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Characterization of Hazards, Vulnerability and Risk of Disaster Management

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Chamhuri Siwar and Rabiul Islam; Characterization of Hazards, Vulnerability and Risk of Disaster Management

ABSTRACT

This paper focuses on the beginning stages of the hazard mitigation planning process, vulnerability assessment and risk management. This community has recognized that it is potentially vulnerable to a wide range of hazards and now needs to identify precisely what its problems are. The hazard analysis is the foundation upon which all emergency planning efforts in the community are built. A hazard analysis provides an understanding of the potential threats facing the community. By examining knowledge of new or emerging risks, it is possible to determine the probability of such events occurring and the vulnerability of people and property. The Great earthquake, hurricane, typhoon, flood, extreme temperature, and many other disasters have had terrible impacts on communities around the world. Disasters will continue to occur, and their social, economic, political, and environmental impacts will continue to increase. Communities are becoming increasingly concerned about this and are working to develop disaster management programmes to prepare for, respond to, and recover from disasters. Hazard, risk, and vulnerability (HRV) analyses form the basis of disaster management processes; unfortunately, to this point, communities and regional districts have not had access to effective HRV models. In short, the HRV model provides a way for communities and emergency planners to make effective use of existing resources in order to develop comprehensive and practical disaster management programmes and to move towards sustainable hazard mitigation.

Key words: Hazard, Vulnerability, Risk, Disaster.

Introduction

Many of those who choose not to define a disaster by its origin/cause define it according to its characteristics. These may include: (i) length of forewarning, (ii) magnitude of impact, (iii) scope of impact, and (iv) duration of impact [18]. Disaster researchers generally agree that a disaster affects people [16,1] and that it is often catalogued in terms of the number of dead and injured. However, others have expanded the definition to reflect major losses to both population and physical structures - losses that disrupt the social structure and essential functioning of a community [9,7,10]. Researchers such as Handmer and Parker [12] have pointed out that in the developed world; the impact of disasters is more readily evident in their psycho-social and politico-economic impacts than in their mortality rates. But, because the impact of a disaster can be both unexpected and extremely varied, it is extremely difficult to include all potential impacts within any single definition.

[23] states the mitigation, preparedness, response and recovery are not separate endeavours and they should not be pursued by separate professionals. They are a long-term process and must be linked." Indeed, this is implicit in my definition of disaster management: Disaster management is the process of forming common objectives and common values in order to encourage participants to plan for and deal with potential and actual disasters.

The concepts of vulnerability and risk are part of the common language and the concepts are used by most people in their daily lives. These concepts are used loosely in many different contexts, from medicine to poverty and development literature. In the context of natural hazards, the concepts are often derived from the social sciences since there is an explicit demand for increasing social protection to natural hazards. In contrast, the concept of risk in engineering is physically based on the computation of failure probabilities in a hydrological system.

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Regardless of the nuance of risk definitions, the key concepts are:

(i) risk relates to the consequences of a disturbance, rather than its agent; and

(ii) risk is a relative measure and critical levels of risk must be defined by the analyst.

There is no clear definition that includes cross-sector (social and physical) concepts. Since the intended user of the guidelines is the policy maker, we provide here the definition that appears in almost all policy documents [31].

It would appear that any adequate definition of disaster must reflect a given locality's capacity to respond; the fact that what has occurred is unusua1; and the fact that the impacts of what has occurred are of social, economic, political, and ecological significance. A disaster is a non-routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region.

While researchers agree that hazard, risk and vulnerability (HRV) analysis is an important part of the disaster management process, they do not agree as to where, in the overall process, this analysis should be conducted. And they often do not agree on the particulars Hoetmer [15], states that the emergency management process requires that the community undertake a hazard and risk analysis, assess its current capabilities in the areas of mitigation, preparedness, response, and recovery, and devise action steps to close the gap between existing and required levels of capability.

It is important to understand the role of HRV analysis in the development of mitigate strategies within the disaster management process. Fischhoff *et al.* [8] state that, since hazards are divided into events and consequences, one has the following options: (i) prevent the event from occurring; (ii) prevent the potential consequences of the event from occurring; or (iii) lessen the harmful consequences of the event, To this could be added (iv) develop strategies to share in risk reduction measures. It is apparent that, without adequate HRV analyses, communities may neglect to plan for likely hazards. This is because, without understanding die extant hazards and vulnerabilities, it would be impossible for them to adequately follow any of the foregoing options. Consequently, they would not be able to achieve sustainable hazard mitigation [22].

HAZARD: A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Each hazard is characterised by its location, intensity, frequency and probability.

VULNERABILITY: A set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards. Positive factors that increase the ability of people and the society they live in to cope effectively with hazards and can reduce their susceptibility are often designated as capacities.

RISK: The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Risks are always created or exist within social systems, therefore it is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

RISK = HAZARD x VULNERABILITY

Source: The UN International Strategy for Disaster Reduction (UNISDR, 2006)

The HRV model follows the four phases outlined in Figure 1.

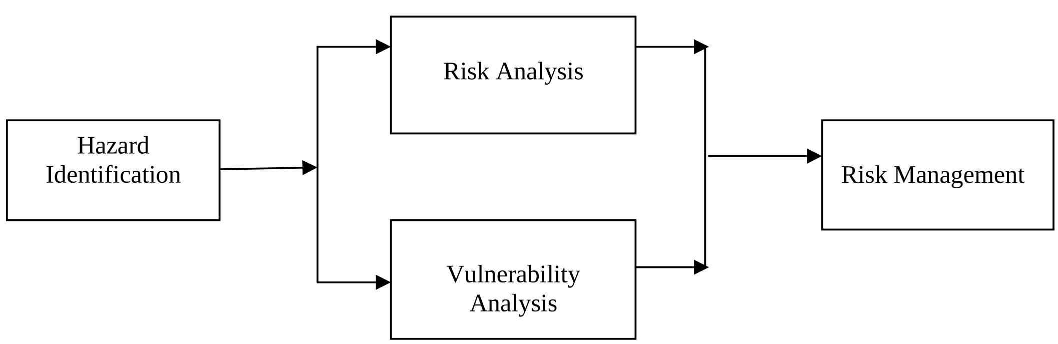

Fig. 1: The Four Phases of the HRV Model
Source: Laurence, 2000.

The first phase of the HIRV model is hazard identification. During this phase, a committee composed of both laypersons and experts reviews a comprehensive list of potential hazards (which is included in the HIRV handbook), reviews the definitions and discussions of hazards, and compiles historical data about past disasters in their given community or region.

The second phase of the HRV model is risk analysis. One of the first tasks the HIRV committee must consider is whether or not the community should be divided into neighbourhoods for the purposes of completing the HRV analysis. This step, which is unique to the HRV model, is critical in setting the groundwork for addressing issues of equity. The next task is to determine, for each location in the community, the risk of the occurrence of a potential hazard. This is done by using the historical data collected in the hazard identification phase as well as the risk factors that are included in the HRV handbook. Another unique feature of HRV is that, once the assessment is complete, the participants have an opportunity to state how certain they are about the decisions they have made. This addresses the problem of uncertainty and the inability of the scientific and expert community to accurately predict potential hazardous events.

The third phase of HRV is vulnerability analysis. In this phase participants use the vulnerability factors included in the HRV handbook. As in the risk analysis phase, participants have an opportunity to mess how certain they are of the decisions they have made.

The fourth and final phase of HRV is risk management. At this point participants evaluate the data for both the risk analysis and the vulnerability analysis phases, and they also provide an impact analysis. The output of the HRV model is a combined value illustrating those areas of high risk, hi& vulnerability; low risk, low vulnerability; medium risk, medium vulnerability; and so on.

The aim of this paper is to analysis the hazards, vulnerability assessment and risk of disaster management.

In the table 1, it can be seen that 1195 people of Indonesia was died on September, 2009 by earthquake. Earthquake of Indonesia was the worst and it was taken top ten natural disasters in the world on 2009. Natural disasters were the earthquake, flood, typhoon, tropical storm, extreme temperature, hurricane “Ida” etc.

Table 1: Natural disasters by number of deaths-2009 (Top ten)

Earthquake, September	Indonesia	1195
Flood, July-September	India	992
Typhoon Morakot (Kiko), August	Taiwan(China)	630
Typhoon Pepeng (Parma), October	Philippines	539
Tropical Storm Ondoy (Ketsana), September	Philippines	501
Extreme Temperature, January-February	Australia	347
Flood, September-October	India	300
Earthquake, April	Italy	295
Hurricane “Ida”, November	El Salvador	275
Extreme Temperature, May-August	Peru	274

Source: Rovins (UNISDR, 2010).

Hazards, Vulnerability Assessment, and Risk Management:

Hazards:

The probability or chance of an event occurring in a particular area based on geological evidence, historical data, and projections derived from theoretical analysis. Some hazard assessment results can be mapped, such as potential frequency and severity of ground shaking.

Hazard Identification:

In disaster management, a hazard refers to the potential for a disaster. 1 use the definition developed by Harris *et al*, [13], who conclude that hazards are threats to humans and what they value: life, well being, material goods, and environment. They indicate the need for judgment when determining whether or not a potential hazard exists. If, for example, a meteor were to fall on a desolate barren area of northern Canada (even if it killed no one, destroyed no property, and left minimal damage to the environment), then it would be considered a potential hazard. This contradicts Hewitt's [14] view that hazard refers to the potential for damage to a vulnerable human community. Following Harris et al., it is not important for a hazardous event actually to take place; it is only important that it is likely to take place.

Beginning in the 1960s disaster management literature discussed hazards without considering their origin. This changed in the 1980s, when hazards began to be described as either natural or technological [21]. While natural hazards were defined as “Acts of Cod," technological hazards were defined as fitting into four categories: hazardous materials, hazardous wastes, hazardous substances, and extremely hazardous substances- As Parker [25] points out, however, 'the significance of these classifications varies across countries and even among agencies within the same country.

Hazard Classification:

Why is it important to classify hazards? First, scientific disciplines tend to be insular and to have narrow foci: atmospheric researchers do not necessarily communicate with hydrologists and other natural scientists. By failing to classify hazards, research may be duplicated and gaps may go unnoticed. Second, and perhaps most important, as the type of hazard affects the choice of mitigation strategy [11], failure to accurately classify types of hazards may lead to the misapplication of mitigation strategies. For example, if one is trying to combat an increase in the number of forest fires by installing additional lightning monitors when, in fact, the fires are being caused by careless campers, not only will the strategy not work, but it will also waste resources. Third, failure to correctly classify hazards leads to failure in other parts of the emergency management process.

Fischhoff *et al.* [8] recognize that, in terms of both events and consequences, nahm1 hazards differ from technological hazards. Similarly, Britton and Oliver [3] differentiate between natural and technological hazards. According to them, natural hazards result from a lack of control, whereas technological hazards result from a loss of control. They conclude that hazards have three origins: (i) natural; (ii) failure or misuse of technological processes; and (iii) misapplication of technology, medicine, or biology. Laurence [19] states that hazards may be classified as: (i) natural; (ii) diseases, epidemics, and infestations; and (iii) person-induced.

Drabek [5] points out that researcher have traditionally identified three types of disasters according to type of potential hazard: (i) natural, (ii) technological, and (iii) civil. He adds that a fourth type of disaster - ecological - has now entered the picture. Ecological disasters are events that are caused principally by human beings and that initially affect, in a major way, the earth, its atmosphere, and its flora and fauna. While the need for natural hazards has already been discussed, the term "person-induced hazards" includes Drabek's typology of technological, civil, and ecological hazards as well as what are commonly referred to as "manmade hazards.

Impact of Hazard Identification:

There has been considerable academic discussion concerning the need to develop disaster management emergency plans for specific hazards rather than for al1 hazards. Some researchers believe that different types of disasters warrant different types of plans, while others believe that the similarities between any two disasters are sufficient to allow for generic plans. A generic, or all-hazard, plan would be one that could be used for any hazard, regardless of its cause or effect. For example, Quarantelli [26] maintains that there are more individual and organizational behavioural similarities than differences for all disaster occasions. Similarly, Kreps [17] States that one of the key requirements for adequate emergency preparedness is a generic rather than an agent specific approach to planning.

Both Quarantelli and Kreps believe that for most disaster management needs, the type of disaster is irrelevant- For example, with regard to warnings, "regardless of whether the threat is a hurricane, a chemical spill, a flood, a tidal wave, or a nuclear emergency, what matters is whether people will understand, believe and respond-to warning messages. There must be an alerting system that works, and warning messages must be accurate, precise, consistent, and timely [17]. Kreps goes on to point out that a general preparedness approach to disaster management is efficient in terms of time, effort, and money and that it helps to avoid duplication of effort, gaps in responses, and possible conflicts between divergent approaches. He believes that for these reasons, moving from a generic all-hazard plan to a hazard-specific plan would be politically undesirable.

Table 2: List of differences between natural and technological disasters

Natural Disasters	Technological Disasters
Are an expected aspect of the physical environment	Are created by human development and use of hazardous materials and are usually caused by human error
Are considered uncontrollable	Are considered controllable
Issues of control appear to produce more psychopathology in affected citizens	Issues of control appear to produce lower psychopathology than natural disasters
Humans are not held responsible	Responsibility is perceived as lying with a human or group of humans who calculate an events predictability
Onset often allows warning/evacuation	Characteristically occur rapidly and without warning
Reluctance to evacuate until the threat is seen as extreme	A large portion of the population will evaluate without formal instructions to do so
Usually have a clear beginning and end via obvious destruction	Although the onset may be clear (e.g., warning sirens signalling a release) its end may not
The event and its effect on people and the environment are generally visible	The event and its effects on people and the environment are generally invisible
Recovery is generally visible (e.g., removal of debris)	Recovery is generally invisible (i.e., removal of radiation cannot be seen)
Individuals can personally observe the effects of a natural disaster	Because the effects are often invisible, individuals are more dependent on authority figures and/or the media for facts
Private individuals, public agencies, and corporations become involved in the response	Corporations and governments respond while private citizens are relegated to roles as victims and/or must be separated from the events aftermath to ensure their safety.
Authority figures are seen as helpful	Authority figures are seen as evasive and unresponsive

Individuals tend to personalize event	Individuals tend to depersonalize event
Mitigation focuses on human adjustment to potential events or to hazardous areas	Mitigation tends to focus on the technical process
Response/relief efforts more common than mitigation because of perceived lack of control over the event	Because of perceived control, mitigation is more common than response/relief
Familiarity develops due to experience	Familiarity is lacking due to lack of experience
Accumulated experience guides mitigation, management, and preparation decisions	Few accumulated experiences to guide mitigation, management, or preparation decisions
Following an event, community solidarity and consensus generally emerges	Following a technological event, a community may search for a culprit, and conflict may emerge
No documented increases in naturally occurring hazardous events	A greater potential exists for hazardous technological events because: (i) a greater number of facilities use hazardous materials; (ii) greater numbers and amounts of hazardous materials arc in the marketplace; and (iii) the population, dong with its spatial distribution, has increased

Source: Showalter and Myers, 1992.

Even though Showalter and Myers [28] were able to list nineteen differences between natural and technological disasters and only fourteen similarities (Table 2), Quarantelli argues that, although tactics may differ (e.g., how far to evacuate), strategies do not. He says that the generic approach to disaster management is difficult to accept because of its tendency to deal with disasters according to cause. He states that the generic approach does not deny that there are important differences between disasters, only that they are not linked to specific types of hazards.

2.2 Vulnerability:

The specific characteristics or conditions of the exposure inventory that increase the chance that a hazard will cause damage, harm, or loss. Vulnerability varies according to exposure characteristics, such as seismic design level, construction materials, demographics, geographic location etc. Frequently vulnerability is used to mean both the fragility of an exposure and the exposure itself. In this paper they are treated separately to keep the different characteristics distinct. Thus, vulnerability of a building might be measured in terms of its damage potential; whereas exposure (value at risk) might be measured in terms of the cost of a building or the number of building occupants. Together vulnerability and exposure define the consequences of a potential hazard impact.

A set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards. Positive factors that increase the ability of people and the society they live in to cope effectively with hazards and can reduce their susceptibility are often designated as capacities.

Vulnerability is a reflection of the community's coping resources and may vary within the smaller social and economic groups which form a large community. [21] As with risk and risk assessment, there are a number of different definitions of vulnerability; however, with regard to the latter, there appears to be a greater degree of consensus. Godschalk [11] offers what is probably the best general definition of vulnerability: The susceptibility to injury or damage from hazards. His definition specifies that both people and structures can be negatively affected, To carry the point further, since, obviously, the contents of structures are as vulnerable to damage as are modes of transportation, recreational areas, and sites of historical or cultural importance, we could Say that vulnerability is (1) the susceptibility of people to injury as the result of a hazardous event, and (2) the susceptibility of the things people value to damage as the result of a hazardous event.

Buckle [4] adds the concept of resilience to the definition of vulnerability. He identifies potential social, economic, and environmental effects and introduces the notion that vulnerability is associated with an ability to recover (which is not always apparent in other definitions), and he implies that there are some political decisions to be made regarding allocation of resources (and that these decisions contribute to vulnerability). He also introduces a key concept of the vulnerability assessment process: the increased susceptibility of a community to a disaster (its vulnerability) results in increased losses. Just as it is important to identify vulnerabilities to a disaster, so it is important to identify the negative impacts of a disaster. These can be social, political, environmental, or economic in nature. We know that, by definition, disasters are capable of causing death and injury. We also know that housing and schools may be destroyed. These particular losses may be considered to be social impacts, as they affect the ability of individuals and families to action. With regard to negative environmental impacts, if a community contains important ecological sites (e-g., the site of a unique flora or fauna habitat), then these areas may be extremely vulnerable to almost any sort of disaster.

Vulnerabilities may be considered in terms of the individual, the general location, the capacity to respond, and the time of day, week, or year. The vulnerability of the individual may be reflected in a number of ways. For example, if a person is of low socio-economic status, then she/he is more vulnerable than is someone of high socioeconomic status and, as a consequence, will be less able to recover from a disaster (Drabek and Key 1984; Bolin

1993). As for general location, one needs to be aware of the vulnerabilities specific to one's area. Clearly, those living near or on a flood plain would be more vulnerable to flooding than would those living on a steppe. Regarding capacity to respond, a prepared community is less vulnerable than is an unprepared community. If residents have adequate stored water, first-aid kits, emergency food rations, and other emergency supplies, then they will not *be* as vulnerable as will those who do not have these things.

Finally, the more vulnerable the region, the greater the difficulty the community has in adequately responding to a disaster. The more vulnerable the people, the greater the potential for deaths. The greater the value and number of buildings, industries, and resources, the greater the likelihood of social and economic instability. Similarly, the greater the uniqueness of a community's ecosystems, the greater the likelihood of the disruption of potentially irreplaceable fauna and flora, Historical buildings are worthy of special note, as it is often only after a disaster that residents realize their importance and that great pains are taken to ensure their preservation.

Risk:

The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Risks are always created or exist within social systems, therefore it is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Risk may be defined as the likely consequences (damage, loss, etc.) that may result from the impact of an event on exposures (values at risk) with specific event related vulnerabilities. Risk may be considered the combination of hazard, vulnerability, and exposure. An event resulting in unacceptable consequences may be considered a high-risk event even if the probability of occurrence is low. For example, a nuclear accident or catastrophic earthquakes are potentially high impact events that may be considered high risks even though the frequency might be low. Similarly, a low impact/high frequency event may trigger unacceptable cumulative consequences. Such an event may be considered a high risk even though the individual impact of any one occurrence is low. Risk may be described subjectively (e.g. high, medium, or low) or mathematically (e.g. 10% probability in 50 years). Risk combines the following three elements:

- Values at risk (Exposure)
- Hazard (Sources of harm; Likelihood that a potential hazard will occur)
- Vulnerability (Probability that a value at risk is vulnerable to potential damage, financial loss, etc.)

Risk Assessment:

The risk assessment defines the nature and severity of the risk problem through two primary steps:

Risk Identification:

It focuses on four tasks: (1) clarifying stakeholder risk management goals and objectives; (2) identifying what exposures are necessary to accomplish those goals and objectives; (3) identifying potential hazards; and (4) assessing the vulnerability of identified exposures to the potential hazards.

Risk Analysis:

It examines the significance of identified risks on the community’s capability to achieve defined goals and objectives. Gasps in understanding the nature of the hazard and uncertainties in expected hazard impacts lead to less accurate risk assessments.

Risk Evaluation:

Risk evaluation is a process for evaluating what to do about the risk, including evaluating the feasibility of possible risk interventions. Integrates risk assessment results with the goals and objectives of the community risk management system.

Risk Policy:

Community risk policy is a written statement that communicates the purposes of the community’s risk management program and the actions others can take to contribute to that effort. The policy establishes (a) program goals and objectives, (b) defines duties and responsibilities of those who will implement risk management measures, (c) coordinates the treatment of potential risks on a reasonably standardized basis within community organizations/departments/neighbourhoods, etc., (d) establishes communication channels and management information systems, and (e) provides for program continuity and facilitates transition when the stakeholders organization changes (adapted from Essentials of Risk Management, 1997).

Steps of Risk Management

Facts and Data	Conceptual Steps	Judgments
Human experience, toxicology, or epidemiology	Hazard Identification	Causality, nature of **ris**k
	Risk Assessment	Incentives and Company information
Exposwe patterns, potency, other challenges, susceptibility	Identification of Regulatory alternatives	
	Decision Analysis	Importance of other economic, social and legal effects
Economic, social, and legal facts	Regulatory Analysis	
	Legal or political challenges	Costs of regulation, projected profits, perceived social goals
Uncertainty, risk, economic and social projections	Implementation and enforcement	Are goals being met?
Emissions, ambient measurements, and epidemiology	Monitoring	
	Hazard identification, etc.	

Lave [20] suggests that risk management is made up of nine steps (Table 3). He includes references to vulnerability factors under the first column (Facts and Data), but he indicates neither how analyses are to be completed nor how judgments are to be made. For example, he says that "the elements of the problem must be pulled together in a decision analysis" (469). How they are to be identified and how they are to be pulled together - and, indeed, how the decision analysis is to be structured - is not given in any practical detail. It is also interesting that there are no lines explicitly forming any relationships between the various elements. Furthermore, Lave makes no mention of who is supposed to be completing the risk management process. Nonetheless, Lave's (470) list of criteria for determining whether or not a risk has been properly managed appears to be a good one.

(i) The first criterion is the extent to which the risk has been reduced to a level of acceptability.
(ii) The second criterion is efficiency.
(iii) The third criterion is equity.
(iv) The fourth criterion is administrative simplicity.

Approaches and Methodologies for Hazard Mapping and Risk Assessment:

Risk Management Approach:

The approach taken in this working paper is based on that used by risk managers to address accidental and business losses likely to interfere with an organization's capability to achieve its goals and objectives. The organization may be a corporation, a public agency, or – as in this paper – a community. Community risk managers, and others involved in strategic management, start by identifying what the community wants to accomplish, what it needs to be successful, and what risks would block that success. Only those risks that interfere with the community's defined criteria for success are considered significant and included in the risk management program.

Policy:

The preparation of a risk management policy sets-forth the commitment of community leaders to the risk management program and establishes guiding principles for preparing plans and for translating those plans into action. The policy helps set the risk management program objectives and targets. This approach is consistent with a number of strategic management systems, including Total Quality Management, ISO 14001, ISO 9000, Environmental Management System (EMS), and NFPA 1600 (National Fire Protection Agency). Each of these examples includes establishing program policy to demonstrate senior management commitment and to guide program actions. See Annex 4 for a sample community emergency management policy.

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Planning:

The Risk Management plan turns the guiding principles included in the policy into action.

Authorities:

Authorities establish by legislation, ordinance, or custom responsibility for the risk management program.

Roles and Responsibilities:

It is essential that those who will be directly involved in identifying, implementing, and/or evaluating risk measures be a part of the stakeholders group who develops the program. Clarifying who "owns" the risk helps clarify who benefits and who might be asked to pay for risk mitigation measures.

Hazard Mapping and Risk Assessment are part of the policy and planning phases of risk management program development and therefore serve to establish the foundation of the program. Feasibility studies are also part of the planning phase as various options are evaluated against their capability to satisfy defined program goals and objectives. Plan procedures provide specific guidelines to put plan elements into action. Training, education, exercises, and after-action reports support the continual improvement process necessary to take advantage of lessons learned. Risk indicators are used to determine if the program is still on track and to assess what progress has been made. The themes in this workshop each address different aspects of this risk management approach.

Risk Assessment:

In risk management, potential loss exposures are broadly classified into four general categories: personnel, liability, property, and income. The causes of the potential losses between and within each category will vary widely, including losses related to the impacts of natural hazards; however, the unifying characteristic is whether or not the potential loss exposure is likely to prevent the community from achieving established risk management program goals and objectives.

Data Collection:

There are seven methods are commonly used by stakeholders for collecting information on potential loss exposures, including information on values at risk, hazards, and vulnerability. These methods provide input to the risk assessment, including risk identification and analysis of the significance of that risk to the community's risk management program. Hazard mapping is a tool for displaying results. Risk maps may also be used to display the results of hazard impacts on community exposures derived from the following data collection methods:

- Surveys and questionnaires
- Loss histories of the organization and other similar organizations
- Financial statements and underlying accounting records
- Other community records and documents
- Flowcharts of community operations (e.g. fire suppression, emergency medical, water supply, sewer treatments, etc.)
- Site inspections (including technical investigations, such as geologic mapping)
- Consultation with experts inside and outside of the community

The method(s) selected will depend upon the availability of resources and the intended application of the collected data. There will always be trade offs. Collecting data that does not contribute to defining the community's essential risk management goals and objectives allocates resources to a task that might better be spent developing strategies to reduce a more significant risk. For example, surveys and questionnaires will take less time and money to prepare, distribute, and evaluate then site inspections. Site inspections, however, will provide greater detail. If the goal of the data collection is to define specific hazard zones on a scale appropriate for land use planning, site inspections may be necessary (unless the data is already available in community or other stakeholder records). However, if the goal of the data collection is to identify which of a number of risks are of greatest concerns to stakeholders, surveys and questionnaires may be more appropriate.

Importance of Hazard Mapping and Risk Assessment:

Hazard Mapping and Risk Assessment are essential to the establishment of a Comprehensive Risk Management Program. As noted in the Introduction, Hazard Mapping and Risk Assessment provide the foundation for the risk management program. This first step in the risk management process involves establishing the program goals and objectives and identifying the risks that would prevent them from being obtained. Hazard mapping is a tool to display one element of the risk triangle, which includes hazards, exposures (inventory), and exposure vulnerability. Risk mapping may display a combination of these three elements modelled to determine the resulting impact or as isolated elements that can be over laid to demonstrate contributions to risk.

Need for Hazard Mapping:

Hazard mapping provides input to educational programs to illustrate local hazards, to scientists studying hazard phenomena, land use planners seeking to base settlement locations to reduce hazard impacts and to combine with other information to illustrate community risks.

Community Threat:

Hazard maps provide clear, attractive pictures of the geographic distribution of potential hazard sources and impacts. These maps frequently provide motivation for risk management actions that would be difficult to obtain without a compelling visual. The colours and detail of the map should reflect the application. Some motivational maps for the public, for example, would best be very simple, colourful sketches. Mapping hazards provides an easily accessible tool for displaying the threat to a community

Scientific Investigations:

The mapping of natural hazards has long been a key element of scientific programs to better understand the causes and impacts of natural hazards, such as landslides, floods, volcanic eruptions, earthquakes, erosion, etc. Mapping facilitates the identification of relationships between the distribution of geologic materials and evidence of geologic processes to reveal connections that would not be obvious if relying on analytical approaches alone. As more is learned about the causes and impacts of geologic hazards, hazard maps are produced to show expected future impacts, such as lava flows from renewed volcanic activity and future flooding. Similarly, the probable distribution of toxic gases that could be released by known point sources of hazardous materials can be modelled and mapped to display the potential areas that would be impacted.

Land Use Planning:

Hazard maps may be used to guide future growth in undeveloped areas by identifying the extent of the hazard problem. While land use planning provides opportunities to reduce potential hazard impacts, planning approaches are often difficult to implement within built areas and if the local view of land ownership stresses individual rights. However, some types of traditional land management may help facilitate the implementation of hazard donation into the land use process. For example, map boundaries need to identify clan boundaries in order to help local leaders understand what hazards could potentially impact their area of responsibility. Ignoring traditional boundaries may result in no one group perceiving responsibility.

Risk Assessment:

Risk Assessment begins with defining the risk management program policy, including establishing guiding principles. From this initiation, the scope and participants can be more easily identified and involved in refining program policies and assist in developing plans. The three elements of risk, as noted above, exposures (inventory), hazard, and vulnerability become more easily assessed after the project is focused on elements of specific concern (the community's vision for the future). The significance of each hazard depends upon its capability to obstruct the community's vision.

So, before analyzing hazards, the values at risk must first be identified and located. This typically requires thinking about the system of essential elements needed to provide a service or quality identified in the community's risk management policy.

The hazard analysis is the foundation upon which all emergency planning efforts in the community are built. In fact, preparing a good hazard analysis and community profile is the first step that the community's emergency planning team should take in building an effective emergency management program. A hazard analysis provides an understanding of the potential threats facing the community. By pinpointing the location, extent and magnitude of past disasters or emergency situations, and by examining knowledge of new or emerging risks, it is possible to determine the probability of such events occurring and the vulnerability of people and property. By viewing this information along with relevant land use, economic, and demographic information from a well prepared community profile, emergency managers can make assumptions about those segments of the community that might be impacted by various types of incidents. This, in turn, allows them to set priorities and goals for resource allocation and response, recovery, and mitigation activities prior to an incident occurring. Collectively, these decisions are the cornerstone of the community's emergency management program, and should guide all decisions pertaining to community emergency management activities.

The process of creating a good hazard analysis will be broken down into four sub-steps in this workbook. These will be called (a) the community profile, (b) hazard identification, (c) risk assessment, and (d) vulnerability assessment, and all fall under step 1 of the overall mitigation planning process. Separate sections (numbered as steps 1 through 4) are now included in this workbook to more clearly describe each of the hazard analysis sub-steps.

Step 1 – Community Profile:

The first sub-step of the development of a community profile is accomplished by identifying (and mapping, where appropriate) information that is relevant to hazard mitigation, such as the community's present land use and development patterns, geography and climate, transportation network, demographic information, key industries, major organizations active in the community, the locations and nature of important community facilities, emergency warning system coverage, and other information that is relevant to the community's safety and smooth functioning.

Step 2 – Hazard Identification:

The second sub-step involves the identification of those hazards to which the community is susceptible. To do this, the community should review the Michigan Hazard Analysis (EMD Publication 103) and investigate local information sources to determine if the community has experienced (or may be susceptible to) specific hazards. The Michigan Hazard Analysis provides a good start in the investigation, but it has a broad, state wide perspective. Local information sources are critically important because they provide information on those events that may not have been widespread or severe enough to be listed in the Michigan Hazard Analysis, but nonetheless had a significant impact on the community. Communities can also add any local hazards that have not been described in the Michigan Hazard Analysis. In this sub-step, experienced emergency managers can share their knowledge of local hazards so as to benefit others who do not have this knowledge. Information can also be gained through questionnaires or other contact with local officials, organizations, businesses, and residents.

Step 3 – Risk Assessment:

The third sub-step, risk assessment, involves the examination of the community's hazards using measures that evaluate such factors as severity, exposure, frequency of events, types and extent of damage scope of impact, etc. Through this evaluation process, hazards are identified in detail and a community's overall risk from those hazards is assessed (and often mapped, to identify key areas and to tie in with community's decision-making about future land development). Considering hazard-specific "worst-case" disaster scenarios may help to determine what critical issues the community may face—life safety, public health, loss of critical functions, economic impacts, and short/long term recovery issues—and to plan ways to deal with them.

Step 4 – Vulnerability Assessment:

The fourth sub-step is the determination of the community's vulnerability to the hazards that were identified and assessed in steps 2 and 3. Since a good community profile has mapped out the locations of the community's people and important facilities, and a good risk assessment has mapped out its hazards, a vulnerability assessment can ensue by comparing areas where the hazards overlap with people and important facilities. An estimate of potential losses (usually expressed in dollar values) will be made, and priorities can be established as to which hazards the most are threatening. The highest-priority hazards will be the ones your community should place more emphasis, effort, and funds toward addressing.

Phases	Tasks: The following steps are to be completed over several months
Hazard Identification	- Become familiar with the educational material provided. - Identify all potential hazards. - Attempt to identify potential multi-hazard events. - Obtain historical data on potential hazards. - Conduct field reconnaissance. - Publish and provide access to information for the community at large.
Risk Analysis	- Become familiar with the educational material provided. - Eliminate all hazards for which there is no possibility of occurrence. - Conduct field reconnaissance. - Establish the location of the potential ha7ard and the area of impact - Determine whether the community is equally affected by most hazards or whether it should be divided into significant areas for comparative purposes and ease of analysis. - Review the risk factors for each beard, using experts to justify the evaluation of risk whenever possible. - Determine the likelihood of a specific beard occurring. - Complete the risk analysis recording sheet with all ratings. - Publish and provide access to information for the community at large. -
Vulnerability Analysis	- Become familiar with the educational material provided. - Review the vulnerability factors for each hazard and rate each factor in terms of whether or not the area is highly vulnerable. - Complete the vulnerability assessment recording sheet with all ratings. - Publish and provide access to information for the community at large. -
Risk Management	- Become familiar with the educational material provided - Compare the risks and impacts for all ha7nrds and study areas - Using the risk management recording forms, determine the high and low priorities for application of mitigation strategies. - Group remaining hazards and study areas into areas of secondary priority (if desired, additional levels may be used). - Get committee ready to formulate specific aspects of its recommendations. - Publish and provide access to information for the community at large.

Source: Laurence, 2000

Strengths and Weaknesses:

- Industries: life and health; property and casualty insurance.
- Climate change:
- Life, auto and liability insurance - little measurable impact compared to other shocks.
- Profound impact on the property insurance and reinsurance industries.
- Will continue to challenge the sector over next 30 or 40 years
- No impact yet on the liability insurance industry, but some believe that the future impact may be significant
- IPCC Report could further explore this issue.

Conclusion:

It is time to adjust to risk and cope with losses from disasters in a manner that takes the resiliency of a community and a sustainable environment into consideration. [24]. The HRV model is based on the principle of community participation, and it is comprised of five parts: (1) hazard identification, (2) risk analysis, (3) vulnerability analysis, and (4) risk management. It provides the means for communities to identify potential hazards, to assess the relative risks and vulnerabilities of a particular area, to assess the impact of potential hazards, and to prioritize findings with regard to the allocation of time and resources.

The HRV model makes an important contribution to the field of disaster management and community planning and has a number of unique elements. The HRV process

i) is carried out by a diverse advisory committee; decisions are shared between community officials and public representatives. Experts, the media, industry, residents and others all have a role on the HIRV committee.

ii) explicitly states that its goal is to focus on sustainable hazard mitigation and, in order to succeed, the HIRV model involves widespread public participation and recognizes that political legitimating is crucial to ensuring the adoption of mitigate strategies.

iii) is grounded in the belief that it is only when the public understands potential hazards and their consequences that enough public pressure will be put on elected officials to ensure that mitigate steps will be taken.

iv) recognizes that disasters do not affect al1 residents equally. It is the only mode1 whose process is designed to empower those most vulnerable through providing a forum within which it is possible to acknowledge issues of equity. In order to enable residents to evaluate equity issues, the HLRV model uses the concepts of zones, or neighbourhoods, to divide a community for comparative purposes.

It is strongly recommended that separate subsections of the plan be developed in each case that a community differs markedly from the county or region as a whole-either in terms of its hazards, the nature of its lands, environment, and community, or in the nature of its political style, trajectory, and relationships with its surrounding communities. The way to successfully accommodate minor civil divisions that are very independent-minded is to provide a separate section in the plan that describes their distinctive features and concerns. This workbook will call these the community subsections of the plan. Communities can customize their subsection of the plan so that they are sure that it reflects their concerns and is politically acceptable within their jurisdictions.

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