

## ECONOMIC CONSIDERATIONS FOR COMMUNITY RESILIENCE

### 1. Introduction

#### *a. Purpose*

To identify and briefly describe the ways in which disasters affect the local economy and the way the economy influences the nature and severity of disasters. This includes understanding the economic behavior exhibited by stakeholders such as households, businesses, local governments and regulatory agencies, and private non-profit organizations to disaster risk. It also includes understanding the incentives those stakeholders face.

#### *b. Scope*

To consider all significant economic impacts resulting from natural and man-made disasters, and all potential community stakeholder actions affecting the occurrence and severity of disasters on local economies.

### 2. Economic Landscape

Organized around the three major sectors of the economy (*sectors are defined based on the production/supply of like goods and services*), the relevance of disasters on individual industries is discussed, including both the stress on the industries from disasters as well as the ability of industries, through action, to contribute to the resilience of communities.

Focus will be on each industry's relative inherent vulnerability to natural and man-made disasters, relevance to the response effort, and importance to short- and long-term recovery effort.

#### *a. Primary Economic Sector*

This sector includes producers of raw materials

- i. Agriculture*
- ii. Forestry*
- iii. Fishing*
- iv. Mining industries*

#### *b. Secondary Economic Sector*

This sector includes producers of goods

- i. Construction*
- ii. Manufacturing*

***c. Tertiary Economic Sector***

This sector includes suppliers of services

- i. Utilities*
- ii. Wholesale and retail trade*
- iii. Transportation and warehousing*
- iv. Information*
- v. Financial activities*
- vi. Professional and business services*
- vii. Educational services*
- viii. Health care and social assistance*
- ix. Leisure and hospitality*
- x. Other services*
- xi. Federal, state, and local government*

**3. Community Economic Development**

Community development is a major concern for local communities. Community development concerns largely consist of attracting and retaining businesses and jobs, enhancing local amenities, addressing poverty and inequality, and maintaining the quality of the local environment. Those factors also affect community resilience.

***a. Attract and retain business and jobs***

A major concern of most communities is attracting and retaining businesses and jobs. It has been observed that communities that cannot attract and retain businesses and jobs fare more poorly after disasters than communities that can. More generally, a community that cannot attract and retain businesses and jobs is one that is in decline.

***b. Increase tax base***

For most cities, local revenue sources consist of property tax and / or sales tax. Sales tax revenue is increased by attracting commercial businesses and jobs.

Property tax revenue is increased generally by increasing property values. Improving disaster resilience can help increase property values, since a reduction in the amount of losses that a property owner will suffer increases its value to the owner.

***c. Poverty / Income distribution***

A major concern of local communities is poverty and income distribution. Many projects that communities pursue are aimed at decreasing poverty in their neighborhoods, and many of the external funding sources available to communities are aimed at alleviating poverty. This concern intersects with disaster resilience in that the disadvantaged are often the most vulnerable to disasters. Improving disaster resilience often starts with protecting the disadvantaged.

***d. Local Services and Amenities***

Local communities are often interested in developing and improving local amenities. The idea is to improve the quality of life for local residents. Often there is a hope that improving local amenities will indirectly help to attract and retain businesses and jobs.

Local services are a core function of local governments. In particular local governments typically supply schools, roads and public safety. Public safety and roads directly impact the resilience of a community in the face of hazards. Schools serve as an amenity that can attract jobs and businesses.

***e. Sustainability***

Local communities are interested in ensuring that their community is sustainable. That includes two distinct ideas. One is protecting and improving their environment. Being “green,” and maintaining a small footprint are important to local communities. In turn, these can impact disaster resilience. A second is the idea of an economy that is vibrant and thriving. Economies that are not tend to fare poorly after disasters.

**4. Resilience Planning & Deployment**

Resilience planning involves the development of prevention, mitigation, response, and recovery plans. These include all actions (e.g., allocation of expenditures and decision tradeoffs) taken before a disaster. The deployment of resources involves the allocation of resources that occur during and after a disaster.

***a. Planning and mitigation***

The planning and mitigation phase requires decisions on investments to be made to reduce the likelihood and / or severity of disasters. It requires accurate risk information, well-defined implementation costs, and an understanding of how implementation alters future risks.

*i. Investment costs*

Expenditures made prior to a disaster.

*ii. Communication*

Includes the establishment and maintenance of communication channels among key stakeholders, as well as the collection and dissemination of risk information between key stakeholders and the public.

***b. Response and recovery***

The response and recovery phases involve the decision-making process allocating expenditures during and after a disaster to limit its consequences (losses), both in the short- and long-term. It also involves updating risk information between key stakeholders and the public during these phases, as risks, vulnerabilities, and community objectives may have changed.

*i. Physical and economic losses*

The consequences of a disaster in quantities (e.g., fatalities) and value (e.g., business losses).

*ii. Incurred costs*

Expenditures made during the response and recovery phases to limit the consequences of a disaster.

*iii. Communication*

Decisions and tradeoffs made during the response and recovery phases. Includes the updating of loss and risk information.

## **5. Desired Levels of Service**

*a. Economic efficiency*

Economic efficiency means obtaining the maximum benefit from the resources available. Equivalently, it means not wasting resources.

*i. Maximization of net benefits*

Improved community resilience will also increase the level of service economically. Several alternatives may be considered to maximize the net benefits to the citizens of the local community.

This assessment takes into account the fact that improved levels of service are typically more costly. This type of analysis will identify the level of service where the net benefits (that is, the increased value of the improved level of service minus the cost of obtaining that level of service) is maximized.

*ii. Minimization of cost + loss*

From an economic perspective, this is an equivalent formulation to maximizing net benefits. Since the “Level of Service” is defined in terms of minimizing costs and losses, it may be a more convenient format for analysis. Expressing the results of this analysis in terms of net benefits is straightforward.

*iii. First-cost vs. life-cycle cost*

Any effort to identify the alternatives that produce a maximization of net benefits depends on accurate estimates of benefits and costs. With regard to the costs of attaining a desired level of service, all costs, covering the entire life-cycle of any mitigation measures, need to be accounted for. It is not sufficient to include first costs only. Operation costs, maintenance costs, replacement costs and end-of-life costs (among others) also need to be included.

***b. Multiple objectives***

There are several complementary (and overlapping) objectives that are likely to be considered, accounting for the types of losses that a community wishes to avoid. In any analysis of avoided losses, care needs to be taken to ensure that savings are not double-counted.

*i. Minimize economic losses*

The simplest consideration is that of minimizing economic losses. Treated in isolation, that simply means making sure that the difference between economic gain (in terms of losses avoided) and costs of the desired level of service are maximized. It is simpler than the other considerations because costs and benefits are both in dollar terms.

*ii. Minimize loss of life*

The remaining objectives all relate to economic losses of one sort or another. The most important consideration is that of avoidance of loss of life and other casualties.

*iii. Minimize other losses*

Other losses that a jurisdiction might be interested in avoiding include disruption of key government services, disruption of social networks, and damage to the environment.

*iv. Considerations regarding non-economic losses*

The inclusion of non-economic factors in the optimization is difficult as the benefits and the costs are measured in different terms. If we are interested in including loss of life in the optimization, the benefits are measured in terms of lives saved (or deaths avoided) while the costs are typically measured in dollars.

The normal economic way of handling this is by assigning a value to the benefits. For lives saved, Value of a Statistical Life is a standard approach used. For other benefits, there are a number of techniques that have been developed for determining the value a community places on those benefits.

However, there is a strong reluctance to put a price on a life (which is nominally what Value of a Statistical Life does) and other non-economic amenities. So as an alternative one could use some form of Lexicographic Preferences. Here each objective is strictly ranked, and then they are optimized in order. For example, you could choose to optimize for loss of life, and then for economic losses. Then you would find the alternative that minimizes loss of life (irrespective of costs). Second, you would find the minimum cost alternative that maintained the minimum loss of life.

Issue: Why not choose zero loss of life? As a practical matter, the tradeoffs cannot be avoided.

### *c. Constraints*

#### *i. Budget*

To the extent that a local community has a limited budget, that has to be factored into the optimization. Other constraints can also be factored in. These will largely consist of screening out the potential plans that do not meet the constraints.

### *d. Economic interdependencies*

The economy in general is affected by the resilience of the built environment. The reverse also holds: the resilience of the community is dependent on the health and resilience of the economy.

## **6. Economic Decision-Making Involving Risk and Uncertainty**

### *a. Expected utility theory*

The basic way that economists approach decision-making is expected utility theory. The basic idea is that people will choose the alternative with the highest probability-weighted average value. The value is adjusted to account for both time preference and risk preference.

#### *i. Time Preference*

Most people prefer consumption now over consumption later. The typical way of handling that is by discounting future consumption.

#### *ii. Risk preferences*

Most people would prefer to avoid risk—that is they are risk averse. For people who are risk averse, a large potential loss weighs more heavily in their consideration than a large number of small losses, which together add up to the same value as the big event. Someone who is risk neutral would weigh the two equally.

Risk aversion is handled in economic theory by weighting the large losses more heavily (or equivalently, by weighting large gains less heavily).

The simplest approach, and the one used most often in net benefit analyses, is to assume that the community is risk neutral. Then you simply compute the present expected value. However, when it comes to disasters it seems unlikely that communities will be risk neutral.

In order to account for risk preferences, it will be necessary to measure those risk preferences. A number of widely-accepted methods for doing this exist.

#### ***b. Behavioral economics***

In fact, people are not Expected Utility maximizers. There is a very large literature regarding departures from Expected Utility maximization. The problem is that expected utility maximization is a hard problem, and we do not have the resources available to solve it. There are several approaches to thinking about these departures from economic theory, but the most widely accepted is the Heuristics and Biases school. They argue that people use standard shortcuts—heuristics—that work well most of the time. However, there will be cases where they do not work well, and in those situations they will be biased. The biases are generally used to try and identify the heuristics used.

##### *i. Cognitive bias*

There are a number of biases that have been identified, some of which are relevant here. These include Uncertainty v. risk, overconfidence, small probability events, etc.

### **7. Incentives & Aid**

The availability of financial incentives and public aid affects the economics of pre-disaster planning and the severity of economic consequences (post-disaster).

#### ***a. Financial inducements***

Financial inducements can alter stakeholder behavior by incentivizing decisions that improve the resilience of communities.

##### *i. Taxes*

A reduction in taxes (e.g., household or business) can incentivize behaviors to improve resilience (or minimize vulnerabilities—i.e., values at risk). The reduction in taxes act as a benefits transfer from society to individual stakeholders who may not otherwise realize the (full) benefits resulting from improved resilience.

*ii. Bonds*

Publically-financed bonds make available resources at a lower (or no) cost, by offering funds at reduced interest rates, making investments in disaster resilience a less expensive venture, thus increasing the likelihood of investment. As with tax reductions, the availability of lower cost loans acts as a benefits transfer to stakeholders who may not receive (full) benefits for their actions, of improving resilience, otherwise.

*b. Design-standard flexibility*

Explores the potential design flexibilities developers are offered to encourage resilient structures while reducing their overall construction costs for the project. For instance, to encourage the installation of fire sprinklers in new homes, some communities offer developers design tradeoffs, allowing higher housing densities if fire sprinklers are installed throughout the community.

*c. Federal disaster relief*

Aid reduces the impact of disasters on affected areas, and can be used to assist the recovery process. The possibility of aid can reduce the incentive to mitigate risk and invest in recovery planning.

*d. Spillover effects*

Incentives (and disincentives) can have unintended indirect consequences. For example, positive spillovers reduce the risk of disasters and their impacts—protecting homes reduces the likelihood of structure damage, but it also protects occupants ensuring the availability of the labor force, thus speeding economic recovery.

**8. Insurance**

Insurance is a mechanism for transferring money from people who have not suffered loss, typically through the payment of premiums, to people who have suffered a loss. For a local community concerned about disaster resilience, insurance is a way of guaranteeing that they will have the resources to fund recovery in spite of the large losses that accompany disasters.

*a. Asymmetric information*

The basic problem of supplying an adequate level of insurance, priced accordingly, involves asymmetric information. By asymmetric information we typically mean that the person seeking insurance has information relevant to the risks to be insured that the insurance company does not have. Asymmetric information falls into two categories: moral hazard and adverse selection.

*i. Moral hazard*



Moral hazard is where a person engages in risky behavior because he or she has insurance. Moral hazard is an issue from the perspective of society. Society has an interest in reducing losses, and insurance does not generally do that, as it can reduce or eliminate incentives for individuals to mitigate against disasters. In fact, moral hazard is a problem in that it actually leads to increasing (aggregate) community losses. So the insured individual is better off for being insured, but (to the extent that moral hazard is an issue) society is worse off.

*ii. Adverse selection*

Adverse selection is where a person seeks out insurance because they carry risks of which the insurance company is unaware. For example, if a family knew that the wiring in their house was frayed and decaying, and decided to obtain fire insurance. The insurance company would be unaware of the problem, and so would underestimate (and underprice) the risks.

***b. Reinsurance***

An insurance company's capacity to insure risks (its supply of insurance if you will) depends on its reserves. Insurance companies in general depend on the law of averages—average losses over their entire portfolio of policies will generally not vary much from year to year. Disasters present issues for insurance companies because they violate the law of averages. They represent large losses for an insurance company relative to their reserves. One way for an insurance company to handle the problem is to seek reinsurance. Reinsurance is basically insurance for insurance companies. If their losses exceed a triggering amount, then the company that carries the reinsurance policy pays off to the insurance company.

A closely related alternative is Catastrophe Bonds. Here the bond is held by investors rather than a reinsurance company. If the event described in the bond occurs, then the investor loses its principal, which is used by the insurance company to pay its policy holders. If the event does not occur, the principal plus interest is returned to the investors.

## **9. Institutional Constraints**

Local communities operate under a number of constraints that limit their alternatives in improving resilience.

***a. Property rights***

*i. Public vs. private ownership*

There are a number of situations where a community is limited in its options due to the fact that some assets are owned by private parties. Many infrastructure assets are owned by parties other than the local community. In other cases it might be beneficial to the community to alter some land uses for

properties with private owners. However, since those properties are owned by parties other than the community, the options a community has for doing so may be limited.

*ii. Land use*

Land use can impact resilience. Communities need to consider resilience in setting zoning and land-use rules.

***b. Social considerations***

Social issues affect a community's resilience, and many resilience measures can impact those social factors. For example, social networks are an important factor for resilience at an individual and family level. Social networks provide financial and social support, temporary housing, emergency day care, and other services that contribute to individual and family resilience. At the same time, some resilience measures can disrupt those social networks. It is well-known that temporary housing adversely impacts social networks.

***c. Political process***

Many decision-makers for the communities are answerable to voters. That often means that they need the support of voters and other stakeholders to carry projects forward. Obtaining that support is partially an exercise in persuasion, but persuasion has its limits. Both the political process itself, and the fact the voters and other stakeholders have their own ideas, needs and opinions limit what local communities can do.

*i. Making the business case*

A good analysis of the benefits and costs can be used to make the business case for resilience measures. That will help with persuading stakeholders to support beneficial resilience measures.

## **10. Standards and Codes**

Some economics-based building standards and codes currently exist to formalize the decision evaluation process, by quantifying returns on risk-reduction investments, while ensuring consistency, transparency, and reproducibility of the process across communities and over time.

***a. ASTM economic standards***

ASTM Subcommittee E06.81 on Building Economics produced 26 standard practices and guides governing the appropriate use of investment decisions of buildings and building systems. The applicability of these will be explored.

## 11. Metrics and Tools

### *a. Measurement needs*

#### *i. Uncertainties*

Uncertainties regarding estimates of expected damages from disasters fall into two categories. First are things that cannot be known in advance. You cannot know in advance how much damage the next disaster will produce, or when it will occur. Second are things that are in principal knowable, but are not currently known. For example, while in principal you should be able to know how much a particular project will cost to build, that has uncertainties associated with the estimate.

Mitigation costs, recovery costs, and losses will have uncertainties in their estimates that can be estimated.

#### *1. Business interruption costs*

There is a great deal of uncertainty about losses from disasters due to business interruption costs. They are known to be large in relation to direct losses. In cases where they have been estimated they are often as large or larger than direct economic losses. However, they are difficult to estimate, due to the lack of data from past events to support estimates.

### *b. Data*

There are several types of data needed to estimate the potential economic burden of disasters and the costs of mitigation and recovery.

#### *i. Inventory of the built environment*

An inventory of the built environment would help in identifying what structures are potentially affected by hazards.

#### *ii. Loss data on natural and man-made disasters*

There are number of databases of losses from natural and man-caused disasters. However, none of them are complete, and most of them have wide error margins. For example, none of the databases contain estimates for indirect losses.

## 12. Summary and Recommendations

Provides key highlights and summarizes linkages with other chapters. Recommendations will be organized around short-, medium-, and long-term measurement needs.