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DOLAKHA DISTRICT VULNERABILITY ASSESSMENT REPORT:

URBAN SETTLEMENTS AND INFRASTRUCTURE (USAI) SECTOR

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Version	B

TABLE OF CONTENTS

1 DISTRICT ASSETS/SYSTEM PRIORITIES

1.1 Urban Settlements and Infrastructure (USAI) in Dolakha District

The strategic urban infrastructure in Dolakha district, which are subjected to the climate change vulnerability assessment, consists of the following types of assets: district government office complexes, high density urban developments located in steep terrain, and river side market towns.

Strategic urban infrastructure are managed by authorities from local agencies such as the municipality; VDCs; district line agencies related to roads, water supply and sanitation; and the town development committees (TDCs). Assets in the urban sector are created through the annual DUDBC programs which are limited to building design and construction, shelter units for low income groups, and urban amenities such recreational parks, and bus parks etc. DUDBC is also responsible for implementation of the Bhimeswor Temple Master plan and management of infrastructure such as roads and drains in urban and village settlements.

The building sector includes the buildings for the various government offices, community buildings, town hall construction, and the rain water harvesting schemes being initiated in select government buildings and community schools at Bhimeswor Municipality. Building plans are specified in the annual program of the DUDBC division office. Urban land development programs are undertaken by the TDCs of Bhimeswor municipality and the Jiri market centre. The responsibility of the DUDBC division office is as member-secretary, providing office space to the TDCs.

The urban development programs are planned and executed within the planning framework of the district sector master plan. The master plan includes the following: Periodic Plan of Bhimeswor Municipality (2010-15); Physical Development Plan and Programs for small market towns – Jiri and Dolakha; special area development programs, and the DUDBC Kavre Division Office's annual programs for Dolakha District.

Urban infrastructures within the district are highly influenced by the following climate, hydrological and geographical conditions:

1) The topology of the district consisting of high Himal, high mountains, and Mid-Hills;

2) Major river systems (Tamakosi, Khimti, Charnawati, Khare Khola and Singati and Chanbiti Khola) with innumerable tributaries;

3) Climatic diversity ranging from warm to extremely cold temperatures depending on location in river basins, the Mid-Hills areas (up to 3,300 m), or in the high mountains (3,300 – 5,000 m);

4) A wide variety of housing densities and settlement patterns (agglomerated, compact, linear and dispersed settlements), depending of cultural and terrain conditions.

1.2 Selection of Priority Urban Assets / Infrastructure

1.2.1 Criteria for selecting priority assets

The established criteria for selecting priority urban sector assets include the following:

- 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.

Based on the preceding sets of criteria, two high priority assets were selected out of 5 short-listed assets as identified in the Dolakha Baseline Report. The two high priority assets include the urban core of Charikot Town, and the Singati Riverside Settlement. These two assets are subjected to the vulnerability assessment analyses. After the vulnerabilities for each asset has been determined, the next step will be for the assets to undergo a planning filtering process to determine priorities for climate change adaptation in Dolakha District.

A brief overview of the two high priority assets and components are described as follows.

Figure 1.1: Location of the assets in Dolakha District

1.2.2 The central urban core of Charikot town

The asset is the central urban core of Charikot town built around the central square named 'Sat Dobato' where 7 roads converge. The asset is located in Ward 1 of Bhimeswor Municipality. The total area is 395 ha, with a total population of 2,724 in 2007. The area is characterized by mixed land uses with predominantly residential and commercial activities. The urban core has a dense cluster of buildings. The ground slopes ranges from 20 to 50

degrees. A majority of buildings are RCC frame structure with multi-storied construction. The building materials are generally bricks imported from Bhaktapur. Other construction materials consist of locally available stones, slate; doors and windows made out of soft woods are abundantly available in the community forests within the district. Fire was recorded as a past event on June 4, 2012 with one house completely destroyed affecting one family. Landslides remain a serious physical hazard in the area. The whole township was haphazardly developed without proper planning, zoning regulations and proper building by-laws. There has been little compliance with the building codes applicable to hilly topography. Buildings constructed on steep slopes with questionable building standards can reduce the disaster resilience of the asset in terms of climate change.

Figure 1.2: Central Square – 'Sat dobato' at Charikot

Figure 1.3: Buildings constructed on steep slopes

Figure 1.4: Poorly constructed commercial / residential buildings located near vertical slope

1.2.3 Singati riverside settlement

Singati market settlement is located at 39 km from Charikot town towards the north, and lies at the confluence of Singati river and Tamakoshi river. The market town consists of a growing cluster of houses along the highway and two bridges. The settlement consists of both the old market or traditional 'Bazar', and the new surrounding settlements.

Singati houses feature traditional building construction technology with a predominant use of wood and mud bricks with increased application of CGI roofing. Nayapul settlement consists of semi permanent buildings with extensive use of wood and CGI roofing. Flood, landslide, fire and thunderbolts are the major events encountered in the past in the area. Particularly, the settlements along the Tamakoshi River are very vulnerable to flood and landslides. Singati experienced heavy rainfall and destructive landslides in mid September, 1985. Thirty six persons died in landslides, and 6 persons were swept away by flood waters.

The buildings at both the settlements need improvement in terms of design, and innovative application of local materials and technology that can withstand future disaster events. Extensive application of the national building code is warranted for buildings constructed at Singati.

Figure 1.5: Confluence of Singati river and Tamakoshi river

Figure 1.6: Cluster of houses with river training works

Figure 1.7: Traditional Singati houses

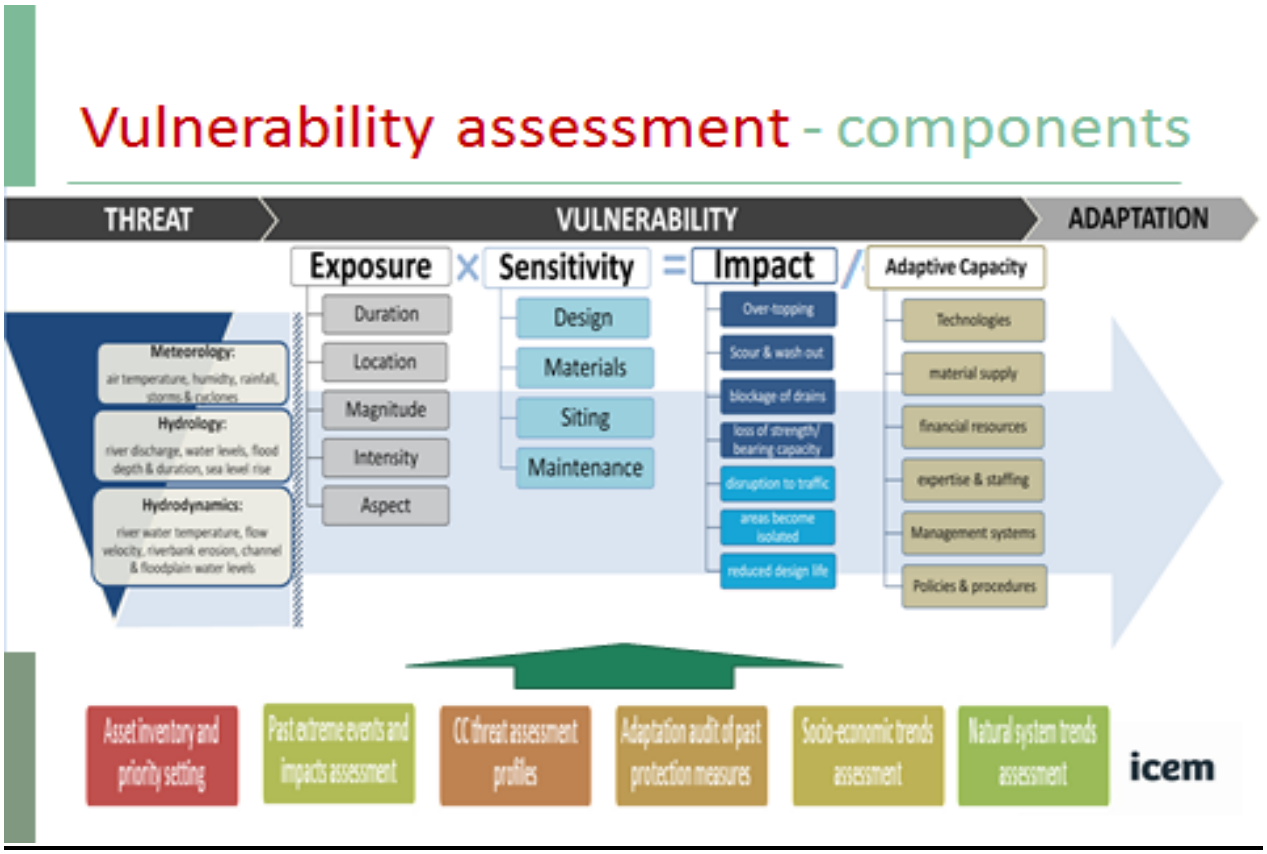
Figure 1.7: New development at Singati

2 VULNERABILITY ASSESSMENT (VA) METHOD

2.1 VA Method

The overall VA method used to assess the vulnerability of urban settlements and infrastructure (USAI) assets is outlined in Figure 2-1. Information for conducting the VA was obtained from the Dolakha District Baseline Report. The components of the baseline report as shown in the bottom part of Figure 2-1.

Figure 2-1: VA Process



For each of the high priority urban infrastructure assets identified in Dolakha, the projected district climate change threats were analyzed with regards to how each asset would be **exposed** to the climate threat as well as the **sensitivity** of the asset to the threat. After an assessment of the exposure and sensitivity of each asset to the projected climate change threats, a relative ranking of **impact** was determined through a standard evaluation matrix based on selected criteria for exposure and sensitivity. The two high priority infrastructure assets were selected because of their high impact rankings. To arrive at an assessment of the vulnerability of each asset to climate change threats, the **adaptive capacity** of each asset was evaluated in order to determine the degree of **vulnerability** to climate change. Again vulnerabilities of the assets were ranked according to an evaluation matrix with specified criteria for adaptive capacity.

The criteria used for determining impacts and vulnerability for the assets are further explained in the next section.

2.2 Criteria for VA Method applied to urban sector

The criteria used for determining risk and vulnerability for the high priority urban assets are (1) Exposure, (2) Sensitivity, and (3) Adaptive Capacity. These criteria are further explained in the Dolakha District context as follows.

Exposure with regards to climate change projections and threats is described by the following criteria:

- Duration of climate change event in terms of hours or days,
- Location with respect to the climate change threat,
- Intensity and volume of the climate change event, and
- Orientation of the asset with respect to a climate change event.

In Dolakha District, the priority urban infrastructure assets are mainly exposed to climate change events through location since the assets are either located on hilly terrain subject to landslides or near rivers that are vulnerable to flooding and flash flooding.

Sensitivity criteria for the assets with regards to climate change threats consist of the following:

- Quality of construction materials and construction technology,
- Levels of asset maintenance,
- Availability of protection systems, and
- Design.

The priority assets in Dolakha District were sensitive to climate change threats because of poor construction design, quality of materials and construction techniques. In addition, the provisions of the National Building Code were not followed or monitored in most cases. For riverside settlements, protective systems such as dykes or gabion walls were either not in place or ineffective.

Adaptive Capacity refers to the ability of Dolakha institutions and communities to cope with climate change threats and natural disaster events. Adaptive Capacity criteria are listed as follows:

- Cross cutting factors such as availability of financial resources; availability of skills, knowledge and management systems to respond to climate change; and political commitment
- Availability of construction and repair resources, and access to adaptation technologies
- Social factors such as community networks, knowledge and skills to adapt to climate change and access to insurance
- Availability and diversity of natural eco-systems to cope with and help alleviate climate change events.

The Adaptation Capacity in Dolakha District is rated as low since there is limited institutional capacity and financial resources in place to adequately respond to climate change.

2.3 Climate Change Threat Profiles

The climate change threat profiles for Dolakha District were prepared by a hydrological and climate modeling team. The climate change threat profiles were analyzed and the potential impacts on assets in the urban sector are outlined as follows.

2.3.1 Increase in temperature

From a downscaling of climate change projections to the Dolakha District level, the following conclusions are drawn:

- District increase in average maximum temperature of up to 1.85^{o}C,
- Higher temperatures occur more frequently and the duration of high temperature periods will be longer, and
- Percentage increases in daily maximum temperature by year 2050 are predicted as follows for these specific locations: Dolakha District (2 to 3.5^{o}C); Charikot town (2.4 to 2.6^{o}C); Singati area (3.0 to 3.2^{o}C).

2.3.2 Change in precipitation

The climate change threat profile for precipitation indicates the following:

(A) <u>Intensity duration frequency of rainfall</u>

- In Charikot, the historical one hour rainfall event that occurs about every 5 years is about 30 mm/hr; the 5 year event for a rainfall of one hour will increase to around 57 mm/hr in 2050.
- Similarly in Charikot, the historical one hour rainfall event that occurs about every 50 years is 55 mm/hr; the 50 year event will increase to about 95 mm/hr in 2050.
- The intensity of extreme rainfall events will increase in the future. For example, a 50 mm/hr rainfall event that occurs every two years has duration of 12 minutes; in the future (2050), the two year event with a duration of 12 minutes will increase to 100 mm/hr.
- On an average, the rainfall intensities will increase by about 76 % in the district.

(B) <u>Rainfall return periods</u>

By 2050, it is projected that extreme rainfall events in the district will reoccur more frequently. Rainfall events that historically used to occur about every 50 years will by 2050 occur about every 15 years. More specifically in Charikot, the 10 year rainfall event which historically was 160 mm, will occur about every 5 years; and by 2050 the 10 year rainfall event will increase to about 190 mm, indicated an increase of about 19%.

The above findings indicate that an increased frequency and volume of rainfall events which are projected in the future will most likely trigger more landslides and flood events, adversely affecting urban settlements and infrastructure in the district.

2.2.3 Increase in flows

Since the Singati riverside settlement asset is situated at the confluence of Singati and Tamakoshi rivers, the asset will likely be impacted by climate change due to increasing river flows resulting from more intense rainfall events during the wet season. Hydrological forecasts have predicted the following changes in river flow:

- Average wet season flow in the Tamakoshi river during the months of June/July could increase up to 35%.
- Maximum water level and average water levels in the Tamakoshi river could increase by up to 1.2 m and 0.7 m, respectively.
- Frequency of the Tamakoshi river high discharge return periods is projected to increase considerably. For example, the 10 year historic discharge of 1,800 m^3/sec is forecast to occur every 4 years by 2050, and the 10 year discharge is expected to increase by about 30% by the year 2050. Similarly, the 30 year discharge of 2,250 m^3/sec could occur every 6 years by 2050, and would increase by about 29% within the same return discharge period.

2.3.4 Landslides

Due to increasing rainfall amounts and rainfall intensities during the wet season, it is likely that there will be significantly higher risks of landslides within the district by 2050.

3 VULNERABILITY ASSESSMENT RESULTS

The detailed results of the vulnerability assessment are outlined in matrix format in Annex 1. A descriptive vulnerability assessment of two assets within Dolakha District is provided in this section.

3.1 Urban Core of Charikot Town Vulnerability Assessment

The VA matrix (Annex 1.1) takes into consideration both the aspects - Change and shift in regular climate and events – for vulnerability assessment of the asset. The following section explains the rationale and decisions made in setting in interpreting climate change threats, exposure to the threats, sensitivity to the threats, and adaptive capacity for the urban core of Charikot Town.

Climate Change Threat: Increased Intensity and Duration of Rainfall and increasing risk of landslides

The following climate change threats have been identified as likely to impact the building clusters within the urban core:

- Average rainfall intensities will increase by 76% by 2050,
- Projected increases in the number of extreme rainfall events,
- Increased risk of localized landslides; building structures and related infrastructure components –road, drains, and water supply and sanitation installations may be at risk.

Exposure: HIGH

The exposure was ranked as high for the following reasons:

- Location: Most of the urban core is located along hill ridges characterized by steep slopes near historic landslide areas, and the urban core is also near a high intensity rainfall zone.
- Duration: Longer duration rainfall events are projected to occur more frequently within the asset area.
- Intensity: High intensity rainfalls are projected to occur more frequently.
- Aspect: Unstable steep slopes coupled with rainfall increases may result in more landslides.

Sensitivity: HIGH

The sensitivity of the asset was ranked as high for the following reasons:

- Poor quality of design and construction of mixed uses buildings (commercial and residential) with little compliance to the Nepal Building Code; and conditions of the buildings very critical at certain locations.
- High landslide potential observed towards the southern part of the town, and inadequate stone retention walls constructed as an adaptation measure.
- Storm drains are not properly designed and constructed within the asset site. The conditions of the road network need improvement to withstand the intense rainfall conditions.

Impact: HIGH

From the guiding matrix, it can be concluded that the impact is HIGH as well. The justification for high climate change impact is as follows:

- Flood waters would cause damage to the buildings, drainage and other urban structures.
- Damage to the urban core would impede services delivery resulting in economic losses and disruption of livelihood opportunities.
- Landslide prone building structures could face the risk of collapse exacerbated with continuing construction activities going on in the area.
- Injury and Loss of lives, and damages to the property envisaged.

Adaptive Capacity: Low

The adaptive capacity to climate change events was ranked as low due to limited institutional capacity of the newly created Bhimeswor Municipality and of the district level government institutions with regards to dealing with the potential disaster events. The newly created Charikot Town Development Committee is so far ineffective.

Vulnerability Scoring: HIGH

As per the below guiding matrix, the vulnerability for the Charikot Urban Core is HIGH.

		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

3.2 The Singati Riverside Settlement Vulnerability Assessment

The detailed results of the Singati Riverside Settlement Vulnerability Assessment are shown in VA matrix (Annex 1.2). The following section further explains the process involved in interpreting the levels of projected climate change threats and subsequent evaluation of

exposure, sensitivity and adaptive capacity with respect to the climate change threats for the Singati Riverside Settlement.

Climate Change Threat: Increased intensity of rainfall and flood risk

Since the asset is situated at the confluence of Singati and Tamakoshi rivers, and due to increasing intensity and frequency of extreme rainfall events, the following climate change threats have been identified as likely to impact on the Singati settlement:

- Average rainfall intensities are projected to increase by 76% as well as an increase in the number of extreme rainfall events.
- Both rivers through Singati are projected to experience increased wet season flows as well as higher peak river water levels.
- Average wet season river flows during the months of June/July are projected to increase up to 35%.
- Maximum water level and average water levels in Tamakosi are projected to increase by up to 1.2 m and 0.7m, respectively.
- An increase in average maximum temperature in the Singati area from 3.0 to 3.2^{0}C.

Exposure: HIGH

The exposure of the asset with respect to project climate change threats was ranked as high for the following reasons:

- Location: The core town settlement is located near the confluence of 2 major rivers, and is also situated in an unstable landslide prone area and is near a high intensity rainfall zone.
- Duration: Longer duration rainfall events are projected to occur more frequently within the asset area.
- Intensity: High intensity rainfall events are projected to occur more frequently.
- Aspect: Steep slopes surrounding the settlement concentrate rainfall runoff which has resulted in past landslides.

Sensitivity: HIGH

The sensitivity of the asset was ranked as high for the following reasons:

- Poor quality of design, construction and maintenance of the river bank protection structures completed 12 years ago.
- Modern mixed uses RCC buildings (commercial and residential) with minimum compliance with the Nepal Building Code.
- Traditional buildings made of poor quality mud bricks and wood are vulnerable to water induced disaster events.
- Unplanned spontaneous growth of the settlements, coupled with limited area for expansion, has resulted in past flooding and landslides impacting the Singati market area.

Impact: HIGH

From the guiding matrix, it can be concluded that the impact of projected climate change threats is VERY HIGH. The justification for the high impact level is explained as follows:

- Previous extreme flooding and landslide events which occurred in 1982 and 1999 resulted in substantial loss of life and property; flooding and landslides also disrupted mobility of people and goods, therefore impeding of services delivery resulting in substantial economic loss and livelihood opportunities.
- The disruption of in delivery of goods and services could also result in substantial hardships to the people depending on trade from Singati market.
- Singati suffered from a multiple natural disaster events - extreme rainfall and landslides - in September, 1985. Intense rainfall lasted up to 9 days. Landslides temporarily blocked river flow, resulting in large containment of water which eventually was released and caused damaging flooding. Thirty six deaths were reported due to landslides, and 6 persons were swept away in river flood waters.
- Similar extreme flooding and landslide events, which could occur concurrently in the future, would most likely result in substantial loss of life and property.
- Localized landslides have occurred in the past, and could happen more frequently in the future as a result of project climate change threats.

Adaptive Capacity: low

The adaptive capacity was ranked as low due to the limited institutional capacity of the local institutional agencies (DDC and VDC) and other government agencies with regards to dealing with disaster events which have occurred in the past. Past adaptation attempts were weak due to limited access to technical and financial resources. A past adaptation response was to temporarily evacuate the town during an extreme flooding event.

Vulnerability Scoring: HIGH

As per the following guiding matrix, the vulnerability for the Singati riverside settlement is ranked as VERY HIGH.

		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)*	*Ve* *L liv system*
Adaptive Capacity	*Very Low* *Very limited institutional capacity and no access to technical or financial resources*	*Medium*	*Medium*	*High*	*Very High*	*Very High*
		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 DOLAKHA DISTRICT VULNERABILITY SUMMARY

4.1 Summary of VA Results

4.1.1 Urban Core of Charikot town

The following below summarizes the vulnerability assessment of the Charikot Urban Core. The analysis shows that the asset is vulnerable to both the intense rainfall and potential landslide events. The most vulnerable components of the urban system are the buildings located the steep slopes, and infrastructure such as roads, storm drains, and septic tanks. The analysis concludes that the Charikot urban system is ranked as highly vulnerable.

THREAT	EXPOSURE	SENSITIVITY	IMPACT	ADPTATIVE CAPACITY	VULNERABILITY SCORE
INCREASED RAIN FALL	HIGH	HIGH	HIGH	LOW	HIGH
LANDSLIDE RISKS	HIGH	HIGH	HIGH	LOW	HIGH

4.1.2 The Singati riverside settlement

The following table summarizes the vulnerability assessment of the Singati riverside settlement. The analysis shows that the asset is vulnerable to intense rainfall, flooding and localized landslide events. The most vulnerable components of the settlement are the shops and home located next to river banks, and infrastructure such as roads, storm drains, and the bridges. The analysis concludes that the Singati riverside settlement is ranked as highly vulnerable.

THREAT	EXPOSURE	SENSITIVITY	IMPACT	ADPTATIVE CAPACITY	VULNERABILITY SCORE
INCREASED RAIN FALL	VERY HIGH	VERY HIGH	VERY HIGH	LOW	VERY HIGH
RIVERINE FLOODING	VERY HIGH	VERY HIGH	VERY HIGH	LOW	VERY HIGH

4.2 Most Vulnerable Assets and Components

Based on the VA performed within Dolakha District, the following conclusions can be made on the assets and components:

4.2.1 Urban Core of Charikot Town

THREAT	DESCRIPTION	IMPACT	WHY IT IS VULNERABLE
Increased Rainfall Increase in landslides	On an average rainfall intensities will increase by 76% 10 year rainfall events exceeding 150 mm per hour will occur more frequently	Cause damage to the buildings, drainage and other urban structures Triggers more landslides	Disturbance to the livelihoods and mobility of people and goods Resulting economic loss and livelihood opportunities

4.2.2 The Singati riverside settlement

THREAT	DESCRIPTION	IMPACT	WHY IT IS VULNERABLE
Increased Rainfall and high flood events Increase in landslides	Increased wet season flows as well as the higher river water levels as a result of climate change	Heavy loss of lives and property in the past, similar and more severe natural disaster events are likely in the future	Disruption in mobility of people and goods Disruption of delivery of goods and services to the people in the hinterland Substantial economic loss and livelihood opportunities

4.3 Lessons Learned and Application to Other Sectors

- A large number of urban and rural settlements in the mid-hill regions of Nepal are and will be subjected to similar climate change threats. The same impacts, vulnerability and adaptation plans can be applied to wider range of urban and rural settlements located on hilly terrain and along river banks within the district.

- The adaptation measures identified can also be applied to other sectors such as water supply and sanitation (WATSAN). The urban sector adaptation measures can be applicable to WATSAN assets consisting of both water supply system and wastewater disposal systems. Majority of the water supply and sanitation assets are experiencing similar sort of exposure, sensitivity as a result of climate change threats, and the appropriate adaptive responses by local authorities is more or less the same. The problems associated with the operation, maintenance and frequent overflows of the septic tanks during and after intense precipitation events are common issues.

ANNEX 1

VA MATRICES

ANNEX 1.1

VA MATRIX OF URBAN CORE OF CHARIKOT TOWN

Threat	Interpretation of threat	Exposure	Sensitivity	Impact Level	Impact Summary	Adaptive capacity	Vulnerability
	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*	*refer to table*
Change and shift in regular climate							
Increase in precipitation	1.One hour event with a return period of 5 years will increase rainfall intensity by 26% by 2050. 2.50 year extreme rainfall (60 minutes event) events will in future occur every 5 years by 2050.	High[1]	Very High [2], [3], [4]	High[5]	▪ The overflow of water would cause damage to the buildings, drainage and other urban structures. ▪ Disturbance to the mobility of people and goods. ▪ Impeding of services delivery resulting economic loss and livelihood opportunities.	Low [6]	Very High

[1] High exposure because of the town's location along the ridges of the hills
[2] Location of the settlements along the topographical features characterised by the steep slopes
[3] Very poor quality of design and construction of the mixed uses buildings (commercial and residential) without any compliance to the Nepal building code in general, and conditions of the buildings very critical at certain locations
[4] Tendencies of landslide observed towards the southern belt of the town, and the stone retention walls being constructed as the adaptation measures
[5] High exposure because of the town's location along the ridges of the hills
[6] Limited institutional capacity of the newly created Bhimeswor Municipality and district level government institutions for dealing with the potential disaster events

	3.10 year event presently delivers 160 mm, and by 2050 will deliver 190 mm implying increase of 19%.						
Change and shift in events							
Landslides	4.Increasing risk of localized landslides 5.At present there is a medium risk of landslide. If the change in landslide risk is considered, by 2050 the risk of landslides will increase, but within the medium risk of landslide.				▪ The already landslide prone building structures would face the risk of collapse with more construction activities going on in the area. ▪ Injury and Loss of lives, and damages to the property envisaged. ▪ Economic loss in terms of disturbance on livelihood, and delivery of goods and services to the people in the hinterland.	Low [7]	Very High
					6.		

[7] Limited institutional capacity of the newly created Bhimeswor Municipality and district level government institutions for dealing with the potential disaster events

ANNEX 1.2

VA MATRIX OF SINGATI RIVERSIDE SETTLEMENT

Threat	Interpretation of threat	Exposure	Sensitivity	Impact Level	Impact Summary	Adaptive capacity	Vulnerability
Change and shift in regular climate							
Increase in precipitation and water flow.	Rainfall intensity average increase of 76%; 50 year extreme event will in future occur every 15 years. Wet season flow increase of 35%	Very high[1]	Very high[2]	Very high	▪ Extreme flooding and landslide events, which can occur concurrently, will result in substantial loss of life and property. ▪ Increased localized landslides	Low[3]	Very high
Change and shift in events							
Riverine flooding	• Wet season river water level increase 1.2m	Very high[1]	Very high[2]	Very high	▪ During extreme events, the market town will have to be evacuated disrupting trade impacting 40% of northern Dolakha district, including 21 VDCs.	Low[3]	

1. Located in confluence of 2 major rivers; located in unstable landslide prone area; previous extreme flooding and landslide events in 1982 / 1999, and also in September 1985 resulting in substantial loss of life (around 36 persons) and property; intense rainfall lasted up to 9 days. Landslides blocked river causing increased impact of flooding.

2. Minimum river bank protection in place; bank protection of poor quality, constructed 12 years ago; maintenance low.

3. Limited institutional capacity and access to technical / financial resources to adapt. Past adaptation has been to temporarily evacuate town during extreme events.