TA 7984: MAINSTREAMING CLIMATE CHANGE RISK MANAGEMENT IN DEVELOPMENT

Sector climate change screening tools and procedures

November 2015

Prepared by: ICEM

Prepared for: Asian Development Bank and Ministry of Science, Technology and Environment, Nepal

Citation: ICEM. 2015. *Sector climate change screening tools and procedures.*. Prepared for the Asian Development Bank, Kathmandu, Nepal, as part of the Pilot Program for Climate Resilience - PPCR3, Mainstreaming Climate Change in Development

More information: www.icem.com.au | info@icem.com.au

ICEM - International Centre for Environmental Management
6A Lane 49, To Ngoc Van,
Tay Ho, HANOI,
Socialist Republic of Viet Nam

Team: TA Team

DOCUMENT SET DESCRIPTION

This document set provides a compilation of two climate change screening tools developed by the TA in close consultation with the Ministry of Science, Technology and Environment (MoSTE) and sector departments. These two tools are drawn from the Climate Change Risk Management Framework developed by the TA, which describes the processes and tools for mainstreaming climate change resilience into the infrastructure sectors for Nepal. The tools are intended for use by the infrastructure departments which have been closely involved in their development - the Department of Water Supply and Sewerage (DWSS), Department of Roads (DOR), Department of Urban Development and Building Construction (DUDBC), Department of Irrigation (DOI), Department of Water-Induced Disaster Prevention (DWIDP), Ministry of Federal Affairs and Local Development (MOFLAD), and the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR).

SECTION A: CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION PLANNING METHODOLOGY FOR INFRASTRUCTURE IN NEPAL

The purpose of this guide is to describe a practical approach to integrating climate change into conventional infrastructure planning and implementation in Nepal. The guide sets out a simple and flexible process with supporting tools which can accommodate varying inputs of scientific evidence and expert judgements as well as community experience and knowledge. The method works as well in community level meetings with little or no climate change information, as it does with rigorous scientific information and expert teams. It can be a rapid process exercised over a day or extended over many weeks. The guide provides concrete examples of what climate change considerations are important and when in project planning and implementation they will have the most effect.

SECTION B: A GUIDE FOR DEVELOPING SECTOR ADAPTATION PLANS FOR ACTION - SAPAS

This guide outlines a process for sector departments to prepare Sector Adaptation Plan for Action (SAPAs). A SAPA is a sector specific plan for mainstreaming climate resilience tailored to the types and vulnerabilities of the infrastructure and the policies, plans and projects of the agency. Each agency would follow a process to develop its own SAPA. This process, modelled on the NAPA and LAPA approaches, would help each agency to identify the package of adaptation measures needed to ensure greater climate resilience in the sector. The SAPAs fill a gap between the NAPA and LAPAs, allowing a specific focus upon the vulnerabilities and technical adaptation requirements of infrastructure.

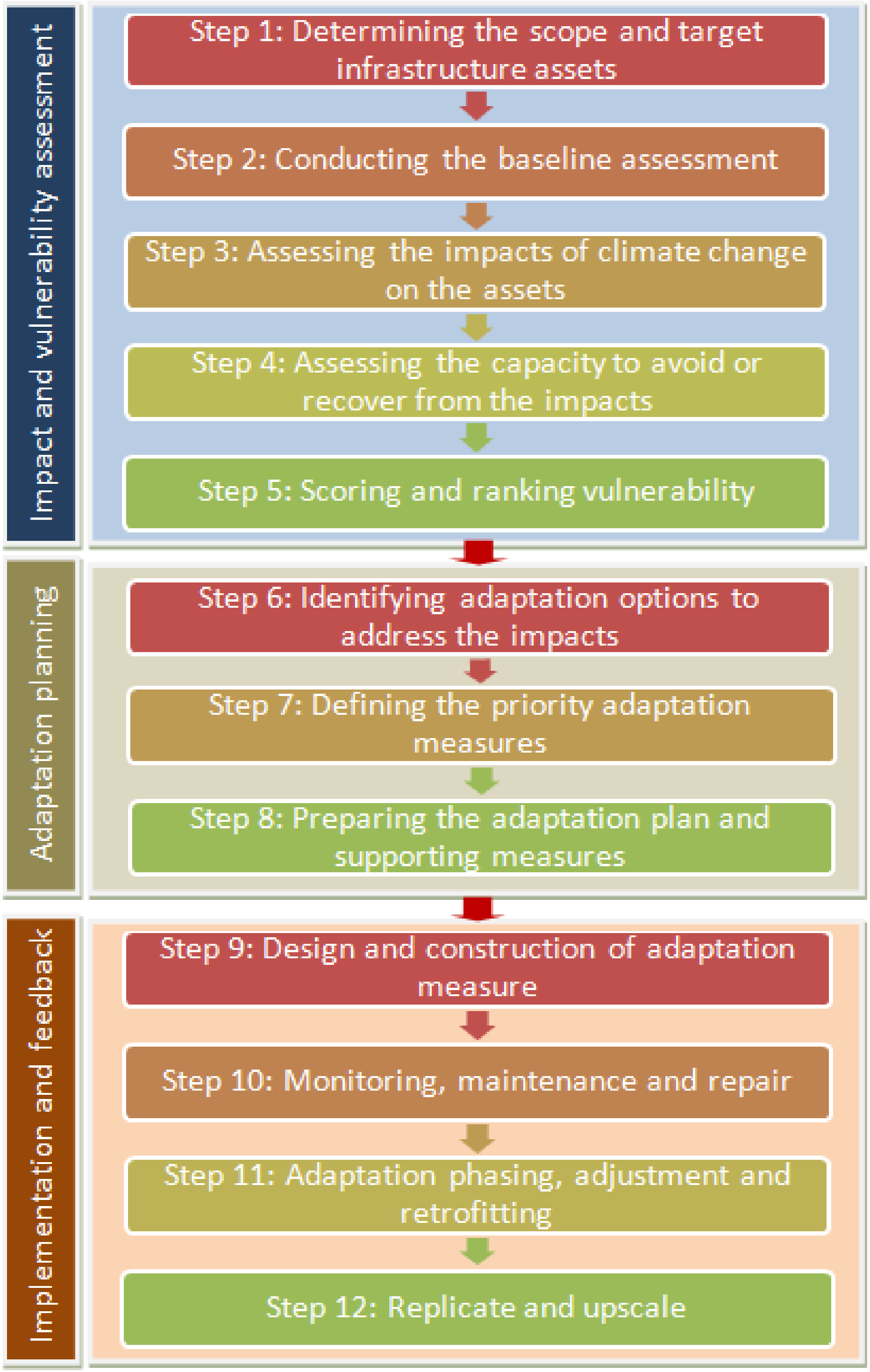
SECTION A:
CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION METHODOLOGY FOR INFRASTRUCTURE IN NEPAL: *A GUIDE FOR INFRASTRUCTURE DEPARTMENTS*

ABBREVIATIONS

ADB	Asian Development Bank
AP	Adaptation Plan
CAM	Climate Change Vulnerability Assessment and Adaptation Method
CBDRM	Community-based Disaster Risk Management
CC	Climate Change
CDTA	Capacity Development Technical Assistance
DHM	Department of Hydrology and Meteorology
DoI	Department of Irrigation
DUDBC	Department of Urban Development and Building Construction
DoLIDAR	Department of Local Infrastructure Development and Agricultural Roads
DoR	Department of Roads
DWIDP	Department of Water Induced Disaster Prevention
DWSS	Department of Water Supply and Sewerage
DRR	Disaster Risk Reduction
EIA	Environmental Impact Assessment
EMDP	Ethnic Minority Development Plan
EMP	Environmental Management Plan
GCM	Global Climate Model
GEF	Global Environment Facility
GoN	Government of Nepal
ICEM	International Centre for Environmental Management
IPCC	Intergovernmental Panel on Climate Change
KDCS	Knowledge Dissemination (or Development) and Communication Strategy
LAPA	Local Adaptation Plan of Action
MoU	Memorandum of Understanding
MCCRMD	Mainstreaming Climate Change Risk Management in Development
M&M	Monitoring and maintenance
MoSTE	Ministry of Science Technology and Environment
MoFALD	Ministry of Federal Affairs and Local Development
NAPA	National Adaptation Programme of Action
NPC	National Planning Commission
O&M	Operation and Maintenance
REMDP	Resettlement & Ethnic Minorities Development Plan
SCCF	Special Climate Change Fund
SEACAP	South-east Asia Community Access Programme
TA	Technical Assistance
TAR	Technical Assistance Report
TR	Technical Report
UNDP	United Nations Development Programme
VA & AP	Vulnerability Assessment and Adaptation Plan
VA	Vulnerability Assessment

TABLE OF CONTENTS

1 VULNERABILITY ASSESSMENT AND ADAPTATION STEPS



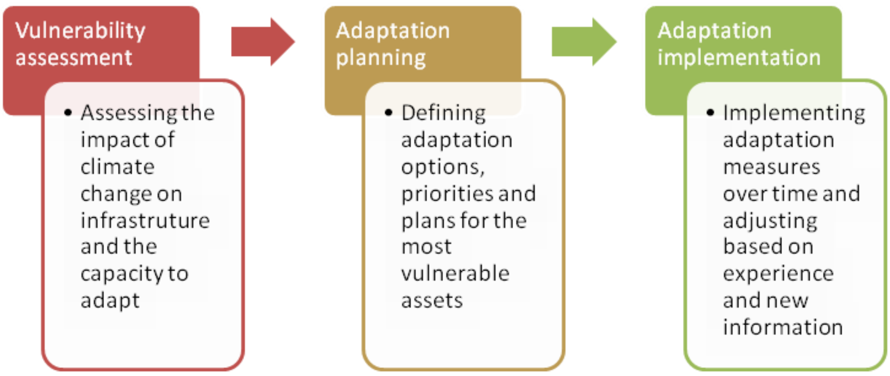
2 PURPOSE OF THE GUIDE

The purpose of this guide is to describe a practical approach to integrating climate change into conventional infrastructure planning and implementation in Nepal. The guide is intended for use by the infrastructure departments which have been closely involved in its development - the Department of Water Supply and Sewerage (DWSS), Department of Roads (DOR), Department of Urban Development and Building Construction (DUDBC), Department of Irrigation (DOI), Department of Water-Induced Disaster Prevention (DWIDP), , Ministry of Federal Affairs and Local Development (MOFLD), and the Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) facilitated by MoSTE and serviced by the Department of Hydrology and Meteorology (DHM/MoSTE).

This guide sets out a simple and flexible process with supporting tools which can accommodate varying inputs of scientific evidence and expert judgements as well as community experience and knowledge. The method works as well in community level meetings with little or no climate change information, as it does with rigorous scientific information and expert teams. It can be a rapid process exercised over a day or extended over many weeks. The guide provides concrete examples of what climate change considerations are important and when in project planning and implementation they will have the most effect.

The method provides a disciplined framework for systematically ordering and ranking the many climate change factors, their impacts and adaptation responses. It is best used as a priority setting process for mainstreaming climate change into infrastructure even in situations of scarce resources and limited information. The process has three main phases– vulnerability assessment, adaptation planning and then adaptation implementation (Figure 1).

Figure 1: Vulnerability assessment and adaptation process



Those phases are intended to be integrated with government development planning and budgeting cycles – for example, infrastructure sector development plans, area wide plans, down to specific project planning and the associated environmental impact assessment process. Over time, the aim is to build the vulnerability assessment and adaptation steps and tools into normal government and private sector infrastructure planning, implementation and review.

3 IMPACT AND VULNERABILITY ASSESSMENT

The impact and vulnerability assessment phase has five main steps to help understand and document the impacts of climate change threats and opportunities on existing and planned infrastructure (Figure 2).

Figure 2: The impact and vulnerability assessment process

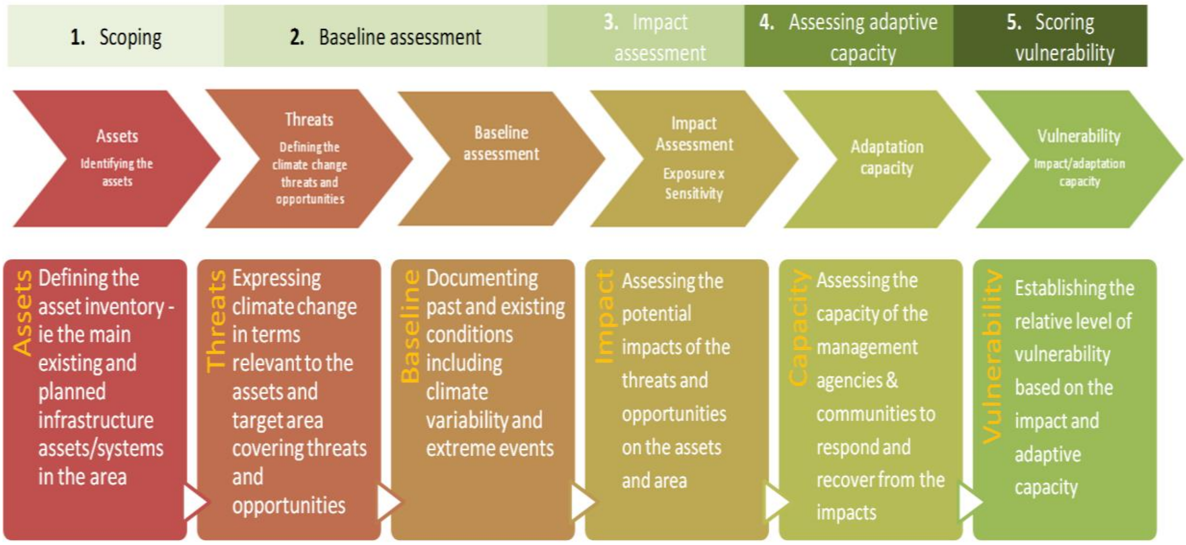
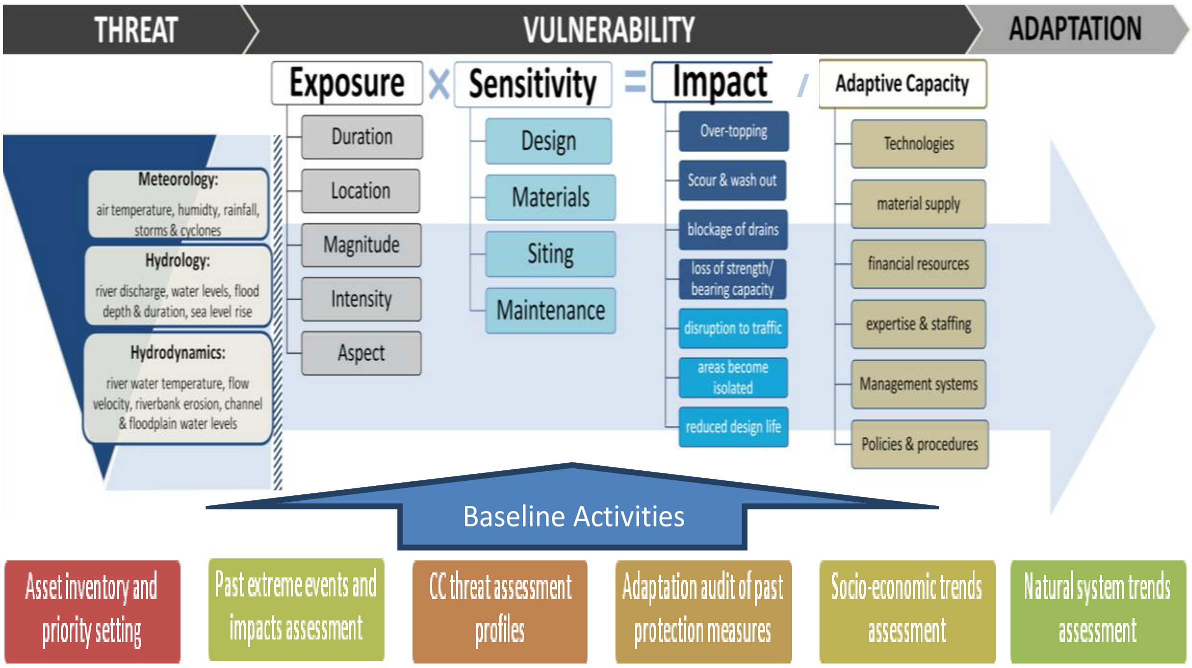


Figure **Error! Reference source not found.**3 shows the vulnerability assessment process and the key actors involved. Also, it illustrates the baseline information and tools that contribute throughout the VA process.

Figure 3: Parameters and issues considered in the baseline and vulnerability assessment process



The overall vulnerability assessment is recorded in summary form on a *vulnerability assessment matrix*. An example of a completed matrix appears as Appendix 1.

Step 1 Determining the scope and target infrastructure assets

The first step in any planning process is to set the boundaries or scope of what is being assessed. No one organisation can address everything. The scope will describe the limits of the planning task including time horizon, geographical area, sectors or assets to be covered, and resource availability for the assessment (e.g. money and human resources).

A clear set of scoping statements should be developed and re-evaluated throughout the planning process. Scoping tends to be an ongoing process of priority setting that happens at various steps in assessment and planning. Investigations in later stages may reveal that it is beneficial to include additional factors or geographical areas or sectors into the scope. Or certain impacts and adaptation measures could be judged to be of low significance or priority and left out of further consideration.

Decisions on scope should be made against predefined criteria to identify:

1. *Specific infrastructure systems* (eg river protection works; water supply and drainage system; and main road or bridge)
2. *Specific geographic areas* (eg is the entire catchment to be considered, a development zone, or a focused project site)
3. *Specific natural and social systems involved* (what natural and social systems and asset are linked to the infrastructure asset – for example, river, forest, wetland, agricultural fields, market, school, and houses)

A selection of the infrastructure systems to be the focus of the impact and vulnerability assessment can be made guided by the criteria listed in Table 1.

Table 1: Scoping criteria for the vulnerability assessment process

Infrastructure
▪ Existing projects which have been shown to be vulnerable to past climate variability or extreme events. ▪ Infrastructure of strategic importance to the nation, town or local community (eg road links to market or airport) ▪ Poor quality or damaged infrastructure which needs to be replaced or repaired (eg repeatedly damaged by floods) ▪ Number of people affected ▪ Area served (eg irrigation command area) ▪ Representative of an infrastructure category and therefore valuable as a pilot for replication
Geographic area
▪ Area exposed to past extreme events and projected climate change threat ▪ Area where communities are committed to participate in management, monitoring and repair. ▪ Area with potential as an accessible and representative demonstration for replication.

Defining the target infrastructure "system": Once a set of broad scoping statements have been made, a more detailed description of the target infrastructure system or asset is required. The system description should include details of the main infrastructure components – for example, an irrigation system might include the water source and catchment, sediment trap, pumps, canals, culverts, distribution pipes and command area. The services provided by the asset and the communities served should be recorded, in addition to the natural and social system components linked to the asset and affected by its condition and resilience (eg agricultural fields, school buildings, market and other infrastructure systems).

For some sectors, defining the "system" and its components is not straight forward – it requires interpretation and judgements by the assessment team. For example, a local feeder road may be 100km long connecting town A with town B. That entire road might be identified as the system with all its culverts, bridges and associated slope and drainage protection measures as components. Or, the assessment team might decide to delineate just a short section of the road which has proved to be especially vulnerable to past extreme events such as floods and landslides. In that case the "system" would be the road section and the few components along that stretch. Assessment teams will need to carefully define the boundaries of the assessment and the components of special interest.

Defining the infrastructure system objectives: It is necessary to establish the objective or purpose of the system being investigated and how each component contributes to that objective. A small irrigation system might have the objective of delivering about 0.9 litres/s/ha of water to a command area of 300 hectares. Each component will have its own role in contributing to this overall system objective which needs to be described – for example, the sediment trap objective is to keep sediment from entering and blocking the distribution piping and canals.

Defining the primary and secondary objectives will assist in assessing the impacts of climate change, and help define adaptation options which assist the system in achieving its objectives with climate change. System objectives may be defined in consultation with the affected community, the sector technical experts, or within the original project documents.

Step 2 Conducting the baseline assessment

The baseline assessment of the target infrastructure asset needs to provide a strong foundation for the entire vulnerability assessment and adaptation process. It establishes the evidence base, justification and credibility for all the judgements and decisions which follow. The baseline describes the past and existing situation, trends and drivers affecting the target systems, and analyses the changes to the system that will occur irrespective of climate change (Figure 4).

Tool
Baseline assessment field template

The baseline assessment also involves documenting the projected climate and hydrological changes which will affect the asset and surrounding area. Usually it requires field missions to relevant locations and consultation with stakeholders, including local government officers and affected communities. The *baseline assessment field template* to be completed by the vulnerability assessment and adaptation planning team appears as Appendix 3.

Often information of past extreme events such as floods and droughts for example, or even design details of existing strategic infrastructure, is not available and gathering of local experiences, knowledge and judgements will be necessary.

Determining the climate change threats: The baseline assessment draws together information on past extreme events and climate variability impacting on the asset and area. Often that information has not been well documented so *participatory mapping* involving government and community members in the area can provide an accurate foundation for hot spot identification.

Tool
Participatory mapping of past extreme events such as flooding and landslides

Figure 4: Baseline assessment components

The baseline assessment also summarises climate change projections of relevance which may be available through earlier studies. In some cases, there may be resources to conduct climate change downscaling and/or linked hydrological modelling for target catchments. As capacities are built for such modelling, the MOSTE Department of Hydrology and Meteorology will develop its climate change information portal which assessment teams can access. The challenge is in communicating the climate and hydrological information in forms which are useful for specific sectors or communities, and which match the target system. That requires an interactive process between the DHM and the sector experts to arrive at a set of climate change threat parameters which are best suited to their needs. The result is summarised in *a climate change threat profile* for the target area.[1]

Tool
Climate change threat profile

[1] The TA – 7984 NEP: *Mainstreaming Climate Change Risk Management in Development Project* supported by ADB worked with DHM and the infrastructure departments to prepare eight district climate change threat

Examples of climate change threats (and examples of linked impacts) which can be defined in the threat profile for the target area include:

- *Flooding (e.g fluvial and flash floods) and increased precipitation*: threat of physical damage from intense flow and inundation, increased destabilization of nearby land, erosion, landslides.
- *Drought:* reduced water availability, sedimentation of canals, threat to productive crops, animal loss, drying/movement of soil/foundations leading to damaged structures, dust storms
- *Storms, strong winds, hail and lightening*: physical damage to natural and built assets (e.g. houses, crops)
- *Heat waves*: crop losses, forest fires, damage to physical infrastructure through heat expansion/cracking (e.g. pipes)
- *Low temperatures/frosts/cold snaps*: crop losses, animal losses, damage to built infrastructure (e.g. expansion of ice and loss of structural integrity)
- *Temperature changes*: loss of species unable to adapt to temperature changes
- *Glacial Lake Outburst Floods (GLOFs)* which occur when increased rain, melting ice, or an earthquake cause a glacial lake to burst and release its water in a very short period of time

It is not necessary to cover all climate change parameters but to focus on those which are most relevant for the target asset and area – identifying those will require discussions with DHM. Some climate changes may have beneficial impacts, for example, increased rainfall in a dry agricultural area. The assessment team should ensure that parameters which might have positive effects are considered.

Step 3 Assessing the impacts of climate change on the assets

The method considers two important factors in assessing impact of climate changes on the target system and its components: *exposure* and *sensitivity*.

Exposure is the extent to which a system is exposed to the climate change threat. **Sensitivity** is the degree to which a system will be affected by, or responsive to the exposure. The potential **impact** is a function of the level of **exposure** to climate change threats, and the **sensitivity** of the target assets or system to that exposure.

Exposure is best assessed by overlaying maps of past extremes such as floods and drought and of projected climate changes on the area where the system is located or planned.

Exposure to a threat depends on:

- *Location* of the system with respect to the threat (eg. distance from the flood zone or river bank).
- *threat intensity* e.g. how deep and fast flowing the flood water is,

---

profiles and one for each sector based on climate change and hydrological modelling. Those initial profiles will need to be updated at least annually through consultation between DHM and each department.

- *frequency* e.g. the "return period" of large, destructive floods – every five years, every 10 years etc, and
- *duration* e.g. destructive flood threat lasts for 1 day, flood waters remain for 5 days.

Judgements based on the information on past extreme events need to be adjusted to account for the expected effect of climate change (e.g. increases in frequency and intensity of flooding event).

The rating system for exposure and other parameters uses a scoring from very low to very high and is applied based on expert judgement drawing from the best available scientific and factual evidence and where appropriate community knowledge and experience:

Very low	Low	Medium	High	Very high
very low intensity/severity and/or very infrequent and/or very short duration	low intensity/severity and/or infrequent and/or short duration	medium intensity/severity and/or average recurrence and/or average duration	high intensity/severity and/or frequent and/or long duration	very high intensity/severity and/or very frequent and/or very long duration

Sensitivity: The next step in impact assessment is to rate the sensitivity which is the degree to which the exposure to a threat will negatively affect the integrity or operation of the system. Asset sensitivity for an infrastructure asset may be influenced by:

- *Specific siting*: asset proximity to most threatened locations e.g. right on river bank or within the flood plain with no natural barrier to the flood.
- *Geotechnical character*: bank stability, soil condition, drainage, vegetation and existing stability measures. May require more formal geotechnical assessment or visual inspection.
- *Integrity of design*: Is the asset designed robustly and with features to mitigate against threats? E.g. Powered irrigation system to protect crops against drought; crop varieties resilient to frost/drought; drainage around buildings, roads, fields; buildings raised above flood line.
- *Integrity of materials and construction*: Does the asset contain strong, durable, appropriate materials in light of the expected threats? (E.g. buildings constructed of bamboo or concrete; unsealed/earth/dirt road or a paved/sealed road)

Taking into account those variables, the assessment team needs to rate system sensitivity from very low to very high:

Very low	Low	Medium	High	Very high
Very good integrity of design, materials and construction	Good integrity of design, materials and construction	Average integrity of design, materials and construction	Poor integrity of design, materials and construction	Very poor integrity of design, materials and construction

Impact: The product of exposure and sensitivity provides a measure of the potential **impact** of the threat on the system. The method provides a support tool for determining the impact rating – *the impact scoring matrix*. This is the most important stage of the vulnerability assessment including detailing the potential impacts in the impacts column of the VA matrix (Appendix 1).

Tool – the impact scoring matrix

Sensitivity of system to climate threat	*Exposure of system to climate threat*				
	Very Low	*Low*	*Medium*	*High*	*Very High*
Very High	*Medium*	*Medium*	*High*	*Very High*	*Very High*
High	*Low*	*Medium*	*Medium*	*High*	*Very High*
Medium	*Low*	*Medium*	*Medium*	*High*	*Very High*
Low	*Low*	*Low*	*Medium*	*Medium*	*High*
Very Low	*Very Low*	*Low*	*Low*	*Medium*	*High*

The listed impacts provide the basis for defining the adaptation responses. Impacts are of two kinds – (i) *direct impacts* which impinge on the system for example, damaging a bridge culvert in a road and (ii) *indirect impacts* such as preventing traffic and transporting produce to market or children to school. In the adaptation planning phase of the VA&A process, adaptation options need to be defined which address the most significant direct and indirect impacts.

Step 4 Assessing the capacity to avoid or recover from the impacts

Adaptive Capacity: Once the impact assessment has been completed, the adaptive capacity of the managing organisation or community to prepare for and respond to the impacts needs to be assessed. Examples of factors to consider when determining adaptive capacity are listed in Table 2. It is not necessary to consider them all. What needs to be addressed depends on the nature of the target system and the responsible organisations. When assessing adaptation capacity of the responsible infrastructure department the most important factors are those of a cross cutting nature – and those relating directly to the asset and its repair/construction.

Table 6: factors to consider when assessing adaptation capacity

1. Cross cutting factors	***2. Infrastructure***
▪ The range of available adaptation technologies such as bioengineering approaches ▪ Management and response systems in place including policies and structures ▪ Availability of relevant technical staff and knowledge ▪ Availability of necessary equipment ▪ Suitable financial resources to support cc adaptation ▪ Appropriate design standards which promote appropriate adaptation responses ▪ Policy commitment to quick response ▪ Availability and distribution of financial resources	▪ Availability of physical resources for repair/reconstruction (e.g. materials and equipment) ▪ Has the asset been regularly maintained ▪ Are there backup systems in place (e.g. an alternative routing if a road or bridge fails) ▪ Presence of other infrastructure negatively affecting the asset

3. Natural systems	***4. Social systems***
▪ Condition and stability of watershed affecting the asset ▪ River bank and slope stability ▪ Water quality (eg in the case of irrigation and water supply assets)	▪ Does the affected community have insurance and financial resources to respond ▪ Is a "user group" established ▪ Do users have access to alternative services

The example given here for rating adaptive capacity is of an organisation delivering and/or managing the infrastructure system (whether a road, irrigation system or water supply intake and pumping station for example).

Very low	Low	Medium	High	Very high
Very limited institutional capacity and no access to technical or financial resources	Limited institutional capacity and limited access to technical and financial resources	Growing institutional capacity and access to technical or financial resources	Sound institutional capacity and good access to technical and financial resources	Exceptional institutional capacity and abundant access to technical and financial resources

Provide reasons for the scores

When deciding on ratings for exposure, sensitivity, impact and adaptive capacity, justifications and explanations need to be footnoted so that others reading the final vulnerability assessment matrix understand the reasoning behind the scores. Also, reasons given for the exposure and sensitivity scores help in completing the detailed impacts column of the matrix (Appendix 1). They increase the authority and credibility of the final vulnerability ranking by making the process transparent.

Step 5 Scoring and ranking vulnerability

If feasible, it is useful for the VA and A team to work on site to complete an initial vulnerability assessment of the target system using the *VA field form template* which appears as Appendix 4. That hand written field form is then brought back to the work room and through discussion with other sector technical specialists transferred into the formal *vulnerability assessment matrix* (Appendix 1). The formal matrix provides the framework for assessing a system and each of its target components.

The final vulnerability score is determined by considering the impact and adaptation capacity together. The method provides a support tool for determining the vulnerability score – *the vulnerability scoring matrix*. An important point to keep in mind is that with increasing severity of impact, vulnerability of the target infrastructure system increases. Adaptation capacity has the opposite effect – with increasing adaptive capacity an infrastructure system would have reducing vulnerability. The vulnerability scoring matrix takes that inverse relationship into account.

Tool – vulnerability scoring matrix

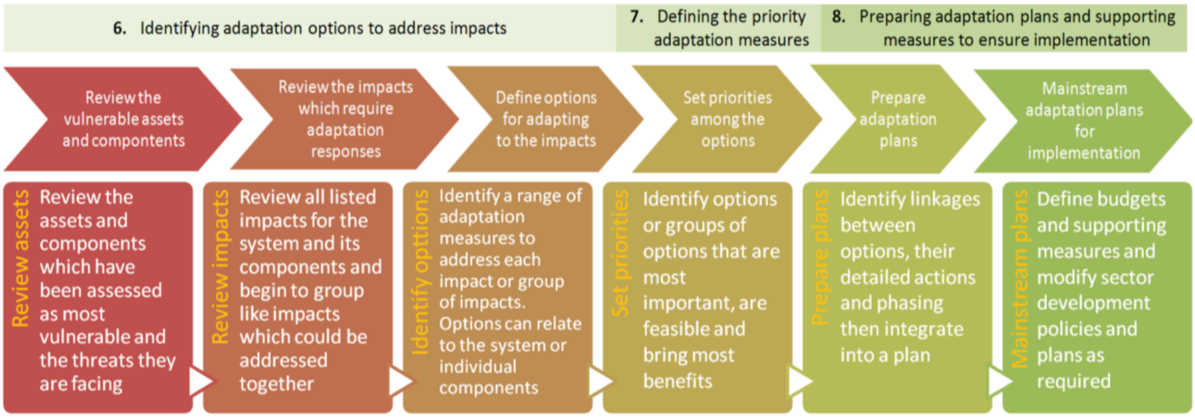
Adaptive Capacity	Impact: Very Low – Inconvenience (days)	Low – Short disruption to system function (weeks)	Medium – Medium term disruption to system function (months)	High – Long term damage to system property or function (years)	Very High – Loss of life, livelihood or system integrity
Very Low – Very limited institutional capacity and no access to technical or financial resources	Medium	Medium	High	Very High	Very High
Low – Limited institutional capacity and limited access to technical and financial resources	Low	Medium	Medium	High	Very High
Medium – Growing institutional capacity and access to technical or financial resources	Low	Medium	Medium	High	Very High
High – Sound institutional capacity and good access to technical and financial resources	Low	Low	Medium	Medium	High
Very High – Exceptional institutional capacity and abundant access to technical and financial resources	Very Low	Low	Low	Medium	High

4 ADAPTATION PLANNING

Adaptation to climate change refers to actions taken by households, businesses, governments and communities in response to the impacts of climate change. It can include actions taken to prevent, avoid or reduce the risks of those impacts (ie proactive adaptation), or in response to impacts as they happen (reactive adaptation). It can take the form of retrofitting and upgrading existing infrastructure as well as an anticipatory response by building adaptation measures into sector and area wide plans and into new infrastructure. Adaptation includes taking advantage of the opportunities that may arise due to climate change, as well as responding to negative impacts.

Adaptation planning involves developing a range of adaptation **options** for each of the main impacts of climate change and then determining **priorities** for implementation which are built into an integrated adaptation plan. With limited resources it is not possible or necessary to do everything at once – choices need to be made on what is feasible and necessary now and what can be left to later planning cycles. Adaptation planning is all about priority setting and phasing of implementation. Adaption planning has three main steps for (i) defining the options, (ii) setting priorities among them and (iii) for preparing adaptation plans and having them integrated with development plans and budgets (Figure 10).

Figure 10: Adaptation planning process



The aim of the adaptation planning process is to guide preparation of an integrated adaptation plan to build resilience in the target system or area (i.e. to prepare an infrastructure system or area wide adaptation plan and have it funded and supported). **Error! Reference source not found.**

Similar to the vulnerability assessment phase, adaptation planning uses a *matrix template* supported by a number of tools to guide scoring. The same *adaptation planning matrix template* (Appendix 2) is used whatever the target infrastructure system - a road or water supply scheme for example, or whatever the area covered, for example an urban settlement, agricultural region or river basin.

Each VA&AP team charged with taking climate change into account when preparing plans for areas or in designing infrastructure systems such as a road, irrigation system or hydropower scheme needs to consider the level of effort and justification which is required in setting adaptation priorities. It is feasible to go directly from the vulnerability assessment phase to defining an adaptation plan – ie without using the adaptation planning matrix. The matrix provides an additional discipline and systematic tool for identifying the most significant problems which need to be addressed and for choosing what adaptation responses should receive attention in situations of scarce resources. Like the vulnerability assessment matrix, the adaptation planning matrix is a guide and discipline for discussion within the team and with stakeholders.

The final adaptation plan does not need to follow the matrix outcomes precisely – other factors may influence the adaptation priorities. Also, in some cases the matrix results may appear counterintuitive. If an adaptation measure is critical to the continued operation of an entire infrastructure system – but scores only medium priority for adaptation because of the high cost then the final plan should override the matrix result and stress its importance.

Step 6 Identifying adaptation options to address the impacts

Reviewing the threats and impacts: The adaptation planning phase of the VA&A method focuses on the most vulnerable assets and areas identified during the VA. The first step in completing the *adaptation planning matrix* is to review the key threats and impacts identified for the most vulnerable assets. The intention is to confirm the VA findings and ensure that all the most serious assessed impacts are to be addressed. The VA matrix has been completed following a systematic and disciplined process – but still it is only a guide and expert judgement and stakeholder consultation should ensure that the impacts of most concern are brought into the adaptation planning phase.[2]

Adaptation options

- Draw from the adaptation audits conducted during the baseline assessment.
- Indicate what adjustments need to be made to existing practices and protection measures to more effectively respond to CC impacts
- Consider adaptation options for the system as a whole and for each of the vulnerable components
- Consider new technologies and approaches

Adaptation options

Listing of the adaptation options for addressing each of the most significant impacts

Identifying Adaptation Options: Adaptation options are shaped by existing conditions at the target location, the climate change threats and the potential impacts on the infrastructure systems being assessed. They are also influenced by the capacity of the system to recover from the impact.

It is important to draw from international, regional and local experience of what has worked in building resilience to extremes in the past. The main purpose of the adaptation audit conducted as part of the baseline assessment is to document the local experience in responding to past storms, landslides, floods, droughts and other extreme events – what has worked and what has not. Reviewing international experience can also expose planners to new approaches, technologies and materials and even institutional arrangements and policies which have worked well in other countries.

Inevitably resources to support adaptation are limited so sharp priorities must be set and approaches need to reflect local capacities and resources. The approach to defining adaptation options is described in Box 2.

Box 2: Defining adaptation options for infrastructure

Area wide adaptation:
The first response is to look broadly at the entire area where the target system (s) is located – this may mean for example, looking at the host town, commune, catchment, river basin or protected area and thinking through the overall area wide approach to adaptation that is needed. Setting a framework of broad principles for adaptation may help shape the more specific measures for the target system and its components. It also promotes integration of adaptation measures across sectors and areas – and seeks to avoid mal-adaptation which reduces resilience in other sectors or areas.
System wide adaptation:
The second response is to identify adaptation options for the target system – whether an irrigation scheme, river embankments or feeder road for example.
System component adaptation:
The third response is to determine the adaptation requirements for each of the key system components – for example, a culvert bridge on the road, a weir and input for the irrigation scheme or a bioengineered slope linked to a river dyke system.
Supporting and facilitating adaptation measures:
The fourth response is often overlooked because it can be the most complex and involve many authorities and stakeholders. To be effective, many of the measures defined for the area or system may require supporting actions by other sectors, areas, resource managers or levels of government. It may involve establishing new decision making and management structures, for example a road user group. It may involve introducing new procedures for example spatial planning and zoning with safeguards. It may involve more detailed modelling of hydrology to better inform infrastructure location and design or the application of other tools to substantiate more fully specific adaptation measures proposed. A comprehensive adaptation plan needs to be a structured combination of mutually reinforcing actions using natural, built, social, economic and institutional systems.

[2] At this stage for large scale plans and projects the VA&AP team wish to conduct an *assessment of impact significance* as an additional part of the vulnerability assessment described in Chapter 5 of this guide.

The consideration of supporting measures such as policy and institutional reforms can be ongoing as the more focussed adaptation planning moves forward – but a VA&AP team should not be distracted from its main focus which is defining adaptation measures for the target system and its components. Also, best initially keep within the mandates and authorities of the immediate stakeholders – ie first identify what they have the authority to do and focus on defining actions within that mandate. Then progressively identify what others can do to reinforce the immediate or core measures and to promote their sustainability and replication.

Table 8 illustrates categories of adaptation measures, some specific options that have been tested in Nepal and elsewhere in various situations and the key actors responsible for implementation.

Table 8: Adaptation options categories and examples

Adaptation category	Specific measures	Main responsibility
Engineering measures	▪ Flood protection: dyke; upgrade drainage system; flood storage reservoir; erosion protection; bridges; road culverts; etc. ▪ Water storages (e.g. dams, tanks) for use during dry months ▪ Reinforcing existing structures or building new ones to withstand severe storms and wind	From district to national level government, can involve local user groups
Bioengineering measures	▪ Vegetation slope instability protection using grasses/shrubs/trees ▪ Rock gabions using local materials ▪ Large woody debris in-streams to help slow flow rate and create protected areas for vegetation to take hold; also creates habitat for aquatic animals. ▪ Rain gardens, biofilters, vegetated swales for reducing/slowing down runoff and increasing infiltration rates	From local to national level government Also, local user groups and community based organisations
Traditional local adaptation measures	▪ Bamboo stakes and vegetation river banks. ▪ Maintenance of traditional water sources and water user groups ▪ Use local natural materials and designs in construction of houses, rock walls and wind breaks; ▪ Re-vegetating foredunes and mud flats with local native species and re-establishing mangroves to combat erosion; ▪ Maintaining fish traps and reviving community gardens that diversify livelihood options. ▪ Traditional seed storage facilities	Land owners, user groups, local government level
Economic instruments	▪ Natural resource and land use taxes ▪ Payments for ecosystem services ▪ Grants and tax reductions ▪ Conditions on licenses and permits	National or provincial government
Natural systems management	▪ Revegetation of watersheds ▪ Rehabilitation of river embankments and flood plains ▪ Establishing biodiversity corridors ▪ Effective management of protected area network and buffer zones ▪ Greening of urban areas ▪ Agro-forestry practices to increase species complexity and stability ▪ Water allocation systems to share limited water supplies during drought.	National or provincial government with delegated responsibilities to user groups
Social responses	▪ Resettlement programs ▪ Livelihood and crop diversification ▪ User groups for maintenance and management of facilities/resources ▪ Seasonal and planned migration ▪ Education and awareness programs	Local communities, national or provincial government
Policies and regulation	▪ Zoning for development control (e.g. no major structures in floodplain or close to river banks) ▪ Regulatory requirements for structural integrity of buildings, materials controls, floor height restrictions. ▪ Sector design standards (eg of culverts, materials, set backs) ▪ Urban zoning and safeguards ▪ EIA and SEA provisions and tools which consider climate change	National or provincial government
Research and development	▪ Research into drought/saline tolerant crops. ▪ New porous surface materials to allow for water penetration in urban areas ▪ Tolerance levels and adaptive capacity in wild species and ecosystems	National or provincial government and institutes
Institutional responses	▪ Formation of local user groups for management and maintenance of infrastructure facilities ▪ Structures for promoting partnerships with business and the community; ▪ Programs to integrate climate change within disaster risk management agencies ▪ Creating inter-agency network on climate change that encourages collaboration between organisations.	National or provincial government

In most cases, an effective adaptation plan requires an integrated set of actions across several fields of management so that each reinforces the others. Also, it is useful to analyse how the action will modify vulnerability, either by minimising exposure, reducing sensitivity or by building adaptive capacity, Identifying adaptation options requires the involvement of a cross-sectoral group of specialists as well as affected stakeholders. As in other phases of the process described in this guide, the extent and nature of consultation will depend on resources available, urgency for action and the level of decision making – for example is the target system a small rural road or a national highway. In most cases, adaptation will require action and commitment of local affected groups so their involvement at each VA&AP phase should be facilitated.

Level of detail in adaptation options

An adaptation measure, such as erosion protection, can be implemented in a variety of ways - from conventional engineering approaches that replace erodible surfaces with hard surfaces to integrated approaches that use bioengineering to protect from erosion and catchment management actions to reduce runoff. The detail design of these options does not necessarily need to be defined when first identifying the adaptation measures, which may be during the pre-feasibility stage of infrastructure planning. But it is important to be clear about the overall approach required from the earliest stages. For example in many situations it is desirable for bioengineering solutions to be explored before or as an essential companion to hard engineering measures.

VA&AP teams should apply the key principle of adaptation to first consider ways of using bioengineering and natural approaches to solving adaptation challenges before hard engineering options are designed. Adaptation should always contribute to ecological sustainability as well as reducing climate change vulnerability.

In general, it is best to consider integrated adaptation options that take wider ecological, social and economic factors into account as early as possible in the planning process. It is more difficult at later planning and implementation stages to achieve synergies and multiple benefits from the same action if they have not been considered early and planned for. Often these synergies can come at little or no additional cost.

Step 7 Defining the priority adaptation measures

It is not possible or necessary to do everything at once; some investments need to be made immediately or soon, others can be left for future financing. Sharp priorities for action are required which are within available funds and which address vulnerabilities in the assets and systems of strategic importance to the target area, sector or community.

Priority setting requires that some measures should lay the foundation for future adaptation investments and facilitate future additions and modifications as climate continues to change. An adaptation measure should not make future adaptation difficult or expensive. It should not rule out future adaption options or actions to build resilience in other sectors or communities.

Strategic options for adaptation

To assist in setting priorities for adaptation in the case of infrastructure development, four strategic options can be defined:

(i) Build now for lifetime adaptation
(ii) Plan for phased adaptation over project lifetime

(iii) Progressive modification to design
(iv) Build to repair

Table 9 describes those options and their operational and financial implications. In most cases *planning for a phased approach to adaptation over the lifetime of a project is the most effective approach*. It may not be a matter of choosing between options but staging them – some will need to be implemented before others are feasible. Others need not be done immediately. Still others will require further consultation and research.

Table 9: Four approaches to design of adaptation measures in infrastructure

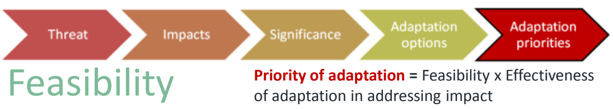
Adaptation approach	Description of adaptation approach	Expected financial implications
1. Build now for lifetime adaptation	▪ Build all adaptation measures immediately to last the project lifetime.	▪ Relatively high investment initially. ▪ No additional investment for subsequent adaptation required. ▪ Long term security is dependent on actual climate change not exceeding the prediction.
2. Plan for phased adaptation over lifetime	▪ Fully plan an upgrade program to progressively adapt the design as climate changes occur. ▪ Initial design provides functionality to adapt over life span.	▪ Medium level initial investment. ▪ Investment required during asset life cycle. ▪ Implementation of project adaptation phases will occur as designed.
3. Progressive modification to design	▪ Redesign and reconstruct as required in response to verified climate change. ▪ Initial design may not provide functionality to adapt over life span. ▪ Redesign and reconstruction required prior to damage or failure.	▪ Lower initial investment. ▪ Climate changes will force re-design costs and investments for reconstruction during asset life cycle to avoid catastrophic failure. ▪ This is potentially an expensive approach.
4. Build to repair	▪ Accept there will be damage and repair as required. ▪ Initial design does not incorporate adjustments to respond to climate change projections. Should asset be damaged as a result, asset manager accepts damage and carries out repairs.	▪ Low initial investment. ▪ Likely financial loss due to damage of asset. ▪ Relatively high repair cost during life cycle but overall may lead to lower whole of life cost if climate change does not cause substantial damage. ▪ This is the cheapest up-front option but comes with the largest risk and potential cost.

Feasibility and effectiveness of adaptation actions

Once a list of adaptation options in response to an impact has been developed, priorities for action need to be set. It won't be feasible or necessary to implement all possible solutions. Some of the options may be mutually exclusive (e.g. it may not make sense to build a flood retention dam as well as raise the level of a downstream bridge). Also resource limits, and policy or regulatory limits and standards may favour certain options over others.

The next step in the adaptation planning matrix (Appendix 2) is to assess the feasibility and effectiveness of each adaptation option to arrive at a rating of priority (Table 11).

Feasibility of an adaptation option



- Is the action technically feasible without additional R&D or does action require some development?
- What is the time required to implement – can it be implemented immediately or does it require long surveys and design time
- What is its cost – how expensive is the measure? Is government budget available?
- What are the capacities of community/user group (eg commitment, labour, materials)?
- What are the capacities of government to support the action (eg skills, institutional arrangements, equipment)?

The assessment of feasibility determines to what extent each option can be accomplished or implemented. Factors influencing feasibility which need to be considered include technical complexity, capacity of the infrastructure agency and user community and the cost:

(i) **Technical complexity and demands:** When addressing this issue the VA&AP team should ask questions like: Does the affected community or lead government agency have the knowledge and skills to use the technologies involved? Is the technology available within the country? Does it have high maintenance demands and costs? Will it require investment in time and resources to understand how best it can be applied locally?

(ii) **Time to implement:** The commitment of time can be a critical factor in situations where past and existing extreme events have caused damage or threaten strategic infrastructure and facilities. Action is required now. Also, some options such as a river bank dyke may need to be fully in place to be effective – others can or need to be implemented over several years. For example, bioengineering measures can take several years of plant growth and adjustment to reach the needed levels of resilience and then to increase in strength over time.

(iii) **Capacity of local communities:** If local communities are an essential force in building, managing and monitoring the adaptation measure many issues will need to be considered through consultation and survey. Key factors include - who within the community will take on the responsibility; will a special management or user group structure be needed; will the key actors be able to set aside livelihood activities to accommodate the new role; and will compensation be needed? It is not necessary for the adaptation team to resolve in detail all these issues and others relating to local community involvement, but it is important that some appreciation be gained on the level of effort which will be required to sort them out.

(iv) **Capacity of government:** In most cases, even for national infrastructure assets, local government will have a role in adaptation management, monitoring and repair. If responsibilities are devolved to local agency staff, duty statements and performance evaluation criteria will need to be revised, new budget items introduced and sourced, and equipment and supplies drawn together to meet the demands. Information and capacity strengthening activities may also be needed.

(v) **Cost:** Cost has been left to last in this list because it can be a "show stopper". It can easily prevent action being taken, or sub-optimal adaptation strategies being pursued – especially when important options might require long term commitment of funds to be disbursed on a phased basis. If the estimated cost of an option is high – and beyond existing budgets – the adaptation matrix may show it as very low priority – even if critical for the effective functioning of a system or for the safety of affected communities. It is sometimes best not to consider cost at this feasibility stage in adaptation planning. Adequacy in budgets is all about priority setting in how to apply scarce resources – and those judgements can be left until the full integrated adaptation plans has been prepared.

The final ranking from very low to very high feasibility is made based on the judgements of the team and/or consultations with stakeholders drawing from the detailed information gathered during the baseline and impact assessment phase. The factors to be considered do not require detailed treatment or any form of cumulative scoring. It is a matter of discussion and then reaching consensus on the level of feasibility for each option considering all things to the extent time permits. In a workshop situation, for example, feasibility and effectiveness can be defined through group sessions over a few hours drawing from the baseline assessment, VA matrix and follow up field visits.

Effectiveness of adaptation options

The next step in priority ranking is to determine the degree to which each adaptation option would be successful in producing a desired result – ie avoiding or reducing the negative impacts of climate change on the target system and enhancing any benefits and opportunities which may arise. In other words adaptation effectiveness is concerned with building resilience in the target system.

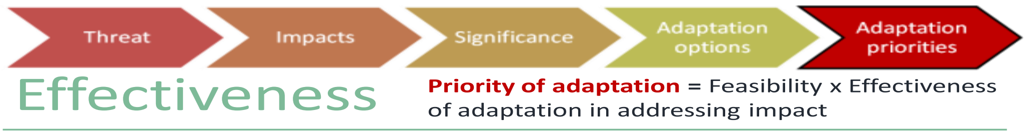
More broadly effective adaptation requires actions that increase the wellbeing of affected communities, especially disadvantaged groups, and the natural systems of which they are part.

Three appropriate questions to assess how effective an adaptation option will be at eliminating or reducing the impact are:

- Will it eliminate the impact?
- If not by how much will it reduce the impact?
- Will it take some time to become effective (eg several years for the root system to establish in a bioengineered slope)?

Those three questions are supported by a simple tool which can be used in settling on the final "score" for each adaptation option from very low to very high (Table 10).

Table 10: Assessing effectiveness in adaptation options



	Very Low	Low	Medium	High	Very High
Can the impact be avoided completely?	Not at all		Partially		Yes
To what extent will it deal with the impact?	<25%	25 - 50%	50 - 75%	75 - 90%	100%
How long will the adaptation measure last?	1 year	2 years	2-10years	10 - 20 years	Permanent

Assessing the effectiveness of adaptation options can contribute to preparing indicators for a monitoring and evaluation framework which would be a section in the adaptation plan.

Table 11: Priority of adaptation = Feasibility of adaptation action x Effectiveness in addressing impact

		Effectiveness in dealing with impact				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Feasibility of action	**Very High**	Medium	Medium	High	Very High	Very High
	High	Low	Medium	Medium	High	Very High
	Medium	Low	Medium	Medium	High	Very High
	Low	Low	Low	Medium	Medium	High
	Very Low	Very Low	Low	Low	Medium	High

Step 8 Preparing the adaptation plan and supporting measures

An adaptation plan sets out in an integrated way the adaptation priorities identified through the consultative planning process, their phasing and implementation arrangements. The plan can be prepared for a specific infrastructure system and its main components. It can also be for an entire area such as a town, catchment or defined landscape – with all its systems and communities.

There is no "right" way to structure an adaptation plan. It might be just a few pages if the target is a small asset such as a bridge culvert and nearby river banks – or it could be a comprehensive document addressing a number of systems over a greater geographic area. The *scope* should have been defined as the first step in the VA&A process.

An adaptation plan should detail the specific actions required to implement each measure and define responsibilities and partnerships involved. There may be measures which are outside the ambit and capacity of a single national and local government agency and which require an integrated all of government response. Where the need for collaborative implementation is identified, those measures will need to be discussed with other relevant agencies with a view to reaching agreements on collaborative arrangements. Box 3 describes possible ingredients for an adaptation plan for an existing or planned infrastructure system.

Box 3: Infrastructure system adaptation plan ingredients

An integrated adaptation plan for a target infrastructure system could include the following sections:

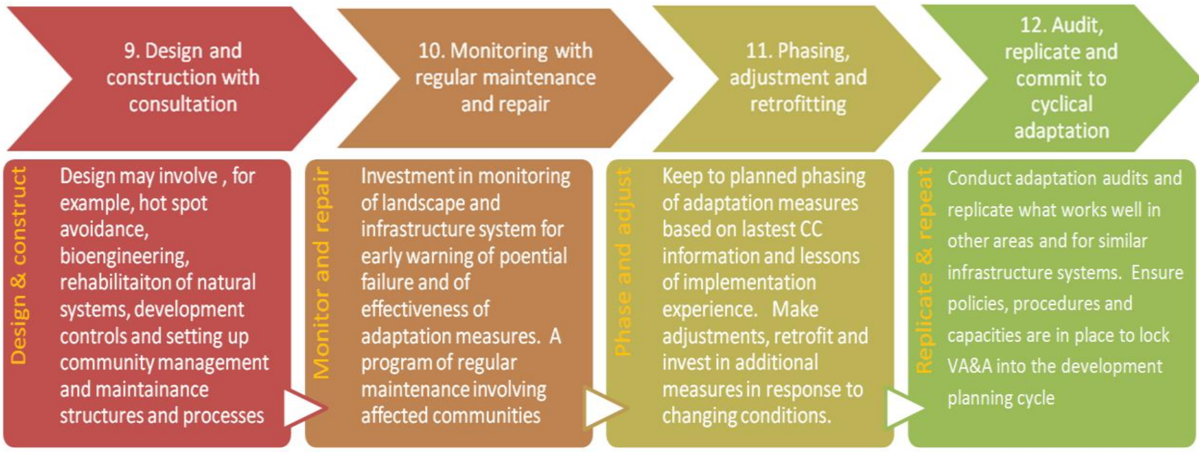
- **The target system**: Describe the system, its key components and its overall objectives (eg the irrigation system serves 80 households and has a command area of 100 hectares)
- **Adaptation measures**: Provide detail of the priority adaptation measures, materials and technologies, approach to management and how they support the overall system objectives
- **Supporting adaptation measures:** Bring in supporting adaptation measures which may not be of a structural or bioengineering nature or which may involve other agencies and levels of government – eg economic incentives, reinforcing land use policies, resettlement approaches
- **Adapting to opportunities:** Identify positive cc effects and opportunities and what "adaptation" measures are needed to take advantage of those opportunities
- **Institutional arrangements and responsibilities:** Detail how the adaptation plan will be implemented, the agencies involved, any special institutional arrangements such as local user groups and funding sources.
- **Adaptation phasing:** Set out the phasing of the adaptation measures and overall plan - Immediate (I), Short (S), medium (M) or long term (LM) (2, 5, 10, 15 years or more). Identify the measures that need to be done urgently and those that need to be taken before others are possible. What measures require new structures, technologies and capacities and therefore may take longer to plan and implement.
- **Adaptation impact assessment**: Conduct a rapid assessment of the impact of the adaptation plan on other areas, sectors or communities. Show how negative effects are avoided or minimised and benefits enhanced and replicated.
- **Other development influences**: Describe other development factors which might affect implementation of the adaptation plan, influence the system and its adaptation measures and identify additional actions needed to control them (ie even if they relate to other agencies)
- **Reforms required within sector:** Identify what adjustments within the target sector are required to implement or replicate the adaptation measures and plan – eg revised guidelines, design standards, policies. This section provides the opportunity to make recommendations for mainstreaming adaptation so that measures can be rolled out more efficiently in other areas.
- **A framework of monitoring and evaluating progress in implementing the adaptation plan**

For specific infrastructure assets the adaptation plan needs to record the adaptation measures proposed for the system and its components within a local area. It should be concise and in the form of a short brief to guide more detailed design and budgeting process. One adaptation plan is prepared for each system assessed, drawing from and explaining the adaptation planning matrix. This guidance for the content of an adaptation plan should be interpreted with flexibility and adjusted to suit the needs of each sector and local conditions.

5 ADAPTATION IMPLEMENTATION AND FEEDBACK

The adaptation planning and implementation process is cyclical and iterative in nature. It needs to be locked into and integrated with normal infrastructure development planning processes so that budgets and staff are committed to adaptation on a regular basis and as a foundation requirement. This section of the guide – more so than the earlier parts – is a work in progress reflecting the state of the art globally in adaptation implementation. Figure 12 describes the four main steps in adaptation implementation

Figure 12: Adaptation implementation and feedback process



Step 9 Design and construction of adaptation measure

Construction and Implementation

There are many guides describing the processes involved in constructing infrastructure or implementing maintenance programs. The key considerations from a climate change adaptation approach is to ensure that the key knowledge gained from the vulnerability assessment and adaptation planning process is incorporated into the design of infrastructure and is then delivered on the ground.

There is a need for strong links between the planning – design – and construction stages of adaptation. Limited communication between the team preparing the adaptation plan and the team involved in detailed design of the adaptation measures and infrastructure asset, or between the design and construction teams, can result in key objectives of the adaptation plan being misunderstood or overlooked. Strong linkages are especially important when changes are made to the original infrastructure concept by design engineers or by contractors during construction (e.g. changes in alignment of a road or in the design standards to be followed). In such cases the adaptation plan will need to be amended to suite the new conditions.

The infrastructure design team needs to have a clear understanding of the objectives of the adaptation plan and its measures and how it differs from a conventional infrastructure project by considering climate change impacts. To accomplish this understanding there should be technical personnel involved who have been part of the vulnerability assessment and adaptation planning for the project. They should be consulted regularly during the design and implementation stages.

Step 10 Monitoring, maintenance and repair

Monitoring and maintenance

A key challenge in implementing infrastructure adaptation measures is in ensuring the technologies are properly operated and maintained. Effective monitoring programs are an essential part of adaptation which requires regular adjustment to changing circumstances.

Monitoring identifies components of infrastructure systems – or surrounding areas such as supporting slopes or upstream stability – that require maintenance, rehabilitation or repair to maintain their resilience. In most countries maintenance and repair of infrastructure following weathering or damage from extreme events is already a major budget item. As far as possible the M&M requirements for the adaptation measures associated with infrastructure development should be well rooted in existing maintenance programs and budgets at local and national level.

Ensuring an effective M&M for adaptation will require capacity building in affected local communities and in responsible infrastructure agencies. Local communities will need to be brought into the M&M process especially in vulnerable areas where government capacity and resources are limited. Adaptation plans and their implementation should include provision for:

(i) Development of M&M processes and plans for each adaptation measure,
(ii) Capacity building of community members on M&M jointly with local NGOs,
(iii) Integration of specific M&M programs into adaptation plans

Knowledge and skills of partners involved in the M&M process – its purpose, methods and implementation steps – need to be built including coverage of the technical background information on the adaptation measures to be operated and maintained and if possible exchange visits to areas where similar approaches are being demonstrated.

The arrangements for M&M need to be spelt out in the adaptation plan including guidance on which parts of the target system have to be maintained, what exactly is to be done, how often M&M activities need to be conducted and who is responsible. It should also address how the M&M activities are financed.

Providing feedback on adaptation implementation: Monitoring implementation and making adjustments and additions based on experience and new information is critical to taking a phased and systematic approach to adaptation. Monitoring requires a clear description of the objectives of the adaptation measures and how they link to the broader infrastructure project goals – ie how the adaptation measures contribute to an infrastructure project's overarching development objectives. The key to effective monitoring at the local level is to keep the indicators of progress measurable and focussed on the specific adaptation measures and local conditions. Appendix 7 provides an example of the monitoring and evaluation framework included in the Old Dolakha water supply system adaptation plan.

Adaptation monitoring indicators may be process-based (to measure progress in implementation) or outcome-based (to measure the effectiveness of the intervention). Developing indicators at the project level is relatively straightforward, as many infrastructure projects are undertaken within sectors where established monitoring and evaluation systems with proven indicators already exist. However, monitoring and evaluation on a broader scale – say for an entire town or catchment, is more complex as it requires strong coordination across sectors and levels and is more susceptible to external development factors.

The Dolakha example in Appendix 7 provides guidance on each key adaptation measure, the main focus of a monitoring program, the suggested frequency in monitoring, who should be responsible and then two kinds of indicators – one set focusing on institutional and policy responses and the other on technical performance of the infrastructure and associated adaptation measures. Many indicators are listed and it would not be feasible to use them all. The relevant sector team overseeing the infrastructure project would need to chose and shape indicators according to the resources available.

Practical difficulties in conducting a monitoring program stem from a general lack of financial, human and technical resources and capacities, a lack of baseline data and historical trends, uncertainty in projected climate change impacts, and insufficient sharing of information across stakeholder groups, levels and sectors. As a result, monitoring and regular review (or auditing) of adaptation is one of the weakest areas of adaptation practice. The goal is to integrate adaptation monitoring with existing frameworks for development planning and implementation at sector and local level.

Step 11 Adaptation phasing, adjustment and retrofitting

Adjustment and Renewal

Some adaptation measures identified in adaptation plans are scheduled for implementation at later phases of the infrastructure systems life depending on climate change projections. The need for those later measures should be kept under review based on regular updating of climate change and hydrological information – and regular on site inspections of asset and surrounding conditions. One tool described in Appendix 8 – walking the route – is designed for that kind of site and asset inspection.

The results from an effective monitoring program should lead to progressive improvements in infrastructure performance and help shape future adaptation measures. That requires capacities in national and local government, as well as in communities to take actions to make those adjustments on a regular basis. There needs to be a commitment in policy to action on adaptation monitoring and review findings and recommendations, the budgets to do so, and all the necessary skills and technologies to rehabilitate, retrofit and reconstruct infrastructure components as needed.

All infrastructure departments in Nepal already spend a large part of their budgets in maintenance and repair – most often when failures occur following landslides, floods, droughts and other extreme events. It is necessary to build on that considerable effort by making it more proactive and anticipatory so that interventions are possible before major failures occur. For that to be possible substantial investments are needed in regular updating of climate change downscaling for Nepal, in hydrological modelling by catchments and in providing practical information to infrastructure sectors on demand and tailored to their needs. That major upgrading of the information systems available to infrastructure sectors is happening through a number of support projects funded through the Asian Development Bank and the World Bank. The benefits of that improved service will begin to show in more sensitive infrastructure siting and design.

Step 12 Replicate and upscale

Adaptation auditing: The experience with implementing adaptation measures should be documented in regular *adaptation audits*. "Audits" can describe case studies of what has and has not worked. They can focus on measures that have been long practiced in Nepal – for example bioengineering techniques for slope and river bank stabilisation. Also they can be conducted every few years of adaptation approaches used in recent infrastructure development and which might involve new technologies and materials. The aim is to build on and *replicate* the best examples of good adaptation through the sector infrastructure programs.

Tool
Adaptation audits

Upscaling of good adaptation field practises means making the necessary reforms to policies, institutional arrangements and procedures at higher levels, which enable those practices to be applied systematically within the sector and in other areas.

Bioengineering and green infrastructure: The other prerequisite to realising *anticipatory adaptation* is through intensive attention to testing and demonstration of fresh approaches. A guiding principle for that piloting is to respect and build on natural features and systems - often using measures that are based on traditional knowledge and practice in Nepal, as well as those which have been practiced by sector agencies for many decades – often called *bioengineering* methods or more broadly *green infrastructure*. Green infrastructure is about changing the way roads, drains, flood gates, river embankments, water supply and sanitation facilities, power supply services and buildings are designed and managed to be ecologically sustainable and resilient to climate change. Green infrastructure includes an array of products, technologies and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality, the infrastructure service and its resilience to climate change.

Already, Nepal has a long history of using green infrastructure approaches in response to extreme conditions and natural disasters. There is much to be gained from documenting that experience and applying successful methods systematically.

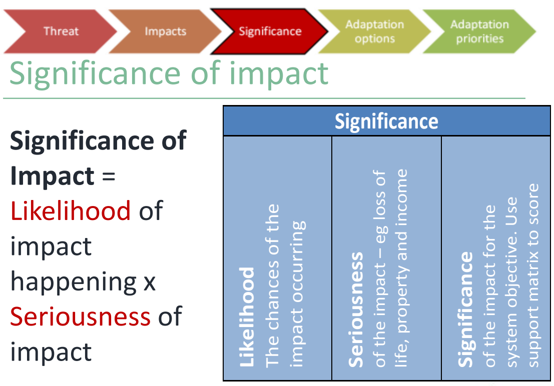
Progressively, the infrastructure line agencies need to take on the responsibility for review and adjustment to their own planning and management instruments to accommodate climate change adaptation on a regular and cyclical basis. For that each sector will need to embrace the preparation and regular review of SAPAs – Sector Adaptation Plans of Action – in keeping with the cycles of their development planning and budgeting.

6 OPTIONAL ADDITIONAL STEPS AND TOOLS FOR LARGE SCALE PLANS AND PROJECTS

In cases of large scale projects or programs of national strategic importance, affecting large populations or areas, a VA&A team can add rigor to the vulnerability assessment by (i) taking a quantitative approach to the scoring rather than applying the very low to very high rankings, and (ii) by adding a step following the VA to assess the significance of the impacts. When large investments are involved the Government may call for added certainty and justification of the team's adaptation recommendations. Adding either or both these methods can provide further evidence to justify and refine specified courses of action.

The quantitative approach to the VA scoring is not described in this guide. It is set out in an accompanying guide. Here, the significance assessment step is presented.

Estimating Significance of the Impacts (risk assessment)



A vulnerability assessment identifies the direct and indirect impacts of various climate change threats on a system and its components. It can be valuable for a team to think through in greater detail the impacts they have identified and to understand and document them more fully. Determining the significance of those impacts can lead to a more detailed ranking of impacts and assist in setting adaptation priorities. Also, it can inform decision makers of the level of risk associated with the impacts. "Significance" is a term widely used and understood among environmental impact assessment practitioners. It is an important concept in the Nepalese EIA system. In the field of Disaster Risk Management, however, the equivalent term is "risk assessment". The challenge with that DRM term is that it has many meanings and associated methodologies and is used in many sectors and industries – for example it is the foundation of the life insurance sector. For the purposes of this guide the estimation of significance can be viewed as a risk assessment method.

It is concerned with assessing how important or significant each impact would be on the asset if it occurred. The *significance* of an impact on an asset/system takes into account *likelihood* that the climate change threat will result in that particular impact and the *seriousness* of the impact. The resultant significance of each impact provides a first guide to priority setting among adaptation options. Significance is assessed on a scale of very low to very high interpreted as follows:

Very low	**Low**	**Medium**	**High**	**Very high**
Very low impact that does not require an adaptation response	Low impact that can be dealt with as and when they happen or as budgets become available	Moderate impact that can be addressed by adaptation measures on a phased basis	High impact requiring some immediate remedial action and possibly more detailed study	Extreme impact requiring urgent action – to be given the highest priority for adaptation measures

If the significance test is to be applied the first consideration is the *likelihood* of the impact occurring.

Likelihood is the chance or probability of something happening. If an impact is very significant but there is little probability of it happening – for example catastrophic failure in a hydropower dam – a team of planners need to make a judgement on *what is an acceptable level of risk for each potential impact*. The assessment of likelihood provides the team with the initial information needed in making that judgement. It is a challenging stage of adaptation planning – even if there is very little chance of an event happening – the consequences could be so ***serious*** in terms of potential loss of life and property that a team can override the matrix results and give adaption measures to avoid the impact the highest priority in the final adaptation plan for an asset or area. Dam failure, for example, can have such serious impacts that, even if unlikely to happen, all the necessary safeguards and adaptation measures should be implemented.

Likelihood

Significance of Impact = Likelihood of impact happening x Seriousness of impact

Ways of considering likelihood:

- How likely is it that the impact will occur – is it certain or uncertain? How uncertain? Why is it uncertain?
- What are the chances of the impact occurring
- What is the likelihood the threat will result in that particular impact

Very low	Low	Medium	High	Very high
≤ 25%	25 – 50%	50 – 75%	75 – 90%	90 – 100%

Seriousness criteria used for assessing seriousness of impacts include: loss of life; loss or destruction of property; property damage; loss of productivity and income; and impediments to socio-economic functions. Environmental criteria may also be important for some areas, for instance a forest area with endangered species or NTFPs essential for local livelihoods may be seriously degraded.

Table 4 guides the "scoring" of significance of any impact to help prioritise adaptation efforts.

Seriousness

Significance of Impact = Likelihood of impact happening x Seriousness of impact

Seriousness criteria:

- Loss of life
- Loss of property – ie destruction of property
- Damage to property
- Loss of productivity and income
- Impeding of function

Table 4: *Significance* of Impact = *Likelihood* of impact happening x *Seriousness* of impact

		Seriousness of impact				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Likelihood of impact happening	**Very High**	Medium	Medium	High	Very High	Very High
	High	Low	Medium	Medium	High	Very High
	Medium	Low	Medium	Medium	High	Very High
	Low	Low	Low	Medium	Medium	High
	Very Low	Very Low	Low	Low	Medium	High

Valuation of impacts: The financial cost will vary in its importance whether an assessment is being undertaken for a poor rural village or a large urban centre for example. It can be difficult to estimate cost – for important impacts a detailed cost-benefit assessment may be required. Estimates for damage and financial losses may be available for past disasters which can be used as cost coefficients. The following is an example of the low and high end of the scale of seriousness for rural infrastructure:

- **Low significance** = no loss of life; no injuries; no destruction of property; some damage to property up to $500; minimal loss of productivity and income up to a total of $1000 across the community; minimal impediment to social/economic function of community (up to 1 day).
- **Very high significance** = severe loss of life; many severe injuries; destruction and damage to property above $100,000; loss of productivity and income above $250,000 across the community; impediment to social/economic function of community longer than 7 days.

Additional tools which can provide more information, rigor and scientific evidence inputs at various steps of the VA&A process are described in Appendix 8. The VA&A process set out in this guide can be conducted as a rapid assessment based mainly on expert and stakeholder judgements and knowledge through to a more rigorous and lengthy process requiring the establishment of a comprehensive scientific evidence base. It will depend on the size and importance of the projects and plans being considered, and on the funds and staff resources the sector has made available for the process.

APPENDIX 1. VULNERABILITY ASSESSMENT MATRIX – BISAMBARA IRRIGATION SCHEME, KATHMANDU, NEPAL

System – Bisambara Irrigation system with 68ha command area. Major system components are:

1. Concrete weir across river with scouring sluice gate,
2. Gated off-take into main canal 3.5km in length,
3. Man canal concrete lined for 270m across landslide zones and incorporating retaining wall over 15m
4. 1 Aqueduct, 2 footbridges and 4 division boxes to assist distribution of water
5. 1 inlet/outlet box to catch additional drainage flows from upstream into the main canal

Threat	Interpretation of threat	Exposure	Sensitivity	Impact Level	Impact Summary	Adaptive capacity	Vulnerability
Change and shift in regular climate	*written description of how the threat relates to the asset*	*refer to table*			*Written explanation of what the impact is, and why it was scored (high, med, low)*	*refer to table*	
Increase in Max. temperature and evapotranspiration	• Increased crop water demand • Frost incidents decreased	[3][4]H	L	M	• Water required at intake slightly increased particularly for paddy land preparation • Second potato crops less susceptible to frost damage • Alternative cropping pattern could be introduced	M	M
Increased Rainfall	• Precipitation increase during early and mid-monsoon period • No impact on infrastructure	[5]L	L	L	• Could reduce water demand from the khola during monsoon period • Little effect on crop production	H	L
Increased River Flow (intake)	• Increases significantly during early monsoon	[6]M	M	M	• Little impact on crop production	H	M

[3]ET increases throughout the year with total demand over the paddy season May/October increasing by up to 380mm
[4] Minimum temperature increase of up to 3 degree in March/April and frost probability in February reduced to only 5%. Less likelihood of damage to second potato crop
[5]Monthly average daily rainfall increases slightly during early monsoon period (maximum of 5mm in July). However decreases post monsoon and during winter periods
[6]River flow increases by some 80% during the May/July period. A 20 year return period flow could occur every 2 years. The rest of the year little change

					• Increased flow could damage system infrastructure		
Change and shift in events							
Flash Floods (Intake)	▪ Increase in bed load during flash floods – might block or damage intake ▪ Khola bed mostly rock so little chance of degradation	[7]H	[8]H	H	• Blockage of intake, leading to temporary restriction of irrigation water • Sediment entering main canal will restrict its carrying capacity	[9]M	H
Flash Floods (Aqueduct)	• Increased flood flows • Scouring of cross drainage channel bed and pier foundations	H	[10]L	M	• Canal water unable to be supplied to downstream areas	[11]L	M
Storms	• Increased rainfall intensity over cropped area	H	[12]L	M	• Crops could be damaged and difficult to harvest • Level terraces will absorb increased rainfall • Terrace banks protected with soya bean.Only vulnerable at start of monsoon	H	M
Drought	• Reduction of water availability in stream during late dry season and delay of monsoon flows	[13]M	M	M	• Could affect yields for the second potato crop and preparation for paddy crops • An alternative to the second potato crop could be introduced	[14]M	M

[7]100 year return period flood could increase in size by up to 100%Rainfall intensity will increase by 60%. Catchment area mostly forest
[8]Well-designed weir across Khola with scouring sluice. No spindle to adjust intake gate height to prevent sediment entering main canal during flood flows
[9]Sediments collected in main canal can be manually shifted relatively easy with local labour
[10]Gabions protecting cross channel bed and channel has adequate capacity for increased flows. New piers provided to support aqueduct.
[11]Farmers cannot redesign or repair without technical assistance

- Cost Rp1.5lakh to recently rehabilitate
- As recently improved it will have low priority for future funding

[12]Wind damage to traditional rice crops only from storms prior to harvesting
[13] River flows reduced by 50% with negligible flows predicted in March/April
[14]DADO providing agricultural extension services in the area

Landslides	• Where main canal passes crosses steeper land • Adjacent to Kholas or aqueduct structure	M	[15]H	M	• Wash out of main canal leading to loss of water supply to full irrigated area (there is no command area above this location, so if this one is damaged the whole system is at risk	[16]L	M

Bishambara irrigation system vulnerability assessment summary

Threat	Exposure	Sensitivity	Impact Level	Adaptive capacity	Vulnerability
1. Increased Temperature (Command Area)	H	L	M	M	M
2. Increased Rainfall (Command Area)	L	L	L	H	L
3. Increased River Flows (Intake Structure)	M	M	M	H	M
4. Flash Floods (Intake Structure}	H	H	H	M	H
5. Flash Floods (Aqueduct)	H	L	M	L	M
6. Storms (Command Area)	H	L	M	H	M
7. Drought (Command Area)	M	M	M	M	M
8. Landslides (Conveyance Structures)	M	H	M	L	M

Concluding statement

Command area least vulnerable to increased temperature and rainfall whilst intake most vulnerable to flash floods. The main canal is more vulnerable to sedimentation and landslide problems.

Notes on completing the VA matrix:

- It is important to be precise in the threats being considered – e.g. storms – what specific characteristics of storms – wind, intense rainfall, lightning?

[15]Remedial works already undertaken in sensitive areas to support main canal against landslide

- No catch drainage above landslide areas to reduce water logging of upper slopes

[16] Farmers cannot repair damage on themselves

- As a recently improved system, it will have a low priority for funding

- In situations where the technical information is poor, there is a greater need to emphasise intersectoral expert discussion and consultation (i.e. rely more on expert judgement and knowledge)
- Similarly, local communities/user groups need to be consulted as an important source of experience and knowledge
- This example of a completed VA matrix considered an entire system. It is useful to conduct separate assessments for each of the main components as the impacts of various climate change threats may be distinctive. That more focussed assessment would allow more precise targeting of adaptation options and priorities.

APPENDIX 2. ADAPTATION PLANNING MATRIX - CHISAPANI NAUBASTA IRRIGATION SYSTEM, BANKE DISTRICT

Asset: Chisapani Naubasta Irrigation System, Banke District, Nepal – Command area 306ha benefitting 575 households growing paddy, wheat, potatoes, pulses and oilseeds. Main system components are (i) the intake structure, (ii) main canal and (iii) the command area.

Threats	Impacts	Significance			Adaptation options	Priority adaptation		
Insert all High or Very High threats – first for the system as a whole and then for each of the most vulnerable components (i.e. H or VH)	Insert the impacts recorded for the H and VH threats (only consider direct impacts)	**Likelihood** The chances of the impact occurring	**Seriousness** of the impact – e.g. loss of life, property and	**Significance** of the impact for the system	Listing of the adaptation options in addressing each of the most significant impacts – focus on structural and bioengineering options	**Feasibility** e.g. cost, skills, staff, equipment,	**Effectiveness** i.e. how well does it avoid, reduce or eliminate the	**Priority**
Intake structure • Increased River Flows • Flash floods	1. Further damage to diversion weir 2. Unable to raise water levels to reach intake 3. Intake becomes blocked with debris 4. Sediment enters main canal	VH[17] H[18] VH[19] H[20]	H[21] H[22] H[23] M[24]	VH H VH M	1. Rebuild diversion weir and intake taking CC into account 2. Improved river bed protection downstream of core wall 3. Increased maintenance/ unblocking of existing structure	L[25] M[26] M[27]	VH[28] H[29] H[30]	H H H

[17] 100 year return period flood increases in size by 50% increasing scouring of khola bed material
[18] Damage to the weir crest level by increased flood volumes
[19] Rainfall intensities increasing by 20% causing the catchment area in the Churia mountains being mostly forested area but steep more liable to landslides and debris flows
[20] Average monthly flows increasing during the pre-monsoon period with a maximum increase in July will bring more sediment into the main canal
[21] Increasing likelihood of diversion structure completely collapsing
[22] Reduction in volume of irrigation water entering the main canal
[23] Approaches to the headworks and the intake gate becoming inoperable due to sediment build up
[24] Build-up of sediment in the main canal could cause a permanent blockage unless regularly cleared
[25] To build a new structure it will take a long time to study, approve designs, obtain budgets and construct as well as being very costly
[26] Rebuilding just the collapsed diversion weir sections and providing stronger bed protection in the khola would require studies and availability of emergency funds
[27] Requires increased inputs by an already dysfunctional water user group
[28] Should ensure diversion weir and intake are resilient against future increased flows and flood events

Main Canal • Landslides	1. Canal silts up, becomes blocked	M[31]	M[32]	M	1. Increased clearance of canal 2. Protect landslide prone weak points+ bioengineering	VH[33] M[34]	M[35] H[36]	VH H
Command area • Increased temperature • Increased rainfall • Storms • Drought	1. Increased crop evapotranspiration increases water requirement 2. More chance of disease to winter crops 3. Increased rainfall reduces irrigation requirement 4. Storms damage crops and more difficult to harvest 5. Drought period in winter affects crop yields	H[37] M[38] H[39] H[40] M[41]	VL[42] M VL VH[43] M[44]	L M L VH M	1. Opportunity for crops or varieties that require less water 2. Introduce more disease resistant variety of crops 3. Opportunities for alternative cropping patterns 4. Choose varieties with shorter stems that are less susceptible to storm damage	M[45] M M M	M[46] H[47] M H	M H M H

[29] Should solve the problems with the diversion weir and the canal intake in the short term
[30] If sediment build up regularly cleared should allow irrigation water to pass into the main canal
[31] Increased rainfall intensity events on the sand hills adjacent to the main canal alignment could induce landslides
[32] Main canal could become blocked with washed down material
[33] Removal of any blockages in the main canal should be able to be quickly cleared by the farmers
[34] Stabilisation measures (bioengineering and improved drainage) on the steep slopes adjacent to the canal would require study, design and cost money
[35] Short term to clearing the immediate problem
[36] A more long term and sustainable solution
[37] Average monthly temperatures to increase by 2^{0}C throughout the year
[38] Average minimum temperature to increase by up to 3^{0}C in the period from December to March affecting vegetable crops in particular
[39] Monthly average daily rainfall is to increase during the monsoon period with a maximum increase of 30% in July
[40] Increase of rainfall intensities by 20% would most likely be accompanied by more severe storm events
[41] Average monthly rainfall predicted to decrease to almost zero between November and March
[42] Increase discharge capacity from the Man Khola at the headworks could be arranged, countered by the prediction of increased rainfall anyway over the cropped area
[43] Storm damage to crops could cause some loss in yield or complete crop failure
[44] An increase in irrigation demand due to drought may not be always met due to khola flows also being lower over the same period
[45] Cropping patterns or improved varieties could be tried after research and trials by Department of Agriculture and would not be too costly to introduce
[46] Continuing development of improved varieties and adoption of alternative cropping patterns required which requires acceptance by farmers
[47] Extension services from DADO this has not been spelt out in abbreviations section at the beginningcould advise on long term preventative measures

System • Increased temperature • Increased rainfall • Increased river flows • Flash floods • Storms • Drought • Landslides	1. System delivery of water fails completely 2. Reduction of water availability at critical times 3. Loss of irrigation to part of the command area 4. Higher irrigation water demand 5. Decrease in productivity due to storms, drought and diseases 6. Increases in productivity due to higher temperature and rainfall	VH	VH	VH	1. Construct new diversion weir and intake 2. Improve river bed protection at diversion weir site 3. Maintain existing river diversion & intake structures 4. Regularly remove silt from structures 5. Protect canal from landslides 6. Review crops to withstand storm and disease damage 7. Reconsider cropping pattern in the light of changes in temperature and rainfall	L M M VH M M M	VH H H M H H M	H H H VH H H M

APPENDIX 3. BASELINE ASSESSMENT FIELD REPORT TEMPLATE

Purpose: To collect information to be able to undertake vulnerability assessment and adaptation planning.

NAME OF TARGET SYSTEM: ____________________________________

DISTRICT: ____
SECTOR: ____
DATE: ____
NAME: ____

1. Provide short description of the system, its components and its location

1. 2. 3.

2. Describe the watershed context of the system

Describe the location of the system within the watershed, the watershed condition and experience of past extreme events in the watershed (e.g. landslides and floods). Document with photographs and sketches any past or existing conditions which illustrate the problems which have arisen.

1. 2. 3.

3. Description of specific location

Include the geographic and manmade features, any slopes, the vegetation, the soil type, proximity to any water bodies and any instabilities

1. 2. 3.

4. Description of the condition of the system and its components

Include description of signs of degradation and apparent causes/implications, and existing approaches to maintenance and repair

1.

2.
3.

5. Describe the design and form of any man-made components in the system

Include description of current component/asset design and materials. Provide drawing and photographs of the asset design and condition.

1.
2.
3.

6. Describe past extreme events and impacts on the System

Include event dates, biophysical description of the events and impacts on the system and its components

1.
2.
3.

7. Describe past adaptation responses to the impacts of past extreme events

Include description of adaptation responses, drawings if appropriate and a description of the success of the adaptation response

1.
2.
3.

8. Provide expert judgment of the design/form appropriateness of the man-made components to withstand extreme events

1.
2.
3.

APPENDIX 4. VULNERABILITY ASSESSMENT FIELD REPORT TEMPLATE

CC THREATS	DESCRIPTION OF THREATS *Circle relevant threat in list provided and describe how it relates to the target system and its components.*
Change and shift in regular climate	
Increase/decrease in temperature	
Increase/decrease in precipitation	
Increase/decrease in flow	
Change and shift in events	
Riverine flooding	
Extreme localised pooling/flooding	
Flash floods	
Storms	
Landslides	
Drought	

EXPOSURE *Refer to guiding matrix to help identify the exposure score* **SCORE** _____

Description

SENSITIVITY *Refer to guiding matrix to help identify the exposure score* **SCORE** _____

Description

IMPACT *Refer to guiding matrix to help identify the impact score* **SCORE** _____

Description

ADAPTIVE CAPACITY *Refer to guiding matrix to help identify the impact score* **SCORE** _____

Description

VULNERABILITY SCORE: _______________

Refer to guiding matrix to help identify the vulnerability score

APPENDIX 5. VULNERABILITY ASSESSMENT SCORING TOOLS

Sensitivity of system to climate threat	Exposure of system to climate threat: Very Low	Low	Medium	High	Very High
Very High	Medium	Medium	High	Very High	Very High
High	Low	Medium	Medium	High	Very High
Medium	Low	Medium	Medium	High	Very High
Low	Low	Low	Medium	Medium	High
Very Low	Very Low	Low	Low	Medium	High

Adaptive Capacity	Impact: Very Low Inconvenience (days)	Low Short disruption to system function (weeks)	Medium Medium term disruption to system function (months)	High Long term damage to system property or function (years)	Very High Loss of life, livelihood or system integrity
Very Low Very limited institutional capacity and no access to technical or financial resources	Medium	Medium	High	Very High	Very High
Low Limited institutional capacity and limited access to technical and financial resources	Low	Medium	Medium	High	Very High
Medium Growing institutional capacity and access to technical or financial resources	Low	Medium	Medium	High	Very High
High Sound institutional capacity and good access to technical and financial resources	Low	Low	Medium	Medium	High
Very High Exceptional institutional capacity and abundant access to technical and financial resources	Very Low	Low	Low	Medium	High

APPENDIX 6. VULNERABILITY ASSESSMENT REPORT CONTENTS DESCRIPTION

District assets/system priorities

- *Short brief on the sector in the district – eg summarise the different types of infrastructure in the sector for the district and overall status*
- *Restate the criteria for identifying priority assets/systems for the vulnerability assessment*
- *Describe each priority system and its components*

Vulnerability assessment method

- *Short summary of method/process (no more than 1 page)*
- *Explain use of the method in this sector - for example the interpretation of the criteria for sensitivity, exposure, impact, and adaptive capacity*
- *Describe how the climate change threat profiles were interpreted for the sector – what projected changes are important for the sector in this district.*

Vulnerability assessment results

- *Present the results for each system in turn referring to the appended matrix.*
  For each system and its components:
- *Go through each step in the VA and draw out the most significant issues and interpretations.*
- *Pay special attention to describing the impacts column – both direct and indirect*
- *Draw together the results for each system (eg some components are more vulnerable than others and why)*
- *Repeat those analytical steps for each system*

District vulnerability summary

- *Provide a summary of the results (including a summary matrix - ie like irrigation project summary matrix)*
- *Describe which systems are the most vulnerable and why*
- *Describe the components of each asset/system which are most vulnerable and why*
- *Draw out the main lessons which can be applied to the different types of systems and different components*
- *Indentify linkages with other sectors or geographic areas within the district*

APPENDIX 7. MONITORING AND EVALUATION FRAMEWORK

For the Old Dolakha water supply system adaptation plan (including three small supply systems with separate intake and pipe system)

Adaptation Measure	Monitoring focus	Frequency	Who should M&E	Organizational Indicators	Technical Indicators
SHORT-TERM ADAPTATION MEASURES					
Increased O&M	Institutes and community capabilities and participation in O&M Improved functioning of system Types of breakdown or issues Access to good quality water	Annual	Water Supply & Sanitation Users Committee	Definition of O&M roles Annual O&M funds allocated Availability of equipment Availability of skills, training and knowledge	% of components in working order Average downtime (number months annually) Non revenue water (to estimate leakage)[48] Suspended solids (EU standard – less than 30%)
Regular removal of sediments from the structures	Functioning of structures Community access to clean water Types of breakdown or issues Reliability of water supply	6 months	Water Supply & Sanitation Users Committee	Definition of O&M roles Availability of skills, training and knowledge Annual O&M funds allocated to sediment removal	Frequency of sediment removal % of components in working order Average downtime (number months annually) Non revenue water (to estimate leakage) Turbidity (EU standard – less than 5 FTU) % community with access to good quality of water
Protect the transmission pipeline from landslides (short term – eg concrete casing for vulnerable sections of the pipeline)	Response to damaged pipeline Functioning of pipeline Sustainability of protection measures Improved water supply reliability Reliability of water supply	Quarterly	Water Supply & Sanitation Users Committee	Availability of emergency team Availability of skills, training and knowledge for protection of the pipeline Existence of new protection measures for pipeline	% of pipeline in working order % of pipeline vulnerable to landslides Average downtime (number months annually) % community with access to good quality of water
(i) Provision of	Functioning of reservoir sites	Biannual	Water Supply &	New screen in place and	Sediment load in water column

[48] Non-revenue water refers to the water leaking or taken from the system which is no longer available to paying consumers

Adaptation Measure	Monitoring focus	Frequency	Who should M&E	Organizational Indicators	Technical Indicators
fine screens and (ii) disinfection arrangements at reservoir site	Improved water quality Types of breakdown or issues Community views on water quality - including male, female and marginalised communities		Sanitation Users Committee	disinfection initiated ▪ Availability of spare parts & material ▪ Availability of skills, training and knowledge ▪ Annual O&M funds allocated	▪ % capacity reduced (due to sediment deposition) ▪ % community with access to good quality of water ▪ % of consumers satisfied with supply service
LONG-TERM ADAPTATION MEASURES					
Construct (i) a new Intake structure with (ii) screening arrangements to evade dirty run-off water	▪ Functioning of intake structure ▪ Improved water quality ▪ Reliability of water supply ▪ Community views on water quality - including male, female and marginalised communities	Annual	Water Supply & Sanitation Users Committee	▪ New intake structures constructed with screen ▪ Annual O&M funds allocated	▪ % of intake structures in working order (in this case there are three systems so 3 intake structures) ▪ Average downtime (number of weeks annually) ▪ % community with access to good quality of water ▪ % of consumers satisfied with supply service
Rebuild the transmission pipeline with better alignment	▪ Functioning of pipeline ▪ Improved water supply reliability ▪ Types of pipeline breakdown or issues	Annual	Water Supply & Sanitation Users Committee	▪ Funds allocated to new pipeline (total investments in new pipeline) ▪ New pipeline constructed	▪ % of pipeline in working order ▪ % community with access to good quality water ▪ Non revenue water (to estimate leakage)
Construct a new water treatment plant between Intake and the Storage Reservoir	▪ Functioning of improved WTP ▪ Improved water supply reliability and quality ▪ Types of breakdown or issues ▪ Reliability of water supply ▪ Community views on water quality – including male, female and marginalised groups	Daily for components and annually for entire WTP	Water Supply & Sanitation Users Committee	▪ New WTP constructed ▪ Funds allocated to new WTP (Total investments in WTP)	▪ % of components within the WTP in working order (eg screens, sedimentation tank, disinfection chamber) ▪ Average downtime (hours per day) ▪ % capacity reduced in sedimentation tanks ▪ % community with access to good quality of water ▪ Total revenue from water supply service

Adaptation Measure	Monitoring focus	Frequency	Who should M&E	Organizational Indicators	Technical Indicators
	▪ Community views on reliability ▪ Community willingness to pay for additional costs				(monthly)

APPENDIX 8. TOOLS SUPPORTING THE VULNERABILITY ASSESSMENT AND ADAPTATION PROCESS

Key climate change vulnerability assessment and adaptation tools include:

Climate change downscaling and modelling: The downscaling of predicted climate change and Global Circulation Models (GCMs) enable spatial assessment to quantify future climate, using both statistical and dynamic approaches. Once MOSTE DHM capacities are in place, results from multiple GCMs and multiples downscaling techniques can be made available to infrastructure sectors on a regular and on-demand basis through the DHM portal and as a results of regular consultation with them.

Hydrological modelling: One of the most important effects of climate change is on hydrological processes and a reason why it is necessary to link projected climate changes with hydrological analysis. Hydrological modelling is used in developing baselines and assessing changes in basic hydro-physical processes, including precipitation, hill slope run-off sub-surface infiltration and groundwater interactions, stream flow and water levels, and sediment transport. Catchment scale hydrological modelling includes flooding, water resource utilisation and land use change. The ICEM IWRM-model which DHM is being trained in using is a physical model which provides an advanced GIS-compatible framework for integrated modelling of water resources and water utilisation in both local and basin-wide scales.

Hydrodynamic modelling: Hydrodynamic modelling enables threats to be quantified. By running detailed 3-D models of lakes, river channels, and floodplains it is possible to quantify erosion, sediment dynamics, stratification of the water column, nutrient transport pathways, water quality, and productivity. Hydrodynamic modelling can also be applied to atmospheric environments for 3-D analysis of pollutant dispersion and emissions modelling.

GIS analysis: A range of GIS techniques are available for assessing the impacts of climate change and development, including zone of influence mapping, sectoral overlays, hot spot mapping and vegetation/land use identification mapping using satellite imagery. All modelling tool outputs and socio-economic analysis can be linked directly to GIS analysis making it a critical tool in the vulnerability assessment and adaptation process in this guide. For participants at all levels, GIS maps can bring to life the relationships between projected changes and infrastructure systems and areas and make the impact assessment process more credible.

Two important GIS tools for VA&AP tools are:

- **Participatory mapping:** When detailed hydrological modelling of past extreme events and of projected climate changes are not available – which is the case in most catchments of Nepal, then past extreme events such as floods and landslides can be mapped with the input of local communities and local government experts who were present at the time. For example in June 2013, continuous rain in upper catchments caused the water level in the Seti River east of the Mahakali to rise from 6.94 m to 11.56 m and 5.53 m to 12.81 m in the Karnali at Chisapani within a 24 hour period. The discharge in the Mahakali River rose from 139,000 to 440,716 cubic feet per second, causing river bank collapse and loss of life and property. Local residents and government officials have a vivid memory of depth, duration and extent of the flood waters and would be able to draw their memories on base maps. Those sketches can be digitised on GIS maps and then checked for accuracy through participatory exercises. Often the *flood hot spot maps* which result are more accurate than maps coming from detailed hydrological modelling. Hot spot maps based on past extreme events are a good foundation for understanding conditions with climate change.

A next participatory mapping step can be the definition of *climate change hot spots*. Simple calculations of increased water volume and flow can be made by considering projected rainfall increases and the size of catchments affecting the target area. That additional information can be discussed by participants who can then rank flood hot spots and interpret the effects of climate change projections on them.

- **Hazard or hot spot mapping:** The process of establishing geographically where and to what extent particular hazards such as floods and drought are likely to pose a threat to infrastructure and to local communities. Hazard mapping can be conducted as a participatory exercise and/or as an output of detailed modelling against various scenarios of climate change.

Macro-economic assessment and valuation: Macro-economic assessment examines the effects of climate change on individual sectors and the economy and cross sector implications of adaptation options. Valuation assesses impact costs and compares adaptation options through Cost-Benefit Analysis, Cost-Effectiveness Analysis, sensitivity analysis and trend analysis.

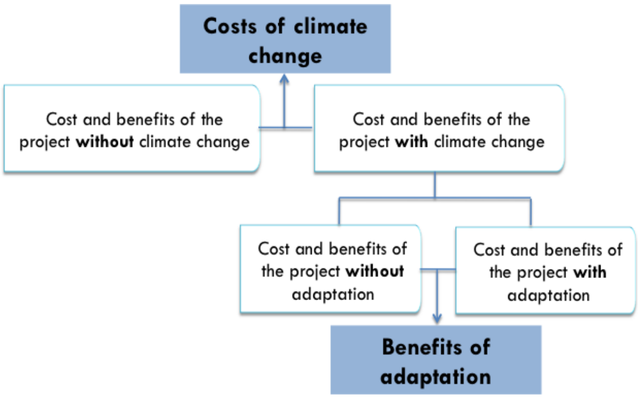
Economic assessments of climate change serve to justify appropriate adaptation response and identify the investment required to make adaptation effective. For infrastructure departments, economic assessments can cover two critical steps (Figure 12):

(i) **Establishes the costs of climate change with respect to the infrastructure project:** comparison of the net present value (NPV) of the project without climate change to the NPV for the project with climate change. The difference between the former and the latter represent the costs (or benefits) of climate change.
(ii) **Determining the benefits of adaptation:** comparison between the NPV of the project with climate change, but without adaptation, and the NPV of the project with climate change and with adaptation.

Integrated spatial assessment: Practical integrated assessment models such as Dyna-CLUE are designed for undertaking integrated spatial assessments and suited to focused climate change assessments for specific areas. The core of the model is spatial land use projections capable of integrating demand for different land uses, location conditions (including climate change) and policy scenarios. The model output can be read directly to assess the environmental consequences of the simulated changes. Integrated spatial models are using, for example, when considering alternative routing of a major road or the siting of water intakes, pump stations and canals in an irrigation scheme.

Impact assessment matrices: Impact assessment matrices for climate change allow the prioritising and weighting of options and recommendations. They are technical and capacity building tools that promote ownership by stakeholders of the process and its results.

Figure 12: Economic Assessment of Climate Change Impact and Adaptation



Geotechnical surveys: Identifying where the likely points of failure are in different road routings, river bank dykes, water supply reservoirs and intakes for example may require field based geotechnical surveys. These are conducted by infrastructure sector engineer familiar with geotechnical issues of slope stability. In its simplest form it involves "walking the route" and recording observations in a field sheet against key variables such as existing road cross-section, natural slope condition and failures and existing earthworks (Figure 13). In a practical tool developed by ICEM, those field observations are scored allowing for the identification and mapping of hot spot zones along the route where failures are likely. In a road section of 10kms, for example, there may be five key points which need to be given priority for adaptation measures.

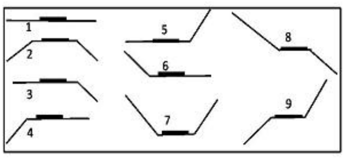
Monitoring and evaluation tools: M&E is critical to continuous learning and adjustment to adaptation measures based on performance and changing conditions. An M&E framework needs to be defined as part of the adaptation plan. The framework needs to identify responsibilities, frequency and indicators for measuring performance and identifying potential for failure. *Adaptation audits*, conducted at regular intervals are needed to consolidate monitoring results and to propose further adaptation action and safeguards.

Community consultation tools: Consultation with affected communities and users of infrastructure is important in conducting vulnerability assessments and adaptation planning, especially in situations where the scientific and technical information is limited. The MOSTE manual on conducting Local Adaptation Plans of Action is a rich source of participatory and consultative tools which can be drawn from in conducting infrastructure VA&APs. [49]

Figure 13: Geotechnical survey data code for field assessment sheet developed by ICEM

10. Structure
0 None
1 Pipe culvert
2 Box culvert
3 Bridge
4 Retaining wall

11. Cross-section



12. Ditch
0 Not required
1 Effective
2 Partially Blocked
3 Blocked
4 Missing

14. Access Condition
1 No issues
2 <10% access affected
3 10-25% access affected
4 25-50% access affected
5 >50% access affected

15. Water Channel
1 Gully/dry watercourse
2 Unlined stream
3 Lined ditch/stream
4 river

16. Earthwork Type
1 Cut
2 Embankment
3 Dumped spoil

17. Earthwork Angle
0 0
1 1-10
2 10-20
3 20-45
4 45-75
5 >75

18. Earthwork Height
0 0
1 0-3m
2 3-6m
3 6-12m
4 12-25m
5 >25m

19. Earthwork material
1 Silty clay
2 Silt
3 Clay
4

20. Earthwork Condition
0 No issues
1 Minor surface erosion
2 Minor slopeface failure
3 Severe gulleying
4 Moderate slope failure
5 Major slope failure

21. Vegetation
1 Bio-engineered slope
2 Mature trees/shrub/grass
3 Grass/shrubs
4 Sparse Grass/shrubs
5 Essentially none

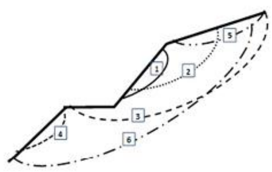
22. Natural Slope Length
1 <5m
2 5-20m
3 20-100m
4 100-500m
5 >500m

23. Natural Slope Angle
0 0
1 1-10
2 10-20
3 20-45
4 45-75
5 >75

24. Natural Vegetation
0 0
1 Mature trees/shrub/grass
2 Grass
3 Dry cultivation
4 Sparse Grass
5 Irrigated cultivation

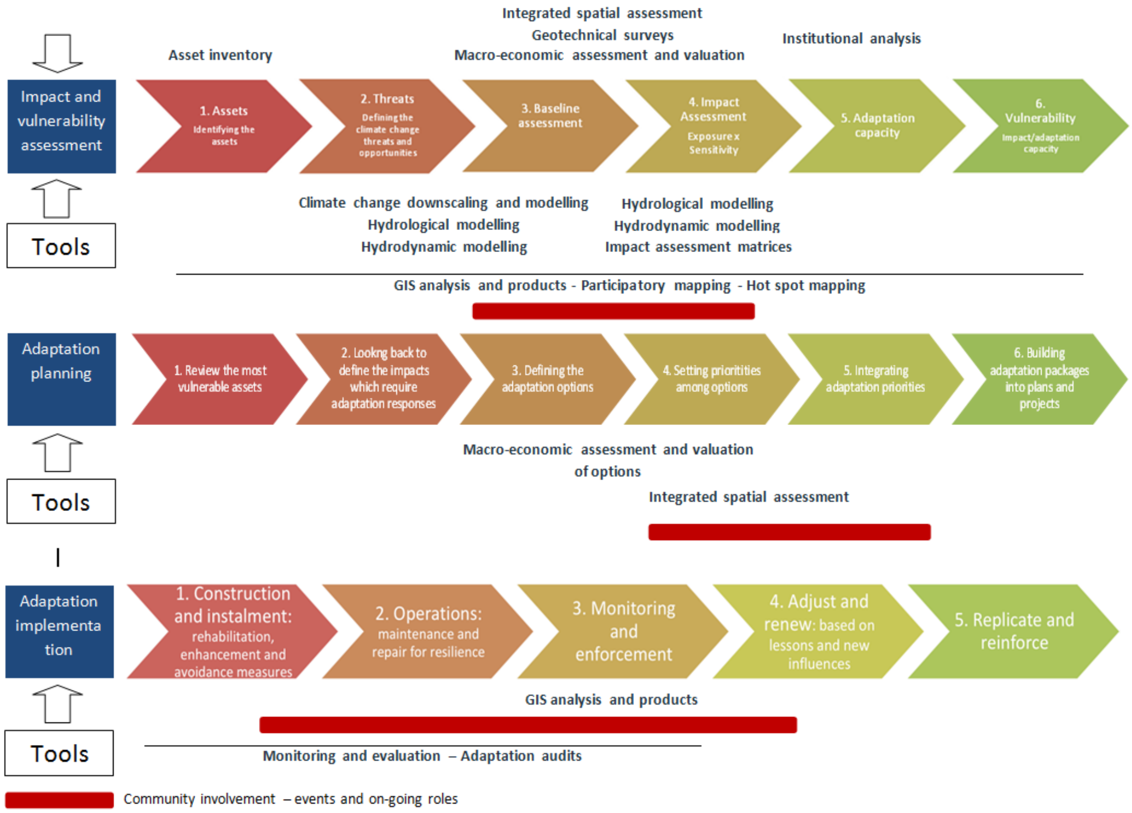
25. Natural Slope Condition
0 No issues
1 Minor erosion
2 Minor surafce failures
3 Significant Upslope Instability
4 Significant Downslope Instability
5 Instability across alignment

26. Slope failure



Notes legend
Buildings
Bridge
C——C Culvert
Road
Ditch
S——S Stream
R——R River

Figure 14: Application of tools in the vulnerability assessment and adaptation process



APPENDIX 9. GLOSSARY

Adaptation – A process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented. Adaptation measures may be used to increase the resilience of infrastructure and other assets to withstand increasing intensity and frequency of climate events. Adaptation might include more regular and effective maintenance and protection measures, through to redesign and rerouting to avoid potential impacts. Adaptation may also include building the capacity of the people and institutions to prepare for and respond to the impacts of extreme events. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **Anticipatory adaptation** – Adaptation that takes place before impacts of *climate change* are observed. Also referred to as proactive adaptation.
- **Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*. Also referred to as spontaneous adaptation.
- **Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve desired resilience.

Adaptation audit – Documenting adaptive measures taken by government or communities in response to past extreme events. Also, assessing their effectiveness as a guide to future adaptation on the principle of learning from the best of what is in place. Adaptation audits are normally conducted as part of the baseline assessment. They can also be conducted at regular intervals (say every 3 years) for measures put in place in response to climate change as part of adaptation monitoring and evaluation programs.

Adaptation impact assessment – Adaptation measures can have unwanted impacts on other geographic areas and on other sectors which undermine their resilience. Also, measures taken now might rule out future adaptation options. Adaptation impact assessment is conducted on the measures in adaptation plans to avoid or mitigate those unwanted effects.

Adaptation deficit – The adaptation deficit is those measures which need to be taken to address the known impacts from past climate variability and extreme events irrespective of climate change, but which would build resilience to future conditions. The adaptation deficit includes many actions required as basic ingredients of good development such as maintenance of drainage systems, effective sediment trapping in irrigation schemes and use of bioengineering methods to strengthen slopes and banks associated with roads and dykes.

Adaptive capacity – The ability 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. One way to enhance adaptation is by building 'adaptive capacity'.

Asset – A resource with economic value that an individual, community, corporation or country owns or controls with the expectation that it will provide future benefit. Assets include infrastructure or **t**he basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organisation, city or community. In the context of adaptation planning, an asset is any piece of infrastructure or resource for which a sector department has responsibility for its construction and maintenance, and for ensuring its long term sustainability.

Baseline – The baseline is the state against which change is measured. It might be a 'current baseline', in which case it represents observable, present-day conditions. It might also be a 'future baseline', which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.

Basin – The drainage area of a stream, river or lake.

Capacity building – In the context of ***climate change***, capacity building is developing the technical skills and institutional capabilities to enable active participation in all aspects of ***adaptation*** to, ***mitigation*** of, and research on ***climate change***.

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).

Climate change – Climate change refers to any change in ***climate*** over time, whether due to natural variability or as a result of human activity. This usage differs from that in the ***United Nations Framework Convention on Climate Change (UNFCCC)***, which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global ***atmosphere*** and which is in addition to natural climate variability observed over comparable time periods'. See also ***climate variability***.

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 prejections***.

Climate forecast – A 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, interannual 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 forecasts***, 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 sensitivity – The equilibrium temperature rise that would occur for a doubling of CO_2 concentration above ***pre-industrial*** levels.

Climate threshold – The point at which external forcing of the ***climate system***, such as the increasing atmospheric concentration of ***greenhouse gases***, triggers a significant climatic or environmental event which is considered unalterable, or recoverable only on very long time-scales, such as widespread bleaching of ***corals*** or a collapse of oceanic circulation systems.

Climate variability – Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the ***climate*** on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the ***climate system*** (internal variability), or to variations in natural or ***anthropogenic*** external forcing (external variability). See also ***climate change***.

Downscaling – A method that derives local- to regional-scale (10 to 100 km) information from larger-scale models or data analyses.

Drought – The phenomenon that exists when precipitation is significantly below normal recorded levels, causing serious hydrological imbalances that often adversely affect land resources and production systems.

Dyke – A human-made wall or embankment along a shore to prevent flooding of low-lying land.

Effectiveness – The effectiveness of a proposed adaptation action to address a potential impact can be measured by assessing whether it will eliminate the impact completely, whether it will reduce the impact and by how much and whether it will take some time to become effective**.**

Erosion The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, ***glaciers***, waves, winds and underground water.

Exposure – is a measure of the extent to which the asset is exposed to the potential threats or existing hazards. Exposure in the context of climate change is limited to potential climate threats. The exposure may depend upon the relevance of the threat (e.g. increase in temperature) to the type of asset, and the extent to which the threat will increase (e.g. in intensity and frequency)

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***.

Feasibility – is a measure of how feasible an adaptation measure may be – whether it is technically feasible, whether the sufficient time and materials available to do the work, Cost – how expensive is the measure? Is government budget available? And the capacities of community and government.

Groyne – A low, narrow jetty, usually extending roughly perpendicular to the shoreline, designed to protect the shore from ***erosion*** by currents, tides or waves, by trapping sand for the purpose of replenishing or making a beach.

Hazard – A hazard is an existing source of danger that may cause harm, damage or loss, or poses a danger to a system vulnerable to the hazard. A hazard may be a static physical obstruction, such as a landslide, or it may be a temporary danger, such as strong winds from a storm. A hazard is different from a threat in that a threat is a potential future event, such as the threat of landslide posed by the combination of heavy rains and a steep, unstable slope.

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***.

Impacts – The effects of ***climate change*** on natural and ***human systems*** or ***assets***. Often, reference to impacts refers also to secondary and tertiary consequences. For example, climate change can result in less rainfall, which will inhibit crop growth. This is either because it means less water falling on plots, less groundwater recharge, or less water in streams from which water is taken to irrigate crops. The secondary consequence of this is less crop product, which can lead to economic difficulties or hunger. 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.

Residual impacts – the impacts of climate change that would occur after adaptation.

Infrastructure – The basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organisation, city or nation.

Integrated water resources management (IWRM) – The prevailing concept for water management, which, however, has not been defined unambiguously. IWRM is based on four principles that were formulated by the International Conference on Water and the Environment in Dublin, 1992: (1) fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; (2) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) women play a central part in the provision, management and safeguarding of water; (4) water has an economic value in all its competing uses and should be recognised as an economic good.

Landslide – A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; the rapid movement of a mass of soil, rock or debris down a slope.

Likelihood – The likelihood of an occurrence, an outcome or a result, where this can be estimated probabilistically. In this context, the likelihood of an impact is a combination of the probability of climatic events happening and that these events will have the predicted impact.

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***. The term mitigation in the climate change context should not be confused with the "mitigation measures" used to address environmental and social impacts of developments.

Projection – The potential evolution of a quality or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasise that projections involve assumptions – concerning, for example, future socio-economic and technological developments, that may or may not be realised – and are therefore subject to substantial ***uncertainty***. See also ***climate projection*** and ***climate prediction***.

Resilience – The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

Riparian – Relating to or living or located on the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater.

Risk – The probability quantifiable damage, injury, liability, loss, or any other negative occurrence that is caused by a threat or hazard. The probability of something happening multiplied by the resulting cost or benefit if it does. Sometimes used interchangeably with "hazard" and "threats", the risk can be reduced through adaptation and addressing the impacts, even if the threats of climate change and the hazards they bring remain the same.

Risk Management Framework – the overall system for managing the impacts resulting from climate change and extremes of climate involving identifying the climate threats to a structure or asset, assessing the vulnerability and potential impacts, and then developing adaptation options and plans for its protection.

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 in respect to climate. Scenarios may be derived from ***projections***, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'.

Scoping is a critical, early step in climate change impact and vulnerability assessment – and in the final preparation of an adaptation plan. The scoping process identifies the boundaries of the assessment and plan – in terms of its infrastructure focus, geographic area coverage and temporal dimensions. Assets and issues that are likely to be of most importance and relevance to the assessment are described and those that are of little concern are eliminated. In this way, the assessment focuses on the significant effects and time and money are not wasted on unnecessary investigations. The scoping process will involve round table consultations with local government sector experts and local leaders and effected communities. It based on an initial understanding of the effects of past extreme climate and hydrological events in the target areas.

Sensitivity – Sensitivity is the degree to which a system is affected, either adversely or beneficially, by ***climate variability*** or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by more frequent flooding due to increased water flow and volume in rivers during extreme flood events).

Seriousness – the seriousness of an impact is a measure of what would happen if the impact occurred. This might include loss of life, the damage to the asset and how long it would take to repair and at what cost, the loss of the services provided by that asset, and the economic implications. (Loss of life, Loss of property – i.e. destruction of property, damage to property, Loss of productivity and income, Impeding of function). This can range from trivial (very low) to catastrophic (very high).

Significance – The extent to which something (the impact) matters; its importance. In a risk management framework the significance of the impact is assessed from a consideration of the likelihood that it may occur with the seriousness of the impact.

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

Streamflow – Water flow within a river channel, for example, expressed in m^3/s. A synonym for *river discharge*.

Surface runoff – The water that travels over the land surface to the nearest surface stream; runoff of a drainage ***basin*** that has not passed beneath the surface since precipitation.

Threat – something that may cause damage or harm (to the asset) in the future.

Threshold – The level of magnitude of a system process at which sudden or rapid change occurs. A point or level at which new properties emerge in an ecological, economic or other system, invalidating predictions based on mathematical relationships that apply at lower levels.

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 judgement 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*** (i.e. threats and hazards), 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.

SECTION B:
A GUIDE FOR DEVELOPING AND IMPLEMENTING SECTOR ADAPTATION PLANS FOR ACTION - SAPAS

ABBREVIATIONS

ADB	Asian Development Bank
CC	Climate Change
DHM	Department of Hydrology and Meteorology
DoI	Department of Irrigation
DUDBC	Department of Urban Development and Building Construction
DoLIDAR	Department of Local Infrastructure Development and Agricultural Roads
DoR	Department of Roads
DWIDP	Department of Water Induced Disaster Prevention
DWSS	Department of Water Supply and Sewerage
DRR	Disaster Risk Reduction
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GoN	Government of Nepal
ICEM	International Centre for Environmental Management
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plan of Action
MoU	Memorandum of Understanding
MCCRMD	Mainstreaming Climate Change Risk Management in Development
M&E	Monitoring and evaluation
MoSTE	Ministry of Science Technology and Environment
MoFALD	Ministry of Federal Affairs and Local Development
NAPA	National Adaptation Programme of Action
NPC	National Planning Commission
O&M	Operation and Maintenance
TA	Technical Assistance
VA & AP	Vulnerability Assessment and Adaptation Plan
VA	Vulnerability Assessment

TABLE OF CONTENTS

FOREWORD BY MOSTE

This section should include:

- Origin of this guide
- Need for this guide and importance of climate resilient infrastructure
- Links to NAPA and SAPA
- Role of MOSTE in implementing climate change policies for Nepal and in climate change projections
- Proposed changes in Environmental Protection Act and Rules to include climate resilience in infrastructure planning and environmental protection
- Outline of ADB TA 7984 – Mainstreaming Climate change risk management in development

1 INTRODUCTION TO THE CLIMATE CHANGE RISK MANAGEMENT FRAMEWORK

This climate change risk management framework describes the processes and tools for mainstreaming climate change resilience into the infrastructure sectors for Nepal. The Sectoral Adaptation Plan for Action (SAPA) is the formalised process for each infrastructure sector agency to develop its specific adaptation plans. ***Error! Reference source not found.*** *shows the steps of the SAPA process.*

It uses the main tools of vulnerability assessment and adaptation planning to increase the resilience of infrastructure and to manage the risk of failure of that infrastructure. The companion MOSTE guide for infrastructure departments on Climate Change Vulnerability Assessments and Adaptation Methodology for Infrastructure in Nepal describes these tools.

1.1 Infrastructure sectors

This climate change risk management framework is directed towards the following sectoral agencies responsible for infrastructure development:

- Department of Local Infrastructure Development and Agricultural Roads – rural roads, bridges, pathways, water supply;
- Department of Roads – national roads and bridges;
- Department of Water Supply and Sewerage – water supply, water treatment, sanitation, sewerage and waste water treatment;
- Department of Water-Induced Disaster Prevention – river training and protection works, flood embankment, landslide protection;
- Department of Irrigation – irrigation schemes;
- Department of Urban Development and Building Construction – urban planning and development, including roads and drainage, building construction ;
- Ministry of Federal Affairs and Local Development – sand and gravel mining;
- Department of Hydrology and Meteorology – GLOF monitoring and management

The SAPA framework could be applied in a similar way for other infrastructure sectors, but would require “tailoring” to fit the sector.

1.2 Objectives

The objectives of the climate change risk management framework for the infrastructure sectors may be stated as:

1. To increase the climate resilience of existing and future infrastructure throughout Nepal
2. To enable the sector agencies to plan, design, construct, operate and maintain the infrastructure for which they are responsible so that they function effectively and continue to provide the relevant services despite changing climatic conditions and extreme events.

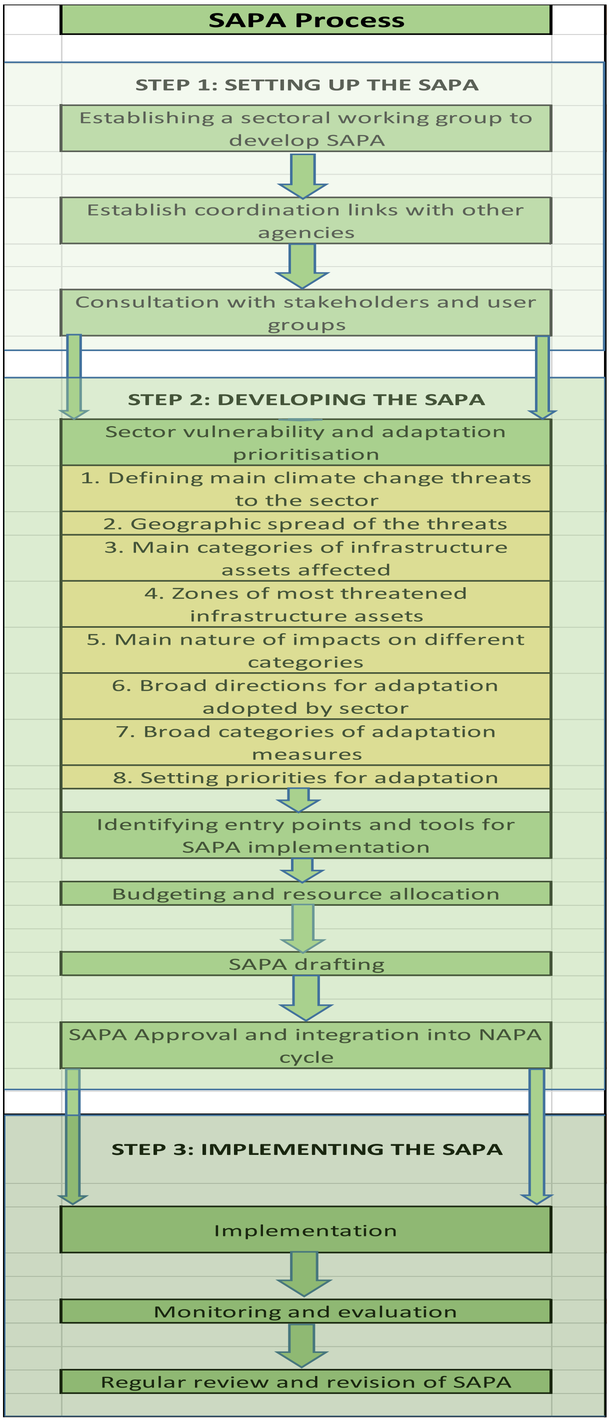
1.3 Principles

The risk management principles behind the development of this framework include:

- Tailored to the sectors, with identification of specific entry points and tools for each
- An integral part of the agencies involved and their decision-making process
- A straightforward process that can be rapidly and easily applied
- Using existing tools and planning processes that can be adapted to consider climate change

- Transparent, so that the rationale and assumptions for the adaptation options proposed are documented and clear for future reference
- Based upon the most recent down-scaled projections for climate change and extreme events, so that more designs can more easily incorporate future conditions
- Flexible and easily modified or updated based upon experience and improved climate data and change projections
- Combined with capacity building to develop the application of the framework at different levels for each sector

Figure 1: Steps of the SAPA Process



2 NEPAL CLIMATE CHANGE POLICY CONTEXT

2.1 National climate change policy

Government of Nepal prepared its climate change policy in 2011[1] to address the adverse impacts of climate change and achieve climate friendly physical, social and economic development. At the time of policy formulation, it was claimed that the new policy would make natural resources management climate-friendly for socio-economic development, and ensure climate-resilient infrastructure development.

The policy lays emphasis on development, promotion and implementation of climate change-friendly technologies and for the formulation and implementation of action plans for climate adaptation, including prohibiting the development of human settlements in climate vulnerable areas.

Other strategies include preparation of plans for disaster risk management, creation of public awareness, improvement in climate forecasting, forecasting of water induced disasters and risk, introduction of disaster insurance and reduction in soil erosion. The coordination and monitoring role in formulating and implementing adaptation actions were given to MoSTE[2].

2.2 Linkages with NAPA

In the Nepal National Adaptation Plan for Action (NAPA), completed in 2010, there is a statement of intent that "*The Government expects that any and all climate change adaptation support programmes will carefully consider the NAPA outcomes as a first step*". The NAPA prioritization process serves as a basis for the development of an adaptation strategy and is thus the starting point for the development of sectoral climate resilient infrastructure – the Sectoral Adaptation Plans for Action (SAPAs).

The continuation of the NAPA process envisaged that the outcomes would be mainstreamed into the national development agenda and would contribute to poverty reduction, livelihood diversification and building community resilience.

The NAPA process identified a listing of nine clusters of priority activities of which three are of direct interest to the risk management framework for infrastructure.

- iv. GLOF Monitoring and Disaster Risk Reduction
- vi. Adapting to climate challenges to Public Health
- ix. Promoting climate smart urban settlement

Within the section on urban settlements and infrastructure the NAPA document noted that earlier development plans (Tenth Plan, 2002-2007) had focused on the development of the roads networks; on planning codes; on water supply and management but that they did not explicitly address climate induced risks and in their current form would only be able to provide post-disaster emergency relief, rather than looking forward to pre-empt such disasters with climate-proofed infrastructure.

It also noted that the Disaster Risk Reduction Action Plan (2010 – 2013) envisaged the preparation of a risk-sensitive land use plan for the Kathmandu valley that would provide a framework for

---

[1] Ministry of Environment (2011). Climate Change Policy. Government of Nepal, Ministry of Environment (MoE), Singhdurbar, Nepal.

[2] MoSTE has two Divisions i.e. Climate Change Management Division and Environment Division and two Departments i.e. Department of Environment and Department of Hydrology and Meteorology that work on climate change risk management and adaptation.

development, land allocations and related strategies and policies and regulatory tools and procedures for controlling future growth and safeguarding it from natural hazards.

Within the water sector, the priority areas of Water supply, sanitation and hygiene, identified a number of programmes of which the following have relevance to this framework for climate resilient infrastructure including Rural, Small Towns, Kathmandu Valley, and Major Towns Water supply and sanitation programmes.

In highlighting priority adaptation options for the urban settlements and infrastructure sector, the NAPA noted that urban areas and infrastructure are highly sensitive to climate changes. Of the adaptation options it noted the following as priority:

- Downscaling of climate change scenarios at meso-level;
- The use of downscaled climate change findings to train/raise the capacity building and educating of policy makers, officials of GoN and engineers from the respective metropolitan/municipalities;
- Enforcement of planning regulations, building codes in urban areas and incorporating climate change dimensions.

This proposed climate change vulnerability and adaptation framework for the infrastructure sectors can thus be seen to be following directly from the priorities identified by the NAPA. It is focused upon the enhancing climate resilience of the infrastructure, especially maintaining its structural integrity, so that it can continue the primary functions of transport connectivity (for roads and bridges), delivery of water (for both water supply and irrigation), or for effective river bank protection and flood defence (for river training and other works).

The issue of GLOF monitoring and disaster risk reduction, can be considered in two ways, either as an additional threat to all the infrastructure within the flood path of the GLOF, or in terms of the infrastructure measures required to reduce that threat.

2.3 Linkages with LAPA

The National Framework for Local Adaptation Plans for Action (LAPA) is expected to provide the effective delivery of adaptation services to the most climate vulnerable areas and people. It provides a systematic process for preparing and implementing local adaptation plans taking into consideration the sector and location, resource availability and distribution system, community access to public services and facilities, and region and areas affected by climate change. The LAPA document recognizes that "*alternatively, it would be appropriate to integrate adaptation into mainstreamed development planning including sector-specific planning and implement accordingly*."

The LAPA process was developed in 10 districts, and has since been deployed in all other districts. It identified agriculture, forestry, health, water and sanitation, watersheds and micro-finance as the main entry points, but also recognised education, **local infrastructure**, disasters and other environment-related areas as other as possible entry points. The LAPA Framework ensures that the process of integrating climate adaptation and resilience into local and national planning is bottom-up, inclusive, responsive and flexible as the four guiding principles. The LAPA framework will support the following activities from local to national level planning:

- Identify the most climate vulnerable Village Development Committee (VDC), Municipality, wards and communities and their adaptation challenges and opportunities, including possible activities;

- Identify and priorities adaptation actions in easy ways whereby local communities make the prioritisation decisions about their needs;
- Prepare Local Adaptation Plans for Action and integrate it into local and national plans in accordance with the Local Self-Governance Act;
- **Identify and mobilize appropriate service delivery agents and necessary resources for the implementation of the Local Adaptation Plans for Action;**
- **Adopt and/or implement adaptation actions sequentially by the service providers in a timely and resource efficient manner**;
- Conduct monitoring and evaluation by ensuring effective implementation of the plan for action; and
- Identify cost-effective adaptation alternatives for scaling up into local and national planning.

The focus for the LAPA starts at the local community and even household level. Community processes and the VDCs may be able to identify the most vulnerable infrastructure providing services to their community – the rural roads, water supply and sanitation and irrigation schemes etc. However, they are unlikely to have the technical capacity to develop the adaptation measures to make them more climate resilient; these measures would be largely engineering or technical adaptations. Where local user groups are involved in operation and maintenance, there would be a direct linkage with the LAPA process in addition to the identification of the most vulnerable infrastructure assets within the community.

Step 5 of the LAPA process is entitled "LAPA Integration into Planning Process". This step has the objectives of i) supporting the integration of climate adaptation and resilience into sectoral and cross-sectoral development plans; and ii) supporting the integration of locally developed climate adaptation plans or identified adaptation actions into public, private and NGO planning processes. This, then, is the link between the LAPA process and the infrastructure sector climate change risk management framework.

The focus for the proposed climate change risk management framework for infrastructure is upon the so-called "service providers", highlighted above. It will enable climate change to be incorporated into the infrastructure sectors providing the services to the communities, in such a way that the agencies involved can apply their own tailored vulnerability assessment and adaptation process – the SAPA – using the most relevant climate change projections, and thus facilitating the continued delivery of those services in the face of changing climate and extreme events.

2.4 Linkages with Disaster Risk Management

The NAPA identified various priority actions for addressing climate induced disasters, in particular, increases in intense rainfall with associated floods and landslides. These included:

- Enhance the capacity of all water-induced disaster related institutions
- Implementation of structural measures
- Hazard/vulnerability mapping and zoning
- Discouraging and restricting settlements in high-risk areas
- Implementation of the building codes

These measures are directly related to the proposed climate change risk management framework for infrastructure sectors.

The various legal and policy instruments for disaster risk management have been formulated by GoN/MoHA which, include:

- Natural Calamity Relief Act, 1982
- National Strategy for DRM, 2009
- Disaster Preparedness and Response Plan, 2010
- National Disaster Response Framework, 2013
- National Disaster Management Act (Proposed)

The draft Disaster Risk Management (DRM) Act is in the process of being updated and includes the establishment of a National Disaster Management Secretariat. There is increasing interest within government agencies of linking disaster risk reduction and climate change.

The Approach paper for the 13th Periodic Plan (2013/14-2015/16) includes a section on Disaster Risk Management, described above, stating that the Disaster Preparedness Network Nepal will coordinate and cooperate with various national agencies in order to run disaster management activities effectively. The National Platform Secretariat supports government of Nepal to implement HFA priorities, works as a mechanism of multi-stakeholders for coordination and collaboration, serves as catalysts for national consultations and consensus building, as well as for DRR priority identification and policy formulation, implementation and monitoring DRR activities and shares DRR knowledge and information. This plan aims to mainstream disaster risk management into the development process to reduce impacts on the human population. The plan has three strategies to cope with disaster: i) develop appropriate legal institution for effective disaster management, ii) strengthen relation of private/local community with NGOs and INGOs for disaster management, and iii) develop early preparedness for disaster events.

The focus for disaster risk management and disaster preparedness is the ability to respond rapidly and effectively in the event of a disaster, and minimize the impacts and effects upon people and communities when a disaster has occurred.

The contribution that the infrastructure sectors can make to disaster risk management is **prevention** i.e. ensuring that strategic infrastructure is protected and well maintained, so that the risk of infrastructure failure is reduced, but that if an event such as a landslide or flood does occur, the services can be maintained and brought back to normal as soon as possible e.g. providing road and bridge access for transportation of rescue and relief supplies, and the provision of water and sanitation. The protection of infrastructure against such events is the responsibility of the different sectoral agencies and reduction of risks of water induced disasters from flooding and landslides is the particular responsibility of DIWDP. These agencies thus have risk reduction responsibilities rather than the main emergency response responsibilities.

2.5 Reforms required

From the above discussion, it is clear that there have been a number of policy level interventions concerning climate change and disaster risk reduction. Policy, programmes and legislation on DRR and climate change have emphasized risk reduction, preparedness and adaptation. The general awareness of climate change has significantly increased both in the communities, and amongst government agencies and decision makers at policy and programmatic levels.

However, the need for climate change resilience is only recently entering the policy frameworks of the sector agencies. In some sectoral agencies, climate change is mentioned in the policy e.g. in the Master Plan for the Department of Water Supply and Sanitation, in other sectors it is not yet included. In some agencies, e.g. the Department of Irrigation, a specific unit with responsibility for dealing with climate change issues has been set up. The Department of Urban Development and Building Construction has established a Disaster Reduction Unit in their Housing Section. The inclusion of climate change resilience in sectoral policies and institutional set up is still patchy.

Within MOSTE, an opportunity exists for inclusion of climate change in the proposed revision of the Environmental Protection Act (EPA), 1976, and the Environmental Protection Rule (EPR), 1977. Climate change is not included in either of these key legal documents. It is suggested that at least within the EPR, the consideration of climate change in Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) should be obligatory.

Often the sector departments have environmental and social impact sections, and some have issued EIA guidelines e.g. Department of Roads, and others have guidelines for the development of master plans, e.g. DOLIDAR and the Guidelines for District Transport Master Plans (DTMP). These documents rarely mention climate change, and even when they do, no guidance is provided on how to do vulnerability assessments and develop climate resilience.

The SAPA process presented here provides an opportunity for each sector to address the needed policy reforms in each sector, to mainstream climate change vulnerability assessment and adaptation in the appropriate laws and regulations, in the sector policies and guidance documents and in the planning processes, as well as in the institutional structure of each agency.

3 DEVELOPING SECTOR ADAPTATION PLANS FOR ACTION

3.1 What is SAPA?

A Sector Adaptation Plan for Action, or SAPA, is a sector specific plan for mainstreaming climate resilience tailored to the types and vulnerabilities of the infrastructure and the policies, plans and projects of the agency. Each agency would follow a process to develop its own SAPA. This process, modelled on the NAPA and LAPA approaches, would help the agency to identify the package of adaptation measures needed to ensure greater climate resilience in the sector. The SAPAs fill a gap between the NAPA and LAPAs, allowing a specific focus upon the vulnerabilities and technical adaptation requirements of infrastructure. In terms of disaster risk management, the SAPAs focus on adaptation in order to prevent disasters, rather than upon emergency response.

The similarities in the processes and linkages between the SAPAs and the NAPA and LAPAs are illustrated in Figure 2. It is envisaged that as the SAPAs are developed, they would contribute to the next round of NAPA preparation. The main linkage point between SAPAs and LAPAs would be at Step 5 in the LAPA process - Integration of adaptation plan into planning process. The main agency which would address local infrastructure adaptation requirements identified by LAPAs would be DOLIDAR.

3.2 Steps in SAPA development and implementation

There are three main steps in the development and implementation of a SAPA:

a) **STEP 1: Setting up the SAPA**
   - 1.1 Setting up a sector climate change working group
   - 1.2 Establishing links with other agencies
   - 1.3 Consultation with stakeholders and user groups

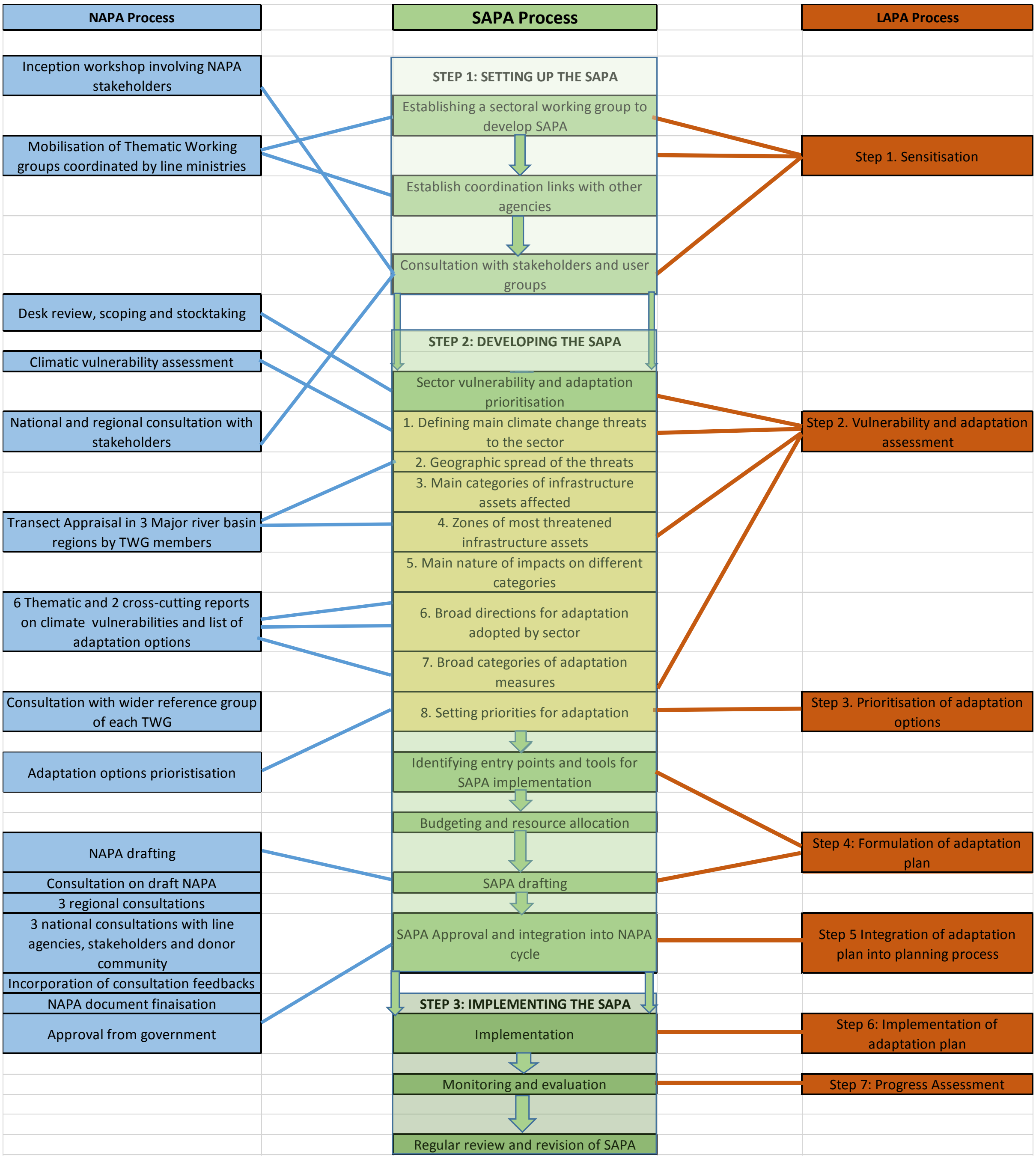
b) **STEP 2: Developing the SAPA**
   - 1.1 Identifying the sector specific entry points for infrastructure climate resilience
   - 1.2 Sector vulnerability and adaptation prioritization
   - 1.3 Drafting and approval of the SAPA

c) **STEP 3: Implementing the SAPA**
   - 1.1 Implementation
   - 1.2 Monitoring and evaluation
   - 1.3 Regular review and revision of the SAPA

Each step has a series of sub-steps; these are illustrated in Figure 1, and the similarities of the processes and linkages with NAPA and LAPA processes illustrated in Figure 2. The steps and sub-steps are described in the following sections.

Some questions to be asked in developing SAPAs and identifying the policy reforms are shown in Box 1.

Figure 2: Similarities and linkages between the SAPA and NAPA and LAPA processes



Box 1: Questions for mainstreaming sectoral climate resilience

1. Within the schematic planning cycle presented, each agency should consider the possible entry points, identifying, and naming the steps in its planning and implementation process. Following questions may help:
    - Does the agency have a policy for building climate resilience in existing or planned infrastructure?
    - Does the agency have a designated unit responsible for addressing issues of climate change and adaptation within its structure?
    - Does the agency have a master plan for future infrastructure to be constructed at national or district level?
    - Does the agency develop its projects with its own staff, or through the use of consulting engineers?
    - Does the agency use design standards, building codes or guidelines that are applied when developing new projects?
    - Does the agency regularly use the EIA or IEE process for its projects?
    - How does the agency prepare its annual maintenance plan at national or district level? Does it have a list or database of its existing assets?
    - Does the agency have an ongoing professional training programme for its staff, e.g. for infrastructure design, environmental impacts, disaster risk management?
2. For each identified entry point, consider the potential for applying climate resilience assessment such as:
    a. How easy will it be to apply climate resilience assessment?
    b. How effective will it be for the overall mainstreaming process?
    c. What are the constraints and incentives:
        - Technical constraints
        - Financial and budgetary limitations
        - Lack of knowledge about climate change and adaptation
        - Absence of a system or process for assessment
        - Lack of appropriate climate change information
        - Lack of policy, regulations or directives
        - Lack of incentives to include climate change in infrastructure planning
        - Lack of staff capacity
3. Assuming that there is a long-term commitment within the agency to include climate resilience in its planning and implementation of its infrastructure, identify the top three entry points. For each of the top three entry points, identify:
    a. The technical units and staff that are most involved at national, district or municipality level.
    b. The requirements for facilitating implementation:
        - Decisions and directives
        - Financial commitment and budget allocation
        - Specification of the most useful tools for each entry point
        - Guidance documents on application of the tools
        - Information and data sources on climate change impacts upon the infrastructure
        - Technical support and advice
        - Capacity building - For capacity building, identify what is required and for whom capacity building is designed
        - Time frame for implementation

Step 1 Setting up the SAPA

4 SETTING UP THE SAPA

4.1 Setting up a sector climate change working group

Each agency should establish a working group to develop the SAPA and mainstream climate change resilience in the work of the agency and its infrastructure. The institutional home for such a working group may be in the climate change or disaster risk management units (if these exist) or the environment and social sections. However members of the working groups should be drawn from other departments involved with planning, design, construction and operation and maintenance of infrastructure.

The working group should be established with specific terms of reference to develop and draft the SAPA within a definite time frame. It will require an allocated budget for the task of developing the SAPA.

4.2 Establishing links with other agencies

Other agencies may provide information and advice for the development of the SAPAs. The working group should start with an identification of useful agencies to coordinate with. For example:

- The links with the National Planning Commission for the NAPA process
- Coordination with climate change sections in MOSTE are essential for advice on the development of the SAPA.
- A regular linkage with the Department of Hydrology and Meteorology is especially important to obtain the latest projections and district climate change threat profiles and sector focused threat profiles, and GLOF threats.
- Other agencies may contribute their own experiences with climate change resilience in infrastructure, particularly when there is overlap in responsibilities, for example:
  - agencies responsible for similar types of infrastructure at national and district levels.
  - between river protection and training works and sand and gravel mining, or
  - between water supply and sanitation and road construction with design in urban planning.

4.3 Consultation with stakeholders and user groups

The working group should consult with both stakeholders and infrastructure user groups about perceptions and concerns related to climate change vulnerability of the infrastructure and the adaptation options being considered.

The consultation process can be used at any point in the development of the SAPA. The outline of the NAPA process shown in Figure 2 illustrates a number of different consultation points in the process. The purpose of consultation with stakeholders and user groups may be to assist with the scoping of the SAPA – what to include or not, and also to verify the findings of the analysis and the recommended action plan.

Consultation draws upon the stakeholders' and user groups' knowledge and experience of the infrastructure and how it may be impacted by climate change, and to develop an understanding of the effectiveness of adaptation options that may be considered. The stakeholders may also identify institutional and policy aspects that need to be addressed.

This is also an opportunity to bring in gender perspectives in the use of the infrastructure, especially where the adaptations being considered may have different implications for men and women, children and disadvantaged groups, or where failure of the infrastructure as a result of an extreme event has more significant impacts upon women or other disadvantaged groups.

Step 2 Developing the SAPA

5 SECTORAL VULNERABILITY AND ADAPTATION PRIORITIZATION

An important part of developing the SAPA is the sector-wide vulnerability assessment and prioritization of the adaptation options. This defines the nature and extent of the relevant climate change issues and how the sector may develop climate change resilience in its infrastructure.

5.1 1: Defining the main climate change threats to the sector

Climate change is most likely to accentuate the historic and current climate thresholds that are used to design the infrastructure. Climate change will bring greater variability and larger extremes which will threaten the infrastructure in similar ways but to a greater extent. An understanding of the historic climate design parameters and challenges for the infrastructure, coupled with the projected range of changes, will help to define the main climate threats to the sector. For Nepal, district climate threat profiles, and sector-based threat profiles have been prepared, to assist the sector agencies in this process.

5.2 2: Understanding the geographic spread of the threats

Climate change projections have been prepared for the 8 districts of the project, and the Department of Hydrology and Meteorology are able to add to these district threat profiles. Taken together these demonstrate the geographic spread of the climate change threats and variation in different parts of the country. This will enable particular areas of the country where the different climate change parameters are likely to be greater – the climate change hotspots – which will be important for identifying the zones of threatened infrastructure.

5.3 3: Categorising the infrastructure assets affected

A fundamental step for all sectors is the categorization of its different infrastructure assets and their components parts in terms of their vulnerability to increased climate challenges. Most agencies will have some sort of database of their assets, with characteristic features, though often such databases are inadequate or out of date. The basic information of the asset category, location, when it was built and maintenance status, can be used to add in a categorisation for general climate change vulnerability. The sector synthesis reports produced by the project, draws upon the district vulnerability assessments to develop categories of infrastructure assets and their vulnerabilities. The strategic importance of the infrastructure may also be noted at this stage.

5.4 4: Identifying the zones of most threatened infrastructure assets

With the locations of key, strategic infrastructure assets and the geographic spread of the most relevant and significant climate changes that are projected, it is possible to use geographic overlays to identify the zones in which the most threatened assets are located. This zoning process allows priority focus for adaptation on those most vulnerable assets.

5.5 5: Identifying the nature of impacts on different categories

Earlier vulnerability assessments of the different categories of assets allows the nature of the impacts of the increased climate challenges to be identified. Such impacts may range from temporary malfunction of the asset to permanent failure. They may increase the rate of deterioration and the need for maintenance. In the event of complete failure, e.g. wash out of a bridge, or collapse of water supply intakes, the impact will be very significant in terms of loss of service for the users and communities that depend upon the assets. The sector synthesis reports produced by the project highlight the potential impacts of the different categories of asset. There can be very different impacts of malfunction or failure upon different sections of the community, with the consequences for women, children and other disadvantaged groups being much greater than for the able-bodied men, for whom the asset was generally designed in the first place. Gender disaggregation of the impacts of climate change threats can be done at this stage.

5.6 6: Developing broad directions for adaptation to be adopted by the sector

There are a number of broad strategies that help in determining the adaptation response. These include:

i) Build now for lifetime adaptation of the asset;
ii) Plan for a phased adaptation over the asset lifetime;
iii) Progressive modification to the design and
iv) Build to repair, accepting that there will be damage as climate change intensifies.

Each of these strategies have different economic implications with greater upfront costs and lower maintenance, compared to lower capital costs, but with increasing repair and rebuilding costs during the asset lifetime.

5.7 7: Broad categories of adaptation measures

Adaptation measures are not only focused on structural engineering approaches. There are many different types of adaptation that will increase the resilience of the assets. These range from:

- avoidance (building the infrastructure in a location or route that avoids the hotspot),
- bioengineering measures,
- traditional local adaptation measures,
- economic instruments,
- natural systems management,
- social responses,
- policies and regulation,
- research and development, and
- institutional responses.

In most cases, the adaptation plan is likely to cover a range of measures. As with vulnerability and impacts, an analysis of the gender and disadvantaged sensitivity of the adaptation measures proposed should be considered at this point.

5.8 8: Setting priorities for adaptation

With this information and analysis it is possible to develop an integrated plan that will focus on the priorities for adaptation, allowing for the significance of the asset and the consequences of its failure, the zonation of the most threatened infrastructure, and the direction and range of adaptation measures to be undertaken.

6 IDENTIFYING SECTOR SPECIFIC ENTRY POINTS

6.1 SAPA Framework

There are a number of different entry points into the development planning cycle from policy review and master planning, through the project cycle and modification of design standards, to monitoring and evaluation and auditing of infrastructure assets. Figure 3 illustrates the different entry points in the infrastructure planning and development cycle. The SAPA process allows the identification and prioritization of the most appropriate entry points and tools for the sector.

Figure 3: Schematic of the infrastructure development planning and implementation cycle

6.2 Sector policy

The SAPA process may identify the need for changes in laws, regulations and directives to ensure consideration of climate change in the different processes such as EIA or IEE or changes in the institutional structure with creation of dedicated climate change and disaster risk reduction units.

6.3 Sector master plan

Sector master plans are designed to meet the future needs/demand for the sector and its services by building on existing infrastructure with a number of strategic projects. Initial estimates for project size, location and cost would be developed as well as some of the possible environmental impacts. This provides the priority listing for investment and a time frame for their development.

Climate change resilience through the sector master planning entry point may be addressed a) by building in climate resilience as the master plan is developed, or b) through review of existing master plans and revision with adaptation measures or c) through the specific tool of Strategic Environmental Assessment processes.

6.4 Spatial plans

Urban planning particularly uses spatial planning and zoning processes in order to identify the optimum locations for the different elements and land uses of the urban plan. It is used to locate strategic infrastructure within the plan, especially to avoid hazardous areas (flood or landslide prone areas). Spatial planning that identifies various hazardous areas can provide the justification for additional protection measures or higher standard building codes to be used for infrastructure in those areas.

Spatial planning may also be used in the river basin context when planning river bank protection and training works. It allows the overall vision of river and flood management to be developed so that the requests for river bank protection may be addressed within the context of that plan, and thus helps to avoid impacts of ad hoc, relatively small interventions.

Spatial planning may also be used in determining the area at risk of a GLOF. Thus if the hazard map of the downstream area that might be affected by a GLOF is produced, the vulnerability of existing infrastructure within the area may be assessed, and decisions taken:

a) to relocate above the hazardous area,
b) to strengthen or protect the infrastructure in some way or
c) to accept that it will fail in the event of a GLOF. New strategic infrastructure may be located or routed away from the hazardous area of the GLOF.

6.5 Project feasibility

During project feasibility studies, various options are considered for the location, routes and design of a project. The general project concept may have been developed in the master planning process, or it may be considered in response to demand. The feasibility studies will include:

- Technical feasibility, e.g. an assessment of the resources available (e.g. water), geotechnical assessments, engineering requirements
- Environmental and social feasibility – identifying the main environmental and social issues that will have an influence upon the design
- Economic and financial feasibility, e.g. capital and operational costs, including environmental and social costs

The feasibility study will compare the different design options, leading to recommendations for the preferred option. This will be the option that is then taken forward for detailed design

Climate change vulnerability assessments provide an important area for comparison between the different options. The adaptation measures required to ensure greater climate resilience of the project options will also contribute to both technical and cost feasibility comparisons. The VA and AP methods can be used to assess and compare the vulnerability and adaptation measures required.

6.6 Project design

Design standards, building codes and guidelines used by the agencies for the appropriate design and construction of the infrastructure are fundamental to ensuring that the infrastructure that is built is of appropriate quality and strength to withstand the climate extremes that have been expected in the past. However, with climate change these extremes are likely to increase in frequency and intensity – the current 1-in-100 year storm event may occur as often as 1-in-20 years by 2050 and the projected 1-in-100 year storm event may have 20% more rainfall falling in one day.

A climate resilience focused review of the design standards is one of the most practical and directly useful tools for including climate change into infrastructure development planning cycle. It has also been noted that some agencies find it difficult to justify the additional expense of adapting the designs of the infrastructure, e.g. DOLIDAR for rural roads, to the Districts without some scientific basis. The use of climate resilient design standards would provide such a justification.

A review of the design standards may be quite a large and detailed task, especially when there are a number of volumes, e.g. DWSS has 12 volumes of design standards for water supply systems and DUDBC has a similar number of Building code volumes. However, the practical experience that has been gained through the district vulnerability and adaptation planning process will provide insight into what is required and the key standards that require attention from a climate change perspective.

6.7 Project implementation and operation

Once projects move into implementation phase – both construction and ongoing operation and maintenance, it is essential that monitoring of these activities from a climate change resilience perspective continues. The monitoring during construction should focus on compliance with the climate resilient designs and building standards. During operation and maintenance, monitoring should combine both the climate changes measured and extreme events with the performance of the adapted designs to cope with changed conditions. In the event of failure of the infrastructure, the reasons for the failure should be analysed.

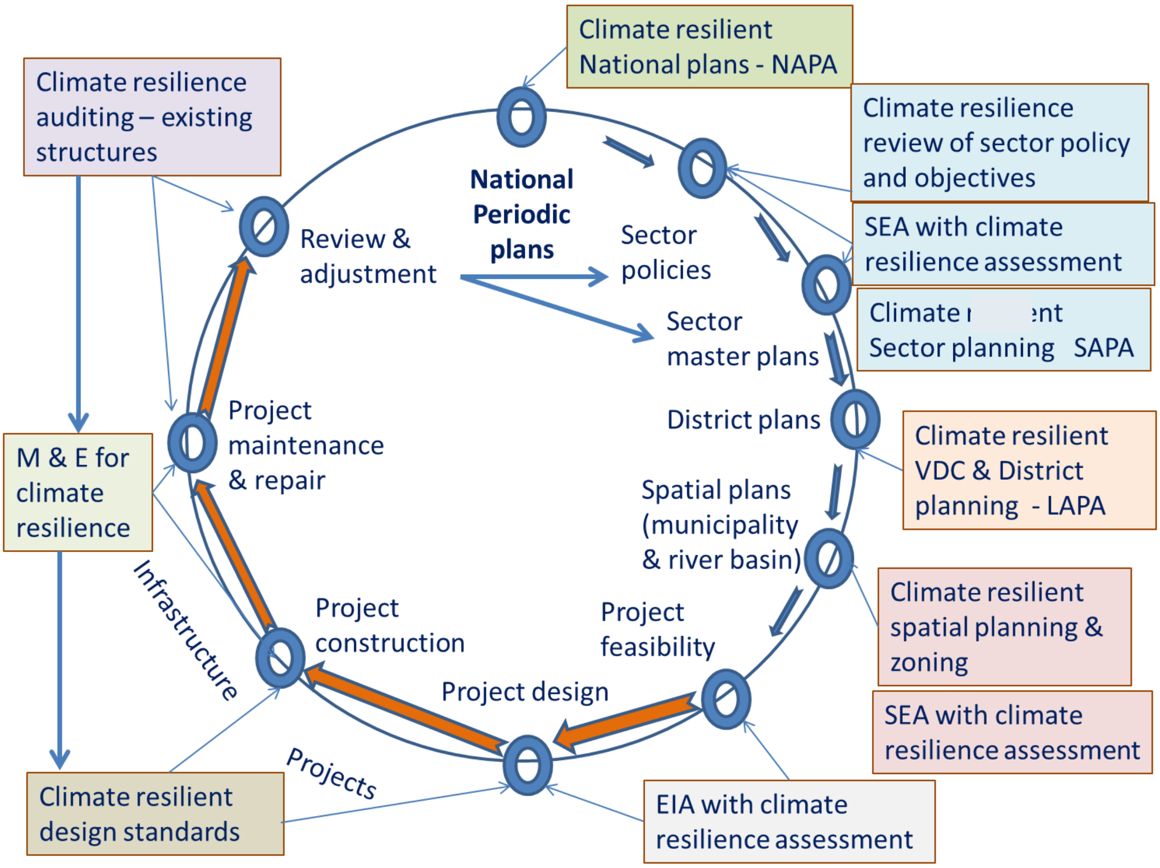
6.8 Review and audit

The review and audit stage of the infrastructure development cycle considers the status of the infrastructure assets and performance of the services provided by the agency. This may be incorporated into an annual maintenance plan, or into a review of the policies and master plans for the sector. It is an opportunity to consider the climate change vulnerabilities of the infrastructure and maintenance systems and to identify further adaptation required. From a climate change perspective this is an opportunity to consider the effectiveness of the SAPA itself.

7 TOOLS FOR IMPLEMENTING SAPA

Each of the entry points in the cycle of infrastructure development may have specific existing tools that can be used to incorporate climate resilience. These are shown in Figure 4. If they do not have an existing tool, the Vulnerability Assessment and Adaptation Method Guide may be used in the review process, e.g. for Master plans

Figure 4: Tools for addressing climate resilience in the infrastructure development planning and implementation cycle



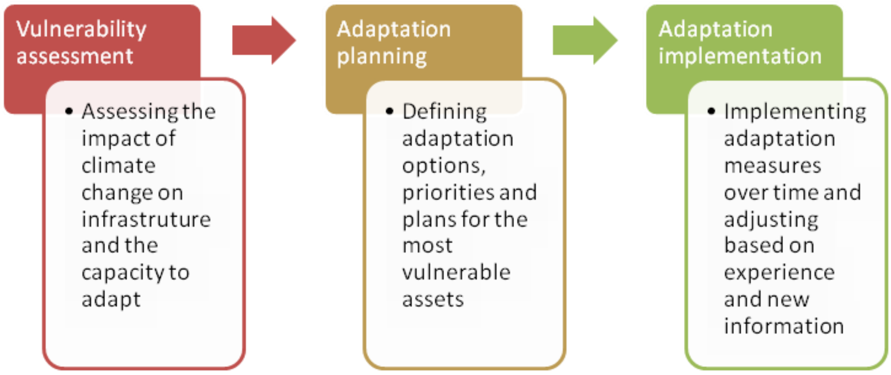
7.1 VA and AP Methods

The Vulnerability Assessment and Adaptation Planning method guide (MOSTE, 2014) sets out a simple and flexible process with supporting tools which can accommodate varying inputs of scientific evidence and expert judgements as well as community experience and knowledge. The method works as well in community level meetings with little or no climate change information, as it does with rigorous scientific information and expert teams. It can be a rapid process exercised over a day or extended over many weeks. The guide provides concrete examples of what climate change considerations are important and when in project planning and implementation they will have the most effect.

The method provides a disciplined framework for systematically ordering and ranking the many climate change factors, their impacts and adaptation responses. It is best used as a priority setting process for mainstreaming climate change into infrastructure even in situations of scarce resources and limited information. The process has three main phases–

vulnerability assessment, adaptation planning and then adaptation implementation (Figure 5).

Figure 5: Vulnerability assessment and adaptation process

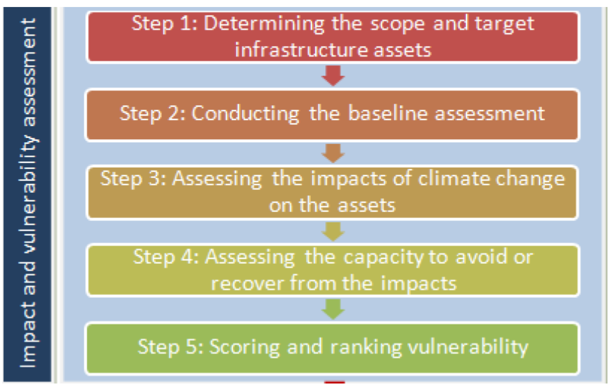


The application of the VA and AP method is illustrated in the different tools described below.

7.2 Using the VA and AP methods in sector master planning

A sector master plan sets out the long-term strategic objectives for the development of infrastructure and provision of the services at a national or regional level. It will consider the natural or social resources available and the demand or needs that have to be met over the next 20 years. It will identify the infrastructure projects that are required and assess these in terms of a number of different parameters, e.g. urgency to meet the demand, technical feasibility, locational constraints, capital costs, operational costs etc. Environmental and social impacts may be considered at a very general level. Based upon these parameters the list of projects is often prioritized, so that the order in which these projects ae selected and implemented may be identified. However, the actual implementation of the projects may depend upon other factors such as the availability of funds and political demand.

The inclusion of climate change as one of the prioritization parameters in the master planning process is becoming extremely important. Each of the proposed projects in the master plan should be screened for their vulnerability to climate change. The first section of the VA and AP methods can be used to do this from a knowledge of the type of infrastructure, its vulnerabilities to the different climate change threats and the location of the project. If the project is located in a particular climate change hotspot or hazard zone within the country, this will increase its vulnerability.



Information sources to assist this vulnerability assessment include:

- Sector specific synthesis reports developed by this project which helps to identify the typical vulnerabilities associated with the infrastructure type
- Sector climate change threat profiles
- District climate change threat profiles, and updates on downscaled projections from DHM
- Hazard maps showing landslide prone areas, flooding etc. where risks may be enhanced by climate change.

The vulnerability assessment of the master plan be used to:

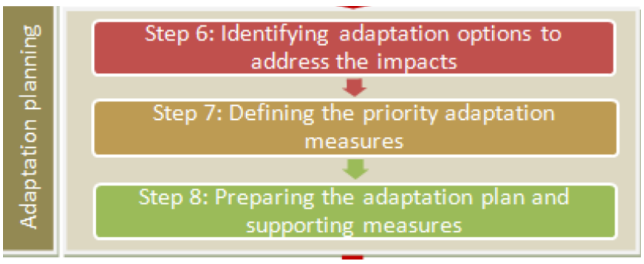
- Identify the most vulnerable of the proposed projects, and hence the overall vulnerability of the whole master plan
- Potential revision of locations of key components of the infrastructure plan, for example to avoid climate change hotspot or hazardous areas.
- Identify what broad measures may be needed to protect or adapt the proposed infrastructure,
- Allow the application of cost norms for adaptation options to be included in the overall budget
- Adjust the priority ranking of projects

7.3 Spatial Planning

The most useful tools to incorporate climate change into spatial planning are the GIS mapping tools, which can take the overall topographic maps with overlays of existing and future projected land use. Analysis of the climate change threats in a particular area, e.g. rainfall and run-off, can be used with hydrological and hydraulic modelling to predict the increase in the size of areas that are already prone to flooding, and to identify new areas that are likely to experience flooding. The climate change analysis builds on information about the historic climate and extreme events and extends these using climate change projections e.g. from the district threat profiles and hydrological modelling.

In areas that will experience the higher rainfalls, without the threat of flooding from the river, may be liable to increases in surface ponding. Analysis of the topography will highlight such areas, and allow for the design of measures to protect or drain the water away. Urban planning, river basin planning and GLOF hazard mapping all use spatial planning methods

In addition to the vulnerability assessment process outlined above, spatial planning uses the adaptation planning process to identify:



a) The zones that are particularly susceptible to hazards such as floods and landslides, that should be **avoided** for development, or have very limited and specified land uses
b) The zones that are slightly susceptible to these hazards, in which other **uses can be specified**, but with generally stricter construction standards and building codes
c) The zones where **normal development** can be allowed with application of general building standards.

7.4 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA) is receiving increased attention globally as tool for assessing the broader environmental and social impacts of policies and plans. It has been highlighted as a powerful tool for including climate change vulnerability assessment. To date it has not been used systematically in Nepal, but MOSTE is considering its application in the future. Climate change projections and sustainability of the infrastructure should be incorporated into these assessments.

The advantage of SEA is that it analyses a sector policy, plan or programme for infrastructure development, rather than a single project, so that cumulative impacts of the plan are considered over a longer period. SEA can be used to assess master plans or sectoral development at different spatial levels, e.g. at national, regional or district levels. This allows a strategic framework to be prepared for future infrastructure development and it helps to identify and manage the environmental and social risks that may not be considered as comprehensively in the EIAs or IEEs of single projects.

The SEA process generally follows a similar process as EIA, following scoping of the main issues of concern, which is often done through a series of consultations with stakeholders, with a study of baseline conditions relevant to those key issues and then the impact assessment itself, judging how the policy or plan under consideration will affect the key issues, either positively or negatively. The final stage is in the development of recommendations or measures to modify the policy or plan to make it more sustainable. Typically SEAs consider several different scenarios for development, e.g. without the plan, with medium development and with high development.

The inclusion of climate change concerns in the Strategic Environmental Assessment process should include:

- A description of both the current and historic climate and extreme events occurring in the area, **and** the projections for the future climate and extreme events.
- The vulnerability assessment would be applied to each of the scenarios to compare them and to understand the climate change vulnerabilities of the infrastructure plan, and the potential adverse effects of the infrastructure upon other climate impacts.
- Recommendations for which scenario is preferred from a climate change perspective
- Identification of policy and broad adaptation directions and options that should be considered.

7.5 Environmental Impact Assessment and Initial Environmental Evaluation

The processes for EIAs and IEEs have been well established and understood in Nepal for a number of years. Impact assessment is a recognized step towards ensuring that the environmental and social impacts of projects are managed appropriately. Impact assessment has also been recognized internationally as one of the most effective routes for considering climate change vulnerabilities and impacts of projects.

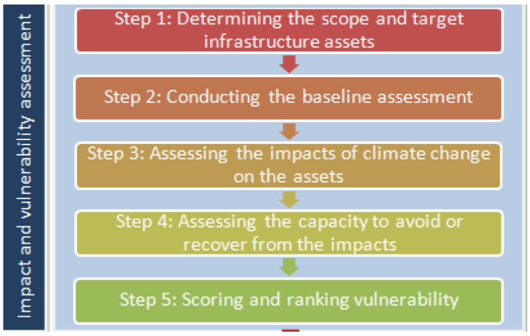
The most effective way of ensuring that all new infrastructure projects in Nepal consider climate change would be by modification of the EIA and IEE regulations. This would make it a regulatory requirement that all EIAs and IEEs should include a section on the potential climate change impacts upon the project and to demonstrate how the project has been designed to be climate resilient, through appropriate adaptation or protection. The revision of the Environmental Protection Act (EPA 1996) and Environmental Protection Rules (1997) is currently being considered by MOSTE.

If an EIA or IEE did not have such a section or otherwise show how climate change has been taken into account, then the report should be rejected and sent back for revision. Environmental compliance certificates should not be granted until climate change adaptation and management measures have been described. The environmental management plan (EMP) developed to address the impacts identified by the EIA or IEE should include the recommended adaptation measures and climate change monitoring.

Climate change assessments of projects can be included at several stages in the EIA/IEE process:

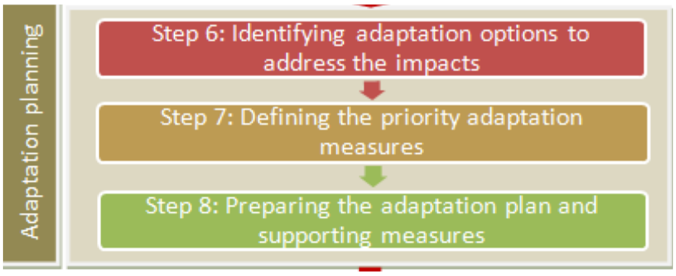
- At the scoping stage, when questions about projected length of life of the project and the scale of the threat can be asked, e.g. will the project be located in a climate change hotspot or hazard area.
- After the scoping, inclusion in the terms of reference (TOR) for the EIA or IEE
- In the main analysis of the EIA report

- In the recommendations for adaptation as part of the Environmental Management Plan



The VA and AP methods can be used to analyse the proposed projects. The vulnerability assessment process can be applied directly to information about the project, its location and the downscaled district projections of the climate changes and the resulting changes in the hydrographs of rivers, and hazard maps. EIAs usually require a comparison of several options for the project; the vulnerability assessment can highlight the differences between the project options.

If the vulnerability assessment indicates a moderate to very high vulnerability for the preferred project, adaptation measures will need to be identified in the EIA report, and included in the amongst mitigation[3] measures in the environmental management plan. For highly vulnerable projects, it may be necessary to revise the design substantially, or consider an alternative location. Adaptation planning may use the second series of steps in the VA and AP methods.



7.6 Prevention of catastrophic failure of infrastructure

For large and strategically important projects it may be useful to extend the vulnerability analysis to an assessment of the significance of impacts of catastrophic failure of the infrastructure. This can be included as part of the feasibility study or as part of the EIA process. It will not be practical to follow such a process for all infrastructure and therefore there will be a need to prioritise the strategic assets or projects, e.g. major bridges, large water supply systems etc. This analysis follows the risk assessment formula as shown in Table 7-1.

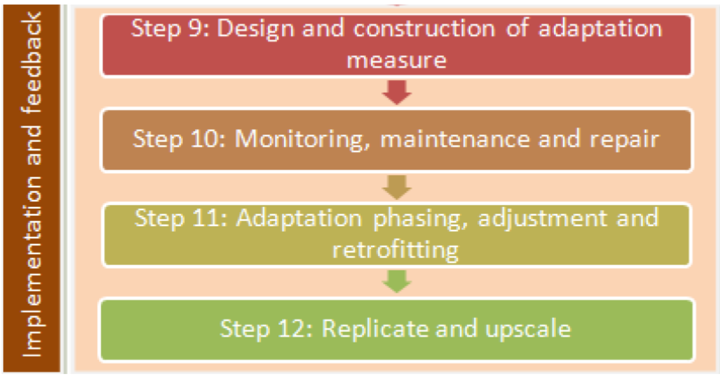
Indications of the likelihood of the impact happening may be gauged, for example, from the increased frequency and intensity of extreme events as projected in the threat profiles.

Table 7-1: Significance of impact = Likelihood of impact happening x Seriousness of impact

		Seriousness of impact				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Likelihood of impact happening	**Very High**	Medium	Medium	High	Very High	Very High
	High	Low	Medium	Medium	High	Very High
	Medium	Low	Medium	Medium	High	Very High
	Low	Low	Low	Medium	Medium	High
	Very Low	Very Low	Low	Low	Medium	High

The seriousness of the impact of infrastructure failure, may include:

[3] In EIA terminology, measures taken to address environmental impacts are usually referred to as mitigation measures. In climate change terminology, mitigation refers to the measures taken to reduce greenhouse gases; adaptation refers to measures taken to make the project more resilient to the impacts of climate change.



- Numbers of people using that infrastructure asset or dependent upon it for their livelihoods
- Numbers of households downstream, or in the flood plain of the asset which would be at risk in the event of infrastructure failure
- Numbers and values of private property at risk
- Other public infrastructure assets at risk
- Secondary impacts if the service provided by that infrastructure asset is curtailed by the failure, e.g. road transport and connections to communities or markets, schools and hospitals

There are three disaster risk management measures that the agency responsible for the asset should consider:

1. **Adapt and protect** – this should be the first priority, but it may not be technically or economically feasible to do this, especially if the adaptation measures have to be retrofitted.
2. **"Fail safe" measures** – if the asset itself cannot be adapted, can the communities, their assets and other infrastructure that may be potentially affected in the event of failure be protected in some way so that when failure occurs, the risks of disaster are limited?
3. When it does fail, what are the **emergency or temporary measures** that need to be planned in order to reinstate the service provided by that asset until it can be rebuilt.

These options will require a step-wise process of assessing the specific risks of failure of the key strategic infrastructure.

The agencies should not be expected to develop full disaster response plans and implement them, since this is the mandate of other agencies. The primary focus of the infrastructure agencies should be upon prevention of failure of the asset, with the temporary and then permanent restoration of the services provided if the infrastructure fails. However, they should develop the sector specific plans with the agencies responsible for the major disaster response actions to ensure good coordination.

7.7 Monitoring and Evaluation

There are two aspects to climate resilience monitoring and evaluation of projects. The most relevant steps of the VA & AP Method for this is the third group of Implementation and monitoring of the projects. Monitoring and evaluation of climate change aspects of projects can be undertaken during both the construction and operation phases of the infrastructure.

During the **construction phase**, the monitoring should be for compliance with the climate-proofed design standards and building codes relevant to the infrastructure. This therefore depends upon the climate resilient design standards, and their incorporation into the "as built" designs.

During the **operational phase**, the climate-related M & E of the project should focus on the monitoring of effectiveness of climate adaptations asking the questions:

- How well is the infrastructure standing up to increased frequency and intensity of climate extremes?

- Have the changes in the design standards to ensure greater climate resilience been effective in protecting or climate proofing of the project?
- What have been the reasons for failure in infrastructure components as a result of climate extremes?

In the event of failure, a retrospective vulnerability assessment may be used to help identify the reasons for failure and for assessing what adaptation measures in rebuilding would be required to make the infrastructure more climate resilient.

The evaluation of the effectiveness of the climate adaptations should be collected systematically and fed-back into the review of design standards, and into future project design.

8 DRAFTING AND APPROVAL OF THE SAPA

The final sub-steps in the development of the SAPA are the drafting and approval of the SAPA. The SAPA is specific action plan tailored for the concerned sector. As with any plan it should provide the following details:

- SAPA objectives for the sector, with a long-term vision and short-term objectives to be achieved over the next three years
- A overview of the sector, its assets and projects
- An assessment of the overall vulnerability of the sector to climate change
- Development of the adaptation directions and options open to the sector.
- Policy reforms necessary to incorporate climate resilience into the existing and future infrastructure, including institutional structural changes
- Proposed activities for building climate resilience, based upon the entry points and tools in the infrastructure development cycle.
- Time scale and schedule for these activities over the next three years
- Resources – staff, equipment, support (e.g. in modelling) that may be required
- Capacity building required
- Budget allocation
- Monitoring and evaluation
- Revision – on a three yearly basis.

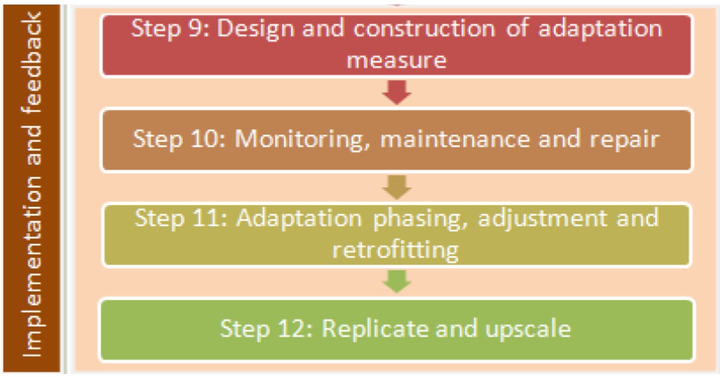
A suggested outline for a SAPA is included in Annex 1.

Approval of each sector's SAPA should be agreed by the agency concerned, in consultation with the National Planning Commission and MOSTE.

Step 3 Implementing the SAPA

9 IMPLEMENTATION

Once the agency or sector SAPA has been approved, implementation of its different provisions and entry points starts according to the action plan with its targets and milestones. Essentially the SAPA should be viewed as a comprehensive set of adaptation actions designed to improve the climate resilience of the sector and its infrastructure.



The steps identified in the implementation and feedback stage in the VA & AP method can apply to the whole SAPA.

10 MONITORING AND EVALUATION

Monitoring and evaluation of climate change and adaptation effectiveness are an essential part of the process. The M & E of the SAPA is different from that of the individual projects undertaken by the agency, though the findings from project related M & E feed into that of the SAPA.

In addition the findings of the SAPA monitoring feeds into the overall monitoring of climate changes and adaptation measures for the NAPA, e.g. as developed under Output 3 of the Mainstreaming climate change risk management in development project.

Monitoring of the SAPA should include:

- The main climate factors and occurrence of extreme events of relevance to the sector, and their distribution in Nepal
- The progress and achievements of implementation of SAPA activities
- Increase in climate resilience of the infrastructure
- The effectiveness of adaptation measures in responding to the changes.
- Incidence of climate related failure of the assets and analysis of the reasons.

11 REGULAR REVIEW AND REVISION OF SAPA

It is envisaged that the SAPAs may go through a review and revision process on a regular basis, e.g. every 3 years, and that they should feed into the NAPA revision process. Regular review is necessary because of changes in projections for climate change, experience in monitoring the performance of adaptations or analysis of failure of infrastructure.

ANNEX 1 – OUTLINE OF A SECTOR ADAPTATION PLAN OF ACTION

Policy statement concerning development and implementation of the SAPA

Executive summary

Chapter 1: Introduction to the Sector

- Objectives and mandate of the sector
- Infrastructure and services for which agency is responsible
- Policies and practices for infrastructure planning, construction, operation and maintenance
- Institutional structure with current responsibilities for environment, social issues and climate change, and disaster risk reduction

Chapter 2: SAPA Preparation process

- Agency working groups
- Coordination with other agencies
- Consultation with stakeholders
- Vulnerability and adaptation prioritisation

Chapter 3: Defining main climate change threats to the sector

- Climate threat profiles
- Geographic spread of the threats

Chapter 4: Vulnerabilities to climate change of infrastructure assets

- Main categories of infrastructure assets affected
- Zones of most threatened infrastructure assets
- Main nature of impacts on different categories

Chapter 5: Prioritising adaptation options

- Broad directions for adaptation adopted by sector
- Broad categories of adaptation measures
- Setting priorities for adaptation

Chapter 6: Prioritised actions for SAPA implementation

- Policy reform
- Institutional structure reform to include climate resilience
- Use of entry points and tools for mainstreaming climate resilience
- Capacity building requirements

Chapter 7: Action plan for SAPA implementation

- Activities to be undertaken with key section responsibility

- Milestones and targets with dates
- Monitoring requirements with indicators identified
- Budget allocation for SAPA implementation

ANNEX 2 - GUIDANCE ON CLIMATE RESILIENCE TOOLS FOR INFRASTRUCTURE

The following general guidance documents are proposed for ensuring climate resilience in different steps of infrastructure planning and training courses for the sectors are proposed for these

- **Climate Change vulnerability assessment and adaptation methodology for infrastructure in Nepal – A guide for infrastructure departments. MOSTE 2014**

This document has already been drafted and is a companion volume to this SAPA Guide.

- **Guidance on climate resilience tools in Spatial planning**
- **Guidance on climate resilience tools for Environmental Impact Assessment and Strategic Environmental Assessment**
- **Guidance on climate resilience tools in Monitoring and Evaluation of projects**