Pandemic Influenza Impact on Workforce and Critical Infrastructure

The National Infrastructure Simulation and Analysis Center (NISAC), a program under the Department of Homeland Security's (DHS) Preparedness Directorate, provides advanced modeling and simulation capabilities for the analysis of critical infrastructures, their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of preparedness, consequence and risk analysis, policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.

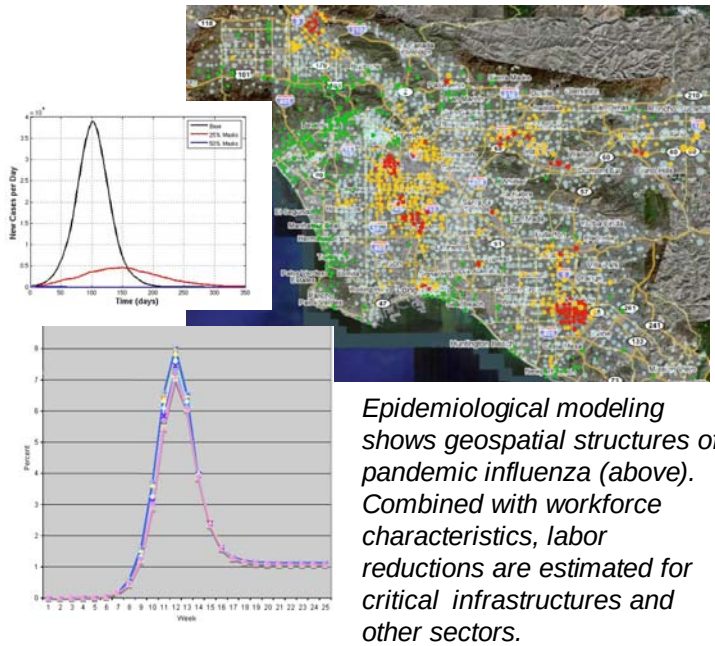
Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL) are the prime contractors for NISAC, integrating the two laboratories' expertise in infrastructure disruption/vulnerability modeling and simulation under the direction of DHS's Infrastructure Protection/Risk Management Division.

Pandemic Influenza Analysis

NISAC models have been enhanced to simulate multi-scale epidemiology and the public health infrastructure. NISAC analysts are using these models to examine disease spread at census-tract level nationally and at an individual level on a regional scale.

Using expected manifestations at the seasonal, 1958/68, and 1918 pandemic levels, explicit modeling of relevant aspects of the public health system has enabled NISAC to couple model output to population, workforce, infrastructure asset, and economic consequence assessments. Analyzed for geospatial structure, modeling output has revealed hotspots, strong correlations with average household size, and other demographic characteristics, emphasizing the importance of geospatial structure for pandemic planning at the local level.

Selected aspects of proposed national pandemic plans, mitigation and response options are being simulated in this ongoing project. In depth sensitivity analysis is planned for strategies deemed most effective and robust.



Epidemiological modeling shows geospatial structures of pandemic influenza (above). Combined with workforce characteristics, labor reductions are estimated for critical infrastructures and other sectors.

Pandemic Influenza Policy Analysis

Conclusions from the epidemiological and mitigation strategy analyses conducted to date include:

- Response time is most important, other factors are secondary
- Partially effective response early is best
- Geospatial dynamics are important
- Face masks can reduce or prevent an epidemic
- Border control can only delay an epidemic and a 95% reduction in the contagious individuals entering the country delays the epidemic by 5 weeks
- Social distancing is also effective in delaying an epidemic, but returning to normal interactions without other mitigation measures causes waves of outbreaks. This strategy corresponds to historical interventions and disease outbreaks.

Working in collaboration with the DHS Science and Technology's Critical Infrastructure Protection Decision Support System (CIPDSS) program, NISAC developed models of workforce impacts on infrastructure operations. These models will be used to evaluate pandemic effects on infrastructures and provide input to the analysis of national economic impacts.

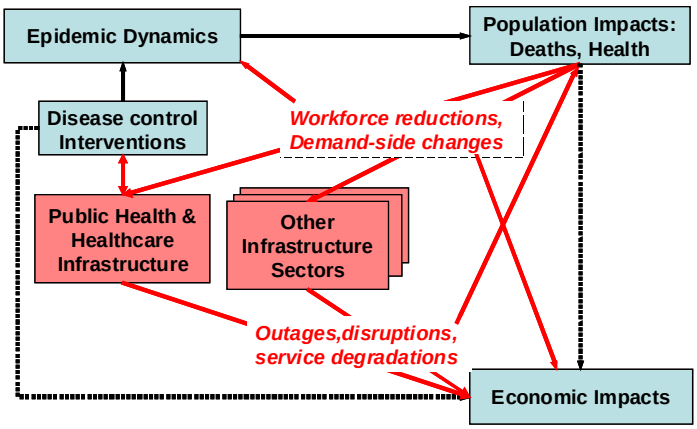
Modeling/Analysis Approach

- Using population and workforce data, epidemiological results are translated into impacts on labor categories by infrastructure, industry and commercial sector
- Functional relationships of labor categories on infrastructure operations are modeled for each sector
- Reductions in workforce are used to estimate reductions in infrastructure service provision
- Impacts of mitigation strategies on workforce are modeled and used to estimate impacts on infrastructure service provision

Impacts on Labor and Infrastructure Operation

Systems models of infrastructures are used to evaluate the effects of labor shortages on operations (transportation, telecom, and energy); data analysis is used to develop labor models for the other infrastructures (banking and finance, water, government, agriculture/food, etc.). Different processes in infrastructure supply chains are represented in the model, and include the effects on the workforce due to illness, parents having to stay home with sick children, employees refusing to go to work out of fear (worried well) and fatigue in staff that are working extraordinary hours.

The NISAC and CIPDSS approach to estimating the economic impacts of a pandemic are comprehensive and multi-dimensional, based on known interactions between labor supply, industry output, consumer demand, and households. By having the economics modeling take a systems approach that is similar to the epidemiological and infrastructure modeling approach, a rich environment is created for cross-model comparison and validation.



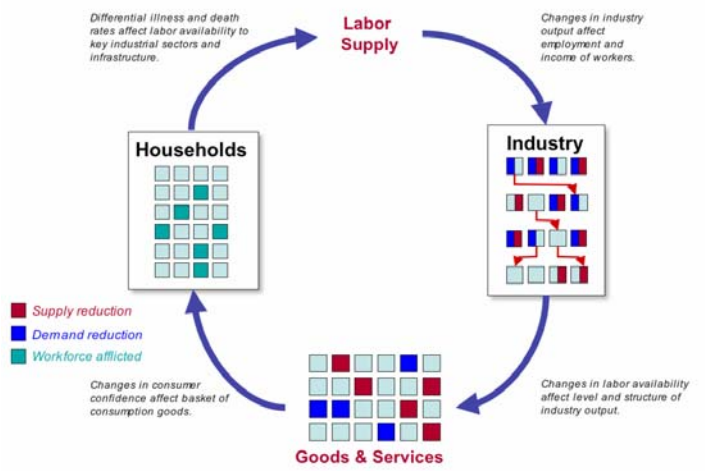
The impacts of a major contagious disease can be dominated by infrastructure disruptions

Estimating the Economic Impacts of a Pandemic Influenza

A central model of how firms adapt to labor losses, under varying epidemiological and government response conditions is applied to estimate the impacts of pandemic morbidity and mortality on infrastructures, their interdependencies, and the economy.

Analyses include the identification of infrastructure and economic vulnerabilities caused by labor losses and overall economic conditions. Estimates are made of:

- firm-level responses by industry, firm-size, policy taken
- socio-demographic effects
- regional and national, short-run and long-run losses in output, employment, trade, price levels



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