Hazard Risk Assessment Instrument

Developed by the UCLA Center for Public Health and Disasters

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Disclaimer

The *Hazard Risk Assessment Instrument* (HRAI) workbook is intended to be used as a guide to enable state and local public health agencies to conduct a risk assessment of their community. The tool is designed for use as a standard approach to hazard risk assessment that is adapted to the public health impacts of hazards. HRAI will allow public health agencies to assess the probability of hazards for a particular geographic area and the magnitude of impact given the local resources, allowing for prioritization of response and mitigation options. As such, this workbook will guide public health agencies in determining the likelihood of a hazard occurring, assessing their community's vulnerabilities and current resources, and prioritizing resources in planning for disasters.

This instrument is based on the expertise of the authors and incorporates disaster-related data in order to illustrate its systematic methodology.

This workbook may not be inclusive of all the parameters pertinent to a specific jurisdiction. Therefore, it is the responsibility of the user to research local procedures and laws to ensure validity of the final product.

Preface

Public health agencies are playing an increasingly important and integral role in disaster response. As entities tasked with protecting the public's health, these agencies have a unique perspective on the planning process. The first step in a well-designed and comprehensive all-hazards disaster plan is a hazard risk assessment. While most communities have engaged in hazard risk assessment, the public health impacts may not have been considered. It is essential that public health agencies understand the potential impacts of the myriad of hazards that their communities face.

The UCLA Center for Public Health and Disasters (CPHD) developed the *Hazard Risk Assessment Instrument* to allow public health agencies to identify the hazards most relevant to their communities in order to facilitate an effective planning process.

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Introduction

Disasters and Public Health: An Overview

What is a disaster? Often when we think of disasters, we assume that an earthquake or a hurricane in itself is a disaster. In fact, disasters are defined by the ability of a community to deal with hazards.

A *hazard* is an act or condition posing the threat of harm, for example, an earthquake or a hurricane. A *disaster* is a "serious and possibly sudden event on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help"[1] (e.g., federal aid, surrounding communities, etc.). Classifying an event as a disaster has to do with how a community is able to cope with its impact. An earthquake in an unpopulated area, for example, would not necessarily be a disaster. However, the same sized earthquake in an urban area might demand resources far beyond the community's capacity, warranting this hazard to be classified as a disaster.

Disasters are a threat to the public's health because they cause:

- Abrupt increases in illness, injury, or death
- Destruction of the healthcare infrastructure
- Population displacement
- Psychological stress
- Changes in the environment

In a disaster, public health agencies and professionals:

- Evaluate health impacts on the community
- Assess water safety and sanitation
- Coordinate sheltering
- Track disease, injuries, and fatalities

[1]Noji EK, ed. *The Public Health Consequences of Disasters.* Oxford 1997.

Planning for Disasters

For public health agencies, planning for disasters requires a multi-faceted approach. The systematic identification of potential hazards in the community is a valuable first step in the establishment of appropriate preparedness measures. Effective plans that utilize local resources to deal with potential disasters are necessary for the agency to determine realistic and appropriate measures to respond to these hazards. Training employees and exercising plans allow agencies to familiarize staff members with their roles in an emergency and to identify potential weaknesses in their plans. Because disasters by definition overwhelm local resources, contracts with surrounding communities may be made to provide additional resources such as staff, space, equipment, etc., during a disaster. All of these are measures that public health agencies take to prepare for disasters.

The *Hazard Risk Assessment Instrument* (HRAI) focuses on the identification of potential hazards, vulnerabilities, and resources in the community. This provides the foundation for additional planning and specifies potential losses so that communities are able to prioritize funding and programming.

Risk is defined as the expectation of loss. Disaster planning rests upon *risk assessment*, which includes a determination of the propensity of things to be damaged (*vulnerability*) and an assessment of the community *resources* that will diminish impact. Thus, vulnerability to hazards and community resources work against each other.

*Risk = Hazard * (Vulnerability – Resources)*

This idea is the foundation behind HRAI. This workbook will allow you to conduct a risk assessment of your community by assessing the likelihood of a hazard occurring and your community's vulnerability and current resources. Your agency will then be equipped to prioritize resources in planning for disasters.

Introduction to the Instrument

The *Hazard Risk Assessment Instrument* facilitates the assessment of hazards, completion of resource and vulnerability analyses, and projections of likely hazard impacts. Key hazards are identified and their potential consequences estimated.

HRAI consists of four steps:

Step 1: Probability of Mishap
This section provides a list of possible hazards, which are to be ranked according to the probability of occurrence in your community.

Step 2: Severity of Consequences
This section is divided into four categories (indicators) in which the vulnerability of the target community and public health agency is assessed according to the severity of the impact of the hazard. The four indicators are: human impact, interruption of healthcare services, community impact, and impact on public health agency infrastructure.

Step 3: Scoring the Consequences
In this section, the consequences determined in the Severity of Consequences section are scored using a scale that measures the impact of disasters on the public's health. The scores will provide a basis for the risk analysis to be undertaken in Step 4.

Step 4: Risk Analysis
In this section, the information from the Probability of Mishap and Severity of Consequences sections are combined to provide a prioritization scheme for each specific hazard.

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Instructions and Supplemental Worksheets

Step 1: Probability of Mishap

What is likely to happen in my community?

The first step in assessing risk in a community is to conduct a hazard identification exercise. This process uses a scale to determine the probability of different hazards occurring in your community.

First, select a length of time for the system lifecycle. You may want to use a period of 25 years, as this span is typically used when major organizations set up their planning objectives and timelines and gives sufficient time for rare events to be measured. However, if your organization consistently uses another pre-determined length, that time period should be employed.

After the system lifecycle is determined, you should complete **Worksheet 1: Probability of Occurrence**. Each hazard listed on the worksheet should be assessed and assigned a probability score relative to the system lifecycle. Probabilities are classified from 0 to 4 based on the following scale:

0 = Improbable	The probability of the occurrence of the hazard is zero.
1 = Remote	The hazard is not likely to occur in the system lifecycle, but it is possible.
2 = Occasional	The hazard is likely to occur at least once in the system lifecycle.
3 = Probable	The hazard is likely to occur several times in the system lifecycle.
4 = Frequent	The hazard is likely to occur cyclically or annually in the system lifecycle.

These classifications are based largely upon 1) the historic patterns of occurrence of the hazard in your community and 2) predictive models. When classifying hazards, it is important that you look at those that have the potential to become disasters, but not necessarily the "worst case scenario". Therefore, you should identify those hazards that are large-scale and most likely to occur (based on the geographic, meteorological, and demographic conditions that exist in your community). You may also need to consider hazards that exist in surrounding areas that may have impacts on

your community. For example, although there are no volcanoes in Los Angeles County, a volcano exists approximately 300 miles away in Mammoth Mountain. An eruption would have a significant impact on the water supply for Los Angeles County, as noted in the example that follows. Therefore, potential hazards in surrounding communities need to be considered in the hazard assessment.

After frequencies for each hazard have been determined and the probability for each has been entered into the worksheet, hazards that pose no credible risk to the region may be deleted. For instance, in the assessment example of Los Angeles County that follows, hazards such as avalanches and tropical cyclones reveal a score of 0 (improbable); thus, to save time and prevent redundancy, these hazards will be excluded from further analysis in this HRAI example.

Worksheet 1: Probability of Occurrence

Geographic Area: Los Angeles County, CA	
Length of Life Cycle: 25 years	
HAZARD	**SCORE: (0-4)** 0 = Improbable 1 = Remote 2 = Occasional 3 = Probable 4 = Frequent
Avalanche	0
Biological Terrorism	1
Chemical Terrorism	1
Civil Disorder	2
Coastal Erosion	3
Conventional Terrorism	1
Dam Failure	1
Drought	2
Earthquake	3
Extreme Summer Weather	3
Fires – Large-Scale, Urban	1
Flood	2
Hailstorm	1
Hazardous Materials Incident – Fixed Facility	1
Hazardous Materials Incident – Transportation	1
Land Subsidence	1
Landslide	2
Nuclear Attack	1
Power Failure	3
Radiological Incident – Fixed Facility	1
Radiological Incident – Transportation	1
Severe Winter Storm	1
Storm Surge	1
Thunderstorm and Lightning	1
Tornado	1
Transportation	3
Tropical Cyclone	0
Tsunami	1
Volcano	1
Wildfire	4
Windstorm	2

Data Sources

Various possible resources exist from which to obtain historical and predictive information. For many counties, mapping tools are available. These maps allow the user to approximate where and how often specific hazards have occurred. Examples of mapping tools available on the Internet are:

- ESRI - www.esri.com/hazards/makemap.html
- Federal Emergency Management Agency (FEMA) - www.fema.gov/maps
- U.S. Geological Survey (USGS) - http://www.usgs.gov

Your state Geological Survey or Office of Emergency Services may have online resources as well. In California, for example, data are available online both from the Office of Emergency Services and Geological Survey.

- Governor's Office of Emergency Services - www.oes.ca.gov/
- California Geological Survey - gmw.consrv.ca.gov/shmp/index.htm

Community organizations and agencies are valuable sources of information as is your local emergency management organization. They may have already conducted a similar hazard assessment for your community and should be partners in your assessment. Your local American Red Cross chapter also may provide regional historic information including a listing of disasters. Additionally, information can be obtained from other sources. For instance, the National Oceanic and Atmospheric Administration (NOAA) can provide information on hurricanes and other wind events and local environmental health agencies or fire departments can provide information on hazardous materials incidents.

Step 2: Severity of Consequences

When something happens, how bad will it be?

The first step of the hazard risk assessment provided you with a list of hazard probabilities affecting your area. You may initially choose to focus on three to five hazards that have been identified as having high probabilities of occurrence. However, a comprehensive analysis will require you to also study hazards that, while infrequent in occurrence, may have higher potential consequence on the public health infrastructure.

In the Los Angeles County example presented in Step 1, the hazards chosen for further analysis were those identified as having the highest probability of occurring in the lifecycle. These hazards, which also happen to include those of high potential consequence to the system, are:

HAZARD	SCORE: (0-4) 0 = Improbable 1 = Remote 2 = Occasional 3 = Probable 4 = Frequent
Wildfire	4
Coastal Erosion	3
Earthquake	3
Extreme Summer Weather	3
Transportation	3

As shown above, the hazards in your geographic area may all have scores of 3 or 4. Once the *hazard probability* has been determined, the *vulnerability* of your community for each of those hazards must be assessed. Vulnerability is assessed by four indicators: human impact, interruption of healthcare services, community impact, and impact on public health agency infrastructure.

Estimations of the severity of consequences for each of the hazards you have determined to be of high probability in your jurisdiction can be made using **Worksheet 2A: Baseline Health Indicators** and **Worksheet 2B: Hazard-Specific Health Indicators**.

Baseline Data

In order to assess the possible severity of an incident, you must first determine baseline data for each indicator. Baseline data indicate measures of community health status on an average day. Determining the baseline will allow you to compare the impact of the hazards against your normal operations. In other words, it gives you a sense of how your community is capable of confronting a hazard with the resources you have.

Complete Worksheet 2A. A sample Worksheet 2A reflecting the baseline figures representative of the public health vulnerability of the Los Angeles County area has been provided to illustrate the worksheet completion process. The following example provides many baseline measures at varying degrees of specificity.

Data may exist in your community, but in a different format that needs to be standardized. For example, at the time of the Northridge Earthquake, there were roughly 225 advanced life support (ALS) units available for the approximately nine million people living in Los Angeles County. This calculates to a baseline of 2.5 ALS units for 100,000 people, which, in this case, was the standardized unit of measurement used. You may need to extrapolate from data available from communities similar to yours or you may need to use state or national data sources for those indicators which don't exist at the local level.

Worksheet 2A: Baseline Health Indicators

HAZARD: Earthquake	Northridge Earthquake, January 17, 1994		
	Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)		
		BASELINE	
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE -SOURCE**
Human Impact			
Fatalities	100,000 pop./day	**1.70**	CA-DHS – Vital Statistics
Injuries Requiring EMS Transport	100,000 pop./day	**4.2**	Los Angeles County EMS
Outpatient Injuries	100,000 pop./day	**12.44**	Santa Barbara County (CA) EMS
Hospital ED Visits Due to Injuries	100,000 pop./day	**36.84**	CDC-NCHS
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**1.5**	UCLA CPHD
Interruption of Healthcare Services			
Basic EMS	ALS systems/100,000 pop.	**2.5**	Los Angeles County EMS
Outpatient Services	PCPs/100,000 pop.	**92.4**	Kaiser Family Foundation
Hospital ED Services	Available ED beds/100,000 pop.	**17**	OSHPD – CA
Trauma Units (levels 1&2)	ORs functioning/100,000 pop.	**18.38**	Northridge Earthquake Lifeline Performance and Post-Earthquake Response
Ancillary Services	Pharmacies/100,000 pop.	**17.67**	Search for pharmacies using yellow pages on Yahoo
Community Impact			
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**	
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**	
Population Displacement	Residents evacuated/100,000 pop.	**0**	
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**	
Transportation	Duration (in days) major transportation corridors disrupted	**0**	
Impact on Public Health Agency Infrastructure			
Personnel	% personnel available/day	**-**	
Equipment Loss	Value (in dollars) computer equipment lost	**-**	
Laboratory Services	Labs/100,000 pop.	**-**	
Community Services	Key partners available to respond	**-**	
Internal Communications	Staff that can be available 24/7	**-**	
Interagency Communications	Agencies PH dept. can communicate with during disaster	**-**	

Hazard-Specific Data

The next step is to generate hazard-specific data in order to compare them to the baselines from Worksheet 2A. The hazard-specific data indicate the amount of activity that resulted from the hazard. It is important to note that this data may or may not be higher than the baseline. For example, in the Northridge Earthquake, the number of fatalities was 0.35 (per 100,000 pop.) compared to a baseline of 1.7 (per 100,000 pop.).

Complete Worksheet: 2B for each hazard that is being assessed. A sample Worksheet 2B reflecting the effects of the Northridge Earthquake on the public health agency infrastructure of Los Angeles County has been included for your reference. Considerations for the process of completing this worksheet are addressed in the following segments.

Capturing hazard-specific data.

The hazard-specific data should attempt to capture data that reflects the maximum credible event regardless of more typical consequences of the hazard. Since the purpose of HRAI is to assess the capacity of your agency to respond to various hazard scenarios, it is more useful to capture the effects of a larger and more rare disaster, such as the Northridge Earthquake, rather than a typical magnitude 3 or 4 earthquake that the Los Angeles area might see dozens of times in a given year. However, if your jurisdiction has not recently dealt with the hazard in question in any great magnitude, data from a jurisdiction similar to yours may be substituted to provide these hazard-specific numbers.

Information sources for data collection.

One possible source for hazard-specific data is a modeling tool. Modeling allows you to estimate losses from natural hazards for a specific geographic area. The Federal Emergency Management Agency (FEMA) has created a model, HAZUS, which may be used to estimate losses from earthquakes, floods (both coastal and riverine), and hurricanes. More information on the program can be found at http://www.fema.gov/hazus/.

If the local public health agency does not have access to HAZUS or if this model does not cover the hazard being addressed, the agency will need to gather information on past hazardous events that have occurred within the community or in similar communities. This information may be found at the health agency, the city, county, or state governments, or at non-profit organizations such as the American Red Cross.

Difficulties in finding data.

Sources for baseline and hazard-specific data are often very hard to find. Some health impact measures, such as fatality rates or Emergency Medical Services (EMS) statistics, will be relatively easy to locate through various local and state agencies. Other measures may be difficult to find or even to extrapolate given the piecemeal data collection that occurs when compiling data from various reporting agencies. Moreover, estimates of presumed impacts on the health system may require data from two completely unrelated sources. For

example, news of a closure of a major hospital due to damage from a hazard may be combined with data on the number of Emergency Department beds at that particular hospital to estimate the number of Emergency Department beds which have been "interrupted". Other data, such as outpatient and ancillary services, may be extrapolated using third party data such as a disaster's effect on small businesses.

The indicators used in this workbook were derived primarily for "injury-producing" events; however, they can be adapted for use with "illness-producing" events such as pandemic flu. For example, negative pressure isolation rooms may be used instead of operating rooms.

Using modeling to create estimates for use in HRAI.

Injury statistics for certain hazard scenarios may not be available. Theoretical injury models, such as the example presented below,[2] are based on actual event statistics and may be used to estimate certain event-specific indicators, such as Emergency Department visits due to injuries.

What if the data does not exist?

Ideally, you should use information from sources within the analyzed jurisdiction. However, this may not always be possible given inconsistencies in reporting and other issues.

Several models for disasters have been attached in **Appendix II** to provide baseline and event information that may be used to fill in the gaps in your own data collection efforts.

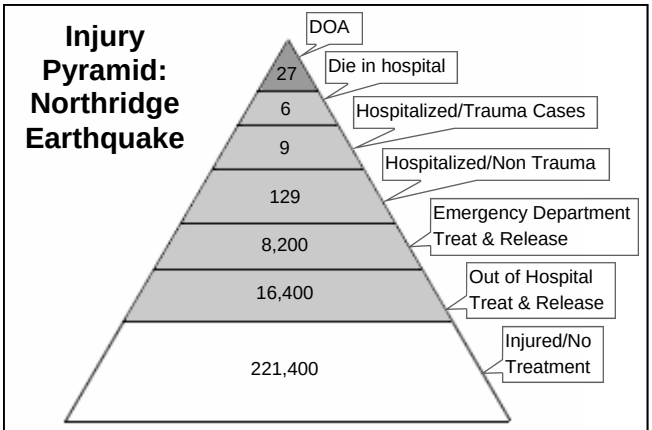


Figure 1. Injury pyramids may be used to estimate a number of health indicators for use in the HRAI. Source: Shoaf KI et al. 2001.

Geographic and severity discrepancies are two important aspects that should be taken into consideration when adapting the examples provided in this workbook into your assessment. For example, the Northridge Earthquake was a moderate (M 6.7) earthquake within a suburban residential neighborhood in the City of Los Angeles containing primarily wood-frame structures built to California earthquake building standards. An earthquake of a similar strength occurring in a less seismic area with a different building code history (e.g., the Midwest) could expect to sustain significantly more damage due to the use of more vulnerable building materials and less stringent building standards. Similarly, larger earthquakes within California or earthquakes located under densely populated urban areas (e.g., Downtown Los Angeles) also have the potential to cause significantly more damage than the Northridge Earthquake.

[2]Shoaf KI, Seligson HA, Peek-Asa C, and Mahue-Giangreco M. Enhancement of casualty models for post-earthquake response and mitigation. *Proceedings U.S.-Japan Joint Workshop and Third Grantees Meeting, U.S.-Japan Cooperative Research on Urban Earthquake Disaster Mitigation*; 2001 Aug 15-16; University of Washington, Seattle, Washington. 2001;547-556.

Worksheet 2B: Hazard-Specific Health Indicators

HAZARD: Earthquake	Northridge Earthquake, January 17, 1994			
	Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)			
		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS***	**HAZARD-SOURCE***
Human Impact				
Fatalities	100,000 pop./day	**0.35**		Peek Asa, et al 1998...
Injuries Requiring EMS Transport	100,000 pop./day	**7.4**	- Increased call...	EMS data provided by Dr. Sam Stratton…
Outpatient Injuries	100,000 pop./day	**172**		Seligson & Shoaf, 2003…
Hospital ED Visits Due to Injuries	100,000 pop./day	**86**	- One provider near...	Seligson & Shoaf, 2003…
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**0.1**		Peek Asa, et al 1998…
Interruption of Healthcare Services				
Basic EMS	ALS systems/100,000 pop.	**2.5**	- No noticeable effect	
Outpatient Services	PCPs/100,000 pop.	**85.56**		Tierney KJ…
Hospital ED Services	Available ED beds/100,000 pop.	**15.74**	- Six of 81 Los Angeles Co...	Schultz CH, et al...
Trauma Units (levels 1&2)	ORs functioning/100,000 pop.	**15.55**	- Two trauma centers...	LAFD…
Ancillary Services	Pharmacies/100,000 pop.	**7.77**	- Extrapolated from...	Dahlhamer JM...
Community Impact				
Water Supply Contamination	Duration (in days) of widespread boil water order	**12**	- Pipeline damage…	EERI…
Water Supply Availability	Duration (in days) of widespread water service disruption	**~1**	- Approximately…	HUD…
Population Displacement	Residents evacuated/100,000 pop.	**525**	- 50,000 occupants…	EERI…
Public Utilities	Duration (in hours) of widespread electricity disruption	**<24**	- Immediately after…	HUD…
Transportation	Duration (in days) major transportation corridors disrupted	**8+**	- Caltrans…	EERI…
Impact on Public Health Agency Infrastructure				
Personnel	% personnel available/day	**-**		
Equipment Loss	Value (in dollars) computer equipment lost	**-**		
Laboratory Services	Labs/100,000 pop.	**-**		
Community Services	Key partners available to respond	**-**		
Internal Communications	Staff that can be available 24/7	**-**		
Interagency Communications	Agencies PH dept. can communicate with during disaster	**-**		

* Hazard-specific comments and sources are truncated in this example. For more detail, refer to Appendix II: Hazard Model A where this chart is printed in full.

Step 3: Scoring the Consequences

When something happens, can we respond to it?

After completing Worksheets 2A and 2B for each of the hazards you are focusing on in your assessment, you are ready to give each indicator a "score". The score, a number between 0 and 4, is based on an assessment of your community's capacity in dealing with the increase brought about by a particular hazard as reflected by the hazard-specific figures. After assigning a score to each indicator, complete **Worksheet 3: Scoring the Consequences**.

The severity score is a qualitative comparison between the added impact of the hazard and your community's ability to meet the needs generated. Your baseline indicator should be a reasonable expectation of your capacity.

Also, consider the following equation when assigning a severity score to each health indicator:

Severity = Magnitude – Mitigation

Your agency's efforts toward minimizing the potential effect of a particular hazard should be taken into consideration when determining severity. While it is presumed that the findings of HRAI will provide a basic framework upon which to base your agency's subsequent preparedness efforts, the steps already taken can also be evaluated based on their applicability to the hazard "reality" that exists in your jurisdiction.

The following subcategories provide measurement parameters for all of the instrument's required indicators. The example representing Los Angeles County's response to the Northridge Earthquake will continue to be used to demonstrate HRAI's function.

Scoring the Data: Human Impact

This indicator is used to determine the human impact of a hazardous event. It is comprised of five subcategories: Fatalities, Injuries Requiring EMS Transport, Outpatient Injuries, Hospital Emergency Department Visits Due to Injuries, and Trauma Center (levels 1&2) Injuries.

Fatalities

Fatalities used in this data set should be those that can be directly attributed to the disaster itself. Deaths with causes indirectly related to the disaster have not been included in the examples provided in this workbook and should not be included in your measurement.

UNIT OF MEASUREMENT	
Number of fatalities per 100,000 population per day	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
1.70	.35

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Added impact of disaster is negligible
1 = Minimal	Cases are adequately handled by agency using existing resources
2 = Moderate	Stretches capacity of existing resources; draws upon resources provided by mutual aid
3 = Severe	Needs far exceed capacity of local authority and adjacent mutual providers
4 = Catastrophic	Available resources are overwhelmed, requiring significant resources from outside affected area for response; recovery will be difficult, even with the help of mutual resources

SCORE (0-4) (Enter this score into the **Fatalities** column on Worksheet 3)	**1**

Injuries Requiring EMS Transport

UNIT OF MEASUREMENT	
Number of Emergency Medical Services transports per 100,000 population per day	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
4.2	7.4

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Added impact of disaster is negligible
1 = Minimal	Cases are adequately handled by agency using existing resources
2 = Moderate	Stretches capacity of existing resources; draws upon resources provided by mutual aid
3 = Severe	Needs far exceed capacity of local authority and adjacent mutual providers
4 = Catastrophic	Available resources are overwhelmed, requiring significant resources from outside affected area for response; recovery will be difficult, even with the help of mutual resources

SCORE (0-4) (Enter this score into the **Injuries Requiring EMS Transport** column on Worksheet 3)	**2**

Outpatient Injuries

UNIT OF MEASUREMENT	
Number of outpatient injuries per 100,000 population per day	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
12.44	172

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Added impact of disaster is negligible
1 = Minimal	Cases are adequately handled by agency using existing resources
2 = Moderate	Stretches capacity of existing resources; draws upon resources provided by mutual aid
3 = Severe	Needs far exceed capacity of local authority and adjacent mutual providers
4 = Catastrophic	Available resources are overwhelmed, requiring significant resources from outside affected area for response; recovery will be difficult, even with the help of mutual resources

SCORE (0-4) (Enter this score into the **Outpatient Injuries** column on Worksheet 3)	**3**

Hospital ED Visits Due to Injuries

UNIT OF MEASUREMENT	
Average number of Emergency Department visits due to injuries per 100,000 population per day	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
36.84	86

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Added impact of disaster is negligible
1 = Minimal	Cases are adequately handled by agency using existing resources
2 = Moderate	Stretches capacity of existing resources; draws upon resources provided by mutual aid
3 = Severe	Needs far exceed capacity of local authority and adjacent mutual providers
4 = Catastrophic	Available resources are overwhelmed, requiring significant resources from outside affected area for response; recovery will be difficult, even with the help of mutual resources

SCORE (0-4) (Enter this score into the **Hospital ED Visits Due to Injuries** column on Worksheet 3)	**3**

Trauma Center (levels 1&2) Injuries

UNIT OF MEASUREMENT	
Number of trauma center (levels 1&2) injuries per 100,000 population per day	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
1.5	0.1

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Added impact of disaster is negligible
1 = Minimal	Cases are adequately handled by agency using existing resources
2 = Moderate	Stretches capacity of existing resources; draws upon resources provided by mutual aid
3 = Severe	Needs far exceed capacity of local authority and adjacent mutual providers
4 = Catastrophic	Available resources are overwhelmed, requiring significant resources from outside affected area for response; recovery will be difficult, even with the help of mutual resources

SCORE (0-4) (Enter this score into the **Trauma Center (levels 1&2) Injuries** column on Worksheet 3)	**1**

Scoring the Data: Interruption of Healthcare Services

This indicator is utilized to determine the impact of a hazardous event on healthcare services. It will be used to determine if interruptions will occur and what the severity of those interruptions will be. This indicator is comprised of five subcategories: Interruption of Basic EMS, Interruption of Outpatient Services, Interruption of Hospital Emergency Department Services, Interruption of Trauma Units (levels 1&2), and Interruption of Ancillary Services.

Interruption of Basic EMS

UNIT OF MEASUREMENT	
Number of advanced life support systems (ALS) per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
2.5	2.5

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Interruption of Basic EMS** column on Worksheet 3)	**0**

Interruption of Outpatient Services

UNIT OF MEASUREMENT	
Number of primary care providers (PCP) per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
92.4	85.56

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area

SCORE (0-4) (Enter this score into the **Interruption of Outpatient Services** column on Worksheet 3)	**2**

Interruption of Hospital ED Services

UNIT OF MEASUREMENT	
Number of available Emergency Department beds per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
17	15.74

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area

SCORE (0-4) (Enter this score into the **Interruption of Hospital ED Services** column on Worksheet 3)	**2**

Interruption of Trauma Units (levels 1&2)

UNIT OF MEASUREMENT	
Number of functioning trauma operating rooms per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
18.38	15.55

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area

SCORE (0-4) (Enter this score into the **Interruption of Trauma Units (levels 1&2)** column on Worksheet 3)	**1**

Interruption of Ancillary Services

This measure is based on pharmacy/business interruption data.

UNIT OF MEASUREMENT	
Number of functioning pharmacies per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
17.67	7.77

Using the scale below, assess your agency's current abilities to respond to the anticipated disaster impact.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Interruption of Ancillary Services** column on Worksheet 3)	**3**

Scoring the Data: Community Impact

This indicator is used to determine the impact of a hazardous event on the community. It is comprised of five subcategories: Water Supply Contamination, Water Supply Availability, Population Displacement/Households Evacuated, Public Utilities Interruption, and Interruption of Transportation.

Water Supply Contamination

This measure is based on the length of a boil water order affecting at least 25% of the population. Because boil water orders are often issued to entire jurisdictions as a precautionary measure, the "percentage of households affected" would be moot to measure here.

UNIT OF MEASUREMENT	
Duration (in days) mandatory boil water order (affecting at least 25% of the population) enforced	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
0	12

Using the scale below, score the length of the mandatory boil water order.

0 = Baseline	No boil water order issued or issued for <25% of population
1 = Minimal	Boil water order issued for up to one day
2 = Moderate	Boil water order issued for one to three days
3 = Severe	Boil water order in place for three to seven days
4 = Catastrophic	Boil water order in place for more than a week

SCORE (0-4) (Enter this score into the **Water Supply Contamination** column on Worksheet 3)	**4**

Water Supply Availability

Ideally, this is measured by the number of gallons of water that are available per person per day. However, because this data is usually unavailable, an alternative measure is to tally the number of days a widespread water outage (affecting at least 25% of the population) exists.

UNIT OF MEASUREMENT	
Duration (in days) widespread water outage (affecting at least 25% of the population) exists	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
0	~ 1

Using the scale below, score the length of the water service outage.

0 = Baseline	Water services not disrupted or disrupted for <25% of population
1 = Minimal	Water services disrupted for up to one day
2 = Moderate	Water services disrupted for one to three days
3 = Severe	Water services disrupted for three to seven days
4 = Catastrophic	Water services disrupted for more than a week

SCORE (0-4) (Enter this score into the **Water Supply Availability** column on Worksheet 3)	**1**

Population Displacement/Households Evacuated

Oftentimes, these numbers are compiled using shelter statistics provided by organizations such as the American Red Cross. However, it should be noted that these figures will underestimate the extent of the human toll that a disaster has on a population, as it is presumed that a significant number of disaster victims will seek temporary shelters at the homes of friends and family members. Anecdotal evidence, which is usually relied upon for the latter measure, but often unverifiable, may be a more accurate reflection of the gravity of any evacuation orders given.

UNIT OF MEASUREMENT	
Number of persons evacuated per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
0	525

Using the scale below, score the number of evacuations.

0 = Baseline	No people evacuated
1 = Minimal	<10% of population evacuated
2 = Moderate	10-25% of population evacuated
3 = Severe	25-50% of population evacuated
4 = Catastrophic	50+% of population evacuated

SCORE (0-4) (Enter this score into the **Population Displacement/Households Evacuated** column on Worksheet 3)	**1**

Public Utilities Interruption

Public utilities interruption is based primarily on electric power disruptions. This measures the length of an electricity disruption post-event affecting at least 25% of the population. Furthermore, outages of electricity may also affect water supply and the availability of other resources, as they are also reliant on a dependable power source to deliver services to customers.

UNIT OF MEASUREMENT	
Duration (in hours) of widespread electricity disruption affecting at least 25% of the population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
0	<24

Using the scale below, score the length of public utilities interruption.

0 = Baseline	Electric utilities not disrupted or disrupted for <25% of the population
1 = Minimal	Widespread (25+% of population) disruption for up to 4 hours
2 = Moderate	Widespread disruption for 4 to 24 hours
3 = Severe	Widespread disruption for 24 to 72 hours
4 = Catastrophic	Widespread disruption for more than 72 hours

SCORE (0-4) (Enter this score into the **Public Utilities Interruption** column on Worksheet 3)	**2**

Interruption of Transportation

This measure is based on the length of time that major transportation thoroughfares (e.g., freeways, expressways, etc.) are closed immediately after a disaster.

UNIT OF MEASUREMENT	
Duration (in days) that at least ONE major transportation corridor is closed	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
0	8+

Using the scale below, score the length of transportation interruption.

0 = Baseline	No transportation corridors disrupted
1 = Minimal	At least one major transportation corridor disrupted for up to one day
2 = Moderate	At least one major transportation corridor disrupted for one to three days
3 = Severe	At least one major transportation corridor disrupted for four to seven days
4 = Catastrophic	At least one major transportation corridor disrupted for eight days or more

SCORE (0-4) (Enter this score into the **Interruption of Transportation** column on Worksheet 3)	**4**

Scoring the Data: Impact on Public Health Agency Infrastructure

This indicator is used to determine the impact of a hazardous event on the public health agency infrastructure. It is comprised of six subcategories: Personnel, Equipment Loss, Laboratory Services, Community Services, Internal Communications, and Interagency Communications. *The parameters and their relative descriptive scores are detailed below, but baseline and hazard-specific data were not available for analysis in the Los Angeles County Northridge Earthquake example*.

Personnel

This measure is based on absenteeism. Factors to consider for percentage of staff absent include: damage, transportation disruption, injury/illness, etc.

UNIT OF MEASUREMENT	
Percent of staff available per day immediately after the disaster strikes	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area

SCORE (0-4) (Enter this score into the **Personnel** column on Worksheet 3)	**-**

Equipment Loss

This is measured based on computers and other relevant equipment necessary for optimal functioning lost in dollars.

UNIT OF MEASUREMENT	
Value (in dollars) of computer equipment lost	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Equipment Loss** column on Worksheet 3)	**-**

Laboratory Services

This measure is based on the number of operational labs per 100,000 population. This information may be extrapolated from business interruption data that addresses the professional support sector of the economy.

UNIT OF MEASUREMENT	
Number of operational labs per 100,000 population	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area

SCORE (0-4) (Enter this score into the **Laboratory Services** column on Worksheet 3)	**-**

Community Services

This measure is optional and may be omitted if the county agency deems it unnecessary.

UNIT OF MEASUREMENT	
Number of key community partners available to collaborate on a hazard-response	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Community Services** column on Worksheet 3)	**-**

Internal Communications

This measure is based on the number of staff you can reach on a 24 hour/7 day a week basis. Additionally, data regarding the methods of contact and dispatch may be useful to include in this section.

UNIT OF MEASUREMENT	
Number of staff that can be reached on a 24/7 basis	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Internal Communications** column on Worksheet 3)	**-**

Interagency Communications

This measure is based on the ability to communicate between agencies using a common system throughout your jurisdiction. This should be an indication of the public health agency's ability to communicate with other public health agencies, healthcare organizations, law enforcement agencies, public officials, and health care providers.

UNIT OF MEASUREMENT	
Number of agencies that the public health agency can communicate with during and immediately after the disaster strikes	
BASELINE DATA	**HAZARD-SPECIFIC DATA**
-	-

Using the scale below, rate your agency's capacity to operate based on the anticipated interruption of the disaster.

0 = Baseline	Negligible deviance from pre-event norms
1 = Minimal	Disruption to services is minimal
2 = Moderate	Level of service is reduced below pre-event norms; response is needed from local authorities and adjacent mutual aid providers
3 = Severe	Level of service, including service provided by local authorities and adjacent mutual aid providers, is critically reduced
4 = Catastrophic	Services are near or at complete cessation; significant resources from outside affected area are required

SCORE (0-4) (Enter this score into the **Interagency Communications** column on Worksheet 3)	**-**

Worksheet 3: Scoring the Consequences

Below is a sample HRAI after inputting scores from the Northridge Earthquake scenario.

HAZARD: Northridge Earthquake				
SCORE	**0 = Baseline 1 = Minimal 2 = Moderate 3 = Severe 4 = Catastrophic**			
SEVERITY = (MAGNITUDE - MITIGATION)				
HUMAN IMPACT				
Fatalities	Injuries Requiring EMS Transport	Outpatient Injuries	Hospital ED Visits Due to Injuries	Trauma Center (levels 1&2) Injuries
1	**2**	**3**	**3**	**1**
INTERRUPTION OF HEALTHCARE SERVICES				
Interruption of Basic EMS	Interruption of Outpatient Services	Interruption of Hospital ED Services	Interruption of Trauma Units (levels 1&2)	Interruption of Ancillary Services
0	**2**	**2**	**1**	**3**
COMMUNITY IMPACT				
Water Supply Contamination	Water Supply Availability	Population Displacement/ Households Evacuated	Public Utilities Interruption	Interruption of Transportation
4	**1**	**1**	**2**	**4**

IMPACT ON PUBLIC HEALTH AGENCY INFRASTRUCTURE					
Personnel	Equipment Loss	Laboratory Services	Community Services	Internal Communications	Interagency Communications
-	-	-	-	-	-

Step 4: Risk Analysis

Integrating Steps 1 & 2: Where does this assessment take me?

The final step in your community risk assessment combines the probability information given in **Step 1** (the likelihood of hazards occurring) with the severity data determined in **Step 2** (how bad it will be if the hazard hits).

Worksheet 4A: Assessment of Risk

Worksheet 4A integrates the information from the previous steps.

HAZARD	PROBABILITY	SEVERITY				
		Human Impact	Interruption of Healthcare Services	Community Impact	Impact on Public Health Agency Infrastructure	Overall Average
		(Average scores from Worksheet 3)				
Northridge Earthquake	**3**	2.0	1.6	2.4	-	**2.0**

This process leaves you with two numbers to compare for each hazard: a probability score and a severity score. In the Northridge Earthquake example, the probability score is **3** and the severity score is **2.0**.

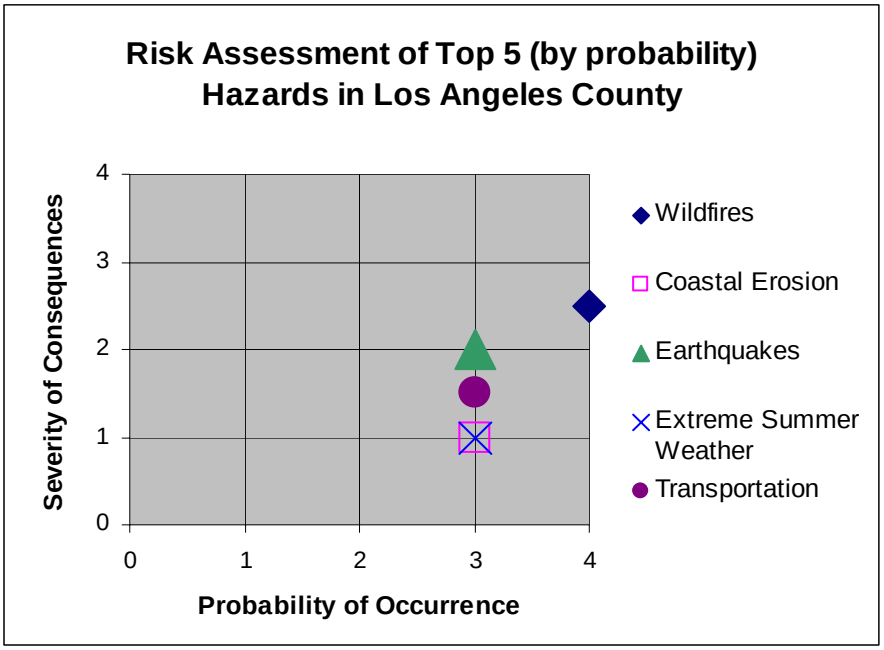
Worksheet 4B: Summary of Risk Analysis

The following represents the most probable hazards and their estimated severity to occur in Los Angeles County.

HAZARD	PROBABILITY OF OCCURRENCE	SEVERITY
Wildfires	4	2.5
Coastal Erosion	3	1
Earthquake	**3**	**2.0**
Extreme Summer Weather	3	1
Transportation	3	1.5

A spatial representation of these relationships, as depicted below, will serve as a prioritization tool, with severity on one axis and probability on the other.

The two scores for each hazard are plotted on an X-Y axis:

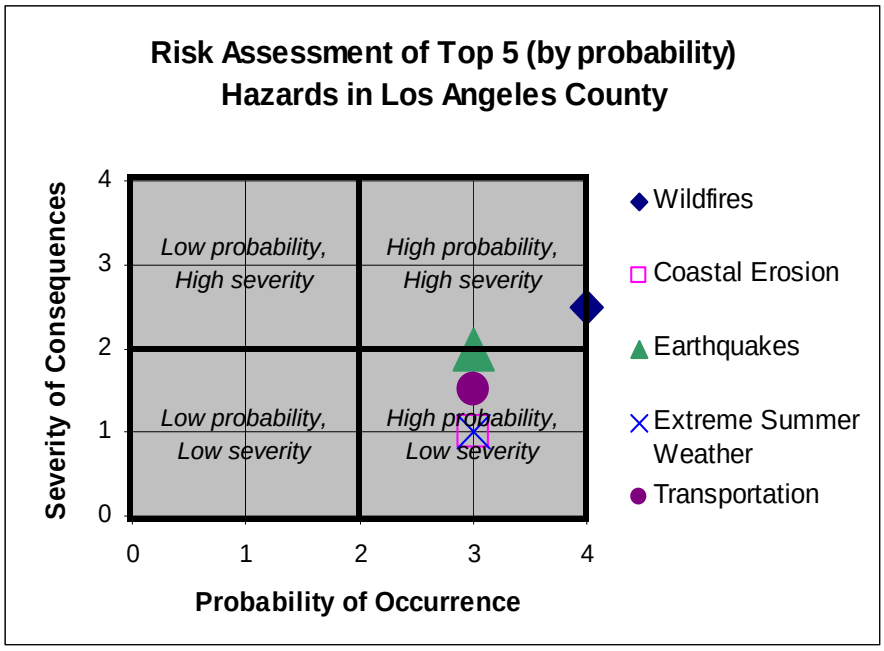


For prioritization purposes, the data plotted above are considered in relation to the following scheme:

Severity of Consequences		
	Low probability, High severity	*High probability, High severity*
	Low probability, Low severity	*High probability, Low severity*

Probability of Occurrence

When the scheme is superimposed on the graph, the following result emerges:



This visual depiction of the HRAI analysis for Los Angeles County indicates that the Northridge Earthquake scenario should be prioritized as a hazard with *high probability* and *high severity*.

Step 5: Translating Theory Into Practice

What's Next?

In summary, the goal of HRAI is to serve as a tool to help public health agencies plan for a hazard response by determining their community's hazards, assessing the likelihood of occurrence, and quantifying their impact on the public's health.

Prioritizing efforts.

It follows from the final step of the analysis that those events with a high likelihood of occurring and a high level of impact should have the highest priority. You may also want to consider those events that, though rare, would have a severe impact were they to occur. For example, earthquakes in the central United States on the New Madrid fault system occur very infrequently, but previous incidents have caused large numbers of deaths and injuries. Preparing for the potential effects of these events should also help you prepare for more common but less extreme emergencies.

After analysis using HRAI, your community can apply the assessment to prioritize planning using community-specific criteria. On initial analyses, HRAI may reveal health infrastructure characteristics that are hazard-specific. These characteristics may be indicative of the ability of your health agency to respond to hazards in general.

The process may provide insight into inherent strengths and weaknesses present in your health system, regardless of the type of hazard. For instance, if one indicator consistently comes up with a better score across several hazards, less emphasis may need to be placed on improving that specific area. This will allow for resources to be allocated to areas where deficiencies have been identified.

Action steps.

After vulnerabilities and weaknesses have been identified, possible resolutions should be addressed. Suggested action steps include:

- Changes in resources and financing
- Establishment of mutual aid agreements
- Training and education for staff and public

Once changes are implemented, an on-going system for the evaluation of impact should be established. As changes occur in the community, new vulnerabilities may arise and new resources may be acquired to change the outcome of your community's hazard risk assessment over time.

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Appendices

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APPENDIX I

A blank version of the *Hazard Risk Assessment Instrument* has been provided.

- Worksheet 1: Probability of Occurrence
- Worksheet 2A: Baseline Health Indicators
- Worksheet 2B: Hazard-Specific Health Indicators
- Worksheet 3: Scoring the Consequences
- Worksheet 4A: Assessment of Risk
- Worksheet 4B: Summary of Risk Analysis

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Worksheet 1: Probability Of Occurrence

Geographic Area:	
Length of Life Cycle:	
HAZARD	**SCORE: (0-4)** 0 = Improbable 1 = Remote 2 = Occasional 3 = Probable 4 = Frequent
Avalanche	
Biological Terrorism	
Chemical Terrorism	
Civil Disorder	
Coastal Erosion	
Conventional Terrorism	
Dam Failure	
Drought	
Earthquake	
Extreme Summer Weather	
Fires – Large-Scale, Urban	
Flood	
Hailstorm	
Hazardous Materials Incident – Fixed Facility	
Hazardous Materials Incident – Transportation	
Land Subsidence	
Landslide	
Nuclear Attack	
Power Failure	
Radiological Incident – Fixed Facility	
Radiological Incident – Transportation	
Severe Winter Storm	
Storm Surge	
Thunderstorm and Lightning	
Tornado	
Transportation	
Tropical Cyclone	
Tsunami	
Volcano	
Wildfire	
Windstorm	

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Worksheet 2A: Baseline Health Indicators

HAZARD:			
	Assessment Location:		
		BASELINE	
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE -SOURCE**
Human Impact			
Fatalities	100,000 pop./day		
Injuries Requiring EMS Transport	100,000 pop./day		
Outpatient Injuries	100,000 pop./day		
Hospital ED Visits Due to Injuries	100,000 pop./day		
Trauma Center (levels 1&2) Injuries	100,000 pop./day		
Interruption of Healthcare Services			
Basic EMS	ALS systems/100,000 pop.		
Outpatient Services	PCPs/100,000 pop.		
Hospital ED Services	Available ED beds/100,000 pop.		
Trauma Units (levels 1&2)	ORs functioning/100,000 pop.		
Ancillary Services	Pharmacies/100,000 pop.		
Community Impact			
Water Supply Contamination	Duration (in days) of widespread boil water order		
Water Supply Availability	Duration (in days) of widespread water service disruption		
Population Displacement	Residents evacuated/100,000 pop.		
Public Utilities	Duration (in hours) of widespread electricity disruption		
Transportation	Duration (in days) major transportation corridors disrupted		
Impact on Public Health Agency Infrastructure			
Personnel	% personnel available/day		
Equipment Loss	Value (in dollars) computer equipment lost		
Laboratory Services	Labs/100,000 pop.		
Community Services	Key partners available to respond		
Internal Communications	Staff that can be available 24/7		
Interagency Communications	Agencies PH dept. can communicate with during disaster		

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Worksheet 2B: Hazard-Specific Health Indicators

HAZARD:				
	Assessment Location:			
		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact				
Fatalities	100,000 pop./day			
Injuries Requiring EMS Transport	100,000 pop./day			
Outpatient Injuries	100,000 pop./day			
Hospital ED Visits Due to Injuries	100,000 pop./day			
Trauma Center (levels 1&2) Injuries	100,000 pop./day			
Interruption of Healthcare Services				
Basic EMS	ALS systems/100,000 pop.			
Outpatient Services	PCPs/100,000 pop.			
Hospital ED Services	Available ED beds/100,000 pop.			
Trauma Units (levels 1&2)	ORs functioning/100,000 pop.			
Ancillary Services	Pharmacies/100,000 pop.			
Community Impact				
Water Supply Contamination	Duration (in days) of widespread boil water order			
Water Supply Availability	Duration (in days) of widespread water service disruption			
Population Displacement	Residents evacuated/100,000 pop.			
Public Utilities	Duration (in hours) of widespread electricity disruption			
Transportation	Duration (in days) major transportation corridors disrupted			
Impact on Public Health Agency Infrastructure				
Personnel	% personnel available/day			
Equipment Loss	Value (in dollars) computer equipment lost			
Laboratory Services	Labs/100,000 pop.			
Community Services	Key partners available to respond			
Internal Communications	Staff that can be available 24/7			
Interagency Communications	Agencies PH dept. can communicate with during disaster			

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Worksheet 3: Scoring the Consequences

HAZARD:				
SCORE 0 = Baseline 1 = Minimal 2 = Moderate 3 = Severe 4 = Catastrophic				
SEVERITY = (MAGNITUDE - MITIGATION)				
HUMAN IMPACT				
Fatalities	Injuries Requiring EMS Transport	Outpatient Injuries	Hospital ED Visits Due to Injuries	Trauma Center (levels 1&2) Injuries
INTERRUPTION OF HEALTHCARE SERVICES				
Interruption of Basic EMS	Interruption of Outpatient Services	Interruption of Hospital ED Services	Interruption of Trauma Units (levels 1&2)	Interruption of Ancillary Services
COMMUNITY IMPACT				
Water Supply Contamination	Water Supply Availability	Population Displacement/ Households Evacuated	Public Utilities Interruption	Interruption of Transportation

IMPACT ON PUBLIC HEALTH AGENCY INFRASTRUCTURE					
Personnel	Equipment Loss	Laboratory Services	Community Services	Internal Communications	Interagency Communications

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Worksheet 4A: Assessment of Risk

HAZARD	PROBABILITY	SEVERITY				
		Human Impact	Interruption of Healthcare Services	Community Impact	Impact on Public Health Agency Infrastructure	Overall Average
		(Average scores from Worksheet 3)				

Worksheet 4B: Summary of Risk Analysis

HAZARD	PROBABILITY OF OCCURRENCE	SEVERITY

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APPENDIX II

The following examples have been provided for reference of the HRAI completion process.

Generic Hazard Models

- A: Earthquake: Northridge Earthquake
- B: Flooding, Rainfall-Induced: Tropical Storm Allison
- C: Flooding, Riverine: Grand Forks Flood
- D: Hurricane: Hurricane Andrew
- E: Terrorist Bombing: Murrah Federal Building Bombing
- F: Tornadoes: Oklahoma City Tornadoes of 1999

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HAZARD MODEL A

HAZARD MODEL A:	Earthquake: Northridge Earthquake, January 17, 1994 Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**1.70**	CA-DHS – Vital Statistics	**0.35**		Peek-Asa C, Kraus JF, Bourque LB, Vimalachandra D, Yu J, Abrams J. Fatal and hospitalized injuries resulting from the 1994 Northridge earthquake. *International Journal of Epidemiology* 1998;27:459-465.
Injuries Requiring EMS Transport	100,000 pop./day	**4.2**	Los Angeles County EMS	**7.4**	- Increased call volume for month of January relative to baseline	EMS data provided by Dr. Sam Stratton
Outpatient Injuries	100,000 pop./day	**12.44**	Santa Barbara County (CA) EMS	**172**		Seligson HA, Shoaf KI. Human Impacts of Earthquakes. In W. Chen and C. Scawthorn (Eds.), *Earthquake Engineering Handbook.* Boca Raton, Florida: CRC Press; 2003.
Hospital ED Visits Due to Injuries	100,000 pop./day	**36.84**	CDC-NCHS	**86**	- One provider near the Northridge epicenter area reported increase from 110 to 185 ED visits due to injuries	Seligson & Shoaf, 2003
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**1.5**	UCLA CPHD	**0.1**		Peek Asa et al, 1998
Interruption of Healthcare Services						
Basic EMS	ALS systems/ 100,000 pop.	**2.5**	Los Angeles County EMS	**2.5**	- No noticeable effect observed	

HAZARD MODEL A: Earthquake: Northridge Earthquake, January 17, 1994
Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)

		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Outpatient Services	PCPs/100,000 pop.	**92.4**	Kaiser Family Foundation	**85.56**		Tierney KJ. Impacts of Recent Disasters on Businesses: The 1993 Midwest Floods and the 1994 Northridge Earthquake. In *Economic Consequences of Earthquakes: Preparing for the Unexpected*. Barclay G. Jones (Ed.), Buffalo, NY: State University of New York at Buffalo, National Center for Earthquake Engineering Research. NCEER Report No. NCEER-SP-0001, 1997, pp. 189-222.
Hospital ED Services	Available ED beds/100,000 pop.	**17**	Office of Statewide Health Planning & Develop-ment (OSHPD) – CA	**15.74**	- Six of 81 Los Angeles County acute care hospitals initiated evacuations immediately after the earthquake - confirmed by Los Angeles Fire Department (LAFD) - Based on this observation, a round estimate of 92.6% (75/81) baseline will be used to reflect event-specific availability	Schultz CH, et al. Implications of Hospital Evacuation after the Northridge, California, Earthquake. *N Engl J Med* 2003;348:1349-1355. Available online at: http://www.lafd.org.
Trauma Units (levels 1&2)	ORs functioning/ 100,000 pop.	**18.38**	Northridge Earthquake Lifeline Performance and Post-Earthquake Response	**15.55**	- Two trauma centers in the San Fernando Valley (Olive View and Northridge) were closed immediately after the earthquake per LAFD; general estimate of 84.6% (representing 11 of 13 trauma centers remaining open) used	LAFD. Available online at: http://www.lafd.org/.

HAZARD MODEL A:	Earthquake: Northridge Earthquake, January 17, 1994 Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Ancillary Services	Pharmacies/ 100,000 pop.	**17.67**	Search for pharmacies using yellow pages on Yahoo	**7.77**	- Extrapolated from data that revealed "56% of firms were forced to close for some period as a result of the earthquake"	Dahlhamer JM & KJ Tierney. Rebounding from Disruptive Events: Business Recovery Following the Northridge Earthquake. *Sociological Spectrum* 1998;18:121-141.
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**12 days**	- Pipeline damage shut down three water treatment plants and resulted in a loss of over one billion gallons per day of treatment capacity - Precautionary boil water orders were issued in Los Angeles, Santa Clarita and Simi Valley -In the City of Los Angeles, all boil water orders were lifted on January 29, after 12 days	Northridge Earthquake Reconnaissance Report, Volume 1. *Earthquake Spectra*, Supplement C to Volume 11, Oakland, California, Earthquake Engineering Research Institute (EERI), April 1995.

HAZARD MODEL A:	Earthquake: Northridge Earthquake, January 17, 1994 Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**~1 day**	- Approximately 100,000 Los Angeles Department of Water & Power (LADWP) customers (~15% of LADWP customers) were without water immediately after the earthquake - Water service was restored to all but a few thousand customers within 5 days; after 10 days, fewer than 100 scattered customers were still without service	"Preparing for the "Big One" -- Saving Lives Through Earthquake Mitigation in Los Angeles, CA." Section 5 – Lifelines, U.S. Department of Housing and Urban Development (HUD), HUD USER Policy Development and Research Information Service. Available online at: http://www.huduser.org/.
Population Displacement	Residents evacuated/100,000 pop.	**0**		**525**	- 50,000 occupants displaced - 30,000 people sheltered in 45 American Red Cross (ARC) shelters - ARC served 1.5 million meals in the month after the EQ -Damaged: ~ 24% of the total number of housing units in the City of Los Angeles - 308,846 units in 65,300 buildings, with 84% of the damaged units in multi-family housing - 350,000 applications for federal disaster assistance	EERI, 1995

HAZARD MODEL A:	Earthquake: Northridge Earthquake, January 17, 1994 Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**<24**	- Immediately after the earthquake, the entire City of Los Angeles was without power (~1.3 million customers); power to the majority of the LADWP service area (93%) was restored within 24 hours and power to virtually all of the service area restored within 72 hours - So. Calif. Edison (SCE) lost power to about 1.1 million customers (~25% of its 4.2 million customers); service was restored to 500,000 SCE customers within 30 seconds; SCE's service territory west of Pardee remained without power, but was restored by emergency repairs at Pardee within 12 hours; the remainder was restored within 20 hours	HUD

HAZARD MODEL A: Earthquake: Northridge Earthquake, January 17, 1994
Assessment Location: Los Angeles County, CA (includes community of Northridge in Los Angeles, CA)

		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**8+**	- Caltrans estimated travel delays: Initial peak-period delays for the I-5 corridor exceeded an hour, delays on the I-10 corridor exceeded 20 minutes, and along SR-118 ranged from 10-35 minutes - Major transportation routes closed for several months for repairs	EERI, 1995

HAZARD MODEL B

HAZARD MODEL B: Flooding, Rainfall-Induced: Tropical Storm Allison, June 8-10, 2001
Assessment Location: Harris County, TX (includes Houston)

		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**1.53**	Fedstats.com	**1.1**		"Service Assessment: Tropical Storm Allison, Heavy Rains and Floods, Texas and Louisiana." National Weather Service, June 2001.
Injuries Requiring EMS Transport	100,000 pop./day	**14.29**	JEMS 2004 Platinum Resource Guide	**.33**		
Outpatient Injuries	100,000 pop./day	**8.33**	CDC-NCHS–Fastats	**n/a**		
Hospital ED Visits Due to Injuries	100,000 pop./day	**83.29**	Kaiser Family Foundation	**n/a**		
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**0.19**	Texas Dept. of State Health Services	**.95**		Tropical Storm Allison, June 2001. *RMS Event Report*, Newark, CA, RMS Inc., Dec. 17, 2001.
Interruption of Healthcare Services						
Basic EMS	ALS systems/ 100,000 pop.	**2.5**	Los Angeles County EMS	**n/a**		
Outpatient Services	PCPs/100,000 pop.	**92.4**	Kaiser Family Foundation	**53.31**	- Estimates based on data from a different flooding event	Tierney, 1997

HAZARD MODEL B:	Flooding, Rainfall-Induced: Tropical Storm Allison, June 8-10, 2001 Assessment Location: Harris County, TX (includes Houston)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Hospital ED Services	Available ED beds/100,000 pop.	**17**	Office of Statewide Health Planning & Development (OSHPD) – CA	**12.92**		RMS, 2001
Trauma Units (levels 1&2)	ORs functioning/ 100,000 pop.	**13.82**	Extrapolation from report by Harris County Judge Eckels	**6.91**	- Three hospitals closed temporarily; of two level-one trauma centers, one was closed while the other was unreachable at times due to flooding	RMS, 2001
Ancillary Services	Pharmacies/100,000 pop.	**27.23**	Search for pharmacies using yellow pages on Yahoo	**15.77**	- Estimates based on data from a different flooding event	Tierney, 1997
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**<7**	- Houston: outage was limited to 500 of 430,000 customers for whom a boil water order was issued - Within Harris County, 24 municipal water supply systems were flooded, necessitating “boil water” orders - In other parts of southeast Texas, nine water systems suffered outages; four of the nine were still under boil water orders a week after the storm	Texas Commission on Environmental Quality. Available online at: http:/ www.tceq.state.tx.us/.
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**n/a**	- No data on water supply availability in the reconnaissance literature - No detailed outage data	

HAZARD MODEL B:	Flooding, Rainfall-Induced: Tropical Storm Allison, June 8-10, 2001 Assessment Location: Harris County, TX (includes Houston)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Population Displacement	Residents evacuated/100,000 pop.	**0**		**882.20**	- 30,000 Houston area residents sheltered in 51 shelters - ARC served 1,833,275 meals - 73,000 residences damaged including 59,000 homes, 11,500 apartments and 2,500 mobile homes in Harris County - 2,744 homes destroyed in Harris County - 120,000 applicants for federal disaster assistance	Tropical Storm Allison Recovery Project. Available online at: http:// www.tsarp.org/ tsa_over/index.html.
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**264 hours (11 days)**	- 8,500 customers; 2/3 of downtown Houston including Texas Medical Center all power restored by June 15 (11 days); total restoration took 3 weeks	RMS, 2001
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**7 days**	- Major transportation routes closed until June 11 (one week)	RMS, 2001

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HAZARD MODEL C

HAZARD MODEL C:	Flooding, Riverine: Grand Forks Flood, April 1997 Assessment Location: Grand Forks County, ND (includes Grand Forks, ND)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**1.78**	North Dakota Division of Vital Records	**0**		Grand Forks Flood. Available online at: www.grandforksflood.com.
Injuries Requiring EMS Transport	100,000 pop./day	**12.63**	JEMS 2004 Platinum Resource Guide	**n/a**		
Outpatient Injuries	100,000 pop./day	**8.33**	CDC-NCHS – Fastats	**n/a**		
Hospital ED Visits Due to Injuries	100,000 pop./day	**111.78**	Kaiser Family Foundation	**n/a**		
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**0.61**	North Dakota Health Department, Trauma System	**n/a**		

HAZARD MODEL C:	Flooding, Riverine: Grand Forks Flood, April 1997 Assessment Location: Grand Forks County, ND (includes Grand Forks, ND)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Interruption of Healthcare Services						
Basic EMS	ALS systems/ 100,000 pop.	**2.5**	Los Angeles County EMS	**n/a**	- United Hospital (only hospital in town and only Level 2 trauma center in NE North Dakota and NW Minnesota) was closed during the flood	Minnesota Public Radio. The Great Flood of 1997. Available online at: http://news.minnesota.publicradio.org/features/199704/04_newsroom_flood/.
Outpatient Services	PCPs/100,000 pop.	**92.4**	Kaiser Family Foundation	**n/a**	- Closure of United Hospital during flood - represents 100% impact on both ED and trauma services - Number of available beds and available ORs equals 0	
Hospital ED Services	Available ED beds/100,000 pop.	**17**	Office of Statewide Health Planning & Develoment (OSHPD) – CA	**0**		
Trauma Units (levels 1&2)	ORs functioning/ 100,000/pop.	**n/a**		**0**		
Ancillary Services	Pharmacies/100,000 pop.	**21.34**	Search for pharmacies using yellow pages on Yahoo	**11.67**	- Extrapolated from Des Moines Flood of 1993 data that showed that 42.5% of "wholesale and business trade" businesses were closed a median of 72 hours post event	Tierney KJ, et al. The Impact of 1993 Midwest Floods: Business Vulnerability and Disruption in Des Moines. *Disaster Management in the U.S. and Canada.* Charles C. Thomas, Richard Sylves, William T. Warigh (Eds.), Springfield, IL, 1996, pp. 214-233.

HAZARD MODEL C:	Flooding, Riverine: Grand Forks Flood, April 1997 Assessment Location: Grand Forks County, ND (includes Grand Forks, ND)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**23**	- Damage to the potable water distribution system, including damage to the water treatment plant (the city's main source of water, which suffered $6.5 million in damage), pipelines and reservoirs, left Grand Forks residents without running water for 13 days and without "drinkable" water for 23 days	"The Red River Flood of 1997: An Assessment of Damage and Long Term Economic Recovery", 1999. Prepared by EQE International for Mayor Pat Owens and the Grand Forks City Council.
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**13**		
Population Displacement	Residents evacuated/100,000 pop.	**0**		**95,000**	- By April 27 (10 days after flooding began), the ARC reportedly had 30 shelters open, had sheltered 5,495 people and served 108,845 meals - 47,500 of the 50,000 residents of Grand Forks were evacuated - 90% of the city was damaged - 28,770 applicants for federal disaster assistance in Grand Forks ND and East Grand Forks MN	FEMA (1998). "The Grand Forks Floods – One Year Later." Available online at: http://www.fema.gov/nwz98/gf420.shtm.

HAZARD MODEL C:	Flooding, Riverine: Grand Forks Flood, April 1997 Assessment Location: Grand Forks County, ND (includes Grand Forks, ND)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**336 hours (2 weeks)**	- For safety reasons, Northern States Power disconnected electric service to the mandatory evacuation areas of the city (90% of Grand Fork's 50,000 residents were told to evacuate) - In all, approximately 12,000 meters were de-energized and later re-energized; service restoration proceeded slowly, with essentially no service within the first 2 weeks, approximately 50% restored in the third week, approximately 80% by the fourth week, and all customers ready to accept power energized by May 23, 36 days after the onset of flooding	EQE, 1999
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**8+**	- Flood waters inundated many transportation routes (e.g., more than one week)	EQE, 1999

HAZARD MODEL D

HAZARD MODEL D:	Hurricane: Hurricane Andrew, August 24, 1992 Assessment Location: Dade County, FL (includes City of Miami, FL)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**2.23**	Fedstats.gov	**1.6**	- 33 fatalities in Dade County, FL	MMWR, April 09, 1993/42(13);242-243,250-251. Available online at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00020139.htm.
Injuries Requiring EMS Transport	100,000 pop./day	**6.48**	Miami-Dade Fire Rescue MIS Bureau	**n/a**		
Outpatient Injuries	100,000 pop./day	**12.44**	Santa Barbara County (CA) EMS	**3.40**		MMWR, 1993
Hospital ED Visits Due to Injuries	100,000 pop./day	**98.36**	Kaiser Family Foundation	**172**	- Three parishes in LA -- St. Mary's, St. John's, and Iberia -- had hurricane-related injury rates higher than 200 per 100,000 population - Injuries accounted for 86%, illnesses accounted for 14%	MMWR, 1993
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**0.43**	Jackson Memorial Hospital website	**n/a**		
Interruption of Healthcare Services						
Basic EMS	ALS systems/ 100,000 pop.	**2.5**	Los Angeles County EMS	**n/a**	- Baptist Hospital in Kendall was southernmost hospital open during and immediately after storm	Medical News Report, 10/92

HAZARD MODEL D:	Hurricane: Hurricane Andrew, August 24, 1992 Assessment Location: Dade County, FL (includes City of Miami, FL)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Outpatient Services	PCPs/100,000 pop.	**92.4**	Office of Statewide Health Planning & Development (OSHPD) – CA	**n/a**		
Hospital ED Services	Available ED beds/100,000 pop.	**17**	OSHPD – CA	**n/a**		
Trauma Units (levels 1&2)	ORs functioning/ 100,000 pop.	**1.60**	Jackson Memorial Hospital Website	**1.60**	- Jackson Memorial Hospital (only Trauma 1 center in area) was far enough from storm direct path to be spared	Medical News Report, 10/92
Ancillary Services	Pharmacies/100,000 pop.	**69.52**	Search for pharmacies using yellow pages on Yahoo	**n/a**		
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**<3**	- Water and wastewater service is provided primarily by the Metro Dade Water and Sewer Agency (WASA), which issued a boil water order immediately after the storm; most water service was restored within 72 hours	FEMA
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**<3**	- No data on water supply availability in the reconnaissance literature - Most water service was restored within 72 hours	

HAZARD MODEL D:	Hurricane: Hurricane Andrew, August 24, 1992 Assessment Location: Dade County, FL (includes City of Miami, FL)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Population Displacement	Residents evacuated/100,000 pop.	**0**		**17,450**	- 85,000 people sheltered in 230 ARC shelters - 350,000 people displaced or temporarily homeless - ARC served more than 4.7 million meals/snacks - 126,000 homes destroyed, 90% (9,000) of South Dade's mobile homes and 10,719 apartment units - 185,000 applicants for federal disaster assistance	
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**72**	- 1.4 million Florida Power & Light customers (43% of their customer base) in six counties were left without power; almost half of the customers had service restored the first day and within 72 hours electricity was restored to most of the affected area	
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**3**	- All Florida Dept. of Transportation highways systems were clear and open after three days	

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HAZARD MODEL E

HAZARD MODEL E:	Terrorist Bombing: Murrah Federal Building Bombing, April 19, 1995 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**2.60**	Fedstats.gov	**33.00**	- 167 fatalities	"Investigation of Physical Injuries Directly Associated with the Oklahoma City Bombing." Injury Prevention Service, Oklahoma State Department of Health. Available online at: www.health.state.ok.us/program/injury.
Injuries Requiring EMS Transport	100,000 pop./day	**17.86**	JEMS 2004 Platinum Resource Guide	**17.78**	- 90 injuries transported by EMS	Hogan, D, et al. Emergency Department Impact of the Oklahoma City Terrorist Bombing. *Annals of Emergency Medicine* Aug 1999; 34:160-8.
Outpatient Injuries	100,000 pop./day	**8.33**	CDC-NCHS – Fastats	**46.04**	- 233 patients treated in private physicians offices	OK State Dept. of Health
Hospital ED Visits Due to Injuries	100,000 pop./day	**96.97**	Kaiser Family Foundation	**70.93**	- 359 patients treated (& released) in ERs	OK State Dept. of Health
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**1.98**	Injury Prevention Service, OK DoH	**16.40**	- 83 survivors hospitalized	OK State Dept. of Health
Interruption of Healthcare Services						
Basic EMS	ALS systems/100,000 pop.	**2.5**	Los Angeles County EMS	**2.5**	- No interruption	

HAZARD MODEL E:	Terrorist Bombing: Murrah Federal Building Bombing, April 19, 1995 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Outpatient Services	PCPs/100,000 pop.	**92.4**	Office of Statewide Health Planning & Development (OSHPD) – CA	**92.4**	- No interruption	
Hospital ED Services	Available ED beds/100,000 pop.	**17**	OSHPD – CA	**17**	- No interruption	
Trauma Units (levels 1&2)	ORs functioning/ 100,000 pop.	**n/a**		**n/a**	- No interruption	
Ancillary Services	Pharmacies/100,000 pop.	**21.34**	Search for pharmacies using yellow pages on Yahoo	**21.34**	- No interruption	
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**0**	- No reports of boil water orders found	
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**0**	- Localized damage and outage only	

HAZARD MODEL E:	Terrorist Bombing: Murrah Federal Building Bombing, April 19, 1995 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Population Displacement	Residents evacuated/100,000 pop.	**0**		**79.03**	- 400 people in 260 occupied units at the Regency Tower Apartments displaced - ARC provided vouchers for food and lodging - Residents were finally allowed to re-occupy their dwellings 6 months after the bombing - ARC also operated a shelter at St. Luke's Methodist Church for 10 days - More than 188,000 meals were served by the ARC, the ORA, and other volunteer groups - 1,242 applications for federal disaster assistance	"After Action Report: Alfred P. Murrah Federal Building Bombing, 19 April 1995, Oklahoma City, Oklahoma." Oklahoma Department of Civil Emergency Management (ODCEM), 1995. Available online at: http://www.ok.gov/oem/.
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**0**	- Localized damage and outage only	

HAZARD MODEL E:	Terrorist Bombing: Murrah Federal Building Bombing, April 19, 1995 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**0**	- Initially, 9 square blocks in the immediate vicinity of the Murrah Building were cordoned off, but the size of the area was reduced to the block containing the Murrah Building as the other structures were examined and cleared by the FBI - An outer security perimeter was also established, containing 18 square blocks - Other than the controlled access area, there was no interruption to transportation routes	ODCEM, 1995

HAZARD MODEL F

HAZARD MODEL F:	Tornadoes: Oklahoma City Tornadoes of 1999, May 3, 1999 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		HAZARD-SPECIFIC		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Human Impact						
Fatalities	100,000 pop./day	**2.60**	Fedstats.gov	**4.15**	- 45 fatalities	"Investigation of Deaths and Injuries Resulting from the May 3, 1999 Tornadoes." Injury Prevention Service, Oklahoma State Department of Health. Injury Update, July 21, 2000. Available online at: www.health.state.ok.us/program/injury.
Injuries Requiring EMS Transport	100,000 pop./day	**17.86**	JEMS 2004 Platinum Resource Guide	**n/a**		OK Dept. of Health
Outpatient Injuries	100,000 pop./day	**8.33**	CDC-NCHS – Fastats	**n/a**		
Hospital ED Visits Due to Injuries	100,000 pop./day	**96.97**	Kaiser Family Foundation	**42.46**	- 460 ED visits	OK Dept. of Health
Trauma Center (levels 1&2) Injuries	100,000 pop./day	**1.98**	OK DoH, Injury Prevention Service	**12.65**	- 137 hospitalized	OK Dept. of Health
Interruption of Healthcare Services						
Basic EMS	ALS systems/ 100,000 pop.	**2.5**	Los Angeles County EMS	**n/a**		
Outpatient Services	PCPs/100,000 pop.	**92.4**	Kaiser Family Foundation	**n/a**		

HAZARD MODEL F:	Tornadoes: Oklahoma City Tornadoes of 1999, May 3, 1999 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Hospital ED Services	Available ED beds/100,000 pop.	**17**	Office of Statewide Health Planning & Develop-ment (OSHPD) – CA	**n/a**		
Trauma Units (levels 1&2)	ORs functioning/ 100,000 pop.	**n/a**		**n/a**		
Ancillary Services	Pharmacies/100,000 pop.	**21.34**	Search for pharmacies using yellow pages on Yahoo	**n/a**		
Community Impact						
Water Supply Contamination	Duration (in days) of widespread boil water order	**0**		**0**	- No reports of boil water orders found	
Water Supply Availability	Duration (in days) of widespread water service disruption	**0**		**<3**	- Reports of physical damage to water systems were limited, although water supply continuity was impacted in areas of power outage; most impacted systems were functional within about 3 days	"Storm Damage Status Report – May 5, 1999." Oklahoma Department of Environmental Qual-ity, 1999. Available online at: http:// www.deq.state.ok.us.

HAZARD MODEL F:	Tornadoes: Oklahoma City Tornadoes of 1999, May 3, 1999 Assessment Location: Oklahoma County, OK (includes Oklahoma City)					
		BASELINE		**HAZARD-SPECIFIC**		
HEALTH INDICATOR	**MEASUREMENT**	**BASELINE**	**BASELINE-SOURCE**	**HAZARD-RELATED**	**ADDITIONAL COMMENTS**	**HAZARD-SOURCE**
Population Displacement	Residents evacuated/100,000 pop.	**0**		**147.7**	- In OK - 899 structures were destroyed, 474 with major damage and 1072 with minor damage - ARC operated 10 shelters, housing 1,600 people at the height of the storm - 9,415 applicants for federal disaster assistance	American Red Cross Chapter Information Bulletin
Public Utilities	Duration (in hours) of widespread electricity disruption	**0**		**192 hours (8 days)**	- More than 167,000 OG&E customers were without electricity at the peak of the storms (of 700,000 OG&E customers in Oklahoma and Western Arkansas) - Power was restored to all customers able to take power within 8 days	"OG&E Wins National Award for May 3 Tornado Recovery." Oklahoma Gas & Electric (OG&E) News Release, January 13, 2000. Available online at: http://www.oge.com/about-us/news-detail.asp?id=49.
Transportation	Duration (in days) major transportation corridors disrupted	**0**		**0**	- No reports of significant impacts to the transportation system were found	