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Mustang Vulnerability Assessment Report-DWIDP

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Version A

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1 DISTRICT ASSETS/SYSTEM PRIORITIES

1.1 Mustang District DWIDP Infrastructure

DWIDP operates the protection works through several groups of activities and programs. The activities of DWIDP in the District mainly fall under the category "Water Induced Disaster Mitigation works" and "Disaster Prevention Program". This category includes emergency works, control works and long-term mitigation works to cope with floods, landslides and debris flows.

Even though Mustang District receive much less annual rainfall amount of only around 250 mm, the area is very vulnerable to climate threat The terrain of the District is very fragile. Even moderate intensity rainfall cause destructive debris flows along the tributaries of Kali Gandaki River. Such events were very common in recent years. The activities of DWIDP are focused on control of erosion on agricultural land along the wide valley of the Kaligandaki and Tukuche rivers and protection of settlement and infrastructure along the river banks.

Sub-Division Office No.2 at Pokhara of DWIDP has prepared socio-technical plans for water induced disaster prevention works for the Kali Gandaki river stretch within the Mustang District. According to these plans a total length of 850 m revetment and 14 spurs are proposed at different locations.

The protection structures of DWIDP in the district include revetments, spurs, studs, embankments built along various stretches of river systems and walls in areas prone to landslides. These structures are normally quantified through their length. Mustang district comes under Himalayan district for which annual budget of DWIDP activities is about 2.5 million NRs.

1.2 Vulnerability Assessments definitions

1.2.1 Identifying priority assets

Prioritization is key to a vulnerability assessment which is the process of identifying, quantifying, and prioritizing (or ranking) the vulnerabilities in a system. Vulnerability refers to the inability to withstand the effects of a hostile environment. The key criteria for prioritization of infrastructure include:

- Infrastructure of national strategic importance
- Infrastructure of district strategic importance
- Infrastructure that has been damaged by past extreme events
- Infrastructure located in the areas prone to past extreme events
- Infrastructure of importance to women (eg. Reduces workloads, increases mobility, supports women's livelihoods)
- Infrastructure of importance to poor or marginalized groups (eg. Dalit, Ethnic groups)

In addition the potential aspects contributing to vulnerability were considered. Climate change vulnerability in DWIDP asset is a function of system's exposure to climate effects, sensitivity to climate effects, and adaptive capacity. Exposure refers to whether the asset or system is located in an area experiencing direct impacts of climate change, such as temperature and precipitation changes, or indirect impacts, such as rise in flood levels. Sensitivity refers to how the asset or system faces when exposed to an impact. And adaptive capacity refers to the systems' ability to adjust to cope with existing climate variability or future climate impacts

Based on the above sets of criteria, two protection works sites has been selected as priority assets for VA assessment in Mustang District. The detailed information on each asset is outlined in the baseline report for Mustang district.

1.2.2 *Protection works along the Kali Gandaki river at Kagbeni and Tiri*

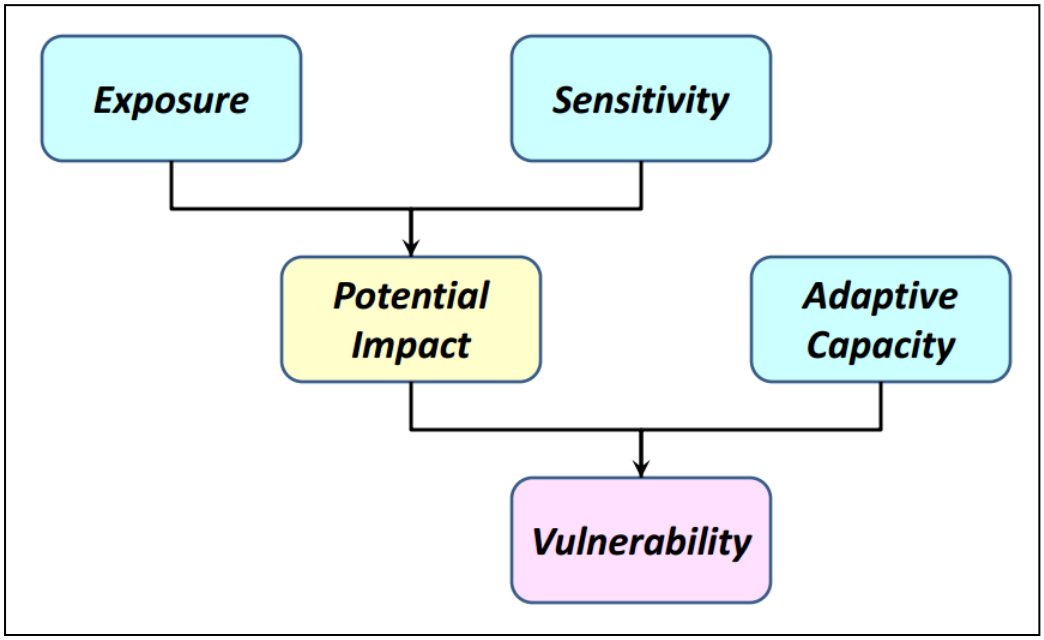
This site is located at the confluence of Kag Khola and the Kali Gandaki rivers. The site is an important destination for pilgrimage in Nepal to perform religious rituals. The Kagbeni settlement lies on the banks of Kag Khola. The Kali Gandaki and Kag Khola rivers constantly erode the banks threatening the collapse of settlements, Gumbas and the temple. The Sub-Division Office of DWIDP has implemented gabion revetments along the left bank of the Kag Khola to control such erosion.

2 VULNERABILITY ASSESSMENT METHOD

2.1 VA Method

The VA method followed to assess the vulnerability of hydraulic structures is widely used technique and tested in several parts of the world. Figure 2-1 outlines the process.

Figure 2-1: VA Process



Exposure refers to the extent to which an asset comes into contact with climate conditions or specific climate impacts. The greater the exposure, the higher the sensitivity to climate change. The exposure also takes in to account the critical aspects such as the location of asset, intensity and duration of the climate threat towards the asset and the magnitude of the event.

Sensitivity is the degree to which an asset is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., increases in flood water levels). If a system is likely to be affected as a result of projected climate change, it should be considered sensitive to climate change. It takes in to account the age of the asset, materials used in the construction and its quality, levels of maintenance, any design considerations that protects the asset from any extreme climatic events.

Impact: Once the exposure and sensitivity assessment are performed, based on the assessment the severity of the impact is estimated using the guiding matrix as shown below:

Figure 2-2: Determining Impact

		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*

Adaptive Capacity refers to the availability of a system to accommodate or cope with climate change impacts with minimal disruption. This takes into account the range of available adaptation technologies and the funds that are available to meet such technologies, locals skills and knowledge base, management responsiveness and relevant polices that make such adaptation to happen and the locally available materials to address such adaptation.

Vulnerability Scoring: Based on the impact and adaptive capacity assessments, the vulnerability of the asset against the CC threats is estimated using the guiding matrix as shown below:

Figure 2-3: Determining Vulnerability

		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

2.2 Suitability of VA Method to DWIDP

Vulnerability assessment is a tool for identifying potential risks to assets providing decision-makers with an early warning signal about the need to monitor potential variation over time. This is important in detecting threats early as well as formulating and implementing measures to reduce negative impacts. Vulnerability assessment will also identify gaps in existing information and the appropriate indicators and management measures required for the government to gather such information. Moreover, the assessment enhances public awareness about potential threats. The approach used for this vulnerability assessment is consistent with other methodological guidelines prepared by UNEP and Peking University (UNEP, 2009) as well as other international VA processes that are widely used in several projects across the globe.

The current vulnerability assessment process followed for DWIDP sectors is to better understand the existing status of protection measures and facilities in the surroundings under the prevailing conditions and to ascertain the most dominant factors that influence vulnerability. The current process helps the decision-makers with options to evaluate and modify existing policies and to implement measures to improve the design of counter measures. Specifically, the assessment is suitable and aims the DWIDP issues such as:

- Assess the vulnerability of existing protection measures against water induced hazards to CC threats, and its impact on development options, human well-being and the environment;
- Identify the potential impacts of climate change on infrastructures of DWIDP, and assess the current adaptive capacity of the sector;
- Create a knowledge base of scientific data and information on extreme weather events and responses by the catchments.
- Evaluate the impacts of environmental change in terms of landslides, debris flows and river morphology;

- Develop the knowledge, policy options; and
- Identify gaps in data and research and recommend needs for further studies.

2.3 Climate Change Threat Profiles

The climate change threat profiles for Dolakha District were prepared by the Hydrological Modeling teams. The threat profile is annexed in Annexure 1. The climate change threat profiles for Mustang District were studied and their relevance to the DWIDP sector is outlined below:

- ***Increasing number of extreme rainfall events*** *– events thatnow occur every 50 years are projected to occur every 2 years.*
- ***Increasing wet season flow on the Kali Gandaki River****–peak monthly average flow will increase by up to 257%*
- ***Increasing risk and severity of flash floods and increase flood duration during wet season***

3 VULNERABILITY ASSESSMENT RESULTS

The results of the vulnerability assessment are outlined in Annexure 2 of this report. However, a brief vulnerability assessment of one asset within Mustang District is outlined below.

3.1 Protection works along the Kali Gandaki river at Kagbeni and Tiri

Asset Description

This site is located at the confluence of Kag Khola and the Kali Gandaki rivers. The existing assets in the vicinity are illustrated in fig 3.1.1. The site is an important destination for pilgrimage in Nepal to perform religious rituals. The Kagbeni settlement lies on the banks of Kag Khola. The Kali Gandaki and Kag Khola rivers constantly erode the banks threatening the collapse of settlements, Gumbas and the temple . The Sub-Division Office of DWIDP has implemented gabion revetments along the left bank of the Kag Khola to control such erosion. The material and design of the structures are not resilient enough to counter the erosive power of Kag Khola which is steep and carries coarse sediment. As a result those revetments are already in the verge of collapse. Currently the District Development Committee (DDC) has been implementing RCC revetments starting from the right bank of Kag Khola near the junction to upstream of Kaligandaki river along the left bank to protect the settlements and Gumbas (see Figure 3.1.2).

Similarly, DWIDP implemented revetment and spur systems to protect valuable agricultural land along the left bank of the Kali Gandaki river downstream of confluence. The orientation, height and other structural elements are not functioning properly. As a result these structures have been damaged severely. A new additional length was provided to strengthen the collapsed one. That portion is again not keyed and oriented in such a way that if the flood level overtopped the crest, it directly hits the bank (Figures 3.1.1 & 3.1.3)

Fig 3.1.1 Bank Protection Works at Kag Beni

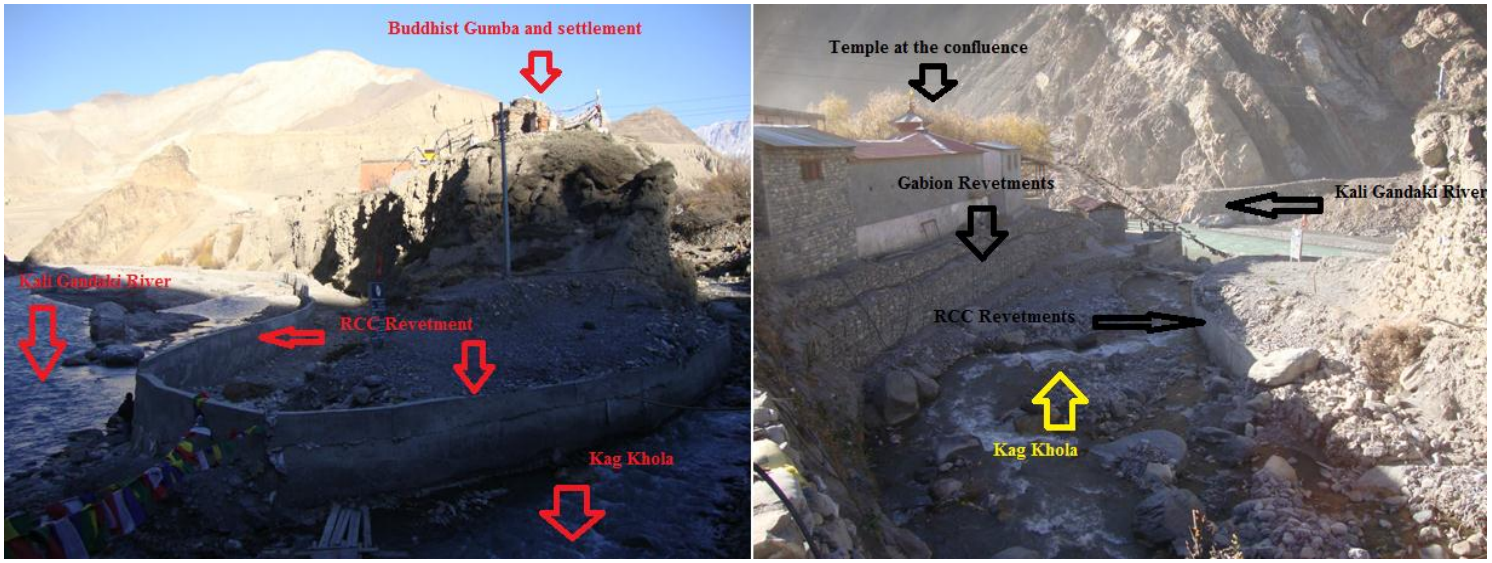


Fig. 3.1.2 Bank Protection works at the confluence of the Kag Khola and the Kali Gandaki rivers at Kagbeni.

Fig. 3.1.3 Bank protection works along left bank of the Kaligandaki river d/s of the junction

3.1.1 Vulnerability assessment

The following section outlines the decisions undertaken in setting the levels of threat, exposure, sensitivity and adaptive capacity for system.

Threat: Increased Intensity of Rainfall

The following threats have been identified as likely to impact on the system:

The river training works were installed by DDC and DWIDP. The protection works include an embankment, revetment, launching apron, studs and spurs. These protection works are aimed at the flood protection of adjoining agricultural lands, temples, Gumbas and settlements. In view of the threats imposed by CC the embankment plus other protection structures are threatened, resulting in collapse of the system or overtopping during high floods.

Exposure: VERY HIGH

The exposure was ranked as very high for the following reasons:

The site is an important destination for pilgrimage in Nepal to perform religious rituals. The Kagbeni settlement lies on the banks of Kag Khola. The Kali Gandaki and Kag Khola rivers constantly erode the banks threatening the collapse of settlements, Gumbas and the temple.

Sensitivity: HIGH

The sensitivity was ranked as high for the following reasons:

River protection measures are in place but the construction materials and design seem not appropriate for this site considering the destructive force of debris laden floods. All assets that have to be protected are located in the vicinity of highly erodible banks.

Impact: VERY HIGH

From the guiding matrix, it can be seen that the impact is VERY HIGH as well. The justification for high impact is:

Damage or destruction of protection works, irrigation system, roads, cultivated lands and settlement by floods laden with large amounts of sediments will have serious consequences for the livelihood of the local communities.

Adaptive Capacity: LOW

The adaptive capacity was ranked as LOW for the following reasons:

- Already DWIDP is putting in place protection measures and provides training to local officers to deal with the impacts of flash flood damage.
- Local materials are available for reconstruction and repair works but the budget for these activities is small.
- There is presently no affordable engineering solution.
- Available DWIDP staff and resources of the Sub-Division office responsible for this site are only minor considering that the Sub-Division office has to cover protection works in 4 districts

Vulnerability Scoring: VERY HIGH

As per the below guiding matrix, the vulnerability for the River Training Works is 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)	Very High Loss of life, livelihood or system integrity
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	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. Mustang District vulnerability summary

DWIDP implements the control works which are the its main assets to protect infrastructures like Airport, Roads, Bridges, irrigation systems, settlements, croplands etc from water induced hazards. Therefore most of those assets are located along the bank or across the river

river or at unstable slopes resulting in the very high exposure to climate threat. Apart from that the components of those control measures are highly sensitive to intensity of rainfall and resulting peak discharges of the river, stream or gullies as well as massive debris flows. In Mustang district the intensity of rainfall and peak flows in the rivers are likely to be increased. Even though Mustang District receive much less annual rainfall amount of only around 250 mm, the area is very vulnerable to climate threat The terrain of the District is very fragile. Even moderate intensity rainfall cause destructive debris flows along the tributaries of Kali Gandaki River. Such events were very common in recent years. Three days of incessant rain during June of 2013 has induced a huge debris flow event along the Marpha Khola River damaging road sections and valuable agricultural land. The same event also induced a serious debris flow along the Khahare Khola at Tiri village. This event damaged houses along the banks of the Khahare Khola.The district has been experiencing such changes in recent years. In addition following issues have compounded the vulnerability of the system to be very high:

- Gabion boxes filled with stones are the only units being used in most cases as counter measures against water induced disasters. DDC with the financial support from Embassy of India has been implementing RRC revetment walls along the bank of Kaligandi at Kagbeni recognising ineffective functioning of gabion wall alone.
- Gabion wires used are not strong enough to resist erosive power of large size sediment flow.
- During design and implementation of river training works there is no practice of integrated basin approach.
- There is no practice of monitoring and maintenance of assets.
- Also, there are no proper guidelines and norms for the design of the protection works.
- The prevailing degradation process demands intervention in the upland watershed, mainly land slide control works. This has not been taken into consideration.
- The gabion revetments and the spurs are designed using thumb rule estimates adopted for normal riverine condition.

Majority of the DWIDP assets are experiencing similar sort of exposure, sensitivity towards the CC threats and the adaptive capacity of the local authorities towards emergency management is more or less the same. Therefore this approach may be applied for vulnerability assessments of other assets too.