COURSE MANUAL

E9: Disaster Management

Module 3

Risk reduction: assessment and mitigation of hazards and risks

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Contents

Module 3

Risk reduction: assessment and mitigation of hazards and risks

Introduction

Module 3 discusses hazard mitigation and preparedness.

The module will provide: a practical overview of hazards and risks including different types of hazards and how these may impact communities; the principles of hazard mitigation; and tools to identify and manage hazards.

Upon completion of this unit you will be able to:

Outcomes

- *identify* different types of hazards and risks
- *explain* how different types of hazards can affect people and communities (vulnerability)
- *discuss* the principles of hazards and risk assessment
- *describe* tools and practices to identify and analyse hazards and risks
- *describe* the relationship between core infrastructure and critical inter-dependencies and mitigation strategies
- *discuss* mitigation strategies and list the steps involved in preparation of disaster mitigation plans
- *explain* community-based preparedness and planning, including land-use planning and the use of building codes for disaster resistance.

Unit 6

Risk identification and assessment

Introduction

In this unit we outline the principles of hazards and risk assessment. We look at available tools and practices to identify and analyse hazards and risks.

Upon completion of this unit you will be able to:

Outcomes

- *differentiate* between different types of hazards and risks
- *state* how different types of hazards can affect people and communities (vulnerability)
- *define the* principles of hazards and risk assessment
- *describe* tools and practices to identify and analyse hazards and risks
- *identify* hazard mitigation actions.

Terminology

Terminology

Complex emergency	A humanitarian crisis in a country or region where there is a breakdown of authority resulting from internal and/or external conflict and which requires an international response that exceeds the capacity or mandate of any single agency (IASC, 1994).
Critical infrastructure	The processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of the country and the effective functioning of government.
Disaster	A serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the affected community's coping capacity (UN, 1992). Disasters are usually larger in scale than emergencies.

Disaster threshold	The point at which the consequences of an event exceed the level of a community's coping resources, and an emergency becomes a disaster.
Extreme event	An occurrence that can cause severe damage within the community, including personal injuries and property destruction (e.g., a hurricane).
Hazard	The potential for a negative interaction between an extreme event and the vulnerable parts of the population that is not addressed by the community's coping resources (e.g., a mudslide resulting from a hurricane).
Preparedness	Activities which are designed to build an emergency response capability before disasters occur, to facilitate effective and efficient response (Mileti, 1999).
Recovery	The co-ordinated process of supporting disaster-affected communities in reconstructing damaged physical infrastructure and restoring the emotional, social, economic and physical well-being of people who have been impacted by the event (Emergency Management Australia, 1996).
Response	Actions taken immediately before, during, and after a disaster to help save lives, minimise damage to property, and enhance effectiveness of recovery (Mileti, 1999).
Risk	The product of two components: the likelihood of an event occurring and the potential consequences of the event.
Risk management	The identification, assessment, and prioritisation of risks (defined in ISO 31000 as *the effect of uncertainty on objectives*, whether positive or negative) followed by co-ordinated and economical application of resources to minimise, monitor, and control the probability and/or impact of unfortunate events or to maximise the realisation of opportunities.
Vulnerability	The relationship between the common social and economic characteristics of the population, individually and collectively, and their ability to cope with the hazards they face, either geographical or functional, to manage an incident by establishing a common set of incident objectives and strategies.

Understanding the concepts

Critical infrastructure and inter-dependencies

Critical infrastructure refers to the processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of the country and the effective functioning of government.

Critical infrastructure can be stand-alone or interconnected and inter-dependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence.

Responsibility for strengthening the resiliency of critical infrastructure is normally shared among federal, regional and local governments and critical infrastructure owners and operators.

Given that disasters most often occur locally, the first response to a disruption is almost always by the owners and operators, the municipality, the province or territory.

The risks to critical infrastructure are increasingly complex and becoming more frequent. They include:

- natural
- intentional
- accidental hazards.

An all-hazards risk management approach to critical infrastructure allows for comprehensive planning, preparations and response and recovery strategies to cover the full range of potential risks. This means more detailed situational awareness and swifter and more efficient response efforts when disruptions occur.

Be it through direct connectivity, policies and procedures, or geospatial proximity, most critical infrastructure systems interact; a disruption of any one service could have a cascading effect across essential services or systems.

These interactions often create complex relationships, dependencies and inter-dependencies that cross infrastructure boundaries. The modelling and analysis of inter-dependencies between critical infrastructure elements is a relatively new and very important field of study.

A risk management approach to critical infrastructure refers to the continuous, proactive and systematic process to understand, manage and communicate risks, threats, vulnerabilities and inter-dependencies across the critical infrastructure community, including the owners and operators of critical infrastructure.

Having a strong situational awareness of the risks and inter-dependencies that confront critical infrastructure is the first step towards a comprehensive risk management process.

Hazards and threats

A hazard is an extreme event or a physical condition that has potential to cause damage to life, property, or the environment. A threat is the possible impact of such an event or situation.

It is important to know the likely location, cause and magnitude of a hazard. This is called hazard identification.

Hazards may be:

- natural
- human-induced
- economic.

They may also be internal or external.

Module 1 discusses the different types of hazards in detail.

Vulnerability and exposure

Vulnerability is the susceptibility of people, settlements, physical assets, resources, and the environment to the impacts of hazards.

Vulnerability depends upon the exposure of any of the above to a hazard and its level of resilience to the impacts of the hazard.

For example, people living closer to foothills are more vulnerable to a landslide than those living away. Similarly, a child is more vulnerable to epidemics than a youth who has a stronger immune system and resistance.

Risks

Risk is the chance or likelihood that a hazard will occur, and the exposure of human population and assets to such a hazard.

Risk is not only the probability that a hazard will occur, but also is dependent on the probability and possibility of exposure to that potential hazard.

Risks are quantifiable and measurable over a specified time period. They could be:

- health risks
- safety
- security risks
- environmental risks
- public welfare risks
- or financial risk.

Risk is a function of hazard intensity and vulnerability. It is determined by exposure potential (or avenues of contact) and characteristics of exposed human beings and assets (receptors), and their capacity to manage or resist the impacts of the hazards.

Probability of occurrence is only a measurement of historical (and location-specific) evaluation of hazard over a specified time period. It does not indicate the impact of such an event on the exposed assets or people. However, risks are reduced further if the capacity of people to withstand and resistance of the assets in hazard prone areas is very high. Thus risk is often measured using the following formula:

Risk = Probability (likelihood of occurrence) x Consequence (expected loss) ÷ Capacity to manage.

The fundamental difference between hazards and risks is that a hazard is an agent that has the potential to cause harm and is a source of risk, while risk is the possibility of a hazard occurring, and its potential to cause harm over a period of time.

Understanding the risk management process

Introduction

To manage risks, you first need to quantify or assess the risks in terms of identifying potential hazards, their location and intensity based on historical analysis or scientific predictions and estimation. The second step is to assess vulnerability in terms of exposure and weaknesses of the exposed population, assets or resources to such hazards in a specified time and location. Finally, assess the capability of the concerned authority/governments to manage it.

The greater the intensity of a hazard in a given location, the higher the risk, but if there is no high value asset or human settlements in the location of occurrence, the risks of loss to human beings is reduced. Risk management is a five-step process (Figure 1) based on correct assessment of hazards and vulnerability, and the strength of the exposed populations or valuables.

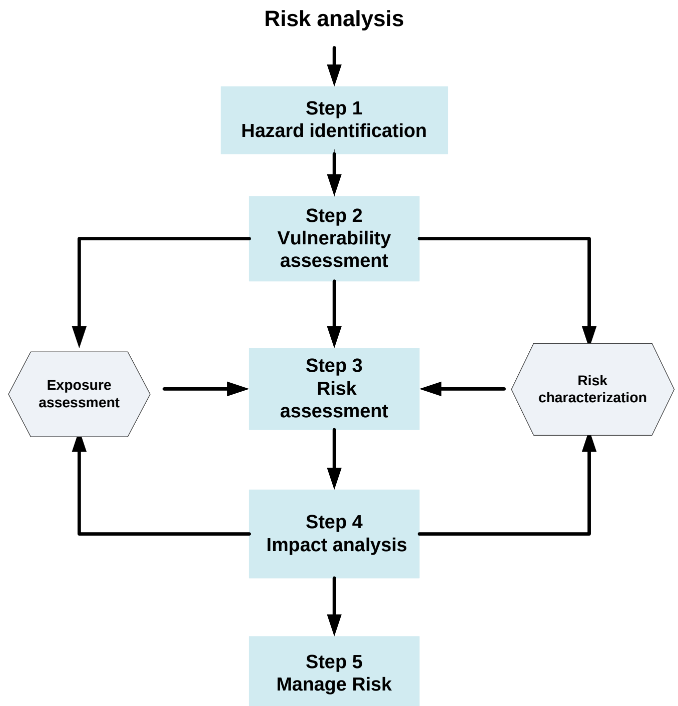

Figure 1: Risk management process flowchart

Step 1: Identifying hazards

The process of defining and describing potential hazards is called hazard identification.

Hazards may be natural or human-induced. For example, an earthquake is a natural hazard, while flash flooding due to drainage blockage or sudden breach of dams may be human-induced.

Hazards may be internal or external.

If you store toxic chemicals on the work site, this is an internal hazard. If your company does not have hazardous materials on site, but the company nearby does, and if those materials were to spill, the result might threaten the operation of your company. That possibility is classified as an external hazard.

Most natural hazards and diseases are external threats (unless your company is a biological laboratory); most person-induced hazards can be both internal and external.

Hazards may be predictable or sudden.

Droughts and flooding are quite often predictable, while earthquakes and air crashes are not.

For the purpose of this course you should concentrate on those hazards that can have adverse impacts on your organisation or settlements which may lead to a potential disaster.

For the purpose of risk assessment, hazard identification would involve hazard assessment and analysis. Hazard assessment is the process of defining a hazard's physical characteristics, causative factors, probability and frequency of occurrence, magnitude and severity, and locations of likely occurrence.

The basis of hazard assessment could be historical data, hazard mapping, or physical characteristics of land, soil and climate (for natural hazards), and operations, maintenance and safety systems within large industrial setups.

Activity 3.1

Activity

Consider the following questions, then discuss with your mentor:

1. What is your understanding of the term hazards?
2. What distinguishes the difference between hazards and risks?
3. List the different hazards you can identify in your area, company, or neighbourhood.
4. Of the hazards you listed, how many are severe enough to cause a disaster?
5. Can you identify the locations of these hazards on a map?
6. Can you measure or quantify the severity of any of the disasters listed above on any scale?

Step 2: Vulnerability assessment

Vulnerability or susceptibility could be any one (or combination) of the following and their exposure to the hazard:

- people
- assets
- preparedness
- time.

Vulnerability is measured as low, medium or high depending upon the combination of the above factors (See Table 1).

Factors that determine vulnerability

The impact of each factor depends on the level of exposure to the hazard, the exposed people or valuables and their capacities to cope with the hazard. For example:

- A child or an old person (because of little understanding or low mobility), may not be able to evacuate quickly in case of an earthquake or storm prediction.
- Buildings and infrastructure facilities built without codal provisions for disaster impacts are more vulnerable than those

designed and built with resilience and structural stability towards disasters like earthquakes.

- Spatial congestions cause faster spread of an epidemic as an aftermath of any disaster. Spatial congestions in lanes and by-lanes cause restrictions to mobility of fire tenders or evacuation equipment after disasters.
- Occurrence of disasters during the night renders inhabitants more vulnerable than during the day. For example, an earthquake in rural areas would cause more casualties in the night when people are sleeping than during the day when they are working in the fields. The case of the earthquake in Latur, Maharashtra, India, is an example of the huge loss of life that took place as people got buried under the debris while sleeping.

The more factors that apply to each area or situation, the more vulnerable that area becomes. The exposure of each of these factors would also help in vulnerability rating.

Step 3: Risk assessment

A situation becomes disastrous if a hazard has a harmful impact on the people and valuables. When assessing risks we first need to assess the likelihood of a hazardous event occurring and then assess who and what would be affected and to what extent.

Probability of occurrence of the hazard can help determine the risks

After identifying potential hazards and the likely exposure of the settings (or the situation), hazard maps could be prepared, which would identify the exposure levels, exposed areas and populations.

Chances of damage to these areas will depend upon the historical data available identifying how many times the hazard has affected the same setting in the past and by conducting a probability analysis to assess the possibility of it occurring again during the current or subsequent years.

An example of this is if a river basin is frequently flooded then the historical data would identify the likelihood of its occurrence during this time of the year and possible inundation of the river and areas coming within its flood zone. This information would help identify risks to those areas or identify their vulnerabilities to the risk of flood. In case of a flood, predictions can also provide information on certainty of its occurrence during a specific time period.

Assessing certainty

Historical data or predictions could be used to estimate certainty of occurrence of hazard. The following model could help in determining the certainty.

Level of agreement	High	Probable	Well-established
	Low	Speculative	Well-posed controversy

Table 1: Assessing certainty

Categories of assessing certainty

Well established

This category denotes wide agreement, based on multiple findings through multiple lines of investigation. A finding could be removed from this category not by a single hypothesis, observation or contention, but only by a plausible alternative hypothesis based on empirical evidence or explicit theory and accepted by a substantial group.

Well-posed controversy

A well-established finding becomes a well-posed controversy when there are serious competing hypotheses, each with good evidence and a number of adherents.

Probable

This category indicates that there is a consensus, but not one that has survived serious counter attack by other views or serious efforts to "confirm" by independent evidence.

Speculative

Speculative indicates not so much "controversy" as the accumulation of conceptually plausible ideas that haven't received serious attention or attracted either serious support or opposition.

Rating risks

The following table is a scale for determining the likelihood of a potential hazard becoming a disaster in your situation/assessment area

This rating would largely depend upon the perception of risk that may vary with each individual or the communities or national governments as a whole. It also depends upon personal priorities, attitudes or knowledge. This is discussed in more detail later on.

+3	Hazard is very likely to occur
+2	Hazard is likely to occur
+1	Hazard is not very likely to occur

Table 2: Rating risks

Determining risk factors

Exposure and possibility of people's valuables (or assets) at risk due to hazard would determine the likely damage it can cause. They are determined by the risk factors and vulnerability assessment.

The next step is to determine the risk factors for each exposed valued commodity such as buildings, facilities and density of the population affected in the likely hazard area. For example, a flood zone map would be able to identify which buildings or facilities are likely to be immersed in the floods if the level of water is more than the high flood level mark. The following is an example for determining risk factor analysis.

If every year flooding of a river basin occurs and surface water level crosses 4 metres above the normal for a period of four days during a heavy monsoon, then the risk factors would comprise:

- Buildings with height less than 4 metres in the flood zone are likely to be fully immersed.
- Buildings with mud plaster or weak foundations will be washed away.
- Drinking water supply-well will be totally immersed and possibly get contaminated.
- There may be disruption of power as the power distribution lines may be damaged within identified flood zones.
- Roads and transportation would be disrupted for four days. The roads may get damaged due to high inundation and high water currents.
- The crops failing (within a certain number of square kilometres) or being washed away.

By assigning weight to each of the above factors based on local situation and importance, you would identify one or more of these factors as risk factors to your situation.

Acceptance of risks

The gap between perception and actual risks is the main cause of inadequate planning when avoiding disasters.

Perception of degree of risks varies from individual to individual. Level of acceptance of risk would vary from the kind of hazard and the vulnerability of the exposed populations and valuables. Although assessment of vulnerability and risk has been used as a very subjective activity, there are several quantifiable methods for determining acceptable levels of risk.

Some of the methods used in quantifying risk are:

- **Benchmarking.** This would depend upon the post-hazard goals of the organisation and may vary from the goal of mere survival of workers and the company to using the opportunity to expand.

- **Using legal standards.** Sometimes legal standards, such as water quality standards or zoning, set the parameters of acceptable risk.
- **By-laws and building codes.** Municipal by-laws and building codes also influence the level of acceptable risk.
- **Analysing past data.** Acceptability is determined by analysing return period of the floods and past performance of an asset withstanding the disaster.
- **Risk matrix.** A risk matrix is often found to be a handy tool for establishing acceptance criteria for an organisation to set up a benchmark. In this probability, a criterion is used to assess the certainty of occurrence of a hazard.

Probability of hazard occurrence

5 Frequent (1 in 2 years)	High Risk Undesirable Needs attention within 1-5 years			Extreme risk Unacceptable
4 Certain (1 in 10 years)	Medium risks			Need immediate attention action within fiscal year
3 Likely (1 in 50 years)			Risk acceptable with controls	
2 Possible (1 in 100 years)	Low risk Limited action		Planned action	
1 Rare (1 in 500+ Years)				Long-term action 2-5 years
	A Very Low	B Low	C Moderate	D High

Consequence = Potential Loss
Exposure inventory/vulnerability

Table 3: Risk matrix.

Source: Table adapted by Wayne Dauphinee from various public domain sources

Step 4: Impact analysis

Examining the impacts

Vulnerable settings suffer impacts of hazards in the form of loss of life and property. Impact analysis may also be termed as loss estimation.

Impacts may be:

- social

- environmental
- economic
- political.

Match the impacts to the vulnerabilities

Social impacts

If an earthquake strikes, social impacts would be the number of deaths, injuries, homelessness, family dislocation and disintegration of social fabrics etc.

These can be matched to the most vulnerable; for example, children and the elderly may suffer on account of death or injury, and women and the poor may lose their socio-economic status.

Example

In the example given below, if a hazard strikes, the identified vulnerable areas listed could be matched to the environmental impacts.

Vulnerabilities	Environmental impacts
industrial sector	quality of air
lifelines and infrastructures	quality and quantity of water
ecological sites	quality and quantity of soil
natural resources sector	destruction to plant life
agricultural sector	deaths and injuries to wildlife destruction of natural resources deaths and injuries to livestock destruction of ecosystems

Table 4: Environmental impacts

Vulnerabilities	Economic impacts
buildings structures critical facilities historical and cultural sites lifelines and infrastructure non-structural property	structural damage non-structural damage

Vulnerabilities	Economic impacts
economic sectors recreational land	loss of jobs loss of revenue loss of service deaths and injuries to livestock and domestic animals destruction of crops

Table 5: Economic impacts

Vulnerabilities	Political Impacts
capability to respond company education and training warning system number of potential technological hazards	public perception of blame

Table 6: Political impacts

Social	Environmental	Economic	Political
number of deaths	quality of air	structural damage	coerced risks government control unfair risks untrustworthy sources
loss of housing	quality and quantity of soil	loss of jobs	industrial risks
loss of critical facilities	death and injuries to wildlife	loss of service	memorable events dreaded risks
loss of recreational space	destruction of natural resources	loss of revenue deaths and injuries destruction of crops	undetectable risks not understood by science catastrophic risks unresponsive process

Table 7: Cumulative assessment matrix

Hazard vulnerability mapping

Having identified hazards and the vulnerabilities, spatial maps can be drawn identifying the highest zones of risk due to different hazards. These zones can be coloured differently to match the high-risk areas for a specific hazard.

An example is the Vulnerability Atlas of India, which has been prepared for around 136 districts in different states of the country, for three types of frequent natural disasters.

The hazards maps identifying areas with different degrees of vulnerability due to a specific hazard are compiled, along with information on the housing typologies in the districts and their vulnerability. Two of the maps are shown below as examples.

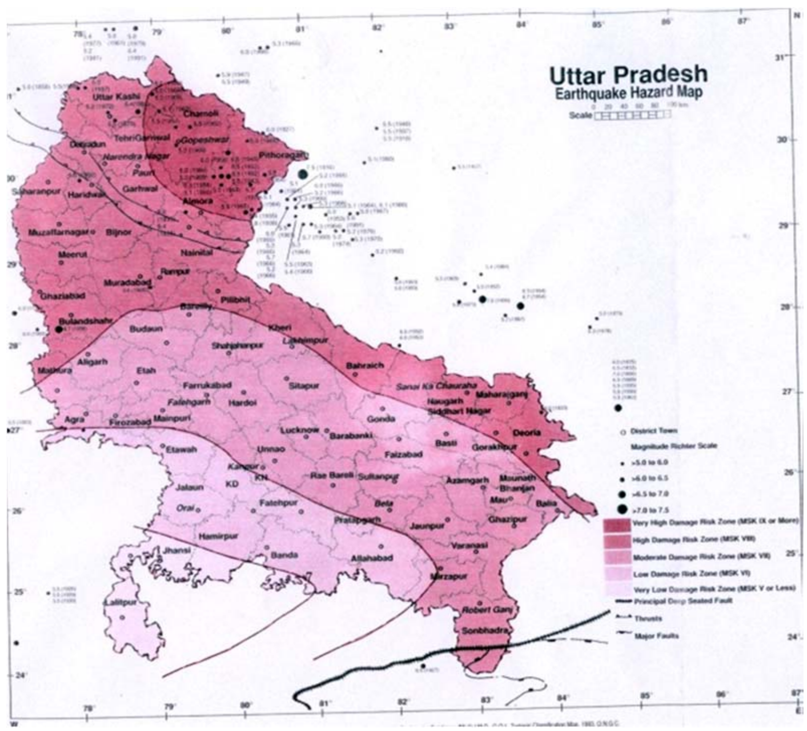

Figure 2: Earthquake Hazard Map for Uttar Pradesh India

Source: Maps of Net

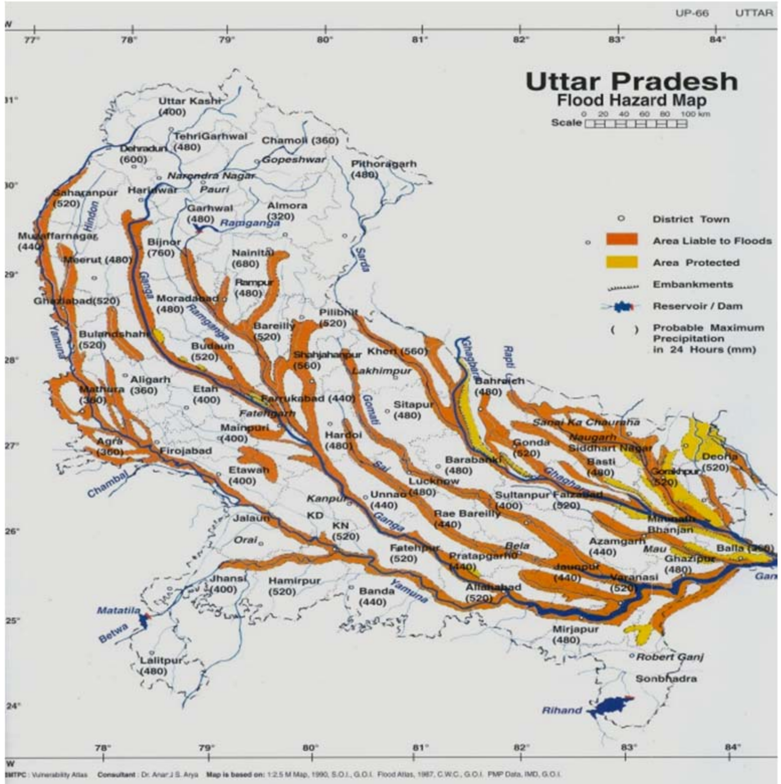

Figure 3: Flood Hazard Map for Uttar Pradesh

Source: Maps of Net

Step 5: Transfer all assessments to the risk management sheet

The comparison between the rankings in the risk analysis and the rankings in the vulnerability assessments provides a sufficient basis for assessing the likely impacts.

If the risk analysis rates any hazard as posing a high rate of risk and vulnerability analysis rates high vulnerability to the risk, then it is important to work out strategies to mitigate impacts due to such hazards.

Risk analysis transferred to a recapitulation sheet (Figure 4) provides you with sufficient information for action planning with the most vulnerable spot that would be at greatest risk from a specific hazard.

Hazard	Risk Rating	Vulnerability Rating	Impact Analysis	Certainty	Risk & Vulnerability Analysis

Figure 4: Risk management recapitulation sheet

To be effective and meaningful, risk management must be an integral part of the overall management of a system. In this regard, organisations concerned with hazard reduction should take the following steps:

1. Identify natural hazards (location, intensity, frequency).
2. Map hazard-prone areas and environmentally sensitive areas.
3. Inventory structures and areas vulnerable to hazards, for example, unreinforced masonry, old wood buildings.
4. Inventory critical facilities and resources, for example, utilities and response materials.
5. Inventory sites containing hazardous and toxic materials, determine vulnerability.
6. Inventory special needs groups, for example, people who require help in evacuations.
7. Conduct hazard and risk assessments (vulnerability of population and natural resources to specific hazards).
8. Prepare hazard overlay maps in order to depict vulnerable areas and populations.
9. Digitise hazard and risk assessments, for example, through the use of geographic information systems.
10. Develop procedures and schedule for updating hazard and risk assessments.
11. Translate hazard and risk assessments into recommendations for action, for example, company awareness, mitigation, preparedness programmes.

The risk analysis process allows management to identify:

- hazards that are likely to occur and which will have a high impact upon the organisation
- hazards that are unlikely to occur and which will have a low impact upon the organisation
- areas in the organisation that are at greatest risk
- areas in the organisation that are at least risk.

Multiple hazards

Since research in the area of multi-hazards is still in its infancy, multi-hazards are beyond the scope of risk analysis for this course. However, in many cases where relationships between hazards are known, they can be addressed in the vulnerability assessment. For example, it is known that earthquakes can cause landslides. Therefore, proximity to an area subject to landslides can be recorded as an added vulnerability to earthquakes. The following table (Table 9) identifies some of the risk factors associated with various hazards.

Hazard	Risk factors
Drought	☐ Inland areas are at more risk of drought. ☐ Previous droughts in the area. ☐ Degradation of land. ☐ Increased water usage.
Earthquakes (natural hazard)	☐ The most fundamental information for a hazard assessment is the record of past earthquakes in a region. Where earthquakes occurred in the past, they will happen again. ☐ Areas nearest to fault segments are likely to move. However, in some cases it is difficult to determine how recently a fault moved and it is not unusual to not recognise that a fault exists until after a strong earthquake. ☐ Unconsolidated sediments: where moderate or poorly consolidated youthful marine and river deposits exist, shaking is increased, especially if sediments are thick and water-saturated.
Earthquakes (human induced)	☐ Previous earthquakes have occurred. ☐ Areas near major projects that are involved in filling large water impoundments. ☐ Areas in the same geological area where projects involving deep well injections are being undertaken. ☐ Areas in the vicinity of underground explosions of nuclear devices.
Hailstorms	☐ Particular geographic areas, for example continental interior of North America. ☐ Time of year, for example May to July is when the maximum size hailstorms occur in Canada. ☐ Previously known hailstorms.
Landslides	☐ The most important risk factor is the presence of previous landslides as landslides are rarely-occurring events and standard statistical methods do not apply to their prediction. ☐ Fine-grained soils that lie on slopes and

Hazard	Risk factors
	that are rich in swelling clays are particularly susceptible to creeping and slumping. Quick clays can flow quickly and with devastating consequences. ☐ Road construction, logging, reservoir creation, irrigation and urban development along slopes. ☐ Known faults, folds and layering of soils which affect the stability of soil and rocks. ☐ Areas of deforestation and poor drainage increase the likelihood of landslides.
Air crashes	☐ A study completed by the International Civil Aviation Organisation in 1981 found that the larger the aircraft, the less likely it is to crash, so places in the flight path of large aircraft are less likely to be impacted by a crash. ☐ Since most air accidents occur on or near airports, at either landing or take-off, airports and areas with large numbers of flights are clearly at more risk. ☐ Areas near flight paths that are near mountains are more at risk. ☐ Areas near flight paths that are near areas of poor weather visibility are more at risk. ☐ Areas near aircraft training stations. ☐ Areas near military missile and artillery training areas. ☐ Areas near air shows.
Hazardous material accidents in situ	☐ Industrial sites that contain large amounts of toxic hazardous materials. Areas close to sites where dangerous substances are handled in a quantity that could cause a serious accident. ☐ Generally speaking chemicals stored under pressure (greater than ambient pressure) pose a greater threat to employees, the community, and the environment than those not under pressure. ☐ Although disagreement prevails concerning what constitutes a safe distance from a chemical plant, a distance of 600

Hazard	Risk factors
	metres has been considered as fatality-free from flying fragments in 99 per cent of plant explosions. The same source indicates that a distance of 2100m or more is 100 per cent safe, although the implementation of such a standard would probably not be economically feasible. ☐ Areas near sites where hazardous materials have been stored for long periods of time. ☐ Areas in proximity to deteriorating hazardous material storage containers or buildings. ☐ Areas in proximity to large-scale chemical plants, especially if the area has large fluctuations in temperature and weather conditions. ☐ In the recent past, a material of increasing concern has been polychlorinated biphenyls (PCBs). Areas around PCB storage sites are at risk. ☐ Areas where previous hazardous materials spills have occurred. ☐ Areas in proximity of fixed sources of hazardous wastes and waste disposal sites. ☐ Areas near forest mills that have large quantities of anti-sap stains (a group of chemicals similar in chemical composition to PCBs that are applied to wood to prevent staining of timber in storage or transport). ☐ Areas in proximity to active pulp and paper mills, which contain a number of serious pollutants that may contaminate the ocean and the air. ☐ Once valuable ores are extracted from the earth during mining processes, the remaining ore is discarded as waste rock or tailings. Areas near these sites can be at risk. ☐ Increased patient care produces a growing amount of biomedical or infectious wastes. For many years, these wastes were dumped in municipal landfills. Wastes are often stockpiled for several days between collections, forming a concentration of

Hazard	Risk factors
	wastes which presents a threat to regional health, in the case of earthquake, flood, or other disaster. ☐ Areas near local municipal or regional garbage dumps. ☐ Areas near nuclear power plants. ☐ Areas near run-down areas susceptible to large urban fires. ☐ Lack of inspection of sites and willingness to enforce regulations for the storage of and training in the use of hazardous materials. ☐ Storage of radioactive and toxic materials (e.g. plutonium).
Human diseases – human transmitted	☐ All urban areas with relatively high population densities are at greater risk. ☐ Decreased numbers of public health inspections and inability to adequately inspect and enforce public health safety regulations. ☐ Deteriorating sewage systems. ☐ Decreased use of vaccinations. ☐ Increases in new diseases or strains of diseases that are resistant to medication. ☐ Many of those affected by communicable diseases are children, who in turn can infect parents or other adults. Therefore, those areas with high numbers of school-age children are also more at risk of spreading infections. ☐ Many infections are spread through economically disadvantaged groups and cultural minorities.
Urban wildfire interface	☐ Areas undergoing rapid urban growth, where pockets of suburban development infringe on wild lands, or undeveloped areas, are potentially high risk areas of wild land-urban interface fires. ☐ Fine fuel moisture – when the moisture content of forest litter and other fine fuels drops to a low level.

Hazard	Risk factors
	☐ Duff moisture when the moisture content of organic surface soils is at a low level. ☐ Drought – when the moisture content of deep organic soils is low (an indication of long-term weather conditions). ☐ Initial spread – fire fuel availability and the potential for high winds. ☐ Build-up – when there is a sufficient amount of fuel available for combustion. ☐ Fire weather – weather conditions likely to precipitate a major fire. ☐ Certain fuel or forest types such as dry conifer and grasses are more combustible than deciduous forests. ☐ Lack of the existence or enforcement of bylaws regulating the building of homes and businesses in wild land areas. Some of these regulations would include: restricting roofing materials such as shakes, not allowing vegetation to physically touch the building, not allowing stockpiling of wood against buildings. ☐ Lack of fire-fighting capacity (e.g. lack of fire hydrants, roads inaccessible by fire trucks).

Table 9: Hazards and associated risk

Activity 3.2

Activity

State whether the following are True or False.

	Question	True	False
1.	A hazard, risk, and vulnerability process is the second step in the overall disaster management process.		
2.	The goal of a hazard, risk, and vulnerability analysis is sustainable hazard mitigation.		
3.	Risk is the threat to humans and what they value: life, well-being, material goods and the environment.		
4.	Vulnerability can be measured in terms of people, place, preparedness and time.		
5.	The risk management step is used to establish priorities for mitigation.		
6.	It is important to classify hazards in order to develop effective mitigation strategies.		
7.	A lack of preparedness can lead to a negative political impact.		
8.	Historical data is the main determinant for predicting risk.		
9.	The HIRV model has four main phases.		
10.	Once the results of the risk management phase are complete the HIRV committee must work at developing mitigation strategies.		
11.	Organising your company into separate sites or functional areas is an important component of the HIRV model.		
12.	Judgments are probable if there is low agreement and lots of evidence.		

Unit summary

Summary

In this unit we covered the principles of hazards and risk assessment, how to describe available tools and practices to identify and analyse hazards and risks.

Unit 7

Mitigation: risk reduction

Introduction

Planning is the most important component of a proactive approach to disaster management and can be taken up as a long-term preparedness effort or a short-term measure.

In this unit we will look at aspects of preventive planning, such as the function of time, scale and opportunities, which require a thorough understanding of post-disaster impacts in order to come up with a well-defined strategy to reduce these impacts.

Upon completion of this unit you will be able to:

Outcomes

- *define* the relationship between core infrastructure and critical inter-dependencies and mitigation strategies
- *implement* planning for prevention, and list the steps involved in preparation of disaster mitigation plans
- *explain* community-based preparedness and planning
- *utilise* physical planning in terms of land-use planning and the use of building codes for disaster resistance
- *integrate* disaster mitigation measures into all stages of development plan.

Terminology

Terminology

Built environment	Human-made surroundings that provide the setting for human activity, ranging in scale from personal shelter to neighbourhoods to the large-scale civic surroundings.
Critical infrastructure protection (CIP)	A concept that relates to the preparedness and response to serious incidents that involve the critical infrastructure of a region or nation.
Mitigation	Any effort taken to reduce risks before, during, and after a disaster. This phase of emergency management is related to short-term and long-term measures; for example, preventing or reducing risk to property or lives by improving the coping capacities of people and the strengths of habitats,

	infrastructure and critical facilities.
Mitigation measurers	Specific design commitments made during the environmental evaluation and study process that serve to moderate or lessen impacts deriving from a proposed action, including avoidance, minimisation, rectification, reduction and compensation.

Critical infrastructure protection

A better understanding of critical inter-dependencies among core infrastructures is one of the most important requirements to mitigate the impact of extreme events and improve survivability.

The dynamic segmentation of critical infrastructures helps to assign valuable and limited recovery resources to the most critical areas, while avoiding the propagation of the emergency by cascading collapses of critical infrastructures to neighbouring areas.

Natural disasters such as:

- earthquakes
- tsunamis
- forest fires
- global disease outbreaks

can dramatically impact (at first) the socio-economic well-being of countries (and in a more serious context) our basic survivability.

The extent of the damage resulting from a catastrophe must (and can) be minimised by the implementation of better preparedness, organisation and action plans among the critical infrastructure operators at all levels.

Enhancing the resiliency of critical infrastructure can be achieved through the appropriate combination of:

- security measures to address intentional and accidental incidents
- business continuity practices to deal with disruptions and ensure the continuation of essential services
- emergency management planning to ensure adequate response procedures are in place in order to deal with unforeseen disruptions and natural disasters.

Enhancing the resiliency of critical infrastructure can be described as actions and programmes that:

- identify risks to critical infrastructure and inter-dependencies
- assess and prioritise risks
- take mitigative (or protective measures) to reduce risks and the potential for disruptions

- conduct exercises to assess measures and identify strengths and areas of improvement
- refine and upgrade critical infrastructure plans in all sectors
- result in swift and more effective response and recovery efforts when disruptions occur.

Mitigation planning

Preventive planning

Risk assessment is one tool for preventive planning. Based on the hazard map vulnerability assessments and risk analysis, you as a part of the community, government, or a company will be able to develop preventive plans.

Preventive planning means:

- strategising about how to move the communities and critical facilities from high-risk areas or reduce densities of settlements in these areas
- minimising high value assets and facilities in most vulnerable areas
- assigning the desired level of standards for protection of utilities and critical facilities
- identifying acceptability and preparedness of the communities to the level of risk
- ensuring availability and maintenance of warning and alert systems and forecasting
- raising awareness of the communities with respect to potential hazards, dos and don’ts in the event of occurrence of such hazards as well as available facilities and information on whom to contact
- training community leaders on the first-response activities including rescue and first aid, holding public simulation exercises, analysing the results and improving arrangements
- following the policies at the government level, including institutional and legal frameworks for disaster mitigation
- strengthening and establishing sectoral and inter-sectoral co-ordination mechanisms
- developing and updating MIS and records on the human settlements, properties, their inhabitants, values of properties, and their vulnerabilities
- making information accessible to communities with respect to the risks, knowledge on dos and don’ts and information on available facilities and relevant contacts. Information on transportation

facilities and emergency evacuation routes; information about trained NGOs regarding various operations and relief operations

- keeping up-to-date information on responsible authorities and their roles and contact information
- ensuring and procuring the equipment for rescue and response, medical facilities, and inventory
- identifying or constructing temporary shelters for housing the evacuees and providing them with relief
- ensuring the need for personnel who are trained in fire fighting, rescue equipment and evacuation, and first aid assistance will be met
- making arrangements for distribution of relief
- conducting training workshops for community, emergency staff, and the personnel involved in disaster mitigation, and establishment of nodal training centres
- establishing parallel communication links during emergencies
- listing of contact information of all stakeholders involved in disaster management like police, fire services, Red Cross, home guards, volunteers, community leaders, international agencies etc. and making it available to the community.

All the above steps when identified and documented in the form of an action plan, with scheduled times and allocation of funds, would result in a sound disaster mitigation plan. This plan would have short and long-term actions for mitigation planning.

Preparing disaster mitigation plans

Disaster mitigation plans are a broad framework of actions at each level of the government, company or unit responsible for safety and minimisation of damage to humanity and assets.

In the case of natural hazards, often both federal and local governments are responsible for safety and damage reduction in an area.

Disaster mitigation plans should have a hierarchy, which has a scale, dependent upon the area covered and the level of responsibility. For example, a mitigation plan includes:

- a regional mitigation plan
- a national mitigation plan
- a state mitigation plan
- a city or municipal/ local mitigation plan
- a community/school or even family mitigation plan.

While the basic objectives of any plan is to reduce the risks and impacts due to hazards and provide quick response and relief to the affected people and assets, the scale of operation and priorities of each plan would vary depending upon the risk and loss estimation and the resources available for mitigation efforts.

However, each plan would have four essential steps to follow and these are identified in Figure 5.

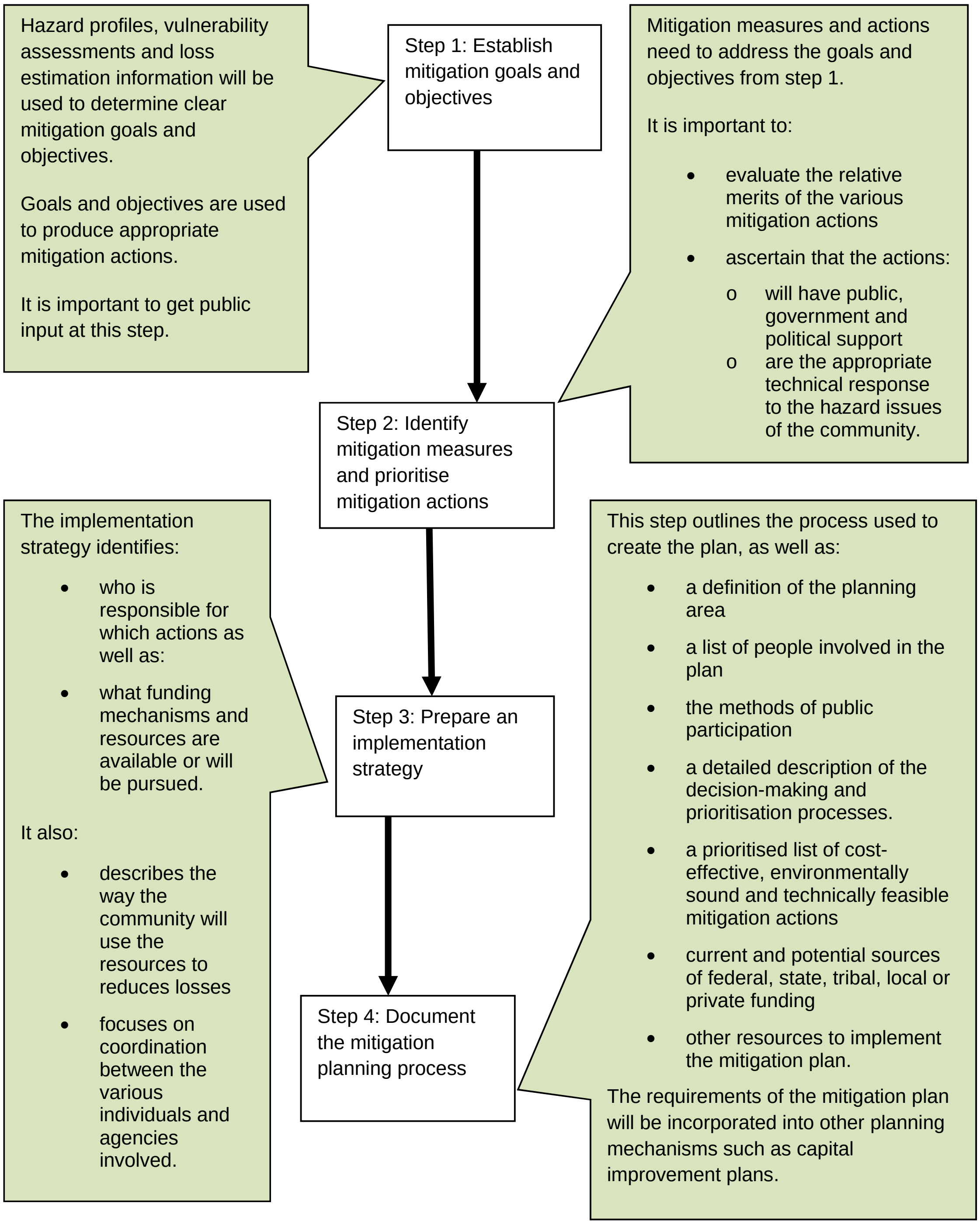

Figure 5: Preparation of disaster mitigation plan.
Source: Figure adapted by Wayne Dauphinee from various public domain sources

Step 1: Establishing mitigation goals and objectives

In this step information collected in the hazard assessment and impact analysis will be used to develop clear mitigation goals, general guidelines that explain what you want to achieve and objectives that detail how those goals will be achieved.

One way to begin this step is to phrase the findings of the vulnerability assessment as problem-statements. These statements will be based on the results of the hazard and loss estimations as well as review of trends or patterns in the types and locations of previous or potential hazard events.

Vulnerability of infrastructure, buildings or populations would help identify problems. The goals can then be structured and objectives created that steer you toward appropriate mitigation actions.

Goals are general guidelines that explain what you want to achieve. They are usually broad policy-type, long-term statements representing global visions, such as:

- The economic vitality of the community will not be threatened by future flood events
- Minimise wildfire losses in the urban wildfire interface area
- The continuity of local government operations will not be significantly disrupted by disasters.

Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable, such as:

- protecting heritage buildings in the historic old town area from flood damage
- educating citizens about wildfire defensible space actions
- preparing plans and identifying resources to help re-establishing county operations after a disaster.

> NOTE:
>
> The loss estimation you completed in the second phase of the mitigation planning process should have helped you determine the following:
>
> 1. Which areas of the community or state are affected by hazards?
> 2. What assets will be affected and how?
> 3. How likely it is that the hazard event may occur?
> 4. How intense might the hazard event be in terms of its economic and social impacts?

Procedure for setting goals and objectives

Review the results of the risk assessment and loss estimation

The hazard profiles include details on the causes of hazards, the likelihood of occurrence, severity and extent of areas affected.

Knowing the severity and frequency of a hazard are factors (among others) that you will consider as you decide which hazards to focus on first.

For example, floods in a community may be due to increased flows from excessive rains, snow melts or backwaters from another river; or your community may experience flash floods in a particular area, flooding use of a small creek's capacity or increased paved surfaces due to development. Knowing the causes of the hazard will help determine what type of actions you can take to prevent future damage.

Based on the risk assessment results, the mitigation planning team members can set mitigation goals, refine them and begin work on the mitigation strategy.

This information can be used to prioritise the hazards and develop problem-statements.

- Determine which hazards impact the largest portion of the community. Maps of where hazards are likely to occur in any given area are useful tools for determining which hazards impact the largest portion of the community.

  Review the composite map of vulnerabilities and loss estimate tables to identify the areas and hazards that would produce the greatest loss. Note whether there are special features or characteristics in these hazard areas, such as an economic hub, parkland or areas of special needs populations including where elderly or low-income residents are located.

- Determine which hazards have the greatest financial impact on the community.

  What are the important and/or critical assets in the hazard areas? For example, look at the asset inventory. Note which important and/or critical assets (historic, civic, emergency facilities, transportation, lifelines, etc.) identified are located in hazard areas.

  Identify specific characteristics of assets in hazard areas that contribute to their vulnerability. Examples are older buildings that are not up to current code and those that are located in the floodplain; manufactured housing located in flood (or tornado-prone areas); a hospital whose access can be blocked by landslides that may occur following an earthquake; or houses with wood shingle roofs located next to fire-prone woodlands.

- Determine which hazard poses the greatest risk. You need to understand the risks and the hazard characteristics.

  How often (or how rarely) does the hazard occur in the community?

  For example, if areas in your community are vulnerable to chronic, low-level, but high-frequency hazard events (e.g., a ten-year flood) you may decide to take immediate actions to protect these assets.

  Similarly, knowing that the community is vulnerable to a lower probability, but high-damage hazard event (such as an earthquake) may lead you to take actions that could be accomplished over a longer period of time but should also be started immediately. An example of this would be initiating the adoption of updated building codes.

Develop a list of problem-statements based on these findings.

Risk assessment findings may not clearly point to which hazard to address first. You may ask: Should we focus on the hazard that could affect the greatest portion of land, such as a wildfire? Perhaps it would be wiser to focus on the hazard that would result in the greatest amount of damage, such as an earthquake with the potential to level the entire community or focus on the hazard with the greatest chance of occurring, such as a flood.

In order to simplify and identify problems, develop a list of problem-statements. For example, if the risk assessment identified flooding, wildfires and earthquakes as hazards affecting the town, then the problem-statements might look like this:

- The manufactured home park is the most vulnerable area to flooding. This area floods each year. Flooding is caused by excessive rains.
- The sewage treatment plant is located in the 100-year floodplain.
- The lighthouse (of significant historic value), is threatened by erosion from coastal flooding. The rate of erosion is 1.5 metres per year.
- Wildfires could destroy the primary forest and a number of residential structures. We are experiencing the fourth year of drought conditions.
- The city has a moderate earthquake threat, situated within a seismic zone that has a 10 per cent chance of exceeding 0.3g in 50 years. An earthquake of that size could damage much of the town, disrupt lifelines and could cause maximum damage to the older buildings located in the downtown business district.

By the time you complete this, you may have a very long list of problem-statements. The challenge now is to convert the problem statements into general goal-statements to address these issues.

One approach to take is to group problem-statements by theme. Look for common characteristics and group those statements together.

Formulate goals

Once your problem statements have been grouped by common themes, you can develop proposed goal statements that correspond to the problem statements. Goals are broad, forward-looking statements that succinctly describe aims. Several problem statements can lead to one broad goal.

For example, the goals for dealing with the problem statements above could be:

Goal

- Minimise losses to existing and future structures within hazard areas.
- Minimise losses to existing and future structures, especially critical facilities, from flooding.

Determine objectives

After you have developed mitigation goals it is time to formulate objectives.

Objectives are more specific and narrower in scope than goals. They expand on the goals and provide more detail on the ways to accomplish them. It is important to have measurable objectives because they provide a roadmap for successfully implementing the strategy.

Examples of the goal above leading to formulation of objectives are:

- Reduce damages to the manufactured home park in the floodplain.
- Address potential flooding problems to the sewage treatment plant.
- Strengthen existing buildings to withstand the impact of earthquakes.

Examples of other goals and objectives are:

Goal

Preserve invaluable cultural resources threatened by hazards**.**

Objective:

- Protect the lighthouse from erosion and coastal flooding.

Goal

Promote sustainable development to improve the quality of life.

Objectives:

- Establish open space parks and recreational areas in hazard areas.
- Provide for the conservation and protection of natural resources.
- Prohibit additional housing (especially for the elderly and high density populations) in areas of high hazard risk.

Goal

Increase public awareness of hazards to facilitate support for (and adoption of) mitigation actions.

Objectives:

- Develop education programmes to reach all citizens, especially those within high-hazard areas.

- Encourage businesses and private property owners to adopt appropriate mitigation actions**.**

Goal

Prevent destruction of forests and structures in the urban wild land interface**.**

> NOTE:
>
> When reviewing the mitigation goals and objectives established by the community, make sure that the mitigation goals identified by the planning team based on the risk assessment are consistent with the community's goals.

Objectives:

- Improve communications capability between local and county/ district emergency management and law enforcement personnel.
- Protect structures in the urban wild land interface.
- Develop evacuation procedures to enable residents near the forest to evacuate safely.

The initial goal is very general. It can apply to any structure, including critical facilities, and also addresses other hazards. The next goal focuses only on floods and points out critical facilities as a priority. There is no right or wrong way of writing your goals.

The key is to write goals that are achievable through the corresponding objectives.

It is advisable to match the identified goals with government policies and programmes that may lead to achieving them.

Look for plans, policies and programmes that address topics that are closely related to mitigating the effects of hazards, including:

- sustainability
- water conservation
- environment management
- health and safety.

In order to consolidate the goals and objectives, it is necessary to get public inputs by organising public forums and Town Hall meetings through working groups or advisory committees. Other participation methods include:

- hosting a public workshop
- establishing a hotline
- conducting interviews
- distributing a survey or questionnaire.

Develop consensus on goals and objectives: sometimes well-articulated goals and objectives that are agreed upon by the planning team, elected officials and the public provide the necessary framework by which decisions on mitigation actions will be based and can keep the planning team focused to find appropriate solutions.

Also performance-linked objectives provide more specific and achievable results.

Figure 6 gives a sample of performance-based objectives analysis to show how these are grouped.

Sample performance-based objectives It may be helpful to include time frames and specific targets within those time frames as part of the objectives. There is no single method for developing good objectives. What is important is that the objectives developed achieve the goals identified and allow measurement of the progress made in reducing the risks identified.	
Element	Performance-based objective
Housing	Within two years, reduce by 10 per cent the number of houses in the floodplain that are subject to repetitive losses from flooding
Business	Within three years, increase from 15 per cent to 60 per cent the proportion of business that has flood insurance.

Figure 6: Sample performance-based objectives

Step 2: Identify and prioritise mitigation actions

Mitigation actions form the core of your mitigation plan and will be the most outward representation of the planning process to the general public and political leadership in the community. As such, it may be tempting at this point in the planning process to quickly finalise a list of projects that would simply get the job done.

However, it is important to take time to evaluate the relative merits of the alternative mitigation actions and the local conditions in which these activities would be pursued. In doing so, it is likely that the resulting actions will have public, government and political support, and will be the appropriate technical responses to the hazard issues in the affected community.

Mitigation measures and solutions

Mitigation objectives describe what has to be accomplished to meet broad mitigation goals. Mitigation measures are the action steps that will be taken to achieve the mitigation objectives.

Mitigation measures are often categorised in six groups:

1. **Prevention measures (future development)**
    - Keep a hazard risk from getting worse.
    - Guide future development away from hazards, while maintaining other community goals such as economic development and quality of life.

2. **Property protection measures (existing development**)

    - Modify existing buildings subject to hazard risk, or their surroundings.
    - Retrofitting, strengthening and waterproofing of buildings/ repair of roads.

3. **Public education and awareness mitigation measures**

    - Inform and remind people about hazardous areas and the measures that can be taken to avoid potential damage and injury.

4. **Natural resource protection measures**

    - Reduce the intensity of hazard effects and improve the quality of the environment and wildlife habitats.
    - Parks, recreation or conservation agencies usually implement these activities.

5. **Emergency services measures**

    - Emergency services protect people before and after a hazard event.
    - Most counties and cities have emergency management offices to co-ordinate warning, response and recovery during a disaster.
    - Actions taken to ensure the continuity of emergency services are considered to be mitigation.

6. **Structural mitigation measures**

    - Directly protect people and property at risk.
    - Measures are deemed structural because they involve construction of man-made structures to control hazard impacts.

The six broad categories of mitigation measures

1. **Prevention.** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programmes, open space preservation and storm water management regulations.
2. **Property protection.** Actions that involve the modification of existing buildings or structures to protect them from a hazard, or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters and shatter-resistant glass.
3. **Public education and awareness.** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centres, and school-age and adult education programmes.
4. **Natural resource protection**. Actions that, in addition to minimising hazard losses, preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
5. **Emergency services**. Actions that protect people and property during and immediately after a disaster or hazard event. Services include warning systems, emergency response services, and protection of critical facilities.
6. **Structural projects**. Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, levees, floodwalls, seawalls, retaining walls and safe rooms.

Figure 7: Six broad categories of mitigation measures

Identify mitigation measures

The best method to develop a list of possible alternative mitigation measures is through brainstorming (or thought showers). Brainstorming can be done in a workgroups, meetings, workshops or surveys. This method ensures public input. First, use a list of mitigation objectives as the foundation, and then identify alternative actions that may achieve these objectives.

Once written, it is advisable (if possible) to discuss your ideas with the task force working in your area (e.g. state disaster mitigation officer). It helps to interact with experts in a particular field if complex engineering solutions are required, and discuss the situation with potential vulnerable communities to determine the most acceptable solutions. It is advisable to review lessons learned from past experiences, too.

Below is an example list of alternative mitigations.

- Adopting land use planning policies based on known hazards.
- Developing an outreach programme to encourage homeowners to buy hazard insurance to protect belongings.
- Relocating structures away from hazard-prone areas.

- Developing an outreach programme to encourage homeowners to secure furnishings, storage cabinets and utilities to prevent injuries and damage during an earthquake.
- Retrofitting structures to strengthen resistance to damage.
- Developing, adopting and enforcing effective building codes and standards.
- Engineering or retrofitting roads and bridges to withstand hazards.
- Requiring the use of fire-retardant materials in new construction.
- Requiring disclosure of hazards as part of real estate transactions.
- Adopting ordinances to reduce risks to existing hazard-prone buildings.
- Imposing freeboard requirements in special flood hazard areas.
- Implementing V Zone construction requirements for new development located in coastal A Zones.

Assess community capability

Assessing community capability includes reviewing and analysing state and local programmes, policies, regulations, funding and practices currently in place that either facilitate or hinder mitigation in general, including how the construction of buildings and infrastructure in hazard-prone areas is regulated.

It also involves learning how local and regional governments are structured in terms of professional staff that would be available to directly carry out mitigation actions, or to provide technical assistance.

This inventory and analysis is often called a capability assessment and should address the community's existing and proposed authorities, policies, programmes and ordinances that may affect its ability to mitigate. Each must be evaluated to determine its effectiveness for mitigation purposes. Evaluation should:

- note any gaps, shortfalls or conflicts associated with their design, enforcement, or implementation
- identify any special opportunities
- determine the community's technical and fiscal abilities to implement mitigation initiatives
- include ability to attract and leverage financing.

Compiling an inventory helps identify what is currently being done and allows assessment of what is working well to begin to be analysed.

The next part of a capability assessment is the analysis of how effective the existing actions and capacities are and what gaps exist that may hinder implementation. This evaluation allows easy identification of what may need to change to support what is working, or what to put into place to undertake new actions or implement existing ones.

The more extensive analysis will occur when the planning team evaluates specific alternative mitigation actions by objective as explained further on.

Evaluate mitigation measures

Whether or not existing and potential alternative mitigation actions fulfil the objectives, there are many ways to develop and apply evaluation criteria. The methods allow the opportunities and constraints of implementing a particular mitigation action in the jurisdiction to be systematically considered before implementing them.

In order to prioritise mitigation measures, ranking criteria and a ranking strategy must be defined**.**

Select your ranking criteria

A critical component of selecting a mitigation strategy to reduce the community's risk to hazards is ensuring that the strategy is consistent with (and complementary) to other community goals and objectives.

It is important to select a set of criteria for evaluating potential mitigation measures.

One set of criteria used for making such planning decisions is identified by the acronym **STAPLEE:**

S – social

T – technical

A – administrative

P – political

L – legal

E – economic

E – environmental requirements

Social

The mitigation strategy must be socially acceptable. For this purpose the following questions must be asked:

- Will the proposed action adversely affect one segment of the population?
- Will the action disrupt established neighbourhoods, break up voting districts, or cause the relocation of lower-income people?
- Is the action compatible with present and future community values?
- If the community is a tribal entity, will the actions adversely affect cultural values or resources?

Technical

The proposed action must be technically feasible and effective, and the following questions asked:

- How effective is the action in avoiding or reducing future losses? For example, if the proposed action involves upgrading culverts and storm drains to handle a ten-year storm event, and the objective is to reduce the potential impacts of a catastrophic flood, the proposed mitigation cannot be considered effective. Conversely, if the objective were to reduce the adverse impacts of frequent flooding events, the same action would certainly meet the technical feasibility criterion.
- Will it create more problems than it solves?
- Does it solve the problem or only the symptom?

Administrative

The community must have the capability to implement the action, which means determining whether or not the team handling the actions has the anticipated staffing, funding and maintenance requirements for the mitigation action, and if the team has the power to spend (or to withhold) spending.

The answers to the following questions would evaluate the same.

- Does the jurisdiction have the capability (staff, technical experts, and/or funding) to implement the action, or can it be readily obtained?
- Can the community provide the necessary maintenance?
- Can it be accomplished in a timely manner?

Political

Mitigation actions must be politically acceptable.

Proposed mitigation objectives sometimes fail because of a lack of political acceptability. Ensure that a designated member of the planning team consults with the board of supervisors, mayor, city council, administrator or manager.

This problem can be avoided by determining:

- Is there political support to implement and maintain this action?
- Have political leaders participated in the planning process so far?
- Is there a local champion willing to help see the action to completion?
- Who are the stakeholders in this proposed action?
- Is there enough public support to ensure the success of the action?

- Have all of the stakeholders been offered an opportunity to participate in the planning process?
- How can the mitigation objectives be accomplished at the lowest cost to the public?

Legal

The community must have the authority to implement the proposed measure. Without the appropriate legal authority, the action cannot lawfully be undertaken. The following questions need to be asked:

- Does the state, tribe, or community have the authority to implement the proposed action?
- Is there a technical, scientific, or legal basis for the mitigation action (i.e., does the mitigation action "fit" the hazard setting)?
- Are the proper laws, ordinances and resolutions in place to implement the action?
- Are there any potential legal consequences?
- Will the community be liable for the actions or support of actions, or lack of action?
- Is the action likely to be challenged by stakeholders who may be negatively affected?

Economic

Economic considerations must include the present economic base, projected growth and opportunity costs. States and local communities with tight budgets or budget shortfalls may be more willing to undertake a mitigation initiative if it can be funded, at least in part, by outside sources. "Big ticket" mitigation actions, such as large-scale acquisition and relocation, are often considered for implementation in a post-disaster scenario when additional federal and state funding for mitigation is available. Questions to be asked include:

- Are there current sources of funds that can be used to implement the action?
- What benefits will the action provide?
- Does the cost seem reasonable for the size of the problem and likely benefits?
- What burden will be placed on the tax base or local economy to implement this action?
- Does the action contribute to other community economic goals, such as capital improvements or economic development?
- What proposed actions should be considered but be postponed for implementation until outside sources of funding are available?

Environmental

Impact on the environment must be considered because of statutory considerations and public desire for sustainable and environmentally healthy communities.

Numerous mitigation actions may well have beneficial impacts on the environment. For instance, acquisition and relocation of structures out of the floodplain, sediment and erosion control actions, stream corridor and wetland restoration projects all help restore the natural function of the floodplain. Vegetation management in areas susceptible to wildfires can greatly reduce the potential for large wildfires that would be damaging to the community and the environment. Such mitigation actions benefit the environment while creating sustainable communities that are more resilient to disasters. Based on this, it is important to know:

- How this action will affect the environment (land, water and endangered species)?
- Will this action comply with local, state and federal environmental laws or regulations?
- Is the action consistent with community environmental goals?

Additional criteria can (and should) be added. An example would be that a project that addresses hazards to a critical facility should receive priority.

Benefit-cost analysis

One of the best ways to evaluate and prioritise mitigation projects is to conduct a benefit-cost (BC) analysis on each project. Benefit-cost analysis is a mathematical method for comparing the benefits to the community of a mitigation action to its costs. If the benefits are greater than the costs, the project is cost-effective.

Why conduct BC analysis at this stage?

Comparing the ratios of benefits to costs for several mitigation projects helps to identify those that offer the greatest amount of return on the communities' money.

BC analysis gives decision-makers an understandable way of explaining and defending their decisions.

In the United States, for many grant programmes, FEMA and the State will use BC analysis to determine whether a project is eligible.

The community can save time and energy by limiting planning activities to projects that will be more likely to receive funding.

BC analysis software

BC software prompts users for data about the community and the hazards, then does all the maths. The latest versions are designed with drop-down menus, help wizards and tutorials. There are many variants of BC analysis software available. For further information visit the reference section at the back of this module.

Identify how you will rate each of the ranking criteria

When determining how to rate each of the ranking criteria the following options should be considered:

- Award one point for each factor that meets the criteria.
- Award a range of points, such as zero to five points for each factor.
- Weigh those factors that are considered more important to the overall selection of mitigation measures, and summarise and document recommended mitigation actions.

After you have evaluated the potential alternative mitigation actions, pull out those actions that the team has determined to be appropriate for the community affected. Update the comment notes (or expand them) to explain any special circumstances that must be kept in mind for the next step. For example, if one action is more effective when undertaken in conjunction with another, then ensure this is noted.

Prioritise selected mitigation actions.

Now that the list of acceptable and achievable actions has been prepared for the community affected, it is time to prioritise them.

There may be a dozen actions identified for each of the hazards affecting the community and now it must be decided where to start. It may help to review the goals and objectives to see if they have changed or altered from when they were first written.

Review and take into account the results of earlier efforts, in which alternative mitigation actions appropriate to the particular hazards were evaluated It should now be evident, given state and local capabilities, what would be required to take and implement the alternative actions that were ultimately selected.

As you start the prioritisation process, look for ways to eliminate from consideration those actions that, from a technical standpoint, will not meet your objective, even though they may have been indicated as generally applicable to your situation.

For example, if an alternative mitigation action is to relocate a building out of the floodplain, the building may be structurally unsound and may not survive a move. Such an action can now be eliminated from your list and there is no need to undertake a detailed evaluation of the remaining criteria, thereby saving you time.

You should provide comments – a short summary of your reasoning indicating why you believe your actions will not work.

During this final step, the following considerations should be kept in mind when prioritising mitigation actions:

Ease of implementation

To initiate (and/or maintain interest) in the planning process, (particularly if support is tentative), it helps to select those actions that are easily implemented first. Initiatives such as media attention to hazards and risks cost little and reach a large number of citizens.

Multi-objective actions

Some mitigation actions may work toward achieving multiple community goals. For example, an acquisition and demolition project can lead to new open space that provides additional natural storage for floodwaters. This solves the problem of repetitively flooded structures, which are now removed, and provides opportunities for recreational use such as hiking/biking paths.

Time

To demonstrate more immediate progress, it may help to choose to initiate mitigation actions that can be quickly accomplished over those that would take a long time to obtain the necessary approvals or funding to carry out the project. For example, if it was decided to implement both riverine and coastal flooding mitigation actions, it may be best to address the riverine flooding first in areas where homeowners and businesses have already expressed an interest in reducing flood damage.

After initiating riverine mitigation actions, it is easier to focus on mitigating coastal flooding in areas where the property owners are unaware of the potential benefits of hazard mitigation, and who may resist cooperation.

Post-disaster mitigation

A number of potential mitigation actions being evaluated by the planning team may not be able to be implemented in the near term due to lack of funding or political and social considerations.

In a post-disaster scenario, however, the extent of damages, political will and access to state and federal mitigation funds can dramatically alter the feasibility of implementation. The acquisition/demolition of flood-prone structures and relocation of residents outside of the floodplain is a prime example. In many cases, this mitigation action becomes more feasible after a disaster. Consider targeting specific mitigation actions for implementation following a major disaster.

Step 3: Implementation of mitigation strategy

The implementation strategy identifies who is responsible for which actions, what funding mechanisms (e.g. grant funds, capital budget, or in-kind donations) and other resources are available or will be pursued and when the actions are to be completed. The strategy describes the way the community will use resources to achieve goals toward reducing losses from future hazard events. It also focuses on co-ordination between the various individuals and agencies involved in the implementation to avoid duplicating or conflicting efforts.

> NOTE:
>
> Now that projects have been identified, this is a good time to examine partnerships and search for organisations that could contribute or support the implementation process.

Procedures and techniques

Identify how the mitigation actions will be implemented. The planning team identify the responsible party or parties, funding resources and give a time frame for implementing the actions identified in the above section.

Identify parties, define responsibilities and confirm partners

The planning team review the list of agencies and organisations identified in the assessment and how they function so that the team can match the appropriate department or agency with the actions called for in the implementation strategy.

For example, if a community decided that enacting a more stringent floodplain ordinance is a top priority, and it is identified that the environmental protection department is listed as administering this ordinance, then they would be listed as the lead agency.

Also important is reviewing the capability assessment findings to better understand the administrative process necessary to see an action through to completion. Knowing the process will assist the planning team in developing a more realistic time frame in order to accomplish the action.

At this point, it is a good time for team members to contact (or meet with) the community manager along with the lead and support agency heads who will play a role in implementing the actions. This provides an opportunity to confirm their commitment and cooperation. Department or agency heads should make sure the person(s) responsible for each task under each action has the time and ability to follow through, otherwise, implementation may be delayed.

Identify resources to implement the actions

Resources include funding, technical assistance and materials. The team should prepare a preliminary cost estimate or budget, laid out by task, for each of the actions.

Knowing the cost will help the planning team target a variety of sources to fund the action. The planning team should also prepare a list of materials (equipment, vehicles and supplies) that would be required to effectively implement the action, and an inventory of existing and required supplies.

The planning team should look at the state and local capability assessments to identify resources to implement the identified mitigation actions. Local and state governments are granted the authority under their police power to protect the health, safety and welfare of citizens. This includes enacting and enforcing building codes and zoning ordinances, developing public education programmes to alert residents to risks and how they can reduce hazard losses.

If the local government is the party responsible for enacting one or more of the mitigation actions, it will need to earmark resources for implementing these actions. A primary funding source for state and local emergency management activities is the emergency management centre.

Sources of local revenue often used to fund emergency management activities include:

- general taxes
- property taxes
- exactions
- connection fees
- impact fees (usually paid by private developers)
- special assessment districts.

In some cases, local governments have procedures to acquire structures in the floodplain. The planning team should take appropriate action to ensure that funding for mitigation projects is incorporated into state or local budgets.

Make priority projects known to the appropriate local, state or federal agencies. Regional or district offices of federal agencies are usually responsible for maintaining an understanding of local needs. If state and federal representatives have been included in the planning process all along, the jurisdiction may be well-positioned to hear about these opportunities and successfully apply for funding. To ensure maximum engagement:

- Assign a team member to track information on new federal, state, and regional grant programmes.
- Examine how a project could be broken into parts or phases that could be quickly completed when funding becomes available. In addition to funding, the planning team should keep in mind that states have experts available to assist local jurisdictions.

Most states have one or more of the following staff and/or technical capabilities and many of these experts were probably consulted when the team profiled the hazards during Phase 2 of the planning process.

- State hazard mitigation officer
- State geologist
- State floodplain manager
- State climatologist
- State forester
- Geographic information system specialist.

The central/federal government is a good source of many grant

NOTE:

The hazard mitigation plan should be:

Complete. Does it list all of the action steps to be implemented in all relevant parts of the community? Does it document all the activities of the state, tribe or community?

Clear. Is it apparent who will do what by when? Are there easily identifiable inter-relationships between the loss estimation, problem-statements, goals and objectives, the capability assessment and the list of actions?

Current. Does the plan reflect the current work that is being accomplished?

and

Does it anticipate newly emerging opportunities or challenges such as pending state legislation?

programmes and technical assistance for mitigation under various programmes related to loss reduction and relief.

Private sector organisations and businesses have much to gain by engaging in activities to reduce risks in the community. Businesses and other private interests may be willing to contribute time, labour, materials, space and other support as part of their commitment to community improvement.

The planning team should also consider securing private grant funds that are available for natural resource protection and for sustainable community development and redevelopment.

Academic institutions can provide valuable resources in the form of technical expertise and low-cost staff (students), meeting facilities, the latest data related to your state or community and training resources for planning and related tools such as HAZUS [1] (http://www.fema.gov/hazus/hz_meth.shtm)

Define the time frame for implementing the actions

The planning team and responsible agencies should develop a specific time frame for implementing each mitigation action that the community has decided to pursue. When identifying start dates, keep in mind any special scheduling needs, such as seasonal climate conditions, funding cycles, agency work plans and budgets. Draw cash flows based on the time schedules, as funding cycles will affect when you can begin implementing an action.

Document the implementation strategy

After completing the process summarised for each action, it is now time to document the results.

Determine the format for presenting the implementation strategy. This, along with discussions of goals and objectives and the identification and prioritisation

> Example of an implementation strategy format
>
> **Action:** (From your list of selected actions)
>
> **Goal(s) and objective**(s) Addressed:
>
> (Sometimes the action will address more than one goal and objective)
>
> **Lead agency**: (Provide the name and a brief description of the agency)
>
> **Support agency or agencies**: (Provide the name and a brief description of each support agency)
>
> **Budget:** (Provide the dollar amount or an estimate, if known; put TBD – to be determined, if not known; and/or indicate staff time if staff will be used)
>
> **Funding source(s):** (List the funding sources – e.g. operating budget, capital improvement budget, XYZ grant etc.)
>
> **Start and end date**: (Indicate start and end dates; short-term, long-term, or on-going; and milestones for longer-term projects)

[1] HAZUS is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes.

of actions, will comprise the overall mitigation strategy.

There are many ways to present the implementation strategy. A format that the planning team can use is listed in the adjacent box.

If an action is currently being implemented, indicate it as ongoing under the time frame and indicate an end date, when applicable.

Be sure to indicate long-term maintenance activities as ongoing. If using short-term and long-term time frames, make sure at the beginning of the implementation strategy you define the time period you consider to be short- and long-term (e.g., short-term actions are usually considered to be those that can be accomplished within one year of plan adoption).

Obtain the consensus of the planning team

The planning team should review the resulting strategy and come to a consensus on the timing of the mitigation actions and on the agencies or other parties responsible. When the team confirms that the timeline and use of resources are realistic, and the appropriate agencies or individuals are designated the appropriate responsibilities, it confirms that the strategy is headed in the right direction.

Step 4: Document the mitigation planning process

One of the most important reasons to document the plan is to help the community make decisions that will reduce its vulnerability to hazards. The hazard mitigation plan is a guide to keep on track and serves as documentation of the thoughts and considerations that were the foundation of the planning process. Even if the stakeholders or the task force members change, it serves as an institutional memory for intense decision-making situations (such as the post-disaster setting and when undertaking major land development decisions). The plan is an all-time reference to the representation of the community's principles for hazard loss reduction.

Writing the mitigation plan document has already begun during the process of formulation. Now it is time to finalise the document.

Procedures and techniques

Make decisions about the style of the document.

Decide how to make the document readable

Length – sometimes the length of the document can be intimidating to readers. There is no "one size fits all" for state or local mitigation plans. Generally, the plan should be long enough to address all of the required elements, but it should still be functional and easy to read.

Format/sections – organise the plan in the following manner:

- planning process
- risk assessment
- mitigation strategy

- plan maintenance.

Detailed technical information should be contained in appendices, along with detailed maps or financial information.

Language level – the language of the plan should not be overly technical or complex, nor overly simplified.

Determine how detailed the planning document should be

Determine how much information should be included in the planning document, and what can be included in an appendix. For example, should the entire risk assessment be included in the main text of the mitigation plan, or should it be referenced as an attachment or appendix?

Establish the schedule for writing the plan

The schedule should allow time for drafting and reviewing the plan. The planning team, affected or interested agencies, the public and the state should review the plan before it goes to your local governing body for approval. If not done so already, ensure a list of agencies to receive the draft plan is created. A public forum should also be scheduled in order to give the public a chance to comment on the plan. It is normally recommended that state plans be updated every three years and local plans every five years.

Determine who should write the plan

This person is not necessarily the same person who recorded the meetings. The person selected, however, should be someone who has been involved from the beginning. Possibilities include someone on the planning team, a consultant, intern or agency staff. Keep in mind that this person has to have good writing and editing skills. If more than one person writes different sections, it is recommended that one person be responsible for final editing.

Write the plan

At this point all previously written information, write-ups etc would be assembled from all parts of the process.

Information to be addressed includes:

- meeting notes that document the planning process
- risk assessment and capability assessment findings and results
- the mitigation strategy
- other existing plans, models, state and programme requirements to provide an organisational framework
- a plan maintenance process.

Review the plan

Provide opportunity for the plan to be reviewed by:

- planning team

- agency
- public.

Produce in final format for distribution

Physical planning and the built environment in preparedness for disasters

A disaster would not lead to destruction if there were nothing to get destroyed. An earthquake would not kill people if they were in the open fields at the time of the earthquake. It is a common saying that disasters don't kill people it is the built environment that kills them, when not built with safe technology.

In most of the cases whenever conscious settlement planning decisions are taken with reference to potential hazard risks, the built environment shelters people from the hazards, however, whenever there is unplanned growth or non-engineered structures without consideration for codal provisions or byelaws there is mass destruction, examples include Gujarat in India and Turkey. It is important to incorporate disaster-resistant planning and construction decisions in the built environment.

Land use planning

The process of establishing and implementing state and community comprehensive development and land use plans provides significant opportunities to mitigate damages caused by natural hazards. Land use planning is generally most effective in areas that have not been developed, or where there has been minimal investment in capital improvements.

Since location is a key factor in determining the risks associated with natural hazards, land use plans are a valuable tool in that they can designate low-risk uses for areas that are most vulnerable to natural hazards impacts.

Comprehensive development and land use plans are implemented through ordinances and policies, subdivision, zoning and sanitary ordinances, police power and through a jurisdiction's capital improvement programme. Tools such as density transfers, transfer of development rights, planned unit developments, cluster development and similar innovative approaches can ensure that the property owners receive an adequate return on their investments while still providing community protection against natural hazards.

For example, floodplains, steep slopes, areas subject to liquefaction and areas susceptible to wildfires, can be designated for open-space uses while the property owner is allowed to develop the remaining areas of the property at a higher density. This method not only reduces the potential for damages, but open-space uses will also enhance the marketability and attractiveness of the development and may even reduce the development costs.

A community can also influence the location and density of development through its capital improvement plans, which determine where the community places critical infrastructure needed for development, such as roads, water supply and wastewater treatment.

For example, eliminating sewer service extensions onto a barrier island will often result in low-density development.

Physical planning measures for disaster mitigation

Many hazards are localised with their likely effects confined to specific well-defined areas. Floods occur in flood plains, landslides occur on steep, soft slopes and so on. The effects can be greatly reduced if it is possible to avoid the use of hazardous areas for settlements or as sites for important structures. Most urban master plans involving land use zoning already attempt to separate hazardous industrial activities from major population centres but urban planners also need to integrate awareness of natural hazards and disaster risk reduction into the normal planning processes for the development of a city.

Physical planning measures are easiest to implement with public sector facilities, since government has direct control over their funding and placement. The careful location of public sector facilities can play an important role in educating the public and reducing the vulnerability of a settlement. Schools, hospitals, emergency facilities and major infrastructure elements like water pumping stations, electrical power transformers and telephone exchanges represent a significant proportion of the core functioning of a town.

An important principle of risk reduction is reducing the concentration of essential elements at risk. For example, services provided by one central facility are always more at risk than those provided by several smaller facilities.

This principle also applies to population densities in a city. A denser concentration of people will always increase disaster potential compared to a more dispersed population. Indirect control of densities is sometimes possible through simple methods such as wide roads, height limitations and road layouts that limit the size of plots available for development.

At a regional level, the concentration of population growth and industrial development in a single, centralised city is generally less desirable than a decentralised pattern of secondary towns, satellite centres and development over a broader region.

The design of service networks (roads, pipelines and cables) also needs to be carefully planned to reduce risk of failure. The usefulness of long, linear supply lines are at risk if these lines are cut at any point. Networks that interconnect and allow more than one route to any point are less vulnerable to local failures, provided that individual sections can be isolated or circumvented when necessary. Vehicular access to a specific point in a city, for example, is less likely to be cut by road blockage in a circular ring road system than in a purely radial type.

In many rapidly developing cities, the control of private sector land use through urban master planning and development policy guidelines is extremely difficult. It is often private sector land use, particularly the informal sectors and shanty towns that have the highest risk of disaster.

Flood plains, steep slopes and other marginal lands are often the only building sites available to lower-income communities and the most vulnerable social groups. The economic pressures that drive people, first to the city for jobs and opportunity, and second to these marginal lands to live must be fully understood as the context for considering their risk.

Prohibitions, or other measures to clear settlers from hazardous areas, are unlikely to be successful if the underlying economic pressures are not addressed. Some indirect measures, such as making safer land available or making alternative locations more attractive, may be effective, but they can only succeed to the extent that there is strong understanding and support by the people immediately affected. This may be accomplished through better access to public transport and better provision of services. Deterring further development in unoccupied areas by clearly declaring areas as hazard zones, denying services, reducing accessibility and limiting availability of building materials may also be effective.

Different ways in which layouts of the built-up areas can be designed to reduce the impacts of high winds in cyclone-prone areas or high-velocity floodwaters in flood-prone areas can also help reduce the impacts of these disasters.

Ultimately, however, it is only when the local community recognises the true extent of the hazard and accepts that the risks of being in a dangerous location outweigh the benefits that they will locate elsewhere or protect themselves in other ways.

Engineering and construction measures

Engineering-dependent mitigation activities are of two types.

1. Those that result in stronger individual structures that are more resistant to hazards.
2. Those that create structures whose primary function is to protect against disaster – flood control structures, dykes, levees and infiltration dams.

Actions to make structures more resistant to hazards primarily involve improvements in design, construction and maintenance of buildings, achieved through institutional means such as design standards, building codes and performance specifications for facilities designed by engineers as well as local builders trained in appropriate construction techniques.

Building codes based on disaster-resistance are unlikely to result in stronger buildings unless the engineers and builders who implement them accept their importance and endorse their use. In addition, engineers and builders must understand the code and the design criteria required of them.

Responsible authorities must fully enforce the code by checking and penalising designs that do not comply. Methods for achieving risk reduction through engineering measures also include:

- increased training for engineers, designers and builders
- explanatory manuals to interpret code requirements and the establishment of an effective administration to check code compliance in practice.

The recruitment of ten new municipal engineers, for example, to enforce an existing code may have more of an effect on improving construction quality in a vulnerable community than proposing legislation for higher standards in existing building codes.

A large number of the buildings likely to be affected by disasters are not designed by engineers and will be unaffected by safety standards established in building codes. These are houses, workshops, storerooms and agricultural buildings built by owners themselves or by craftsmen or building contractors based on their own designs. In many countries these non-engineered buildings make up a large percentage of the total building stock.

The engineering measures needed to improve the disaster-resistance of such non-engineered structures involve the education of local builders in practical disaster-resistant construction techniques. The resistance of a house to cyclone winds, for example, is ultimately dependent on how well the roofing sheets are nailed down, the quality of joints in the building frame and its attachment to the ground. Training techniques to teach builders the practicalities of disaster-resistant construction are now well understood and form part of the available menu of risk-reduction activities.

Builder training is effective when it persuades owners and communities to build safer, more disaster-resistant structures and to pay the additional costs involved in constructing such structures. While building contractors may play a role in persuading clients, contractors are unlikely to find many customers unless there is general public awareness of the disaster risk and an acceptance of the need for greater protection.

Incentives for improving the hazard resistance of non-engineered buildings include grant programmes, preferential loans and supply of appropriate building materials. Legalising land ownership and giving tenants protective rights also encourages people to upgrade building stock as a result of their secure tenure and a larger stake in their own future.

Technology for physical planning and data management

There is a wide range of tools available to assist emergency managers with their mapping and information needs. Description and examples of actual uses of some of these follow.

Geographic information system and remote sensing

For years, maps have helped decision makers to determine trends, patterns, and distance relationships; they remain particularly valuable as a focus for group discussion and choices. Geographic Information Systems (GIS) are computer systems that allow users to:

- collect
- store
- manipulate
- link together
- analyse
- update
- present "geospatial" data.

In mapping data stored in spread sheets or databases that have a geographic component, a GIS enables users to see patterns, relationships and trends that cannot be seen in normal data tables.

A GIS allows users to select and remove any of the data categories from the map, thereby enabling quick analysis of how different factors might affect a decision.

The factor that distinguishes a GIS from other information management technologies is that it deals with spatial information. As such, a GIS requires spatial data to be gathered by *location* and *attribute.* Location may be annotated by x, y and z co-ordinates of longitude, latitude and elevation, or by such systems as postal codes. Each particular location may have a number of associated characteristics, properties or *attributes.*

For example, vegetation cover, soil type, altitude, rainfall pattern can be measured and recorded and consequently inter-related by a GIS quickly and much more easily than any manual system.

GIS packages are particularly powerful in detecting patterns and answering "what-if" scenarios. A few of the many GIS applications for disaster management include quantification of the total expected losses in a particular location from a flood and postal code-based maps of seismic effects such as ground shaking and forecasts of locations where the heaviest damage from an earthquake may be located.

A surge in the availability of remote sensing data is greatly benefiting the spread of GIS. In brief, remote sensing involves making measurements of the earth from sensors, such as cameras carried on aircraft, satellites or other devices.

Example

In Bangladesh, GIS tools are being applied in the country for flood prevention. The Disaster Management Bureau, working with a US NGO, used GIS to develop not only an early warning procedure for areas prone to cyclone-generated floods, but also mapping flood patterns to guide the construction of more permanent facilities in areas least prone to flooding and less-permanent structures recommended for areas identified as most at risk.

Global positioning systems

The Global Positioning System or GPS is a satellite and computer-based triangulation (locating) system used to measure precise locations of positions anywhere on earth. The high accuracy obtainable with the GPS also makes it a precision survey instrument.

Civilian use of GPS receivers decreases and new applications are realised. Uses include numerous applications in the fields of navigation, engineering, surveying, resource management and the emergency management.

The community is just beginning to explore the myriad possible uses of GPS in data gathering. GPS data, for example, is used in GIS applications to pinpoint critical locations in emergency preparedness and mapping exercises.

The World Food Programme/Sudan uses GPS to monitor the precise location of its Nile River barges as they pass through insecure areas of the country delivering food assistance to the victims of war. The barges are equipped with GPS receivers and radio transmitters, and barge operators are trained to transmit their location co-ordinates every two hours. They are tracked by the WFP Office of Logistics in Khartoum. In the event that a barge encounters a hostile situation, WFP can readily locate and evacuate its barge crews by air.

A private United States firm under contract to the US Federal Emergency Management Agency (FEMA) is using GPS/GIS technology to provide rapid damage assessment data for federal and state disaster officials during and after emergency crises such as the Mississippi floods, Hurricane Andrew and the Californian earthquakes.

Information, which normally requires weeks to gather, is acquired within days. Instant digital maps, detailing road conditions, damaged housing, downed power lines, or toxic releases are transmitted to FEMA and state agency headquarters for planning and response purposes.

Epi-Info

A technology developed by the US Centers for Disease Control and Prevention, this personal computer-based software is designed to assist emergency assessment teams with the collection and on-site analysis of epidemiological data. The software assists the user to set up and process a data-collection questionnaire in minutes and also forms the basis for a disease surveillance system database. The software is made available by WHO and CDC and is not copyrighted; indeed, users are encouraged to make copies for others.

Unit summary

Summary

In this unit you learned the subtleties of mitigation planning and how to evaluate alternate mitigation strategies/actions. In Module 4 you will be introduced to the planning process and learn how to develop emergency plans.

Activity answers

Activity 3.1

1. The potential for a negative interaction between an extreme event and the vulnerable parts of the population that is not addressed by the community's coping resources (such as a mudslide resulting from a hurricane).
2. While a <u>hazard</u> is an extreme event or a physical condition that has potential to cause damage to life, property, or the environment a <u>risk</u> is the chance or likelihood that a hazard will occur and the possibility of exposure to a potential hazard.

3–6. Answers will vary by location.

Activity 3.2

1. False
2. True
3. False
4. True
5. True
6. True
7. True
8. False
9. False
10. False
11. True
12. False

Assignment 1

Assignment

This assignment focuses on the interface between humans and disasters.

The assignment should be about 10 pages in length (double spaced). All references are to be cited in APA format.

Part 1

Use examples from major disasters to explain the concepts below:

1. How humans often turn hazards in to disasters and why ‘natural hazards’ are not always ‘natural’.
2. How human vulnerability is generated and why disasters do not affect all people or sectors of a society equally. For example: what makes some people more vulnerable than others?

Part 2

Identify approaches used to reduce hazards and the impact of disasters on people.

- Focus on mitigation and preparedness rather than response and recovery.
- Consider the importance of international strategies as well as mitigation efforts that can be taken at a country or community level.
- Cite specific examples to illustrate your points.

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Further reading

Reading

An Introduction to the Maharashtra Disaster Management Plan. (to be found in your Additional Readings Booklet)

US National Oceanographic and Atmospheric Administration. *Community Vulnerability Tool Kit* (CD ROM). Available from http://www.csc.noaa.gov/products/nchaz/startup.htm

Are you Ready?: Evacuation. Federal Emergency Management Agency. http://www.fem25/07/201009/09/201309/09/2013 4:37 PMa.gov

Incident Command System Flowchart. (May 1999). Dispatch Monthly Magazine. (to be found in your Additional Readings booklet).

Web resources

Clallam County Sheriff's Search and Rescue
http://www.olypen.com/ccsosarp/

Communication Systems
https://admin.qsl.net/index.php

Contingency Planning & Management
http://www.contingencyplanning.com

Disaster Preparedness Colouring Book
http://www.fema.gov/pdf/library/color.pdf

Disaster Prevention and Preparedness Guidelines
http://cpc.stanford.edu/disasters/generic/unit1.html#sect1

Emergency Information Management and Telecommunications
http://www.undmtp.org/english/telecoms/telecoms.pdf

Family Preparedness Planning
http://www.mailman.hs.columbia.edu/news/blackout.html

Federal Emergency Management Agency, *Developing Mitigation Plan: Identifying Mitigation Measures and Implementation Strategies*, How-to Guide #3. http://www.fema.gov/fima/planning_howto3.shtm

Florida Division of Emergency Management
http://www.floridadisaster.org/

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http://www.floridadisaster.org/publications/2001%20EM%20Capabilities.pdf

Ministry of Public Safety, British Columbia. (2004). *British Columbia Hazard Risk an Vulnerability Analysis (HRRVA) Tool Kit*. Retrieved from http://www.pep.bc.ca/hrva/toolkit.pdf

New York State Incident Command System
http://www.semo.state.ny.us//programs/training/ICS/ICSexplain.cfm

Search and Rescue Society of British Columbia
http://www.sarbc.org

Unit 1-IELDRN Generic Disaster Plan Workbook. Available at:
http://cpc.stanford.edu/disasters/generic/

Worksheet Job Aids
http://www.fema.gov/pdf/fima/planning/howto3_appd.pdf

Your Family Disaster Plan
http://www.fema.gov/rrr/displan.shtm