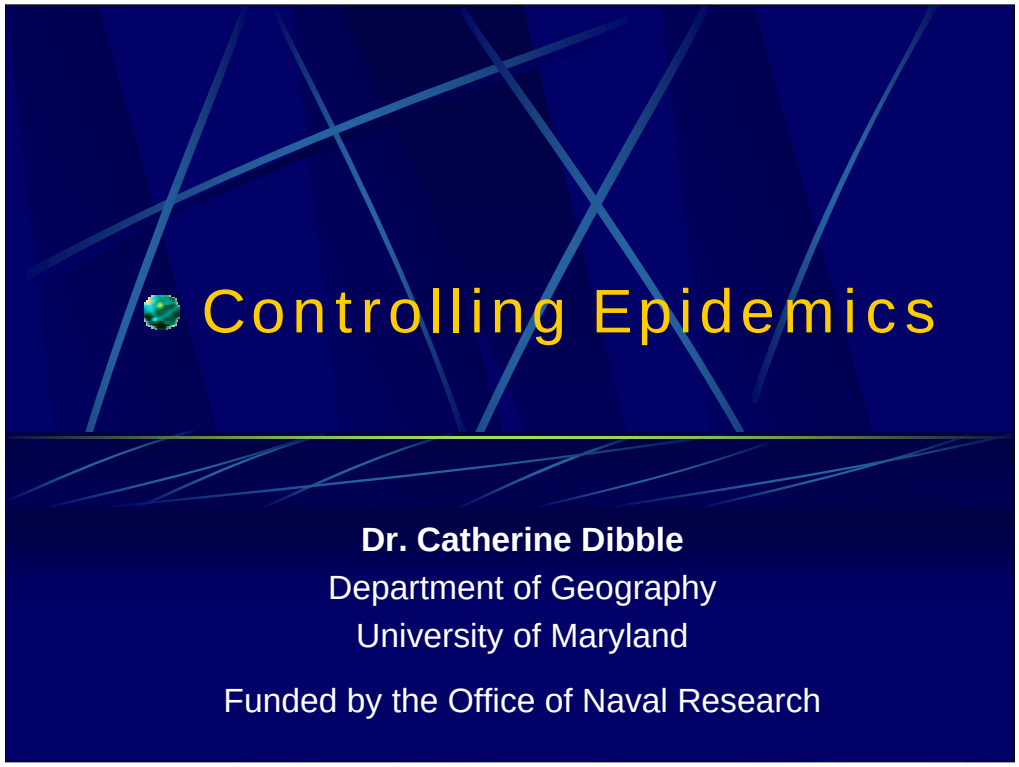
Answering these questions maximizes the effectiveness of limited public health resources for controlling epidemics.

1. **Cities at highest risk?**
2. **Key city interventions to protect the entire country?**
3. **Key transportation interventions?**

Status and Next Steps

- **These models are developed and are running in our laboratory at the University of Maryland.**
- **Thanks to funding from the Office of Naval Research (ONR) Networks Group (Dr. Goolsby)**
- **Next: USA Transportation and Cities**

Thank you



Good morning… ☺

I'm Dr. Catherine Dibble from the University of Maryland.

I'd like to thank Dr. Rebecca Goolsby and her Network Group at the Office of Naval Research for funding us to develop our strategic models for controlling epidemics.

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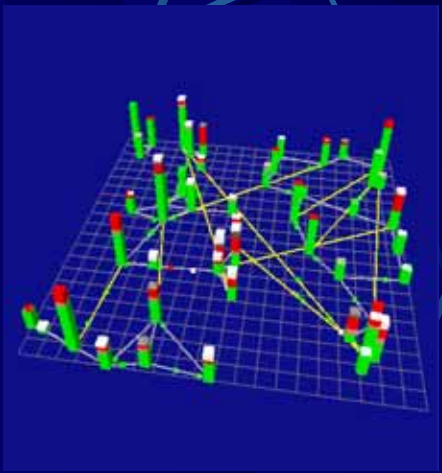

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This can also include seasonality (e.g. for SARS and flu) and superspreader events.

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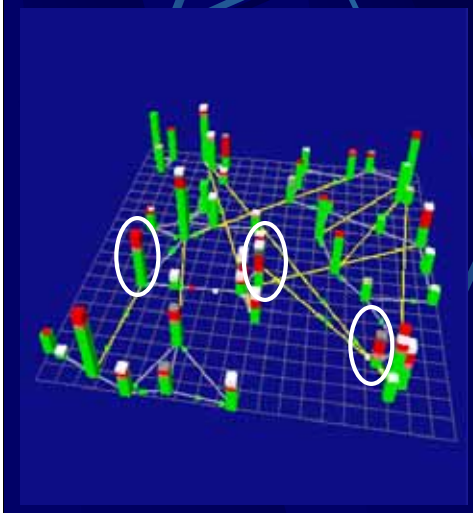

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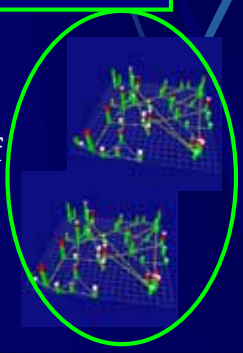

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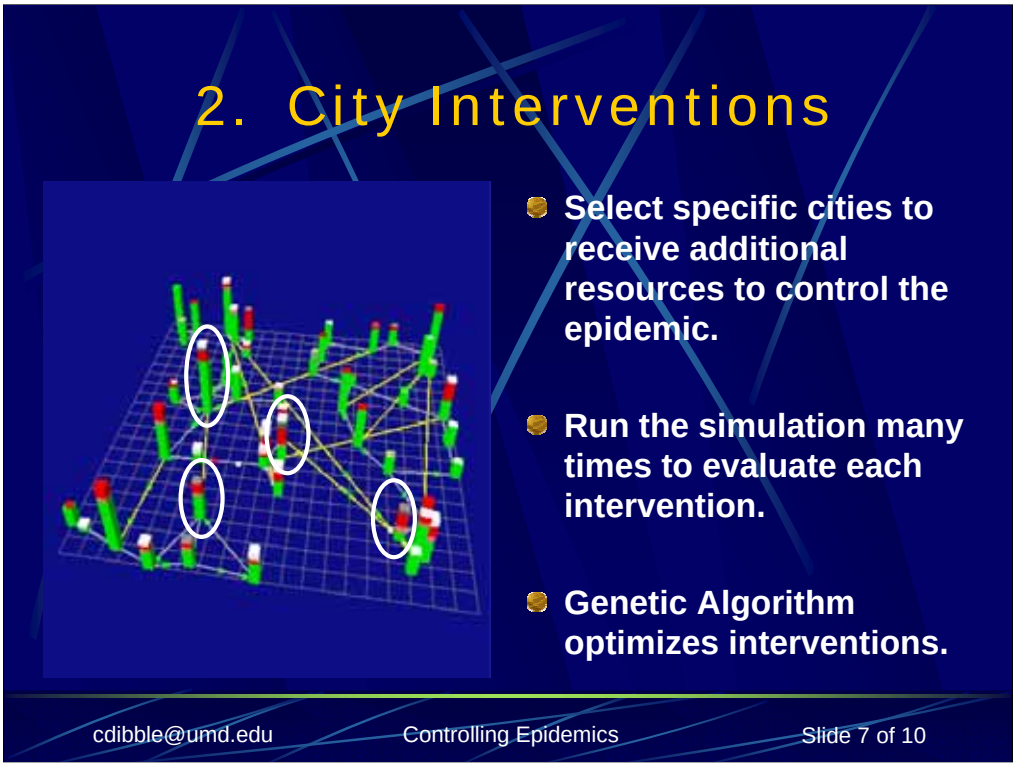
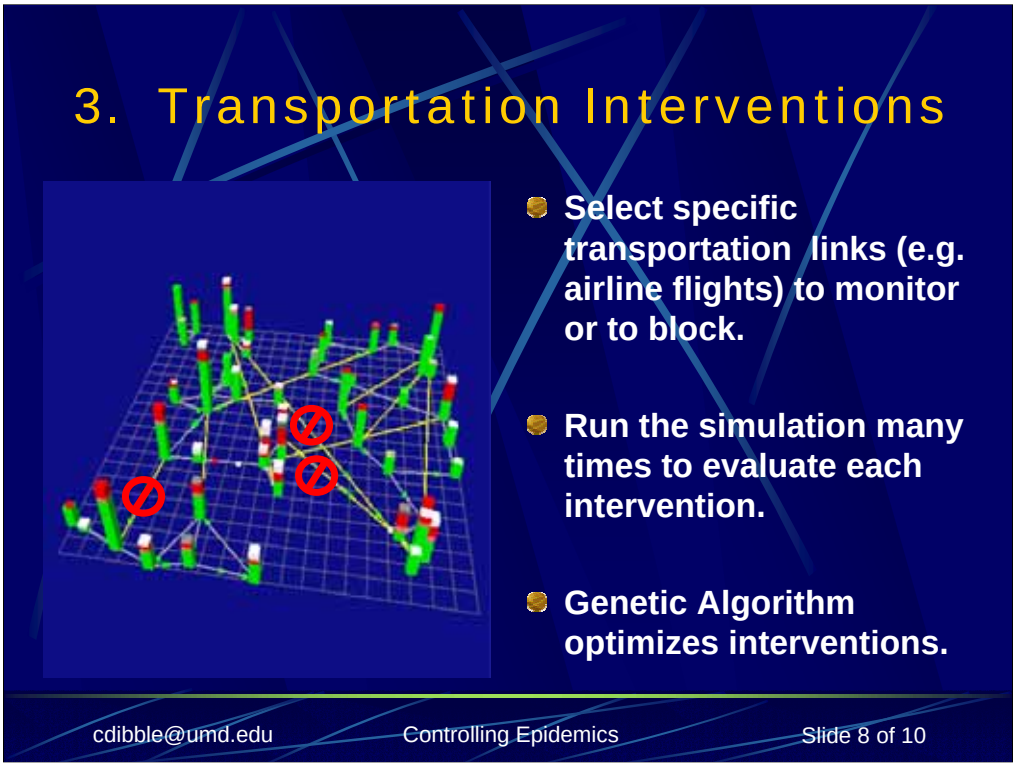


The key is to evaluate the effectiveness of these interventions based on their ability to reduce cases and deaths for the entire country. Protecting **strategically selected cities** can provide far greater leverage for protecting all cities. Which cities should be protected? This analysis can be cost-sensitive, with costs either fixed for each city or proportional to population. How to prevent the greatest number of deaths for any given intervention budget.



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