TA – 7984 NEP
September 2014

Mainstreaming Climate Change Risk Management in Development

1 Main Consultancy Package (44768-012)

RURAL ROAD SECTOR (DOLIDAR)
PANCHTHAR VULNERABILITY ASSESSMENT REPORT

Prepared by	ICEM – International Centre for Environmental Management METCON Consultants APTEC Consulting
Prepared for	Ministry of Science, Technology and Environment, Government of Nepal Environment Natural Resources and Agriculture Department, South Asia Department, Asian Development Bank
Version	A

TABLE OF CONTENTS

1 DISTRICT ASSETS/SYSTEM PRIORITIES

1.1 Briefing on Panchthar District

Overall View

Panchthar district is located in Mechi Zone of the Eastern Development Region of Nepal. It has borders with Taplejung to the North, India to the East, Ilam to the South and Tehrathum to the West. The total area of the district is 1,252 sq. km having different types of topography. The elevation of the district ranges from 1000 m to 4000 m. As a result of the elevation differences, the district has two different types of climate: sub-tropical from 1000-2000 m and temperate above 2000 m. The district is famous for tea and cardamom. The total population of the district is 240,818 of which 119,671 are male and 121,147 are female (source: Nepal Population Report 2011, Ministry of Health and population, GoN). The headquarter of the district is Phidim.

Major rivers in the district are; Hengwa, Nawa, Silsile, Marhang, Khaireni, Kabeli etc.

Rural Road Network

There are 14 rural roads (village and core network) with a total length of 579 kilometres in the district. Out of the total, only 236 km of roads are motorable (as per rural road data of DoLIDAR; FY 2009/10).

Panchthar District Technical Office (DTO) is the main implementing agencies of all type of rural infrastructure works. DTO is headed by a senior divisional engineer (SDE). The other staff in the DTO are: 1 Engineer, 4 Sub-engineers, 4 Assistant Sub-engineers 3 support staff.

District Transport Master Plan (DTMP) is the key tool for implementation of rural roads. Hence GoN has instructed to DDCs/DTOs of all 75 districts of the country for timely preparation/update of DTMP. The DDC/DTO has planned to complete the DTMP of Panchthar District within three months.

Climatological Record

The climatological record and monthly rainfall of the district is presented in Table 1 and 2.

Table 1: Climatological Record of Panchthar District

Location: Phidim; Latitude: 27^{o} 09' N; Longitude: 84^{o} 45E; Elevation: 1205 amsl (2008)

Air Temperature					Relative Humidity		Precipitation (mm)		No. of Rainy Days
Mean			Absolute Extreme		Observed at				
Max.	Min.	Daily	Max. & Date	Min. & Date	08:45 NST	17:45 NST	Total	Max. in 24 hrs. & Date	1:100
26.5	15.7	21.1	34.0/Jun.	4.9/Feb.	84	78	1438	73/July	129

Source: Department of Hydrology and Meteorology

Table 2: Monthly Rainfall of Panchthar District (mm) Location: Phidim

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0	0	41.1	29.4	179.6	142.3	219.5	312.3	34.6	71.7	0	0

Source: Department of Hydrology and Meteorology (2009)

11

1.2 Criteria for Identifying Priority Assets/Systems for the Vulnerability Assessment

In the road sectors (both DoR and DoLIDAR) it is considered that the primary assets or systems are the road links joining important centres of population or production; for example a feeder road joining a national highway to a district centre is considered as a system. The priority assets in that system are the parts or sections of the link which, if affected by an extreme weather event, would cause serious disruption to the movement of traffic on the link.

The key criteria for prioritisation include:

- Infrastructure of national strategic importance
- Infrastructure of district strategic importance
- Infrastructure that has been impacted by past extreme events
- Infrastructure located in areas prone to past extreme events

In each district the consultant in consultation with the division chief prepared final lists of the priority structures of the district. The list was prepared following the criteria provided in District Office Report.

1.3 Description of Priority System

In total three assets were covered in baseline report. Among them Shiwa Khola Bridge and Ithum-Tamakhe-Tribeni-Phidim village road are selected for vulnerability assessment and adaptation planning. Their location is shown in Fig.1.

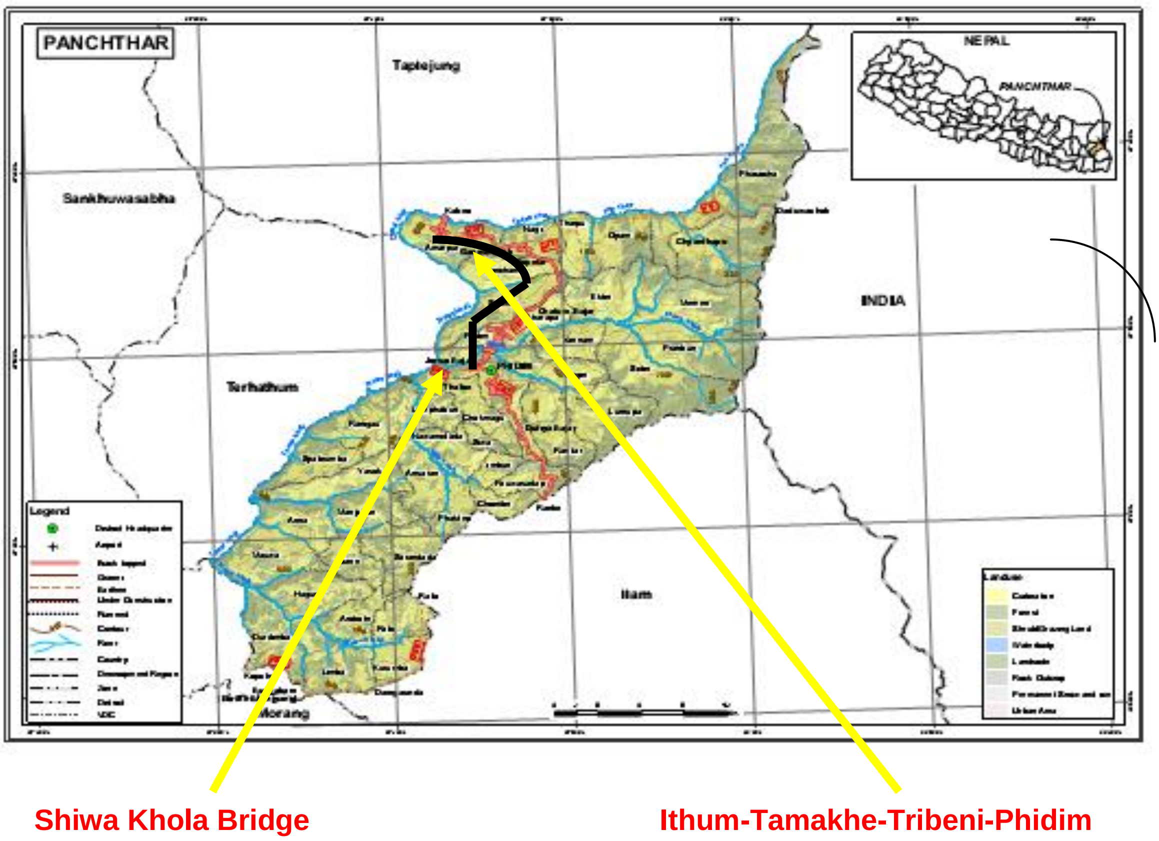

Fig. 1: District maps showing asset locations

Shiwa Khola Bridge

The bridge is located along Phidim-Ranigaun-Yachok Road. It is a single span bridge with a total of 25m. It is constructed on open foundation. The carriageway width and overall width of the bridge is 4.25m and 5m respectively. The whole bridge structure is constructed of RCC. Its construction was completed one year ago. The total cost of the bridge including approach roads and protection works is about 20 million rupees.

This asset is selected because (i) it is the first bridge implemented by DDC/DTO in the district and (ii) it is resilient to climate change effect.

Ithum-Tamakhe-Tribeni-Phidim

The road, which is in the form of earthen track, starts from Ithum, a small settlement along Mechi Highway, passes through Tamakhe and terminates at Phidim. The total length of the road is about 20km. The road was constructed by the local people about 7 years ago. There are very few structures on the road. Due to poor condition, very few vehicles ply on this road.

In 2009, there was a big landslide at km 16 (from Ithum). Although the local people cleared the landslide several times, it occurred time and again. The main reasons for the landslide are: (i) the slope is highly unstable (ii) land on the top of landslide is under cultivation and (iii) an irrigation canal is carried through the crest of landslide. The site condition shows that the landslides can be stabilized if a big retaining wall is provided at the valley side and the drainage of the landslide area (including relocation of irrigation canal) is properly managed. The cost of retaining wall and drainage management is estimated to be 1.5 – 2 million rupees.

Although the significance of this road is not high, it is selected to show the extent of vulnerability of village roads in Nepal. It is to be noted that several roads are constructed or are under construction with local participation. Traffic on such roads is very low; in majority cases not more than 20. Because of low traffic as well as lack of fund (for maintenance rehabilitation and upgrading) these roads become defunct after few years of their construction. In this case also, the road could not be made operable due to lack of 1.5-2 million rupees. As result substantial amount of money and local people's effort are wasted. This type of problem is common in all 75 districts. With climate change effect the scale of damage will be more and the number of such non-operational roads will substantially increase. Hence GoN/DDC should discourage construction of such roads and protect people's effort and properties.

2 VULNERABILITY ASSESSMENT METHOD

2.1 Summary of method/process

The VA of the assets is carried out following the procedure as outlined below:

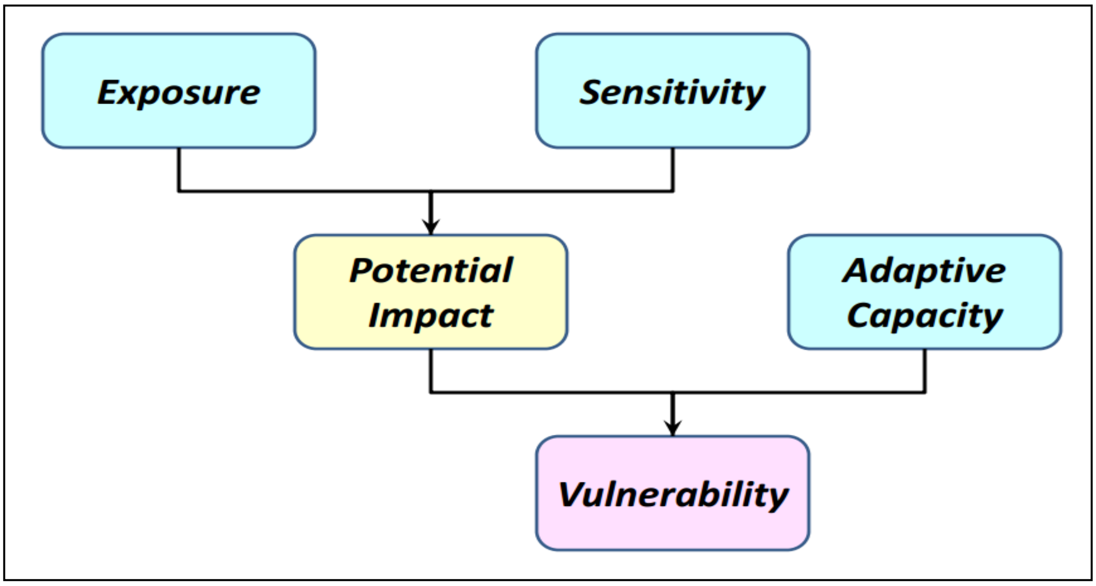

Fig 2: VA Process

There are two components in this phase

1. Assessing the impact of a climate threat on an asset and system; and
2. Defining the level of vulnerability of the asset and system to the projected threats.

Impact Assessment

The potential impact (or level of risk) is a function of the level of **exposure** to climate change induced threats and the **sensitivity** of the target asset or system to that exposure.

Exposure: exposure is the degree of climate stress on a particular asset. It is influenced by long-term changes in climate conditions and by changes in climate variability, including the magnitude and frequency of extreme events.

The following criteria influence exposure:

- Duration (e.g. hours or days of flooding)
- Location (e.g. distance from flood)
- Intensity (e.g. strength of rainfall, speed of flow)
- Magnitude (e.g. volume, flow or size of event)

Sensitivity: Sensitivity is the degree to which a system will be affected by, or be responsive to, climate change exposure.

The following variables affect infrastructure sensitivity:

i. Construction quality
ii. Levels of maintenance
iii. Protective system (e.g. river training wall to protect asset)
iv. Design (including safety margins)

A key tool in the process is the use of the **Climate Change Impacts Matrix** (Fig.3). The matrix is completed using descriptors for exposure and sensitivity, for example, 'very low' to 'very high'. If the exposure of a bridge to the threat of high flash floods is **High**(due to catchment area and topography) and its sensitivity to scour is **Very High** (due to soil type and foundation design) then the Matrix tells us that the **Impact** of the threat is **Very High**.

	Exposure of system to climate threat					
Sensitivity 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*

Fig.3: Impact Assessment Matrix

Vulnerability Assessment (VA)

A vulnerable system or asset is one that is sensitive to changes and extremes in climate and hydrology and one for which the ability to adapt is constrained. The vulnerability of an asset is therefore a function of the potential impact of changes in climate and the ability **(Adaptive Capacity)** of the responsible authority to respond to any possible impact.

The following variables affect the **adaptive capacity** of the responsible institution:

i. Institutional Strengths/Weaknesses
ii. Financial Resources
iii. Technical Capacity
iv. Ability to respond effectively to extreme events in the District

The Vulnerability of an asset is determined by applying the Impact value given by the Impacts matrix and the assessed value of adaptive capacity to the **Vulnerability Assessment Matrix** (Fig. 3).

This value of **Vulnerability** obtained (from Very High to Very Low) is then carried forward to the Adaptation Planning phase of the Climate Change Risk Management methodology.

		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
Adaptive Capacity	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

Fig 4: Vulnerability Assessment Matrix

2.1 Interpretation of the Climate Vulnerability Assessment Methodology Criteria for the Roads Sector

In the highways sectors there are two major elements which make up a road link:

1) Road Pavement & Side Drainage
2) Cross drainage structures

It is necessary to consider for both these elements their sensitivity and exposure to the various increased threats due to climate change.

Sensitivity

The following tables outline the sensitivity of the two road elements to various climate threats.

Table 3. Road pavement and side drains sensitivity to climate threats

CLIMATE THREAT	SENSITIVITY	IMPACT
Increased rainfall Increased intensity of rainfall	Depends on condition of existing pavement – a pavement in poor condition will have a High sensitivity	Damage to surface of pavement
Increased rainfall Increased intensity of rainfall	Side drains which are in good condition and well maintained will have a low sensitivity	Damage to side drains
Increased rainfall increases instability of hillside Increased intensity of rainfall increases instability of slope High flow in river scours base of hillside & causes landslide	A road across an hillside prone to landslides will have a Very High sensitivity A road above a river which is eroding the toe of the hillside will have a Very High Sensitivity	Landslide destroys road & side drains

Increased rainfall causes high monsoon flood Intense rainfall causes flash flood	A road constructed next to a river will have a Very High sensitivity	Road running along river valley damaged by adjacent river

Table 4. Cross road drainage sensitivity to climate threats

CLIMATE THREAT	SENSITIVITY	IMPACT
Increased rainfall causes riverine flooding	A road with adequate cross drainage structures for today's floods will have an increasing sensitivity as climate change takes effect	Road on embankment crossing flood plain washed out
Increased intensity of rainfall causes large flash flood	Design and condition of bridge foundations will cause sensitivity to vary from Medium to Very High	Bridge on river with small catchment area is damaged by flood
Increased intensity of rainfall increases size of flash flood	Design and condition of causeway slab and retaining walls will mean sensitivity will vary from Medium to Very High	Causeway for stream with small catchment area washed out by flood
Increased temperature variation from cold to hot season	The condition and design of the expansion joints & bearings will cause the sensitivity to vary from Low to High	Large Bridge over major river – damage to bearings & expansion joints
Increased rainfall causes high monsoon flood	The condition and design of the bridge piers and abutments will cause the sensitivity to vary from Low to Very High	Settlement or scour at pier or abutment

Exposure

The above tables illustrate examples of the sensitivity of various elements in the highway infrastructure to climate change. It shows that for both roads & bridges the major climate change threats are increased rainfall and intensity of rainfall which result in high monsoon floods, riverine floods and flash floods. For large bridges, very high temperature variations will be a threat to the viability of expansion joints and bearings.

The Climate Change Threat Profile for Panchthar District show that the flood magnitude will increase in the range of between 16-41 % in 2040 and 40-57 % in 2060 for different return periods.

The table below provides interpretation of exposure for different road and bridge assets to the climate threats identified for Panchthar district. This general interpretation can be used along with consideration of the relative magnitude of the climate change threat at the target system site to assess the exposure of the assets of the target system.

The highway infrastructure in Panchthar District will generally, depending also on upstream catchment area and topography, have a High or Very High Exposure to climate change.

Table 5. Interpretation of climate change threats and exposure for road and bridge assets

TYPE OF ASSET	CC THREAT	EFFECT OF THREAT	EXPOSURE
Large bridge on large river	Increase in max. temperature	Increase in expansion of deck – more stress on joints and bearings	Low to Medium
	Increase in wet season flow	Increased velocity of flow increases likelihood of scour to foundations	High to Very High
		Increased height of flood threatens stability of bridge deck and causes erosion of approach roads	Medium to Very High
		Increased sedimentation reducing clearance under bridge	Medium to Very High
Smaller bridge on smaller river	Increasing risk & severity of flash floods during wet season	Increased velocity of flow increases likelihood of scour to foundations	Medium to Very High
		Increased height of flood threatens stability of bridge deck and causes erosion of approach roads	Medium to Very High
Pipe culverts & causeways on roads crossing watershed	On hill roads - increasing risk & severity of flash floods during wet season	Increased velocity of flow threatens to wash out pipe/ causeway & headwalls	High to Very High
	On flood plain roads - increase in wet season flow	Increase volume of flow threatens to wash out pipe/ causeway & headwalls	High to Very High
Hill road crossing watershed on sloping ground	Increasing risk of landslides	Road blocked or totally destroyed	Medium to Very High
Hill road running along valley bottom adjacent to river	Increasing wet season flow	Road eroded by height & high velocity of flow	High to Very High
	Increasing risk & severity of flash floods		
	Increasing risk of landslides	Road destroyed as erosion to toe of hillside causes landslide	
Road crossing flood plain	Increasing wet season flow and water levels	Road overtopped by flood water and pavement/ embankment destroyed	Medium to Very High

Impact

The impact of an extreme weather event on an asset is a function of the Sensitivity and the Exposure and can be found by considering the Climate Change Impacts Matrix given in Fig. 2 and interpolating between the value of Sensitivity and the value of Exposure to give a value for Impact.

The value for Impact obtained by using the Impacts Matrix should be judged from a practical engineering point of view and if considered incorrect then the values used for Exposure and Sensitivity should be revisited. In particular, for road infrastructure, the value for sensitivity is very difficult to determine without carrying out detailed condition surveys for the particular asset under review. If sufficient design detail is unavailable, or the ground conditions difficult to judge, then an expert judgment of Sensitivity needs to be made and clear notes made justifying the decision.

Adaptive Capacity

Evaluating the Adaptive Capacity of DoLIDAR and DDC/DTO is not a simple task. Baseline assessments including consultations and site visits have shown that the DTO Panchthar which is responsible for rural roads and bridges in the district has the following capacities:

- Sufficient experience in rural road and trail bridge construction;
- Do not have sufficient experience in design of roads and bridges
- Insufficient technical manpower in comparison to the number of projects;
- Inadequate financial resources;
- Inadequate management system; and
- Not very prompt in responding to disasters.

However, the efficiency and technical capability of DTO has increased in the last few years after the involvement of big donors such ADB, WB, DfID etc in the rural transport sector.. Considering the above factors, it is deemed that the adaptive capacity of DoLIDAR/DDC/DTO as **'Medium'.**

Vulnerability Scoring: Based on the impact and adaptive capacity assessments, the vulnerability of the asset against the climate change threats is estimated using the guiding Vulnerability Assessment Matrix provided in Fig.3.

3 VULNERABILITY ASSESSMENT OF ASSETS

3.1 Asset Description

Shiwa Khola Bridge

Table 6: Salient Features of the Asset

Name of Bridge	Shiwa Khola
Design parameters	No. of spans: 1; Total length: 25 m; Materials for superstructure, and abutments: RCC; Type of foundation: Open.
Name of the road	Phidim-Ranigaun-Yachok Road
Financed by	RRRSDP (ADB funded project)
Implementing agency	DDC/DTO, Panchthar
Location of Asset (Culvert)	About 5km from Phidim
Major components of the Asset	- Bridge - Bank protection walls - Approach roads
Existing Condition of different components	The condition of bridge, approach roads and bank protection walls is good.

Fig. 5a: Photo of the bridge from upstream. As seen on photo, the length of the bridge is almost equal to the waterway width and its vertical clearance is also sufficient.

Fig. 5b: Carriageway of the bridge. Its overall condition is good.

Fig. 5c: The structure is built at about 60 downstream of the confluence of Shiwa Khola and Nibu Khola. However, there is no threat to the bridge due to the confluence. The bank protection wall which is located at left side is damaged at few locations and requires repair works.

Fig. 5d: The locals are extracting riverbed materials (sand, gravels and stones) from immediate upstream of the bridge. There is very little threat to the structure due this activity at present. But if the activity continues for longer period the bridge will be damaged.

Ithum-Tamakhe-Tribeni-Phidim

The following table describes the important detail aspects of the asset

Table 7: Salient Features of the Asset

Name of the road	**Ithum-Tamakhe-Tribeni-Phidim**
Road category	Village orad
Type of problem	Traffic blocked due to landslides at km 16.
Financed by	Local community; some extent of technical and financial support was provided by DDC/DTO.
Implementing agency	Local community of the area from where the road passes
Major issue	Road is blocked for four years; landslide could not be stabilized due to fund crunch
Existing Condition of different components	The whole road section is in very poor. Very few structures (retaining and drainage) are provided. Similarly, the road is not maintained for several years. There are several road stretches where the vehicle cannot pass. The landslide is totally obstructing the vehicle movement.

Fig. 6a: Photo of landslide from opposite hill slope. The size of the landslide is 40m x 30m.The landslide can be stabilized with the combination of retaining walls, surface water management and bio –engineering. The total cost of such measure is estimated 1.5-2 million rupees.

Fig.6 b: View of landslide from the road. As seen on photo the road is totally washed away by landslide.

Fig. 6c: An irrigation canal is located just at the crest of the landslide. It is one of the main reasons of the landslide.

3.2 Climate Change Threat to Infrastructures in Panchthar District

The experts of the study team prepared climate threat profile of Panchthar District. The main findings of the threat profile are presented below. The threat profile is reproduced in Annex 1.

Threat due to Temperature Increase

As per the threat profiles, the average temperature increase in Panchthar District will be 1.7^0 by 2050.

Adverse effect on the road and bridge assets due to above temperature rise will be nominal.

Threat due to Precipitation and Flood Increase

The threat profile indicated the following change on rainfall and flood patterns:

(i) Increasing number of extreme rainfall events – events that now occur every 10 years are projected to occur every 2 years.

(ii) Increasing wet season flow of Tamor River– peak monthly average flow in wet season will increase by up to 170%.

The above findings show that there will substantial increase in frequency and magnitude of extreme discharge. Hence following aspects need serious consideration while designing road and bridge structures:

Design life: At present the important bridges are designed for 100 years return period and rural road bridges for 50 years return period. The drainage structures, in general are designed for 10, 20 or 25 years depending upon the importance of the roads. In order to accommodate the increased flood volumes, bridges as well as drainage structures should be designed for higher return periods. For example there will be a need to design important bridges for more than 200 years return period (instead of 100), rural road bridges for 100 years return period (instead of 50) and drainage structures for 50 years return period (instead of 25) to accommodate the increasing flood volumes.

Invert level of bridges/culverts: Due to increase in discharge, the high flood level (HFL) will increase. This will require increasing the invert level of bridges/culverts.

Foundation depth of bridges/culverts: The increased discharge will cause more scouring requiring more foundation depth.

Size of drainage structures: Sizes of both side drainage and cross drainage structures should be increased to accommodate increased flood volumes.

Road pavement: Roads lying in low land and adjacent to rivers will be highly affected by increased flood. The wetting of subgrade for longer duration will decrease its strength (CBR) requiring thicker road pavement.

3.3 Vulnerability Assessment Results

The tables below present the vulnerability assessment for the different components of the assets.

Table 8. Vulnerability assessment *of* Shiwa Khola Bridge

Climate change threats	Interpretation of threat	Exposure	Sensitivity	Impact Level	Impact Summary	Adaptive capacity	Vulnerability
Component 1: Superstructure							
• Increasing intensity and duration of rainfall • Increasing number of extreme rainfall events • Increasing in wet season flow.	The increased flood may overtop the bridge.	L[1]	L[2]	L	The superstructure will be washed away.	M[3]	M
Component 2: Abutments and foundation.							
• Increasing intensity and duration of rainfall • Increasing number of extreme rainfall events • Increasing in wet season flow	If the discharge increases, flood impact and scour depth will increase.	H[4]	L[5]	M	Damage to bridge due to impact and scouring effect.	M[3]	M
Component 3: Bank protection works							

• Increasing intensity and duration of rainfall • Increasing number of extreme rainfall events • Increasing in wet season flow	The gabion bank protection wall will be hit by increased flood.	H[6]	L[7]	M	Gabion walls will be damaged more frequently.	M[3]	M
Component 4: Approach roads							
• Increasing intensity and duration of rainfall • Increasing number of extreme rainfall events • Increasing in wet season flow	The flood may overtop the approach roads at both sides and damage them.	VL[8]	L[9]	L	The approach roads will be damaged.	M[3]	M

Notes:

1. *The probability of overtopping of the bridge superstructure with increase in wet season flow is low.*
2. *The vertical clearance is sufficient. Superstructure is made of RCC. It will not be easily washed away even if it is overtopped to some extent.*
3. *Refer to section 2.2.4.*
4. *The abutments and foundation are highly exposed to flood.*
5. *The sensitivity is low because: (i) the abutments are RCC and their condition is good; (ii) the foundation depth is more than 4 m which is sufficient at such small river and (iii) the traffic is not high.*
6. *The bank protection walls are regularly hit by the flood.*
7. *The loss of lives and properties will be nominal. Repair/rehabilitation cost will not be high.*
8. *Probability of overtopping the approach roads is very low.*
9. *The loss of lives and properties will be nominal. The road can be reopened with minimum cost.*

Note: The vulnerability of bridge, approach roads and bank protection works is low to medium. Its analysis is done to show an example of climate resilient structures (or how climate resilient structures should be built).

Table 9: Ithum-Tamakhe-Tribeni-Phidim

Climate change threats	Interpretation of threat	Exposure	Sensitivity	Impact Level	Impact Summary	Adaptive capacity	Vulnerability
Component 1: Hill slope							
• Increasing intensity and duration of rainfall; • Increasing number of extreme rainfall events; • Increasing slope erosion and landslides	Increase in rainfall intensity will accelerate the slope erosion and landslide events.	VH[1]	L[2]	M	The road will be closed more frequently. The rehabilitation cost will also increase.	M[3]	M

Notes:

1. *The hill slope is highly unstable. Its exposure to increase in intensity and duration of rainfall is very high.*
2. *Loss of lives and properties due to slope failure is nominal. The road has very little traffic*
3. *Refer to section 2.2.4.*

3.4 Asset Vulnerability Summary

Vulnerability summary of both the assets is provided in table 8 and 9.

Table 8. Summary of Vulnerability of Shiwa Khola Bridge

THREAT	IMPACT	EXPOSURE	SENSITIVITY	IMPACT	ADAPTIVE CAPACITY	VULN.	COMMENTS
The increased flood may overtop the bridge.	The superstructure will be washed away.	L	L	L	M	M	The vertical clearance is high. Probability of overtopping by increased flood volume is low.
Flood impact and scour depth will increase.	Damage to bridge due to impact and scouring effect.	H	L	M	M	M	The depth of foundation is sufficient and abutments are made of RCC. Hence the chances of bridge failure are low.
More impact to gabion walls by increased flood.	Gabion walls will be damaged more frequently	H	L	M	M	M	Damage to gabion walls due to increased flood will be high. The loss of lives and properties due to gabion collapse is minimal.
The flood may overtop the approach roads at both sides and damage them.	The approach roads will be damaged.	VL	L	L	M	M	The approach roads are located at higher elevation. They will be damaged in case of extreme flood only.

Table 9. Summary of Vulnerability of Ithum-Tamakhe-Tribeni-Phidim

THREAT	IMPACT	EXPOSURE	SENSITIVITY	IMPACT	ADAPTIVE CAPACITY	VULN.	COMMENTS
Increase in rainfall intensity/flood will accelerate the slope erosion and landslide events.	The road will be closed more frequently. The rehabilitation cost will also increase.	VH	L	M	M	M	The slope failure will be extensive. Its sensitivity is considered low because the traffic volume is very little. There will be minimal loss of lives and properties. .

ANNEX 1: KEY CLIMATE CHANGE THREATS OF PANCHTHAR DISTRICT

(Presented separately)