UNIT 6 VULNERABILITY ANALYSIS AND RISK ASSESSMENT

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6.0 LEARNING OUTCOME

After reading this Unit, you should be able to:

- Appreciate the significance of Vulnerability Analysis;
- Understand Vulnerability and Capacity Analysis; and
- Inquire into the vulnerability of the Himalayan Region.

6.1 INTRODUCTION

Disasters are being looked at in a holistic manner rather than approached piecemeal. Disasters are on an increase and so are the risks and losses resulting there from. To

reduce disaster risk, it is important to decrease the level of vulnerability of population and infrastructure. There has been a phenomenal increase in the disaster studies and literature in the recent past. The relevance and significance of vulnerability has been very well established. "The concept of vulnerability expresses the *multidimensionality* of disasters by focusing attention on the *totality of relationships* in a given social situation which constitute a condition that, in combination with environmental forces, produces a disaster"(Bankoff et al. 2004). It is worth appreciating that with regard to hazards and disasters, the concept establishes and links the relationship that people have with their environment to social forces and institutions and the cultural values that *sustain* and *contest* them (Cannon, 2000). As per Pelling, vulnerability is an ongoing state rather than a statue to be identified in relation to a specific hazardous event' (Pelling, 1997a; 1997b). The word 'vulnerability' has been used by the British Red Cross as 'people in need and crisis' (Graz, 1997). It appears to be indifferent from the term 'victim' and does not have element of predictability. It becomes important to understand that it is the capabilities and potentials of people that balance vulnerability. The concept of vulnerability enables disaster sociologists to ascertain the impact of disasters on people's lives, property, livelihoods and environment. Over the period, it has been felt that communities need to be involved in carrying out vulnerability analyses.

In general terms, the extent to which a community, structure, service, or geographical area is likely to be damaged or disrupted by the impact of a particular disaster hazard, on account of their nature, construction and proximity to hazardous terrain or a disaster prone area, is understood as vulnerability. As explained in the Disaster Management Training Programme (1994), "in engineering terms, vulnerability is a *mathematical function* defined as the degree of loss to a given element at risk, or set of such elements, expected to result from the impact of a disaster hazard of a given magnitude. It is specific to a particular type of structure, and expressed on a scale of *no damage* to *total damage*; for more general socio-economic purposes and macro level analysis, vulnerability is a less-strictly defined concept. It incorporates considerations of both the intrinsic value of the elements concerned and their functional value in contributing to communal well being in general and to emergency response and post-disaster recovery in particular. In many cases, it is necessary to settle for a qualitative classification in terms of *high*, *medium* and *low* or explicit statements concerning the disruption likely to be suffered."

Similarly, in general terms, the process of estimating the vulnerability to potential disaster hazards of specified elements at risk, may be termed, vulnerability analysis. As per Coburn Sspence, Pomonis in the Disaster Management Training Programme, 1994, "for engineering purposes, vulnerability analysis involves the analysis of theoretical and empirical data concerning the effects of particular phenomena on particular types of structure, for socio-economic purposes, it involves consideration of all significant elements in society, including physical, social and economic considerations (both short and long term), and the extent to which essential services and traditional and local coping mechanisms are able to continue functioning."

6.2 ADDRESSING SEMANTICS

The concept of vulnerability has to be understood in relation to related terms, which are often hard to distinguish semantically. Though an attempt could be made and has in fact been attempted, not much is gained out of the effort. Confusion relates primarily to the relation between 'vulnerability' and 'sensitivity' of a system. The Inter Governmental Panel

on Climate Change (IPCC, 2001), Third Assessment Report (TAR) defines vulnerability as "the degree to which a system is susceptible to, or unable to cope with the adverse effects of climate change, including climate variability and other extremes of nature. Vulnerability *is a function* of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity and its *adaptive* capacity.

Another definition of IPCC (2001 TAR, Pg. 894) cited from Smith et. al and quoted by Nick Brooks (2003) describes vulnerability as the *degree to which* a system is susceptible to *injury, damage or harm*. Sensitivity is described as the attribute of a system which is affected by or responsive to climate stimuli." As per Nick Brooks, while the first definition views vulnerability as a function of sensitivity, the second understands vulnerability as a *sub set* or one of the other determinants of sensitivity. Hence related terms causing confusion are *vulnerability, sensitivity, resilience, adaptation and adaptive capacity*. Such semantic jugglery is derided by a group of scholars. To convey disapproval of an over concern with terminologies, Grant (2000) could be quoted:

"Political Scientists with definitions are like dogs with a bone: they will continue to gnaw at it while ignoring more nutritious alternatives.

6.2.1 Interpretations of Vulnerability

Of late, there has been an increasing realisation of the significance of vulnerability in disaster related issues. Consequently, there has been a welcome growth of literature on vulnerability under the generic rubric of disaster management, which replaces the previous narrow hazard centric focus in disaster management (Cannon, 2000). Since vulnerability is expressed as a variable in disasters by the mathematical notation, Disaster= Hazard + vulnerable people, understanding of vulnerability factors becomes as important as the understanding of hazards. Concomitantly, there has been growing specialisation in the respective fields of *hazard* and *vulnerability* assessment. While specialisation is welcome, there is an inherent danger of increased isolation among respective specialists in physical science and social science arenas. Even within the broad specialisation of physical sciences and social sciences, perspectives are likely to differ with respect to emphasis areas as per super/sub specialisations. Hence an engineer or a scientist/researcher in related fields is likely to perceive vulnerability more in terms of Risk, while a climate scientist, in terms of the likelihood of occurrence and impacts of weather and climate related events. The *biophysical* concept of Risk is akin to the concept of 'Risk' while the *social science perspective* defines it more in terms of socio economic parameters. Experts from the following fields are involved in study and analyses of vulnerability; *climate science, policy development studies, economics, disaster management, health, and social sciences along with others* (Nicholas et al., 1999). According to Brooks, each of these limits themselves to a partial understanding of vulnerability. There is a need to rise above specialisations and take an across the board, interdisciplinary and cross-cultural view treatment of the issue of vulnerability to present a more complete and holistic analysis of vulnerability for meaningful interest articulation and policy science in the area. Physical vulnerability has to be understood in the context of political conflict, issues of class struggle, iniquitous access to power and social backwardness to formulate comprehensive vulnerability reduction approach. The same should be attempted by integrating, through a conceptual model, through research, these different and diverse "traditions in a coherent yet flexible fashion."

As stated by Nick Brooks, generally, there are two approaches applied in understanding vulnerability. The *Hazards and Impact Approach*; and *The State of Vulnerability*

Approach; the former focuses on the hazard, and the damage likely from the hazard's onset; the latter on the state that exists before the hazard strikes, attempting to inquire into the causes of vulnerability which crated the predisposition to the hazard in the first place. The former view focuses on natural causes while the latter relates the impact of hazard to human interventions. To explain in terms of climate change, vulnerability to climate change would be understood in terms of the people at risk due to rise in sea level rise, implying *exposure* in technical disaster management terminology.

In terms of the Hazard and Impact Approach, "the combined vulnerability, a function of hazard, extent of human exposure, may be referred to as biophysical or physical vulnerability. The terms biophysical suggests both a physical component associated with the nature of hazard and its first order physical impacts, and a biological or social component associated with the properties of the affected system that act to amplify or reduce the damage resulting from these first order impacts". In the words of Jones and Boer, quoted by Brooks, as " Vulnerability is measured by the by the indicators such as monetary cost, human mortality, production costs, (or) eco system damage…." These are indicators of outcome rather than indicators of the state of outcome rather than indicators of the state of a system prior to the occurrence of a hazard event.

On the other hand, *The State of Vulnerability Approach*, views vulnerability as arising due to inherent social characteristics of the system or the properties of the system, which could be inherent or resulting as stimulus from external factors. This implies a structuralist critique of the system to identify the factors that make communities and regions vulnerable to hazards. Factors causing vulnerability could be social or economic, exogenous or endogenous, referring to certain independent or internal variables exacerbating or inducing situations of vulnerability. The interaction of natural hazard with social vulnerability that produces an outcome measured in terms of human losses or damage to property.

Hence "biophysical vulnerability is a function of hazard severity or probability of occurrence while social or inherent vulnerability is not."

Social vulnerability incorporates the understanding of natural hazards with reference to the interaction between human and natural processes such as river engineering schemes, ground water reserves, etc., which result in disturbances in natural processes and consequently, to hazards turning to disasters, if left unregulated / unchecked.

6.2.2 Vulnerability Analysis

There is a tendency to understand vulnerability purely as a negative situation of peoples/ communities/regions. Vulnerability Analysis, takes a *political economy approach* in that the state is enjoined the responsibility to mitigate vulnerabilities through policy interventions. Previously, the Hard Approach that understood vulnerability purely in terms of engineering terms, gave only a partial understanding of vulnerability. Now vulnerability is understood more as a *socio political problem* to be tackled over a period of time through state action. The limitation of the structuralist approach were exposed in river training schemes in Mississippi, the Yangtze delta and Bangladesh etc., on which huge capital investments had been made and the results gained were far from satisfactory. To quote Cannon (2000), in relation to riverine and rainfall floods, technical interventions have usually meant storm drains and channel modifications in urban environments and river training and embankments elsewhere. The importance of non- structural mitigation measures is now being recognised, which advocates reducing socio-economic vulnerabilities of people through policy interventions following empirical analysis of underlying causes of vulnerability

and capacities which offset vulnerabilities and building on social capital reserve inherent in communities.

6.2.3 Vulnerability Modeling

Vulnerability modeling henceforth, would have broader scope in that it would encompass areas surrounding the specific area under review with a view of studying the impacts of disasters over the spatial spread. In the words of Tarrant, 1997: quoted in Cannon, 2000), " Modeling the vulnerability of people would require the collection and anlayses of data in quantitative and qualitative sense, with a combination of surveys, of households, institutional analysis, local governments, insurance companies, voluntary organisations, business and employers), livelihood and welfare analysis (of income sources and employment patterns), and surveys of physical structures and infrastructure (with the emphasis not only on property damage, but also the impact of floods, on welfare and income earning opportunities)". Methodologies are being developed for analysis of socio economic vulnerabilities of people in Australia. Attempt is currently on to study vulnerability cross culturally.

6.2.4 Significance of Vulnerability Analysis

For example, Tokyo, Japan, Managua and Nicaragua, are prone to earthquakes. But the people of Tokyo are far less vulnerable to injury by earthquakes because Tokyo has strictly enforced building codes, zoning regulations and earthquake training and communications systems. In Managua, there are still many people living in top-heavy mud houses on hillsides. They are vulnerable.

Landslides or flooding disasters are closely linked to rapid and unchecked urbanisation that forces low-income families to settle on the slopes of steep hillsides or ravines, or along the banks of flood-prone rivers.

Famines can be closely linked to shortages of purchasing power caused by rural unemployment or a sudden influx of refugees into a country from a strife-torn neighboring country.

High numbers of deaths accompanying earthquakes almost always result from structural collapse of poor, low-cost houses.

In other disasters, such as cyclones and tsunamis, humans can increase their vulnerability by removing bits of their natural environment that may act as buffers to these extreme natural forces. Such acts include destroying reefs, cutting natural windbreaks and clearing inland forests.

The poor countries that suffer the worst disasters are those in which environmental degradation is proceeding most rapidly. Countries with severe deforestation, erosion, over cultivation and overgrazing tend to be hardest hit by disasters.

Natural hazards are agents or trigger mechanisms that can come into contact with a vulnerable human condition to result in a disaster.

In a nutshell, vulnerability is the propensity of things to be damaged by a hazard. People's lives and health are at risk directly from the destructive effects of the hazard. Their incomes and livelihood are at risk because of the destruction of the buildings, crops, livestock or equipment, which these depend on. Each type of hazard puts a somewhat different set of 'elements at risk'. Most of disaster mitigation work is focused on reducing

vulnerability and in order to act to reduce vulnerability, officials involved in development planning need understanding regarding which *elements* are most at risk from the principal hazards, which have been identified. It is important for development planners to make some effort to quantify the tangible aspects of vulnerability and loss to assist mitigation and preparedness planning. Some methods for undertaking this are discussed in this Unit. But, the intangible aspects of vulnerability are as important as the quantifiable aspects, which must not be neglected. Local experience is a good guide to what is vulnerable in a society. The list of potentially vulnerable elements should be supplemented by a study of written reports and the knowledge of those who have lived through previous disasters.

6.3 APPROCHES TO VULNERABILITY ANALYSIS

Wisner (2001) has categorised approaches to the theoretical understanding of Vulnerability as: *techno-centric*, *target group*, *situational* or *community based*. The different approaches denote various indicators that are considered for analysing vulnerability, depending on the dominant paradigm applied to the analysis.

Techno-Centric Analysis

Vulnerability is defined in terms of threat to the 'elements at risk' such as structural vulnerability of buildings, bridges, health infrastructure etc. Attempt is made to analyse structures in terms of faults or weaknesses in design, soil type in basement, active faults, location analysis, possible alternate sites, possible correlation if any between different sets of data, with a view to correcting structural weaknesses to reduce further risk. It involves use of mathematical models for risk assessment of physical infrastructure. Loss estimation involving life and property is also done on the basis of data collected for risk assessment.

Target Group Analysis

Emphasis is on studying social vulnerability of communities with a view to classifying them as per *degree* of vulnerability to disaster threats. Components thereof or criterion for taxonomy are broken down as *social*, *economic*, *environmental*, *informational* vulnerability, etc. As part of this approach, Ayson (1993), has identified certain aspects, which undermine capacity for self-protection, resilience and coping capacity and communities. These are:

- Lack of access to resources (material/economic vulnerability)
- Disintegration of social patterns (social vulnerability)
- Degradation of the environment and inability to protect it (ecological vulnerability)
- Lack of access to information and knowledge (educational vulnerability)
- Lack of public awareness (attitudinal and motivational vulnerability)
- Limited access to political power and representation (political vulnerability)
- Certain beliefs and customs (cultural vulnerability)
- Weak buildings or weak individuals (physical vulnerability).

Ayson further classifies above stated vulnerabilities on the basis of gender, economic class, etc., to arrive at a more specific understanding of vulnerability with respect to a target group.

Situational Analysis

This approach moves a step further than the above two approaches and puts vulnerability into context, studying it in relation to certain contingent factors which it directly depends on. Vulnerability is not static but a dynamic condition which changes in relation to shifting forces and factors in the environment, such as access to resources and power, (context of situation) and the specific context of the particular hazard. (Wisner, 2001-05) summarises its basic principles thus:

Situational Analysis recognises two or three kinds of contingencies. *First,* social vulnerability is not a permanent property of a person or group but changes in respect to a particular hazard, The *second* kind of contingency concerns the constantly changing daily, seasonal and yearly circumstances of a person' situation as regards access to resources and power. Such circumstances change dramatically as the life cycle unfolds, as physiological and anatomical changes accompany childbirth or occupational disease or accident etc. *Finally*, there is the contingency born of the complex interaction of particular overlapping identities and forms of empowerment or marginality.

Wisecheselgarner and Bertner (2000) view vulnerability as *'net'* condition in a given geographical area, arising after a consideration of the pre existing vulnerability and the response which tempers it in some measure. Indicators considered for assessing vulnerability within the given space, are biophysical, technical and social vulnerability. The following factors are considered as relevant with regard to loss reduction:

- *Hazard* (the physical process itself)
- *Exposure* (all individuals, infrastructure, etc., which are exposed to hazard)
- *Preparedness* (all precautionary activities and measures which enable rapid and effective response to hazard events)
- *Prevention* (all activities and measures in advance of a hazard event to reduce hazards and their effects and provide permanent protection from their impacts)
- *Response* (all activities and measures taken immediately prior to and following a hazard event to reduce impacts and to recover and reconstruct an area affected by a hazard event).

Peter Winchester's model based on *'differential vulnerability'* looks at vulnerability from a development perspective in that the aim of policy makers should be to minimise suffering through policies designed to improve exchange relationships, apart from geographical factors like climate and physiography (following Amartya Sen's understanding of famine as being caused not by production failures but because of 'capacity deprivation' by way of poor health, inadequate schooling and employment which reduce access to income leading in time to malnutrition, starvation and other forms of deprivations).

6.4 MODELS OF VULNERABILITY ANALYSIS

There are three models of vulnerability applied by disaster management specialists:

- Capacities and Vulnerability Analysis (CVA)
- Pressure and Release/Access (P/RA)
- Sustainable Livelihoods (SL)

All approaches bring out the different ramifications of vulnerability research and attempt to correlate disasters and development. The approaches are discussed below in detail:

A) **Capacities and Vulnerability Analysis:** This model was developed in the 1980s and was initially used to relate relief programmes to developmental objectives. It uses a simple matrix of three-dimensional study to probe a community's vulnerability. Pertinent questions asked in the context of each specific dimension are as follows:

(a) Physical/Material dimension: Poverty and vulnerability form a vicious cycle in that each reinforces the other. The solution is to pull people out of the vicious circle of poverty by income and employment generation schemes to increase their coping/restorative capacity in the event of disasters. The question asked is, *what productive resources, skills and hazards exist?* The attempt is to find out the correlation that exists between the aforesaid three variables and planning accordingly, to augment the skills and offset vulnerability.

(b) Social/Organisational Dimension: The question asked is, what are the relationships among people and how are they organised? The question is relevant to the extent that bonds of cohesion/ discord in communities determine their resilience and their restorative capacity during disasters. For example, communities in Gujarat tackled the earthquake better then they did the communal riots. These are obviously two different kinds of disasters but ethnic cleavages or the nature of social capital in each case proved to be the determining factor. The former exhibited social capital, while the latter, negative social capital.

(c) Motivational /Attitudinal Dimension: The pertinent question is, how a community perceives its ability to enforce change and how much it believes change is possible, determined for instance, in the case of developing countries like India by the confidence people have in the administration. The function of political communication accredited to political parties is significant in this context, since communication between elected representatives and the people is an important factor in building required confidence among people in the official agencies. The limitation of this approach is that it is general and overarching and may not tackle sufficiently, the *specific* vulnerabilities in each case.

B) **Pressure/Release Access Models:** These models developed in the 1990s, emphasised human/ man made aspects of disasters. This model takes contextual factors into account for assessing vulnerability. Vulnerability is perceived as moving through three successive levels in a linear continuum as *root causes, dynamic pressures and unsafe conditions*. Root causes refer to basic issues like iniquitous social order, consequent lack of access to power center and resources, oligarchic nature of society, where few own most resources and also arrogate power. Root causes when acted upon dynamic pressures intensify existing vulnerabilities. This approach points to fundamental issues, which need to be addressed at macro levels in order to address the underlying vulnerabilities. Dynamic pressures refer to factors such as urbanisation, and lack of training and education opportunities for communities etc. The third factor is unsafe conditions, which is a resultant of the two primary factors, that is, root causes and dynamic pressures. Unsafe conditions refer to factors such as unsafe locations, lack of health facilities, uncertain employment, dependence on moneylenders, etc. In developing countries, the poorest sectors of the society in general and urban poor in particular are more vulnerable because they perforce settle in inadequate areas, and generally receive insufficient state assistance. They are forced to build their dwellings on unstable land that is subject

to flooding or landslides, or is in close proximity to dangerous industrial activity. This is particularly true of large cities, where the poor constitute the most vulnerable social category.

Concomitant, Access Model focuses on livelihood strategies adopted by different communities, which determines their vulnerability. This data together with the pressure model provides insights into practical strategies that need to be formulated and implemented in case of each vulnerable section, to reduce vulnerability arising out of situational factors. Strategies have likewise to be devised for specific communities in the context of their differing capabilities and access to resources *as per* prevalent power equations and the specific pressures incident on them due to livelihood factors. Examples could be access to credit, insurance, mobilisation through community based organisations and local self-government institutions like the *gram sabha*, which operate at the grass roots level and correct distortions in social and political processes. With this detailed analysis, it becomes possible to identify ways in which livelihoods can be supported and made more sustainable.

C) **Sustainable Livelihoods (SL) Model:** Like the P/RA model, the sustainable livelihoods model puts livelihood at the center of study for strategy formulation. Livelihood choices are made in a situation of vulnerability. The contextual factors of livelihood strategies have therefore to be kept into account and studied. Therefore, rather than categorise people into groups such as farmers or fisher folk, the SL approach seeks to understand the many factors determining peoples' choice of livelihoods to find ways to reinforce the positive aspects of such 'choice' and eliminate the negative influences. A person's livelihood is sustainable if/when he or she can cope with and recover from stresses and shocks and maintain or enhance their capabilities and assets both now and in the future while not undermining the natural resource base. Policies institutions and processes impact upon livelihood assets (physical, social, human natural and financial capital, which people utilise to achieve positive livelihood outcomes (good heath, access to services, political enfranchisement sustainable use of natural resource base, heightened self- esteem. It aims to enable poor people to improve their access to assets, the core of livelihood strategies, and give them a fair opportunity to choose independently and adapt to changing circumstances.

6.5 QUANTIFICATION OF VULNERABILITY

Vulnerability is attempted to be quantified in order to develop specific policy to reduce it. Accordingly, vulnerability is defined as the degree of loss to a given 'element at risk' (or a set of elements) resulting from a given hazard at a given severity level. The distinction between this definition and that of risk is important to note. Risk combines the expected losses from all levels of hazard severity, taking account of their *occurrence probability* as well. The vulnerability of an element is usually expressed as a percentage loss suffered in case of a specific element for a given hazard severity level. The measure of loss used depends on the nature of the *element(s) at risk*, accordingly may be measured as a ratio of the numbers of killed or injured to the total population or as repair cost or as the degree of physical damage, etc., In a large number of elements, like building stock, it may be defined in terms of the proportion of buildings experiencing some particular level of damage.

As the severity of the hazard increases, the level of damage that the element is likely to suffer will increase. For a fuller definition of vulnerability, the expected damage level at

every level of severity of hazard would need to be defined. Vulnerability for a range of events of different severities can be given by means of a *Damage Probability Matrix.* Where data permit, a continuous vulnerability function mapping values of damage to values of hazard severity can be defined graphically or mathematically as an equation. An example of this is the vulnerability relationship for a class of buildings against increasing severities of ground shaking in an earthquake, compiled from a collection of damage statistics.

6.6 ASSESSMENT OF RISK

The assessment of risk is the process of determining the impact of a disaster or events on a society, the need for immediate emergency aid to save lives, and expediting recovery and restorative activity. Assessment is an interdisciplinary process undertaken in phases and involving on the spot surveys and the collation, evaluation and interpretation of information from various sources concerning both direct and indirect losses, short and long-term effects. It involves determining not only what has happened and what assistance might be needed, but also defining objectives of projects undertaken, and how assistance is to be is to be provided to the victims (the modalities). It requires attention to *both short-term* needs and *long-term implications of moves.*

6.6.1 Risk and Vulnerability Analysis

Historically, Risk and Vulnerability Analyses (RVAs) had tended to examine only the structural elements that is, buildings, facilities, infrastructure, etc.). Engineering analyses of the built environment effectively determine the following (NOAA, Coastal Services Center).

- vulnerability of structures based on the building type
- construction materials
- foundation type and elevation
- location within a Special Flood Hazard Area (SFHA)
- wind load capacity, and other factors

The Understanding of Risk and Vulnerability Analysis has now become more inclusive in that besides, structural engineering analysis, a more holistic analysis of the environment at risk is undertaken, which include:

- *Critical Facilities Analyses*, focusing on the threat to critical public facilities such as fire police services, etc.
- *Environment Analyses*; understanding likely threat to fragile ecosystems such as wetlands, habitats of endangered species, etc., for potential hazards such as oil spills, chemical hazards etc. Such analyses are important because the quality of public facilities, water supply agriculture, public health and hygiene etc depend on the quality of environment.
- *Societal Analyses;* focusing on the vulnerability of segments at varying degrees of risk from natural hazards. Such analyses are important to frame targeted policies towards protection of such communities.

- *Built Environment Analyses;* focuses on determining the vulnerabilities of non-critical structures and facilities. The built environment includes a variety of structures such as businesses, single- and multi-family homes, and other man-made facilities. Such analyses are required to prepare an economic loss inventory in the event of natural hazard. It also provides data and information regarding possible relocation options for affected communities, required structural and non-structural mitigation measures etc. for preparedness and mitigation planning.
- *Economic Analyses;* focuses on determining the vulnerability of major economic sectors such as agriculture, mining, construction, manufacturing, transportation, wholesale, retail, service, and finance, insurance, and real estate industries. On the basis of risk and vulnerability assessment of major projects and industries, targeted hazard mitigation measures can be devised.

6.7 VULNERABILITY AND CAPACITY ASSESSMENT

It is widely believed that risk assessment should be a holistic process and all aspects of social vulnerability and capacity should be integrated with assessment all in other sectors, such as physical and environmental.

There has been a tendency to look upon vulnerability as a single dimensional issue, that is, as a state of weakness of the vulnerable subject as a' client'. It was also looked upon as a state of permanency, which never changed for the better or was even preordained. The understanding of vulnerability now is more realistic in that vulnerability is perceived not in fatalistic terms but as a situation of disadvantage balanced by the equally potent force of capacity of a community, which enables it to withstand threats. If capacity balance is negative (-ve), vulnerability *quotient* is high, and if it is positive, (+) vulnerability quotient is low. The severity of disaster impact or the damage it would cause would depend on the vulnerability and capacity balance of a particular community; in other words, on the extent to which vulnerabilities outweigh capacities of which determine resilience in the face of disaster and the potential to recover from its devastating impact.

To quote from the FAO directory:

"Within the context of disaster management, development is defined as a process that reduces vulnerabilities and increases capacities. For further clarity, vulnerabilities are generally defined as long-term factors that affect the ability of a community to respond to events or make it susceptible to calamities. They contribute to a disaster's severity, impede effective responses, are present before disaster strikes and remain long after the event is over. In this respect, vulnerabilities differ from needs, which arise from the crisis and are often short term in nature (e.g. the need for relief food supplies immediately after a forest fire). Vulnerabilities to forest fires, however, are more enduring and have intensified in recent years because of increased conflicts, a lack of law enforcement, and poor natural resource management."

Vulnerability is also multi-dimensional in nature. Research would have to be significantly encouraged to enquire into the specific causes of vulnerability of communities at risk, to pin point the exact causes in each case in order to devise appropriate strategies. Social vulnerability assessment would include, improving the participatory process with the groups being assessed, integrating vulnerability and capacity analysis (VCA) with sustainable

livelihood analysis, expanding VCA to assess root causes of vulnerability to create holistic risk assessments.

As per the Kobe draft report, a VCA has the following characteristics:

- VCA puts people first. People-centered assessment ensures that actions taken by authorities, aid organisations and communities are relevant to real needs and available resources.
- VCA is a learning process that develops into a systemic or ecological perspective to encompassing the study of the operating environment.
- VCA is an inclusive process that involves all stakeholders. In this, the VCA acts as, a catalyst in facilitating interface and synergy. A Comprehensive Vulnerability Capacity Analysis as advocated by the proponents of this approach would demand:
- Empowering the local groups by providing for their increased participation in decision making generally, and particularly, with regard to disaster preparedness response and recovery strategies.
- Constant monitoring and evaluation based on empirical data collected from time to time should be ensured.
- The attempt is to understand underlying causes of hazards rather than merely addressing the symptoms. Understanding of underlying causes needs input from different levels and requires a multi-sectored approach. Attempt is to be predictive and prescriptive with regard to problems and their solutions.
- There is need for a Holistic Risk Assessment (including social, physical economical and environmental approaches. Social VCA is only one element in the overall process of vulnerability assessment that needs to include a wider range of concerns such as physical, economical and environmental approaches. All need to be integrated into a comprehensive and interdisciplinary review of vulnerability and capacity.
- Following the initial exercise VCA models should be attempted to be replicated at macro levels.

The Tearfund International presents a conceptual framework for disaster risk reduction (a modification of the Pressure and Release or Crunch Model). This model is being developed amongst Tearfund partner organisations in Africa and Asia as the basis for participatory disaster risk assessments at the local level.

To assist the facilitator in this process of assessment, five categories of analysis are used. These categories are based upon the ‘capital’ within a community (as developed by the “Sustainable Livelihoods Framework”).

The Five Categories of Analysis are:

1) Economic
2) Natural
3) Physical
4) Human, and
5) Social

These encompass livelihood earnings savings, loans, assets, soil, forests, water, crops, grazing, housing, infrastructure, equipment, services, people, skills, knowledge, health, for example, relationships, memberships, networks, leadership By analysing vulnerabilities and capacities of the community within each of these five categories, the facilitator can ensure that an objective and empirical analysis is undertaken. Possible interventions following vulnerability and capacity assessment can include hazard control, developmental relief, risk reduction within development and advocacy. The model suggests a political economy perspective in that responsibility for vulnerability reduction and capacity building is enjoined on the state.

6.7.1 Components of Vulnerability

Terry Cannon (2000) in his framework considers vulnerability in terms of five components; *initial well-being, self-protection, social protection, livelihood resilience and social capital*.

Initial Well Being: This involves examining the state of health of subjects based on factors like nutritional status, which determines their resilience to disasters. It also incorporates considerations of spiritual and psychological health.

Self Protection: This implies the extent to which an individual is able or willing to avoid vulnerable circumstances based on knowledge of vulnerability factors and risk avoidance measures attempted at the individual level.

Social Protection: Some societies are more segmented along the caste and class lines than others. Degree of such segmentation determines how inclusive/otherwise a society is. On it rests the measure the societal protection accorded to people or positive social capital evoked during times of distress.

Livelihood Resilience: This determines the ability of communities to bounce back from adverse situations induced by disasters. Livelihood resilience determines economic coping capacity of subject communities.

Social Capital: The concept of social capital was elucidated in the previous Unit. Suffice it to say that it is important to assess how much cohesion or rivalry is expected from a community during disasters to carry out a realistic vulnerability and capacity analysis.

6.7.1.1 Example of VCA

As referred by Johan Kieft and Aspian Nur, East Kalimantan has been increasingly prone to forest fires. The Indonesian government took a natural resource management approach that was not sufficient.

The World Bank estimated that only 1 percent of forest fires were due to natural causes while large-scale land clearance was responsible for 34 per cent, shifting and permanent agriculture for 17 percent, arson for 14 percent and transmigration for 1 percent of the occurrences. The fires in 1997 caused a total loss of US$9.3 billion for Indonesia, including US$7.9 billion of socio-economic costs and US$1.4 billion for carbon emissions and environmental damages. Recurrent plagues and floods have compounded the problems for people of this region; repeated crop failures have forced farmers to a take up illegal logging, petty trade and occasional work, while others rely on coconut farming. The effect of these disasters has been impoverishment and malnutrition of the masses, which will increase their vulnerability to other hazards in the future. The approach up till now had

been looking at emergency management and post impact rebuilding including vulnerability reduction as two distinct and discreet phases in disaster management activity. There is now an increasing awareness of the fact that development concerns are not separate from but an integral part of development strategies. Development is understood as a process that decreases vulnerabilities and augments capacities over time.

6.7.1.2 Constraints in VCA

Certain constraints have, however, been identified in that sufficient data to develop a 'policy science' for reference through consistent interdisciplinary research and deductive comparative analyses has still not been attempted to impart 'rationality' to articulation of policy inputs for national economic and social planning. The final 'value' /end desired in this case in successful implementation of risk reduction measures. The other major challenge is to seek priority for risk reduction in policy planning as against other pressing concerns such as poverty and unemployment in poor developing nations. The same is possible if the two concerns are not divorced from each other but looked upon as related.

6.7.1.3 Proposed Improvements

The Pro-vention Consortium organised an International Workshop on Social Vulnerability and Capacity Analysis in Geneva on May 25-26, 2004 at the International Federation of Red Cross and Red Crescent Societies. Desired attributes of a VCA were identified as:

- Integrating VCA with Sustainable Livelihoods Analysis,
- Improving the participatory process with the groups being assessed,
- Expanding VCA to address root causes of vulnerability.

In the process, certain shortcomings in the VCA as it is being practiced today were identified and suitable correctives suggested,

6.7.1.4 VCA Toolbox

A planned VCA Toolbox and the Bibliography on Disaster Preparedness has been developed by the International Federation (June 2000). Information is provided under the following categories:

The Spatial Dimension: Information is provided on the physical environment and the human activities across a region.

Groups of people: Class and caste hierarchies are shown under this category.

Institutions: Social capital between local organisations and social groups is depicted under this heading.

Time Use: Daily time-use charts and seasonal calendars can capture cyclical variations in activities (such as income and expenditure from various activities), seasonal variation in food availability, and employment and income diversification. Historical diagrams and time lines can be used to represent changes taking place through time.

Sequences: Flow charts and problem trees are useful diagnostic tools that can assist understanding of the flow and sequence of activities in a community.

Comparisons: The use of graphs, charts and matrix ranking and scoring can provide the means to compare the people, activities and objects among individuals and communities.

VCA has been used in Bolivia and in Argentina in order to strengthen and support the work of approximately 2,000 Red Cross branches. This task included training branch members in participatory planning and vulnerability analysis methods. And, to continue the work of the Red Cross at the community level, the active participation of vulnerable groups was sought in the diagnosis and prioritisation of problems affecting their communities.

A SWOT analysis was undertaken at two levels: at the branch level involving management committees, technical staff and volunteers; and at the National Society level (involving members working with local institutions, vulnerable groups, the general public and International Federation staff).

Negative social capital was detected between voluntary organisations, and within organisations between tiers. Stress was laid on building effective leadership at the local level to bridge the gaps. Bolivia and Argentina were able to create plans to reduce their vulnerabilities.

6.8 VULNERABILITY OF THE HIMALAYAN ECO-SYSTEM

Due to geological and physiographic characteristics, the Himalayan region is very fragile. Slight disturbances can misbalance this eco-balance easily and this is really what has happened during the last few decades. Man with his ever-increasing needs, rather greed has exploited the natural resources beyond the safer limits, resulting into catastrophic consequences. Unwarranted increase in soil erosion, landslides, floods, etc., are due to unscientific exploitation of nature, which has been carried out under the label of development in these most fragile and unstable mountainous ranges. Large-scale deforestation, construction of roads and hydropower station, without taking into consideration the geological and environmental aspects are some of the primary reasons for this destruction. The population growth and urbanisation, unscientific agricultural practices on sensitive slopes, dependency on forest for fuel and fodder, extensive grazing in forest area, indiscriminate industrialisation and large scale building construction for tourism industry etc. are the other major human induced activities, which have shaken the foundation of eco-balance in Himalayan region.

Among the factors mentioned above, deforestation is the major cause of environmental degradation, which resulted in increased vulnerability of the Himalayan region to natural hazards. Himalayan forests, rich in flora and fauna have been brutally exploited by man for many decades. After independence a huge portion of the Himalayan forest has been earmarked for the same of green revolution. Thousands of hectares of forest have been cleared especially in the *'Terai'* belt of the Himalayas for agriculture purpose. This shortsightedness of policy makers has caused loss to the Himalayan ecosystem. Besides, during the last two-three decades, due to population increase and lack of other livelihood resources for this increased population, the dependence on agriculture has increased. This has forced the villagers to encroach upon forestland. The *'Jhoom'* cultivation in North-Eastern States has been an age-old traditional agricultural practice, which has damaged large forest areas. Forest fire, grazing, fuel and fodder collection, road construction and other developmental projects have been the major factors responsible for deforestation in Himalayas. Though after enactment of Forest Conservation Act of 1980 (No forest land

can be diverted for non-forestry purposes without sanction of the Central Government) there has been a remarkable decrease in forest land diversion, but so many other activities directly or indirectly connected with human need and greed are badly damaging the forests in these areas. According to the Forest Survey of India (State of Forest Report, 1999) the total forest cover in the 98 hill districts of the country is 251.219 sq. km., constituting 37 percent of the total geographic area, which is very less against a goal of 66 percent as laid down in the National Forest Policy.

Deforestation in the Himalayas has increased the severity of floods during the rainy season and reduced steam flows and dried up springs during dry seasons. The increase of soil erosion has reduced the water carrying capacity of the rivers resulting into swallowing of riverbeds leading to floods in the plains. Rapid deforestation in the Himalayas and resulting degradation of its ecology has posed a potential danger to the greenery of the Indo-Gangetic belt causing sporadic floods in one and drought in the other area.

The worst impact of deforestation is the manifold increase of soil erosion and landslides. The mountains consisting of fragile rocks either due to mineral composition or due to fractures and shears in them are worst affected by deforestation. The loss of tree cover loosens the soil and rock material, otherwise bound by the roots of the trees disallowing it to be eroded by water and wind. The problem has become very serious in some parts of the Himalayas where due to deforestation and soil erosion the major portion of the fertile topsoil is lost and the area is approaching to desertification. The natural appearance of xerophytic plants in some Himalayan areas is certainly a matter of concern for the country. In comparison to relatively stable areas, the problem of soil loss and slope failures is much more serious in technically active zones of the Himalayas. Scientists near Kathmandu identify some pockets of the Himalayas with an alarming rate of soil erosion. – Kankani is in Central Nepal, where 126 sq. km. of ground is lost every year through mass movement at the rate of 1000 cubic meter / sq. km. Similarly in Shiwalik hills of Hoshiyarpur, Punjab the seriously eroded land has increased from 195 sq. km. in 1852 to 200 sq. km. In the Sindhu valley, the rate of erosion various from 2 to 12 mm/year.

On an average, the Himalayan mountains region is losing its soil cover at the rate of more than 1.00 mm per year. In the central sector of the Himalayas, the sediments yield of rivers is 16.43 ha. meters per 100 sq. km. of catchment area per year. This large-scale soil erosion by the flowing rivers has led to multifarious problem in the Himalayan region and the adjoining downstream plains. The shortage of water in one area and floods in other are common as a result of large-scale soil erosion and mass movement. The situation further gets aggravated when this soil is deposited in the streams of lakes. Lakes like Dal and the Wular in Kashmir, Naini Lake of Nainital (Uttaranchal) and Sukhna lake of Chandigarh shrinking due to the problem of sedimentation.

Thus we see that deforestation in the Himalayan region has not only accelerated but also initiated disasters. This phenomenon has multiplied the adverse impacts on the society and the land as far as disasters are concerned. Deforestation, while on one hand accelerates the frequency and intensity of natural hazards, on other hand it increases and vulnerability of society and the region to natural hazards and thus the risk?

Along with deforestation and forest degradation, the plantation of some exotic species is also having adverse impact on Himalayan environment and ecosystem. The invasion by pines in the Himalayas has adversely affected the water tables; ground biomass, undergrowth of other smaller species etc. Due to this reduced undergrowth, the ecosystem of pine

forest is not wild life friendly. Deforestation and degradation of forests have lead to adverse environmental impact. The invasion of forest vegetation like *Lantana Camara* and *Euthorbia Roylaena* has really created an alarming situation. These vegetations do not allow the growth and survival of other plants and thus degrade the forest quality.

Unscientific development practices adopted in the Himalayas have been yet another major factor causing immense loss to the environment and initiating disasters in this fragile ecosystem. After independence and especially after the China War in 1962, the main emphasis of the central government was to increase connectivity in the Himalayas region through roads. During this period even the interior villages were connected by roads. But the most unfortunate part of this development had been that these roads were constructed without proper scientific investigation. This activity has generated huge amount of debris and other waste, which ultimately deteriorated the environmental conditions and shattered the eco-balance of the region. The blasting carried out to clear mountains for making new roads also results in landslides and rock falls. Beside roads, other developmental projects, i.e. hydropower, irrigation, railway tracks etc. have also caused irreparable loss to the environment of the region increasing the risk for human society by natural hazards.

Industrialisation is another major cause for environmental degradation in the Himalayas. After independence, availability of natural resources (forest, minerals, raw materials etc.), electricity, communication, cheap labour etc. encouraged prospective industrialists to establish industries in various towns and cities of the Himalayas region. Sri Nagar, Jammu, Shimla, Solan, Bilaspur, Dehradun, Haridwar, Almora, Gangtok, Darjeeling, Tejpur, Guwahati, Shillong and many other towns developed various industries, which have resulted to environmental problems like pollution, deforestation etc., further exposing and making the region more susceptible to natural hazards.

Urbanisation in the Himalayan belt has also been responsible for increased vulnerability to disasters. With the urbanisation, the demand for various natural resources increased leading to their brutal exploitation and consequent environmental degradation. Increased demand for residential accommodation and tourism etc. forced the people to build houses in hilly terrain without following the specific norms or guidelines stipulated for such area. It has been observed that mostly in newly developed / developing towns or cities the buildings constructed are mere copies of plain areas without due consideration to local seismicity, ecological or environmental aspects.

6.9 CONCLUSION

Vulnerability analysis and risk assessment on the above lines, with the involvement of community, will be helpful in terms of making the community cautious about using natural resources. This will definitely enable them to initiate precautionary measures and be prepared for post-disaster mitigation. Shortsighted development policies have damaged eco-systems in India and around the world. Sustainable development has as much *utilitarian* value as *ethical* as damage to life and property accruing due to increasing natural and man made disasters is immense. The World seems to have woken up albeit partially to the necessity of a disaster perspective to development. Existential philosophy, which gained credence after the industrial revolution, would have to be accommodative of the ideal of sustainable e development to b viable. *'Existentialism'* is explained in the *Collins Gem English Dictionary* as a "philosophy stressing importance of personal responsibility and the free agency of the individual in a seemingly meaningless universe."

6.10 KEY CONCEPTS

Downstream : In its down stream movement the river carries the load of debris, which it has accumulated during its upstream course and is highly corrosive. The river's natural course culminates in final merger with the sea. If the debris is overloaded, delta formation takes place at/near the 'mouth'. Wetlands and mangroves are found in this area and also rich biodiversity.

El Nino : As explained in the Discovery Encyclopedia (*Series One)*, in a year with normal weather pattern winds blow westward and push the warm surface water towards the western Pacific Ocean In some years when the winds weaken, warm water spreads almost over almost the entire tropical pacific ocean This warm water prevents the upwelling of cool, nutrient rich deeper water along the east coast of the pacific. Fish die and severe climate change takes place. Rain follows the warm water eastwards causing drought in Southern Asia and Australia and Floods in North and South America.

Terrai : The Himalayan Kingdom is divided into three regions, running east to west is a Terrai region that forms a low flat land, inhabited by almost 50% population. This region is currently threatened by unsustainable resource use, which has posed a threat to the nature's ecosystem, flora, fauna and rich biodiversity.

6.11 REFERENCES AND FURTHER READING

"A Climate Risk Management Approach to Disaster Reduction and Adaptation to Climate Change" UNDP Expert Group Meeting, Integrating Disaster Reduction with Adaptation to Climate Change Havana, June 19-21, 2002 United Nations Development Programme, at

http://www.undp.org/bcpr/disred/documents/wedo/icrm/riskadaptationintegrated.pdf.

"Initiating a Vulnerability and Capacity Assessment,"at http://www.ifrc.org/docs/pubs/disasters/Vca_part3.pdf

Ayson, 1993, quoted in Rohit Jigyasu, Ph.D. Thesis, 2002, *Reducing Disaster Vulnerability through Local Knowledge and Capacity: The Case of Earthquake Prone Rural Communities in India and Nepal.*

Bankoff, Greg, George Frerks and Dorothea Hilhorst, 2004, *Mapping Vulnerability*, Sterling, Earthscan.

Brooks, Nick, "Adaptation: A Conceptual Framework", 2003, Tyndall Centre Working Paper no 38, Norwich.

Cannon, Terry, 2000, "Vulnerability Analysis and Disasters", D J Parker (Ed.) *Floods*, Routledge, London.

Cutter, S.L, J.T. Mitchell, and M.S. Scott, 2000, "Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina," *Annals of the Association of American Geographers* 90 (4) 713-737.

Gilbert, C, 1998, *Studying Disaster Changes in the Main Conceptual Tools*, Rouletdge, London.

Grant, 2000, "Globalisation, Big Business and the Blair Government", Center for Study of Regionalisation and Globalisation Working Paper No. 58/00, University of Warwick, UK.

Graz, L, 1997, *A Question of Vulnerability*, Red Cross, Red Crescent, No.3, pp.2-7.

Ingleton, J, (Ed.), 1999, *Natural Disaster Management*, Tudor Rose Holdings Ltd. Leicester, UK.

IPCC, 2001, "Climate Change, 2001: Impacts Adaptation and Vulnerability", Summary of Policy Makers, WMO, Geneva.

Johan, Kieft and Aspian Nur, "Community Based Disaster management: A Response to Increased Risks to Disaster with Emphasis on Forest Fires" FAO Corporate Document Repository, at http://www.fao.org/documents/docrep/005/AC798E

Jones R. and R. Boer, 2003, "Assessing Current Climate Risks Adaptation Policy Framework: A Guide for Policies to Facilitate Adaptation to Climate Change," UNDP, at http://www.undp.org/cc/apf-outline.htm

Kasperson, J.X., R.E. Kasperson, and B.L. Turner III (Eds.), 1995, *Regions at Risk: Comparisons of Threatened Environments*, United Nations University Press, Tokyo.

Kobe Report Draft Report of Session 1.4, Thematic Cluster 1: "Turning Practice into Policy: Supporting Community Risk Reduction through Government and Institutional Policy", Summary of the Session's Presentations and Discussions at http://www.unisdr.org/wcdr/thematic-sessions/thematic-reports/report-session-1-4.pdf.

Mitchell, J.K, 1999, *Crucibles of Hazard: Disasters and Megacities in Transition: Tokyo and New York*, United Nations University Press, Tokyo.

NOAA Coastal Services Center, "Linking People Information and Technology,: "Risk and Vulnerability Assessment Tool", at, http://www.csc.noaa.gov/rvat/criticalEdd.html

Pelling, M, 1997, UN-IDNDR & QUIPUNET Internet Conference on *Floods, Drought: Issues for the 21st Century*, at http://www.quipu.net: 1997/English/Welcome.htm

Pelling, M, 1997, "What Determines Vulnerability to Floods: A Case Study in Georgetown, Guyana", *Environment and Urbanisation* Vol.9, 1, pp.203 - 226.

Sen, Amartya, 1981, *Poverty and Famine: An Essay on Entitlement and Deprivation*, Oxford University Press, Clarendon.

White, G.F, 1974, *Natural Hazards: Local, National, Global*, Oxford University Press, New York.

White, Gilbert F. and J. Eugene Hass, 1975, *Assessment of Research on Natural Hazards,* Cambridge, the MIT Press, MA.

Winchester, Peter, 1992, *Power, Choice and Vulnerability: A Case Study in Disaster Management in South India*, James &James Science Publishers.

Wisecheselgarner and Bertner, 2000, quoted in Rohit Jigyasu, Ph.D. Thesis, *Reducing Disaster Vulnerability through Local Knowledge and Capacity, the Case of Earthquake Prone Rural Communities in India and Nepal.*

Wisner, Ben, 2001, "Vulnerability in Disaster Theory and Practice", International Work-Conference Disaster Studies of Wageningen University and Research Centre 29/30.

Wisner, Ben, 2001, *Disaster and Development*, Development Studies Institute, London School of Economics and Political Science, El Salvador.

6.12 ACTIVITIES

1) What do you understand by the concept of vulnerability? Explain with suitable examples.
2) Discuss various approaches of vulnerability analysis.
3) Write a note on VCA.