ECONOMIC IMPACT ANALYSIS FOR DISASTER ASSESSMENT AND PLANNING: A REVIEW OF TOOLS AND TECHNIQUES

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Executive Summary. This paper presents a non-technical review of tools and techniques for assessing the impacts of disasters at the local level. To set the framework for discussion, the paper begins with a review of macroeconomic analyses of disaster events. The tools and techniques reviewed include surveys, econometric techniques, input-output models, hybrid I/O-econometric models, computable general equilibrium models, ARIMA models, economic accounting approaches, and the HAZUS impact model developed by FEMA. The paper concludes with a discussion of how these models could be used by economic development professionals for disaster planning and mitigation.

The purpose of this paper is to offer the economic development professional a review of the tools and techniques commonly used to assess the economic impacts of disaster events. Some of these techniques can be accomplished by professional staff with training in conducting regional research. Others require advanced skills that are more consistent with technical staff in large state development agencies or consulting experts. Each approach has its advantages and limitations based on ease of use, data requirements, accuracy, costs, and timing. The specific needs, skills, and resources available to the development professional will largely influence their choice of impact assessment approaches.

The hurricane events of the past three years – in addition to mud slides, floods, and other catastrophes – have reinforced awareness among economic development practitioners and their stakeholders of the challenges in responding to business disruptions due to a disaster. Once human needs are addressed, such as treating injuries, providing temporary or transitional housing, and repairing critical services, the community must assess an event’s impacts on the business community and its implications for employment, labor income, and economic sustenance. For example, if a railroad bridge into town suffers structural damage, the plant relying on rail service to deliver raw materials may have to shut down operations. As noted by the American Red Cross, 300 businesses outside of the immediate impact zone of the Oklahoma City bombing were negatively affected by the event (Thompson, 2004).

Importantly, the tools and techniques described in this article are increasingly being used to aid in disaster planning.
and mitigation efforts. There is never enough money available to completely protect everything and everyone from disasters. Therefore, disaster planners working with economic development professionals need tools and information to assess which economic sectors of a community are most vulnerable to disruptions, and how to choose where best to direct disaster mitigation efforts.

While most of this article is devoted to economic impact analysis at the local level, a brief review of macroeconomic level analyses of disaster events provides some background to the issue at hand. This section is followed by a review of specific tools and models used at the local level to assess disaster impacts. The paper concludes with some general remarks about the increasing role of the economic development professional in responding and planning for disaster events.

**Measuring Disaster Losses**

Economic development professionals will almost never be called on to estimate the direct physical damage caused by disasters. This is a job for engineers, architects, construction specialists, and others. These damages include property damage to buildings and infrastructure, debris removal, and the cost of emergency protective services (McEntire and Cope, 2004). It is the losses associated with employment, income, and indirect losses that occupy the efforts of development professionals and the economists they hire in assessing the consequences of a disaster. Though there is some disagreement among scholars as to exactly what counts as indirect costs, they generally include the loss of business activity due to reduced activities at damaged firms, loss of income in secondary and tertiary employment, and business disruptions not directly attributable to damage. For example, if a manufacturing firm is damaged sufficiently to disrupt production, then they will not require trucking services to deliver raw materials or pick up finished goods, which may impact the employment of drivers. Rose (2004) illustrates indirect effects with the example of a utility plant being damaged resulting in utility customers (businesses) not being able to operate. Cochrane (2004) uses the comparatively simple definitions that direct damage is property damage plus lost income, and indirect damage is anything else. Rose, along with other researchers cited in his study, find that direct and indirect business interruption losses can be as large as physical losses. Of course, the degree of impact of a disaster depends in large part on the scale of the analysis.

Macroeconomic analysis considers economic events and activities on a national scale. Dacy and Kunreuther (1969) held that the total national cost of a disaster is the replacement value of the property damaged, regardless of the presence of a relief program. Even when other costs are included, it is a matter of simple division to see that disaster impacts rarely have a meaningful impact on a national economy. Whatever the damage, the divisor is very large. As noted by Mileti (1999), capital markets are simply too large to be disturbed beyond a short period of time by natural disasters. The notable exception would be sustained droughts in countries with an agrarian-based economy (Albala-Bertrand, cited in Horwich, 2000).
The Great Hanshin earthquake struck Kobe, Japan on January 17, 1995. In the earthquake and subsequent fires, more than 100,000 businesses were destroyed, 300,000 individuals became homeless, and 6,500 people were killed with total damages estimated at $114 billion (Horwich, 2000). The damage estimate represented about 2.5 percent of Japanese gross domestic product (GDP) in 1995. Yet within one year trade at the port was operating at close to pre-earthquake levels, at 15 months manufacturing was operating at 98 percent of the pre-earthquake trend, and within 18 months all department stores and 78 percent of small shops had reopened (Horwich, 2000; Landers, 2001). Data from the US Department of Labor estimates that Hurricane Katrina took 230,000 jobs from directly affected areas, but that total national employment for the month of September 2005 declined by only 35,000 – little more that a statistical blip on the economic map (Balls and Swann, 2005). Tavares (2004), using pre-Katrina data, calculates that natural disasters lower US GDP by 0.052 percent per year. Nobel Laureate Gary Becker (2005) has noted that even the pandemic flu of 1918-1919, which killed an estimated 30 million people, had no major effect on the world economy.

From a national perspective, much of the economic activity lost due to the physical damage is regained in the form of rebuilding and repair. As suggested above, large industrialized nations have substantial resilience due to their size and breadth of economic activity. However, even smaller nations, in terms of economic output, appear to possess economic resilience to disaster events. One week after the Sumatra tsunami of 2004, the Indonesian and Malaysian stock markets had gained value from the pre-disaster level, the Thai stock market declined slightly, and the Sri Lankan markets were off only a few percent (Becker, 2005). Of course, the same may not hold true for smaller nations with more specialized economies.

In addition to the previously mentioned agrarian-based economies, Auffret (2003) finds that natural disasters are an important determinant of economic volatility in Caribbean economies, which is attributed, in part, to consumption shocks due to underdeveloped or ineffective risk management mechanisms. Of course, tourism-based economies are subject to market responses to disaster events – or predictions of disaster events – over which they have little control.

The other factor that minimizes the impacts of most disasters is their short duration. Waters recede, storms pass, and eventually droughts break. But for some types of disaster, the threat of an event can have a long-term effect on macroeconomic performance – specifically the threat of terrorism. Tavares (2004) estimates that the continuous threat of terrorist attacks reduces gross domestic product in Israel by four percent. The Basque region of Spain, which has seen decades of separatist terrorist activities, loses about ten percent of its potential economic activity due to the threat of terrorism. Hobijn (2002) estimates that increased security costs incurred after 9-11 has reduced US economic activity by 0.66 percent. Moreover, aggregated analyses at the macroeconomic level miss the intensity of regional and local
impacts that create comparative winners and losers when disaster strikes.

It is well documented that the cost of disasters are rising, though care must be taken when making comparisons across time and when translating impacts across different currencies. Milet (1999) reports the following disaster cost estimates based on a review of several studies:

- Loma Prieta Earthquake 1981 $10 Billion
- Hurricane Hugo 1989 $6 Billion
- Hurricane Andrew 1992 $20 Billion
- Northridge Earthquake 1994 $25 Billion

Current assessments of private and public liabilities for rebuilding New Orleans in the wake of Hurricane Katrina exceed $200 billion. Yet, there are mitigating factors and evidence to suggest that the impacts are not always as large as advertised. Tomsho (1999) reports on one of the most common factors that complicates the assessment of damage costs of disaster events – the Jacuzzi effect. The Jacuzzi effect occurs specifically when homeowners add new or improved features to their dwellings during disaster repairs. Of course, this ability to rebuild and restructure is one of the primary reasons that post disaster regional economies often improve their performance in the long term. As noted by Horwich (2000): “Destruction of physical assets is a form of accelerated depreciation that hastens adoption of new technologies and varieties of investment” (page 530). In addition, federal grants and low-interest loans act as economic stimuli with effects similar to transfer payments. The Charleston, South Carolina economy received $370 million in unexpected income after Hurricane Hugo in 1989 that helped the local economy to perform better than expected in seven of the ten quarters following the disaster event (Tomsho). But, as suggested earlier, the overall effect masked a great deal of disruption and volatility. Some businesses were permanently destroyed while new businesses opened.

The tools and techniques of economic impact analysis can bring an understanding of the dynamics of the economic churn that is sparked by a disaster event. Which industries are most heavily impacted? Which are most likely to gain? A few years ago while riding in a taxi in Derry, Northern Ireland, the driver observed to me that the first people on the scene of a terrorist bombing in his city are often the construction contractors preparing their repair bids. Even if this is a bit of an Irish yarn, it clearly points out that some industries and businesses will see potentially huge increases in their business activities resulting from disasters.

Techniques and Models of Disaster Impact Assessment
Economic development practitioners and their consulting experts have a choice of several techniques for assessing the indirect and income effects of disasters. These techniques include surveys, econometric models, Box-Jenkins time series analyses, input-output models, general equilibrium models, and economic accounting models (Cochrane, 2004; Chang, 2003; Zimmerman, et al., 2005). Table 1 at the end of this paper offers a summary of characteristics for each methodology.

Surveys provide direct information from those impacted or in close association with those directly affected by disasters.
They can be flexible in design to accomplish simple data gathering (How much will it/did it cost to rebuild your facility?) to more in-depth approaches (How did you finance your rebuilding? Have you lost customers because of down time? Are you looking to relocate your business?). Tierney (cited in Rose and Liao, 2005) used surveys to assess impacts on businesses of the 1993 midwest floods and the Northridge earthquake. The largest problem with survey approaches is non-response bias. The researcher cannot know if the respondents are truly representative of the broader population of disaster victims. Given the psychological trauma associated with disasters, the researcher would have to be diligent in assessing response reliability — respondents’ answers may change if questioned immediately after the event versus six months later. There could be issues of strategic behavior in the responses such as exaggerating losses in the hope of attracting additional aid. There are also potential logistics problems with surveys. Researchers may not have access to the disaster area immediately and may be unable to locate victims later. Moreover, the most appropriate survey medium would likely be in-person interviews, which are expensive and time consuming. To capture all of the economic interactions in a regional economy, the number of interviews could be very large. Still, surveys offer the best opportunity for obtaining direct, relevant data.

Econometric modeling approaches can be used when there are substantial data readily available for the affected region. Using a variety of regression techniques, the fully-partialled effects of a disaster event can be modeled as an intrusion on a series of data. (Fully-partialled means that other factors affecting the economy are controlled for statistically so that the estimates relate to only those costs associated with the disaster.) However, data availability can be a problem. Much of the economic data that would be used are gathered and published with substantial lags. This approach may not be practical until two or three years after the event. Of course, predictive models can help us understand post-disaster dynamics, but most econometric approaches do not easily account for product substitution, immediate changes in the imports of goods, or the non-linear nature of production functions inevitable when an economy receives a significant shock. Still, several researchers have offered credible analyses using regression techniques including Ellison, et al. (1984); Cochrane (1974); and Guimaraes, et al. (1993) among many others.

One econometric modeling approach is to use variations of hedonic pricing models. Hedonic models (derived from the term hedonism) account for preferences in purchasing decisions. These models are most commonly used in real estate research to explain why some homes are more desirable (higher priced) even when other factors such as size and features are the same. MacDonald, et al. (1987) use a hedonic model to assess housing value impacts of being located in a flood-risk area. Brookshire, et al. (1985) examine hedonic price gradients based on earthquake safety attributes for housing. This modeling approach could add valuable insights into consumer behavior, especially if standard housing price models are adapted for longitudinal studies to examine changing hedonic
factors in cases of recurring disaster events, such as housing prices in Florida after multiple major hurricanes or the impacts on small businesses hit by multiple disaster events.

A variation on the intrusion model method is an Auto-Regressive Integrated Moving Average (ARIMA) model. This analytic technique takes a Box-Jenkins approach to time series analysis. A Box-Jenkins analysis uses previous values of the study variable to predict the next value. Data analysis software packages use complex algorithms to account for secular trends in the data (e.g., is overall employment rising or falling?), the correlation between current and previous observations, seasonal variations, and other factors. For example, in examining the impacts of a tornado event on local retail sales, the analyst considers trends and patterns in a series of relevant data. The ARIMA model would control for a trend that total retail sales have generally risen over several years, seasonal variations for Christmas, back-to-school, and other especially busy times, and the fact that if a retailer is successful one month, they will likely be successful the following month. The ARIMA model provides a prediction for what retail sales should be, which can then be compared to what actually happened after the disaster. The difference is an estimate of the disaster’s impact on retail sales. The biggest weakness of this approach is being able to account for confounding concomitant events — such as a large retailer closing about the same time as a disaster for unrelated reasons. Because ARIMA models do not require the gathering of data for large numbers of relevant variables, the approach is very cost effective. Enders, et al. (1992) use an ARIMA model to assess losses in the tourism industry due to terrorist events, while Worthington and Valakhani (2004) use this modeling technique to estimate the impacts of disasters on the Australian All Ordinaries averages. Due to its relative simplicity and powerful analytical strengths, this data analysis methodology should be more widely used in disaster research.

Input/output (I/O) models are based originally on the work of Wassily Leontief in the 1930s in which the flow of goods across industries are captured using transaction matrices. For any given commodity, there are raw materials, goods, and services purchased as inputs in the production process. Based on economic surveys, we know, on average, which industries produce which commodities and services. These models then provide a description of how demand-satisfying production creates upstream and downstream economic activities. For example, a writing pad is made of backing, paper, ink for the lines, and glue to bind the pages. There are firms that produce each of these inputs. In addition, the paper converter (manufacturer of goods converted from raw paper) hires accountants, computer services firms, and trucking companies, buys advertising space in trade publications, and purchases a host of other goods and services to support its business operations. The I/O models then use data from government organizations such as the Bureau of Labor Statistics to reflect relationships between labor demand for production activities and prevailing salaries, wages, and benefits to estimate not only the value of economic activity associated with a given level of production for a
commodity, but also how many jobs are supported and how much is paid in labor earnings.

National-level I/O models can be adjusted for regional economies by allowing for some activities to “leak” out of the economy. If the ink used to print lines on a tablet is not produced locally, then spending for that good does not impact the local economy and the related jobs and income are created elsewhere. However, being more precise, in a large regional economy there is likely to be at least one company that makes the ink, but that does not mean that company gets 100% of local market ink sales. Therefore, the regional I/O models estimate the proportion of total spending for intermediate goods that stays in the regional economy (expressed as regional purchasing coefficients). An I/O model may or may not include the economic activities (purchases) of households, though most do. The models produce three types of impact assessments: direct, indirect, and induced. Direct effects can be thought of as direct purchases by the industry being described. Indirect effects include purchases by related companies in the supply chain, such as the ink manufacturer buying office supplies from a local retailer. The induced effects capture the economic activity created by employees spending a portion of their earnings in the local economy for goods and services. When you add the direct, indirect, and induced impacts, expressed as coefficients, you can get a total effect greater than 1.0, which is the economic multiplier. For example, demand for $100 worth of writing pads in the Houston economy could create a total of $160 worth of local economic activity when all three types of impacts are summed.

Unfortunately, the multiplier effect works when production is added and when production is lost. If the paper converter’s plant is damaged or destroyed, the related indirect and induced impacts spread across the regional economy.

The popularity of I/O modeling approaches has grown with the use and affordability of personal computers. There are two major off-the-shelf I/O models available on the market. One is produced by the Bureau of Economic Analysis (BEA) of the US Department of Commerce, and the other is called an IMPLAN model developed by the Minnesota IMPLAN Group. Both models are cost effective and offer modeling capability at the county, regions of multiple counties, and state levels.

The BEA’s Regional Input-Output Modeling System (RIMS) offers multipliers for up to 473 industry designations or 60 aggregated industry groups. Users must provide the input data including adjustments for regional purchasing coefficients and manually calculate the estimated impacts from the RIMS tables.

The IMPLAN offers estimates of economic activity at a highly disaggregated level – as many as 528 different industry categorizations. The model provides estimates of the regional purchasing coefficients (RPC) and even allows the user flexibility in adjusting RPCs. Importantly, the IMPLAN output provides detailed descriptions of how each industry segment is impacted by
changes in the study industry. IMPLAN’s report features provide
detailed multipliers and industry by
industry purchasing matrices that would
allow a disaster planner the ability to see
how losses in one industry could affect
activities in other industries within the
region.

At the basic level, I/O models are
relatively easy to use and can be used to
quickly obtain an initial impact estimate.
The greatest weaknesses of I/O models
are that they are static (measuring
economic relationships at a particular
point in time), the highly disaggregated
impacts sometimes require heroic
assumptions, and they are linear (not
accounting for scale economies). If a
new firm has come to town, or an
existing firm has departed since the data
base year, the regional purchasing
coefficients may be wrong. Because
detailed data for individual firms are
masked in economic surveys, calculating
very detailed industry estimates requires
using national level data that may not
accurately reflect local economic
relationships. Finally, I/O models do not
easily account for product substitutions,
and the coefficients are fixed, which
likely will not reflect reality in the
aftermath of a disaster. The regional
purchasing coefficients will be wrong if
a supplier is not able to provide goods or
services because of damage and the
importation of temporary service
providers and employees, such as repair
contractors, disrupt pre-event economic
relationships in the local economy. The
BEA (2005) asserts that RIMS can be
used for assessing the impacts of
hurricane Katrina in Alabama or
Mississippi, but that damage in New
Orleans was so extensive that the model
could not offer meaningful impact
estimates.

If used appropriately I/O models can
provide reasonable estimates, not exact
calculations, and are a valuable addition
to the development professional’s
toolkit. For an example of I/O modeling
in disaster research, see Rose, et al.
(1997) in which the indirect regional
economic effects are simulated for an
earthquake event that damages
electricity generating infrastructure.

I/O models can also include social
accounting matrices (SAM) that expand
the I/O model calculations to include
transfer payments, value-added
accounting, and the ability to examine
distributional impacts across households
at various income levels. IMPLAN
includes an option to use SAM
I/O model to project potential impacts of
damage to the electric industry in upstate
New York to aid regional disaster
planning.

Another adaptation of I/O modeling uses
econometric techniques to address some
of the weaknesses noted above. The
improvements include better coefficients
that more accurately reflect local
economic conditions and the ability to
alter those coefficients to adjust for the
structural economic changes that would
attend a major disaster. This approach
iteratively feeds back and forth from the
I/O to the econometric portions of the
model. Of course, the increased
complexity and accuracy come with a
price. The base models are more
sophisticated than typical I/O models
and thus are substantially more
expensive. In addition, operating and
adjusting the parameters is not typically
accomplished by the end-user without extensive training and experience. Therefore, these hybrid models usually do not offer details for as many industries as covered by I/O models.

The most widely used commercially available econometric-I/O hybrid model is REMI (Regional Economic Models Incorporated). However, a review of the disaster literature did not find any published articles using this model. Nonetheless, many state economic planning bodies have contracted access to the REMI model that could be used for disaster planning and impact analysis. For example, a REMI model could assess the regional and state level economic impacts of a tornado where repair services are being performed by a combination of firms previously located in the local economy, firms that open a permanent office in the region, and firms that send in ‘guest workers’ for as long as there is sufficient demand.

Another recent adaptation of an I/O model was developed by the Center for Risk and Economic Analysis of Terrorism Events at the University of Southern California. This model begins with an IMPLAN model of the Los Angeles area (multiple counties), then applies a regional disaggregation model to allocate induced impacts across the region at the municipal level. The disaggregation model uses journey-to-work and journey-to-non-work (shopping) transportation matrices that also account for infraregional freight flows (Gordon, et al., 2005). However, because the base data of IMPLAN does not reach the sub-county level, this model aggregates 509 IMPLAN industry sectors into 17 sectors. Still, this modeling approach could improve our ability to forecast or estimate how the economic impacts of a disaster event affect individual municipalities in a large metropolitan area. For example, Gordon, et al. use the model to assess where the greatest economic disruptions would occur within the Greater Los Angeles area if there were terrorist attacks on the ports of Long Beach and Los Angeles.

The methodology being increasingly used in disaster research over the past few years has been computable general equilibrium models (CGE). Advocates of this modeling approach assert that CGE models are much more accurate than I/O models because they can incorporate a range of input substitutions and different elasticities of supply and demand can be applied across different tiers of economic activity (Rose & Liao, 2005). If a given input in a production process is no longer available in a post disaster environment, but can be easily imported from another region, then the CGE model more accurately estimates the direct, indirect, and induced effects of this change. However, this level of flexibility is very data intensive. Therefore, CGE models rarely cover more than a few industrial sectors. In addition, CGE models emphasize equilibrium states – a situation not likely to be the case in the aftermath of a significant disaster. Among recent disaster-related research, Wittner, et al. (2005) use a dynamic regional CGE model in a simulation modeling exercise on the effects of a disease or pest outbreak, while Rose and Liao (2005) demonstrate how CGE models can be used to value pre-event mitigation. Rose (2004) reviews at least three other studies that use CGE models for analyzing disaster impacts and policy
responses. Because of its intensive data requirements and practical limitation on the number of industries that can be effectively analyzed at one time, CGE approaches to disaster impact modeling are better suited to pre-event assessments of potential impacts for planning purposes.

FEMA offers an impact assessment software that uses a combination of I/O, hybrid-I/O, and CGE modeling approaches to estimate direct and indirect economic impacts of disasters. The HAZUS-MH model is available for download from the FEMA website, but it does require geographic information system (GIS) software for input and output operations (FEMA, 2005). The HAZUS model is highly flexible, from doing a relatively quick and simple analysis using preprogrammed assumptions about the local economy (though FEMA cautions that the assumptions may be far from reality), to having to engage in detailed data gathering that would likely require the services of subject matter experts. The portion of the model that estimates indirect economic disaster impacts starts with IMPLAN data matrices and then employs adjustment algorithms similar to those described for hybrid-I/O and CGE models. While the HAZUS model does offer many solutions to the problems of I/O impact analysis, it does not offer much in the way of industry detail aggregating the total regional economy into ten basic industrial sectors that correspond to one-digit Standard Industrial Code classifications. The HAZUS technical manual, available by request from FEMA, offers a case study based on the Northridge earthquake as well as simulation studies showing applications of the HAZUS mode.

Finally, the economic accounting approach to estimating the impacts of disaster events differs from other approaches covered in this section in that it explicitly includes the valuation of human life and injuries. The economic accounting approach also draws from other methodologies to estimate business losses using case based analysis (surveys), GDP (econometric) estimates, or I/O models. These elements are then added to estimates of physical losses to estimate the total economic impacts of a disaster (Zimmerman, et al., 2005). The greatest challenge for the economic accounting method is valuing human life. The US National Safety Council uses a loss of life value of $20,000 compared to the Environmental Protection Agency that calculates the value of lost lives at $5.8 million each. The Special Master for the Department of Justice overseeing claims related to the terrorist attacks on the World Trade Centers has used life values ranging from $250,000 to $7 million (Zimmerman, et al.).

There are a number of weaknesses in the study of the economic impacts of disasters pointed to by many of the researchers cited above. Milet (1999) and Cochrane (2004) both lament that most disaster impact studies only include losses that can be measured in transactions. The loss of historic monuments, memorabilia, cultural assets, and the hidden cost of trauma are rarely quantified (Milet, 1999). In addition, Cochrane (2004) cautions against confusion over causality of a post-event loss, using too limited a time frame, and double counting losses. McEntire and Dawson (forthcoming) have called for formalizing an approach to document volunteer disaster
responders’ efforts. These researchers note that volunteer time can be used in federal grant matching requirements. Standardized methods of valuing volunteer time should be used in calculating the total economic impacts of a disaster event. While volunteers do not draw compensation, the time they spend in disaster response does have an opportunity cost.

**Conclusions**

Even with some weaknesses, there have been great strides in the analytic approaches to estimating the economic impacts of disaster events at the macro- and micro-economic levels. The challenge is to continue to improve the accuracy of our impact models, while keeping the methods computationally reasonable and having the ability to provide timely information to disaster management planners, political leaders, and responders.

Perhaps the best use of many of these tools is for disaster planning and mitigation. For example, using regional purchasing coefficients from an I/O model can provide indications of which local industries are the most vulnerable to disruptions in business activity at the area’s largest employers. Similarly, cross referencing this information with indirect and induced employment multipliers could inform local planners on which industries indirectly support the most employees in the region. If electric power generation is partially destroyed, is there an economic impact approach to deciding the order in which businesses see their power supply restored to minimize the negative effects on local employment?

While this paper has not specifically addressed the issue of assessing the fiscal impacts of disaster event on local governments, the implications are clear. If businesses can’t operate, the taxable value of their property decreases. If stores are not open or if employees lose income, sales tax revenues will potentially decline. What is the financial exposure of the City of Corpus Christi, Texas if a hurricane substantially damages local refineries, which comprise about 20 percent of total local economic output? What are the implications for a sales tax supported economic development corporation if a town’s primary retail complex is destroyed by a tornado?

Understanding the consequences or potential consequences of a disaster is critical for surviving the event. The Institute for Business and Home Safety estimates that 43 percent of all businesses involved in local disasters never reopen; and, of those that reopen, 29 percent do not survive beyond two years (Thompson, 2004). Communicating the need for planning and mitigation strategies for communities and individual businesses is essential.

In sum, allocating limited resources for disaster mitigation can be improved through the inclusion of assessments of the potential secondary economic impacts of disaster events. This modeling can also be used to improve disaster response by having local officials armed with a better understanding of how business disruptions in one sector of the local economy spread to other sectors and areas.
<table>
<thead>
<tr>
<th>Method</th>
<th>Ease of Use</th>
<th>Data Requirements</th>
<th>Accuracy</th>
<th>Costs</th>
<th>Timing</th>
<th>Level of Disaggregation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveys</td>
<td>Easy, some training required</td>
<td>Few</td>
<td>Can be very</td>
<td>Low to high</td>
<td>Immediate</td>
<td>Can be very detailed</td>
<td>Flexible, finding respondents can be a problem.</td>
</tr>
<tr>
<td>Econometric Models</td>
<td>Requires special knowledge</td>
<td>High</td>
<td>Isolate disaster effect, limited adaptability</td>
<td>Moderate</td>
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<td>Can be detailed</td>
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</tr>
<tr>
<td>ARIMA</td>
<td>Requires special knowledge</td>
<td>Moderate</td>
<td>Good</td>
<td>Moderate</td>
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<td>Can be detailed</td>
<td>Must account for simultaneous non-disaster events</td>
</tr>
<tr>
<td>Input-Output RIMS, IMPLAN</td>
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<td>Moderate</td>
<td>Has limitations, especially after massive destruction.</td>
<td>Moderate</td>
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<td>Highly detailed</td>
<td>IMPLAN can be user-adjusted to improve accuracy.</td>
</tr>
<tr>
<td>I/O Hybrid (REMI)</td>
<td>Requires special knowledge</td>
<td>Can be high</td>
<td>Good to very good</td>
<td>Expensive</td>
<td>Takes time, data lags</td>
<td>Not very detailed</td>
<td>More accurate, but costs limit level of detail</td>
</tr>
<tr>
<td>Computable General Equilibrium</td>
<td>Highly specialized knowledge</td>
<td>High</td>
<td>Very</td>
<td>Expensive</td>
<td>Data lags 2-3 years</td>
<td>Not very detailed</td>
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</tr>
<tr>
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<td>Not very detailed</td>
<td>Includes direct damage. Recognized by FEMA.</td>
</tr>
<tr>
<td>Economic Accounting</td>
<td>Specialized knowledge</td>
<td>Moderate to high</td>
<td>Includes value of lost lives</td>
<td>Moderate</td>
<td>Data lags 2-3 years</td>
<td>Can be detailed</td>
<td>Debate on how to value life.</td>
</tr>
</tbody>
</table>

*Table 1: Characteristics of Economic Impact Assessment Tools for Disaster Events*
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