A SCIENCE-BASED TOOL FOR EMERGENCY PLANNING

The Scout motto “Be prepared” applies to many fields, including federal, state, and city emergency preparedness. For several decades, Lawrence Livermore researchers have helped federal emergency officials and their state and local counterparts gain a better understanding of the science behind natural and human-caused disasters. (See S&T, April/May 2015, pp. 4–13.) As a part of that effort, Livermore engineer Maureen Alai and a team of Laboratory engineers, computer scientists, and health physicists have recently developed a planning resource that can assist local governments in determining the best actions to take following the detonation of an improvised nuclear device (IND).

The IND City Planner Resource (iCPR) grew out of an earlier request from the Federal Emergency Management Agency (FEMA) and other Department of Homeland Security (DHS) agencies to further the science-based understanding of what to expect from an IND detonation. Several years ago, DHS—which provides technical guidance for regional, state, and local authorities that prepare IND response plans—asked the Laboratory to develop a tool that provided in-depth analyses for emergency planners. As part of the effort, Alai and the research team were tasked with developing a tool that provided city-specific, scientifically based IND effects information.

To help cities prepare and plan for the potential detonation of an improvised nuclear device (IND), the IND City Planner Resource (iCPR) provides downloadable animations that show how fallout radiation’s effect on an area evolves over time, from detonation out to one year. This hypothetical example illustrates plume projections (top right) 55 minutes and (bottom right) 11 hours after detonation.

Alai, along with colleague and materials scientist Amy Waters, proposed a standardized modeling and post-processing approach to develop a web-based tool for providing faster, more cost-efficient analyses for emergency planners. As part of the effort, Alai and the research team were working with other national laboratories, technical organizations, and federal agencies, Lawrence Livermore demonstrated that local planning could save thousands of lives. The analyses, which originally focused on seven major U.S. cities, were well received and highly valued by the areas’ emergency planners. The success of this work prompted other cities and regions to request their own evaluations. However, a detailed city-specific analysis took approximately one year to complete, making it difficult to meet the growing demand for “more.” Born from this need, iCPR provides U.S. cities and regions a less costly, more efficient tool for developing response protocols.

Doing More for Less

The genesis of iCPR began when FEMA and DHS’s Science and Technology National Urban Security Technology Laboratory (NUSTL) asked Livermore to explore ways of providing faster, more cost-efficient analyses for emergency planners. As part of the effort, Alai and the research team were asked the Laboratory to develop a detailed assessment of how U.S. cities and regions could prepare for an IND detonation. Such a device would release energy equivalent to 10,000 metric tons of TNT. At the time, little science-based research existed on the likely effects and best mitigation strategies for a low-yield, ground-level IND detonation in a modern U.S. city.

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The technical foundation for iCPR stemmed from this previous work. Ultimately, a successful iCPR tool needed to provide users with several key features: an IND’s prompt and delayed effects (to guide evacuation planning); potential impacts to critical infrastructure and key resources, such as power grids and hospitals (to determine the availability of resources); building protection factors (to show how sheltering in structures could affect radiation doses from fallout); and injury and casualty information (to help ascertain the medical needs of victims).

Alai, computational engineer Stephanie Neuscamman, and statistician Kristin Lennox also identified two “uncertainty drivers” for the scenarios—terrain and weather. Alai explains, “Since the fallout cloud forms into the atmosphere’s upper levels, we initially speculated terrain might be unimportant in how fallout patterns evolve. Models and simulations showed substantially aid the response and recovery process by accelerating the speed of execution, improving public health and safety, and addressing major resource limitations and critical decisions before an incident. The technical foundation for iCPR stemmed from this previous work. Ultimately, a successful iCPR tool needed to provide users with several key features: an IND’s prompt and delayed effects (to guide evacuation planning); potential impacts to critical infrastructure and key resources, such as power grids and hospitals (to determine the availability of resources); building protection factors (to show how sheltering in structures could affect radiation doses from fallout); and injury and casualty information (to help ascertain the medical needs of victims).

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Levatin developed and implemented detailed injury and casualty analyses based on a methodology from a previous project by Buddemeier that provided essential estimates of health impacts for each scenario. Levatin also used FEMA’s HAZUS database—which typically helps estimate and visualize potential losses from earthquakes, floods, hurricanes, and tsunamis—to obtain detailed information on building types for each area. Using HAZUS data and NARAC model-based building protection factors, Levatin developed map estimates illustrating the protection provided by buildings from fallout radiation down to the census block level. Such maps can inform planning strategies for sheltering in place and evacuation.

In addition, computer scientist Whitney Kirkendall developed an interactive geographic information system (GIS) component consisting of infrastructure and building protection modules. Using this capability, IND effects data can be overlain onto customizable maps. Alternatively, the DHS-supported Homeland Security Infrastructure Program Gold database, or Levatin’s building protection data, can also be overlain onto GIS and queried for each of the iCPR scenarios. This GIS component helps planners see the specific effects of an IND on their community.

Emergency planners can use the interactive GIS at the heart of iCPR to display a fallout radiation zone on a map, change maps, and explore different critical infrastructure and key resources, such as hospitals (shown here).