

Estimating the Total Economic Impacts of Terrorist Attacks: Computable General Equilibrium (CGE) Modeling of Resilience and Extended Linkages

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This research focused on five areas:

Advances in computable general equilibrium modeling for application to terrorism: This included conceptual advances in incorporating more features of resilience and in modeling disequilibrium, as well as updating an LA County model and constructing a U.S. model. The research team (Rose, Oladosu and Liao) applied the LA model to a 2-week disruption of water and power systems, with the former published in Risk Analysis. The results indicated losses in excess of \$20 billion in terms of business interruption for each case. However, taking full advantage of resilience at the level of the individual firm, market, and regional economy could reduce these losses by 80-90 percent. This is primarily due to the fact that these disruptions are caused by damage to infrastructure but not factories (unlike an earthquake, for example) and are of short duration, so that firms can readily recoup a large portion of lost production since they are unlikely to lose customers on a permanent basis.

Advances in modeling and specifying resilience: A definitive paper on the topic was accepted for publication in Environmental Hazards: Human and Social Dimensions that establishes a strong foundation for the analysis of economic resilience. This included an effort to make the definition compatible with definitions in related disciplines and to develop metrics for static (resource re-allocation) and dynamic (recover and reconstruction) aspects of the concept. A related project sponsored by the DHS Integrated Network of Centers on economic resilience was begun with one aspect involving the further refinement of the metrics to the activities of the Transportation Services Security Administration (TSA). A related project sponsored by the DHS Integrated Network of Centers on economic resilience was begun with one aspect involving the further refinement of the metrics to the activities of the Transportation Services Security Administration (TSA). This project, coordinated by Adam Rose, involves other CREATE researchers (Gordon, Richardson, and Moore), as well as researchers from START, PACER, FAZD, and NCAFD. Another aspect of the project relates to the development of a computable general equilibrium model to serve as an organizing framework for the various advances in analyzing and measuring resilience.

Analysis of the economic impacts of shutting down the U.S. border to a terrorist or health threat: The research team (Rose, Asay and Wei) used the Regional Econometrics Models (REMI), Inc. Policy Analysis Model to estimate the cost of a complete shutdown of the U.S. borders to imports, retaliation on U.S. exports abroad, migration, and international travel.. The results indicated a loss of GDP of \$1.4 trillion on an annual basis, which can be pro-rated for more likely shorter periods of time. An important aspect of this study was an evaluation of the REMI Model for use in terrorism impact analysis. We concluded the model could not be applied without significant refinement, though it should be kept in mind that this would also apply to most if not all pre-packaged models when applied to extreme scenarios.

Development of a module for the RAMCAP-Water decision support tool for DHS: The supplementary module, Regional Economic Impact Model (REIM) is able to quickly estimate the economic impacts of a disruption to water and wastewater systems. It contains a set of default databases that can be manipulated by the user, including substituting user-specified data for the analysis. The program is devised to be user friendly and to be integrated in the overall RAMCAP framework. It is under consideration for circulation to the membership by the American Water Works Association.

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Developing a framework for estimating the total economic impact of a terrorist attack: The team advised on the National Bioterrorism Encounter Measures Center bi-annual report to the President. It developed a comprehensive analytical framework for terrorist impact analysis and advised a researchers at Battelle Memorial Institute and a CREATE team using input-output models as to its application. Phase 2 of the project was begun with further refinements of CGE modeling to estimate economic impacts of various bioterrorist threats on a range of targets.

Figure 1 illustrates details of the modeling framework for the case of a hypothetical radiological attack on a municipal water system. In the left hand margin of the figure, the various stages in the causal chain of events leading from event to consequences are listed. Across the top margin, the hierarchy of analysis is distinguished, beginning with the water system itself and extending through to the macro level consequences. Note also that the figure distinguishes impacts on businesses and households, as well as including linkages and impacts relating to decontamination/remediation and reconstruction/resettlement.

The flow of events in Figure 1 begins with the example of a “radionuclide attack” in the upper left-hand corner, which results in an actual water system contamination. However, as expressed by the dashed line in the figure, suspected water system contamination may cause a shut-down of water services or “do not drink/use” edicts in neighboring areas. Both the real and imagined contamination will lead to direct business interruption losses, with the suspected water system contamination working through the “fear factor.” Only actual water system contamination will result in deaths and injuries, which will then translate into lower effective demand for goods and services, i.e., increased business interruption (BI). Direct effects then cause changes in supply and demand through markets, with prices changing to achieve new equilibria (indirect BI). Evacuation and relocation can help reduce the number of deaths and injuries, but, at the same time, this results in an increase in BI as well. In fact, massive evacuations can result in larger BI than would be suffered from an actual event. In such instances policymakers place a higher premium on saving lives than on business activity. Note that resilience influences many of the linkages. Microeconomic options for resilience include input/import substitution, conservation, use of inventories and rescheduling of activities.

At Macroeconomic Level I, the direct BI and direct business stimulus are injected into the broader economy subject to resource constraints to capture price and quantity interactions in multiple markets. At this initial macro level, resilience relates to the rationing role of prices for goods, such as water, in short supply, as well as general signaling of relative scarcity of resources and goods for the economy as a whole.

Another layer of impacts stems from protection and remediation. Here, decontamination and reconstruction of the water system decreases the damaging agent and thus stunts the business interruption. In addition, decontamination or reconstruction of businesses and remediation or buyout of homes both could stimulate economic activity at the direct level. However, they typically siphon off resources from other activities, and this combination of effects comes together at the general equilibrium level, such that the positive stimulus might be more than offset by the diversion of the necessary resources from normal (and often more productive) economic activities. Also coming into play at this level is the role of external assistance and its effect on government fiscal operations. Massive expenditures on security, either warranted or affected by the “fear factor,” would also represent an extended linkage.

The final perspective in Figure 1 is referred to as Macroeconomic Level II, which provides details of the overall outcome. Note, however, that these details are not additive (recall our admonitions against double-counting for indicators that subsume each others or with respect to adding outcomes that are expressed in different units, e.g., income and employment). The bottom line macroeconomic indicator would relate to the total production in the economy, stated in terms of gross output (total sales) or some net measure such as gross regional product, value-added, or income. Employment is also listed, since, as

we noted before, it contains broader aspects of the “human condition.” Other details would include the government sector fiscal position (the extent to which the government incurs a deficit or finds other ways to finance the situation, and the effects of the disaster on its ability to borrow). This would also relate to matters of external aid and reduced tax payments from a deterioration of the tax base, both stock (property) and flow (sales). This final column also includes the value of death, injury, and trauma to the population.

With respect to more extended linkages, the analysis would ideally evaluate changes in real estate values, though it would include only those that continue in the long run. It would also evaluate impacts on financial markets. This would include factors such as the interest rate, which would have a major bearing on micro decisions (housing sales), fiscal considerations (government’s ability to borrow), and other macro variables (money supply, exchange rates, etc.).

Finally, the last column includes aspects of enhanced productivity, resilience, and security. Many of these stem from explicit policies, investments and experience, such as reconstruction and enhanced protection of the water supply, learning by businesses and households on how to cope with terrorist attacks, and heightened security.

In addition to work on resilience noted above, research was begun on further development of the analytical framework through a study on extended linkages funded by the National Science Foundation Human Social Dynamics Program. One major objective of the research team (Slovic, Burns, Rose and Asay) will be to measure the direct and indirect economic impacts of risk amplification such as the “fear factor.”

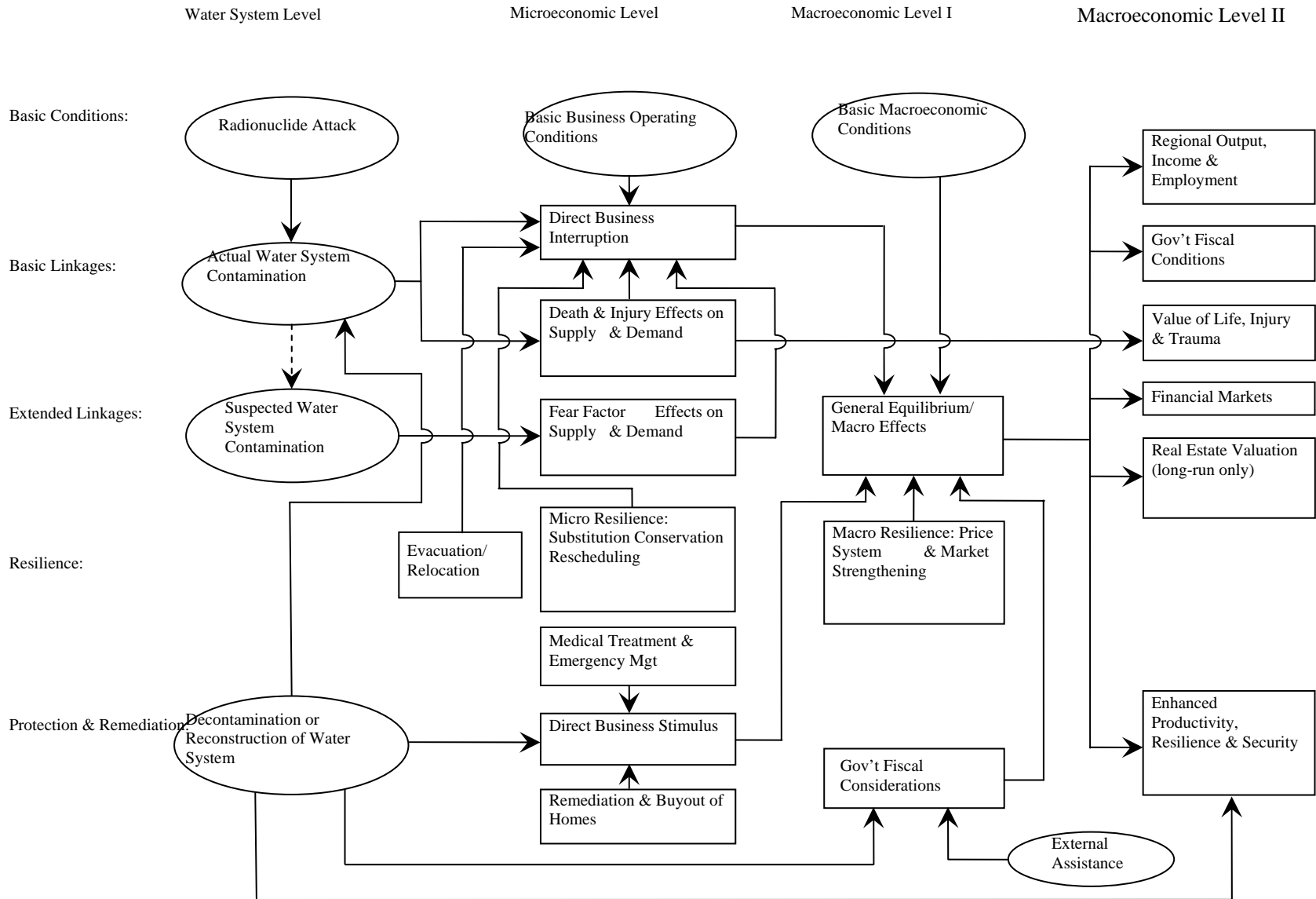


Figure 1. Estimating the total economic impacts of a radiological attack on a municipal water system