

SuPeRBE Training Material

Macro Area of Expertise:

1 Climate change and built environment

Area of Expertise:

1.4 Climate adaptation strategies and solutions

Level of competence: 3

INTRODUCTION

- Adaptation to climate change is essential since it is already impacting the built environment
- Climate adaptation strategies help communities and sectors adjust to current and expected climate impacts
- Adaptation planning is complementary to climate mitigation
- Tools like Risk and Vulnerability Assessments (RVAs) and Sustainable Energy and Climate Action Plans (SECAPs) support targeted and effective adaptation
- Proactive adaptation saves lives and money



HAZARDS

- “The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.”
<https://www.ipcc.ch/sr15/chapter/glossary/>
- Hazards can be separated into 2 different categories:
 - Climate-related hazards - encompass extreme weather events and slow-onset climate processes (extreme temperatures, droughts, heavy precipitation, storms, floods, sea level rise)
 - Non-climate hazards - triggered by climate hazards (wildfire, chemical change, mass movement, biological hazards)

Climate-related hazards

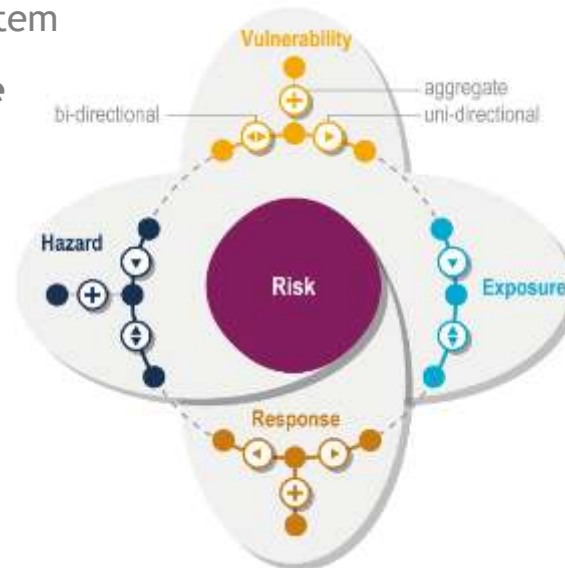
Hazard	Description
Extreme precipitation	Unusually intense or prolonged precipitation events that significantly exceed normal pattern Rainstorm, monsoon, heavy snow, fog, hail.
Flood	Overflow of water onto normally dry land. Flash/surface flood, river flood, coastal flood, groundwater flood
Extreme heat	Prolonged periods of unusually high temperatures. Heat wave, extreme hot days
Drought	Prolonged period of abnormally low precipitation, resulting in water shortages that negatively impact ecosystems, agriculture, and human activities.
Extreme wind	Unusually strong and sustained winds, often associated with storms, cyclones, hurricanes, or tornadoes.
Extreme cold	Prolonged periods of unusually low temperatures.
Sea level rise	Long-term increase in the average level of the world's seas resulting in a permanent inundation.

Non-climate related hazards

Hazard	Description
Wildfire	Uncontrolled fire that spreads rapidly through vegetation, forests, grasslands, or other natural landscapes.
Chemical change	Sal water intrusion, ocean acidification,
Mass movement	Landslide, avalanche, rock fall, subsidence, soil degradation, soil erosion
Biological hazards	Water borne diseases, vector-borne diseases, air-borne diseases, insect infestation

CLIMATE RISK

- Potential for adverse consequences of a climate-related hazard on human or ecological systems
- Results from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system
- **Risk = vulnerability + exposure + hazard + response**
- **Risk management** - plans, actions, strategies, or policies to reduce the likelihood and/or magnitude of adverse potential consequences, based on assessed or perceived risks



Components of risk

Hazard:

- “The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.” (<https://www.ipcc.ch/sr15/chapter/glossary/>)

Vulnerability:

- “The propensity or predisposition to be adversely affected” (<https://www.ipcc.ch/sr15/chapter/glossary/>)

Exposure:

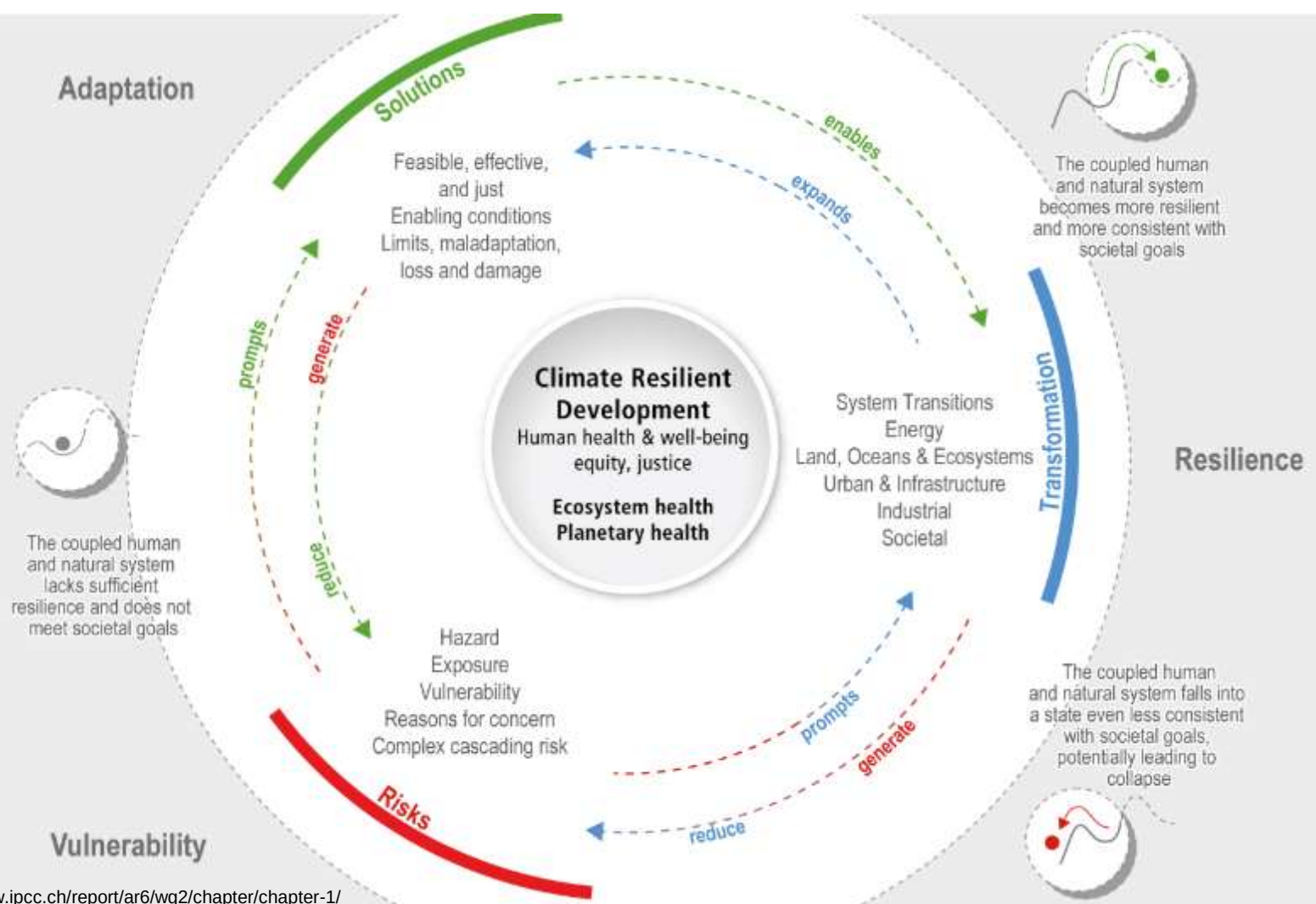
- “The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected” (<https://www.ipcc.ch/sr15/chapter/glossary/>)

Response (Adaptive capacity):

- “The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (<https://www.ipcc.ch/sr15/chapter/glossary/>)

VULNERABILITY

- “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.” <https://www.ipcc.ch/sr15/chapter/glossary/>
- Degree to which a system is susceptible to and unable to cope with the adverse effects of climate change
- Components of vulnerability:
 - Sensitivity
 - Adaptive capacity
 - Lack of resilience



CLIMATE ADAPTATION SOLUTIONS

- Climate adaptation solutions can be:
 - Infrastructural - modifications in the built environment to protect against climate hazards
 - Institutional - frameworks, regulations, and policies
 - Behavioural (social) - behaviour changes of the local community
 - Nature-based solutions (NBS) - use of ecosystems and natural processes to reduce vulnerability and enhance resilience
 - Technological - innovative tools and technologies supporting climate adaptation efforts
- 2 categories:
 - Structural (infrastructural, NBS)
 - Non-structural (institutional, behavioural, technological)

Infrastructural solutions

- Physical measures to reduce exposure and sensitivity to hazards
- Designed to protect infrastructure, buildings and public services from direct climate threats
- Offers immediate and visible protection
- Large-scale and capital-intensive
- Long life span
- Requires maintenance



Hazard	Infrastructural solution	Function/benefit
Flooding	Floodwalls, levees, stormwater drainage system	Physically block or redirect excess water
Heatwaves	Cool roofs, green roofs, reflective pavements	Lower indoor/outdoor temperatures; reduce heat island effects
Drought	Rainwater harvesting systems, irrigation infrastructure	Improve water availability and reduce water stress
Storms	Wind-resistant buildings, underground power lines	Reduce damage from strong winds and falling debris
Sea-level rise	Sea walls, tidal gates, elevated infrastructure	Prevent coastal inundation and infrastructure damage

Institutional solutions

- Strengthening governance, policy frameworks, regulatory systems, and administrative capacities to enable effective climate adaptation planning and implementation
- Embeds climate adaptation into decision-making
- Supports long-term systemic change
- Requires cross-sectoral coordination
- Addresses underlying systems and decision-making processes
- Implemented by governments or inter-institutional bodies

Behavioural and social solutions

- Changes in attitudes, practices, and behaviours of individuals and communities that help reduce vulnerability and enhance adaptive capacity
- Education, training, and awareness raising
- Promotes inclusive, bottom-up participation
- Usually low-cost and locally driven
- Depend on awareness, education and motivation
- Should be used as a complement to other adaptation types



Hazard	Behavioural solution	Function/benefit
Flooding	Community emergency drills and flood preparedness	Improves local response capacity and evacuation readiness
Heatwaves	Public awareness campaigns on health safety	Reduces health risk, promotes self-protection
Drought	Water conservation practices in household/agriculture	Reduces water use during shortages
Storms	Mangrove planting, dune restoration, coral reef protection	Reduces property damage and injuries
Wildfires	Community-led fire prevention, promoting volunteering	Minimizes ignition risk and spread

Nature-based solutions (NBS)

- Use of natural processes and ecosystems to reduce climate risks
- Co-benefits for biodiversity, human health, and quality of life
- Act like buffers or microclimate regulators
- Low-carbon
- Cost-effective
- Examples:
 - Floods: wetland restoration, urban green spaces,...
 - Drought: agroforestry and soil conservation, wetland conservation, drought-resilient landscaping,...
 - Heatwaves: urban forests, tree planting, green roofs, green corridors, park and water body restoration,...
 - Rainfall: permeable pavements, urban green spaces,...



Hazard	Nature-based solution	Function/benefit
Flooding	Wetland restoration, riparian buffers, green urban infrastructure	Store excess water, slow runoff, reduce flood peaks
Heatwaves	Urban green spaces, green roofs/walls, urban trees	Reduce urban heat islands, improve air quality
Drought	Reforestation, soil conservation, agroforestry	Increase water retention, restore soil fertility
Coastal storms	Mangrove planting, dune restoration, coral reef protection	Dissipate wave energy, reduce erosion and storm surge impacts
Landslide	Forest conservation on slopes, vegetation buffers	Stabilize soil, reduce erosion risk
Sea-level rise	Living shorelines, coastal wetland preservation	Buffer against coastal flooding, absorb wave energy

Technical solutions

- Innovative tools and technologies that support adaptation through forecasting, monitoring, infrastructure resilience, and data-driven decision making
- Enables evidence-based planning and early response
- Data-driven
- Provides real-time insights and enables precision responses
- Enhances efficiency
- Supports decision making



Hazard	Technological solution	Function/benefit
Flooding	Early warning systems, remote sensing, flood modelling tools	Improve flood preparedness and allow for timely evacuation and disaster response
Heatwaves	Heat-health warning systems, climate dashboards	Alert authorities and citizens to upcoming heat events, enables health sector readiness
Drought	Smart irrigation systems, soil moisture sensors	Optimize water use, reduce water losses
Storms	Real-time weather radar, structural health monitoring sensors	Provide early warnings and monitor infrastructure performance during storms
Wildfires	Fire risk forecasting tools, satellite fire detection	Detect and track fires in real time, guide firefighting efforts
Sea-level rise	GIS-based coastal risk mapping	Identify and prioritize vulnerable coastal zones for planning and mitigation
All hazards	Climate information portals, decision-support tools	Provide accessible, science-based data to support local adaptation planning

STRUCTURAL SOLUTIONS

- Tangible, built interventions constructed or modified to protect against or reduce the risk of climate-related events
- Capital intensive
- Engineering design
- Implemented by governments, urban planners, or developers
- Physical infrastructure and land-use modifications
- Long-term and durable
- Focused on protecting assets and minimizing damage
- Requires technical expertise and financial investments

NON-STRUCTURAL SOLUTIONS

- Measures that influence human behaviour, governance, planning, and social systems to build resilience to climate change
- No major physical construction
- More flexible, cost-effective, and community-centered
- Types:
 - Regulatory/legal measures
 - Institutional/planning tools
 - Economic instruments
 - Education and behavioural change
 - Early warning systems

Choosing between structural vs. non-structural solutions

	Structural adaptation	Non-structural adaptation
Risk level	High-risk, high-impact	Moderate to low risk
Timeframe	Long-term solution	Short to medium term
Flexibility	Low-fixed structure, difficult to adapt	Easy to revise and adjust
Institutional needs	Requires technical expertise, funding, maintenance	Requires governance, awareness, community participation
Best use case	Protecting critical assets	Raising awareness, managing land use, increasing preparedness
Examples	Levees, seawalls, elevated roads, green roofs	Zoning laws, risk mapping, heatwave alerts, water-use policies
Environmental impacts	May alter ecosystems or natural processes	Lower impact, often more sustainable

How to choose right solutions

1. Understand local climate risks
2. Consider local context
3. Match solution type to hazard
4. Weight cost, feasibility and maintenance
5. Prioritize co-benefits
6. Use a mix of solutions
7. Engage stakeholders
8. Check policy and legal alignment
9. Plan for flexibility
10. Monitor and evaluate

MULTI-SECTORAL PLANNNS

- Comprehensive strategies that address climate risks across multiple sectors
- Brings together policies and stakeholders from different sectors for coherence
- Addresses interdependencies
- Long-term planning
- Uses risk and vulnerability assessment as a foundation
- Examples: SECAPs, National Adaptation Plans (NAPs), Resilience Strategies,...
- Benefits: efficiency, risk reduction, better funding opportunities, improved policy coherence

SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN (SECAP)

- Action plan that Covenant of Mayors (CoM) signatory cities must develop
- Outline key actions that translate political commitments into practical measures and projects to tackle climate change and reach the goal of reducing GHG emissions by 55% by 2030
- Long-term commitment to implement plans
- Progress report every two years
- Often also used by non-CoM municipalities to create plans and strategies for combating climate change
- Two parts of SECAP:
 - Emission inventories and plans
 - Climate risk vulnerabilities and plans

EMISSIONS INVENTORIES

- Recommended to use the approach and emission factors that are in line with the IPCC
- Key sectors:
 - Municipal (buildings, equipment, facilities)
 - Tertiary ((non-municipal buildings, equipment, facilities)
 - Residential (buildings)
 - Transport
- Methodology mainly focuses on CO₂, but other GHGs can also be accounted for
- Macro-sectors:
 - Buildings, equipment, and facilities
 - Transport
 - Energy Supply
 - Other non-energy related



REQUIREMENTS FOR EMISSION INVENTORIES :

- Approved by the Municipal Council or equivalent body
- Specifies mitigation, adaptation, and energy poverty commitments
- Based on the results of the Baseline Emission Inventory (BEI) and Climate Risk and Vulnerability Assessment (RVA)
- Mitigation requirements:
 - BEI should cover at least 3 key sectors
 - Mitigation actions should cover at least 2 sectors
 - The action plan should list a set of actions, including at least 3 Key Mitigation Actions
- Adaptation requirements:
 - Should include at least one adaptation goal
 - List a set of actions, including 3 Key Adaptation Actions
- Energy Poverty requirements:
 - One energy poverty goal
 - One indicator
 - At least on Key Energy Poverty Action

BUILDING EMISSION INVENTORY (BEI)

- Methodology:
 - Focus on final energy consumption
 - Focus on the geographical jurisdiction of the local authority
 - Allocates emissions to the consumption side
 - Bottom-up collection of data
 - Monitoring the progress towards the target
- Relevant, flexible, and accurate
- Should cover 4 key sectors

MONITORING EMISSION INVENTORY (MEI)

- Methodology is similar to BEI
- Encouraged to be compiled yearly (can also be 2- or 4-year intervals)
- Advantages:
 - Closer monitoring
 - Better understanding factors that influence the CO2 emissions
 - Annual input to policy making
 - Specific expertise necessary for inventories can be maintained and consolidated

EMISSION INVENTORY CONTENT

- Definition of the local territory
- Population in BEI year
- BEI year
- Reduction target (in %)
- Reduction target type (absolute or per capita)
- Emission inventory approach (standard or LCA)
- Emission reporting unit (CO₂ or CO₂ equivalent)
- Emission factors used
- Responsible body/department/consultant
- Detailed results per activity sector and energy carrier
- Results of the estimation of the planned emission reduction per key sector

EMISSION INVENTORY STRUCTURE IN SECAP

- Section A: Final energy consumption
 - Reports final energy consumption data by activity sector and by energy carrier
- Section B: Energy supply
 - Data related to green electricity purchases and local energy production
- Section C: CO2 emission tables
 - Provides Emission factors

RISK AND VULNERABILITY ASSESSMENT (RVA) IN SECAP

- Minimizing climate impacts in cities is a priority for the public and the private sectors
- Assessing climate risks is one of the first steps in the adaptation cycle
- The optimal level of adaptation is a balance between the cost of investment and the expected benefits in terms of reduced losses and damages
- Determines the nature and extent of a risk by analysing potential hazards and assessing the vulnerability
- Risk can be qualitative or quantitative
- 2 approaches to RVA
 - Assessment based on the spatially explicit climate impact models
 - Indicator-based assessment



INDICATOR BASED RVA

- Suitable for smaller and mid-size cities
- Level of aggregation depends on the general objectives of the study, technical skills of local authorities, and data availability
- Steps for creating RVA:
 1. City exploratory analysis (stakeholder engagement, qualitative understanding)
 2. Identify climate hazards
 3. Select vulnerability indicators
 4. Data gathering and processing
 5. Assess vulnerability score for each hazard

STEP BY STEP RVA

1. Define scope and objectives (what is being assessed, why, and what time frame)
2. Gather relevant data
3. Identify climate hazards (using climate data and scenarios)
4. Assess exposure (who and what is at risk)
5. Assess sensitivity (how vulnerable and exposed systems are)
6. Evaluate adaptive capacity (ability to cope, respond, or recover)
7. Highlight key risks (who and what is most at risk)
8. Determine adaptation priorities and set adaptation objectives
9. Engage relevant stakeholders in the whole process