
UNIT 1 GLOBAL CHANGE

VULNERABILITY ASSESSMENT

Structure

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1.1 INTRODUCTION

We have already learnt in the previous units that climate change has direct impact on the lives and livelihoods of various communities residing in different socio-ecological settings. We have also learnt that it has differential impacts and affect badly the people residing in developing countries. This is because majority of population residing in this part of the world rely upon natural resource based livelihoods like farming, fisheries and forestry. Climate related disasters can cause damage to both lives and livelihoods, thus a deeper understanding of vulnerability to climate change is required. Now the question arises that who are the people or what are the regions that are more susceptible for getting harmed? For that purpose, we have to look in to the concept and measurement or assessment of vulnerability.

In this unit, we shall start our discussion by analysing the need for climate research for the society. This would be followed by a detailed discussion on the concept and measurement of vulnerability along with the opportunities and the related challenges associated with vulnerability assessment. The concept of social vulnerability will also be discussed. We will conclude this unit by briefly describing assessment of social-ecological systems through various frameworks.

1.2 OBJECTIVES

After studying this unit, you should be able to:

- describe the need of climate research for the society;
- define vulnerability and its components in the context of climate change;

- explain the various challenges and opportunities of vulnerability assessments; and
- assess social vulnerability and social-ecological systems.

1.3 CLIMATE-SOCIETY RESEARCH

As you know that climate has been affecting the human society since ages but the impact can be felt more aggressively in last few decades. The study of climate in isolation may not be much of useful unless we carry out in combination with the society. Climate and society have been interacting with each other and there exists a two way interaction between the both. The IPCC further states that these changes in climate can be due to “natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use” (IPCC, 2014, p. 120). The Article 2, of United Nation Framework Convention on Climate Change (UNFCCC), states that there is need for stabilisation of the greenhouse gases as it may lead to “dangerous anthropogenic interference with the climate system”. Now this would require scientific research and social values to achieve the vision mentioned in this article. The communities or the nation has to make a decision about the level of emission which may not be in category of “dangerous”. Scientific research can provide answers to it but it is up to the societies to act upon and it becomes more relevant when losses of human lives or the future generation is at stake (IPCC, 2014; pp.1047).

The focal point of inter-relationship is the impact of climate on the livelihood of the communities that depend upon resources that are climatic sensitive. Societies especially in developing countries have a larger dependence upon agriculture and related activities. Similarly, the coastal areas have dependence upon fisheries and the indigenous communities have larger stakes in forest based livelihoods. Now any changes in the climate or its variable may bring a paradigm shift in the lives of people. Some of the climate related hazards like storm, floods, cyclone, inundation of low lying areas and drought may not only impact the livelihood but can also be a major cause for displacement, economic loss and threats to existence for flora and fauna including the humans. The IPCC fifth assessment report has given a focus analysis by analysing climate change through the livelihood perspective. It states that climate change intermingles with lives and livelihoods in “multifaceted and cross scalar ways” (Olsson et al., AR5, WGII IPCC, 2014, p.796). The IPCC further notes the adverse impacts of climate and its extreme events that are threatening and eroding the basic requirements, capabilities and rights to gain livelihoods especially of poor and marginalized communities thus reorganizing their traditional occupational structure and livelihoods. The impacts can trigger price rise of commodities as there would be loss in crops, destroying of natural habitats leading to food insecurity. Human security can also be at stake as there would be increased migration which may lead to a compromise of “cultural identities” causing internal and external strife that can limit the abilities of state in providing necessary conditions for human security (IPCC, 2014).

Human Development Report, 2007 highlighted that climate change has been determining the human development by eroding long-term opportunities, by declining the productivity and eroding human capabilities as it limits the choice of human freedom. It has identified key areas like agricultural production, water

stress, sea level rise, ecosystem services, and human health which can reverse the development and all these areas are directly impacted by climate change. Moreover these impacts do not act in isolation but may interact with wider social, economic and ecological processes that are being responsible for shaping the opportunities for human development (UNDP-HDR, 2007).

Climate change poses threats to all, but larger impacts will be casted upon developing nations as per the World Bank report 2010. Developing nations may have higher level exposure and low level of inherent resilience due to limited institutional capacities for combating the risks generated by climate change, and communities have larger dependence upon climate sensitive livelihoods (World Bank, 2010). The India's second communication to United Nations on climate change highlights that livelihoods of rural people were vulnerable as the main source is agriculture that has high level of climatic sensitivity (NATCOM, 2012).

Hence considering all these arguments, we need to understand the climate and its variability in totality predicting futuristic scenario scientifically. Besides, the research for social capacities as well as capabilities also to be carried out for implementing various mitigation and adaptation strategies at individual, societal, national and global levels with appropriate policy interventions.

Check Your Progress 1

- Note:** 1) Use the space given below for your answers.
2) Check your answers with those given at the end of this unit.

1. Explain why the research for the climate is significant for the society.

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1.4 DEFINITIONS, CHALLENGES AND OPPORTUNITIES OF VULNERABILITY ASSESSMENT

When we discuss about vulnerability, there exists hundreds of concept which revolves around this term. In the year 1990, vulnerability has emerged as a debatable concept amongst researchers working in the field of developmental studies (Chambers, 1994), though initially it can be traced in the academic discussions on the occupational structures of communities residing in flood plains (White, 1964). Besides, different disciplines have also used this concept to view problems like food insecurity (Sen, 1981), disaster assessment (Cutter et al., 2003; Wisner, 2004), sustainable livelihood evaluation (Chambers and Conway, 1992) and numerous authors have used to evaluate the impacts of climate variability and change (Adger, 2006; Brenkert and Malone, 2003; Ericksen et al., 2011; O'Brien et al., 2004; Midgeley et al., 2011).

1.4.1 Defining Vulnerability

Various definitions of vulnerability exist but at times it is difficult to have consensus amongst the scholars about the exact definition of vulnerability. In simple sense, vulnerability communicates an idea of propensity to get harm or damaged. The concept has been viewed differentially across different disciplines and hence it has gained a multi-disciplinary approach. It has also been equal to concepts like resilience, risk exposure, marginality and adaptability (Liverman, 1990). Hinkel (2011) has stated that there exist many definitions and interpretations of vulnerability but we will look into definitions propounded by different authors in the context of climate change

Table 1.1: Definitions of vulnerability in context of climate change

Author(s)	How they have defined vulnerability
Watts and Bhole (1993)	Vulnerability in relation to food insecurity can be viewed as characters having exposure, capacity and potentiality.
Cutter (1996)	As a phenomenon which has potentials for loss.
Moss et al., (2001)	Vulnerability can be the point up to which any society or system may experience interruptions due to climate change.
Turner et al., (2003, p. 8074)	It is defined as “the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor.”
Adger (2006, p. 268)	Vulnerability as “state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt.”

Authors like Chambers (1989) and Watts and Bhole (1993) pointed that vulnerability has two sides which have been distinguished as “internal” and “external” aspects. The external side represents the “stress” which any system has been exposed to, whereas the internal aspects reflects its intrinsic incapacity for coping and recovering from stresses or a particular hazard. Another view on vulnerability has been given by Moser. According to him, vulnerability should include the capacity of any system for withstanding against the risks generated by changing climate. The vulnerability can be linked with possession of assets and entitlements, thus the units that are having lesser assets may be more vulnerable than those commanding more for facing the crisis like droughts and famine (Moser, 1998). The two important characteristics of vulnerability is its context specificity and dynamism. The nature of vulnerability may be contextual, i.e. different factors that cause vulnerable situation in any region or household may be different in another region or household (Brooks et al., 2005; Fussel, 2010). The other characteristic is the dynamic nature of vulnerability, wherein the

level or intensity changes, in case of any variation in either biophysical or socio-economic conditions (Cutter et al., 2009; Smit and Wandel, 2006). The definitions given by different assessment reports of IPCC is presented in the box 1.1

Box 1.1: Definition of vulnerability given by different Assessment Reports of IPCC

IPCC Third Assessment Report (TAR)

“The degree to which a system is susceptible, or unable to cope with adverse effects of climate change, including climate variability and extremes, and 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.” (Smit and Pilifosova, 2001, p. 995)

IPCC Fourth Assessment Report (FAR)

“The degree to which an environmental or social system is susceptible to and unable to cope up with, the adverse effects of climate change, including climate variability and extremes” (IPCC, 2007, p. 883).

IPCC Fifth Assessment Report (AR5)

“The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.” (IPCC AR5, 2014, p. 1048)

The recent fifth IPCC Report has discussed as to how the physical climate system and the prevailing socio-economic process interacts with each other to produce the outcome which is “risk”. The IPCC has defined risk as “the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values” (IPCC, 2014, pp. 1048). Here, when we discuss risk in context of climate change, it shows about the probability of occurring of any climate related hazard or event and it is multiplied by the possible impacts which may occur due to such risk. Mathematically, risk can be represented as

$$\text{Risk} = (\text{Probability of Events or Trends}) \times \text{Consequences}$$

The figure 1.1 illustrates that the climate system which may include the natural process of variability as well as variability which is being caused by the activities of humans like emission of greenhouse gases and changes in land use pattern. Both the factors cause the occurrence of climate related hazards. The socio-economic processes like social status, wealth, adaptation processes and mitigation actions taken by the government and communities as well as the policies and practices which are involved in the process of governance are the key drivers which may affect the vulnerability and the exposure of the communities and the regions. From the figure, we can see that the risk which can be generated by the global change is an outcome of the interaction between the vulnerability of the communities, their exposure, and the occurrence hazard, its frequency and intensity.

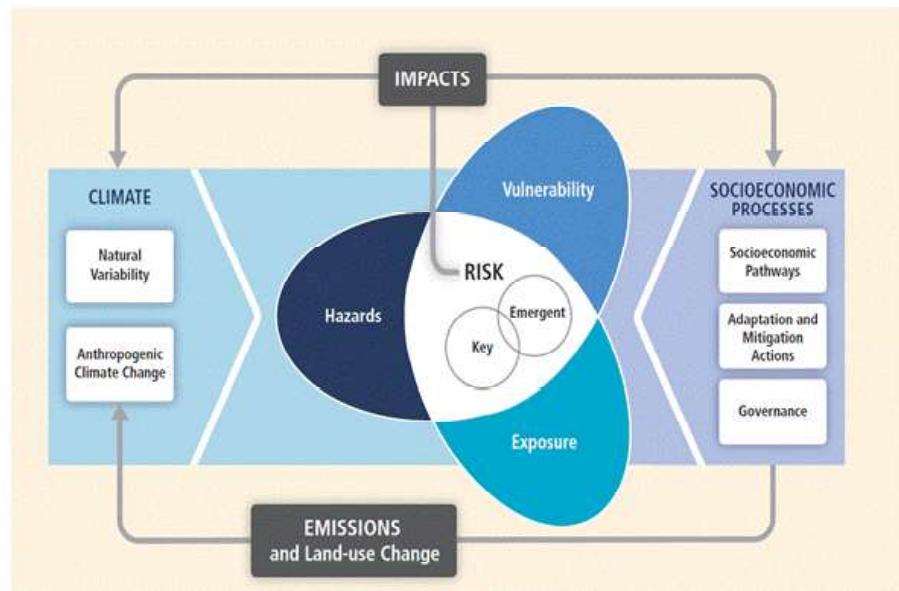


Fig. 1.1: Interaction between the climate system, exposure, and vulnerability producing risk.

(Source: IPCC AR5, 2014; pp. 1046)

1.4.2 Challenges of Vulnerability Assessment

The assessments of vulnerability pose many challenges for researchers and the major reason for these challenges are as follows:

- (i) **Dynamic and intangible nature of the vulnerability:** Inherent dynamic nature of the vulnerability posed challenges, especially when it is measured in different spatio-temporal dimensions (Cutter et al., 2009; Eriksen and Kelly, 2007). Another reason which aggravates the challenge of measuring the vulnerability is that at times, vulnerability do depicts certain characters which are difficult to be observed directly (Downing et al., 2001). Cutter et al., (2009) have presented in detail the methods used in vulnerability assessment and have discussed the challenges and limitations as well. Some of the challenges are being discussed in this section.
- (ii) One of the major challenges during defining and mapping the communities for social vulnerability by using different frameworks is that the parameters that have been used may not include the distinct personal characteristics.
- (iii) **Reflecting heterogeneity:** Another challenge is that whenever the vulnerability is measured by using a group approach or for a group of people, the results may not reflect the heterogeneity of the group. Suppose you have chosen to assess the vulnerability at the household level, the composite level may not reflect the vulnerability of individual member of the household which may differ. For example, the vulnerability of children, women and elderly persons may be different as compared to the male working members.-
- (iv) **Selection of appropriate indicator:** While using the indicator approach which is one of the most popular methods for measuring the vulnerability, there exist certain challenges for developing and using the indicators. There may be complex situations where the indicators may interact within the

system for a variable or a set of variables, which may cast a major influence on the fact that what is to be measured and how is to be measured (Bogardi and Birkmann 2004; Barnett et al. 2008). It may be also possible that at times some concepts or interacting factors may not be easy to quantify. For example, if you want to measure parameters like involvement in social network, confidence level in public and government institutions and the capacity of readiness in tackling climate related hazards, it can be difficult and challenging situation for any researcher to map these traits using quantitative measures.

- (v) **Availability of the reliable secondary data:** Another major challenge is the availability of the reliable secondary data from government sources with regard to hazards which may relate to climate variability and its impact on communities. Considering these limitations, the vulnerability indices generated may have a limited scope in the scale of analysis, more specifically when the index may reflect a limited geographical area or time frame. Another big challenge is in comparing the results generated by different vulnerability indices as they have used different set of characters, geographical unit or approaches for constructing the index (Cutter et. al., 2009).

1.4.3 Opportunities of Vulnerability Assessment

Vulnerability assessment is a complex and difficult process because sometimes it has challenges of being observed and projected in futuristic mode. However, the assessment of the vulnerability provides various opportunities at different levels of decision making in adapting and mitigating towards the impact of global change (Schroter, et al., 2004).

The significance of assessment of people, communities, areas, regions have enhanced because the climate change have differential impact on various regions as well as communities. Hence, the outcome of the assessment cast a significant impact on designing policies and plans for adaptations. Seeing the importance now, there have been various studies both in the domain of science and public policy disciplines about the various frameworks, methods and tools to understand and assess the vulnerability. Several researchers like Fussel and Klein (2006), Patt et al. (2009) and Hinkel (2011) have elaborately discussed the purpose and the opportunities for vulnerability assessment. These are as follows:

- (i) **To set mitigation goals:** Assessment are being made to evaluate the various impacts of climate change under different greenhouse gases emission scenarios which is one the most important cause of anthropogenic interference in the atmosphere. This calls for setting up immediate targets and time frame for reducing the emission of gases responsible for global change. The assessment of vulnerability gives an opportunity to international community and states/parties to different conventions and UNFCCC to take corrective measures for reducing the emission and meeting the mitigation goals.
- (ii) **Channelizing funds and allocating resources:** The vulnerability assessment gives an opportunity for identifying specific community or region which may have highest level of impact for allocating appropriate resources that can be helpful in adaptation process. At

international level also, a huge funds are being channelized to different countries and regions which can be judiciously used on the basis of the priority obtained from the outcome of the vulnerability assessment.

- (iii) **Prioritization for adaptations:** The results of the vulnerability analysis can converge the knowledge domain of scientific community and the local stake holders for designing suitable adaptation process and policies which may enhance their adaptive capacity in the context of their issues. The evaluation can also give an insight on the prioritization of process which may include the integration of traditional as well as modern scientific knowledge for diminishing the sensitivity and exposure to the climatic extremes.
- (iv) **Monitoring and evaluation:** Another important opportunity which the vulnerability assessment provides is the evaluation of the impact of the ongoing adaptation policy. The current adaptation practices which the communities are being adopting can be monitored and evaluated in terms of the outcome of vulnerability analysis.
- (v) **Information and awareness about the impacts:** If the impact of climate change can be assessed for particular region or communities through vulnerability analysis, it will provide an opportunity for informing and sensitizing the communities about the futuristic possible effects and can help them for their readiness to cope or adapt with it. It may be also helpful for the decision makers as they may not have a deeper understanding in the complex issues related to global change and its impact on the society.
- (vi) **Opportunities for research:** It provides an opportunity for further research regarding the complex nature of human-environment interaction and its consequences due to global changes. Moreover, the methods, frameworks and tools utilized in vulnerability analysis may provide a broader base for understanding the vulnerability in the contextual scenario from the perspective of various disciplines. The researchers' may have the opportunity to look into the issues through multi-disciplinary approach with scientific outlook and the outcomes can be predecessors for the appropriate policy interventions.
- (vii) **Helpful in development of adaptation policies:** Another important opportunity as highlighted by Preston et al. (2011) is about the two distinct process of vulnerability assessment that may be helpful in development of adaptation policies. The first includes the problem orientation view of vulnerability assessment in which the focus is on gathering various information about the current and future vulnerability scenarios, assessment of impacts and adaptive capacity and the issues which may be helpful in decision making process for incorporation in the on-going or new policies. The second view of vulnerability assessment is the decision support view which mainly focuses on the strategic aspects of vulnerability management. These two processes may complement and supplement each other and the appropriate opportunity for vulnerability assessment should be in providing outputs which can be easily communicated to the decision makers for integration in policies which may have powerful impact in reversing the vulnerable situations in relevant context.

Check Your Progress 2

- Note:** 1) Use the space given below for your answers.
2) Check your answers with those given at the end of this unit.

1. What is Vulnerability?

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2. What are the major challenges and opportunities you have to face while assessing the vulnerability to climate change of a particular area or community?

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1.5 SOCIAL VULNERABILITY ASSESSMENT

When we describe about social vulnerability, it indicates the characteristics of the community which have influence over their capacity for preparing, responding and recovering from the climate related hazards and disasters. If we want to define the term in the simplest way, it can be as “the differential capacity of groups and individuals to deal with hazards, based on their positions within physical and social worlds” (Dow, 1992), or as “the inability to take effective measures to insure against losses” (Bogard, 1988). When we look the aspect of social vulnerability in connection with the livelihood, the definition propounded by Adger is as “the exposure of groups or individuals to stress as a result of social and environmental change, where stress refers to unexpected changes and disruption to livelihood” (Adger, 1999, p. 249). Social vulnerability gives an insight as to why certain communities face the hazards more severely than others though there is a similar exposure. This indicates that the nature of the social vulnerability is “pre-existing condition” or an inherent property of the societies which is independent to the nature of hazard.

To measure the social vulnerability directly is difficult as there are multiple aspects which interacts and influence the social vulnerability. Hence, there are some broad indicators which are being used by the researchers to assess the social vulnerability. The most common indicators includes socio-economic status, gender, age, special needs, employment status, geographical locations, occupational status, education, family structure, housing ownership patterns, access to emergency medical services, level of development and geographical locations. Some other indicators can also be added to the list according to the local and contextual requirements. These indicators have a different impact individually and in a combined way over the level of the vulnerability as it either increases or decreases the vulnerability. For example, the high per capita income will reduce

the vulnerability; where as high percentage of the young and elderly population in the area may enhance the social vulnerability as these categories of people may not be able to respond to the risk or the hazards without any external support.

Of the many indices developed for assessing the social vulnerability, there is a special need to mention about the Social Vulnerability Index (SoVI) developed by Cutter et al. in 2003. This index is a multi-dimensional, scale dependent and can be used across the spatial units for assessing relative socio-economic and demographic characters to measure the vulnerability. The distinctive character of this index was that it stood like an indicator which gave an acceptance to the theoretical perspective about the independence of social vulnerability with the type of the hazard. For the assessment of social vulnerability, certain steps have been suggested by the United Nations Development Programme (UNDP) Report titled “Social Vulnerability Assessment Tools for Climate Change and DRR programming, 2017”.

The first step involves developing a set of reliable indicators which may be suitable for that particular geographical area. For that you need to prepare a list of preliminary indicators for which the data can be made available. A preliminary qualitative survey can be carried out by using interviews with the stake holders and focused group discussions. One should keep in mind while selecting the indicator that the related data is available and the survey can be further repeated for that indicator in the study area.

Another important consideration that should be kept in the mind while selecting the indicators as several indicators may communicate different meaning at different level. For example, the educational attainment may communicate a different sign at individual, household, regional or national level. The indicator should be identified with a view that it must cast much influence to social vulnerability as the analysis generally remains context specific, there is a requirement for having a larger consultation with the local experts to know the factors which may be suitable in the specific context and their functional relationship with the social vulnerability.

Now the next step is to identify the tool for data collection. Generally, household survey can be one of the important tools for collection of the socio-economic data, though it has certain limitations. It tells us about the composite data at the level of the households and not at the individual level which may have the implications of intra-household inequalities. So, again one has to decide the method of data collection which is cost effective and time saving.

Once the indicator have been chosen we need to give them weight to find out the more important variables affecting the social vulnerability in the data sets. Weights can be assigned by using either equal weight method as utilized by UNDP in calculating the Human Development Index (HDI) or by unequal method by using the statistical tool Principal Component Analysis.

For qualitative analysis, one may have to choose the method which may be most suitable in the context of the analysis, considering the strength and weakness of the methods. For example, the in-depth interview can provide a larger insight in the issues however they are time consuming. Focus group discussions are less time consuming and can give new ideas with the broader consensus of

group, however it has a limitation that the output can have an element of domination by few influential persons in the group.

The data collection can be done by employing techniques like field survey or online data collection that also depend upon the situation and circumstances. The data collected needs to be cleaned and should be consistent without noise. All the chosen variables need to be defined at the highest measurement level as possible. Classification of data should be done as per the requirement of the analysis. The data collected may be in different units and standards. Hence, it should be standardised to make it unit less. The statistical tool PCA can be applied to the data for checking dimensionality and for avoiding the redundancy in the data sets.

The scores for each indicator can be computed which can further be aggregated to produce a composite social vulnerability index for the particular geographical area or unit. After obtaining the results the social vulnerability scores can be depicted through visual maps using various software tools and open source GIS tools. This will help the researcher to plot the social vulnerability data on the point of map where the study has been conducted which may give a visualization effect of social vulnerability and its inter-connections with various indicators in relevant geospatial context.

1.6 ASSESSMENT OF SOCIAL-ECOLOGICAL SYSTEM

When we talk about “Social-Ecological System” (SES), it gives an image in our mind about a complex system where human and environment are into a constant interaction with interconnectedness. Earlier the ecologist used to study about the ecological systems and the sociologist was studying the social system. It was felt that study of ecological systems cannot be done in isolation and hence the concept of integrating the social system with the ecological system emerged which was called “Social-Ecological System”.

Berkes and Folke (1998) conceptualized that Social-Ecological System as the systems where nature and humans have a strong inter-linkages. In these systems, the bio-physical and social factors interact in a resilient and sustainable manner. Petrosillo et al., (2015) have described the social-ecological systems where different social, economic, ecological and technological parameters interact and they are truly inter-connected with a coevolving nature across the time and space. The authors have also discussed the main frame works which can be utilised for assessment. Binder, et al. (2013) have analysed and compared ten different types of SES assessment framework and have concluded that the frameworks have been developed according to the needs of context and they have tried to find out the criteria to make decision in regard to the use of the framework for a particular SES. Owing to the importance of the SES, numerous studies have been carried out to understand the SES through inter-disciplinary perspective through various frameworks for assessment of the SES. Some of them have been discussed below:

1. **The Driver-Pressure-State-Impact-Response (DPSIR) Framework:**
This is a conceptual model that depicts the cause-effect relationship. It tries to understand the causal relationship about the pressure which the human system exerts on the environment system. It has integration of environmental

assessment and system science frameworks. Mainly this framework has been used to analyse the human interference in aquatic systems such as coastal zones, water transport or water pollution.

2. **The Ecosystem Framework:** This framework includes the concept of ecosystem where the biotic and abiotic components interact with each other providing services to human systems. It has been mainly developed to ensure the availability of sustainable ecological services. It has been mainly applied for assessing integrated systems like forest and grassland, etc. One of the important frameworks is the millennium ecosystem assessment that has been used to appreciate the linkage between ecosystem services and the wellbeing of the humans who are the beneficiaries.
3. **The Vulnerability Framework:** It is one of the popular and widely used frameworks which uses characters like exposure which denotes how the communities or the region is being exposed to climatic parameters or hazard; sensitivity which indicates about the impact on farming, economy and other wellbeing of the communities and the adaptive capacity which denotes the capacity or capabilities through which the communities can change or adjust their strategies to cope up with the stress. Many researchers have used the framework to assess the vulnerability, which has been taken as “as a function of exposure, sensitivity and adaptive capacity” (IPCC, 2001; 2007). Vulnerability being a complex phenomenon can be assessed by using this framework as both the biophysical and the socio-economical parameters have been taken into consideration which has strong inter-linkages while they operate within the SESs.
4. **The Human Environmental Framework:** It has been developed as a tool for finding out the solutions which have cropped up due to human interactions with the environment. The framework provides an opportunity to explore the problems created by humans for the environment and can be applied to any scale of investigation. It has borrowed concepts from different disciplines such as system sciences, sustainability sciences and theories of decision making. The structures within the SES can be analysed and the dynamics between the social and ecological components can be understood by applying this framework.
5. **The Social-Ecological Systems Framework:** This is a general framework that analyses the resource tiers or cores in the SESs. This adopts a multilevel hierarchical approach in which the levels can be classified as resource system, resource units, users and the governing system. These levels have been further divided into variables which operate relatively separately but are in interacting mode with each other and determine the outcome of the SES. This framework has its origin from the political science discipline and is based upon theories like common pool management and natural resource management. It is mainly used to assess the SESs operating in forest, fisheries and water resources.

Check Your Progress 3

- Note:** 1) Use the space given below for your answers.
2) Check your answers with those given at the end of this unit.
1. Describe in brief the available frameworks which can be used to assess the Social-Ecological System?

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1.7 LET US SUM UP

- Climate has been affecting the human society since ages but the impact can be felt more aggressively in the last few decades. Climate and society have been interacting with each other and there exists a two way interaction between the climate and society.
- We have studied in this unit about the need of climate research for the society; components of vulnerability from the perspective of climate change; challenges and opportunities of vulnerability assessments; and social vulnerability and social-ecological systems.

1.8 KEYWORDS

- Mitigation** : An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases so that we can avoid the likelihood of the occurrence of the climatic variability and extreme events.
- Sensitivity** : “The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)”.
- Vulnerability** : “The degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a systems is exposed, its sensitivity, and its adaptive capacity”.

1.9 SUGGESTED FURTHER READING/ REFERENCES

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1.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

The study of climate in isolation may not be much of use unless we carry out in combination with the society. Climate and society have been interacting with each other and there exists a two way interaction between the both. The focal point of inter-relationship is the impact of climate on the livelihood of the communities that depend upon resources that are climatic sensitive. Societies especially in developing countries have a larger dependence upon agriculture and related activities. Similarly, the coastal areas have dependence upon fisheries and the indigenous communities have larger stakes in forest based livelihoods. Now any changes in the climate or its variable may bring a paradigm shift in the lives of people. Climate change intermingles with lives and livelihoods in “multifaceted and cross scalar ways”. We need to understand the climate and its variability in totality predicting futuristic scenario scientifically. Besides, the research for social capacities as well as capabilities also to be carried out for implementing various mitigation and adaptation strategies at individual, societal, national and global levels with appropriate policy interventions.

Check Your Progress 2

1. IPCC defines vulnerability as “The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt”.
2. The challenges in vulnerability assessment are as follows:
 - Dynamic and intangible nature of the vulnerability;
 - Reflecting heterogeneity;
 - Selection of appropriate indicator; and
 - Availability of the reliable secondary data.

The opportunities in vulnerability assessment are as follows:

- To set mitigation goals;
- Channelizing funds and allocating resources;
- Prioritization for adaptations;
- Monitoring and evaluation;
- Information and awareness about the impacts;
- Opportunities for research; and
- Helpful in development of adaptation policies.

Check Your Progress 3

1. Social-Ecological System is construed as the systems where nature and humans have a strong inter-linkages. Owing to the importance of the SES, numerous studies have been carried out to understand the SES through inter-disciplinary perspective through various frameworks for

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assessment of the SES. The frameworks that are used to assess the social-ecological system is as follows:

- The Driver-Pressure-State-Impact-Response (DPSIR) Framework;
- The Ecosystem Framework;
- The Vulnerability Framework;
- The Human Environmental Framework; and
- The Social-Ecological Systems Framework.

