Detailed Identification and Classification of Hazards and Disasters for Effective Hazard Vulnerability Assessments.

Abstract

The identification and classification of the terms *hazard*, *incident*, and *disaster* are often vague and used interchangeably by all levels of government and in many different references. Each reference compiles and categorizes a different set of *Hazards*. Since evaluating what is truly a *hazard* is the first step in the Hazard Vulnerability Analysis, it is important to develop criteria for the identification and classification of *hazards*, *incidents* and *disasters*. The result of this study will be to create a definitive chart of *hazards*, *incidents* and *disasters* by testing the definitions of these terms through the use of a cause (independent), effect (dependent), area (control) and impact (result) formula (Creswell 94).

The purpose of this study is to evaluate if the Federal Emergency Management Agency (FEMA) and National Fire Protection Association's (NFPA) general identification and classification of a *hazard* is too broad and covers terminology that are in fact the effects and outcomes of a *hazard*. Defined as a possible source of danger, a *hazard* is the cause of an *incident* or effect (American Heritage 624). An *incident* is the result of a *hazard* which has occurred. Therefore, a *hazard* is the independent variable, while the *incident* is the dependant variable. The *area* at which the event occurs is a control variable. The *vulnerable resources* located within that *area* is also a control variable. Depending on the *vulnerable resources* located in the *area* of a *hazard* that has occurred, an *incident* can create a *disaster*. A *disaster* is the impact (damage and destruction) of the *incident* occurring in the *area* where there are

vulnerable resources. This study will devise a more detailed identification and classification of *hazards, incidents* and *disasters,* in order to develop and evaluate more effective comprehensive hazard vulnerability assessments.

The majority of disaster hazard references are produced by the United States Government through the Department of Homeland Security and its directorate, the Federal Emergency Management Agency (FEMA), which was created by executive order in 1979 by President Jimmy Carter (About FEMA). Another major resource for the analysis of *disasters* and *hazards* is the National Fire Protection Association (NFPA) 1600 Code which is adopted by many local and state governments.

FEMA publications and the NFPA Code 1600 create evaluation programs to determine what disaster hazards are and how to assess these *hazards* in terms of emergency preparedness, mitigation, response and recovery activities and planning. Whereas, FEMA's Multi-Hazard Identification and Risk Assessment classifies *hazards* into the two categories of: (1) Natural Hazards (atmospheric, geological, hydrological, seismic and other) and (2) Technological Hazards; NFPA Code 1600 classifies *hazards* into the two categories of: (1) Natural hazards (geological, meteorological, and biological) and (2) Human-caused events (accidental and intentional). Both entities require the emergency manager to develop an "impact analysis" using the *hazards* identified. As with FEMA, the NFPA code also identifies a wide selection of *hazards* that can be easily assessed as "causes", "effects" and "outcomes". The NFPA code, in fact, considers several *hazards* to be "direct impacts" and "secondary impacts" of other *hazards*.

Herein, lies the difficulties that face today's emergency managers. Should "direct impacts" and "secondary impacts" be considered *hazards*? An impact is the result of a "cause and effect"

occurrence. A *hazard* causes an *incident* or effect. Depending on the *area* and *vulnerability* of an at-risk entity, an *incident* will create impacts. The FEMA and NFPA publications do not go into detail about what truly defines what a hazard is and what is a *disaster*. These publications do not establish criteria for their definitions; instead the publications simply provide categorized lists of *hazards*. Therefore, the researcher of this paper will present proposed criteria for defining and classifying *hazards*, *incidents* and *disasters*.

In order to better understand the process, the researcher composed a survey of county and state emergency managers in his home state of Maine. The survey instrument contained twenty questions and assessments relating to the definitions and criteria of *hazards* and *disasters*. Ten out of sixteen county emergency management directors and one state emergency management official responded to the survey instrument. The results of the survey were interesting and the various professional opinions helped the researcher to validate the need for the hazard identification criteria.

The emergency managers varied greatly on which FEMA or NFPA hazard classification was appropriate. The majority tended to classify hazards in to either “Multi-Hazard” or “Natural and Technological”; however a significant number also chose “”Natural and Human-Caused”. This indicates that there are no one preferred hazard classification. The emergency managers also varied greatly on the Robert T. Stafford Disaster Relief and Emergency Assistance Act (About FEMA) definition of a “Major Disaster”. The Stafford Act is the primary Federal Legislation dealing with disaster activities. However, when presented with an example situation that did not fit the definition of a major disaster under the Stafford Act, a vast majority felt that the situation did warrant the classification of a major disaster. There was no consensus in the responses to

several of the questions relating to what defines a *hazard* and a *disaster* and in many cases, the responses to one question conflicted with another question in the same vain. This is a possible indication that the FEMA and NFPA definitions and uses of the terms *hazard* and *disaster* are vague or confusing, even for professional emergency managers. However, 100% of the respondents do believe that the terms *hazard* and *disaster* should not be considered synonymous.

When presented with a question that gave a specific disaster example, there was consensus on the determination of the cause of the disaster. This gave an indication that the respondents did feel that a *disaster* is a result and not a cause and that a specific *hazard* is the cause. Although FEMA and NFPA tend to classify the results of flooding as a natural disaster, 100% of the respondents felt that flooding caused by terrorists or human-neglect should not be classified as a natural disaster. Additionally, 81% of the respondent felt that flooding that result in no damage is not a disaster incident. In another question which contained a "cascading" series of hazard incidents, nearly two-thirds felt that the *disaster* was the resulting damages and not the hazard incidents.

What did the researcher conclude from this survey instrument? The FEMA and NFPA definitions and uses of the concepts of *hazards* and *disasters* are imprecise and misused. A clearer definition of these concepts is required. Additionally, it is evident to most professional emergency managers that a *hazard* is the cause of a resulting *disaster*. The question that remains though, is what are the effects of a *hazard* and what are the control variables that result in a *disaster*.

The Hazard-Disaster sequence can be assessed using a process that evaluates dependent, independent, intervening and control variables (Creswell 94). An independent variable is the cause of a dependent variable. The National Response Plan defines a *hazard* as "something that

is potentially dangerous or harmful, often the root cause of an unwanted outcome" (NRP 66). By this definition, a *hazard* is an independent variable that causes a dependent variable. The National Response Plan further defines an *incident* as "an occurrence or event, natural or human-caused, that requires an emergency response to protect life or property" (NRP 66). In this case, *incident* is a dependent variable.

An intervening variable "stands between the independent and dependent variables, and they mediate the effects of the independent variable on the dependent variable" (Creswell 94). The intertwined concepts of *probability* and *severity* and mediate the effects of the *hazard* on the *incident*. *Probability* is defined as "the likelihood that an event will occur" (FEMA Hazard Analysis 5). *Severity* is defined as "the state of being severe" (American Heritage 1248). With these definitions, *probability* and *severity* can be described as the likelihood of a *hazard* causing an *incident* of a certain *severity*.. A good example of the *severity* and *probability* concept can be described using a wildland fire incident. A wildland fire incident might be caused by lightning strikes or accidental or intentional human acts, all which can be described as *hazards*. The *probability* of a very severe wildfire incident in the State of Maine is low; somewhere on the order of once every decade (MEMA 3-35). However, the *probability* of a small wildfire is very high; these occur multiple times every year in the State of Maine. *Probability* and *severity* are variables that stand between the *hazard* (cause) and the *incident* (effect). A *hazard* may cause a larger *incident*, depending on the *probability* and *severity* of that *hazard*.

A control variable "potentially influence[s] the dependent variable" (Creswell 95). Two concepts that can influence an *incident* are *area* and *vulnerable resources*. An *area* can be anything that describes *where*, such as a coastal floodplain, a forest or cyberspace. *Vulnerable resources* can be any asset that can be impacted (damaged, destroyed or disrupted) and may

include people, homes, utilities, the environment and information (FEMA 386-2 A-7). *Area* and *vulnerable resources* are control variables in the Hazard-Disaster assessment.

The result of the interaction of the dependent, independent, intervening and control variables is something "that can be measured or observed" (Creswell 93). The result of a *hazard* which causes an *incident*, mediated by *probability* and *severity* and after being influenced by an *area* and a *vulnerable resource*, is a *disaster*. FEMA's The Guide to All Hazards Emergency Operations Planning, defines a *disaster* as "an occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, deaths, and/or multiple injuries" (FEMA GLO-1). The results are measurable in the numbers of deaths and injuries or people, the cost of the damages to facilities, utilities and infrastructure and the loss and expenditure of resources for response and recovery. This process is further described in the following diagram.

Independent Variable	**Intervening Variable**	**Dependent Variable**	**Control Variable**		**Measured Result**
Cause	Mediation	Effect	Influence		Impact
Hazard	Severity & Probability	Incident	Vulnerable Resources	Area	Disaster
Hurricane	100 year Flood	Flooding	Homes	Coastal Area	Destruction of Homes & Lives Lost

NFPA and FEMA identified nearly 40 different *hazards*, many which do not fit a definition based on the variables listed above. After reviewing FEMA and NFPA's lists of *hazards*, the researcher critiqued the compiled list of *hazards* utilizing the preceding table and compiled the following *hazards*.

Hazard Table

Animal or Insect Acts	Human Acts (accidental or intentional)
Disease/Blight	Iceberg
Earthquake	Lightning
Extreme Temperatures (hot & cold)	Meteor
Extreme Precipitation (too much or too little)	Tropical Cyclone (hurricane/typhoon)
High Winds (tornado, thunderstorm, microburst)	Volcanic Eruption

One or more of these *hazards* can cause one or more *incidents*. For example, extreme cold temperatures combined with high winds and a large amount of precipitation can cause a winter blizzard incident. All the *hazards* listed in the above table meet the definition of an independent variable. Earthquakes, humans and volcanic eruptions are all "causes" of *incidents*. Whether these *hazards* will cause an *incident* or not is based on the mediating concepts of *probability* and *severity*.

Reducing the table of *hazards* to a list of twelve then leaves a large number of *incidents* that tend to be listed as *hazards* in the FEMA and NFPA publications. However, as explained earlier in this research, an *incident* is the effect of a cause or *hazard*. Therefore, the researcher carefully evaluated the original list of *hazards* to determine which should be classified as *incidents*. The researcher compiled the following list of *incidents*.

Incident Table

Animal or Insect Infestation	Hazardous Materials Release
Ash Deposits	Hostage Taking
Avalanche	Landslide/Land Erosion/Mudslide
Building/Structural Collapse	Magma Flows/Lahars/ Pyroclastic Deposits
Civil Disturbance/Public Unrest/Riot/Strike	Misinformation
Cyber Attack	Severe Ground Movement
Drought	Snow, Ice, Hail, Sleet
Economic Depression/Inflation	Subsidence/Expansive Soils
Electromagnetic Pulse	Terrorist Attack
Epidemic/Pandemic/Endemic	Transportation Accident
Explosion	Tsunami
Famine	War (national, civil, insurrection, global)
Fire	Water Control Structure/Dam/Levee Failure
Flooding	

All of these *incidents* are the effects of a *hazard* and are not self-initiated or spontaneous. A flood incident will not transpire without a hurricane, earthquake, extreme precipitation, tropical cyclone or human-caused hazard causing the flood incident to occur. One hundred percent of the professional emergency managers surveyed by the researcher felt that if a terrorist cell blows up a dam and causes a downstream city to be severely flooded, this is a "human-caused" *disaster*. The identified *hazard* is human-caused, i.e., terrorist-initiated. Likewise, a fire incident can be caused by an earthquake, lightning or meteor strike, volcanic eruption or by accidental or intentional human acts. A good evaluation of what is a *hazard* and what is an *incident* is important to understanding the cause and effect process. The most effective preparedness and mitigation activities will be aimed towards understanding the cause or *hazards* that are present.

The Incident Table identifies 27 types of *incidents* that are caused by *hazards*. The next variable in the process is the control variable. The researcher has already identified *area* and *vulnerable resources* as the control variables in this research. The surveyed professional emergency managers, by a wide margin (81%), felt that if a flood were to occur in an area where there are no damages, then the *incident* will not result in a *disaster*. A *hazard* may cause an *incident*, but if it does not occur where there are vulnerabilities; then there is no *disaster*. FEMA defines a *disaster* as "an occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, deaths, and/or multiple injuries" (FEMA SLG101 GLO-1). If there are no deaths, injuries and damages, then there is no *disaster*. The following two tables are compilations of areas and vulnerable resources assembled from FEMA, NFPA and the Public Risk Entity Institute (Rick Identification).

Area Table

Atmosphere	Air, Space
Land Mass	Land, Waterbodies
Ocean	Marine, Ocean Floor, Coastal
Human Development	Communities Cyberspace/Internet/World Wide Web/Information Systems

Vulnerable Resources Table

Animals	Information
Environment (Air, Water, Soil)	Plants
Energy	Societies and Services
Facilities & Infrastructure	Transportation Systems
Financial	Utility Systems
Human Beings	

The last variable in this research is the result of *hazards*, mediated through *probability* and *severity*, which cause an *incident* to occur in an area with *vulnerable resources*. The resulting deaths, injuries, damages, disruptions and destruction are classified as a *disaster*. As has been explained earlier in this research, a flood which causes no damage is not a *disaster*. If a supertanker accidentally (a probable and severe human-caused hazard) releases thousands of gallons of crude oil (incident) into a harbor (area) occupied by sea creatures and vegetation (vulnerable resource), and hundreds of sea creatures and a large quantity of vegetation is killed, then a disaster (result) has occurred.

The purpose of analyzing the hazard identification process, by evaluating the definitions and differences between a *hazard*, an *incident* and a *disaster*, is to devise an effective Hazard Vulnerability Assessment (HVA). A hazard vulnerability assessment is important to assess what *hazards* and *vulnerabilities* a specific area could experience. This assessment will determine what emergency activities will be required. The concept of *emergency management* was designed to create a system that analyzes *hazards*, plans actions, makes decisions and assigns resources in order "to mitigate, prepare for, respond to, and recover from the effects of all hazards" (FEMA Principles 2.3). These "emergency activities are divided into four phases that form a cycle" (FEMA Principles 3.1). These phases are mitigation, preparedness, response and recovery. The final objectives are "to save lives, prevent injuries and protect property and the environment" (FEMA Principles 2.3).

Developing an effective hazard vulnerability assessment is an important first step in achieving an effective emergency management program that protects lives, property and the environment. By evaluating the *hazards*, *incidents*, *areas* and *vulnerabilities* the emergency

manager is able to develop mitigation activities. Mitigation activities are "designed to reduce or eliminate risks to persons or property or to lessen the actual or potential effects or consequences of an incident" (NRP 69). These activities "involve ongoing actions to reduce exposure to, probability of, or potential loss from hazards" (NRP 69). The emergency manager must comprehend what the *hazards* are and what the results will be before the manager can devise activities that will mitigate the impacts of a *disaster*. A good example of a mitigation activity is the relocation of residential properties (vulnerable resource) out of a flood zone (area) and enacting ordinances to prevent further development in the flood zone. The emergency manager has not eliminated the *hazard* or the resulting *incident*; instead the manager has removed the *vulnerable resource* from the hazard *area*, thereby breaking the chain that leads to a potential *disaster*.

When the emergency manager assesses the hazard vulnerability, the manager is able to develop an emergency preparedness program. Preparedness is the process of "building the emergency management function to respond effectively to, and recover from, any hazard" (FEMA Principles 3.1). The preparedness process includes the hazard identification and vulnerability assessment activities, along with the pre-disaster activities of training and equipping emergency responders, planning disaster response and recovery activities before the disaster occurs, and identifying resources that will be needed to reduce the impact of the potential *disaster*. A good example of a preparedness activity is the exercising of multiple emergency response agencies during an exercise that simulates a potential *disaster* situation created by a hazardous materials release. The emergency manager has not eliminated the *hazard* or the *incident*, but has reduced the impact of the disaster by ensuring an effective response that

reduces the *vulnerability* of the resources in the hazard *area*. An effective preparedness program will ensure a successful response and recovery during and following the *disaster*.

When the emergency manager assesses the hazard vulnerability that the manager's community or responsibility faces, the response to a *disaster* will be more efficient. The response by emergency management and response agencies who comprehend the *hazards*, *probabilities*, *severity*, *incidents*, *areas* and *vulnerable resources* will better estimate the impacts of the disaster and will complete activities that reduce the impacts of the disaster. A good example of a response activity is the early and efficient evacuation and sheltering of residents during the days and hours before the landfall of a major hurricane. Another example would be the rescue of encircled wildland firefighters during a major wildfire. The emergency manager does not eliminate the *hazard*, nor the *probability* or *severity* of the *incident*, but is able to remove the *vulnerability* from harm, thereby reducing the impact of the resulting *disaster*.

The recovery from a disaster will be more successful when the emergency manager has assessed the hazard vulnerability. The recovery of a community from the impact of a disaster will be less painful when the emergency managers understand the *hazards*, *probabilities*, *severity*, *incidents*, *areas* and *vulnerable resources* impacted by the disaster. A good example of a recovery activity is the rapid removal of debris and the quick repairs to the community's electrical system following a severe ice storm. If the emergency managers know which roads to clear and which power lines to repair first, fewer of the most vulnerable of the community's population will be impacted severely. Understanding the *hazard* of severe temperatures and precipitation and the community's *vulnerable resources*, will allow the emergency manager to recover more effectively from the ice storm *incident*.

Conclusion

The purpose of this research is to devise a more detailed identification and classification of *hazards*, *incidents* and *disasters*, in order to develop and evaluate more effective hazard vulnerability assessments. The current hazard vulnerability assessment process is a very good beginning; however, the current definitions and use of the concepts of *hazard*, *incident* and *disaster* are too vague and are inappropriately employed. This research devised a process using the variables of independent, intervening, dependent and control to define the phases of a hazard vulnerability assessment. Hazards listed by FEMA and the NFPA were evaluated against a formula derived from these variables that assess the causes, mediation, effects, influence and impact and new lists were created by the researcher. The importance of the hazard vulnerability assessment process to the four phases of emergency activities was explained.

James Lee Witt, the FEMA Director from 1993 to 2001 described FEMA's hazard vulnerability assessment goal when he wrote:

"The Federal Emergency Management Agency has embarked on a full scale effort to build safer communities. Our goals include increasing the public's awareness of hazards and loss reduction (mitigation) measures, reducing the risk of loss of life and property, and protecting our nation's communities and the economy from all types of natural and technological hazards" (FEMA Multi Hazard i)

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