UNIT 1 RISK ANALYSIS TECHNIQUES

Structure

1.0 LEARNING OUTCOME

After reading this Unit, you should be able to:

- Understand risk assessment;
- Examine the process of risk assessment; and
- Know about hazard and risk maps

1.1 INTRODUCTION

Disasters have struck mankind with increasing severity of late. According to Munich Re (2003), over the last decade, around 7,000 natural disasters, including earthquakes, volcanic eruptions, tropical cyclones, floods and droughts have taken place the world over, killing more than 300,000 people and causing over US$800 billion in economic losses. Many of the Asia and Pacific developing countries are situated in the world's hazard belts and are subject to floods, droughts, cyclones, earthquakes, windstorms, tidal

waves and land slides, besides man made, technological, biological, hazards, etc., with the added threat now of terrorism.

Since disaster management is a technical area of expertise, science and technology has a vital role to play in the research and dissemination of knowledge about disasters. It has both an *educative* and a *deliberative* role to perform for the purpose of creating awareness in society, articulating policy inputs, and upgrading response mechanisms. Public administrators have the task of organising and synergising (co-operative action involved in public administration) activities, coordinating personnel involved, that are both generalists and specialists, placing them in organisations as per specialisations and requirements, for achievement of organisational goal, institute coordination and communication between wings/agencies *inter se* and utilise organisations' optimum potential. Thus public administration as theory and practice has a more substantive role to play in disaster management in general and disaster risk reduction in particular.

Risk is defined as follows in the Disaster Management Training Programme, (1994).

"For engineering purposes risk is defined as the expected losses (lives lost, persons injured, damage to property and disruption of economic activity) caused by a particular phenomenon. Risk is a function of the probability of certain occurrences and the losses each would cause. Other analysts use the term to mean the probability of disaster occurring and resulting in a particular level of loss."

Accordingly, *"risk assessment, (sometimes risk analysis) is the process of determining the nature and scale of losses (due to disasters) which can be anticipated in particular areas during the specified time period. Risk analysis involves an analysis of both theoretical and empirical data concerning: the probability of known disaster hazards of particular force or intensities occurring in each area ("hazard mapping"); and the losses, both physical and functional expected to result to each element at risk in each area from the impact from each potential disaster hazard ("vulnerability analysis" and "expected loss estimation").*

With this understanding, risk assessment of a natural hazard involves the collection of relevant information regarding the following:

a) Identification of the natural hazard and the probability of its occurrence

b) The chain of events, processes and pathways that connect the cause to the effects

c) The relationship between the characteristics of the natural hazard and the types and magnitude of its effects.

With the above outline, risk assessment comes across mainly as a scientific and *quantitative* activity undertaken/attempted for the purpose of objectivity and rationality of policy for disaster mitigation and response processes. It is imperative that policy be objective and fact based, to the extent possible, in order to avoid *a prior* judgements in policy 'choices'. The exploration of historical, scientifically relevant data, its analysis for understanding of factors underlying disaster phenomenon, and incorporation of facts derived thus, into disaster planning initiatives makes for objective policy. Success of the exercise will depend on objective risk evaluation, the 'awareness' or 'perception' of risk in the society, chiefly among policy makers, co-ordination in policy formulation and implementation processes, prioritising of disaster mitigation over other concerns, though not implying preference of any one concern to the exclusion of other equally important ones,

but rather, providing for in–built disaster mitigation mechanisms/provisions in each sector policy, as also on a macro scale, in the national socio economic development policy as a whole. Reference is mainly to resource allocation decisions.

1.2 UNDERSTANDING RISK ASSESSMENT

The process of risk management had been elucidated in the previous Units. Risk management, as per Coburn, Sspence and Pomonis (1994), has two components: *Risk Assessment and Risk Evaluation*.

Risk assessment is the scientific process of data collection and accumulation over time and its analysis to foretell disasters and aid preparedness planning in accordance with articulated requirements. Hazards (s) are examined closely to understand the chain of causation leading up to the undesirable event, estimate the losses incurred/ probable in possible repeat of the event and human lives lost with a view to framing suitable strategy for future risk reduction. It also involves estimating the probability of repeat of an event, question being if yes, with what frequency, and what magnitude? Such an exercise has to be undertaken on *a continuous basis* since risk factors undergo changes over time, to ensure continued relevance of preparedness strategies.

As a natural corollary, an important component/aspect of risk assessment is hazard assessment, understood as the process of studying the nature and characteristics of a hazard, that is, whether one dimensional or complex, the nature of hazard; whether natural or human-induced, if man made, ascertaining the factors, the likelihood of the hazard striking, the probable frequency of its occurrence, level of severity and expected losses. The regions likely to be affected are mapped through satellite imagery. Specifically, hazard assessment is defined as follows in the Disaster Management Training Programme (1994):

"*Hazard assessments, also called hazard evaluation and analysis is the process of estimating for defined areas the probability of occurrence of potentially damaging phenomenon of given magnitude within specified period of time.*

Hazard assessment involves analyses of formal and informal historical records and skilled interpretation of existing topographical, geological, geomorphological, hydrological and land use maps."

Hazard assessment estimates the consequences arising out of an identified hazardous situation. To reiterate, it depends on two factors; the probability of occurrence of such an incident and the potential damage it can cause, (if it occurs).

Correspondingly, an inquiry into the factors making regions (s) vulnerable to a hazard (s) is necessary. These factors could be physical, i.e. relating to topography, hazard proneness or proximity to water body etc., or socio economic, i.e. arising out of backward/ disadvantageous positioning of a community in society or lack of resources to sustain life, especially during catastrophes. Hence vulnerability analysis/assessment is the third important component of risk assessment.

Each of the three steps/processes outlined above, as part of risk assessment, are indispensable components of the exercise, since each complements/ supplements the other. Hence for a total/comprehensive perception/understanding of the situations involving vulnerabilities and consequent risks, technical analyses involving hazard assessment has to include vulnerability analysis as an imperative condition. Hence risk assessment is an

inclusive and multi -dimensional process. It would now be in order to discuss each component aforesaid separately and in detail.

1.3 PROCESS OF RISK ASSESSMENT

1.3.1 Measurement of Risks

Quantitative risk assessment involves estimation of disaster potential and the probability of event occurrence using simple arithmetic. Though estimations arrived at are gross/ crude, they help increase awareness of risk or risk perception among the general public and in the political circles, particularly. It also helps articulate the level of 'acceptable risk' for the purpose of policy. As explained in the Disaster Management Training Programme (1994), one standard method of 'measuring risks, is to count all the people' exposed' to a particular risk; divide the number by the number of people who have actually experienced the hazard over a definite time span. For example, if the number of people who travel by train in any one year is ten million and ten people are killed on an average each year, then the annual risk of being killed by train travel is one in one million. However such estimations do not give the *spread of risk* that is they do not say to what degree a community is at risk. To clarify further, people living near a chemical facility will be at varying degrees of risk depending on the physical proximity to the facility. Such considerations are not brought to light in such crude estimates. Some of the commonly used estimations as referred in the Disaster Management Training Programme (1994) are as follows:

Probability of an individual dying in a year	
Smoking 10 cigarettes a day	One in 200
Any kind of violence or poisoning	One in 850
Influenza	One in 5000
Leukemia	One in 12,500

1.3.2 Risk Assessment using Statistical Models

The purpose of statistical analysis is to arrive at a peculiar statistical model that relates risk posed by a natural disaster to socio economic parameters. UNDP carried out an exercise to relate the risk posed by natural disasters such as earthquakes, tropical cyclones, floods and drought etc. to specific socio economic factors like HDI, rate of urban growth etc. that create losses. The study was carried out under the aegis of the United Nations (UNDP) using data for more than 90 countries over a period of 20 years.

Statistical analyses is based on two major assumptions; *one*, that risk can be measured in terms of the number of victims of past hazardous events, and second, that the equation of risk follows a 'multiplicative model,' in that following risk identification in each case (taking into account) the number of people killed is arrived at by taking into account the relevant 'factor' values in each case, for example, rate of urban growth was taken as the factor that would determine loss of life from earthquakes, and access to water supply in case of droughts, etc.

Methodology

The exercise has two key assumptions.

The number of people killed by a natural disaster is a measure of Risk (physical exposure or PhExp)

The equation of risk follows a multiplicative model where the number of people killed is related to socio economic factors and number of people exposed to the risk by the following equation

$K = C.(PhExp)^{\alpha}.V_1^{\alpha 1}.V_2^{\alpha 2}....V_N^{\alpha N}$

Where,

K is the number of people killed by the disaster

C is a multiplicative constant

V_{1-N} is socio economic parameters

α_{1-N} is the exponent of V_{1-N}

{Note: Taking logarithm of both sides transforms this into a linear equation. Empirical data of natural disasters is taken and relevant socio economic parameters and their exponents are estimated using linear regression (difference between actual and desired states)}

For example in case of earthquakes, the socio economic parameter is urban growth, in case of cyclones, percentage of arable land and human development index; in case of floods, local population density and gross domestic product; in case of droughts, percentage of population with access to improved water supply *{read at*, http:// www.undp.org/bcpr/disred/documents/publications/rdr/english/ta/t5.pdf.}

1.3.3 Hazard Assessment

As explained above, to perform risk calculations, we need to know the probability of the occurrence of a hazard, within a specified time period, in a given area. Information regarding probability of hazard actually occurring along with related information like the level of severity or intensity of impact is necessary to derive proper risk assessment data. As explained in the Disaster Management Training Programme (1994), like risk, hazard occurrence is expressed in terms of average expected rate of occurrence of the (specified type of) event or on a probabilistic basis regarding occurrence probability/possibility. Hazard maps present graphically, the annual probability and magnitude of the event following intensive geological analysis of the area, along with a study of past records, sometimes dating a century back or more, as in case of dormant volcanoes. Other corroborative evidence such as soil composition analysis to predict landslides or the NDVI (normalised drought vegetation index) to predict droughts may be used in case of inadequacy of temporal data to predict the recurrence of an event. Information gathered is collated and depicted on a hazard map for necessary correlations tracing causes and effects for the purpose of objective derivations of variables (independent and dependant) involved in the phenomena and their analysis (statistical methods discussed above). Information collation is relatively easier for events with relatively regular periodicity. Corroborative evidence can be gathered from geological 'hints' such as silt deposit, high water marks, deposits in case of floods, and past fault lines in case of earthquakes, and, human records as the main source evidence regarding hazard probability in all cases. The

latter are considered more important and are being stressed more as compared to geological records by scientists.

The level of severity of natural hazards can be quantified in terms of the magnitude of occurrence as a whole (event parameter) or in terms of the effect the occurrence would have at a particular location site (site parameter).

Like risk, hazard occurrence may be expressed in terms of average expected rate of occurrence of the specified type of event, or on a probabilistic basis. In either case, the annual occurrence rates are usually used. The inverse of an annual recurrence rate is a return period. Examples of hazards as defined by Coburn, Sspence and Pomonis (1994) in terms of their occurrence parameters are:

There is an annual probability of .08 of an earthquake with a magnitude exceeding 7.0 in Eastern Turkey."

This is effectively the same thing as saying,

"the average return period of an earthquake of M=7.0 in eastern Turkey is 12.5 years."

Rare events like volcanoes are hard to predict since adequate historical data is not available. It may be possible for geologists to analyse old lava flows and try to date the eruption frequency from that.

Smaller more frequent events can also be studied for indications of severity of future large-scale events.

Knowledge of the consequences of events will be helpful in planning for control of hazards during the design and operation of the facility by taking proper action to reduce hazard rate or minimise the consequences, as the case may be, or else the assessed risk may just be ignored. By evaluating the risk of various hazards to which the country is liable or potentially liable, it becomes practicable to formulate strategies to mitigate the impact of hazards in a cost-effective way. If a community is especially vulnerable to a particular type of disaster, severe risk treatment measures may be required to reduce the disaster risk to 'acceptable levels'.

The other important function of risk analysis is to develop a comprehensive disaster preparedness plan by providing a clear understanding as to what hazards exist and what risk(s) they pose vulnerable neighboring communities.

Risk Assessments are conducted on several parameters with regard to both natural and man made hazards. Studying risk assessment as a management activity with regard to single unit can have complete understanding of Risk Assessments.

Taking the example of a chemical processing unit, the hazard potential of the unit depends on:

1) Chemical identities
2) Locations of facilities that use, produce, process or store hazardous materials
3) The type and design of chemical container or storage
4) Quantity of material that could be involved in an air borne release and,
5) Nature of the hazard (for example, air borne toxic vapors or mists, fire, explosion, large quantities stored or processed, handling conditions, etc.) most likely to accompany hazardous material spills or release.

Conditions, under which the chemicals are processed, handled or stored including the temperature, pressure and other unique features in manufacturing, storage or handling if any are also to be understood. Information may also be obtained on transportation routes used for movement of chemicals, quantities involved in transportation, frequency of such movements and form of transportation such as tankers, tank cars, drums, wagons, pipelines, etc.

1.4 ANALYTICAL SYSTEMS FOR RISK ASSESSMENT

The task of disaster management and of preparedness and protection can be thought of as making up a 'cycle' of events. It is the objective of a National Disaster Plan or Service to complete and command the 'whole' cycle from the central to the local level, both in the planning and operational senses. This command would seek man-environment equilibrium, leading to reduction of risks from natural hazards in a sustainable way.

There are many excellent analytical systems in use for the identification of potential and actual hardware errors, such as 'fault tree analysis'. Some such analytical models are discussed as under:

A) **Effect Models**

A disproportionate amount of time and resources is spent on crisis and emergency plans, which are not pre-evaluated from sustenance or workability point of view. The operation of a plan frequently fails due to the omissions and oversights that occurred during the plan formation stage. In order to estimate the disaster potential, calculations are done based on the basis of *Effect Models*. These mathematical models are those relating to idealised situations that can be approximated in actual operating conditions of the plant or installation. Mathematical models are used to study processes like:

1) Discharge of liquid, gases and vapors: The release of liquid, gas or a mixture of gas and liquid from containment through a hole or pipeline rupture and the spreading characteristic immediately after the release.
2) Evaporation of liquids on land: Nature of the evaporation process depending on the surface characteristics and heat drawn from the ground for boil off.
3) Evaporation of liquids on water: Extent of release into air once the liquid spills over water.
4) Gaussian dispersion models: For dispersion of neutrally buoyant plumes and for heavy gases at sufficiently high wind velocities and at sufficient distance from down wind.
5) Heavy gas dispersion models: These incorporate terrain effects, complex geometries and wind effects.
6) Heat radiation due to pool fire, flash fire, and Boiling Liquid Expanding Vapor Explosion (BLEVE): Pool fire can be from a pool of fuel spread over ground, water or a tank fire. Flash fire involves delayed ignition of a dispersed vapor cloud, which does not cause blast damage. BLEVE result from the overheating of a pressurised vessel by primary fire.
7) Unconfined Vapor Cloud Explosions (UVCE) or explosive deflagration of a dispersed flammable vapor.
8) Lethality due to toxic gas release: These include acute toxic effects arising out of short-term exposure at high concentrations and chronic effects from long term exposure at low concentrations.

These models will quantify the effect of the disastrous situation in terms of the damage criteria. In most cases the damages occur mainly due to thermal radiation effects, pressure wave effects and toxic gas release that imply digression from the idealised state. Effect models conjure up a perfect state and analyse real life situations heuristically, which involves examining processes to observe the degree of divergence from the perfect process and making attempts at approximating the perfect state to the extent possible.

B) **Quotient Method**

For industrial and chemical Units, currently for pesticides, the quotient method (QM) of ecological risk assessment is used. This method compares the predicted, expected or measured environmental concentration with a measurement test end-point or in many cases the LOC:

$$\frac{\text{Environmental Concentration}}{\text{LOC}} = \text{Quotient}$$

Or

$$\frac{\text{Predicted Environmental Concentration}}{\text{Quotient}} = \text{Predicted No-effect concentration}$$

If the quotient is equal to 1 or more, a risk of equaling or exceeding the LOC or PNEC[2] is inferred. If the quotient is less than there is less risk of reaching the concern level. This method is very simple and contributes with the exposure and ecological effects characterisation carried out by the USEPA.

The quotient method can identify risks that exceed measurement end-point (for example, mortality, growth and reproductive effects), but it cannot relate these risks to assessment end-point. There are limitations to the quotient method. It does not address taxonomic or life-stage sensitivities to an industrial chemical or pesticides, and it cannot address risks objectively at intermediate levels where the quotient is 'almost' 1 or approaches it.

LOC - Level of Concern

PNEC - Predicted No-Effect Concentration

As discussed by Keong Hiap Tang in "Risk Assessment Methodologies", a number of qualitative and quantities risk assessment techniques are being used by industries which are equally relevant to disaster management. Some of those techniques are discussed below:

C) **Preliminary Risk Analysis**

This is a qualitative risk analysis technique that traces the cause and effect sequence of a hazard turning to disaster. Each undesirable event in the chain of causation is analysed separately for remedial treatment. Hazards are ranked in the order of importance, as per damage potential, and, resources allocated accordingly to minimise the collective threat posed by hazards. Information is graphically depicted with the help of diagrams, called the *Frequency Consequence Diagrams* (Keong).

D) **Hazard and Operability Studies (HAS)**

Imperial Chemical Industries Ltd developed the Hazard Operability Studies Technique or the HAZOP technique in the early 1970s. This technique emphasises process improvement

in that the process is studied in relation to design specifications to detect whatever, if any, deviations might have occurred. Analysis brings to light the structural improvements that might be needed in design specifications to prevent possible hazards that could result. This technique had gained wide acceptance in the process industries as an effective tool for plant safety and operability improvements (*ibid*).

E) **Failure Mode and Effects Analysis (FMEA/FMECA)**

This technique was developed in the 1950s by reliability engineers to detect potential micro system failures and their impact on the functioning of the total system. Hence each potential failure mode in a system is analysed to determine its effect on the system and to classify it according to its severity Failure mode and effects analysis has gained wide acceptance in the aerospace and the military industries. All the above-discussed techniques are hardware specific and widely employed today, especially in nuclear power plants and chemical processing industries (*ibid*).

F) **Tree Based Techniques**

Tree based techniques include, fault-tree analysis (FTA), event-tree analysis (ETA), cause-consequence analysis (CCA), along with other techniques such as the management oversight risk tree (MORT) and safety management organisation review technique (SMORT), which may not particularly be relevant here.

i) The Fault Tree Analysis

The concept of fault tree analysis (FTA) was originated by the Bell Telephone Laboratories in 1962, as a technique to perform safety evaluations of the Intercontinental Ballistic Missile Launch Control System. This is an analytical technique to identify a particular (unusual) effect in the system and to trace it back to its causes. Fault tree is a graphical display of how faulty situations in a system can lead to a predefined failure. It gives a quantitative evaluation of the probability of the occurrence of the "top event" which can be broken down into sub events and studied deductively. Fault tree analysis (FTA) is widely used, especially where extremely tight process controls are needed to attain the required standards of safety.

Understanding of the systems' functioning is necessary to construct a fault tree. System function diagram is used to show the pathways by which signal or materials are transmitted between components comprising the system. A logic diagram is also required to depict the logical relationships of the components.

A fault tree is a logical diagram, which shows the relation between a specific undesirable event in the system and the failures of the components of the system. The system failure events to be studied are called the 'top event'. Successive subordinate (for example, subsystem) failure events that may contribute to the occurrence of the 'top event' are then identified and linked by logical connective functions. The subordinate events are then broken down into their logical contributors, and in this manner, a failure event structure is created. Progress in the synthesis of the tree is recorded graphically by arranging the events into a tree structure using connecting symbol called gates (see diagram below). Once the tree structure has been established, subsequent analysis is deductive and takes two forms: -

a) Qualitative Analysis: To inquire into the causes of digressions with a view to qualitatively upgrading the system by analysing specific combinations of basic events sufficient to cause the undesired top event to occur.

b) Quantitative Analysis: Numerically calculating the probability of occurrence of the top event from the probabilities of occurrence of the basic.

In case of qualitative analysis, the fault tree is comparatively loosely structured, since the analysis in this case is not as rigorously specific as in case of a quantitative analysis; being more judgemental and valuation based, compared to the former which is more 'fact based' and 'objective.'

In multi-component systems as complicated as nuclear reactors, it is important to analyse the possible mechanisms for failure and to perform probabilistic analysis for the many events that interact to produce other probably undesirable events. Reference may be made to the Bhopal gas tragedy and the Uphaar cinema fire, which could use fault tree, both as a diagnostic and a preventive tool to avoid future losses. These events can be related using simple logical relationships and these relationships permit a methodical building of a structure that represents the system.

A complete safety analysis on an extensive system such as a nuclear power plant normally requires three levels of fault tree development. The top level includes the top undesired event and the key sub-events that are modeled from the point of view of how the system functions. As the events are statistically independent, actual construction of fault trees is an art as well as a science and comes only through experience. For trees containing several tens of events, computer applications are needed. Several computer codes have been developed for this purpose. Environmental risk assessment is likely to become increasingly important in development planning in the coming years, considering the level of environmental degradation that has taken place. As managing and utilisation of increasingly scarce natural resources involving water and soil sustainability becomes more and more complex, the need increases for improving our understanding of environmental risk and the relationship of ecology to economic development and social welfare.

To date, risk assessment techniques have been applied mostly to potential industrial hazards and to the assessment of environmental health risk. The assessment of ecological risk is still not as common, although methods are increasingly being tested and applied, often in conjunction with environmental cost-benefit analyses (for example, in forestry project involving a combination of production and conservation activities, or in the assessment of impacts on natural habitats of water diversions). The main reason for this 'lag' when it comes to ecological risk assessment is that the relationship between different human activities and ecological 'chain reactions' in different environmental settings is still subject to great *uncertainty*. Consequently, there is some resistance towards applying the methodology on a *systematic basis.* The World Bank will continue to encourage and expand the use of environmental risk assessment and seek to contribute to the development and refinement of risk assessment techniques and their application to new areas.

ii) **The Event Tree Analysis (ETA)**

An event tree is similar to a fault tree but differs in exploring the consequences of an undesirable event as against causes in fault tree. This is a bottom up approach, suggesting how one wrong initiating event can lead to a potential disaster. The event tree follows *inductive logic* in that consequences following an identified event are studied as against deductive logic of fault tree, which studies events and subsequent causes. Event tree analysis is a *forward reasoning technique*, which identifies the ultimate consequences arising out of a basic cause or initiating event. It gives the probability of occurrence of the ultimate consequence. Event tree analysis (ETA) records the accident sequences and

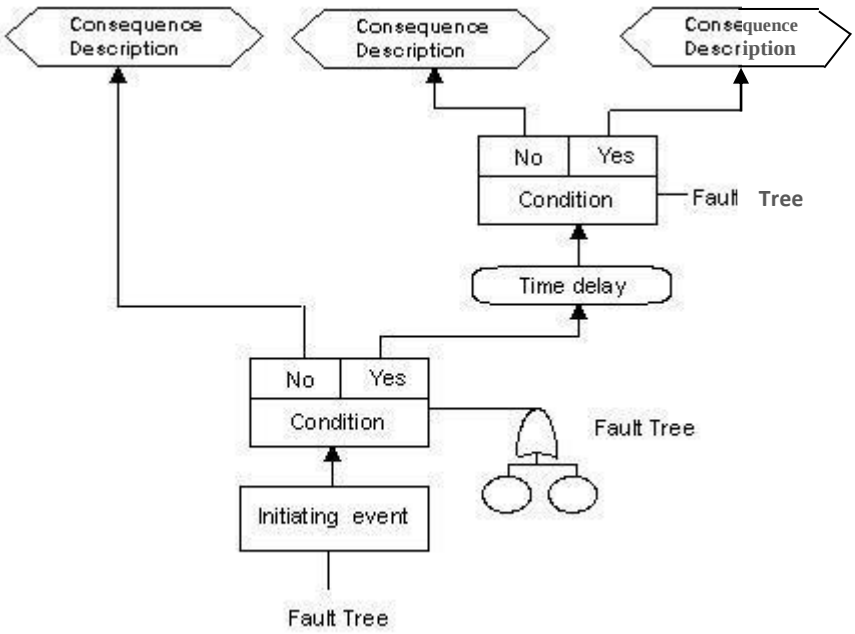
defines the relationship between the initiating events and the subsequent events that combine to result in an accident. The procedure involves identifying the initiating event, listing all events that could arise as a result, constructing the event tree and evaluating the resultant failure. If the failure frequency level is intolerable, special efforts should be made towards containing the same. The fault-tree method allows one to proceed back in time from possible catastrophic accidents to examining components of the sequence. The event-tree method allows the observer to proceed forward in time from potential component failures to their accident implications. These methods can make the study of such accidents more systematic. They establish a classification of some potential accident sequence and permit identification of procedures for estimating the risk(s) associated with these sequences. A database must exist on the risk of the failure of critical component elements. The methods however cannot be totally comprehensive. The important thing is the attempt at completeness and the ability to provide assurance that only minor contributors to accidents might have been left out (Keong).

iii) **The Cause Consequence Analysis (CCA)**

This technique was invented by RISO Laboratories in Denmark to be used in risk analysis of nuclear power stations. However, it can also be adapted by the other industries for estimation of safety.

The purpose of CCA is to identify the chain of events that can result in undesirable consequences. With the probabilities of the various events in the CCA diagram, the probabilities of the various consequences can be calculated, thus establishing the risk level of the system. The cause-consequence diagram can be considered as a combination of fault and event tree analyses. It presents the sequence of events in the form of a logic diagram and makes possible quantification of the risks from the system. It is easier to identify by this method, the sequence of events that finally culminated in the disaster. The CCA therefore combines the benefits of fault tree and event tree in that both causes and consequences of undesirable events are studied using both inductive and deductive logic. With the probabilities of the various events in the CCA diagram, the probabilities of the various consequences can be calculated, thus establishing the risk level of the system. The diagram below from Tang's is illustrative of it (*ibid*).

Figure 2 below shows a typical CCA



The above methods display logical relationships, identify combination of failures that lead to undesired events and can be used as the basis for hazard assessment. One of the major distinctions between man-made and natural hazards is the notion that the former is possibly preventable. The natural hazard, the earthquake or typhoon is not preventable. One can act so as to mitigate its impacts but not forestall the occurrence of the natural phenomena. Of course, a continuum may be said to exist between hazards, which are totally man-made, and those, which are exclusively natural, presuming that man's activities interfere with natural processes and lead to hazards. Man-made or institutional hazards are typically subject to the development of a logic structure, which can be used to analyse the preventability of the rare event. The Ramussen Report on nuclear accidents, for example, used the methods of the Fault-tree/ Event-tree analysis.

Evaluation of Tree Techniques

Risk-benefit analysis based upon methods such as fault-tree and event-tree have proceeded a long way in the last several years for examining hazards from nuclear plants, food additives and pharmaceuticals. Fault-tree studies of reactor accidents have established that between one-third and two-third of hypothesised accidents are caused by human error. What is human error? Is it frailty, vulnerability, and incompetence in the assigned task? When one superimposes the maps of seismic risk and population density over the maps showing the location of nuclear reactor sites, along with their management and operation safety rating which varies considerably, the aggregate distribution of catastrophe potential is probably high but still to an unknown degree. When one adds to this distribution the potential danger from sites now under construction and those planned to begin construction soon, that composite picture of the distribution of hazard is gained which adds to rationality of policy choices involving location and scale of activities of projects.

Largely, the area of fault tree application is the prediction of institutional, legislative and judicial impacts of measures taken and proposed improvements for better compliance with risk reduction guidelines. The private sector and public sector projects and programmes can be studied with reference to their impact on the economy to point out possible shortfalls. Natural disasters like earthquakes, landslides, floods and cyclones strike nations most unexpectedly, inflicting massive damage to life and property. Man-made installations such as chemical storages, chemical processing industries add yet another dimension to the devastating impacts of natural calamities. A number of tools are available for identifying the potential hazards from a plant. These are based on previous experience, discussions involving people with more specialised knowledge and other creative and analytical methods.

1.5 NATURAL HAZARD/ RISK ASSESSMENT

A) Earthquake Risk Assessment

According to a recent study by Khattri (1999), an important factor that controls the ground motion severity is site characteristic. Sites covered by loose soft soil are liable to *amplify ground* motion in the event of an earthquake. Various studies are used for site investigation (i.e. dominant period and amplification level). Techniques such as *noise studies, shallow refraction* and *swell boring* are used for studying site characteristics. Using this information, a detailed map of expected ground motion in different areas can be prepared which can be a suitable basis for vulnerability mapping.

The RADIUS Tool

Risk Assessment Tool for Diagnosis of Urban areas against Seismic disasters (RADIUS) tool was developed for IDNDR (International Decade for Natural Disaster Reduction) by OYO Corporation, Japan and RMSI to enable the city administrator to do quick assessment of earthquake risk to a city. The tool was showcased at IDNDR (International Decade for Natural Disaster Reduction) seminar, Mexico in 1999 to many city planners and administrators.

The goal of this tool is to aid users in understanding the seismic hazard and vulnerability of their cities and to guide them in preparedness programs for future risk management. The tool provides risk-mapping of the area of a city and probable loss estimates involving infrastructure and life, which is displayed as a mesh of rectangular cells which allows the user to get a graphical view. The outputs are seismic intensity, building damage, lifeline damage, and causality estimates which are presented in tabular forms as well as in map forms.

Epicentral Maps

Epicentral maps are used for preparing seismic hazard maps. These maps are prepared after collecting data over a period of time, possibly for the past hundred years and its analyses by computer programs. Apart from earthquake data, geological factors, structural design, soil data etc., are used for preparing building codes. These codes are used for designing earthquake resistant structures in the region. Upgrading of this code is a continuous exercise since changes take place in geological factors such as soil composition over time. The building code is accordingly reviewed from time to time. The different zones indicate vulnerability from seismic disturbances and help assess actual disaster potential of the hazard.

However, in order to assess the exact nature of risk, several data regarding important factors such as gravity, magnetic, geodetic and, electrical data are necessary. These data are then used to prepare micro-zonation maps, which are used for urban and rural planning.

Example from China

From a public administration perspective, the administrative set up is significant in the way it applies principles of organisation theory to maximum effect in implementation of policy. Reference is to unity of command; specialisation, work division and coordination etc. which determine the efficacy of policy implementation and evaluation processes. A policy unsuccessfully implemented is a waste.

Recent initiatives taken by China would be worthy of consideration here. In response to the United Nations current emphasis on disaster management, through the International Secretariat for Disaster Reduction, (ISDR), China has set up special Earthquake Management Agencies in every major city and large state enterprises. As related by Tao Xiapin, some cities located in high earthquake risk area ensure regular rehearsals of rescue squads, and rush-repairing procedure every year. The anti-seismic awareness of the public is upgraded by training and awareness programmes. Such initiatives are necessary because of the specific geological situation where the famous Circum-pacific active structure zone intersects the Himalayas-Mediterranean active structure zone. China faces high earthquake disaster risk and hazard.

The Chinese administrative arrangement resembles a pyramid, in that primary responsibility is with the General Emergency Directing Center, led by the Chinese State Department and Chinese Seismological Bureau. Provincial government and related Ministries is the second layer, the Local Government is the third layer, and other organisations or enterprises form the lowest rung. In the event of a catastrophe, the machinery swings into action, with the emergency-directing center at the helm of affairs. The system is functional in that there is there is *unity of command* as well *unity of direction* in public administration parlance, since agencies report to the top authority which issues guidelines and supervise the work of provincial authorities. In order to keep the information moving smoothly and fluently into the networks of earthquake preparedness and rescue effort, the Chinese government had started a series of programs to set up digital networks since 1990, based on GIS, GPS and RS, take in a lot of new achievements in earthquake engineering and information science. Other organisations in the middle and lower rungs have clear-cut responsibilities relating to implementation of plans and no jurisdictional disputes have been known to jeopardise or in any way affect the collective effort.

This endorses the significance of collaboration between the twin fields of specialist scientific expertise and generalist mainstream public administration public administration to articulate meaningful policy and ensure quick and efficient implementation.

B) **Landslide Risk Assessment**

According to A. I. Kelarestaghi, geological, topographic and climatic condition of the area and human factors such as land use changing and road construction are the important factors that have caused landslides.

Landslide zonation map is a map demarcating the stretches or areas of varying degrees of anticipated *slope stability* or *instability*. The map has an in-built element of forecasting and is hence of a probabilistic nature. Depending upon the methodology adopted and the comprehensiveness of the input data used, a landslide hazard zonation map provides help concerning some or all the following aspects:

- Location of proposed project
- Extent of the slope area likely to be affected, and
- Rate of mass movement of the slope mass.

The use of aerial photographs and adoption of remote sensing techniques helps in the collection of data. For storage, retrieval and analysis, adoption of computerised techniques speeds up information processing.

Hazard zonation maps have multifarious uses, some of which are listed below:

- In the preparation of development plans for townships, dams, roads, and other development
- General purpose Master Plans and Land use Plans.
- Discouraging new development in hazard prone areas.
- Choice of optimum activity pattern based on risk zones.
- Quick decision making in rescue and relief operations.

C) **Drought Risk Assessment**

As explained by Fatima Rabab, the Normalised Difference Vegetation Index (NDVI) index helps forewarn of droughts. NDVI is a satellite data processed index, which can be used to indicate deficiencies in rainfall and portray meteorological and /or agricultural drought patterns and measure of the amount of radiation being absorbed by plants. Amount of radiation absorbed is directly related to 'evapo-transpiration,' since the plant must cool primarily by evaporating water. The evapo-transpiration is constrained by the amount of water in the soil, which in turn is constrained by low rainfall. (Rowland et al, 1996), Onset of drought conditions over a large area can be predicted by comparative analysis of the trend of derived NDVI of that year, relative to the trend in the normal year. Other factors along with vegetation cover that need monitoring; include climate, soil type, hydrology, and socio economic condition of people. Hence multidisciplinary spatial analysis with the help of GIS can lead to a decision support system for concerned government departments, NGOs and others to help drought vulnerable people and others living in potential drought prone areas.

Application of NDVI will aid decision-making allowing better integration and more timely planning of methods to promote food security. Droughts affect the poor more than the resourceful (access to labour capital and wealth). Unlike rapid onset events like earthquakes, drought has slow onset, which can be observed and curbed with timely preventive action. Accordingly, *Drought Indices* have been developed to monitor and forecast drought. Such indices incorporate data collected over time regarding multifarious factors like rainfall, snow pack stream flow, and other water supply indicators, which together give the comprehensive 'big' picture. Drought indices for areas with undulating topography need to take account of additional factors like surface water supply index etc.

According to Verstappen (1995), Satellite Remote Sensing (SRS) and the Geographic Information System (GIS) should be integrated for identification of drought vulnerable conditions in a particular geographic area for research purposes. There are two principal advantages of such integration. First, the technology allows long-term series studies and storage of the information; second, information accessibility is improved. Remote sensing can provide large amounts of data quickly and inexpensively, relative to other means of collection and GIS can bring together vast amounts of information from a wide variety of sources and make the information quickly visible and applicable in emergency situations.

New scientific techniques such as remote sensing, satellite imaging, geographical information system and geographical positioning position (GPS), can be put to effective use in forecasting and monitoring droughts.

D) **Volcano Hazard Assessment**

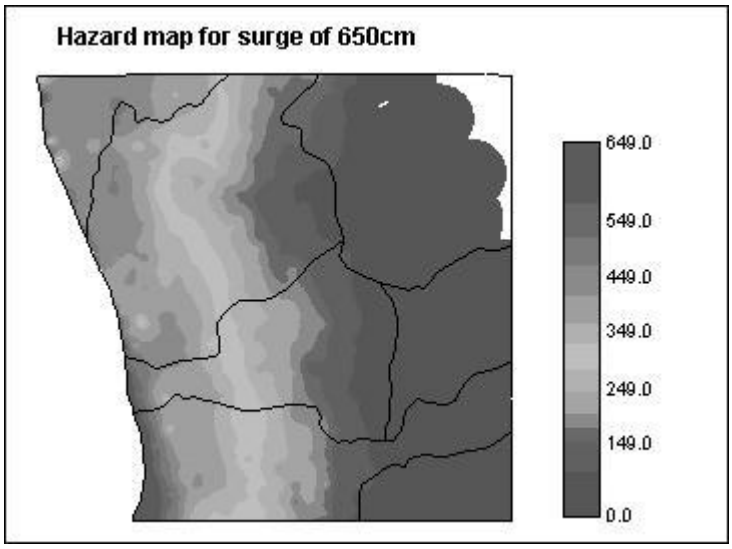
GIS is being used to map areas of intense *mudflow paths* from water filled craters in adjoining residential areas. GIS contributes in identifying areas at risk, monitoring and forecasting hazards to warning the possibly affected people or responsible teams to take precautions.

E) **Flood Risk Analysis**

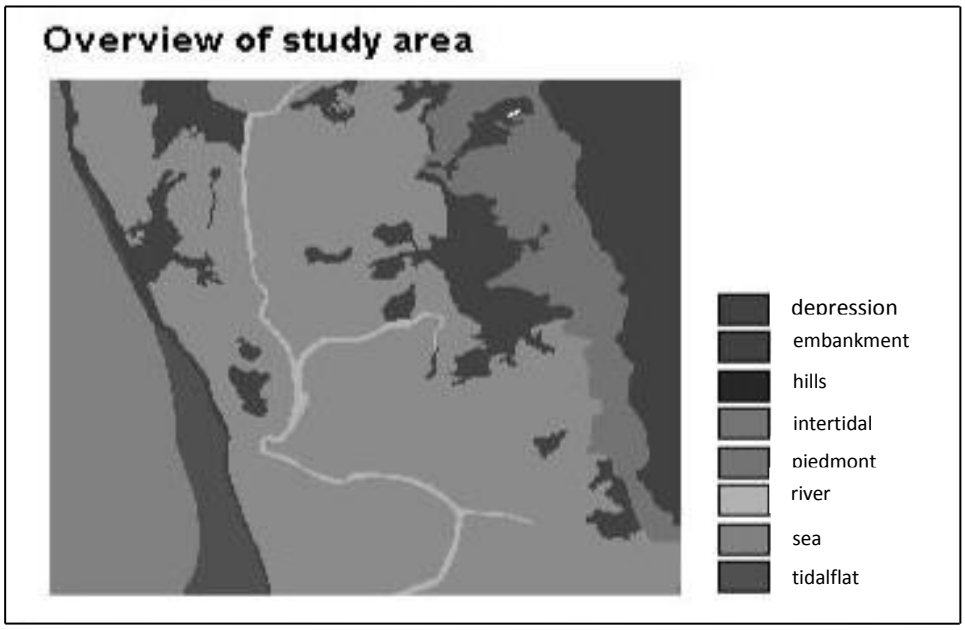
Flood Risk Analysis is done using GIS and RS tools. Land use maps are prepared which show residential areas and main commercial complexes in hazard prone areas. Lack of land use planning is also exposed in a flood hazard map. Critical facilities' map is prepared separately to depict hospitals, schools, and colleges in hazard prone areas.

The map below gives an overview of the Banskhali study area situated in the East of Bangladesh, South of the city of Chittagong. Area maps and attribute tables of the geomorphology, village population, the Union-districts, roads, embankments, cyclone shelters, and the elevation of the terrain with cm accuracy are provided (Demon and Westen, 2002).

MAP-1



MAP-2



F) **Cyclone flood modeling**

Surge heights are modeled as follows:

- the surge height remains constant for a certain distance from the coast line
- then, the surge height decreases according to a constant factor, the so-called Surge Decay Coefficient (SDC); this is the influence of resistance caused by surface forms and land cover, at a certain distance from the coast the surge height will be zero.

The SDC is calculated as:

$$\frac{\text{Surge height – Average elevation at end of surge}}{\text{Total inundation width – Width of constant surge}}$$

For a surge height of 650cm at the coast, a flood hazard map can be calculated which depicts the water height (in cm) in the area (all required parameters are given):

- first a distance calculation from the coast line is performed,
- The map is obtained with the water height (in cm) in a particular area after the surge of 650cm. (decreasing water height showed in colours, descending towards left- see Map 2)

Taking into account population densities in different hazard zones and other factors such as infrastructure etc. vulnerability and risk assessments are done. Satellite imagery enables superimposition of maps providing information on different counts such as the infrastructure in the area, the tribes inhabiting the area, the occupational pattern of people, livelihood options, communication network etc. Different information can be put together on map
"The highest loss of people (factor 1.0) will occur at places where high flood depths occur while there will be no loss of people (factor 0.0) at places where the flood depth is zero. (In this exercise, vulnerability is regarded as a kind of 'killing factor'" (Demon and Weston, 2002). Population densities are calculated separately for each village in terms of the elderly, women and children among vulnerable sections.

Risk calculations are done separately for different surge heights, over the next 15, 20 or 25 year periods and for different categories of people, women, children, elderly, young. It has been observed that small surge height cyclones are more frequent creating more risk especially to children.

1.6 UNDERSTANDING CLIMATE RISK

The United Nations has called for factoring 'risk' from climate change in every developing decision taken with regard to any project, especially in the third world. Climate change in part has been a natural process, which has been misdirected and mismanaged by human intervention through the course of development; to the extent, that natural 'resources' like water and sunlight have today turned to hazards. As per Hazard Assessment of the Intergovernmental Panel on Climate Change (2001), human activities which have disturbed the ecological balance are; industrial processes leading to emission of green house gases lack of alternate energy sources, everyday activities involving burning of charcoal and fossil fuels, deforestation, migration of rural folk to urban metropolises creating problems of urban congestion etc.

Some of the natural and man-made factors highlighted in the IPCC report are discussed below:

A) **Natural factors**

a) **Continental Drift**

Based on geological evidence, such as similarity of plants and animal fossils etc., scientists contend that continents of the world were once part of a huge landmass. The continents have since then drifted apart, causing changes in the physical features of the landmass, their position and the position of water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate. This drift of the continents continues even today with the Himalayan range rising by about 1 mm (millimeter) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily.

b) **Volcanoes**

When a volcano erupts, volcanic ash, composed of SO_2 and dust particles, can reach up to the stratosphere, trap sunlight cooling the troposphere, which alters weather patterns in the region and around the globe. Gases and dust particles lead to cooling of the earth surface by trapping much of the energy. SO_2 combines with water vapour (H_2O) to form sulphuric acid ($H_2 SO_4$) which floats for long periods and travels long distances in the form of tiny droplets resulting in climate changes in different parts of the globe. (H_2SO_4 reflects sunlight.) The extent to which it happens is still under study. There was a famous year without a summer when significant weather-related disruptions occurred in New England and in Western Europe with killing summer frosts in the United States and Canada. These strange phenomena were attributed to a major eruption of the Tambora volcano in Indonesia in 1815.

c) **The Earth's Tilt**

The earth is tilted at 23.5^0 to the perpendicular plane of its orbital path. The more the tilt, more acute the angle, more the severity of seasons experienced since the distance between the sun and earth gets different. The earth's axis is not fixed as is generally assumed. It is moving at the rate of a little more than a half-degree each century. When the pyramids were built, around 2500 BC, the pole was near the star Thuban (Alpha Draconis). This gradual change in the direction of the earth's axis, called *precession* is responsible for changes in the climate (IPCC, 2001)

d) **Ocean Currents**

Ocean Currents affect the climate of adjoining regions. For example the warm Gulf Stream current affects the temperature of South West America and the cold Labrador Current affects the temperature in Northern Europe. Winds change the direction or the speed of an ocean current, which leads to phenomena such as the El Nino. Ocean currents absorb large amounts of heat from the atmosphere that gets released in the form of water vapour. Water vapor is the most abundant green house gas on Earth. But water vapour also leads to cloud formation and contributes to cooling of the atmosphere.

B) **Human Factors**

Human made causes, are emission of green house gases from electrical appliances, (Use coal) automobiles (petrol and diesel) which run on fossil fuels (Oil, coal, natural gas, large

scale deforestation for various purposes such as buildings, paper, timber etc, plastic waste that cannot be recycled. All such activities have contributed to rise in greenhouse gases in the atmosphere. The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides and carbon monoxide, which is not greenhouse, gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases (IPCC, 2001).

1.7 MAPPING FOR RISK ASSESSMENT

Methods developed for near accurate estimations include f: N curves, scenario mapping, potential loss studies as explained by Coburn, Sspence and Pomonis (1994) in the Disaster Management Training Programme.

a) **f:N Curves:** Data on the size and frequency of disaster occurrences for a particular country can be plotted as f:N curves. These involve plotting the frequency of events causing greater than a certain number of fatalities. Different numbers of casualties (or magnitude of losses expressed in some other way) are plotted for different frequency of occurrence on *x* and *y-axis* on a graph respectively. However such relationships always show aggregated losses for a large region over a period of time. They do not help identify the geographical distribution of damage, for which risk mapping is needed.

b) **Scenario Mapping:** In scenario mapping the presentation of the impact of a single hazard is attempted. Scenario mapping is used to estimate the resources likely to be needed to handle an emergency. The number of people killed and injured and the losses likely with respect to other 'elements' are estimated. From these can be assessed the resources needed for medical attention, accommodating the homeless and other measures to minimise the recovery period. For example assessing the state of the present infrastructure can aid damage assessment in the event of an earthquake. Circles and shaded regions on a map are used to depict settlements and building types, low density and high-density areas etc. to assess damage likely in particular locations, based on past experience and development since the last event for proper assessment in the changed scenario. Hence a scenario map can identify 'communities at risk' and regions at risk. Hot spots thus located are the foci of restorative and regenerative activities post disaster.

c) **Potential Loss Studies:** Mapping the impact of expected hazard occurrence probability across a region or country shows the location of communities like to suffer heavy losses. The effect of the hazard of each area is calculated for each of the communities within those areas to identify the communities most at risk. This shows for example which towns or villages likely to suffer heaviest losses, which should be priorities for loss reduction programs, and which are likely to suffer heaviest losses, which should be priorities for loss reduction programme and which are likely to need most aid or rescue assistance in the event of disaster of differing magnitudes.

d) **Annualised Risk Mapping:** The annualised specific risk from any hazard at any location is the average expected total losses from all events over an extended time period. The probability of each level of hazard occurring within unit time period is combined with the consequence of that level of hazard to generate the expected

losses within that time. Summing up losses of all levels of hazards gives the total losses likely over a time period. Hence an annualised risk map gives the total losses over both time and space. With high level of precision in calculations, the desired focus of disaster mitigation policy as also the effects of disaster mitigation measures if attempted can also be assessed. Areas of concentration of damage over a year in a given area are depicted on the map. It is expressed as a proportion of the total value (or number) of the total population at risk. Calculation of the probable levels of losses occurring within a unit time period is combined with the consequences of that level of hazard to generate the expected loss within that time. (Coburn, Sspence and Pomonis, 1994)

1.8 DECISION MAKING FOR RISK REDUCTION

1.8.1 Risk Evaluation

Decision-making regarding risk depends on the perception of risk or risk evaluation carried out in the social and political circles. Risk evaluation entails 'comparative evaluation of risks' faced by a society and the relative ordering of risks as per resource availability and the significance attached by the society to the risks it faces. In developing countries, development policy for risk reduction has not been evident on a satisfactory scale, since there are other pressing concerns such as poverty reduction, employment generation, public health etc., which are ordered higher than disaster risk reduction. Not being a core public policy issue, disaster management remains a 'contingency' measure, dependent mainly on international assistance, in case such an eventuality occurs. As part of daily governance, risk largely remains un- accounted in decision-making. This is a fundamental error since risk reduction and development are inextricably linked. There has been a realisation by the international community that disasters set back development, negating years of effort. There has been an extended understanding of poverty in academic circles of late in that poverty assessment is not limited to the income criterion alone, but to myriad issues concerning quality of human life, such as better education, access to public health facilities, gender equity, child care and a better overall sense of well being. Accordingly, poverty reduction is increasingly being looked upon as an integral aspect of development planning relating to other sectors, such as environment management, gender development and public health. Such integration with disaster management however, is still not evident on a satisfactory scale (DMTP, 1994).

According to Suvit Yodmani, definitions of poverty reduction and disaster management have evolved over the years, almost concomitantly, in that a similar pattern can be discerned in shifting paradigms. Disaster management over the past few decades was seen as a technical issue, which only trained scientists, could handle. The approach was consequently techno centric or concerning only engineering expertise. With the change in the understanding of poverty, has come about a corresponding, though not necessarily related, change in the perception of disasters as issues in development. For example, provision of livelihood options is an important development issue and also an important risk reduction measure. The change in perception was brought about, as technical know-how or even better contingency planning could not curb disaster losses. It was evident that there was some other factor at work, apart from the natural causes of hazards or the deficiency in contingency planning. The other factor was diagnosed subsequently as 'vulnerability'. Frederick Cuny in his much-acclaimed book *Disasters and Development* cites an example to illustrate the point. Earthquakes of almost similar magnitudes struck

California in 1971 and Managua in Nicaragua, two years later. While only 58 deaths were reported in California, which has a total of seven thousand people, Managua were reduced to rubble with six thousand reported dead.

The context of disaster management only makes development policies empirical in that they are based on scientific vulnerability analyses, involving a number of agencies, which ensures better effectiveness of policies and also cost effective implementation. It also ensures 'sustainability' of policies in the long run, in terms of compatibility with environmental concerns (protecting environmental degradation, pollution, modifying cultural practices that harm the environment, etc.). It also makes policies 'relevant' from the public administration perspective in that they are need based and hence ensure benefit over the long run.

1.8.2 Vulnerability Assessment

Vulnerability is not a uniform phenomenon. It differs across regions and communities. Specific vulnerabilities relating to a specific community or a region have to be identified through empirical study and area/people specific strategies devised accordingly, to tackle vulnerabilities. The exercise to identify what creates risk is termed *vulnerability assessment*. The Disaster Management Training Programmed, 1994, defines vulnerability assessment in the following words:

Vulnerability Analysis is:

"*The process of estimating the vulnerability of specified elements at risk. For engineering purposes vulnerability analysis involves the analysis of theoretical and empirical data concerning the effects of particular phenomenon on particular types of structures. For more general socio economic purposes, it involves consideration of all significant elements in society, including physical social and economic considerations, (both short term and long term) and the extent to which essential services and traditional local coping mechanisms) are able to continue functioning."*

Vulnerability thus can be physical, economic, social or cultural. *Physical vulnerability* refers to the resilience of the infrastructure in the face of disasters. If quality of infrastructure is poor, buildings collapse easily; communication gets disrupted, creating hurdles in relief effort, causing loss of capital infrastructure and more loss of life. In the aftermath of an earthquake, buildings are analysed for damage resistance, and categorised as per differing levels of susceptibility. 'Retrofitting' measures are accordingly applied to provide for more hazard resistant construction. As a preventive measure, building codes and regulations are drafted to force hazard resistant construction in hazard prone areas.

Social vulnerability refers to a state of weakness, which creates a predisposition to harm. Social and economic vulnerability are found to go together in that in that weak and the marginalised do not have access to power centers wherein the means of production are concentrated. Statistically, the poor and the marginalised have been seen to suffer more in the event of a disaster than the relatively better off, on account of iniquitous access to power and resources. Vulnerable position depends significantly on differential access to 'power', which is an intangible resource, though a prime determinant of 'survival quotient' or resilience in the event of difficulty. Power situation determines largely, the access to relief resources in the aftermath of a disaster. This explains the particularly weak position of women and children and backward sections of society in securing aid relief. Therefore, in the current paradigm of risk management approaches, there is more room than ever before for addressing the issues of risk reduction for the poor. This is

also in consonance with the paradigm shift in the mainstream development practice, which is now characterised by emphasis on good governance, accountability and greater focus on people friendly bottom-up approaches.

Warning systems detect impending disasters. Warning systems are complex systems because they link many specialties and organisations, science (government and/or private, engineering technology, government news media, and the public. Disaster preparedness involves integrating the subsystems of management of hazard information and public response. Preparedness components are, planning, exercise, and training of officials concerned along with local volunteers. Thus warning system must be considered having scientific, managerial, technological and social components that are linked by a variety of communication processes. One pertinent finding has been that a single warning concept will not equally serve the requirements for all hazards (Mileti and Sorensen, 1990). For example, a system designed for a hurricane will not be good for a flash flood. Likewise a general alert or warning may not be adequate when a very specific warning is needed. There have been cases where a warning system failed because the wrong system design was used. This is often found in areas, where a lesser-known hazard strikes, for example, tornadoes occurring in areas of frequent hurricane activity. Over the past years, significant progress has been achieved in the United States, in predicting forecasting and graphically presenting scientific information and warnings hurricanes and nuclear hazards. In case of other hazards, such significant improvement is still not discernible.

1.8.3 Instituting Disaster Response

Traditionally, due to lack of technology and scientific approach, it was difficult to carry out the search, rescue and evacuation operations. Today there are techniques available, like remote sensing through satellite imagery and GIS, which help to identify areas that are disaster prone, zoning them according to risk magnitudes, inventory populations and assets at risk, and simulating damage scenarios. The information communication revolution has greatly facilitated matters in search and rescue. Specific areas of use include warning and forecasting, creating awareness among people, establishing contact between relief teams, instituting coordination mechanisms through control rooms set up for the purpose.

1.9 PROBLEMS IN RISK ASSESSMENT

Risk assessment is largely ignored in policy making. Where it does figure, it tends to be confined to hazard mapping and the assessment of physical vulnerability; consideration of the political and social dimensions being conspicuously absent. There is also the need to appreciate the concept holistically, in the sense of integrating hazard and vulnerability assessment with development planning. For disaster management planning to be effective, certain minimum standards based on acceptable risk should serve as guidelines. Below, is a summary of the necessary activities, which can be taken up to advance and improve the process?

- hazard mapping of all key hazards to various scales; frequency, location, severity and duration
- vulnerability assessment; social, economic, physical, institutional
- risk evaluation where absolute requirements for mitigation and preparedness are decided.

Resource constraint is a major problem. Disaster prevention, however, has been found to be far costlier than preventive strategies. The emphasis of Risk Assessment has consequently to be on devising innovative approaches to prevent disasters as part of development planning.

1.10 CONCLUSION

Risk assessment is a scientific approach to understanding disaster phenomena with a view to preempting/preventing them by means of innovative and proactive policy. Risk analysis is an important element in the wider function of policy analysis especially with respect to development administration. Researchers and academics have to consider risk assessments in wider context of 'policy analysis' from the point of view of public interest. By the public choice perspective, policies are democratic to the extent they are based on the imperatives of public interest. Since disaster management is now imminent, it should form an important perspective in analyses of development policies. Such broad conception of policy analyses or the widening of this scope of policy analyses will contribute to its success at the implementation stage. Policy analyses also lead to the development of 'policy science' that is a ready body of knowledge for reference in similar circumstances would be presented. Therefore, provision for risk assessment has to be built into regular policy design to arrive at a proper cost benefit analysis regarding disaster related development planning. Right estimate of expenditure for e.g., could lead to better economic policies in the country such as a better, more just taxation policy.

1.11 KEY CONCEPTS

Vulnerability : The degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss).

Elements at Risk : The population, building and civil engineering works, economic activities, public services, utilities and infrastructure etc. at risk in a given area.

Specific Risk : The expected degree of loss due to a particular natural phenomenon and as a function of both natural hazard and vulnerability.

Risk : The expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements of risk.

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1.13 ACTIVITIES

1) Risk analysis involves an analysis of both theoretical and empirical data. Discuss.

2) Discuss the process of risk assessment with suitable example from India.

3) Write a note on risk evaluation.

UNIT 2 PARTICIPATORY RISK ASSESSMENT

Structure

2.0 LEARNING OUTCOME

After going through this Unit, you shall be able to:

- Understand rationale of people's participation in risk assessment;
- Analyse the participation between the community and government organisations; and
- Examine participatory risk assessment methods.

2.1 INTRODUCTION

It has been realised over the years that peoples' participation and/or involvement in governance related matters is an important factor determining success or otherwise of any policy. Some scholars differentiate between 'involvement' and 'participation' in that involvement suggests a function of reciprocity and reference in policy matters between informed/educated people and official agencies and more a measure of 'right' on the part

of people, participation suggests more a duty or responsible citizenship expressed by them which is supportive/supplementary of/to government effort, provided for/institutionalised by the state. The reason why peoples' participation is so important is that the process of policy formation in developing (transitional) societies like India, partakes within the ecological context of the perennial contest involving the opposing forces of *tradition* and *modernity*. A mono-centric order suggests a top down approach and a directive culture in which people are largely passive beneficiaries. Such an approach is more suited to homogenous societies, which follow totalitarian ideology and concomitant political systems (the variants of which are many). In the context of pluralism and democracy such an approach is unsuited, as in every case, 'public interest' has to inform public policy. It might be argued that public interest is an abstraction; therefore, whatever the legislators 'commit' is public interest, since elected representatives have legitimate authority (by delegation as sovereignty resides in the people) imparted by the democratic process to 'voice' the concerns of people on their behalf. Such an approach however does not quite fathom reality, as is brought out by the below par performance of most public policies, particularly those related to rural development, women and child welfare, and, uplift of the downtrodden sections of society. If the debate is rightly resolved in favour of pluralism, peoples' participation is a necessary condition or almost an imperative, with respect to any public policy, at the formulation, implementation and evaluation stages. Peoples' participation in the context of disaster management implies risk and vulnerability assessment at the local level on cultural and social criteria and subsequent involvement at the implementation and evaluation stages to assess real needs and concerns articulated by them and preserve communities' cultural diversities/identities.

2.1.1 The Concept of Community

First and foremost, it would be desirable, to distinguish between the related concepts of *community* and *society* in that, the former is a naturally ordered entity, typified by the family, while the latter is based on structured social relationships, institutionalised in many cases in the form of organisations (Tonnies, 1988). While the former is understood by the *ethnological perspective*, which implies cultural understanding of living communities by careful observing the system and relationships existing in a community at a particular point in time, denoted by the label *Gemeinschaft, (*also referred to as the 'pre- industrial', 'pre – literate', traditional, organic communities); the latter represents a more diverse and heterogeneous entity, comprising different cultures, religious beliefs etc., and denoted by the label, *Gesselshcaft* which explains the social structure in industrial societies. However these concepts represent extremes and should be treated as 'ideal types' that serve the heuristic purpose of analysing and categorising real life situations as per a standard yardstick. Human associations are rooted in the basic gregarious instinct of men (Aristotle). Precisely, thus, community is based on *natural will*; society on *rational will* (*ibid)*

Marsh (2001) refutes geographical contiguity as an imperative condition for community. Another group of scholars allude to the '*feeling of community'*, which may develop spontaneously between people on the basis of sentiments or feelings, irrespective of distances. By this argument, community is more a diffused and a spontaneous development rather than a deliberate construct.

Proffering a more generic understanding, Marsh understands a community as *evolving*, both in the temporal (over time gradually) and spatial senses (expanse); hence as a *process* not a static condition.

2.1.2 The Concept of Social Capital

Social capital is an economic analogy for bonds of community cohesion, which can translate into tangible gains. "Social capital refers to the collective value of all social networks and the inclinations that arise from these networks to do things for each other; in other words, "norms of reciprocity"(Putnam, 2005). The central premise of social capital is that social networks have tangible value, which cannot be discounted in cost-benefit analyses or policy implementation and evaluation. Social Capital is seen to operate in a network fashion. It is articulate horizontally; inter institution/ally; between organisations of a similar nature, for example, *Panchayat* to *Panchayat*, and dissimilar nature, for example, private corporate body to a *Panchayat* or government office to a panchayat or private agency. It also operates vertically intra organisation and also connects institutions and people, imparting dynamism to administrative processes and life at large.

2.1.2.1 Implications of Social Capital

Research conducted in Manitoba following the Red River flooding in 1997 demonstrated the positive effect of social capital on the communities' ability to respond effectively to the catastrophe (Buckland and Rahman, 1999). Communities with a higher level of social, human and physical capital were found to react more effectively to the flooding.

Barton (1970) has pointed out that the extent of people's integration into the community affects the context, source and the number of warnings they will receive. The greater one's social contacts, the more one is likely to receive more information regarding a potential hazard. Study of evacuation behaviours over time gives the idea that community ties often replace kinship ties in cases of emergencies.

2.2 RATIONALE FOR PEOPLES' PARTICIPATION

According to Sahni and Dhameja (2003), community participation in disaster policy and implementation is desired for the following reasons:

- Projects are implemented at the local level; hence it is there that their efficacy can be judged;
- Paucity of resources can be compensated by active participation of people, since capital can be substituted by labour in many cases;
- Participation infuses self confidence and self- belief in people which leads to empowerment and belief in the democratic process in the long run;
- Local projects can be monitored for results by the beneficiaries;
- Regular exchange of views between the government agencies and local community organisations helps 'consistency' and 'relevance' of policy through regular review and the relevance of policies in changed circumstances/situations;
- Participation ensures rationality of polices in that they are more based in 'fact' than abstract judgements are real more than academic, based as they are on need articulation by local community representatives. It is also likely to be more inclusive in that marginalised and segregated sections are granted 'voice' for their specific requirements through the democratic process of interest articulation through self-governing institutions and local community based organisations, operating at the grass roots level; and

- Participation ensures that governance is more in consonance with the idea of grass roots democracy. There is a need to have "proper match between goals and methods of these agencies with the needs and capacities of beneficiaries" (Sahni, and Ariyabandu 2003). This is possible only through community participation.

To realise the possibility, four main actors are involved:

- Politicians in governments
- The news and information media
- Government administrators and professionals
- People in the community

Administrators are expected to articulate interest(s) on the part of the 'passive public' and elevate these to the level of administrative norms as policy inputs. In this case, the administrator is expected to exercise discretion in distinguishing private from public interest *in each case,* since public interests pressing for attention at each stage in the hierarchy may be diffused or possibly operating as subterfuges for private interest which might make identification/sieving of public interest difficult in the maze.

The vital function of political communication is performed by the elected representatives of the people and also the 'Fourth Estate' which is important in ensuring 'responsiveness' of administration and in raising the level of risk perception, in other words, awareness of risk among people and their elected representatives, and its prioritising among policy choices.

In order that community members articulate needs successfully, access to information is vital in understanding administrative processes. The public's right to information is a fundamental feature of democracy and an essential prerequisite for disaster preparedness. Once people have access to information as a right, not just from their country's government, local authorities, companies and interest groups, but also from international organisations they can act to reduce their vulnerability. As Boothroyd and Anderson
(1983) explain, those involved in social planning must continuously address the question: "planning for whom?" for if the differences within any given community are not addressed prior to a disaster, then typically, they hamper recovery efforts.

In the new emerging paradigm of public administration, the idea of responsible citizenship is being emphasised along with the requirement of responsive ness of administration.

Such association has practical value. The disadvantaged (the poor, the sick, the marginalised) need to be able to gain access to information and have a say in the mitigation strategies. For example, as Bolin (1993) points out, with regard to the earthquake in Whittier Narrows, a suburb of Los Angeles, the construction that followed, resulted in reduced low rent housing and increased rents in commercial buildings' firm to prepare a plan for the uptown area. The Whittier Narrows' Earthquake Relief Fund ($420,000), originally intended to provide relief to all victims, ended up going exclusively towards grants for small businesses that agreed to stay in the uptown area.

Participation also has subjective value in that a feeling of self-reliance is inculcated in subject communities. "Community participation stimulates and encourages people of *all social classes* to be aware of their expertise, power, usefulness, responsibilities and resources so as to ensure their spontaneous contribution." Participation of women and other backward sections of society promote solidarity in-group functioning *(Ibid).*

Participation also ensures cost effective implementation in that local transportation, storage and maintenance is much cheaper and also minimises loss which generally accrues in centralised control of implementation and monitoring functions. More choices are inherent in a pluralised set up than in a centralised, directive set up.

Such an arrangement is also in accord with public choice stipulates in that it provides people 'choice' between a 'mono-centric' order/arrangement wherein the government has monopoly over provision of goods and services as a monopoly and a 'polycentric' order where people can exercise choice between institutions for delivery of goods and services and also opt for self- help in many cases, which creates alternates for service provision between the continuum of state on the one hand and market on the other. Civil Society organisations function primarily between the continuums, encompassing though not excluding the state and the market. The chief activity areas in each of the phases are discussed below:

2.2.1 Community Based Risk Assessment (CBRA)

It has been realised through past experience that specialist vulnerability and risk assessments do not provide all needed information. It is necessary to supplement expert analysis, usually undertaken by economists and scientists, by a vulnerability and capacity Analysis (VCA) conducted at the community level, involving community members in analyses and articulation of their own problems. Vulnerabilities, that is, factors that create the proneness or predisposition or susceptibilities to risk in the community should be studied in relation (in opposition) to their capacities (resilience, strengths) to find clues to augment the capacities and offset the vulnerabilities of communities. Hence assessment is a participatory process undertaken in phases and involving on- the- spot collection of data, interpreting and analysing it for information from various sources. It involves analysis of both scientific and empirical data.

2.2.2 Considerations in Vulnerability and Capacity Analysis (VCA)

Cross-categorisation to identify vulnerable communities besides simple categorisation of at risk communities on the basis of gender, age, ethnicity, religion or caste has to be attempted. For example, women and children are vulnerable groups, cutting across caste and class categories in disaster situations. Hence disaster policy has to be sensitive to such differentiations especially in the matter of involving people in disaster policy**.**

2.2.3 Advantages of Community Based Risk Assessment

As Britton (1989) points out, there was " a rift between the public and the planners and the destruction of public confidence contributed significantly to the failure of the planners to bring about changes in land use that were desirable, following a cyclone in Darwin, Australia. By 1977, as reconstruction neared completion, land use change in Darwin had, if anything reinforced the pre-cyclone trends which the planners had tried to halt."

According to the International Federation of Red Cross and Red Crescent Societies (1995), all disaster research in the past decade has clearly indicated that community members in disaster-stricken areas already knew of both the risks and (for the most part) the remedies as in, "the gap has been in the political will to apply remedies prior to full scale disaster and to commit resources to this vital developmental need rather than, for example, to the building up of a sophisticated armory." In Vietnam, local institutions are beginning to implement the grassroots democracy program which calls for increased discussion of development priorities and budgets among local people, and for commune

authorities to exercise greater transparency and accountability in their interactions with local communities. Together with the *Commune*, (government agency) the people's committee has become increasingly active in formulating development plans for land use development, organising input supply, training commune extension workers, and planting bamboo and indigenous species, agro forestry development to alleviate poverty and achieve ecological objectives; such a strategy could reduce villagers' reliance on vulnerable, stony lands in the flood plain.

In this context, local or indigenous knowledge should not be lost sight of. Traditionally, Pacific Islanders have been known to build their houses from local, lightweight but strong materials that could absorb torrential rains, yield superficially to the high winds of typhoons and withstand the shaking of earthquakes. Local crop preservation techniques were also used as a hedge against possible drought or other conditions of food shortage.

In Gujarat, India, traditional housing structures, *Bhungas*, timber laced structures and adobe constructions are more resilient to earthquakes than modern structures. Strong social networks are a key strength, which assist people in disaster situations and provide social and psychological support. In Marathwada, good quality stone masonry structures are more resilient to shocks than modern structures.

According to Paul Mundy and J. Lin Compton (1991 quoted in Jigyasu, 2002) sources of indigenous information are: -

- Indigenous experts (such as farmer particularly skilled in certain activities)
- Indigenous professionals (such as healers and irrigation specialists)
- Innovators (people who experiment with and develop new techniques)
- Intermediaries (those who pass on messages, such as town criers and messengers) and
- Recipient disseminators (all others who receive information, modify it and pass it on.

Three essential shifts are advocated for reducing vulnerability in rural communities of India and Nepal, namely,

- Moving from external resources to development of local resources in land and land use practices, cultural heritage and skills and construction materials;
- Moving from only stressing social consequences of disaster towards ethical and overall developmental perspectives;
- Moving from command and control and relief model towards community determined development model facilitated by CBOs, NGOs, and local self-governance (Panchayat institutions).

Specifically for improving post- earthquake rehabilitation policies and practices, the following measures are recommended (Jigyasu, 2002).

- Formulating the policies by understanding the linkages to cultural and livelihood patterns;
- Recognising the linkages of rehabilitation strategies to long term development and sustainability;

- Perceiving disaster resistant technology within a wider social economic and cultural perspective;
- Emphasis on culturally rooted education;
- Ability to intervene in local power structure;
- Redefining the priorities from relief to rehabilitation; and
- Proposing alternative strategies for housing reconstruction through partnerships, between contractors, local artisans and house owners.

Stress should be on community capacity building through institutionalisation of social capital and sustained work on building committees and formulating plans (Sahni and Dhameja, 2003). It would be pertinent in this context to refer to an attempt at 'twinning communities' attempted under the aegis of the World Health Organisation.

2.2.4 Twinning of Communities

In this particular context the innovative idea of Twinning of Communities could be discussed.

Twinning (WHO, 1989) involves the conclusion of an agreement between communities, providing for various types of activity such as:

- Collaboration, joint initiatives and exchanges for preventive activities, organisation of a health information network, mapping resources, training of staff, education of the population; sanitation plans, strengthening or recuperation of the building stock, study seminars, volcanic, seismic or hydrological zoning, etc.;
- Determination and preparation of the resources to be sent in the event of a disaster: equipment and machines for clearing rubble, specialised personnel, health equipment and personnel, communications equipment and personnel;
- Provision for means of transport and temporary accommodation in the event of evacuation;
- Organisation of joint exercises.

Experience shows that even in the absence of specific disaster preparedness activities, the population and the staff of public services respond much better if the community develops activities and initiatives beforehand based on:

- Encounters, exchanges the expression of needs, information and communication;
- Community discussion and action to gain;
- An understanding of the causes of disasters and associated problems, plan the most appropriate measures and put them jointly into effect;
- A feeling of belonging to the community by making proper use of local cultural values, forms of social life, resources and products;
- Combating the rejection or exclusion of the disabled, the mentally ill, the handicapped and other persons in difficulty;
- The development of assistance and mutual aid; and
- Meetings with local authorities and collective discussions to resolve community problems.

2.3 ROLE OF CIVIL SOCIETY ORGANISATIONS

The outside facilitator or the catalyst in this case is often the non-government organisations. Not much can be gained by isolated efforts on the part of people and individual agencies unless some kind of synergy is built up between concerned agencies engaged in disaster management and the beneficiaries whose interests are directly at stake, that is, the people. The role of non-government organisations (NGOs) and community-based organisations (CBO) has been stressed by scholars. The specific areas of activity where their potential could be utilised are first aid, search and rescue operations which civil society organisations have been known to perform better than government agencies. On the other hand, the government has more resources, such as equipment, transport etc. required for these activities. There the possibility of coordinated action can be explored in that manpower resources, organisational arrangement and mobilisation skills of the NGOs can be combined with the resources and initiatives of the government to get desired results. As many government institutes and civil society organisations are involved, there is a threat of getting stuck-up with innumerable coordination meetings. There should be only a single coordination council at each level for all so as to avoid too many meetings and conflicting decisions at different forums in addition to saving manpower and time in attending meetings. Hence, they should all work through the NGO Disaster Coordination Council to be set up by the government (Sahni and Ariyabandhu, 2003).

Indian NGO *Discipleship Centre* presented its community-based, low cost flood preparedness and mitigation project operating in the Indian State of Bihar. The context of vulnerability to flooding in Bihar was explained in relation to the different components of the conceptual framework. The NGO then outlined examples of capacity-building interventions targeted at the different categories of vulnerability. These included physical measures such as the building of escape routes, raised hand pumps and the provision of boats, plus social measures such as the formation of women's self-help groups, village development committees and flood response teams. This was all explained within the context of the causes of people's vulnerability, with particular emphasis on the caste system.

The gravity of the problem of disasters is well appreciated in the context of impoverishment suffered by poor third world countries like Bangladesh. Though the government of Bangladesh along with the international agencies can be credited with significant and fairly successful development plans, it is the NGOs that are at the center stage. The performance of particularly one NGO as related by Rehman (2003) has been notable in pushing forward the agenda of 'disaster mitigation for development.' The Rangpur Dinajpur Rural Service (RDRS) has been operative since the war of liberation of 1972. The focus of RDRS activities has been on institutionalising the cooperative endeavor of people in the form of a 'Union Federation' at the grass roots level, which galvanises efforts of the local community based organisations by bringing them under an umbrella, networking knowledge and providing a platform for combined interest articulation. The RDRS follows a household primary group approach that moves up as a tier structure and culminates in an apex organisation, which is the Union Federation. The Union Federation looks after logistics to provide instant essential services during disasters. Since the rural poor are the stakeholders, the main aim of the initiative is empowerment of local communities by giving them 'voice' in matters concerning their day to day living and the problems they encounter within the context of disaster management. The scope of the organisation is wide ranging in that it is active both in pre-disaster mitigation planning, and

post- disaster rehabilitation stages. Its interventions range from maintaining stocks of relief supplies like food and medicines to providing credit to rehabilitate uprooted families, seeds and fertilizers at subsidised prices and organising awareness and training programmes in normal times to promote a prevention culture among the local populations RDRS is a well organised institution in that it maintains specialised units which deal with different subjects relating to environment and disaster preparedness. It has made significant moves such as promoting tree planting on a regular basis, promoting education to increase employment opportunities and increase livelihood options among vulnerable communities at the grass roots level.

Institutionalisation of cooperation, also understood as harnessing of positive social capital resource, is strongly endorsed by Uma Medury (2003) through appropriate structures at the local level through which people "can participate effectively in the decisions that affect their lives. She also calls for integration of rural development strategies that are presently fragmented across villages. There is need for integration, since there are ecological, ethnic and cultural differences between villages. Though it can be said that policy needs to be sensitive of such plurality, it cannot be handed down as an excuse for a dispersed/ scattered approach to policy planning that is largely infructous. She supports her argument by citing some case studies that have shown successful results applying the aforesaid approach. Such successful attempts call for the desired paradigm shift in public administration geared towards good governance.

Concerted effort on the part of people and the government has transformed the Jhabua village in Madhya Pradesh into a "sea of green." The people were involved at the initiative of the administration in management of land and water resources "on a big scale." The results borne out by case studies have been heartening.

1. The famous 'Chipko Andolan' raised awareness among people, especially women, regarding the significance of forest conservation. Various measures like planting of trees chosen by the village women to meet their local needs promotion of agro forestry etc have been taken up by the village women.

2. An environment friendly way of disposing waste was devised by the local residents through local organised communities, like welfare residents associations, civic forums, women clubs etc under the aegis of the Centre for Environment Educations (CEE). Organic methods were used to decompose and recycle waste.

3. The North- East serves a good example of collective endeavor in many aspects of governance, not just environment management. Traditional dug-cum-embankments were an excellent eater harvesting technique collectively set and used by the members of the community.

4. A fodder security system was set up at the initiative of SEWA (Self Employed Women's Association), the National Diary Development (NDDB) and the Disaster Mitigation Institute. The scheme used the infrastructure of local cooperatives that bought fodder at fewer prices and stored it up for dry season, in Banaskantha in Gujarat to meet the threat of droughts. The village community and the Panchayats were convinced of acquiring wastelands (these are common property that are individually used but managed by the village community) for fodder storage. Fodder was developed collectively and distributed among village members, which prevented livestock loss during droughts.

There is strong case therefore for local management of resources such as has been attempted in Andhra Pradesh where local resources were pooled to form a disaster relief fund *(ibid.).*

2.4 IMPACT OF GLOBALISATION

Globalisation has considerably widened the scope of social capital with respect to policy. Growing synergy between global and national institutions unearth the large untapped social capital which can be fruitfully engaged in the service of nations and communities.

The role of communities in disaster management is strongly supported by the United Nations International Strategy for Disaster Reduction (ISDR) whose vision is to enable all communities to become resilient to the effects of natural technological and environmental hazards. This shift from a top- down relief and response approach to a more inter- sector risk management approach has begun to influence the way disaster management programmes are now being planned and implemented. Many high-level policy makers from the government sector and international agencies are recognising the importance of community based disaster management (CBDM).

The British Government's Department for International Development (DFID) developed a livelihood framework, which views people as operating in the context of vulnerability. The Disaster Preparedness –European Community Humanitarian Office (DIPECHO) developed an action plan for South East Asia in 1999, which identified the need to provide an institutional arrangement in targeted countries for training of national, provincial, local governmental and non- government institutions to enable them to incorporate community based disaster risk management in their programmes. ADPC with support from DIPECHO aims to meet this need in South East Asia (Mursheid, 2003). The following examples endorse the point.

In response to the 1999 Super Cyclone in Orissa, UNDP along with other UN organisations on the ground provided a coordination support mechanism to rebuild lives and livelihoods in Orissa. Community preparedness plans were formulated. A people-centered approach to disaster management, combined with the enhancement of local capacities, has been the key factor in ensuring the achievement of long-term disaster prevention and mitigation objectives.

The most important components of disaster mitigation interventions in the Orissa state have been:

- Piloting community-based disaster preparedness programmes
- Promoting alternative technology in housing for hazard mitigation
- Demonstrating the use of Information and Communication Technologies (ICTs) in disaster preparedness and response
- Strengthening multi-disease surveillance systems
- Drought–mitigation through decentralised planning in drought proofing
- Sustainable livelihood recovery in flood –affected areas
- Promoting volunteerism for disaster preparedness.

In case of Gujarat, in order to ensure vulnerability reduction, the UN system had established an integrated strategy to respond to the post-earthquake scenario. The UNDP focused on reduction of social vulnerability, particularly with respect to women, children, aged, disabled and other disadvantaged groups. UNDP's long- term strategy for transition recovery was intended to:

- Build capacity of local communities for the recovery process by working through government and civil society structures and the mechanisms that are already in place;
- Bridge the gap between the disaster relief operations and the start of rehabilitation activities;
- Building multi-hazard resistant social and economic infrastructure, especially shelters thereby increasing livelihood security and sustainability, particularly in rural areas;
- Co-ordinate with donors, NGO networks, the government of India and the government of Gujarat to facilitate the preparation of community-based risk management and disaster preparedness plans. Community members working together can minimise the impact of disasters. A village disaster preparedness team can respond immediately when a disaster strikes the area, to help affected people so as to reduce injury, death and damage. This team may consist of different people, including members from the Panchayat, Gram Sabha, Health Workers, Mahila Mandal, etc. The members of the village disaster preparedness team can help to reduce the impact of the disaster through warnings of impending disaster resulting in evacuation; special assistance to pregnant women, children, old and sick people, rescue, first aid and transportation of the injured; food relief and distribution; monitoring of the situation.

2.5 ACTIVITIES AND ROLES FOR THE COMMUNITY

All communities have some vitally important assets when it comes to coping with disasters; be it the traditional capability for understanding the disasters, knowledge of local and safe vulnerable areas, experience of survival, etc. should all be organised and accepted to the maximum extent.

As per Sampath (1991), drought and conflicts in many developing countries have forced many people in the rural areas to move to cities for personal and employment security. The precarious living conditions there cause several problems:

- Poor building conditions (plastic sheeting, wood, cardboard, and hardboard) catch fire quickly;
- No phones are available to call the fire department;
- Firefighting squads get lost on the way to the fire, because streets and addresses are not on township plans;
- During floods, muddy waters gush through the flimsy structures carrying away household belongings and damaging the remaining ones;
- Health, education and other services are rarely available, creating further problems for the already disadvantaged communities.

Several organisations can start community and household gardens for food security and enough can be produced for home consumption and sales. Development committees may

be set up to discuss community needs and aspirations. The key to success is community participation and initiative in identifying its own vulnerabilities to floods and other extreme events.

2.6 RISK REDUCTION THROUGH COMMUNITY ACTION

Community participation could be in the following ways:

a) ***Community based early warning system***

The generation, interpretation, translation and communication of flood warning information requires an in-depth assessment of community perception and the role of local institutions. In developing countries, technical equipment and technical know- how for institution of warning facilities and dissemination of information may be lacking. Indigenous methods like beating of drums, running door to door, announcing the warning, or from vantage points can help disseminate warning though not over long distances. Residents may introduce early warning systems such as warning bells, door-to-door warnings, and repeated radio alerts. People in some regions are now learning first aid techniques and forming response groups. They can also identify a 'safe house' where victims can be sheltered in case of emergencies, before alternative arrangements are made. Community initiative and support can make such countries self-reliant in disaster situations. However technical support and community support are both required in equal measure. Mobilisation of community effort is significant, which should be planned and provided for, before hand, as part of local community disaster preparedness plan.

b) ***Community-based disaster risk reduction***

In the words of Zubair Ahmad (2003), the prime objective of the application of participatory risk assessment (PRA) tools in community risk assessment is not data collection, but empowerment of people. "Once people learn to analyse the situation, and identify the causes of their problems, they could also find solutions."

Capacity building of communities through catalytic government intervention could contribute significantly to disaster risk reduction. Specific areas for capacity building are outlined as follows by Zubair Ahmad (2003):

- Training of local masons, in disaster resistant construction in flood and earthquake prone areas could go a long way in minimising the threat to human life and property in the event of a disaster.

- Similarly, imparting awareness and training to farmers in water harvesting techniques in drought prone areas and water purification techniques in flood prone areas (specific application, also generally in case of other disasters such as chemical spills, drought resistant crops etc. can bring about a sea change in disaster management in the countryside. Commendable work is being done in Sri Lanka, and Thardeep Pakistan under the Thardeep Rural Development Programme (TRDP).

- Alternate livelihood options as per the vulnerability and capacity analysis should be attempted. One of such attempt is the crop diversification scheme in which the farmer is encouraged to plant drought resistant varieties along with the main crop to sustain loss in case of a drought. Such work has been successfully implemented in the Philippines and Vietnam.

- Pest resistant seed varieties are being replaced by hybrid varieties in the market. It is important to establish seed banks and nurseries to strengthen peoples' capacities as against vulnerabilities during droughts. Nurseries propagate different varieties of trees such as utility trees, bamboos, forest trees and other plants, which provide viable options during droughts. Appropriate storage facilities should be provided to prevent loss of income during lean seasons. Awareness should be created about environmental protection measures such as reforestation, rehabilitation of watersheds, and replenishments of first reserves. They should be made aware of destructive impact of slash and burn agriculture. They need to be trained in environment friendly technology to reduce risks from environmental hazards.

- Community based organisations have a crucial role to play in rescue and rehabilitation efforts. Local rescue teams should be organised and trained, in rescue activities and use of relief equipment like life jackets, megaphones, first aid kits and rescue boats etc.

- Relief goods warehouse and local functionaries better maintain emergency shelters at the local level.

- Some officials and staff of mass organisations recommend that decision-making about the use of reserve funds and rice stocks in case of emergencies should be decentralised, probably to the commune and in some cases possibly to the district level. Sanctions from Central Ministries and the PMO take time, which cannot be afforded in emergencies.

c) ***Public Awareness Programmes***

As with training, responsibility for public awareness programs needs to be clearly stated. The authorities, which also cover training, should be given the responsibility for public awareness. The main aspects of public awareness programmes have to be clearly identified, which includes the content of information to be conveyed, the format of the communication and the medium to convey that information. Apart from these, other aspects that need to be focused on are community experience of disaster and expectancy and dependency factors that have made people dependant on the government for assistance. The three main aspects are discussed below:

- Information to be communicated to the public includes community relevant details of the national disaster management plan, any information that gives more details about the foregoing basic community needs, post disaster response effort of the government, etc.

- The format for the dissemination of information refers to channels like notices, posters, cartoons, photographs, films, film clips, videos, talks or presentations, short radio or television features and others.

- The medium to convey the desired information refers to telephone directories, shopping bags, government programs, utilisation of popular sporting events to display posters or banners, community gathering, amongst many others.

The awareness program should be effective in the sense of gaining and maintaining the interest of the people who are being informed. It should be checked regularly that the people are receiving the information imparted in the intended sense. Also, the content of the information should be constantly monitored. In marginalised communities, with high

concentrations of the poor, the capacity of the administration to intervene with mitigation efforts is undermined if the community does not appreciate the linkages of these interventions with vulnerability reduction. Administrative intervention alone may not be adequate without effective peoples' participation.

For pursuing a policy for risk reduction, community authorities have three broad areas for participation. *First*, by setting laws, regulations, incentives and penalties they provide guidelines or 'constraints' for choices made by citizens. *Second*, they make decisions concerning the use of resources and response to hazards, including the deployment of large-scale, expensive technology, such as dams, etc. And *third*, they dispense hazard adjustment services.

2.6.1 Co-operation between Communities and Government Agencies

During and after a disaster, proper understanding and co-operation between the communities and government agencies can help in preventing and mitigating the impacts of a disaster. In conjunction with the foregoing community crisis needs, there are several factors which affect good understanding and co-operation between governments and communities. In addition to knowing what government has planned to do to assist the community in times of disaster, the community should also have, at least, a broad understanding of the scope and limitations of government responsibility. This applies to all disaster-related matters, including prevention, mitigation and national development. The community needs to understand and be able to implement certain measures of self-preparedness when required to do so. Similarly, it is important for the community to understand the government's problems in providing post-impact relief, especially the difficulties in accurately establishing immediate needs. It is usually in the community's own interests to co-operate, to the maximum extent possible, with the government in disaster management programs.

For its part, the government needs to understand and take into account the fact that, under disaster conditions, the public is usually affected by shock, loss and other trauma, and needs treatment accordingly. The government and the community must act together to overcome the crises, which arise from disaster, and to ensure a rapid return to normal conditions.

2.7 PARTICIPATORY RISK ASSESSMENT METHODS

The concept of good governance demands that government must not only be representative but also responsive in that people should have a substantive role to participate in decision-making and implementation. Cohen and Uphoff (1980) regarded participation as "generally devoting the involvement of a significant number of persons in situations or actions which enhance their well being". Paul (1987) defined participation as, "in the context of development, community participation refers to an active process whereby beneficiaries influence the direction and execution of development projects rather than merely receive a share of project benefits". Disaster risk reduction through participation addresses four important questions:

1) Who is participating?
2) How is participation assured?
3) At which stage is participation occurring? and
4) How is participation facilitated?

Some widely used methods of participation, which could be made ample use of for participatory risk assessment, include:

A) **Workshop-Based Methods**

The workshops of stakeholders are organised for collaborative risk assessment. Termed, 'action-planning workshops', these are used to bring stakeholders together to assess risk in concerned locations in the light of the disaster profile of the area. The purpose behind such endeavours is to begin and sustain stakeholders' collaboration and foster a 'learning by doing' atmosphere, which in longer term is supposed to enable communities and groups to be conversant with the amount of risk for themselves on their own. In such workshops, a trained facilitator, who has diverse knowledge and expertise, guides stakeholders namely government organisations, NGOs, CBOs, local governments, communities, and citizens, through a series of activities to build consensus in identification of elements at risk and also the most vulnerable area, infrastructures and populace ("Development Planning and Administration", 2003). Some common types techniques and methods, which could be of greater relevance towards participatory risk assessment include:

a) *Appreciation-Influence Control (AIC)*, which is, a workshop based technique encouraging the stakeholders to consider the social, political, economic and cultural factors along with technical and economic aspects that influence a given area. AIC helps the participants in identifying a common purpose and pursuing that purpose collaboratively, which in this case is risk assessment. It also encourages the stakeholders to realise the relevance of the purpose and creates an enabling forum in that activities in these workshops focus on building appreciation through listening, influence through dialogue and control through action.

b) *Objectives-Oriented Project Planning (OOPP)* is a project planning and management method that encourages participatory planning and analysis with a series of stakeholder workshops for assessing risks. In this technique, stakeholders could come together in a series of workshops to set priorities and plan for risk assessment, implementation and monitoring. The main output of ZOPP workshops is a risk assessment-planning matrix built by stakeholders, on the basis of consensus, to provide in-depth analysis of objectives, outputs, and activities. While preparing the matrix attention is required to be on five important issues, namely participation analysis, problems, objectives, alternatives, and assumptions.

c) *Community Based Methods* (*CBM*) is an approach whereby the government departments undertake participatory risk assessment work with local communities. Two such techniques are (1) PRA, and (2) SARAR:

Participatory Rural Appraisal (PRA)

Most widely used approach, Participatory Rural Appraisal (PRA), has captured the imagination of all development planners and thus could be of much relevance in risk assessment. Many believe that PRA has evolved out of Rapid Rural Appraisal (RRA). It goes without saying that good PRA activities empower; are different each time; improvise and innovate; thus enhancing awareness in rural folk about their surroundings. However, there are examples, where a lot of activities labeled as PRA are routinised and wooden, and at worst exploit and disillusion poor people who participated. PRA is a label given to a growing family of participatory approaches and methods that emphasise local knowledge and enable local people to do their own appraisal, analysis, and planning.

There are three terms, which we should be acquainted with, especially for participatory risk assessment purpose ("Development Planning and Administration", 2003):

i. *RRA:* RRA originally stood for Rapid Rural Appraisal, but its approach and methods are also used in urban and other contexts. RRA is a data collecting approach, with the analysis done mainly by experts. There are some methods, which are typically RRA methods, like observation, semi-structured interviews, transects etc. Whereas participatory mapping, diagramming, using the ground in various ways, making comparisons etc., often in small groups are typically PRA/PLA methods.

ii. *PRA:* PRA originally stood for Participatory Rural Appraisal, but its applications are in many other contexts besides rural and good practice is far more than just appraisal. It enables others to do their own appraisal, analysis, planning and action, to own the outcome and to share the knowledge. The target group could be local; rural or urban concerning people, women, men or old, or members of an organisation or group. Three common elements found, all over world, in a PRA approach, are:

> *Self-Aware Responsibility:* individual responsibility and judgement exercised by facilitators, with self-critical awareness, embracing error.
>
> *Equity and empowerment:* a commitment to equity, empowering those who are marginalised, excluded, and deprived, often specially women.
>
> *Diversity:* recognition and celebration of diversity.

As PRA is about innovation, other features too can be added to the list. Inventiveness and improvisation, which are a part of PRA, are helping people in different parts of the world in developing their own varieties of approach and method. In the past decade, PRA has expanded and spread: from appraisal and analysis to planning, action and monitoring and evaluation; from rural to urban; from field applications to applications in organisations; from a few sectors and domains to many; from NGOs to government departments and universities; from a few countries to many; from methods to professional and institutional change; from behaviour and attitudes to personal change; from action to policy influence; and from practice to theory; etc., and could be of substantive use in assessing risks. PRA entails shifts of emphasis from: dominating to empowering; closed to open; individual to group; verbal to visual; and measuring to comparing, ranking and scoring.

iii. *PLA:* PLA stands for Participatory Learning and Action. As a term, it is often used interchangeably with PRA. As per Linda, PLA combines:

- A set of diagramming and visual techniques originally developed for livelihoods analysis and now widely used in Natural Resources departments in development agencies. They have since been adapted for use in other sectors including enterprise development; and,
- Underlying principles of grassroots participation from human rights activism, which involve rethinking power relations and partnerships between development agencies, experts and poor people. These are now being developed further to facilitate negotiations between different stakeholders in projects and policy dialogue.

The underlying principles of PLA, listed by Linda include: "embracing complexity; recognition of multiple realities; prioritising the realities of the poor and disadvantaged; grassroots empowerment; from assessment to sustainable learning; and relating learning to action".

Self-esteem, Associative, Strengths, Resourcefulness, Action Planning, and Responsibility (SARAR):

This participatory approach is geared specifically to the training of local trainers/ facilitators. It builds on local knowledge and strengthens local capacity to assess, prioritise, plan, create, organise, and evaluate. It promotes fives attributes, namely, self-esteem, associative strengths, resourcefulness, action planning, and responsibility. SARAR's purpose is to:

i. Provide a multi-sector, multilevel approach to team building through training;

ii. Encourage participants to learn from local experience rather than from external experts; and,

iii. Empower people at the community and agency levels to initiate action. A commendable aspect of community-based methods is that they enable participation regardless of the literacy level. This approach is based on interactive and often visual tools. As the emphasis in the process is on drawing upon everyday experiences, it demystifies research and planning processes and instills a sense of empowerment in participants making them feel their contributions are valued ("Development Planning and Administration", 2003).

B) **Methods for Social Analysis**

Social Analysis could assume importance in risk assessment in the light of the fact that social factors and social impacts, including gender issues, need to be a central part/ concern of/in all risk assessments. The methods for Social Analysis incorporate participation and social analysis into the risk identification process. Two widely used Social Analysis Methods for this purpose are:

i. *Social Assessment (SA)*

SA attempts at systematic investigation of the social processes and factors that affect risk impacts and results. The objectives of SA are to:

a. Identify key stakeholders and establish the appropriate framework for their participation;

b. Assess social impacts and risks; and

c. Minimise or mitigate adverse impacts.

ii. *Gender Analysis (GA)*

GA focuses on documenting and analysing the differences in gender roles, activities, needs, and opportunities in a given context by disaggregating quantitative data by gender. It has been established through GA that women are neither a homogenous group nor are gender attributes immutable in that different roles and learned behaviour of men and women based on gender attributes vary across culture, class, ethnicity, income, education and time.

There is much likelihood of Social Analysis methods to initiate process for building information into risk assessment plans and for such plans to be translated into action. Systematic analysis identifies the communities' need perception and steps up ways to communicate this back to implementing agencies. Flexibility in these methods helps design to be consistent with major goals.

iii. *Social Invention*

Social Analysis facilitates 'Social Learning' that stakeholders generate and internalise during the participatory planning and/or implementation of an activity. 'Social Invention' follows Social Learning. In this approach, the stakeholders invent certain new practices

and institutional arrangements, which they are willing to adopt. In the process they individually and collectively, develop insight and understanding of the new behaviours required to attain the objectives they set. Advantages of this approach are that it reduces the need for the transfer of expert learning from one group of stakeholders to another. Also, quite often-local people create most important parts of risk assessment exercise ("Development Planning and Administration", 2003).

2.7.1 Organisational Implications of Participatory Approaches

Disaster management is a holistic exercise. It is built on experiences carried out in related fields for learning and making use of the same in appropriate circumstances in management of disasters. The participatory approaches, which could and rather should be used for risk assessment, lay emphasis on the facilitating organisations or agencies to have flexibility and innovativeness According to Paul (1987), the World Bank has made specific guidelines to direct concerned organisations staff to inculcate the spirit of participation within while working in the field for ensuring fruitful participation. Some organisational implications of the approaches are given in the following table:

Organisational Implications of Participatory Approaches

Core Principles of Participatory Approaches	Organisational Implications
A systemic learning process	• Value the learning process by creating time, and equipping staff with skills,to reflect on each new experience. • Develop system for efficient and effective sharing between staff members. • Allow staff Members to make mistakes without punishment. • Encourage Learning at different levels in the organisation through monitoring learning experiences and changes in attitude and wrong practice.
Seeking diverse perspectives	• Equip staff with skills to value sees and analyse different social groups/individuals • Accept only fieldworks/plans that have sought and incorporated diverse perspectives
Content specific	• Allow enough time to refine the basic framework of any policy or procedure to each geographical area/level at which staff operate. • Ensure that staff incentives recognize heterogeneity between field sites. • Reward staff for sit
Group inquiry process	• Equip staff with skills to facilitate group discussions and encourage analysis, including conflict resolution skills • Equip staff with skills to recognize local power relations and How these influence group-based discussions.
Facilitating external agents with key responsibility resting with local people	• Equip staff with awareness and skills to take a listening and Encouraging role rather than an implementi ng role
Leading to sustained learning and action	• Ensure that staff emphasise the motivation of local people and others to act independently of external support agency. • Field staff to focus on building local planning capacity that can operates independently of external support

In a document; "Initiating a Vulnerability and Capacity Assessment" the following strengths and shortcomings of participatory approaches have been identified

Strengths	Shortcomings
1) Provides a more reliable and qualitative understanding of various group activities and capabilities.	1) Will not provide data available from national level information and sources, which are often desired by the community.
2) Creates a strong community ownership in the assessment process.	2) Participatory approach requires greater sensitivity, time and resources to conduct.
3) Builds a stronger foundation for Creating sustainable programme with local communities.	3) Many lead to unrealistic expectations of assistance offered in future development programmes.
4) Effective in developing both a long-and short-term approach to risk and hazard mitigation and response.	4) Process too complicated if the objective of VCA is to develop a 'baseline' to assume future programmes.

2.8 CONCLUSION

As per the new paradigm of public administration, civil society is expected to be actively involved in the management of public systems. Civil society is understood as groups and institutions occupying the intervening space between the state and the market (including institutions in the state and the market). It is both inchoate and specific in that identifiable and amorphous groups and unorganised bodies of people working individually and/or in-group both constitute civil society. Community is a spontaneous, gregarious association of people. It has a significant role in governance with regard to articulating policy inputs as also implementation of measures. In keeping with the changing paradigm of public administration, it is only desirable that civil society groups play an important role in disaster prevention and mitigation functions. Active participation of people in response activities has been significant. The challenge for governance is to harness this social capital inherent in societies in constructive ways. Concerning the relationship between disaster management planning and community planning, we need to consider two phenomena: (1) those planning activities that occur before the disaster and (2) those that occur during or after the disaster. In both the phases, discussions should include the local disaster managers as well as community planners. New facilities should not be built without considering both existing and potential hazards and risks. This is especially important with regard to schools, hospitals and other critical facilities. Community planners should be directly involved in discussions as well as decision-making.

2.9 KEY CONCEPTS

Civil Society **:** Individuals and groups operating between the state and the market, including institutions in the state and the market. The term is increasingly being employed in academic literature, as vast potential can be

unearthed through civil society partnership with the government along with the private corporate. This also denotes the shift in thinking which is also being referred to as paradigm shift in public administration systems and governance round the world, with the state assuming the role of the 'facilitator' and the 'catalyst' rather than the traditional directive role it played under the traditional mono- centric dispensation.

Community : Spontaneous associations of people, cutting across geographical boundaries. Ties of language, religion, and ethnicity apart from geography are chief determinants of community.

Participation : Participation is understood in terms of the official strategies of peoples' participation in decision-making, implying involvement of people in interest articulation and aggregation stages in public policy formation and later at the policy implementation stage for the sake of more 'real' policies in the first place and, speedy and more effective implementation subsequently.

Social Capital : Social capital is an economic analogy for social ties. Just as there is physical capital and human capital, there is the intangible social capital inhering in social ties, which have vast economic potential. Ways have to be found to convert this intangible potential to tangible resource. Group culture or 'social capital' may be negative or positive in nature. The negative has to be deemphasised in furtherance of the positive.

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2.11 ACTIVITIES

e) Examine the concepts of community and social capital in the context of participatory risk assessment.

f) Analyse the significance of community based risk assessment.

g) Do you feel risk can be reduced through community action? Discuss with illustration form your local conditions and the role of community you have discerned.