UNIT 1 HAZARD, RISK AND VULNERABILITY

Structure

1.0 LEARNING OUTCOME

After studying this Unit, you should be able to:

- Acquire conceptual understanding of relevant disaster terminology;
- Discuss vulnerability factors in brief; and
- Understand vulnerability and risk assessment.

1.1 INTRODUCTION

The understanding of disasters has progressed from a purely techno- centric perspective to a social and ecological perspective to unraveling the phenomena associated with disasters. Through most of the twentieth century, the theory and practice of disaster management had been dominated by the scientific perspective, whereby, disasters were thought of purely as a geological or a climactic problem, the solutions for which lay in engineering and management sciences. In the last two decades, there has been a paradigmatic shift in the understanding of disasters in that the human factor, which had been neglected in the earlier approach, is now in focus. The attempt consequently is to inquire into sociological processes that determine or undermine a community's resilience, coping capacity and response to disasters. Understanding of disasters hitherto had been limited to natural hazards. Presently, the term disaster is a more inclusive concept, in that it includes man- made, and technological hazards, as also terrorism, which has added a new dimension to its understanding.

There are two important perceptions on disasters. According to one school of thought, disasters are natural, vengeful acts of nature: an opportunity for man to atone for his sons, wherein death and destruction are inevitable. As per the other perspective, disasters are man-made. An event whether a product of natural phenomena or human activities, turns out to be a catastrophic disaster, if the community or society fails to adequately cope up with it. By systemic understanding, hazard simply acts as a 'catalyst' in that it brings forth underlying tensions that are always present as potential pressure (Watts, 1983).

By the ecological perspective, "disasters are totalizing events in which all dimensions of a social structural formation, involving organised human action in the environmental context in which it takes place is studied. The ecological concept of disaster as a total event involving interaction between environment and nature follows the social perspective on disaster by which hazards are understood to arise when there is lack of mutual relation between the environment and man" (Hoffman and Oliver Smith, 1999). As a society interacts with the environment, with its values and perceptions and engages in a series of processes over which it has incomplete control and knowledge, for example, development and planning processes, production and distribution of goods, over long periods of time, underlying hazards turn to disasters (Oliver Smith, 1999).

1.2 THEORETICAL UNDERSTANDING OF RELEVANT CONCEPTS

For the sake of conceptual clarity, it is desirable to clear the semantic confusion between three interrelated terms, viz. hazard, risk, and vulnerability, which are used often in disaster literature. Such an exercise is necessary in view of the fact that a major part of disaster management theory and practice involves scientific precepts and analyses, which requires precision in terminology used. Project planners are required to present an inventory of risks from specific hazards, risks and vulnerability factors that require exactitude in definitions. Hence, hazard is defined as a potential or a latent/dormant cause, which is activated when the right configuration of factors; natural or man made or both, present themselves. For example, a chemical plant in a populated area is a potential threat to life and property within defined vicinity; hence a hazard. Disaster is the actual occurrence of the apprehended catastrophe. Hence, disaster is "any occurrence, that causes damage, ecological disruption, loss of human life, deterioration of health and health services, on a scale sufficient to warrant an extraordinary response from outside the affected community or area." *World Health Organisation (WHO)*

A *hazard* technically is not a disaster unless the 'trigger' (natural or man- made) sets it off. The trigger could possibly the be weak legislation that failed to regulate the functioning of the facility, as was the case in Bhopal gas tragedy. Hence a "disaster should be defined on the basis of its human consequences, not on the phenomenon (hazard) that caused it. That precisely brings out the difference between disasters and hazards. Earthquakes, floods and cyclones are 'natural hazards' which cause large-scale loss of life and property (disaster) when the trigger mechanism (natural or man made) is activated. Till then, they are simply events in nature. A hazard may or may not lead to an event, or the event in itself may or may not cause damage. Such probabilities are determined by the vulnerability of 'elements' at risk. Vulnerability is the extent to which an 'element' (animate/inanimate) is harmed in the event of a disaster; in other words, is susceptible to a given hazard. 'Elements' are identified as life and property likely to suffer damage in the event of a disaster. *Observation* and *perception* of risk involves ascertaining, specifically, such

'elements' at risk. *Identification* of risk involves inquiring into the specific natural, technological or chemical etc., processes that create the vulnerability of the elements identified for risk analysis". Vulnerability can be natural or man made. It can be physical, owing to factors such as weak buildings, habitation in hazard prone areas; or socio economic, arising due to poverty or marginalisation of the weaker sections of society who lack the wherewithal of defending themselves in the event of a disaster. Aforesaid concepts are discussed below in detail:

1.2.1 Hazards and Disasters

The International Secretariat for Disaster Reduction (ISDR) defines a hazard as "a *potentially* damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation." Hazards could be, *natural* (geological, hydro-meteorological and biological) or *induced by human processes* (environmental degradation and technological hazards). Hazards can be *single*, *sequential* or *combined* in their origin and effects. Accordingly, Hazard analysis entails the identification, study and monitoring of a hazard to determine its potential, origin and characteristics.

A fine line separates environmental hazards and environmental resources, as between *water out of control* (flood hazard) and *water under control* (reservoir resources). The atmosphere is considered 'benign' when it produces holiday sunshine but 'hostile' when it produces damaging '*loo*'. (Smith, 1996).

Classification of Hazards

Though hazards could be classified on many criteria; some of the general classifications are as follows: (S. Gopalakrishnan).

- *Sudden onset hazards:* geological and climatic hazards such as earthquakes, tsunamis, floods, tropical storms, volcanic eruptions, and landslides.
- *Slow onset hazards:* (environmental hazards) drought, famine, environmental degradation, desertification, deforestation, and pest infestation.
- *Industrial/Technological: s*ystem failures/accidents, spillages, explosions, and fires.
- *Wars and civil strife*: armed aggression, insurgency, terrorism, and other actions leading to displaced persons and refugees.
- *Epidemics:* water and/or food-born diseases, person-to-person diseases (contact and respiratory spread), vector-born diseases and complications from wounds.

Hazards could also be classified as *direct* and *indirect*. For example, earthquake hazard would lead to direct and indirect consequences, tabulated as under (*ibid):*

Direct Hazards:

- Ground shaking
- Differential ground settlement
- Soil liquefaction
- Immediate landslides or mud slides, ground lurching and avalanches

- Permanent ground displacement along faults
- Floods from tidal waves, sea surges & tsunamis

Indirect Hazards:

- Dam failures
- Pollution from damage to industrial plants
- Delayed landslides.

Site risks in an earthquake prone area, as explained by S. Gopalakrishnan, would be:

- *Slope Risks*: Slope instability, triggered by strong shaking may cause landslides. Rocks or boulders can roll considerable distances.
- *Natural Dams*: Landslides in irregular topographic areas may create natural dams, which may collapse when they are filled. This can lead to potentially catastrophic avalanches after strong seismic shaking.
- *Volcanic Activity*: Earthquakes may be associated with potential volcanic activity and may occasionally be considered as precursory phenomena. Ash falls and/or pyroclastic flows, volcanic lava or mudflows, and volcanic gases normally follow explosive eruptions

Besides, hazards can be of both *short-term and long-term* duration, as per the classification proposed by K. Smith (1996).

Classification of Disasters

Hazards and the disasters they cause are classified as "*rapid onset* or *cataclysmic*, and *long-term* or *continuing"*. In a cataclysmic disaster, one large-scale event causes most of the damage and destruction but soon dissipates. Recovery, in the sense of restoration of equilibrium conditions is relatively faster. In a long-term, continuing disaster, the situation following the event remains constant or may even deteriorate further. Examples of cataclysmic disasters are earthquakes, volcanic eruptions, cyclonic storms, and floods. Examples of continuing natural disasters are droughts, crop failures, environmental degradation such as deforestation and desertification, etc. The damaged area in a cataclysmic disaster is usually relatively small, while the area affected in a continuing disaster stretches over a wide expanse, spatially and temporally (long- term impact which affects the past, present and future of communities).

Disasters are also classified as *compound* and *complex*. A Compound disaster is explained as one crisis leading to other contingencies, such as famines followed by civil strife, mass displacement of people etc.

Complex disasters are those that lead to collapse of the political authority or lead to some other complexity where the problems involved/generated are intensely political in nature, such as communal bias in distribution of relief, relocation of communities, compensation disbursement, etc.

Identification of Hazards

Identification of hazards involves analyses of scientific data to trace the *causal path* of events leading to a disaster. For example, identification of chemicals causing water

pollution; their source, impact on specific 'elements' such as human health, etc.; inquiring into the nature and characteristics of a hazard with a view to distinguishing the man made and natural components thereof; for example, floods, which are caused by both natural and man made factors. Manmade factors include bad land use management policies such as allowing habitation and location of critical facilities in flood prone areas, which increase the vulnerability of 'exposed' populations, etc. It also entails policy analysis in that the *unintended* consequences of environment related legislation has to be examined with a view to framing more environment friendly legislation in the future. Hazard analysis is the basis of 'sustainable development' policies; for example desertification is a *slow-onset* disaster. *Desertification* arises as a result of interaction between a "difficult, unreliable and sensitive dry land environment" and the human use and occupation of it in an effort to make a living." Following a hazard analysis of the process of desertification effective strategies can be devised to address the problem.

Pollution of water, fire hazard and air arise due to high levels of carbon monoxide (CO) and sulphur dioxide (SO_2) in the atmosphere. Other man-made hazards include oil spills, pesticides, etc., which build up in the environment as a result of excessive/ repeated application of chemicals by agriculturalists, and flooding and erosions resulting from inappropriate land management practices. Flooding, for example, has been promoted by policies, which have allowed building and intensive land use on flood plains and flood-prone regions.

1.3 UNDERSTANDING RISK

Risk is a technical concept, which is used by engineering and management specialists to arrive at an estimation of losses in the event of a disaster and the expected probability of its occurrence. Risk is precisely defined by the ISDR as "the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions". *Conventionally, the notation expresses risk:*

Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.

Risk is different from *threat*. Threat is a more abstract concept while risk is an expression of perceived threat in specific terms. Threat is a danger that has an extremely low probability of occurrence. For purposes of public policy, threat has to be articulated objectively in terms of risks, the probability of their occurrence and the damages involved in each specific case. For example, apprehension of terrorism was a *threat* in America. No policy could be devised to meet the threat, since threat had not been articulated as risks for the sake of preventive policy. Vulnerability is understood as system faults or weaknesses, which threat *exploits* to create the negative 'impact' known as disaster. Risk management involves minimising the vulnerabilities so as to reduce the impact of the threat. *Risks are both inherent in social systems; are created, or exist due to inherent characteristics in the system. The ecological context is therefore significant in the understanding vulnerabilities of people in different cultures.*

Risk is sometimes taken to be synonymous with hazard, but risk has an additional implication of the probability of a particular hazard actually occurring. Risks are created due to excessive resource use that leads to serious degradation of the environment. Factors behind such intensified resource use are rapid population growth, market induced

demand, greed of the rich and resource exploitative public policies such as mining for which rocks are blasted and poisonous substances are released in the environment. Invariable consequences are the disruption of conditions conducive to biophysical processes that ultimately harm the stability and sustainability of mountain environments.

Presentation of Risk

Risk is a matter of precise quantification. Risk may be expressed in terms of average expected losses from a given hazard to a given element at risk, over a specified future time period, for example, as; "25000 lives lost over a 30 year period or as 75000 houses experiencing heavy damage or destruction within 25 years or alternatively, on a probabilistic basis, as a 75% probability of economic losses to property, exceeding 50 million dollars, in the town of Puerto Neuvo, within the next ten years".

The term *specific risk* is used to refer to risk or loss estimations of either type which are expressed as a proportion of the total; the first two examples might also be expressed as; 10% of the total population killed by natural hazards within 30 years or 50% of houses heavily damaged or destroyed in the next 25 years. Specific risk is also used for financial losses to property where is usually refers to the ratio if the cost of repair or reinstatement of the property to the total cost of replacement. Frequently, the shorter-term risk is used to refer to what are strictly 'specific risks.'

Specific risk gives the average rate of loss or attrition rate. While this is useful for estimating losses over a long period of time it can give a misleading idea of the nature of risk from natural hazards. Most of the losses actually occur through infrequent single large events, rather than in the form of a slow continuous process of destruction. (Coburn, Sspence, Pomonis, Disaster Management Training Programme, 1994)

Precise quantification of risk, however, is difficult. At best, a gross estimation of risk is possible, taking, for example, number of deaths and the number of people exposed to a hazard. Such crude estimates give only a limited idea of the likely damage from a hazard for different peoples at different places or even the probability of its occurrence. For example;

> *"… the probability of being killed in an earthquake in Iran during any one year is obtained from the total number of killed by earthquakes in Iran this century (120,000) divided by 90 years. This gives an average of 1, 300 people killed annually. The population of Iran, currently (55 million) averaged over the past ninety years is less than 30 million, so the average probability of being killed in an earthquake is given as one in 23,000.6…"*
>
> *(Source: Disaster Management Training Programme, 1994)*

The assumption seems to be that everybody in Iran is equally at risk, which may not be true. Vulnerabilities of communities and regions within Iran will vary with differential physical (poor quality housing, etc.) socio economic vulnerability. Vulnerability Analysis entails assessing the loss of life and property from a *particular hazard* striking at a particular *intensity.* For example, *x* number of people are expected to be killed and property worth *y* destroyed if a cyclone strikes with strong winds at 130km/hr.

1.3.1 Risk Assessment and Evaluation

Risk Management has two components (a) Risk Assessment (b) Risk Evaluation.

Risk Assessment is understood as "the methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend." "*The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios…."(I.S.D.R.)*

Risk evaluation entails assessment of proposed risk reduction measures from the point of view of cost efficiency. Efficiency is examined by means of cost-benefit comparisons, which imply assessing benefits procured or expected to be procured from a measure against costs likely to be incurred.

Assessment has significant administrative implications in that precise understanding of the underlying process of a hazard enables formulation of targeted risk reduction policies. Precise quantification of risk is often difficult in the absence of adequate data and proper analyses techniques. Moreover, certain areas are multi-hazard prone, which poses challenge for risk assessment. Risk reduction policy for such areas requires risk assessments regarding each type of hazard to arrive at an estimation of losses involved. Besides, risks are not amenable to simple quantification in that intangible factors are involved that cannot be easily identified and quantified.

Disaster risk is seen as a function of the *hazard, exposure* and *vulnerability, denoted by the mathematical function:*

Disaster Risk = function (hazard, exposure, vulnerability where "exposure" refers to the element which is affected by natural disasters, *people* and/or *property.* To reduce disaster risk, it is important to bring down the level of vulnerability and to contain 'exposure' by relocating populations and property away from the hazardous zones (*Wisconsin Disaster management Center).*

Risk Perception

Risk perception is understood as the 'awareness' of risk, which differs in different cultures/societies. Poor countries, with other more pressing problems, do not attach much priority to disaster mitigation. General level of awareness among people regarding the significance of disaster mitigation and preparedness is also quite low. Consequently, there is less interest articulation for policy in this area. On the other hand, risk perception is found to be quite high in the developed world where much effort has been put into disaster mitigation efforts, though vulnerability is low as compared to developing countries. The role of the media is significant in creating 'awareness 'regarding disaster management among people, particularly those 'at risk.' Risk perception depends on certain *subjective* and *objective* factors. Risk Perception depends on four specific factors:

Exposure: actual quantitative risk level, as articulated through risk assessments

Familiarity: personal experience, which makes one alive to the dangers of disasters

Dread: horror of the disasters' scale and consequences, which makes policy imminent

Preventability: belief in prevention methods, which leads to disaster mitigation policies. (*DMTP, 1994)*

Risk Identification

In a general way, political representatives informally undertake/attempt risk assessments by way of informed/subjective judgements as part of daily governance to justify legislations in foreign policy, the judicial reform, law enforcement, etc. Risk assessments are now being conducted in more sophisticated ways, particularly in the field of environmental legislation.

Risk has to be 'empirically' ascertained, for which subjective biases arising due to cultural or ideological inclinations need to be kept out of policy judgements. The best example of risk assessment comes from the insurance industry where "insurers have well-defined roles of actuary, underwriter, agent, auditor and adjustor." Each of these is an assessor in somewhat different circumstances or stages of the insuring, reinsuring, adjustment, recovery and claims payment processes. Hence, risk assessment is a continuous process of 'articulation', which needs to be undertaken periodically at every stage/, phases in said activity/process. Objectivity of the risk assessment depends on the availability of adequate and timely data. Lack of the same has inhibited risk assessments.

Risks are divided into 'systematic' and 'cumulative' (K. Smith, 1996). In a 'systematic' risk, the cause and effect phenomenon underlying a disaster is 'immediate' and 'direct' on the global system and results from production related policies, for example, global warming due to emission of green house gases. In cumulative risks, the relation is indirect, entailing long-term consequences; and resulting due to policies in disregard of environment protection lead to *accumulation* and *compounding* of risks over time, for example, groundwater depletion, soil depletion, deforestation, etc. The effect of bad policy affects the global system, which suggests that commitment to sustainable development has to be equal in the developing and the developed world.

A technical evaluation process is usually undertaken, commonly called *hazard assessment, vulnerability analysis,* and *risk analysis* for risk articulation. These are structured analytical procedures for identifying hazards and estimating the probability of their occurrence and anticipating consequences. These estimations are compared in relation to a standard criterion in order to decide whether or not an action is desirable to reduce the probability of damage or to protect the people, property, or environment. Realistically, it is necessary also to consider to what extent perceived constraints of time and resources might slow down the application of desirable countermeasures.

In the case of extreme events and very high level of damage, such as dam break or nuclear power plant accident, the risk is ascertained/ estimated by the number of persons affected (victims, injured, etc.) and / or the damage in monetary terms that can be expected on an average per year. Risk is also linked to fragility. Fragility denotes the stage of deterioration to a point where damage will occur. Fragility reflects the properties of human-ecosystem interactions. It may be defined as " the sensitivity of a particular ecosystem to human induced perturbations and its resilience to such perturbations."

1.4 UNDERSTANDING VULNERABILITY

Vulnerability gives the *extent to which* a community is affected by a disaster. It involves the measure of 'resilience' and 'coping capacity' of a community in the face of disasters. Vulnerability is an 'inclusive' concept in that vulnerability of a particular community to a particular type of disaster (flood or earthquake) is a resultant of a number of factors; including *physical factors,* (geographical perspective) *social* (sociological perspective) and

economic factors (income and employment, involving micro and macro economic policy), besides *institutional or administrative*, which are essentially governance related issues. The process of vulnerability has been evidenced as proceeding along phases such as; *root causes*, *dynamic pressures* that translate these into *active problems*, which are a result of a priori decision-making in governance related matters over time, for example, drought in a dry land area, leading to a famine in the absence of disaster mitigation efforts.

Social scientists and climate scientists often mean different things when they use the term "vulnerability". Social scientists tend to view vulnerability as representing the set of socio-economic factors that determine people's ability to cope with stress or change (Allen, 2003); climate scientists often view vulnerability in terms of the likelihood of occurrence and impacts of weather and climate related events. Related terms are *fragility, stability, resilience and sensitivity* of a system. These are the constituents of 'vulnerability'. Resilience and coping capacity develop over time as a result of proactive government policies. Stability is the balance, which is disturbed by events such as disasters; hence restoring balance means correcting distortions. Stability depends on *fragility*; or the weakness of the system owing to physical characteristics of its ecology; *sensitivity* refers to the extent of alteration that is brought about due to exogenous pressures exerted by events such as a disasters. Though disaster related, these are standard sustainable development terminology.

Vulnerability Identification

Vulnerability identification implies examining the root causes of vulnerability that could lie in technological, physical, or socio economic conditions and addressing the same through empirical research and policy. Identification of vulnerability is challenging in that complex processes interact in resultant vulnerability of a system or a specific region/ people(s). Tackling vulnerability involves both short- term and long-term mitigation measures in that the problem of vulnerability is essentially a problem of development. The solution lies in developmental planning, which addresses the problems of poverty, class and gender discrimination, public health, education and hygiene on a sustained basis. Vulnerability is studied in detail in subsequent Units in the course.

1.5 VULNERABILITY AND RISK ASSESSMENT

The international community pioneered by the United Nations has attempted to analyse disasters overtime and prepare an inventory of causes that lead to them, the extent of damage suffered, what and how mitigation needs to be applied, and where, successfully. Vulnerability assessment is a subset of risk assessment, which analyses differential vulnerability of communities in differential areas of disaster impact (such as increasing or decreasing degree of hazard proneness).

An attempt should be made at redefining disasters in a dynamic and integrated perspective, integrating socio-cultural, developmental and ecological outlooks.

The desirables in an academic analysis of vulnerability with the practical perspective of policy design would include:

- Development of an integrated perspective, taking into account socio-cultural, developmental and ecological perspectives to develop a comprehensive framework of disaster mitigation; and

- Emphasis on poverty alleviation and community empowerment, sustainability of livelihoods through grass roots democracy through local governance.

1.6 VULNERABILITY FACTORS

As has been rightly pointed out, "The study of the vulnerability of human and natural systems to climate change and variability, and of their ability to adapt to changes in climate hazards, is a relatively new field of research that brings together experts from a wide range of fields, including climate science, development studies, disaster management, health, geography, policy development and economics, to name but a few areas. There is need for an integrating framework to bring together these diverse traditions in a coherent yet flexible fashion, allowing researchers to assess vulnerability, and the potential for adaptation in a wide variety of different contexts"(IPCC, 2001).

Both natural and man-made factors contribute to vulnerability. Some of the contributing factors are discussed below:

Population Displacement

Population displacement is both a *cause* and a *consequence* of disaster. There is evidence of positive correlation between poverty and economic inequality and rural to urban migrations, in that more the level of poverty and income inequality, more is the extent of rural to urban migrations. The phenomenon is most observed in poor third world countries where the poor migrate from rural to urban areas in search of livelihoods. The social order remains basically '*oligarchic'/ 'oligopolistic'* in that inequality in income and wealth distribution persists over time. System change through 'soft' democratic options, such as legislation and rhetoric is not successful as entrenched powers are hard to reconcile to socialist ideas. Result has been corruption and implementation hurdles, more specifically at the implementation change. This largely explains why land reforms and social forestry legislations have not met with expected success. While the size of agricultural holdings has gradually reduced, 'exploitation' of the small and marginal framers at the hands of rich and the resourceful farmers has persisted. Frequent droughts have compounded existing problems. The cumulative effect of such conditions has been mass migration of rural folk to urban metropolitan towns.

In the last decade, issues related to natural disasters and development-led population displacement and resettlement and rehabilitation have generated considerable debate. Focus on population displacement, direct and indirect, resulting from five natural and human processes wherein data and information is still far from adequate. These processes are natural disasters, urbanisation and industrialisation, natural resource development, agricultural transformation and infrastructure expansion. There is also a concern that especially vulnerable social groups, including women, ethnic minorities, and landless people have generally suffered more than others from displacements.

On the other hand, population displacement is also a consequence of disasters. In the event of disasters, large-scale displacement of populations from affected areas takes place, which leads to temporary to permanent loss of livelihood for people. Small-scale industries and micro enterprises are particularly hit. Much work has not been done on providing insurance against disasters to people residing in hazard prone areas. Though some initiatives have been taken, all disasters have not yet been covered properly and resource mobilisation also is far from adequate (Dhar, 2002). Relocation options have also to be

carefully weighed so as not to result in unintended consequences that negate the very purpose of the exercise. Unintended consequences as different forms of vulnerability that might be induced because of relocation for example, loss of livelihood for small businessmen because of increased distance from urban commercial centers.

Urbanisation

Rural to urban migration has led to unmanageable urbanisation and urban congestion that has forced human and physical capital extension in high-risk zones. Consequently, the loss potential of hazards has gone up. Urbanisation has brought in its wake, growth of informal settlements, unsafe living conditions, disease, class conflict and social capital depletion as some segments have been socially and economically marginalised. Globalisation has also contributed in many ways to increasing the vulnerability of the urban poor by creating 'uncertain' employment though the obvious impact seems to be betterment of life and better opportunities for all. Though urbanisation is a worldwide phenomenon, it is more pronounced in the third world, because of the above recounted factors. As per the 1991 census figures, (provisional) 217 million out of 844 million persons lived in 4,689 cities and towns in India. In terms of proportion, slightly more than one- fourth of the country's population lived in urban areas. Corresponding figures from the first census of the present century (that is, the 1901 census) indicate that 25.8 million persons, that is, one-tenth of the total population lived in 1,917 cities and towns. It thus shows that while the number and proportion of total population living in cities and towns has more than doubled, urban population itself has increased by more than eight times during the last 90 year period (Jain, Ghosh, 2005).

About 25 per cent of the world's population lives in areas of high risk from natural disasters. Most of these people are in poor regions, where vulnerability arises from poverty, discrimination and lack of democratic functioning hampers the development process. The poorest people often have little choice but to live in unsafe settings, whether it is urban shanties or degraded rural environments. In terms of loss of life and relative economic impact, disasters hit hardest where poverty stricken people are concentrated. In less developed countries, rural inhabitants outnumber people in the urban areas. Even then, now there are more urban dwellers in the third world than in Europe, North America and Japan combined. Metropolitan cities are growing at a faster rate. It is estimated that in urban squatter settlements, population densities may reach as high as ten times of present level. Many buildings are erected on steep slopes or flood prone land, exposed to strong winds and landslides without suitable material or construction skills. In highly populated rural areas, population density can exceed 1000 per km^2 and life is a recurrent struggle to secure cultivable land. Many people are landless and disadvantaged by land tenure systems, which deny them access to the means to support themselves.

Migration also has significant cultural impact, besides the more obvious, physical dislocation of populations in that mass migrations introduce communities to alien cultural practices which disturb the cultural homogeneity of the community. In extreme conditions they cause civil strife. Different building practices and construction technologies may be introduced, which might be unsuited to the requirements/ cultural ethos and practices of those particular area/ inhabitants. Besides, administrative and political problems are caused due to the influx of refugees, which disturbs the political and social matrix of the region, like the influx of Bangladeshi refugees in India, following the 1971 war. Epidemics and congestion are other administrative problems caused due to mass influx of refugees.

Gender

Vulnerability due to Gender is a result of accretion of unfair social practices over time, which has caused disempowerment of women in social economic and political spheres. Gender inequality in social, economic and political spheres has resulted in vast differences between men and women in emergency situations, concerning matters such as, household decisions about use of relief assets, voluntary relief and recovery work, access to evacuation shelter and relief goods, and employment in disaster planning, relief and recovery programs among other areas of concern in disaster relief. Disaster mitigation as also response policy, particularly concerning control over relief resources have to factor this component in decision- making with a view to making it more equitable and on the whole, more effective.

Economic Factors

Positive correlation has been evidenced between poverty, disasters and environmental degradation. Relative vulnerability of people is comparatively much higher in third world countries than in the developed world. As per United Nations estimates, although least developed countries show less physical exposure to hazards (11%) they account for far greater number of casualties, (53%). On the other side, the most developed countries represent more (15%) physical exposure to hazards and account for significantly less (1.8%) victims. The inference drawn is that the magnitude of disaster suffered is directly correlated to the level of development, which explains largely the fact of the Third World accounting for significantly more losses than the developed countries. This difference is shown by a list of disaster events and fatalities over 1960-81. Japan suffered 43 earthquakes and other disasters and lost 2,700 people that mean 63 deaths per disaster. Peru suffered 31 disasters with 91,000 dead, a vast majority lost in the single event of the 1970 earthquake.

The world economy functions and works against the poor who have little opportunity to process and market what they produce and are largely dependent on the imports from the industrialised nations for manufactured goods which are quite often unstable. The poor regions have little opportunity to process and market what they produce and are dependent on the import from the industrialised nations of manufactured goods, which are often highly priced or tied to aid packages. The progressive hardship for the small-scale farmer, combined with a foreign debt burden that may be many times the normal annual export earnings, takes resources away from long-term development in a process that has been described as a transfusion of blood from the sick to the healthy. The cycle is reinforced when natural disaster destroys local products and undermines incentives for investment. Major disasters, such as the droughts, disrupt and destroy local economies and bring about shortages in neighbouring regions resulting in innumerable international refugees and stimulate aid programmes to the extent that the consequences of environmental hazards are truly global.

Poverty situation increases vulnerability to disasters and contributes in enabling poverty. In order to facilitate sustainable development, it is essential to eliminate this vicious circle. Sustainable development, with emphasis on the long-term and intergenerational aspects enables us to face challenges. Compatibility between economic growth and sustainable development demands a method to measure the kind of growth that encompasses all important aspects pertaining to quality of life, such as human exposure to risk situations and lifestyles.

While all countries may be confronted with natural hazards, the poorer developing countries, in particular, are disproportionately vulnerable to hazards. Disasters can bring poor communities to even greater poverty, as households may be forced into increased debt to rebuild homes and meet basic needs.

There is also the paradox that the economic aid that may flow to a country for devastation by a natural disaster will be recorded as an increase in GDP, thus hiding the real economic situation in the recovery phase.

Effects of disasters on poorer developing nations are long-lasting and cause excessive disruption in the GDP (United Nations, 2004). The effects are more severe than in developed countries, often depleting scarce financial resources and diverting important funds towards post-disaster relief.

Poor nations have been known to sanction activities like forest clearance for commercial activities and export of hardwood, since sizeable numbers of their population depend on such activities for livelihood. Unsustainable agricultural practices followed in developing countries, particularly by small and marginal farmers harm the environment. The poor are forced to live in high-risk zones that increase their vulnerability (Ayson, 1999). Poverty is not a single dimensional economic concept. Poverty affects the 'positioning' of the affected segment in relation to the 'haves', which is a situation of *political disempowerment, economic deprivation* and *social marginalisation*. As has been recently reported, relief and rehabilitation assistance does not reach the backward sections of society adequately. During the recent tsunami, it was found that society in coastal areas comprises generally farmers and fishermen who have strict social hierarchies. This differentiation was reflected in relative access of communities to relief provisions. Affirmative state action as per constitutional provisions (Article 14, 15(1) 15(4), and Article 21(right to life) would have be enforced to ameliorate the iniquitous situation. Directive Principles of State Policy, namely Article 39 (a) (right to livelihood) 41(public assistance in cases of 'undeserved want') and 47 (raise the level of nutrition) reaffirm the obligation of the state to protect livelihoods of those discriminated against.

It is proposed that risk reduction strategies targeting poverty should involve local institutions more meaningfully and focus on providing alternate livelihood options to the poor and providing safe working environment by reducing occupational hazards which increase the vulnerability of the poor to hazardous events (Ayson, 1999).

Geographical Factors

Global warming threatens to disrupt agriculture in developing countries though most green house gas emission has taken place from the developed world. Global warming has particularly increased the vulnerability of coastal areas, especially small island development states (SIDS) in that sea level rise will threaten the fragile eco system of these regions, raising the frequency and intensity of natural hazards like tsunamis, cyclones, floods and storm surges. Coastal zones, wetlands and coral reefs are likely to be harmed which act as natural buffers against hazards like cyclones. The magnitude of disasters is also likely to be greater because of the increased pace of infrastructure development that has taken place in these regions in the last few years, owing to population pressure and growing attractiveness of these regions from the point of view of tourism (UNDP, 2002).

SIDS are subject to excessively high impacts from natural hazards and disasters. As has been noted, "they are particularly vulnerable to tsunamis, tropical cyclones, which can in

one go negate years of development effort. Numerous small island developing states are facing water scarcity. Drought, sea-level rise and natural disasters have a profound impact on fragile freshwater lenses in SIDS. Water availability is also climate-sensitive. Countries such as the Bahamas that traditionally depended almost totally on groundwater, now also have to use desalination, which contributes to their vulnerability. In addition, the economies of many SIDS are dominated by agriculture and tourism. Agriculture can cause degradation of water quality by agro-chemicals as well as harm the coral reefs; tourist hotels use excessive quantities of water; and wastewater discharges from towns and hotels, are damaging fragile coastal and marine ecosystems on which these islands rely" (Herrmann, et al.).

Livestock Vulnerability

Livestock at times is the poor man's only asset. Unlike other forms of property, livestock loss is irreplaceable. The contingent issue here is immediate provision of alternate occupation, which is the most difficult part of rehabilitation. Shortage of food affects livestock before it starts to affect human beings. Malnutrition and disease reduce their productive capacity, which results in reduced income for the farmer. Diseases among livestock also spread during disasters. These still remain less considered aspects of disaster management. Insurance is the best option but it still needs to be duly considered in India. Vulnerability factors would be discussed in detail in subsequent units.

1.7 CONCLUSION

Shift of emphasis from disaster response to risk reduction has opened up areas of exploratory research in the subject of disaster management. Vulnerability analysis seeks to preempt disasters by ensuring timely preparedness on the part of people and institutions and government agencies involved. Disaster management is an imminent administrative task for reduction of disasters through prevention, preparedness, mitigation and response. There has been a paradigmatic shift of emphasis in the last decade from disaster relief and rehabilitation to prevention and mitigation strategies. Post-occurrence treatment of disasters has proved an insufficient measure for proper protection of lives and property. There is also an emphasis on mainstreaming disaster management in everyday governance by treating it as integral to policy formation and implementation processes. Disaster management as a growing arena of state action raises questions related to new public management and public choice paradigms. Though civil society, typified by non- government organisations, has taken/is set to take an active part in restorative and rehabilitation measures, it is the government agency that is expected to function as the 'prime mover' besides being the *regulator* and the *facilitator*. It is pertinent to refer, in this context, to the social contract theory of the origin of state, which is widely accepted, as a secular explanation of the evolution of the state. According to social contract stipulates, people impart authority to a state abdicating a measure of their personal liberty and 'delegating' the same to the state, in return for protection of life, liberty and property. By this theory, people are the sovereign entity and state, the instrumentality to carry out the delegated responsibility.

The emerging arena of disaster management as an integral aspect of development planning, policy formulation and implementation is of particular significance in the wake of the *new public management* contention of expected roll back of the state and ascendant civil society and private corporate sector. Despite assumptions to the contrary, new vistas continue to emerge for state action/ intervention. The basic question remains, can the state

roll back? Any answer would only be diffident in view of the fact that despite public choice assertions, and new public management propaganda of the economy and efficiency of alternate service delivery mechanisms, the government remains the major player. It is the government that is called upon to bear the major share of responsibility and accountability for protection of life, liberty and property of its citizens. It is the government that is looked upon for responsibility and accountability in almost every regard, more so, in emergencies.

1.8 KEY CONCEPTS

Biological Hazards : Biological hazards emanate from processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Examples of biological hazards are outbreaks of epidemic diseases, plant or animal contagion, insect plagues and extensive infestations

Disaster : Disaster is explained as a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected people to cope using their own resources. Disasters are natural and man made

Geological hazard : Geological hazards emanate from internal earth processes or are of tectonic origin, such as earthquakes, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surface collapse, expansive soils and debris or mud flows. Geological hazards can be single, sequential or combined in their origin and effects floods, debris and mud floods; tropical cyclones, storm surges, thunder/ hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wild land fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches

Hazard : A precise definition of hazard is difficult. The International Secretariat of Disaster Reduction has defined hazard as a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards have both natural and human components. For example, flood problems may be exacerbated by fluctuations in climate, such as increased storm frequency, and also by certain human activities, such

as land drainage and deforestation. The loss of life caused by a tropical cyclone will depend to some extent on storm severity but it can be greatly reduced by means of a warning system. Attempt has continually been made to employ science and technology to harness nature and better living conditions.

Hydro meteorological hazards: These hazards are of atmospheric, hydrological or oceanographic nature. Hydro-meteorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wild land fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydro-meteorological hazards can be single, sequential or combined in their origin and effects.

Risk : Risk is explained as the likelihood or probability of a loss (es). Risk could be voluntary as for example, a game of boxing or bull fighting, or involuntary, which is unforeseen and unprepared for. The word is employed in general usage as also technical usage whereby it denotes the extent of likely damage or the hazard potential of a particular event.

Sustainable Development : Sustainable development is development that meets the needs of the present without compromising with the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and the future needs (Brundtland Commission, 1987). Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.

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1.10 ACTIVITIES

1) Define disaster and list out important perceptions on disasters.

2) Identification of hazards involves analyses of scientific data to trace the causal path of events leading up to a disaster. Discuss.

3) Discuss important vulnerability factors with illustrations.