Decision Making & Analysis Tools for Biosurveillance & Biosecurity: An Integrated Model for Pathogen-Host-Environment Interactions

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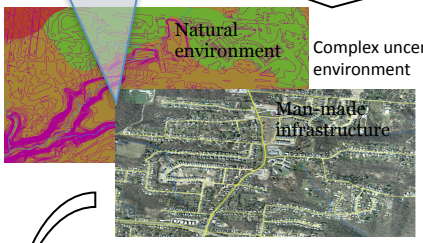
Integrated Model for Pathogen-Host-Environment Interactions

Agent Fate & Transport
Pathogens make their way into municipal water distribution system from a contributing watershed. The transport model is coupled with a Geographic Information System (GIS) and a risk assessment module. The model output contains information on probability of exceeding a safe pathogen concentration threshold in water at any point in time and space.

Sample & Data Processing
Environmental & epidemiological samples taken from different sources are analyzed in the lab. This information is combined with transport & risk assessment model, and disease transmission & progression model.

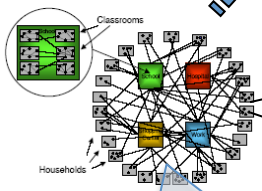
Environmental Contamination
Infected hosts shed agents into the sewage system, thus completing the environment – host - environment transmission pathway. Contaminated biosolids from water treatment plants may be deposited in landfills or used as fertilizers.

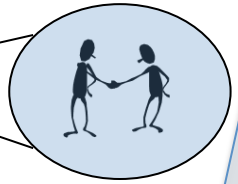


Complex uncertain environment

Lab
- Sample processing
- Bio Information storage
- Data analysis

Susceptible → • Infected • Symptomatic • Asymptomatic → Removed





Exposure
Hosts are exposed to pathogens from drinking water or during recreational activities. Host-to-host infectious contacts take place in a variety of settings (home, school, hospital, *etc*).

Host Disease Progression & Transmission
The progression of disease of infected individuals is modeled on multiple scales involving within-host cellular population dynamics & host-to-host transmission in populations. Medical interventions are incorporated into the model.

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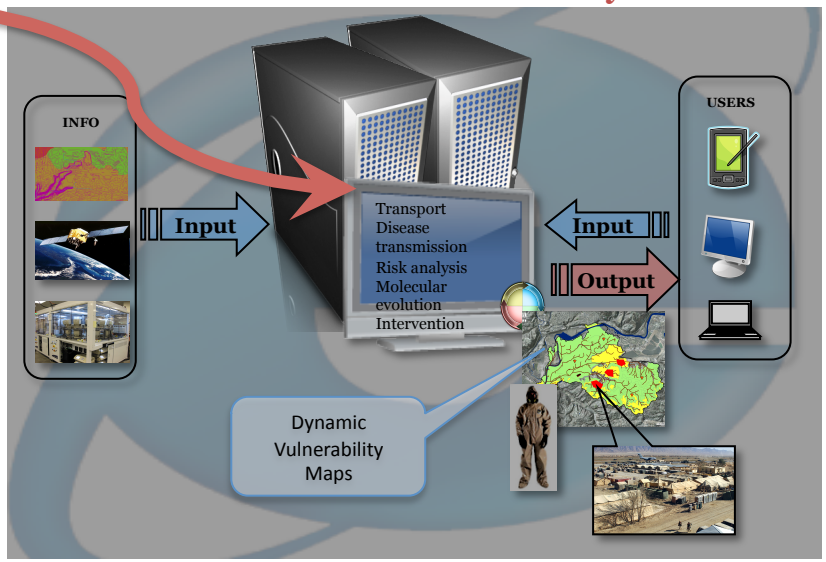

Web-based, comprehensive, systems-based decision making tool

- Better understanding of links between ecological processes & human health on local & global scale
- Prediction & prevention of infectious disease outbreaks due to waterborne pathogens
- Rapid response during such events

- **Framework:** the computational engine located on a central server to enable employment by users from a large variety of platforms including Personal Digital Assistants (PDAs).

- **Input information** for simulations provided by users & also compiled using local area information from epidemiologic studies, geological surveys & geographic Information Systems (GIS). Lab data & metadata from environmental and biosurveillance efforts, as well as high-resolution satellite/imaging data are used.

- **Integrated Model for Pathogen-Host-Environment Interactions** is executed on central server & describes pathogen transport in the environment, epidemiologic & evolutionary processes.

- **Risk analysis** using systems reliability methodology is performed at any desired temporal & spatial resolution, down to scale of individual camps or houses.

- **Output** contains
  - **Dynamic vulnerability maps** with locations of highest contribution to overall risk
  - Results of **sensitivity analysis** identifying the most important environmental/ epidemiological factors contributing to overall risk.