Vulnerability

vulnerability was defined as the degree to which a system is exposed and susceptible to the adverse effects of a given hazard.

Vulnerability = (Exposure) + (Resistance) + Resilience

Exposure: at risk property and population
Resistance: Measures taken to prevent, avoid or reduce loss
Resilience: Ability to recover prior state or achieve desired post-disaster state.

- **Types of Vulnerability**

- Physical vulnerability
- This refers to the potential losses to physical infrastructure such as roads, bridges, railways, radio and telecommunication mast and other features in the built environment.
- Also includes impacts on the human population in terms of injuries or deaths.

- **Social vulnerability**

- Social vulnerability refers to losses as experienced by people and their social, economic, and political systems
- Vulnerability refers to the extent to which elements of society such as children, the aged, pregnant and lactating women, single parents, physically and mentally challenged, the poor and destitute, social class, caste, ethnicity, gender, family systems, political systems, economic systems and cultural values degrade after being exposed to a hazardous condition.

- **Economic vulnerability**

- This refers to the potential impacts of hazards on economic assets and processes and includes vulnerability of different economic sectors.

- **Ecological/environmental vulnerability**

- This refers to the degree of loss that an ecosystem will sustain to its structure, function and composition as a result of exposure to a hazardous condition.

- **Vulnerability Assessment**

- This refers to the quantification of the degree of loss or susceptibility to an element at risk.
- Variations exist in the method of quantification of vulnerability based on the following:

  a. Type of vulnerability being measured

  b. The scale at which vulnerability is being measured

  c. The type of hazard.

- ***Data needed for vulnerability assessment and their usefulness***

- Historical data on the magnitude of a hazard and the level of damage it caused
- Socio-economic data such as level of education, social networks, sanitation, income level, access to land, access to technology etc
- Level of exposure to hazardous conditions
- Data on policies, institutions and processes which influence capacity of individuals, households and communities

- **Approaches to Physical Vulnerability Assessment**

- There are a wide variety of ways to measure physical vulnerability.
- Two main methods are the empirical and analytical methods.
- The analytical methods rely on the use of geotechnical engineering software and are often limited to individual structures
- The empirical methods can be applied to groups of related structures.

Methods of measuring physical vulnerability

Group	Method	Description
	Analysis of observed damage	Based on the collection and analysis of statistics of damage that occurred in recent and historic events. Relating vulnerability to different hazard intensities.
Empirical methods	**Expert opinion**	Based on asking groups of experts on vulnerability to give their opinions, e.g. the percentage damage they expect for the different structural types having different intensities of hazard. This is meant to come to a good assessment of the vulnerability. Method is time consuming and subjective. Re-assessments of vulnerability after building upgrading or repair are difficult to accommodate.
	Score Assignment	Method using a questionnaire with different parameters to assess the potential damages in relation to different hazard levels. The score assignment method is easier to update, e.g. if we think about earthquake vulnerability before and after application of retrofitting.

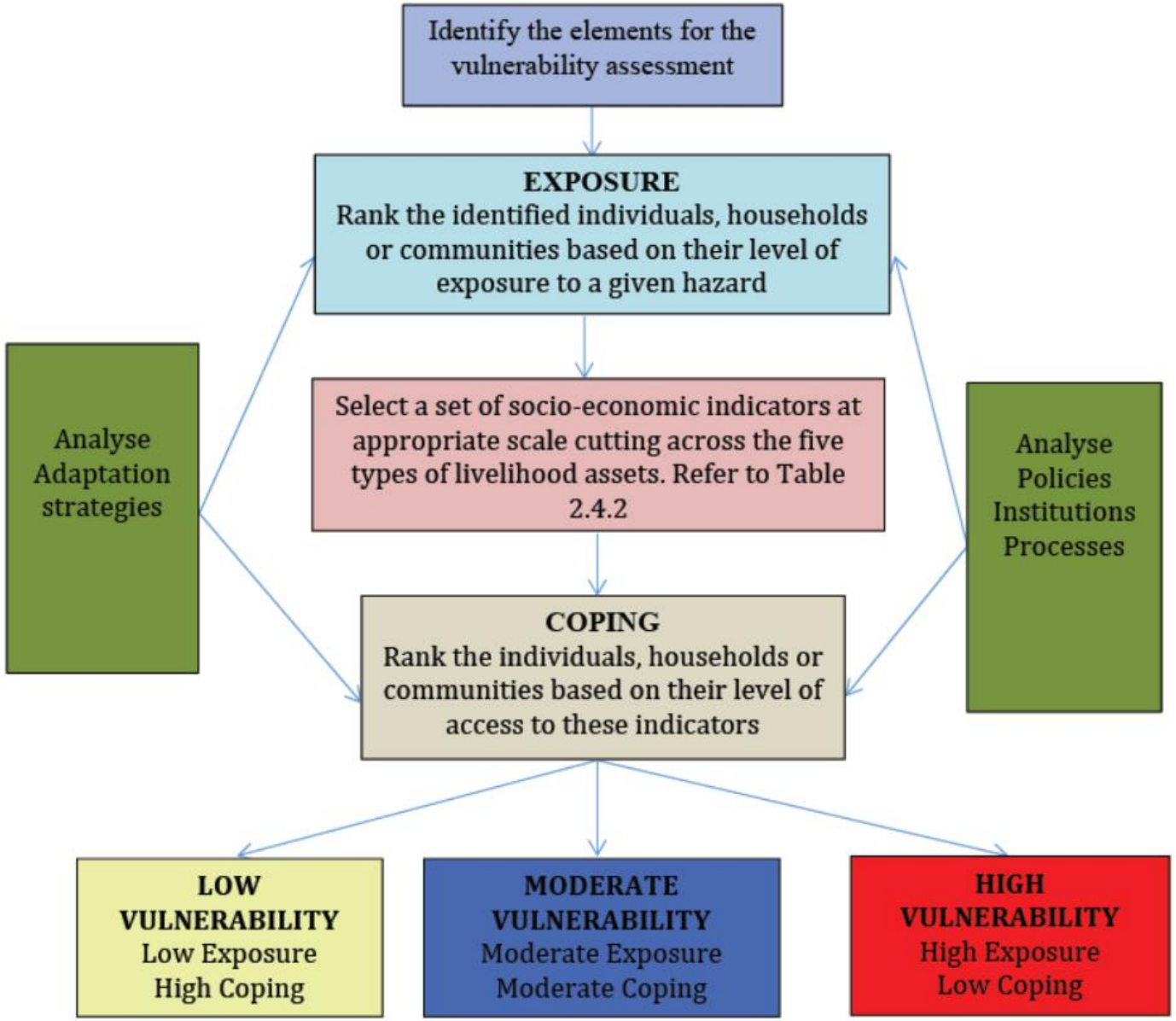
Methods of measuring physical vulnerability

Analytical models	**Simple Analytical models**	Studying the behaviour of buildings and structures based on engineering design criteria, analysing e.g. seismic load and to derive the likelihood of failure, using computer based methods from geotechnical engineering. Using, e.g. shake tables and wind tunnels, as well as computer simulation techniques.
	Detailed Analytical methods	Using complex methods. It is time consuming, needs a lot of detailed data and will be used for assessment of individual structures.

- **Methods of Measuring Socio-economic Vulnerability**

Socio-economic vulnerability is indicator-based and can be assessed by analysing the level of exposure and coping mechanisms of individuals, households and communities.

- **Method for assessing socio-economic vulnerability**



Socio-economic indicators

Human Capital	Natural Capital	Social Capital	Physical Capital	Financial Capital
Health	Land and produce	Networks and connections	Infrastructure • Transport - roads, vehicles, etc. • Secure shelter & buildings water supply & sanitation	Savings
			• Energy communications	
Nutrition	Water & aquatic resources	Patronage	Tools and technology • Tools and equipment for production • Seed, fertiliser, pesticides • Traditional technology	Credit/debt - formal, informal, NGOs
Education	Forest products	Neighbourhoods		Remittances
Knowledge and skills	Wildlife	Kinship		Pensions
Capacity to work	Wild foods & fibres	Relations of trust and mutual support		Wages
Capacity to adapt	Biodiversity	Formal and informal groups		Dividends
	Environmental services	Common rules and sanctions		Return on Investments

- **Methods of Representing Vulnerability**
- **Vulnerability indices**: Based on indicators of vulnerability
- **Vulnerability table**: The relation between hazard intensity and degree of damage can also be given in a table.
- **Vulnerability curves**: These are constructed on the basis of the relation between hazard intensities and damage data

➢ Relative curves: They show the percentage of property value as the damaged share of the total value to hazard intensity.

➢ Absolute curves: Show the absolute amount of damage depending on the hazard intensity

➢ Fragility curves: Provide the probability for a particular group of elements at risk to be in or exceeding a certain damage state under a given hazard intensity.