Adapting South African cities and towns

A local government guide to climate change adaptation planning

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CITY ENERGY SUPPORT UNIT

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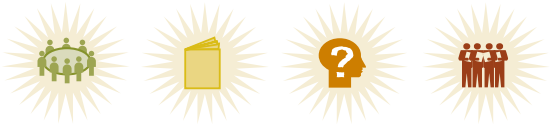

Credits

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- Review climate information - current and expected changes.
- Assess the ability of the municipality to deal with climate variability.
- Identify climate vulnerabilities.

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- Develop a holistic picture of who is vulnerable to what.
- Draw on the experience and knowledge of the stakeholders of the affected sectors (this will also provide insight into adaptive capacity of sectors).

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- Review current development plans of the municipality.
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Major components of the adaptation plan:

- Goals and guiding adaptation principles
- Key initiatives
- Communication strategy
- Monitoring and evaluation

IMPLEMENTATION

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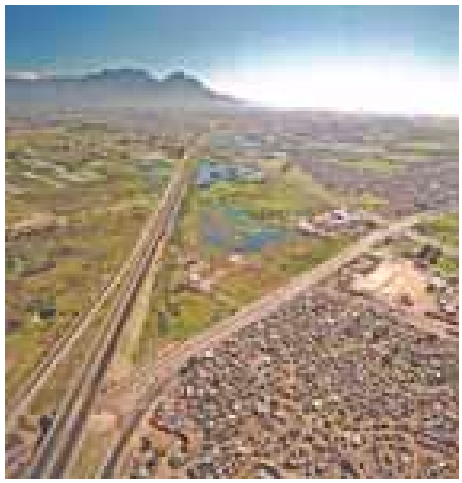
- Periodically review assumptions for the vulnerability and risk assessments.
- Adjust interventions based on new scientific information.
- Evaluate whether adaptation goals have been addressed.
- Check whether climate change is addressed in sectoral planning documents and new municipal programmes.
- Conduct stakeholder workshops to share new information.

Adaptation Strategy Roadmap

This practical guideline has been written for South African municipalities, to promote robust climate change adaptation in the context of **local sustainable development**. Preparation of an adaptation strategy is the first step in an ongoing process to reduce a municipality's vulnerability to climate variability and climate change. The guideline recognises the need to prioritise adaptation strategies that enhance municipal priorities and existing initiatives. The adaptation strategy process presented in this guideline consists of six steps that build upon each other as shown on the next page:

Cities and Adaptation



A local response to climate change

The term climate change is specifically used for current and projected changes in the climate system that can be significantly attributed to the altered composition of the atmosphere from human activities. However, climate variability and natural cycles are equally important and the emphasis in this guideline is on addressing the impacts of, and potential responses to, both natural climate variability and human-induced climate change.

Municipalities are well placed to develop and implement effective adaptation strategies. They are the site of government closest to people, local knowledge and experience – all important attributes in designing strategies that must address the specific vulnerabilities of local areas, communities, socio-economic activities and ecosystems in the context of climate change. This important role is recognised in national strategy, such as the draft National Climate Change Response Strategy and National Framework on Sustainable Development.

Municipalities have limited financial and human resources and juggle multiple pressing issues of immediate concern, making it seemingly impossible to take on another issue, such as climate change. This guide aims to provide practical assistance towards tackling climate change and emphasises that preparing for climate change does not differ so much from managing present day concerns. Climate change adaptation is about **sustainable** development, good governance and effective risk management that integrates response to current and future climate impacts. Furthermore, adaptation to climate variability and change does not have to be expensive. Small practical steps and strategic thinking can go a long way in making the municipality more resilient to climate change.

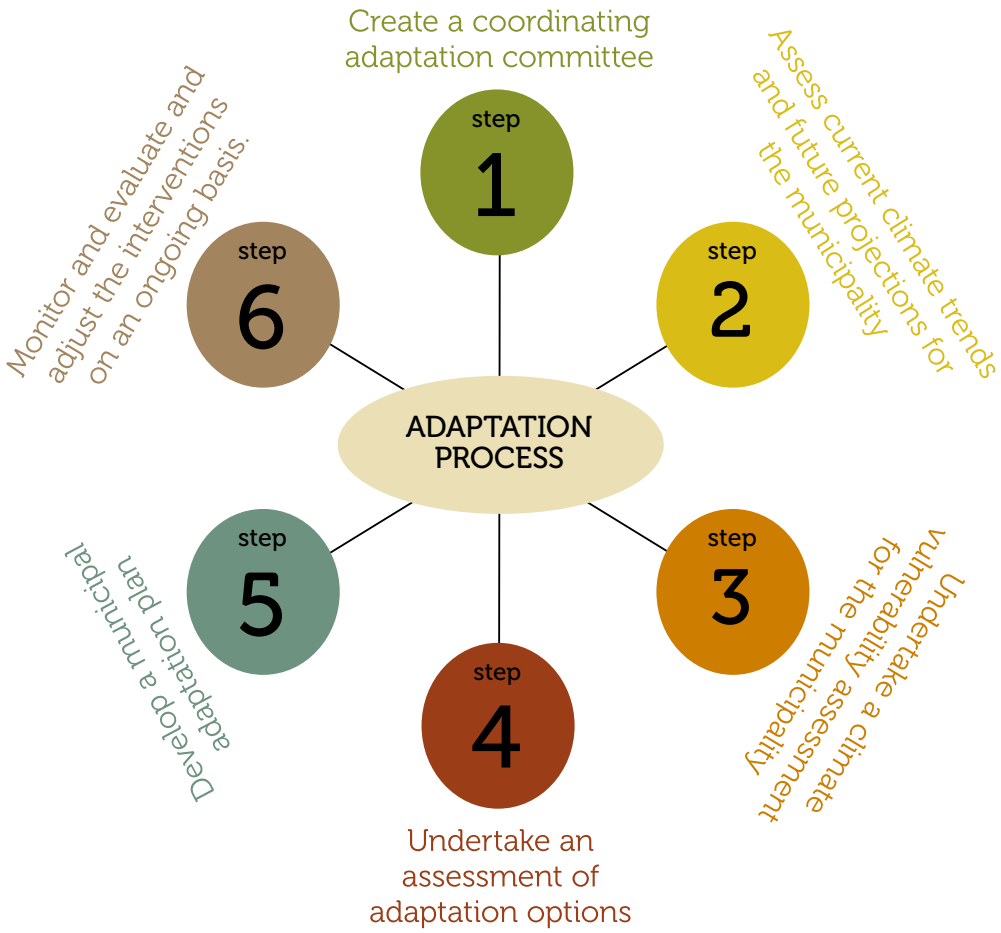
Developing an Adaptation Strategy

An adaptation strategy should be a systematic, proactive and coordinated response to enhanced climate variability and projected climate change. It refers to the overall process that guides your planning and decision making for a sustainable future. However, as the experience of an early adapter like the eThekwini municipality shows "a strategy provides a general framework that can integrate citywide action and offers opportunity for public input. However, strategic plans need to be augmented with sector plans that include specific goals and implementation targets" *(Carmin et al 2009:20).*

"... preparing for climate change does not differ so much from managing present day concerns."

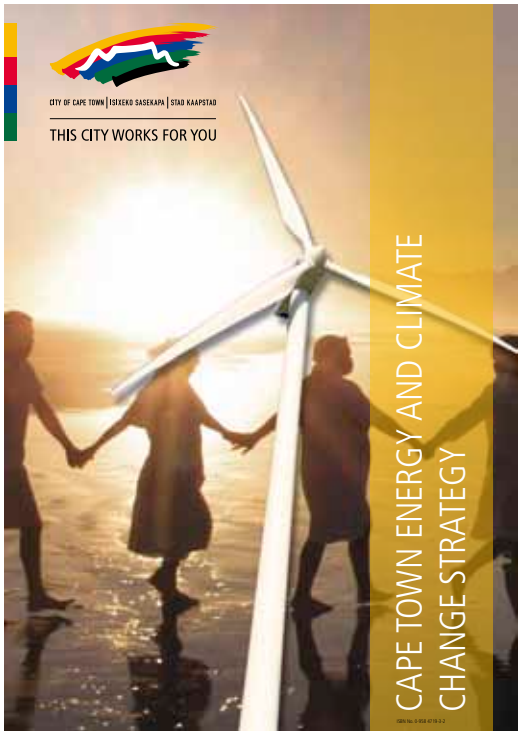
The planning process

This planning guide uses a six step process as a framework. The next sections will guide you through these systematic planning steps. The adaptation process presented in this guideline consists of six steps that build upon each other:



An "ADAPTIVE" Municipality:

- Takes proactive steps towards reducing the vulnerabilities and risks associated with climate variability and climate change.
- Takes a coordinated and integrated approach, based on the most recent climate information available.
- Given that uncertainty and surprise are elements of climate change, an "adaptive" municipality chooses robust adaptation strategies, which are effective for a range of climate change projections.
- Monitors the implementation and effectiveness of its adaptation plan and actions on a regular basis.



Benefiting from your adaptation measures

Adaptation measures taken by a municipality can bring immediate benefits to the municipality. For example:

- Implementing a water conservation programme in anticipation of changing drought frequencies offers immediate benefits for managing current droughts, as well as future benefits for the more frequent and more intense droughts projected in coming decades.
- Modifying present-day policies and practices, with future climate change impacts in mind, can reduce current and future risks. For example, zoning for new housing projects in an area which is at risk to future sea level rise and coastal flooding can be altered before that area becomes built up and, in doing so, avoid likely future flood damage.
- Planning for climate change and its specific impacts on different municipal sectors may help to limit the future economic costs. For example, clearing storm water drains before heavy rainfall is likely to be more cost effective that paying for the damage from flooding.
- This can also include creating opportunities to capitalize on potential beneficial impacts of climate change, such as where a longer growing season might provide farmers new business opportunities by being able to grow a variety of agricultural products.

Vital lessons from municipalities that have begun to develop local adaptation strategies:

1. The adaptation process should be guided by the vision of knowledgeable and committed **political leaders or champions.**
2. An integrated **communication strategy** is likely to enhance public buy-in, as well as support cross-sectoral adaptation planning and implementation.
3. Strong collaboration with **local research institutes** can help to assure rigour in the quality of research linked to climate change impacts **and sector specific vulnerability assessments.**
4. The creation of **institutional mechanisms** such as a coordinating adaptation committee and municipal adaptation plans help to ensure a systematic and integrated adaptation process.
5. It is critical to link adaptation planning and implementation to **municipal priorities** and existing initiatives.
6. Ongoing active **engagement of stakeholders** in the adaptation planning and implementation will lead to a better understanding of how climate change impacts different stakeholders and sectors within the municipality, better design of practical and effective adaptation strategies and actions, and strong support in the implementation process.

Sources: Carmin et al (2009); Penney and Wieditz. (2007).

STEP 1:

Create a coordinating adaptation committee

"Political endorsement of this committee and senior management leadership will greatly enhance the chances of success."

Political championship

In order to ensure the development of an integrated and coordinated municipal adaptation strategy, a municipality will need to coordinate activities across municipal departments and engage key stakeholders from major sectors affected by climate variability and climate change. This coordination may be achieved through the establishment of a coordinating adaptation committee. Political endorsement of this committee and senior management leadership will greatly enhance the chances of success. This could come, for example, through a council resolution. You might wish to make a presentation to your council and senior management on climate change in order to develop awareness and build political will.

An integrated committee

The coordinating committee could include a representative from each of the following departments (these could vary depending on your municipality):

- Transport
- Housing
- Environment
- Energy and electricity
- Health
- Social development
- Disaster management
- Planning
- Water
- Agriculture

It is important to brief all members of the adaptation committee on climate change and climate change science to ensure that all have a similar understanding of the issue. During the adaptation process, you might discover that climate change will affect more sectors or resource areas in the municipality than initially realised,

meaning that additional team members from other departments or divisions, or from different external organisations, may need to be invited to participate in the committee.

This committee should consider:

1. Building on existing institutional structures and programmes (e.g. environmental, planning or energy programmes).
2. Locating itself within a 'champion' department that is prepared to take leadership on the issue of climate change, understands the nature and urgency of the problem and also has the political backing from, and linkages to, relevant decision-makers.

Kick start your committee

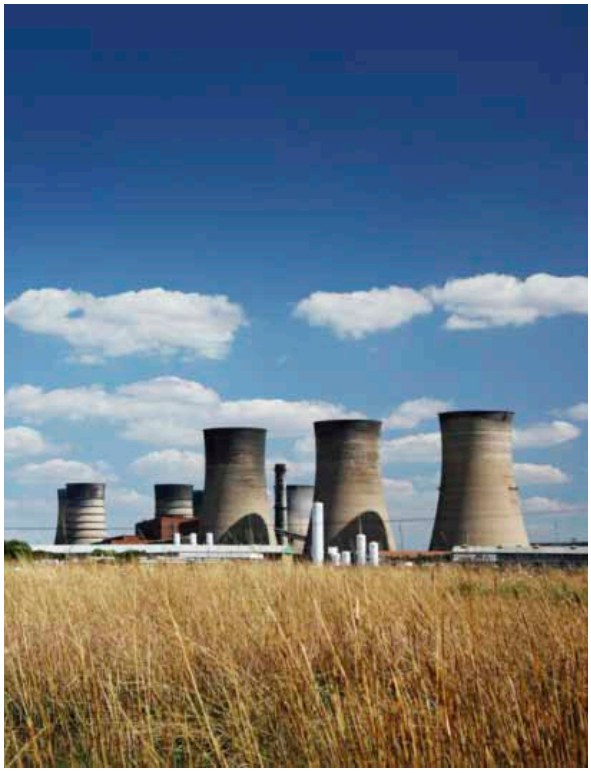
Climate change is only one stressor among many that impact the municipality, and it could potentially exacerbate the impact of other stressors. You could start by documenting the impact of relevant climate variables and stressors on key sectors in a simple table, as given below:

Key responsibilities of the coordination committee include:

1. *The supervision of specific climate impact and vulnerability assessments.*

1. *The engagement of stakeholders, and local and regional decision-makers*
2. *Developing the municipal adaptation plan*
3. *Coordinating, advocating and implementation of the various adaptation measures.*

SECTOR	IMPACTING CLIMATE VARIABLE AND/OR HAZARD	EXISTING NON-CLIMATIC STRESSORS	EXPECTED IMPACTS
HEALTH	Rise in average max. temperatures	Understaffed health facilities	Increase in vector born diseases
	Increase in number of days above a critical temperature threshold	Poor health of informal settlement dwellers	Heat stress impacting the young and elderly
WATER SUPPLY	Less rainfall during rainy season	High level of water pollution	Reduced water quality and quantity
	Increase in number of intense rainfall events	Leakages	Insufficient storage capacity
		High migration rates to urban areas	Damage of storm water and sewage infrastructure



Stakeholder engagement

It is important to initiate municipal department and key stakeholder engagement at an early stage of the adaptation process. This can be done through measures such as:

- tailored workshops (for example using the table presented above to develop detailed pictures for each sector)
- forums
- informative policy briefs
- awareness campaigns.

It is vital that municipal departments and key stakeholders are made aware of the importance of climate impacts in their spheres of responsibility, and that they understand that there are sensible and practical measures that can be taken to reduce vulnerability. Successful implementation can be achieved only when stakeholders understand how climate change impacts will affect their sector, and when they are engaged in thinking about how the organization of their services can be changed or adjusted to reduce vulnerability to these impacts.

Outcomes of step 1

OUTCOME	ACHIEVED?
• Political endorsement and top management leadership through council resolution, KPIs, etc.	
• Identification of the appropriate department as steward of the adaptation process	
• Creation of the coordinating adaptation committee	
• Identification of key climate variables and hazards	
• Identification of major sectors where activities, operations and planning (amongst others) are likely to be affected by climate variability and climate change	
• Engagement of stakeholders/decision-makers in respective sectors	

STEP 2:

Assess current climate trends and future projections for the municipality

It is important to understand the nature of the current climate and expected climate changes in order to have a frame of reference against which to assess the ability of the municipality to cope with current climate variability and identified future vulnerabilities. The major task in this section is to collect and review important climate information. In addition to obtaining information about changes in climate variables and extreme weather events, you should begin to investigate what these changes mean for infrastructure, the local economy, natural resources and vulnerable communities. This step forms the foundation for all subsequent steps and should be an ongoing process as new information relevant to the municipality becomes available.

There are 3 building blocks to a climate assessment:

BUILDING BLOCK 1: UNDERSTAND CURRENT CLIMATE TRENDS AND EXISTING CLIMATE HAZARDS/ EXTREME WEATHER EVENTS

BUILDING BLOCK 2: REVIEW CLIMATE CHANGE PROJECTIONS: HOW MIGHT THE CLIMATE OF THE MUNICIPAL AREA CHANGE?

BUILDING BLOCK 3: CONSIDER CLIMATE CHANGE IMPACTS: HOW MIGHT THE PROJECTED CLIMATE CHANGE IMPACTS AFFECT MAJOR MUNICIPAL SECTORS AND LIVELIHOODS?

1 BUILDING BLOCK 1:

UNDERSTAND CURRENT CLIMATE TRENDS AND EXISTING CLIMATE HAZARDS/ EXTREME WEATHER EVENTS

This exercise will help you to familiarize yourself with the existing local climate and climate trends in the municipality. This work can be done by qualified staff within the municipality, or you might decide to delegate the work to consultants or academic researchers.

1. Collect climate data from the last 20 years. This can be obtained from the South African Weather Service or places such as agricultural research facilities or airports.

2. Analyse this data. You will gain a good understanding of relevant climate variables and their trends as well as inter-annual variability. Responding well to existing cycles now, is as important as preparing for some of the long-term climate changes that might be experienced in decades to come.
3. Using the guiding questions, collate this information in a table as demonstrated below:

Guiding questions:

- What are the major climate variables that impact the municipality?
- What are the natural cycles of variability for different climate variables (e.g. rain)?
- Have there been any significant changes in seasonality, frequency and magnitude of these variables?
- Have the temperatures significantly increased above the mean average?
- Has the number of days below a certain minimum temperature threshold changed?
- What kind of extreme weather events is the municipality subjected to? Have they changed in frequency and magnitude? Have you experienced new types of weather extremes?
- How do existing weather patterns and extreme weather events affect specific sectors?
- What were the responses to extreme weather events in the past (general and sector specific)?

CLIMATE VARIABLE/ EXTREME WEATHER EVENTS	RECENT TRENDS
Temperature	Warmest years on record occurred after 1989 Fewer frost days & longer frost free season Growing season lengthened by 30 days since 1900s
Precipitation	Shortening winter rainfall season with more intense rain events Increasing summer rainfall over 150-200 years
Drought	More frequent drought, with longer durations

Table format adapted from Penney and Wieditz 2007:21

2 BUILDING BLOCK 2:

REVIEW CLIMATE CHANGE PROJECTIONS: HOW MIGHT THE CLIMATE OF THE MUNICIPAL AREA CHANGE?

Future projections are important for municipal departments which have to make long-term decisions (e.g. building a new bridge or a dam).

Climate change scenarios, based on Global Climate Models (GCMs), have become an important source of information for providing us with a picture of future climate trends, but are not always relevant at the local planning scale. Downscaled climate change scenarios, which take into account local weather data and local geography, have been developed to provide a picture of possible future climates at a higher resolution.

The degree of change in the climate will depend on the impacts of future emissions and, thus, future concentration of greenhouse gases in the atmosphere. Since these are uncertain, climate models incorporate different climate scenarios based on different emission levels. Therefore, one might want to work with several scenarios (worst-case, medium, best-case) to develop robust adaptation strategies against a range of future emission scenarios. In a similar manner, one might want to work with multiple GCM models, as different models have different biases and it is important to get a range, or envelope, of future expected climate.

Regardless of who does the climate change projection study, the following guidelines can be very helpful in assessing how local climates may change in the future:

1. Focus on key climate variables such as temperature and precipitation, as well as other variables that might be of importance to a municipality. (e.g. sea level rise, wind, evaporation or extreme weather events, if applicable.)
2. Specify the future time horizon (2030, 2040) and the time frame for comparison (i.e. 1970-1999)
3. Ask how the identified variables are projected to change for the specified time horizon.
4. Are there any significant changes expected in the nature of the variables or the seasons (e.g. changes in number of frost or rain days, frequency and intensity of extreme rain events, duration of dry spells, increase in minimum temperatures, etc)?
5. Record the level of confidence for the projections, as well as noting which GCMs and emissions scenarios were used.

Example: Table shows climate changes for greater London under low and high emission scenarios

CLIMATE VARIABLE	SCENARIO	EXPECTED CHANGE					
		2020S		2040S		2080S	
		SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER
TEMPERATURE (C°)	Low emission scenario	1 to 1.5	0.5 to 1	2 to 2.5	1 to 1.5	2.5 to 3	1.5to 2
	High emission scenario	1 to 1.5	0.5 to 1	3 to 3.5	1.5 to 2	>4.5	3 to 3.5
PRECIPITATION (%)	Low emission scenario	-10 to -20	0 to 10	-30 to -20	10 to 15	-30 to -20	10 to 15
	High emission scenarios	-20 to 10	0 to 10	-40 to -30	15 to 20	< -50	25 to 30
NET SEA LEVEL CHANGE (CM)	Low emission scenario	12		19		26	
	High emission scenario	22		48		86	

Table format adapted from Penney and Wieditz (2007:24)

One may initiate a tailored study for a specific municipality, or refer to existing regional climate change reports (provided that they are current).

USEFUL INFORMATION SOURCES:

National climate change reports

- South Africa's first national communication was published in 2000; the second should be available in 2010. It will contain an assessment of work undertaken in the climate change field in the last ten years.
- The National Climate Change Response Strategy for South Africa is currently being finalised by the Department of Environment.
- The Long Term Mitigation Scenario (LTMS) for South Africa was released by the Department of Environment and Tourism in 2008. Although the focus of the study was on mitigation, there was also an adaptation component.
- A report titled *'Impacts, Vulnerability and Adaptation in Key South African Sectors: An Input into the Long Term Mitigation Scenarios Process'* was published by Midgley et al (2008).

Regional climate change reports

Western Cape:

- *'A Status Quo Vulnerability and Adaptation Assessment of the Physical and Socio-Economic Effects of Climate Change in the Western Cape'* (Midgley GF, Chapman RA, Hewitson B, Johnston P, De Wit M, Ziervogel G, Mukheibir P, Van Niekerk L, Tadross M, Van Wilgen BW, Kgope B, Morant PD, Theron A, Scholes RJ, Forsyth GG, 2005)
- *'A Climate Change Strategy and Action Plan for the Western Cape'* (The Department of Environmental Affairs and Development Planning, Western Cape, December 2008) http://www.capegateway.gov.za/other/2009/1/cc_strategy_and_action_plan_finaljanuary_09.pdf
- The City of Cape Town's Environment Resource Management released a report *'Framework for Adaptation to Climate Change in the City of Cape Town (FAC4T)'* (Mukheibir and Ziervogel, 2006).

KwaZulu-Natal:

- The eThekwini Municipality has developed a Headline Adaptation Strategy and is currently developing sector specific adaptation plans (water and health). For more information please contact: Dr. Debra Roberts, Deputy Head: Environmental Management, Development Planning, Environment and Management Unit, Ethekwini Municipality, e-mail:RobertsD@durban.gov.za

Scientific institutions

- The Climate Systems Analysis Group (CSAG), based at the University of Cape Town, South Africa, operates one of the few empirical downscaled models used for the whole of Africa, which simulates responses to global climate change at a growing number of meteorological station locations across the African continent. The approach delivers daily and monthly climate change information, including multiple rainfall and temperature parameters, for multiple models and two future time horizons (2046-2065, and 2081-2100). Contact: www.csag.uct.ac.za.

3

BUILDING BLOCK 3:

CLIMATE CHANGE IMPACTS: HOW MIGHT THE PROJECTED CLIMATE CHANGE IMPACTS AFFECT MAJOR MUNICIPAL SECTORS AND LIVELIHOODS?

You may want to conclude STEP 2 with a scoping exercise in which you assess how changing climate conditions and specific climate change impacts might affect major sectors and livelihoods of your community. You can do so by developing a preliminary list of potential impacts on the various sectors. However, this exercise needs to be advanced in STEP 3 where you will conduct sector specific vulnerability assessments.

SECTOR	POTENTIAL IMPACTS
WATER SECTOR	Less available surface water and run-off because of less winter precipitation Increase in damaged infrastructure (dams, sewage systems, etc) because of increase in frequency and magnitude of storms Saltwater intrusion into groundwater and coastal wetlands due to sea level rise
AGRICULTURE	Decreased chill unit accumulation from fewer frost days Less soil moisture due to declining precipitation and greater evaporation rates More frequent crop failure from more droughts Increased incidence of pests (e.g. fruit flies) due to higher mean temperature
TOURISM	Damages of beaches and coastal tourism infrastructure due to sea level rise and/or increased intensity and frequency of coastal storms
ENVIRONMENT	Increased wildfire danger Increase in invasive alien species and destruction of biodiversity hotspot due to rising temperatures
LIVELIHOODS	Declining livelihood opportunities in the agricultural sectors and fisheries Increase in fires and flooding in informal settlements due to their risk-prone locations Weakening of food security, especially in poor communities that depend on subsistence farming

Outcomes of step 2

OUTCOME	ACHIEVED?
• Knowledge of current climate conditions and extreme weather events	
• Understanding of trends in climate conditions and weather extremes	
• Understanding of how your regional climate is projected to change	
• Preliminary understanding of potential climate change impacts on your major sectors	

STEP 3:

Undertake a climate vulnerability assessment for the municipality

A vulnerability assessment is the foundation for the construction of any adaptation strategy. Vulnerability varies widely across communities, sectors and regions, and must be understood as a dynamic process. A vulnerability assessment provides you with a holistic picture of who is vulnerable to what. In addition to identifying the most vulnerable communities and sectors, it can provide a foundation for assessing the adaptive capacity and resilience of communities and sectors to current climate variability and future climate change. The incorporation of the experience and knowledge of the stakeholders of the affected sectors forms a crucial element of your vulnerability assessment. We therefore recommend workshop processes in which key stakeholders are engaged to carry out your sector-specific vulnerability assessments. Useful tools and methods for workshop settings are described in Section (A) and (B).

There are three building blocks to carrying out a climate vulnerability assessment for the municipality. Building blocks 1 and 2 demonstrate how you can carry out a sector-specific vulnerability assessment. In addition to the sectoral vulnerability assessments, you will also need to conduct a livelihood assessment to evaluate who are the most vulnerable communities in the municipality in the context of climate change. The livelihood assessment is discussed in building block 3. Depending on your resources and needs, you can go into a more detailed assessment or simplify it.

A vulnerability assessment is the foundation for the construction of any adaptation strategy

1 BUILDING BLOCK 1:

IDENTIFY CURRENT SECTORAL AND CROSS-SECTORAL VULNERABILITIES BASED ON CURRENT CLIMATE VARIABILITY RISKS AND TRENDS

Current vulnerability is assessed based on present climate variability. This part of the vulnerability assessment allows you to evaluate known and existing risks and stressors in order to find implementation measures to reduce them. The tools and methods described below will assist you in understanding how sensitive your sector is to current climate variability and how you are currently able to respond to changing climate conditions.

Because sectors that are subjected to current climate stressors are more likely to be sensitive to climate change it is crucial to:

1. Identify existing major climate stressors that impact your sector.
2. Evaluate the existing adaptive capacity of your sector. N.B: Adaptive capacity is strongly influenced by the way your sector is managed and regulated.
3. Evaluate whether your governance structures are flexible enough to deal with current and projected climate change.
4. Assess whether current structures enable flexibility of management and allow the concerns of different stakeholder groups to be heard and addressed.

The assessment of current vulnerabilities should be undertaken by the adaptation committee and major stakeholders (e.g. business, residential, agriculture). The following methods/tools can be used in the assessment process, usually carried out in a workshop format:

Methods/tools

- **Brainstorming** – a process of capturing free-flowing ideas. The process aims to enable people to think through the process of related elements that they might not have thought of otherwise. A skilled facilitator could ensure that different stakeholders are given space to express their views.
- **Cognitive mapping** – development of conceptual models of the current situation of who is vulnerable to what; established using interactive methods with stakeholders. This process helps to establish the different perceptions and underlying assumptions of the problem.
- **Institutional analysis and mapping of stakeholders** – the mapping of key actors and their interactions. Evaluation of formal and informal rules, norms and organizations that govern behaviour is useful for understanding how responses occur and the roles of different actors.
- **Vulnerability indicators/mapping** – mapping of the different indicators of vulnerability for different groups.

For a detailed description of all tools/methods see APPENDIX 1

Guiding questions

Regarding SENSITIVITY:

- What are the existing stressors your sector is vulnerable to?

e.g. the water sector might already be stressed due to increasing water demand, triggered by an expanding urban population and by a reduced water supply that is the consequence of leakages.

- How do current climate conditions (climate variables as well as extreme weather events) impact on your sector?

e.g. you might frequently experience reduction in yields because of seasonal floods.

Regarding ADAPTIVE CAPACITY

- Do you already have measures in place that address existing impacts of climate variability? Are they successful?

e.g. as a response to higher summer temperatures you might already have changed to irrigation systems that reduce the evaporation rate, such as micro-sprinklers. Or in response to less rainfall, the planning department might prohibit the building of new golf courses, as they deplete too much of the existing water resources.

2 BUILDING BLOCK 2:

IDENTIFY FUTURE VULNERABILITIES BASED ON FUTURE PROJECTED CLIMATE SCENARIOS AND FUTURE CLIMATE RISKS

When assessing future vulnerability you will need to consider the trends and changes in the local economy, population size, the broader political environment, consumer patterns, etc, as all of those factors will influence the municipality's vulnerability to climate change. There is high uncertainty associated with future change and so an assessment of future vulnerability is just a guideline.

The assessment of future vulnerabilities should be carried out by experts who incorporate inputs from responsible municipal departments and associated stakeholders.

Methods/tools

Socioeconomic scenarios

(Adapted from Bizikova et al 2008): refers to the development of plausible storylines created by experts, which describe economic, political, social and technological changes that will impact future conditions, emission levels and adaptive capacities. Taking key drivers and uncertainty into account, a range of possible outcomes are produced.

Guiding questions

Regarding SENSITIVITY:

- How might projected changes of climate conditions affect your sector?
- Are there certain components of your sector that are more vulnerable to projected changes than others?

Regarding ADAPTIVE CAPACITY

- To what extent will your sector be able to adjust to the projected changes in climate and the associated impacts?
- Is your sector flexible enough to accommodate a range of future climate conditions?
- Will existing coping measures be adequate to respond to future climate change projection? Do some of the coping strategies undermine future responses?

3 BUILDING BLOCK 3:

LIVELIHOOD ASSESSMENT

Vulnerable groups in the municipality will most likely be exposed to a range of stressors of which climate change and climate variability is only one. Non-climatic stressors will substantially alter the ability to cope with, and adjust to, the changing climate in the municipality. Poor communities are often the most vulnerable, because they have limited access to resources, few income-generating opportunities, and their settlements are often located in climate risk-prone areas. Furthermore, their livelihood conditions are strongly impacted by economic and social forces over which they have little control.

Consequently, it is important that sectors which target vulnerable groups understand how climate change might affect those people and their livelihoods. For example, informal dwellers are often extremely vulnerable to climate variability due to the poor physical and social conditions of their settlements. Inadequate infrastructure, high water tables and poor access to services, means that heavy rainfall might often turn into flooding. Increasing temperatures on the other hand may increase the frequency of fires, destroying a large part of the overcrowded dwellings and often the entirety of people's physical assets.

Methods/tools

Livelihood indicator approach: assessment of impact of climate stressors on livelihood typologies (detail on this approach found in Appendix 1).

Guiding questions

- Who are the most vulnerable groups in the municipality and why? Where are they located?
- What are the major climate hazards they are subjected to? Where and how are the impacts of the hazards likely to be felt?
- What aspects of livelihoods might be threatened because of changing climate conditions?
- What is the coping capacity with regard to existing weather extremes? How will a change in these events affect those that are already at risk?

Outcomes of step 3

OUTCOME	ACHIEVED?
• Identification of sectors and livelihoods that are vulnerable to current climate variability, including extreme weather events	
• Documentation of existing coping mechanisms	
• Identification of future vulnerabilities in major sectors and livelihoods	

STEP 4:

UNDERTAKE AN ASSESSMENT OF ADAPTATION OPTIONS

This step focuses on the identification of a range of adaptation options and the assessment of those options based on their capacity to address current and future vulnerabilities and their ability to help achieve the development priorities of the municipality.

CLIMATE IMPACT:
FLOODING: ADAPTATION OPTIONS
Diversion of river flows
Construction of wetland areas
Widening of dams
Establishment of an early warning system
Designing flood-proof buildings in vulnerable locations

You will find that there are often a number of ways to respond to specific climate change impacts. The choice of actions depends not only on the effectiveness of the specific measure, but also local development priorities as well as the availability of financial and human resources. Building blocks 1 - 5 below will help you to carry out STEP 4 in a systematic manner without losing sight of development priorities and implementation barriers.

Stakeholder engagement is essential in the assessment of adaptation options because they are best positioned to:

- Generate a range of feasible adaptation options and to select the most adequate adaptation actions.
- Identify obstacles or opportunities that may accompany specific options.

1 BUILDING BLOCK 1:

REVIEW OF CURRENT DEVELOPMENT PLANS AND PRIORITIES

Before thinking about possible adaptation options it is important to review the integrated development plan (IDP), integrated municipal environment plan, sector specific development plans and other relevant policies of the municipality, with regard to their long-term priorities and the identification of potential synergies between the stated development goals and your adaptation efforts. Furthermore, the inspection of major development plans will give you a sense of the extent and manner that climate sensitive information is already incorporated in the documents.

Guiding questions:

- What are key development priorities for the municipality?
- What socio-economic scenarios are currently used in the municipal planning processes? What are the assumptions that form the basis of these scenarios? Do they take climate variability and climate change into consideration?
- To what extent do current plans and policies account for the local climate conditions and climate hazards/ weather extremes and their projected changes?
- Can you identify existing coping and/or adaptation strategies that are promoted in response to current climate variability? Are these measures adequate with regard to future climate change projections?
- What programmes can create a foundation for the implementation of specific actions?

2 BUILDING BLOCK 2:

IDENTIFY HOTSPOTS

This exercise is crucial for determining those areas and sectors that are so-called vulnerability hotspots and require urgent attention. To do this you will need to overlay development priorities, expected climate change, current climate vulnerability and expected future climate vulnerability.

Once a climate vulnerability assessment has been completed, areas of high vulnerability should be identified. It is important to assess where these areas overlap with areas targeted for broader development. It is not uncommon for strategies addressing development priorities to be undermined by climatic factors. For example, supporting urban agriculture in an environment that depends on irrigation might be unsustainable if water prices are increasing. If changes in the rainfall indicate that the amount of rainfall is reducing, this strategy is likely to increase people's vulnerability rather than reduce it.

Mapping and GIS (Goegraphic Information Systems) techniques are useful in visualising these overlays. Mapping can be undertaken by technical experts or achieved through participatory methods. For example, a group mapping exercise might encourage residents of a certain suburb to document areas prone to flooding, as well as areas of poor health or high crime. Hotspots are identified where these areas overlap.

3 BUILDING BLOCK 3:

DEVELOP ADAPTATION OPTIONS

Appendix 2 provides you with a list of sector-specific adaptation options from which you may want to either draw directly or use focus groups for brainstorming of potential options. A useful exercise is to list your options with the specification of their benefits, costs and whether they can be classified as short- term, medium-term or long-term measures. It is important that you add existing adaptation strategies to your list to prevent any duplication.

Methods/ tools

Focus groups: are methods that bring together a group of stakeholders (5-10 participants) whose ideas and opinions are of particular interest to the discussed topic. The group is guided by an experienced facilitator through an interactive discussion around specific questions (see Appendix 1 for more detail).

SECTOR	OPTIONS	BENEFIT	COST	TIMEFRAME (SHORT, MEDIUM, OR LONG TERM)
WATER SECTOR	Water conservation programme	Reduced demand	Moderate	Short and medium term
	Desalination	New water source, less dependency on rain fall	Very High	Long term
HEALTH	Greening of urban areas	Cooling Beautification	Moderate	Short to medium term
	Heat alert system	Preparedness	Moderate	Medium term
COASTAL AREAS	Relocate existing development from coastal areas at high risk	Reduced existing risk and vulnerability	High	Medium to long term
	Prohibit building in flood-prone areas	Reduced future risk and vulnerability	Low	Medium to long term

4 BUILDING BLOCK 4:

PRIORITISE THE ADAPTATION OPTIONS

Several methods exist for evaluating which action might be selected and prioritised from the range of adaptation options that you have explored in the previous section. This section will introduce you to some useful methods, as well as general criteria that can aid you in your selection process. Please bear in mind that on their own the individual methods have limitations and weaknesses. It is therefore recommended to focus not only on a single criterion or method, but to combine several to ensure that factors such as equity, sustainability or social acceptance are considered.

One method that has wide application is the **Multi-criterion analysis (MCA)**. MCA allows for the comparison of adaptation options using monetary and non-monetary values. Its consideration of many factors makes it a useful tool for aiding decision-making. However, this tool can be biased, since it reflects the opinions and understanding of a small group of stakeholders and/ or experts who define and evaluate the criteria. Additional criteria and more flexible methods should be explored in addition to choosing priority adaptation actions.

LIST OF CRITERIA TO CONSIDER	
1. EFFECTIVENESS	Vulnerability hot spot: Does the action target identified vulnerability hot spots that require immediate attention? Priorities: Will the measure contribute to municipal development priorities? Robustness: How robust is the specific action under a range of possible future climate change scenarios? Is the action capable of dealing with changes in extreme weather events (e.g. increase in frequency and magnitude)? Can the action easily be adjusted to changing climate conditions? No-regrets measures: Will the action provide benefits in current and future climate conditions even if no climate change occurs? (For example, expanded tree planting not only reduces air pollution and storm water run-off but also improves urban aesthetics and reduces ambient temperatures on hot summer days by providing shade).
2. ECONOMIC COST OF THE ADAPTATION ACTION	Cost Benefit Analysis (Bizikova et al 2008:64) (CBA) is useful for determining the financial implication of the action in terms of cost and benefit to the municipality. CBA is a quantitative approach that is applied to determine the costs and benefits of an action in monetary terms. CBA can evaluate whether benefits outweigh the costs, whether net benefits are maximised, and which of the various options presents the greatest net benefit. CBA is a very useful tool for evaluating objectives that can be meaningfully assessed in monetary terms. However, one of the significant drawbacks of CBA is that its application is problematic when non-monetary values such as social and environmental objectives are being evaluated.
3. SUSTAINABILITY AND EQUITY	Does the action create any new vulnerabilities or limit the adaptive capacity of other communities and future generations (this includes the consideration of ecosystems)?
4. IMPLEMENTATION	Institutional capacities: Does the specific action require the cooperation of other government levels (e.g. provincial or national) or the partnership of the private sector? Is the local government capacity to implement adaptation actions adequate in terms of budgetary and personnel constraints? Windows of opportunity: Do windows of opportunities for the implementation of the action exist (e.g. updating the highway system)?

Illustrative example for adaptation measures in the water sector:

ACTION	VULNERABILITY HOT SPOT (-/+)	NO REGRET (-/+)	COST OF IMPLEMENTATION LOW /HIGH	EQUITY & SUSTAINABILITY (-/+)	INSTITUTIONAL CAPACITIES (-/+)	CROSS-SECTORAL (YES /NO)	WINDOW OF OPPORTUNITY (-/+)	PUBLIC ACCEPTANCE (-/+)
WATER CONSERVATION PROGRAMME	+	+	low	+	+	No	-	+
DRY SANITATION SYSTEM	+	+	High	+	-	Yes	-	-
WATER RESTRICTIONS	+	-	high	-	+	yes	-	-

5 BUILDING BLOCK 5:

MAINSTREAM ADAPTATION INTO EACH SECTOR

Municipalities administer a wide range of programmes and regulations that can be used as avenues for implementing your adaptation actions. You might discover that you can quite easily merge specific actions into existing planning efforts, such as updating the municipal disaster management plans. Where required, modify existing plans and policies so that they explicitly consider climate-sensitive information in their planning and decision-making (e.g. zoning rules, building codes). Incorporate the knowledge you have gained from your review of the municipal development plans in subsection (A).

OUTCOMES OF STEP 4

OUTCOME	ACHIEVED?
• List of a wide range of adaptation options	
• Selection of prioritized adaptation actions	

STEP 5:

DEVELOP A MUNICIPAL ADAPTATION PLAN

The Adaptation Plan is the institutional mechanism that takes the adaptation process forward and ensures that climate-sensitive information is mainstreamed into existing policies and programmes.

The adaptation plan:

- defines important adaptation goals and milestones
- creates mechanisms that guide and coordinate the implementation of the adaptation strategies of the various sectors
- assigns roles and responsibilities to the different departments of the municipality
- ensures that stakeholders are continuously engaged in the decision-making processes
- defines milestones and a timeline under which specific actions will be implemented (many actions will need to be implemented in phases; some may even take years to implement).

The sheet below provides an overview of the major components of the adaptation plan:

MAJOR COMPONENTS OF YOUR ADAPTATION PLAN	
1. GOALS AND GUIDING ADAPTATION PRINCIPLES	To achieve the overarching goal of the adaptation strategy and subsequent adaptation plan, namely transforming the municipality into an "adaptive" municipality, you may want to establish key principles that will guide the plan and initiatives. The guiding principles listed in this guideline should be read as examples and not prescriptions. You will need to develop your own goals/principles which reflect the local context, priorities and available capacities. Principle 1: Increase public awareness regarding climate change and its potential impacts in the municipality Principle 2: Incorporate new climate change related information as it becomes available and constantly monitor progress of your adaptation efforts. Update the plans and sector specific strategies accordingly Principle 3: Strengthen the science policy collaboration Principle 4: Promote active stakeholder engagement Principle 5: Mainstream climate sensitive information into your municipal plans and investment decisions

2. KEY INITIATIVES:	What is the adaptation plan focus? List the cross-sectoral planning and implementation programmes that are most important in terms of development priorities and previously identified climate vulnerabilities. Develop specific adaptation strategies for the identified areas, including goals and timelines. Since most of those areas are cross-sectoral, specify which municipal department will coordinate the interventions in the area and define the roles of key stakeholders and/or other municipal departments. Examples: * integrated water management programme * livelihoods programme * early warning system
3. COMMUNICATION STRATEGY:	A communication strategy is a vital mechanism for awareness creation, education (e.g. training for specific departments and sectors) and for the facilitation of ongoing stakeholder engagement through the establishment of forums or other permanent platforms. A well-structured communication strategy, which effectively targets different audiences, will help to develop the required buy-in and support from the public and political decision-makers. (For an example of a well-designed communication strategy, see the Western Cape Climate Change Strategy and Action Plan).
NITORING & EVALUATION (M&E)	M&E is put in place to ensure that the actions identified and prioritised, effectively reduce the vulnerabilities and risks associated with climate change impacts. See STEP 6 for a detailed discussion.

Each component of the plan should also address relevant barriers such as:

- a weak understanding of climate change and its local impacts (➔ communication strategy & research),
- the uncertainty with regard to timing and magnitudes of specific climate change impacts (➔ constant M&E and incorporation of new information)
- lack of political will and cooperation across municipal departments (➔ communication strategy; link to key initiatives)

OUTCOME OF STEP 5

OUTCOME	ACHIEVED?
• An integrated adaptation plan including goals/objectives, priority areas and timelines	

STEP 6:

MONITOR, EVALUATE AND ADJUST THE INTERVENTIONS ON AN ONGOING BASIS

How can you ensure that the actions identified and prioritised effectively reduce the vulnerabilities and risks associated with climate change impacts? These guidelines will help you to evaluate the municipal adaptation plan and/or sectoral adaptation strategies and ensure that they remain up to date and effective:

1. Periodically review the basic assumptions that have been the basis of the vulnerability and risks assessments. It is important that in addition to climate you need to consider changes in the economy, political priorities and population trends.
2. Incorporate new scientific information on climate change as it becomes available at all stages of the adaptation process.
3. Assess whether the actions contribute to the goals/principles defined in the adaptation plan and/or sector-specific adaptation programmes. Are all goals sufficiently addressed (e.g. awareness and preparedness campaigns)?
4. Measure the degree of mainstreaming: Is climate change addressed in sectoral planning documents? Do sectoral guidelines exist that assist you in obtaining relevant climate change information? Do new programmes consider climate sensitive information in their decision making?
5. Do forums exist, which engage stakeholders and municipal departments systematically through the decision-making and implementation processes? Are workshops initiated in which new information is communicated and learning is shared?

Adapted from Snover et al (2007: 113-119)

OUTCOME OF STEP 6

OUTCOME	ACHIEVED?
• An institutionalised monitoring and evaluation system	

APPENDIX 1. Tools for vulnerability and adaptation assessments[1]

Brainstorming

Summary

Free-flowing lists and diagrams of all ideas and options

Description

Brainstorming is a semi-structured process of capturing free-flowing ideas. The process is logical and enables people to think through the process of related elements that might not be thought of otherwise. It is also important as a process of internalising ideas.

Method

Techniques that can be used:

- A large sheet of paper can be put on a central table, around which everyone sits with a pen
- A facilitator can write all ideas that come up on a board
- People can write their ideas on post-its that can be stuck on a board/wall.

Ideas to be followed up can be circled or, if post-its are used, common ideas can be grouped together. These can be prioritised if necessary. Brainstorming is done in a group setting and therefore enables a range of ideas to be captured in one process. Because of this, a large number of ideas are generated in a short time and it is important that information is used in a constructive manner. The initial brainstorming session that lays out many ideas should therefore be followed by a session that evaluates options and enables novel ideas to be used in future planning.

Points to remember for a successful brainstorm:

- Use an experienced facilitator
- Ensure even participation
- Have a clear topic
- No more than 10 people in a group.

It may be useful to use brainstorming for developing a range of adaptation options that may be pursued, or in helping to gain a picture of the stakeholders that may be impacted by certain aspects of climate change. It can also be used by stakeholders that may be impacted on by certain activities. This process will help them to have ownership of the product and to better understand where other stakeholders are coming from.

Example

Brainstorming can be used to gather ideas on many themes. For example, it may be used to establish what risks a certain livelihood group is exposed to. The brainstorm can be taken further by examining the characteristics of certain risks. For example, natural hazards, particularly heavy rainfall and frost, might be specified as a risk. The topic of heavy rainfall can then be brainstormed further by examining the characteristics of the risk. This helps to focus intervention on the range of concerns without excluding some.

Institutional analysis and stakeholder thematic networks

Summary

The mapping of the key actors and their interactions, and evaluation of the formal and informal rules, norms and organisations that govern behaviour

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Source: Adapted from toolkit prepared by Gina Ziervogel and Thomas E Downing for the Climate Change Capacity and Development Project (C3D+), (June 2004)

Description

When assessing vulnerability and adaptation, it is critical to understand the context within which people operate. It is vital to note that decisions are rarely made in relation to climate risk alone. Institutional change (through change of social, cultural and other norms) can play a much larger role than the signal of climatic variability and change. Institutional change can be highly variable and unpredictable and it can limit and/or facilitate adaptation today and in the future. Institutional analysis requires an assessment of the types of institutions (the rules, norms, values and laws, both formal and informal) governing people and the systems within which they exist. It is this range of factors that are crucial to assess when understanding who is vulnerable and why, as it helps uncover some of the key drivers of vulnerability that may not be clear upon initial analysis of the situation. Institutional analysis is also critical when anticipating how to support adaptation as it will help determine why certain options might be more appropriate and successful than others.

Method

Stakeholder Thematic Networks (STNs) are an analysis of stakeholders and the efficiency of the networks within which they operate. STNs enable qualitative information to be analysed through semi-quantitative mapping of relationships that enable the networks and scales of linkages to be visualised.

In order for networks to be classified and for dissemination to be judged as effective or not, the following needs to occur:

- stakeholders need to be characterised
- the relationships between stakeholders must be defined
- a description of how the environment controls stakeholder interaction must be included

This can be achieved by accomplishing four tasks:

- examining users' perceptions of information
- establishing the users' role as both receiver and disseminator of information
- establishing the interaction of users uncovers the existing networks
- existing networks should be contextualised within their wider decision environment.

Stakeholder networks and their components of nodes and channels are semi-quantitative tools for achieving a thorough institutional analysis. STNs can be extended into multi-agent systems, which are essential when complexity increases as the number of actors, levels and emergence increases.

Example

In the field of agricultural adaptation, it might be assumed that farmers will perceive and respond efficiently to climate signal and that decisions on crop choice, management, inputs and labour are flexible and responsive to market prices; that households will act to optimise profits and/or yields and that adaptation options are within the agricultural sector. An institutional analysis of a farming group might be achieved by using a number of tools to gather information about the institutions that govern farmers' behaviour. For example, community timelines would illustrate important events and key changes in livelihoods. Surveys might provide perceptions of tendencies of socio-economic change (points of vulnerability/opportunity) and the impact of non-climatic vs. climatic factors influencing decisions.

Different groups are likely to have different perceptions of the impact of institutional change. For example, a subsistence community might view recent change as positive with new availability of welfare support. Semi-commercial farmers might have a mixed view of change, as new programmes have been developed, but they have been excluded. Input costs have risen and producer prices stagnated. Within this context, crop diversification might also have constraints. Farmers might be informed that shorter-cycle crops are better adapted to future climate variability but there are no subsistence or economic incentives for changing and there is no insurance and credit to support this change.

VULNERABILITY INDICATORS / MAPPING

Summary

Mapping of the different indicators of vulnerability for different groups

Description

Indicators and indexes are methods used in quantifying the level of vulnerability. An indicator is a single measure of a characteristic and an index is a composite measure of several indicators or indices. Indicators and indexes can be useful when guiding decision-making and prioritising intervention, as they allow for a comparison of characteristics. They can also be a useful policy tool, as they enable clear visual mapping of priority areas. However, there are some drawbacks/ cautions:

- Indexes of vulnerability should be treated with caution, precisely because of the complex nature of vulnerability that results in many factors being at play, and the difficulty in capturing the diversity and sensitivity of vulnerability.
- To be reliable and effective, indicators need to reflect an explicit conceptual framework of vulnerability.
- Comparing indicators and indexes that assess different temporal and spatial scales is challenging, because units of measurement are often inconsistent. This can result in inappropriate comparisons.
- The impact of a linked chain of stresses might not be accurately reflected when indicators are added up, even when they are normalised. Stresses that might have catastrophic impacts when combined might not be captured when indexes are overlain.
- Critical enabling conditions might be excluded from the assessment and so the value of the indicators is reduced. It is therefore critical that the methods for collecting and combining individual indicators are understood.
- The dynamics of local vulnerability are not usually captured in the final product.

Method

1. Select indicators. Generally this is done with regard to some conceptual framework, but often this linkage is descriptive and poorly related to the selection process. For instance, the common definition of food security as comprising economic, demographic and political dimensions may lead to indicators of GDP per capita, infant mortality and female literacy as 'appropriate' indicators. Each is clearly related to the definition, but not uniquely so and perhaps not the most sensitive indicator for capturing local conditions and multiple stresses.
2. Explore the structure of the indicator data base. This is often overlooked. Questions that help to do this include:
    - ✦ What is the range of values?
    - ✦ Are there critical thresholds for vulnerability?
    - ✦ Are indicators correlated with each other?
    - ✦ Are there clusters in the data that capture higher order factors (perhaps corresponding to the original definition)?
3. Transform the indicators into some sort of standard scores. Often these scores are mapped to identify geographic 'hot spots'. Standard scores are the relative location between the low and high value in the data set, generally in the range of 0 to 1 or 0 to 100. For example, an international comparison of GNP per capita can be expressed as 0=the minimum (some $200) and 100=the maximum (some $20,000). Some use a range from negative (below the mean) to positive (above the mean) but this implies that negative scores can be balanced by positive scores.

Example

Indexes are used at the global, national and local scale. For example, the Environmental Sustainability Index (ESI) is a global index that assesses the 'progress towards environmental sustainability' of 142 countries. Twenty

'core' indicators are used to give each country a ranking of its environmental sustainability. The indicators are divided into the following categories:

- environmental systems
- environmental stresses
- human vulnerability to environmental risks
- a society's institutional capacity to respond to environmental threats
- a nation's stewardship of the shared resources of the global commons

These core indicators are themselves composed of multiple indicators, based on the best available quantitative data. Although the ESI might not pick up local diversity, the aim is to improve global environmental decision-making, so that it can be more informed when comparing countries or regions, using their national indexes.

LIVELIHOOD INDICATOR APPROACH

Summary

An assessment of the impact of climate stressors on livelihood typologies

Description

The livelihoods concept has become widely utilised as a framework for assessing rural livelihoods. Its strength lies in the ability to look at a wide range of resources, activities and socio-economic elements that make up the livelihood of an individual or household. A livelihood is seen as sustainable when it

- can cope with and recover from stressors and shocks
- can maintain or enhance its capabilities and assets both now and in the future
- does not undermine the resource base.

This is important in the climate change context as it enables the impact of climate variability to be assessed on different aspects of livelihoods. For example, the direct impact of reduced rainfall might result in reduced yield and so households would have to find alternative food sources. The framework might help to consider that reduced rainfall might lead to reduced opportunities for temporary jobs picking fruit on farms and so casual labour might be reduced leading to reduced household income. In a similar way, the framework also enables consideration of the range of adaptation options that might be available to households.

The livelihood indicator approach builds on the livelihood framework in order to assess the vulnerability of livelihood typologies to different stresses. Advantages of the method include:

- The method takes advantage of expert knowledge in a structured way that builds on bottom-up local observations.
- It can readily lead to formal indicators.
- The focus on livelihoods leads directly to targeting suitable adaptation options while maintaining the key components of each livelihood typology.

Method

1. Undertake an initial analysis of the dominant livelihood typologies in the case study region.
2. Identify the threats to these livelihood typologies.
3. Develop a matrix that assesses how sensitive each typology is to each risk identified. This serves to reveal who is vulnerable to different threats and stresses.
3. Rank the outputs according to different variables. For example sensitivity to mortality might have a different pattern than exposure to loss of livelihood or well-being. The livelihood sensitivity matrix is the foundation for further analysis. The approach essentially melds a hazard + vulnerability = risk framework with the common Pressures-State-Impacts-Responses (PSIR) approach. It also links to subsequent steps in a climate adaptation assessment including identification of a range of adaptation options targeted toward vulnerable livelihoods and climatic threats and consideration of criteria for evaluation adaptation options, including effectiveness in reducing vulnerability and relevance to targeted stakeholders.

The exercise could be reported in short (1-page) briefing notes on each vulnerable livelihood:

- Short description of the livelihood
- Characteristics and relative scores for key indicators
- Geographic location

- Narrative describing exposure to climatic hazards
- Trend in livelihoods
- Role of other stressors

Example

The example shown in the table below is based on farming systems in southern Africa. It shows how different livelihood assets and activities (such as natural resources and farming activities) are impacted by different climate stresses (such as drought and intense rain). These scores are added up to produce exposure indexes.

Table: Example of a livelihood-sensitivity matrix

Climatic risks							**Exposure indices**	
Drought		**Dry spells**	**Intense rain**	**Flood**	**Warm spells**	**… other**	**Exposure score**	**Weighted exposure index**
Frequency		*20*	*40*	*10*	*5*	*10*	*85*	*8.88*
Resources and Livelihoods **Ecosystem services**								
Soil water balance		*5*	*4*	*1*	*5*	*1*	*64*	*3.59*
Water supply		*5*	*2*	*2*	*4*	*1*	*56*	*2.71*
Water quality		*2*	*1*	*3*	*4*	*2*	*48*	*1.76*
Non-farm wood fuels		*3*	*1*	*1*	*2*	*1*	*32*	*1.53*
Grazing and fodder		*4*	*2*	*1*	*4*	*1*	*48*	*2.35*
… others								
Livelihood activities								
Coarse grain production		*5*	*4*	*2*	*3*	*1*	*60*	*3.59*
Market crop production		*5*	*3*	*2*	*2*	*1*	*52*	*3.06*
Livestock production		*4*	*3*	*1*	*3*	*1*	*48*	*2.76*
Charcoal/wood fuel use		*2*	*1*	*2*	*2*	*1*	*32*	*1.41*
Craft sales		*2*	*1*	*1*	*3*	*1*	*32*	*1.35*
Rural casual labour		*3*	*1*	*1*	*3*	*1*	*36*	*1.59*
Non-farm permanent employment		*2*	*1*	*1*	*3*	*1*	*32*	*1.35*
… others								
Livelihoods	*Prevalence*							
Smallholder farmers	60	5	3	*1*	*3*	*1*	*52*	*3.00*
Emerging farmers	25	3	2	*1*	*2*	*1*	*36*	*2.00*
Ranchers	10	4	2	*1*	*2*	*1*	*40*	*2.24*
Market traders	5	3	1	*1*	*4*	*1*	*40*	*1.65*
…others								
Impacts score	**100**	**75**	**40**	**20**	**55**	**20**		
Weighted impacts index	**11.55**	**4.30**	**2.55**	**1.00**	**2.70**	**1.00**		**8.88**

Source: Material prepared by SEI under the UNEP support project for the NAPA workshops organised by the LEG, UNITAR and UNDP.

Notes:

- The example shown here is based on farming systems in southern Africa—these should not be taken as authoritative ratings, they are intended to show the technique rather than results from formal expert judgements.
- ***Exposure score:*** Sum of the columns for each row divided by the total possible score (25).
- ***Impacts score:*** Sum of the rows for each column divided by the total possible score (20). This is calculated only for the livelihoods—the preceding rows are elements of the livelihood scores and would result in double counting if added together.
- ***Weighted exposure index:*** This takes each cell in the row and multiplies it by the frequency for the climatic risk (shown at the top of the table). The sum of these weighted values is then divided by the sum of the frequencies. Note that the frequencies may not add to 100. In Excel this is done using the sumproduct function.
- ***Weighted impact score:*** As above, the sumproduct of the cell values is weighted according to the prevalence of the livelihood (shown in the left column of values). The sum of the prevalence of livelihoods should be 100, assuming they are discrete groups.
- ***Two aggregate values are shown:*** The sum of the weighted exposure scores for the livelihoods (8.88) and the sum of the weighted impact scores for the hazards (11.55) might be useful in comparing different regions or scenarios. However, these scores should be used with caution as they have no explicit meaning in and of themselves.

Source: Material prepared by SEI under the UNEP support project for the NAPA workshops organised by the LEG, UNITAR and UNDP.

COGNITIVE MAPPING

Summary

Development of conceptual models using interactive methods with stakeholders

Description

Cognitive mapping applies to a group of methods for measuring mental representations. Advantages of the method include:

- It helps structure messy or complex data for problem solving.
- The involvement of different stakeholders helps to establish the different perceptions and underlying assumptions of the problem.
- It is a tool that can usefully summarise and communicate information in a way other than as a literal description of mental images.

Mental mapping is a simple example of cognitive mapping. For example, if you asked children to draw their neighbourhood and what was important in the neighbourhood, it would show their perceptions of what was important. It is a useful tool to use:

- when different stakeholders have different perceptions of the problem
- when the options for addressing the problem are unclear
- when a common framework is desired.

Method

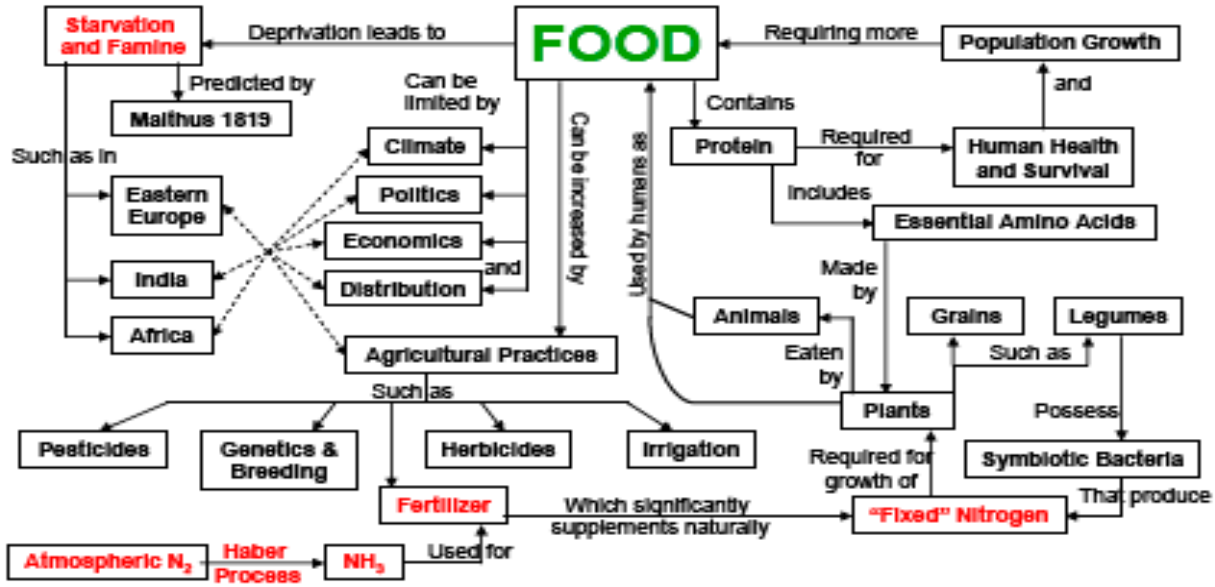
1. Cognitive mapping follows a general process:
2. State the problem
3. Brainstorm all associated assumptions and solutions
4. Group the concepts that emerge

5. Build up a hierarchy/topology
6. Re-illustrate the concepts so they form a conceptual model
7. Go back to participants to see if they are happy with the model; if not, restructure the model until they are
8. Produce a formal model

Example

The example shown in Figure 4 shows how a proposition is thought through using a cognitive map that enables a number of different aspects to be captured. The proposition here is, 'Without the industrial chemical reduction of atmospheric nitrogen, starvation would be rampant in third world countries'. The map captures aspects of the food system, including agricultural, political, regional and biological factors.

Figure 4: Cognitive map of food systems without the reduction of nitrogen



EXPERT JUDGMENT

Summary

The assessment of experts in the field on specific propositions

Description

Expert evaluation requires specialists to present their opinion of options, giving their reservations and support where appropriate. Two to three analysts may be asked to evaluate the system with reference to established guidelines or principles, noting down their observations and ranking the options. Expert judgment can be conducted at various stages of a process. It is helpful to have done some analysis of the decision or project context in order to provide the experts with background information. The approach can be undertaken by bringing experts to one location or by asking them to correspond by email or letter. It is a rapid means for getting expert and outside opinion on a project and often leads to suggestions for improvement. There may be a focus on the problematic aspects of the project, as the method is normally not used for the identification of the strengths.

Method

1. The panel of experts must be established in good time for the evaluation.
2. There should be an agreed set of evaluative criteria so that there is some consistency between evaluators.

3. The experts should not communicate with one another until the initial evaluation has been completed.
4. After the initial evaluation, the analysts can collate the problem lists and collectively evaluate responses.
5. A list of identified problems, which may be prioritised, should be produced.
6. A report detailing the identified problems should be provided to the project development team. The report should clearly define the ranking scheme used if the problem lists have been prioritised.

Example

Expert judgment can be used in many instances for both vulnerability assessments and adaptation assessments and planning. For example, if there was a decision to undertake adaptation in the water sector, a team of experts might be assembled to help decide on possible strategies. This team could include hydrologists, engineers, water resource managers, etc. Once an adaptation strategy is chosen, for example, to increase the use of water-saving devices, another team of appropriate experts could be consulted on how best to implement the strategy.

Table: Guideline for focus group questions

Questions NOT to ask in focus groups	Questions suitable for focus groups
Is excessive rainfall destructive to households and fields?	*How do people deal with excessive rainfall? What impact does it have on households?*
Is drought a problem in this area?	*What enables people to cope when conditions are dry and there is no water?*
Do many people have their own vegetable gardens?	*What are the ways are in which people ensure food in the household?*
Is crime a problem?	*What are the main social problems in the area? What can be done about them?*

MULTI-CRITERION ANALYSIS

Summary

Scoring and weighting of options using indicators and more than one decision criterion

Description

Multi-criterion analysis (MCA) enables options to be evaluated using a range of criteria that include unquantifiable analysis, especially when distributional implications need to be considered. The purpose of using MCA is to aid decision-making rather than to evaluate options on monetary terms. It is useful for assessing options for adapting to climate change, as there are many factors that need to be considered, including equity, efficiency, short or long term benefits, as well as many other non-monetary factors.

Method

In order to undertake MCA, the following steps should be completed:

1. Identification of objectives
2. Identify options for reaching the objectives
3. Establish criteria to evaluate the options. Keep in mind:
   a) It is important to note that the criteria can be both qualitative and quantitative. A criterion can be seen as a 'standard' or 'indicator'.
   b) It is important that the criteria are relevant to the decision context and that they are sensitive to the cultural, social and economic factors for each country or area for which adaptation options are being considered.
   c) The criteria often relate to advantages or disadvantages, whether quantitative or qualitative.

4. Analysis of options. In the context of climate change, the options may be assessed in terms of their ability to decrease the risk of climate change impacts and the contribution to sustainable development. An analysis process example:
    a)The range of options can be entered into a matrix and each option assessed for a range of criteria.
    b) A score may be used to evaluate each option, or absolute units might be used (such as cost or number of people affected).
    c) Each criterion can have a different unit. All the units are then standardised by interpolating and ranking from 0 to 100, for example, increasing for benefits.
    d) The scores can then be averaged and the options ranked. The criteria can also be weighted if some are seen as more important than others.
5. Analysis of results
6. Evaluation and feedback

Example

MCA example from NAPA guidelines: Cape Verde

In Cape Verde, among the poverty alleviation (PRSP) objectives proposed, the creation of opportunities for increasing income through sustained economic growth, as well as for improving the living standards of the local populations, constitute major strategic orientations. Poor, economically and socially vulnerable populations currently represent a third of the total Cape Verdean population, whereas 10 years ago 15% of the population was considered very poor.

Exploration of livelihood exposure and sensitivity to climatic hazards identified the following clusters as the principal concerns:

- Coastal, traditional fishing communities exposed to coastal storms, sea level rise and coastal erosion
- Small-scale agriculturalists exposed to drought
- Urban poor exposed to drought, intense rainfall and flooding.

Also of concern, but somewhat lower in priority (in this hypothetical example) may be:

- Critical sectoral infrastructure, such as bridges between ports and agricultural areas
- Sensitive ecosystems, such as coastal wetlands, that provide services for priority economic activities

The following preliminary list may provide potential interventions options:

1. Developing fodder crop cultivation in areas with the least agricultural potential.
2. Developing intensive livestock farming (especially goats) in arid zones.
3. Building reservoirs to capture and channel excess superficial water runoff from rainfall.
4. Introducing drip-irrigation, particularly in horticulture.
5. Developing more resilient crop species.
6. Developing chemical fertilisers for use in combination with organic manure.
7. Developing a joint management system for forest resources.
8. Developing renewable energy resources and Liquefied Propane Gas (LPG).
9. Protecting the industrial and tourist complexes of Sao Vicente in the Santa Maria Bay.
10. Rationalising sand and gravel extraction.

Obviously not all of these options can be implemented, due to financial constraints and/or lack of capacity to take on the activities. Some of them may be discarded or amended. The selection among these options is done in the following way:

- Establish criteria for selection.
- The different criteria are not all expressed in the same unit of measure, e.g.
  - ✦ Some are expressed in absolute values, but not necessarily in the same units (costs, rates, etc.)
  - ✦ Others are awarded scores
  - ✦ Binary choices (such as yes or no) are also possible
  - ✦ A variety of different scoring scales also exist.
- The values must now be standardised; that is, expressed in one common unit, according to one common scale. This standardisation is done by plotting each criterion value on an axis (linear interpolation), ranging from 0 – 1, or from 0 – 100, increasing in value when it concerns 'benefits' (advantages) and decreasing in value based upon the cost criterion (disadvantages). This standardisation process is then undertaken for all options and criteria, yielding the results of the most suitable option to follow.

SCENARIO ANALYSIS

Summary

The fuller picture of the implications of uncertainty, gained through simultaneous variation of key uncertainties

Description

Scenarios are possible futures. The future is unknown and so it is necessary to consider many alternatives of what the future might be; taking account of the full range of imaginable futures. From this population of possible (or plausible) futures, a number of outcomes can be chosen and combined to produce coherent consistent scenarios that can help to envision possible futures. The approach allows expected impacts from the reference case to be compared to those from scenarios of more concerted action (optimistic visions) or of deteriorating environmental and economic conditions (increasing the reference vulnerability).

At present there are two dominant modes of scenario construction:

1. The most widely known and visible ones are constructed by relatively small teams, usually experts, chosen to represent different sectors; working at a generalised and often global level. This 'top-down' approach provides a consistent framework for a variety of studies, but it is considerably more difficult to construct a participatory, representative process around global scenarios. A practical constraint is the type of data available and the level of detail needed in the data.
2. 'Bottom up' scenarios tend to be oriented toward more local levels with a base in participatory and stakeholder methods. Bottom up scenarios are more likely to capture local vulnerabilities and dynamics.

Scenarios have tended to be used for specific enquiries. For example, scenarios might focus on global food security or global climate change. It is therefore of paramount importance that they are used with the acknowledgement that they do not include all sectors or characteristics, but focus on the outcome of certain futures. The ability of scenarios to cover a lot of ground and their ability to consider future options has resulted in their growing use in the field of vulnerability assessments.

Method

The scenario planning process is as follows:

1. comprehensive discussion about how participants see shifts coming in society, economics, politics, technology, etc, related to the topic of enquiry
2. group draws a list of priorities or a sensible range of options
3. sketch out rough pictures of the future based on these priorities (scenarios)

4. option to support future pictures with storylines or narratives of the dominant scenarios
5. identify early warning signals that are indicative of a particular scenario occurring
6. monitor, evaluate and review

Example

The Special Report on Emission Scenarios (SRES) presents the scenarios of greenhouse gas emissions for the IPCC. The SRES scenarios focus on four possible futures up to the year 2100 that have distinctly different directions of development. The categories they use to determine "future" characteristics include demographic change, economic development, and technological change. However, the SRES are not oriented toward socio-institutional vulnerability.

ROLE-PLAY

Summary

A participatory 'game' to uncover behaviour, trends and expectations

Description

Role-playing activities stimulate discussion, pave the way for improved communication, and thus stimulate collaboration. These activities involve participants as a group in analytic thinking and assessment. Role playing can be simple stories with only a few characters or elaborate street theatre productions with a large array of stakeholder characters. Benefits of role-playing include:

- Applicable at community and agency levels
- The use of information from everyday life in the analysis of development problems carries the added benefit of working around any class and literacy barriers that may exist.
- Useful for considering adaptation to future climate, because of the exploratory nature of the tool.
- It is often hard for people to think through what they might do in future if asked a one-off question. However, if they are given the opportunity to think and act through the process, they may be able to think more realistically about how they could respond and what they might do in the future.
- Helps the researcher to uncover issues that are not always clear at first.
- It helps participants to think outside their usual frame and so provide information for themselves and the researcher on what might constrain or facilitate more appropriate management of resources and assets or creative solutions to a wide range of problems.

Method

1. An open-ended story is told to the participants or a written case description is used to describe the setting for the action.
2. The participants are asked to act out potential scenarios, to uncover what might happen under different circumstances.
    a) A tape recorder or video recorder is useful to record the role play for the facilitator's reference or for further discussion directly after the dramatisation.
    b) Transcription of tapes for later use can be a time-consuming process. It is advisable to have a number of observers who document key points or phrases that are mentioned for future analysis.
3. Discuss/ comment on the role-play

Example

Role-play is used here to determine health priorities. Priority actions need to be defined in order to improve health facilities in a village. The community roles might be the traditional healer, sick child, family head and local dispenser of western medicine. The outside roles might be a regional NGO representative and clinic worker.

Participants might use creative props to act out present health problems. They then act out present facilities and solutions. Lastly, they act out potential solutions. This serves as an entry point for discussion, where everyone can comment on the role-play and suggest what they think potential solutions might be. By acting the existing situation out, they are able to think through the process and potential options in a more creative manner.

STAKEHOLDER CONSULTATION

Summary

Consultation with individuals and/or groups affected by future processes

Description

Stakeholder consultation is increasingly being recognised as imperative to any future development. Those who might be affected by change have a right to voice their opinion on what might happen. During the process it is important that stakeholders are informed about why they are involved and what role they might play. Advantages of this method include:

- The process contributes to long term capacity building by involving and educating a wider group of people about the adaptation process.
- It is of practical value to have stakeholders involved. If the process has buy-in, it is more likely to succeed.
- Stakeholders can voice their concerns about the process, which might not have been picked up by external experts.

Keep in mind:

- "Stakeholder" can refer to policy makers, scientists, community members or any others that are part of a decision, either by making the decision or by being impacted on by it.
- It is important that all groups are considered, so that a joint understanding of the issues and solutions can help to ensure sustainability and enhance adaptive capacity.
- Stakeholder consultation is imperative for considering what type of adaptation strategies should be pursued and how viable each of these options is.
- Relevant stakeholder groups need to be brought together to identify the most appropriate forms of adaptation and will contribute to the success of implementing adaptation policies.

Method

Designing a stakeholder process entails:

1. Background
    a) What is the context for the process?
    b) What links are there to decision-making?
    c) How are stakeholders to be identified?
    d) Who is facilitating the process?
    e) Who is funding it?
2. Framing
    a) What is the composition of the stakeholder group?
    b) What are the goals?
    c) What is the agenda?
3. Inputs
    a) Stakeholder preparations
    b) Agreed rules and procedures
    c) Power gaps
    d) Capacity building

4. Dialogue/meetings
    a) communication channels
    b) facilitation/chairing
    c) Reporting
    d) Decision-making
    e) Closure
5. Outputs
    a) Documentation
    b) Action/ implementation plan
    c) Official decision-making

The level of stakeholder engagement can range from passive engagement to self-mobilisation. In passive engagement, stakeholders provide information through meetings or interview, where they voice opinions. More interactive methods enable stakeholders to initiate and design the process. One method is not necessarily better or worse than the other, but it is important to recognise where one needs more active involvement and where it is more appropriate to get initial information.

There are many ways of engaging stakeholders.

- At the local level, meetings may be held, interviews undertaken, key informants approached. Local government facilities can make it easy for members of the public to be informed of decisions affecting them.
- At the district and national level, there might be an effort to include civic members in government meetings and discussions. Interest groups might be asked to present their opinions at meetings or gatherings. Policy papers should be reviewed by experts as well as the public, and public concerns should be addressed in a manner that is transparent.

Consultation requirements:

- It is critical that an effort is made to include representatives from some of the most vulnerable groups that may not normally be involved. In order to do this, it is important that these groups are not alienated by complex language and unfamiliar environments.
- There should be support for the stakeholder groups, so that their involvement is made as easy as possible.
- There should be enough time allocated to the process so that stakeholders can be made aware of what is going on and have time to respond.
- There should be ample opportunities for feedback, so that stakeholder participation is acknowledged and the stakeholders' contribution recognised where appropriate.

APPENDIX 2: EXAMPLES OF ADAPTATION OPTIONS

Sector	Adaptation option
WATER SECTOR	• Demand side: • Water tariff structures • Water restrictions: prepare plans to balance the needs of competing users when water availability is reduced • Pressure management • Awareness & Education campaigns for water conservation • Encourage use of water conservation technologies (e.g. low flush toilets) • Changes in agricultural management practices (e.g. changes in crop types, dry land farming) • Supply side: • Rainwater harvesting for uses such as toilet flushing, car washing, irrigation • Re-use of grey water or water from sewage treatment • Control of invasive alien vegetation • Reduction of leaks
STORMWATER / FLOODING	• Improved monitoring and forecasting systems for floods and droughts • Introduce of early warning system • Preservation of wetlands required for current and future flood risk management • Permeable pavements • Introduction of green roofs to increase on-site retention of storm water • Institute land-use planning and zoning to avoid buildings and infrastructure in flood or landslide prone areas • Maintenance of storm water infrastructure • Design of resilient infrastructure and buildings
HEALTH	• Improved sanitation • Increased awareness on/ preparedness for climate related health threats (vector-borne diseases, heat, air pollution, floods) • Pollution warning system • Improvement of emergency response systems • Interventions to reduce air pollution • Protect and increase green spaces, introduce green roofs to reduce heat island effect • Increase support for health facilities

LIVELIHOODS	• Assessment of vulnerable livelihoods • Ongoing data gathering • Disaster risk reduction measures in informal settlements, including improved infrastructure , planning and management • Diversification of livelihood strategies
URBAN ECOSYSTEMS	• Protect and increase existing ecosystems and green spaces • Monitor and control alien plants and pests • Enhance conditions for street tree survival and growth (e.g. increased spaces for roots) • Protect and conserve water sheds • Rehabilitate river banks
FIRE MANAGEMENT	• Increase fire fighting capacity • Control of invasive plants • Installations of fire breaks • Erosion protection
COASTAL AREAS	• Coastal vulnerability mapping • Shoreline management plans • More stringent set-back lines • Increase shoreline buffers to protect against increased runoff from more intense storms • Research and monitor climate change impacts on fisheries
BUILT ENVIRONMENT	• Strengthen building code requirements according to increased risks of flooding, heat waves, intense storms and wind speed on building developments • Maintain and update drainage systems • Assess and retrofit vulnerable transportation infrastructure • Employ innovative techniques to minimize energy consumption and cost in building construction (e.g. solar energy geyser, natural ventilation) • Map highly vulnerable areas (flood lines etc.) and implement development bans in highly vulnerable zones • Integrate climate change factors into infrastructure planning

Sources: Bizikova et al (2008), Snover et al (2007), Mukheibir and Ziervogel (2006), DEAPD, (2008)

APPENDIX 3: CLIMATE CHANGE GLOSSARY[2]

Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Change in procedures, practices and structures with the view to limiting or eliminating the potential damage from, or capitalizing on the opportunities created by, climate variability and change.

Adaptation Benefits

The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures.

Adaptation costs

Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs.

Adaptive capacity (in relation to climate change impacts)

The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Adaptation measures and policy

Policies and measures are usually addressed together. They respond to the need for climate adaptation in distinct, but sometimes overlapping ways. ***Policies***, generally speaking, refer to objectives, together with the means of implementation. In an adaptation context, a policy objective might be drawn from the overall policy goals of the country – for instance, the maintenance or strengthening of food security. Ways to achieve this objective might include, e.g., farmer advice and information services, seasonal climate forecasting and incentives for development of irrigation systems. ***Measures*** can be individual interventions or they consist of packages of related measures. Specific measures might include actions that promote the chosen policy direction, such as implementing as irrigation project, or setting up a farmer information, advice and early warning programme. Both of these measures would contribute to the national goal of food security.

Adaptation options

Different possible response measures in response to current and future adverse effects of climate variability and climate change.

Adaptation Strategy

The outline of a process to implement policies, plans and actions to reduce the impacts of climate variability and change. Such a strategy should be designed to link climate change adaptation to sustainable development and consist of the following basic components: a climate change impact assessment (trends and projections), a vulnerability assessment (current and future), development of adaptation options, prioritization of adaption measures, creation of an coordinating adaptation plan and ongoing monitoring and evaluation.

Climate

Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO).

2 *Sources: Bizikova et al (2008), IPCC (2007), Snover et al (2007), UNDP (2005)*

Climate change

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human

activity.

Climatic hazards

These include increasing frequency of extreme weather events (floods, hurricanes, tornados, droughts), increasing summer temperatures, lower level of precipitation during main growing seasons, changes in streamflow, changes in snowfall

Climate model

A numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties. The climate system can be represented by models of varying complexity (i.e., for any one component or combination of components a hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical, or biological processes are explicitly represented, or the level at which empirical parameterisations are involved. Coupled atmosphere/ocean/sea-ice General Circulation Models (AOGCMs) provide a comprehensive representation of the climate system. More complex models include active chemistry and biology. Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal, and interannual climate predictions.

Climate prediction

A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, e.g., at seasonal, inter-annual or long-term time scales. See also climate projection and climate (change) scenario.

Climate projection

The calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based on simulations by climate models. Climate projections are distinguished from climate predictions, in that the former critically depend on the emissions/ concentration/ radiative forcing scenario used, and therefore on highly uncertain assumptions of future socio-economic and technological development.

Climate (change) scenario

A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships and assumptions of radiative forcing, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate scenario and the current climate.

Climate Variable:

Qualitative classification of a weather element (e.g. temperature, precipitation, wind, humidity, etc.) at a place over a period of time.

Ecosystem

The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, biomes at the continental scale or small, well-circumscribed systems such as a small pond.

Ecosystem services

Ecological processes or functions having monetary or non-monetary value to individuals or society at large. There are (i) supporting services such as productivity or biodiversity maintenance, (ii) provisioning services such as food, fibre, or fish, (iii) regulating services such as climate regulation or carbon sequestration, and (iv) cultural services such as tourism or spiritual and aesthetic appreciation.

Emissions scenario

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships.

Extreme weather event

An event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called 'extreme weather' may vary from place to place. Extreme weather events may typically include floods and droughts.

Exposure

Refers to the extent to which the system comes into contact with specific climate conditions or hazards.

Greenhouse gases (GHGs)

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary greenhouse gases in the Earth's atmosphere. As well as CO2, N2O, and CH4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Human system

Any system in which human organizations plays a major role. Often, but not always, the term is synonymous with 'society' or 'social system' e.g., agricultural system, political system, technological system, economic system; all are human systems in the sense applied in the AR4.

(Climate change) Impact assessment

The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems.

(Climate change) Impacts

The effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts: Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.

Non-Climatic Hazards/ Stressors

These include negative consequences of globalization and growing competition, a deepening wealth gap, changing demographics and population patterns, socio-political insecurity, rapid technological change, declining natural resources, ecosystem services, natural habitat and biodiversity, increasing level of pollutants in the natural environment as well as health issues .

No Regret Adaptation Options

Adaptation options (or measures) that would be justified under all plausible future scenarios, including the absence of man-made climate change.

Likelihood

The likelihood of an occurrence, an outcome or a result, where this can be estimated probabilistically, is expressed in this Report using a standard terminology, defined in the Introduction. See also uncertainty and confidence

Mainstreaming

The integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes and budgets at all levels and stages.

Maladaptation

Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but instead increases it.

Mitigation

An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Potential Impacts

All impacts that may occur given a projected change in climate, without considering adaptation.

Resilience

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk (climate-related)

The result of interaction of physically defined hazards with the properties of the exposed systems – i.e., their sensitivity or (social) vulnerability. Risk can also be considered as the combination of an event, its likelihood, and its consequences – i.e., risk equals the probability of climate hazard multiplied by a given system's vulnerability Risk is the probability that a situation will produce harm under specified conditions. It is a combination of two factors: the probability that an adverse event will occur; and the consequences of the adverse event. Risk encompasses impacts on human and natural systems, and arises from exposure and hazard. Hazard is determined by whether a particular situation or event has the potential to cause harmful effects.

Risk Management

The implementation of strategies to avoid unacceptable consequences. In the context of climate change adaptation and mitigation are the two broad categories of action that might be taken to avoid unacceptable consequences.

Robust adaptation measures

Actions that reduce vulnerabilities and risks under a range of possible future climate change scenarios. Robust actions are particularly important in the context of long term projects or infrastructure with a long life span. Such actions are also able to provide adequate responses as extreme weather events change in frequency and magnitude.

Scenario

A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'. See also climate (change) scenario, emissions scenario and SRES.

Sensitivity

Refers to the degree to which a sector/ system (including built, natural and social systems) is directly or indirectly affected by changes in climate conditions (including extreme weather events) or by specific climate change impacts. 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).

Socio-economic scenarios

Scenarios concerning future conditions in terms of population, Gross Domestic Product and other socio-economic factors relevant to understanding the implications of climate change. See SRES (source: Chapter 6).

Stakeholder

A person or an organization that has a legitimate interest in a project or entity, or would be affected by a particular action or policy.

Susceptibility

Extent a system, or elements of a system, will suffer loss as a result of a perturbation or stress

Sustainable development

Development that meets the cultural, social, political and economic needs of the present generation without compromising the ability of future generations to meet their own needs.

Uncertainty

An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

Vulnerability

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Weather

The state of the atmosphere at a given time and place with regard to temperature, air pressure, humidity, wind, cloudiness, and precipitation. The term weather is used mostly for conditions over short periods of time.

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