Feasibility Study for the Project ´Building a Resilient Churia Region in Nepal´ (BRCRN)

Accredited Entity: Food and Agriculture Organization of the United Nations[1]

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LIST OF ABBREVIATIONS

ACOFUN	Association of Collaborative Forest Users Nepal
ADS	Agriculture Development Strategy
AEPC	Alternative Energy Promotion Centre
BRCRN	Building a Resilient Churia Region in Nepal
CEDAW	Convention on the Elimination of all Forms of Discrimination Against Women
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CFM	Collaborative Forest Management
CFOP	Community Forest Operational Plan
CFUG	Community Forest User Groups
CKC	Churia Knowledge Center
CRA	Climate-Resilient Agriculture
CSO	Civil Society Organization
DGIS	Dutch Ministry of Foreign Affairs
DoF	Department of Forests
DRAP	District REDD+ Action Plan
DRR	Disaster Risk Reduction
DWIDM	Department of Water Induced Disaster Management
ER-PD	Emissions Reduction Program Document
ESA	Environmental and Social Assessment
ESMF	Environmental and Social Management Framework
EWS	Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FECOFUN	Federation of Community Forestry Users Nepal
FPIC	Free, Prior and Informed Consent
FRL	Forest Reference Level
GAP	Gender Action Plan
GCF	Green Climate Fund
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GHG	Greenhouse Gas
GIS	Geographic Information System
GLOF	Glacial Lake Outburst Floods

GoN	Government of Nepal
HDI	Human Development Index
HVAP	High Value Agricultural Product
ICS	Improved Cooking stove
ICIMOD	International Center for Integrated Mountain Development
IP	Indigenous Peoples
IPCC	Intergovernmental Panel on Climate Change
LAPA	Local Adaptation Plan of Action
LHF	Leasehold Forestry
LPG	Liquefied Petroleum Gas
LRAP	Local REDD+ Action Plan
LRP	Local Resource Persons
M&E	Monitoring and Evaluation
M4P	Market for Poor Approach
MAP	Medicinal and Aromatic Plants
MFI	Micro Finance Institutions
MIS	Management Information System
MoALMC	Ministry of Agriculture, Land Management and, Cooperatives
MoF	Ministry of Finance
MoFE	Ministry of Forests and Environment
MoEWRI	Ministry of Energy , Water Resources and Irrigation
MoSTE	Ministry of Science, Technology and Environment
MoWSS	Ministry of Water Supply and Sanitation
MRV	Measurement, Reporting and Verification
NADSIC	National ADS Implementation Committee
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NBI	Investment Board of Nepal
NBSAP	National Biodiversity Strategy and Action Plan
NDA	Nationally Designated Authority
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
NPD	National Project Director
NPR	Nepalese rupee
NPV	Net Present Value
NRM	Natural Resource Management

NSDRM	National Strategy for Disaster Risk Reduction Management
NTFP	Non-timber Forest Product
NTIS	Nepal Trade Integration Strategy
OWL	Other Wooded Land
PAM	Policies and Measures
PCU	Project Coordination Unit
PMSU	Project Management Support Unit
PPCR	Pilot Programme for Climate Resilience
PSC	Project Steering Committee
RISMFP	Raising Income of Small and Medium Farmers Project
REDD+	Reducing Emissions from Deforestation and Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests, Enhancement of Forest Carbon Stocks
RETs	Renewable Energy Technologies
SFM	Sustainable Forest Management
SME	Small and Medium-sized Enterprises
SNRM	Sustainable Natural Resource Management
SOPs	Standard Operating Procedures
ToT	Training of Trainers
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
VADEP	Value Chain Development Program
WOCAN	Women Organizing for Change in Agriculture and Natural Resource Management

1 INTRODUCTION AND OVERVIEW OF PROJECT RATIONALE

1. The Churia hills are located between the mid hill areas to the north and the plains in the south of Nepal (Terai), where the Churia hills perform critical ecological and socio-cultural functions both upstream and downstream (Figure 1). With more than 50% of its area under forests and riverine areas, the Churia hills render hydrological services such as regulating surface water flows and recharging groundwater. All major river systems in Nepal pass through the Churia hills before reaching the densely populated alluvial plains in the Terai and northern India.

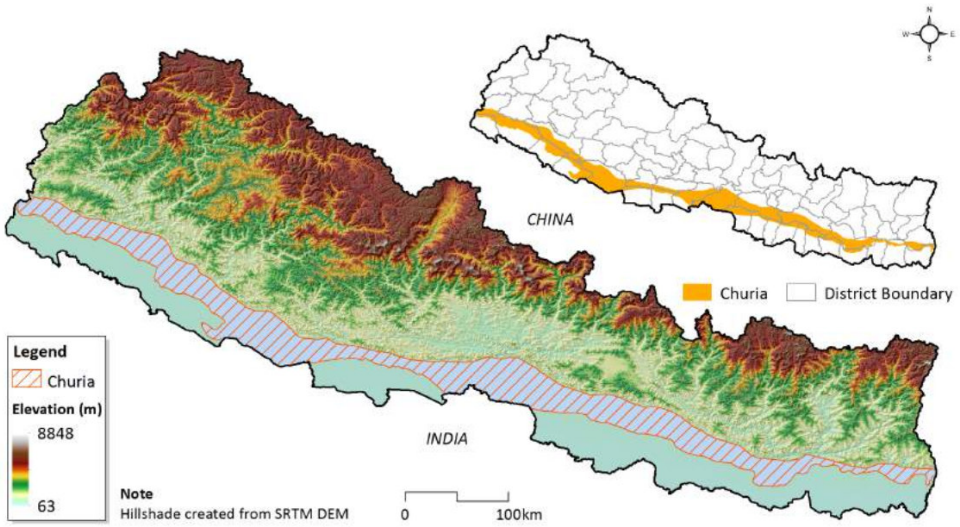

Figure 1: Location of the Churia (or Shivalik range) along the Himalayas and within Nepal

Source: Bharti et al. 2017; GoN 2014

2. Men and women living in the Churia are highly dependent on natural resources to maintain their livelihoods. Agriculture is the main form of employment in the region, with 60% of the economically active population involved in the sector. Forests are an essential resource and safety net for communities. In addition to providing key ecosystem and cultural services, forests provide diverse products including timber for construction, fuelwood, and other non-timber forest product (NTFPs) including plants for fodder, subsistence and medicinal plants. Thus, households in the Churia region are directly dependent on the health of Churia ecosystems to ensure their food, water and energy security.
3. The region is naturally in a more vulnerable situation, with friable soils, high vulnerability to flash flooding and frequently changing watercourses. Climate change coupled with unsustainable natural resource management (NRM) that lead to landslides, flooding and erosion, among other climate-induced natural disasters[2]as well as agricultural land use exacerbate

[2] Yohe et al. 2007

this vulnerability. A concerted and immediate response to the incremental risks posed by climate change is thus warranted.

The 'Building A Resilient Churia Region in Nepal' Project

4. Recognizing the scale and extent of this environmental degradation and the likely impacts due to climate change, the Government of Nepal (GoN) and FAO are proposing the project *´Building a Resilient Churia Region in Nepal´* (BRCRN) as a cross-cutting project to be submitted to the Green Climate Fund (GCF). GCF grant resources, together with government co-financing, will invest in climate-resilient land use planning, as well as the implementation of climate-relevant sustainable natural resource management (SNRM) and disaster risk reduction (DRR) measures in 26 river systems that are vulnerable to climate change.
5. This document comprises the Feasibility study of the project, describing the analysis conducted to assess the overall feasibility of the proposed project. It has been conducted based on feedback from the GCF and other stakeholders on the concept note submitted in February 2017, and is further informed by relevant literature, expert interviews and stakeholder consultations with over 420 men and women that were held from November 2017 until June 2018.[3]
6. The findings and recommendations from this study are reflected in the design of the full proposal to be submitted to the Green Climate Fund (GCF), as well as in other supporting documents such as the Gender Action Plan (GAP), Environmental and Social Management Framework (ESMF) and Indigenous Peoples Planning Framework (IPPF).
7. The assessment has been conducted within the framework of the submitted concept note and GCF comments, and is further informed by available data from studies conducted by the Government of Nepal, donor agencies, civil society organizations (CSOs) and other stakeholders. Various technical meetings and stakeholder consultations were held from June 2017 to March 2018 with diverse actors,[4] including communities, government officials, indigenous peoples and organizations, ethnic-minority organizations, women's associations and non-governmental organizations (NGOs), among others, to collect direct feedback on the current context and barriers, as well as the overall technical, political, institutional and financial feasibility of such measures. Feedback was further provided on the opportunities, challenges and barriers for the inclusion of such measures within the BRCRN project, and to clearly identify which measures will most effectively and efficiently promote a shift to low-emission development pathways and increase climate-resilient sustainable development.

[3] More detailed information can be found within the ESMF.

[4] The annex of the project´s Environmental and Social Management Framework (ESMF) contains a detailed list of the consultations conducted for the elaboration of the GCF proposal. It further includes meeting minutes and organizations consulted, along with other pertinent information. All meetings were conducted based on the principle of Free, Prior and Informed Consent (FPIC).

1.1 Problem statement and overview of project rationale

8. The following figure demonstrates the main changes in climatic variables, and the resulting primary and secondary impacts to which the proposed project will support the Churia region – and its inhabitants – to respond.

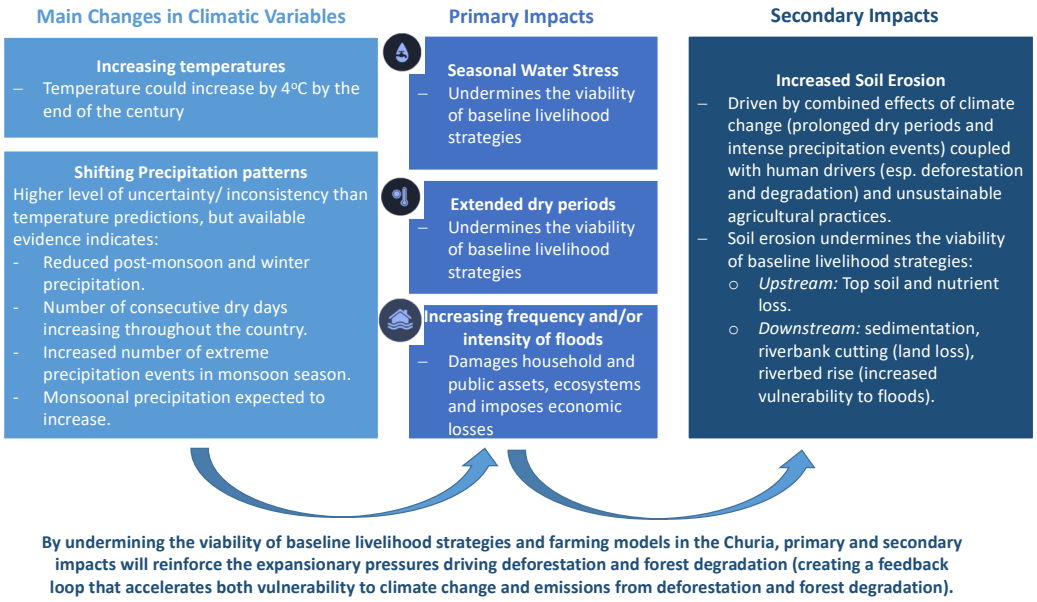

Figure 2. Overview of climate change projections and resulting primary and secondary impacts

9. Projected changes in climatic variables indicate an increase in temperature and shifting precipitation patterns.[5] Whilst there is greater variability with regards to projections of future precipitation patterns, studies indicate that precipitation may decline in the post-monsoon and winter season and that extreme precipitation events may increase in the monsoon season (see Section 2 for a more detailed description). As a result of these changes, it is expected that prolonged dry periods and seasonal water stress will become more common and pronounced, all of which will undermine local livelihood strategies. Increased frequency and intensity of floods is also expected, with the potential to damage public and household assets, negatively impact ecosystems and cause economic losses. Due to such trends and impacts, soil erosion will accelerate driven by climate change impacts (prolonged dry periods and intense precipitation) coupled with human drivers, especially deforestation and forest degradation and the use of unsustainable agriculture and other land use practices.

[5] ICIMOD 2015; ICIMOD 2009

10. The overall problem to be confronted, with a focus on the specific project area – the Eastern Churia Terai Madhesh Region – is illustrated in Figure 3. A landscape of four distinct physiographic zones is naturally exposed to climate-induced disasters causing cascading and interlinked impacts from the hills to the downstream areas. A set of triggering factors – on the one hand human caused underlying and direct drivers, on the other hand the negative impacts of climate change which will (inter alia) increase the frequency and intensity of damaging climatic events (e.g. water deficit) and climate-induced natural disasters (e.g. seasonal flooding) – will significantly undermine the viability of predominant livelihood strategies in the project area and result in widespread damages and losses, while also exacerbating existing vulnerabilities in the future and increasing emissions in the agriculture, forests and other land use (AFOLU) sector. **In other words, in an already-vulnerable region, climate risk and vulnerability are both increasing. This is expected to steadily undermine local livelihoods, which (in turn) is expected to further reinforce vulnerability in tandem with steadily increasing climate change impacts – a vicious cycle that must be broken.** Failure to do so could have severe medium/long term consequences for the Churia region and its inhabitants, as well as for downstream communities and broader food security in Nepal.

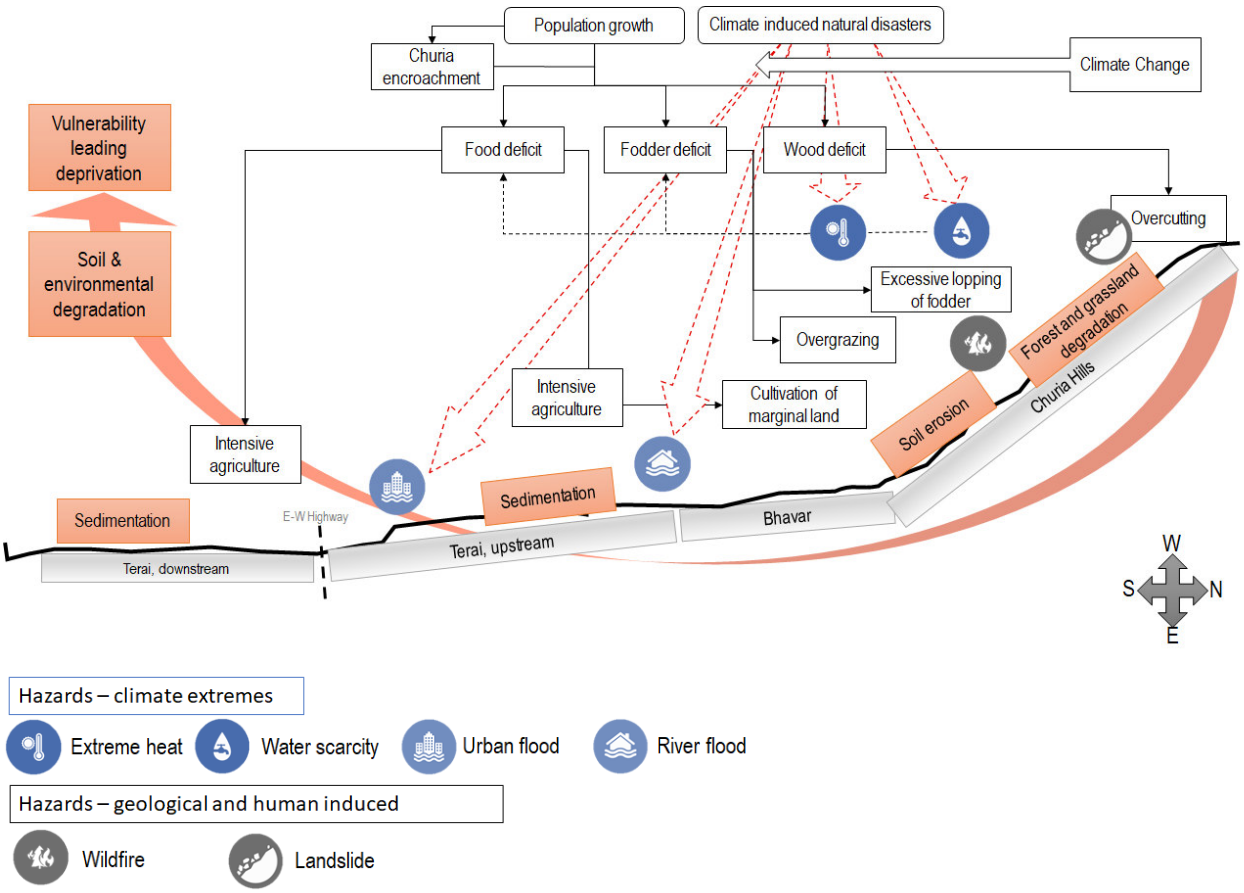

Figure 3: Overall illustration of the vulnerability of the project region with multiple climate and human induced disasters in view of climate change causing cascading impacts

Source: UNIQUE

11. While Nepal is only responsible for about 0.027% of global greenhouse gas emissions (30,011 $MtCO_2eq$ in 2008), the country has acknowledged its intention to support climate change mitigation in key sectors.[6] More than two thirds of the country's total emissions come from the agriculture, forestry and other land use (AFOLU) sector, with 52% coming from agriculture and 15% from land use change (mainly forest degradation and deforestation).[7]
12. Within the project area, deforestation and forest degradation have been increasing in recent years. Annual deforestation rates are estimated to be about 1.7% in the project area.[8] The main proximate drivers of deforestation and forest degradation are: over-harvesting of forest products (timber, fuelwood, fodder, NTFPs); uncontrolled livestock grazing; settlement establishment; encroachment; and illegal logging. More information on the proximate and indirect drivers of deforestation can be found in Appendix E of this feasibility study.[9]
13. In addition to increasing GHG emissions, deforestation and forest degradation are reinforcing the vulnerability of communities and ecosystems within the Churia-Terai Madhesh region to climate risk and climate-induced natural hazards:[10]
    - Exposed soils on slopes increase vulnerability to floods and landslides, especially in the hilly Churia region and to a lesser extent in lower flat regions (Bhavar and Terai). Increasing (monsoon) precipitation and extreme/ intense precipitation events – key climate change challenges that the Churia region must confront – will increase the risk and exposure to such events if appropriate adaptation measures are not adopted.
    - Increasing temperatures and prolonged dry periods as well as increasing (monsoon) precipitation contribute to soil erosion and soil degradation, especially in deforested and degraded areas. Wind and water erosion can directly remove or displace soil. Soil erosion further leads to soil degradation (loss of nutrients and soil organic matter) that can reduce agricultural productivity, causing shortened fallow periods and increased clearing of forested land. Increasing temperature and water deficits can cause cracks in the soil and reduce the volume of water that soils are able to withstand, reducing fertility. Areas in Nepal are already experiencing reduced soil moisture and accelerated soil loss due to a combination of changing climatic conditions and unsustainable anthropogenic activities.[11] The Koshi Basin in Nepal lost nearly 40 million tons of soil between 1990 and 2010, implying an average loss of 22 tons per ha per year.[12]
    - Erosion can also further change hydrological patterns, including limiting ground water recharge and contributing to increased water scarcity downstream.[13] Many households in the Terai are already exposed to seasonal water shortages given their reliance on seasonal precipitation. Climate change projections suggest that precipitation in the post-monsoon season and winter will likely decline, and that dry periods may increase. This

[6] MoPE 2016
[7] CIAT; World Bank; CCAFS and LI-BIRD 2017
[8] DFRS/FRA 2015; DFRS/FRA 2014
[9] UNREDD-2014
[10] GTZ 2004; MoFSC 2014; PCTMCDB 2017
[11] Dhakal et al. 2016 ; Selvaraju et al. 2014
[12] Uddin et al. 2016
[13] Neupane et al. 2015

would increase water scarcity for many Churia households, which in turn could have major impacts on local livelihoods, as well as food and water security.

- Sediment transfer contributes to river bank rise downstream, and has long-term implications. Nepal´s rivers already transfer huge amounts of sediment derived from natural and geological processes such as landslides and other mass movements and the erosion of riverbeds and banks. Rainfall events (particularly cloudbursts) accentuate these processes, thereby increasing regional sedimentation. Coarse sediment deposition is particularly intense at the base of hills, where river gradients decline dramatically as they enter the plains. In this zone, rivers shift their channels frequently.[14] Accelerated sedimentation due to climate change (e.g. increased extreme precipitation events) and anthropogenic impacts (deforestation, forest degradation, unsustainable agricultural practices) may increase the risk of flooding events downstream, with sedimentation causing the narrowing of channels, riverbank cutting and riverbed rise.

14. Commonly applied unsuitable agricultural practices increase the vulnerability of communities to climate change.[15] Many communities are dependent on rain-fed agriculture, yet have not adopted appropriate soil and water conservation practices into their agricultural systems that are capable of increasing water retention and reducing soil erosion and degradation. Agricultural activities in the Churia hills are often not well-adapted for the terrain, including activities on steep slopes and activities with exposed soils that in turn contribute to accelerated erosion and sedimentation. Surface soil erosion from primarily agricultural land is significant in Nepal and varies from 2t/ha/year to 105t/ha/year.[16]Traditional and commonly-applied animal husbandry practices are based on free-grazing systems that not only have low yields but contribute to increased forest degradation and soil erosion.[17]
15. Declining soil fertility has been reported in the region, attributed to:[18] soil erosion, organic matter depletion, acidification, forest degradation and cultivation on marginal land, and climate change, among other factors. Soil erosion and degradation due to the application of inappropriate practices can also contribute to deforestation due to low-productivity and the need for new agricultural areas to adjust to declining fallow-periods and increasing degradation.[19] They further contribute to emissions due to high losses of soil carbon, contributing to large proportion of GHG emissions in Nepal that come from the agricultural sector.
16. People living within the project area have relatively low-adaptive capacities and are highly dependent on forests and/or agriculture to maintain their livelihoods. Unsustainable land use practices exacerbate the vulnerability of local communities to climate-induced natural hazards, and ultimately climate change in the region. Given climate projections for Nepal, and specifically the Churia region, it is likely that the region will become increasingly exposed to extreme heat, intensifying seasonal water deficits, flooding and landslides, manifesting in

[14] Ibid.
[15] CIAT et al. 2015 ; Das and Bauer 2012;
[16] Acharya 2007
[17] Chaudhary et al. 2016 ; Poudel 2015 ; UN-REDD 2014
[18] Paudyal et al. 2015; Shrestha at al. 2013
[19] Chaudhary et al. 2016; UN REDD 2014

negative impacts for local communities and contributing to the further degradation and loss of key ecosystems and ecosystem services.

17. The **overarching vision of the proposed GCF project** is to enhance the climate resilience of ecosystems and vulnerable communities in the Churia region through integrated climate-resilient rural development and natural resource management approaches from upstream (in the hilly terrain) all the way downstream (to the upper Terai region). At the same time, the proposed interventions offer significant and cost-effective way to reduce GHG emissions, and create low carbon landscapes with climate-friendly land use systems. Figure 4 provides an overview of envisaged climate-resilient and low carbon land use in BRCRN project zones.

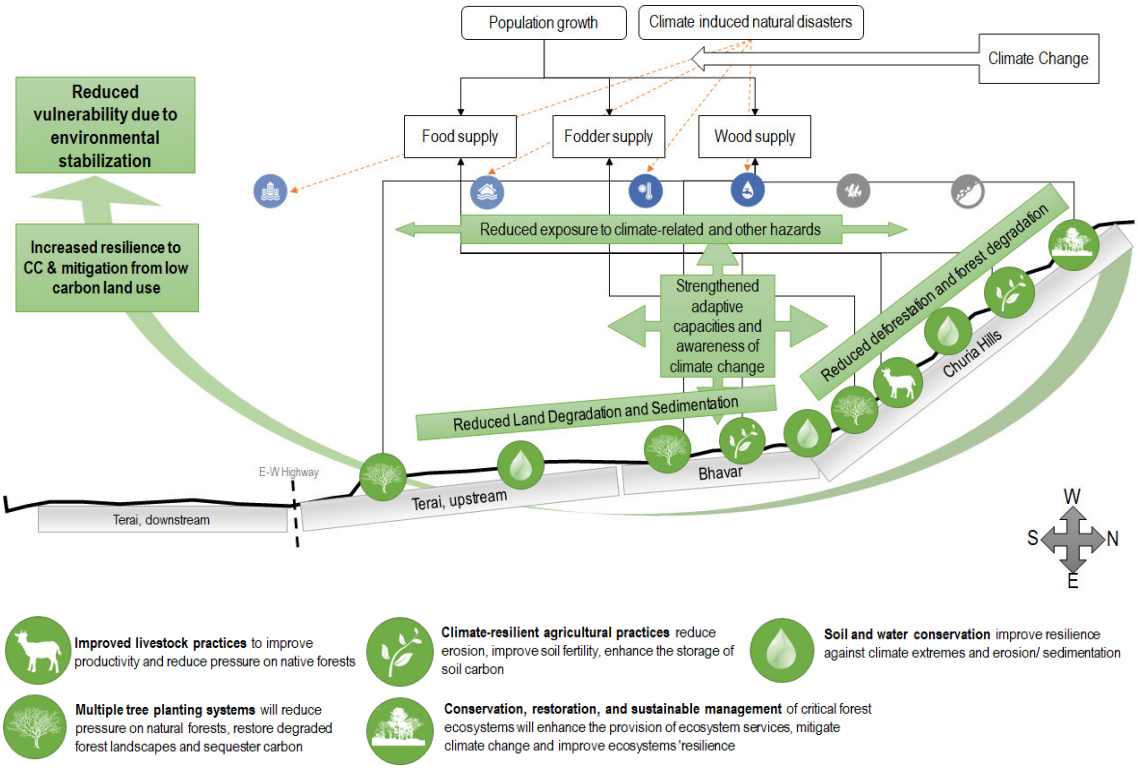

Figure 4: Overall illustration of proposed interventions to strengthen the resilience of the project region with multiple climate and human induced disasters in view of climate change causing cascading impacts

Source: UNIQUE

18. Moreover, due to its strategic location, the project will contribute to Nepal's broader ecological and socio-economic sustainability. Wedged between the high mountain areas (Mahabharat range) of the north and the plains of the south (Terai) as a continuous landscape, the Churia hills perform several critical social and ecological functions – all of which are currently threatened by climate change and other natural and anthropogenic factors. In terms of downstream linkages, with more than 50% of its area under forests and riverine areas, the Churia hills render hydrological services such as regulating surface water flows and recharg-

ing groundwater. They are the main source of water for more than 14 million people inhabiting the downstream Terai plains. Furthermore, with the clearance of the majority of forest areas in the Terai over the last century, the Churia hills are now the primary source of timber, fuelwood, fodder and other forest products for not only communities living in the Churia hills, but also for downstream communities in the Terai-Madhesh region. Together, the Terai and Churia comprise about 25% of Nepal's land area, but harbor close to 50% of its population.[20]

19. The project will deliver a complementary set of field-level investments and enabling environment interventions to improve the provision of ecosystem goods and services, thereby reducing the vulnerability of communities in the Churia to the impending impacts of climate change while reducing greenhouse gas emissions. It will ensure that appropriate measures are in place to reduce the impact of climate-induced disasters and post-disaster recovery. Interventions in climate-resilient agriculture and forestry as well as ecosystem restoration will be implemented to increase adaptive capacities of local people, and enhance the provision of ecosystem services within the context of climate change.
20. With regards to mitigation, the variety of identified project interventions contributes to the utilization of a low carbon land use approach on a landscape level with diverse mitigation impacts. The impacts related to mitigation are focusing on either maximizing carbon stocks or minimizing emissions from land use activities, in particular forests. This includes the reduction of deforestation and degradation within forests (REDD+ approach), as well as the active improvements of forest carbon stocks within degraded forests as a result of improved forest management planning and implementation. Outside existing forests, new commercial and riverbank protection plantations as well as horticulture and other multipurpose-use tree systems will lead to enhanced sequestration within the landscape. Furthermore, the improved management of livestock, in particular with regards to better grazing management and improved feeding systems, will reduce methane emissions.

[20] http://www.rccp.gov.np/

2 CLIMATE CHANGE AND IMPACTS IN NEPAL AND THE CHURIA REGION

2.1 Vulnerability of Nepal (overview)

21. Nepal is ranked as the world's 4th most vulnerable country to anthropogenic climate change.[21] Climate change is resulting in increasing temperatures, erratic and extreme rainfall patterns, and increased frequency of floods, landslides, and droughts that annually result in the massive loss of lives and properties.[22] The most profound impacts in Nepal will be on agriculture and food security, water resources, public health and energy.[23]
22. The Himalayas are among the world's most sensitive hotspots to global climate change, with impacts manifesting at a particularly rapid rate[24] – a situation that is predicted to intensify in the coming years, with dire and far-reaching impacts on food, water and energy security, as well as biodiversity and species loss.[25]
23. Precipitation has become increasingly unpredictable, while biodiversity depletion, deforestation, and increased frequency of extreme weather events have all impacted agricultural production. As the majority of Nepalese citizens engage in smallholder farming – a sector that is particularly susceptible to weather volatility – a substantial portion of the population will find itself directly affected by climate change. High levels of poverty will restrict the adaptive capacity of Nepali farmers.[26]
24. Nepal and the project region (shown in red in the Nepal map below – see Figure 5) has high combined vulnerability as well as high biodiversity vulnerability, water vulnerability, ecosystem vulnerability and human wellbeing vulnerability.[27]

[21] Maplecroft 2011
[22] ICIMOD 2015; FAO 2014; Karki et al. 2011; NAPA 2010; ICIMOD 2009; Dixit et al. 2008
[23] World Bank 2011; NAPA 2010
[24] ICIMOD 2015
[25] WWF 2017 available online: http://wwf.panda.org/what_we_do/where_we_work/eastern_himalaya/threats/climate/
[26] Synnott 2012
[27] ICIMOD 2009

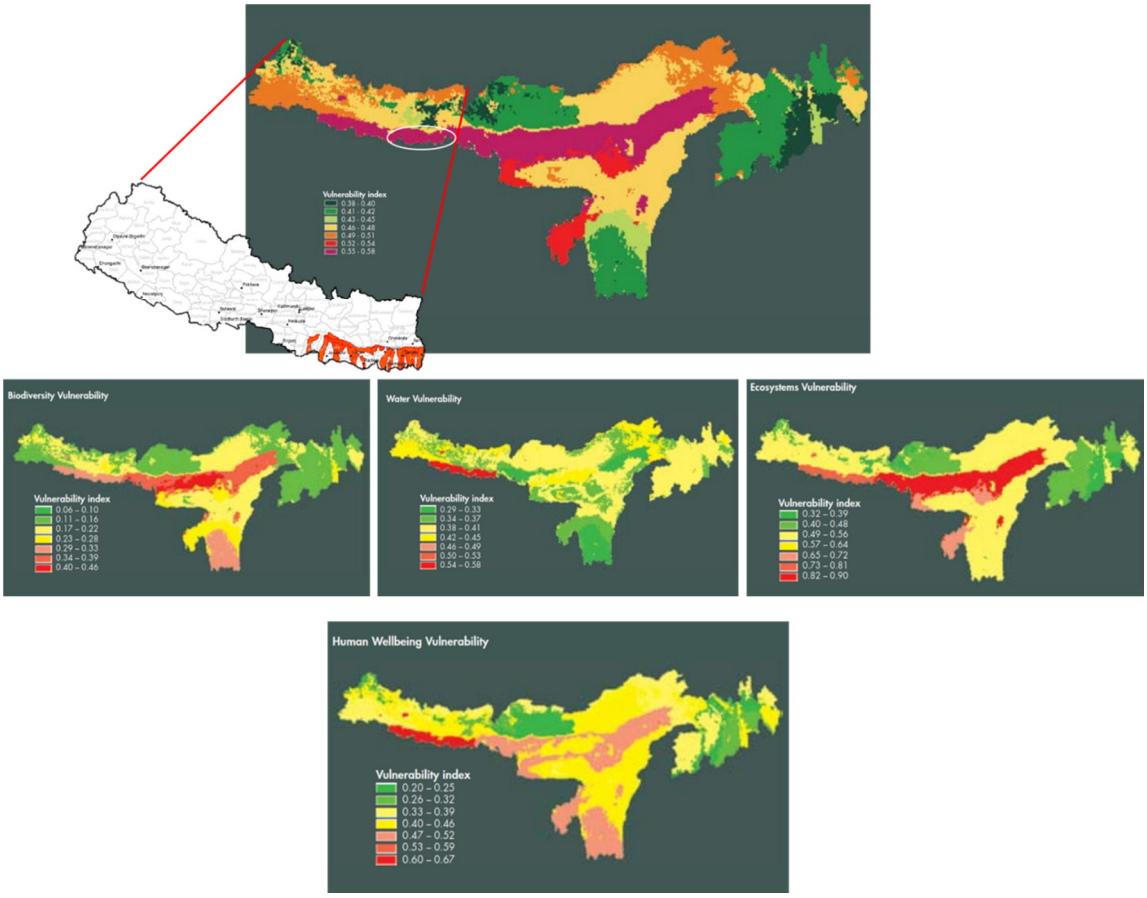

Figure 5: Collective vulnerability in the Eastern Himalayas, i.e., vulnerability integrated across different components of mountain ecosystems and dimensions and relative vulnerability of biodiversity, water, ecosystems, and human wellbeing to climate change impacts.[28]

Source: ICIMOD 2009

2.2 Climate context of Nepal and the Churia region

2.2.1 Overall climatology

25. Nepal lies in the central part of the Great Himalayas with high mountains, valleys and plains. Climatology of the Himalayan region is characterized by extreme diversity with some of the wettest areas on earth and a few extremely dry areas. Under the strong influence of monsoons, the annual precipitation varies from the rainy/ wet period during the four months of southwest monsoon (June- September) to relatively dry periods during rest of the year.

[28]A total of 17 sensitivity indicators grouped under four categories of potential vulnerability were evaluated, and the vulnerability under the separate categories and overall calculated and mapped across the region from low variability (green) to very high variability (red)

Nearly 70% of annual rainfall is received during the summer months, whereas winter accounts for only 5% of rainfall.[29]

26. Based on the Koppen climatic classification, 70% of Nepal lies in the humid subtropical region with distinctly dry winters and temperatures in the warmest month exceeding 22°C.[30] About 30% of Nepal lies above 3,000 m, which is an uninhabitable area due to harsh climatic conditions.
27. The annual temperature varies from 27°C in low lands to -21°C in the Himalayan region.[31] The average temperature of Nepal is about 16°C.[32] As topography is the major agent controlling temperature, spatial patterns of temperature vary significantly from one location to another.

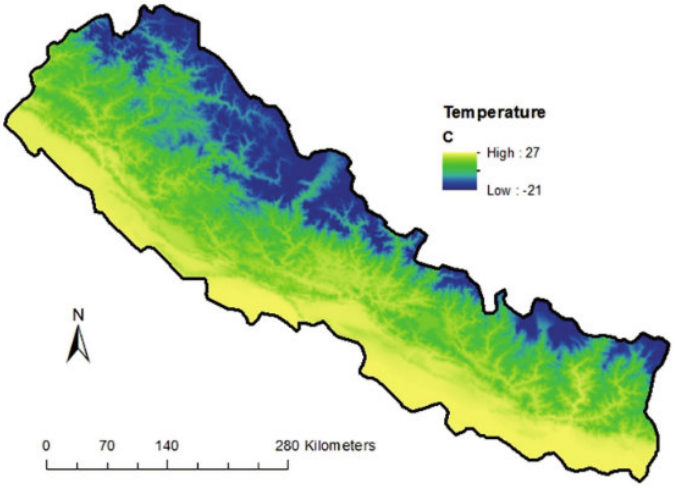

Figure 6: Spatial Distribution of Annual Average Temperature in Nepal

Source: CBS 2016

Extreme precipitation

28. Major precipitation events causing disastrous floods are mostly associated with large-scale synoptic processes. Such processes usually develop with movement of low pressure area during monsoons, which are also known as monsoon depressions.[33]
29. An assessment of the probability of extreme precipitation indicated that most of the intense precipitation zones in the country are located in the South: mainly within the mid-hills and the Churia region.[34] Intense precipitation in Churia also results in high sediment transport, as the Churia hills are comprised of conglomerates and loose rocks.[35]

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[29] ICIMOD 2015
[30] Sharma 2014
[31] CBS 2016
[32] Ibid.
[33] Ibid.
[34] Ibid.
[35] Ibid.

30. Spatial patterns of 2-year and 100-year daily precipitation in Nepal are presented in the Figure below:

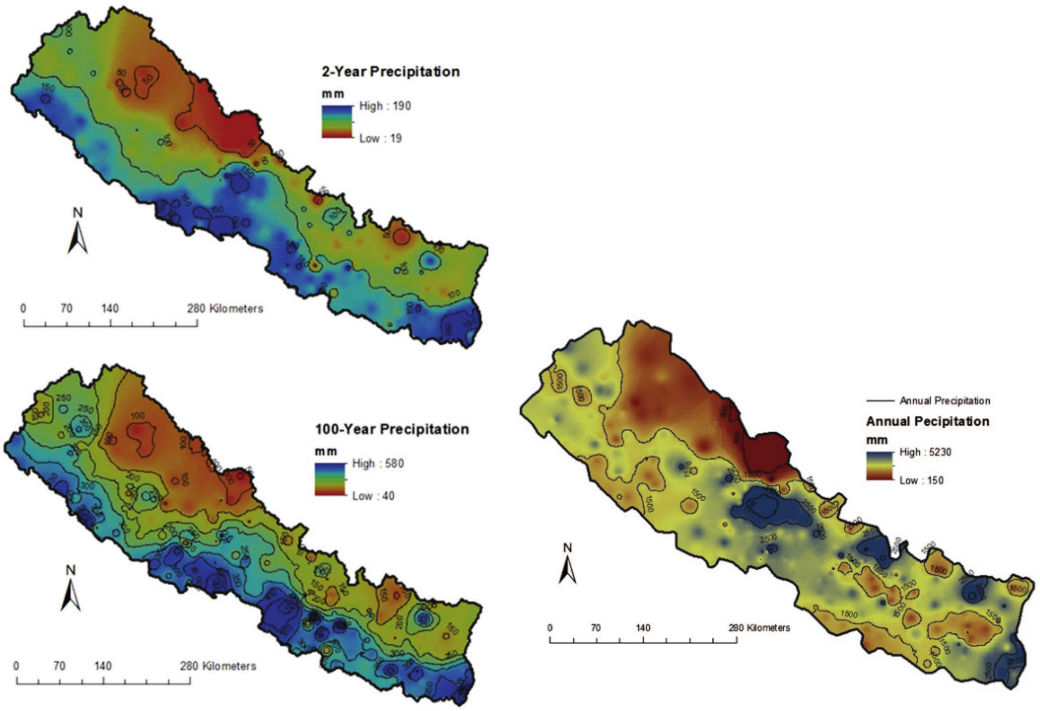

Figure 7: Spatial Pattern of 2-year and 100-year Daily Precipitation in Nepal[36] in comparison with the average annual precipitation (to the right)

Source: CBS 2016

31. The comparison between the spatial patterns of annual average precipitation and the maximum daily precipitation indicates that the orographic and convective precipitation is more pronounced in the Churia and foothill areas compared to middle mountains.[37] Daily precipitation exceeding 100 mm is common in most of Southern Nepal. Most of the intense precipitation in the country, exceeding 400 mm, was recorded in areas lying below 2,100 m. Similarly, more than half of precipitation events exceeding 400 mm are found in areas below 1,000 m.

Water

32. Nepal is rich in water resources. There are more than 6,000 rivers flowing from the Himalayan Mountains to the hills and plains. Nepal is located entirely in the Ganges river basin which is the most populated river basin in the world, with over 400 million people and a population density of about 390 people per km (Figure 8).[238]

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[36] Two-year precipitation can be considered as the annual average maximum daily precipitation, whereas 100-year maximum daily precipitation can be considered as a severe case likely to happen only once in the life-time of most of the hydraulic structures

[37] CBS 2016

[38] ICIMOD 2015

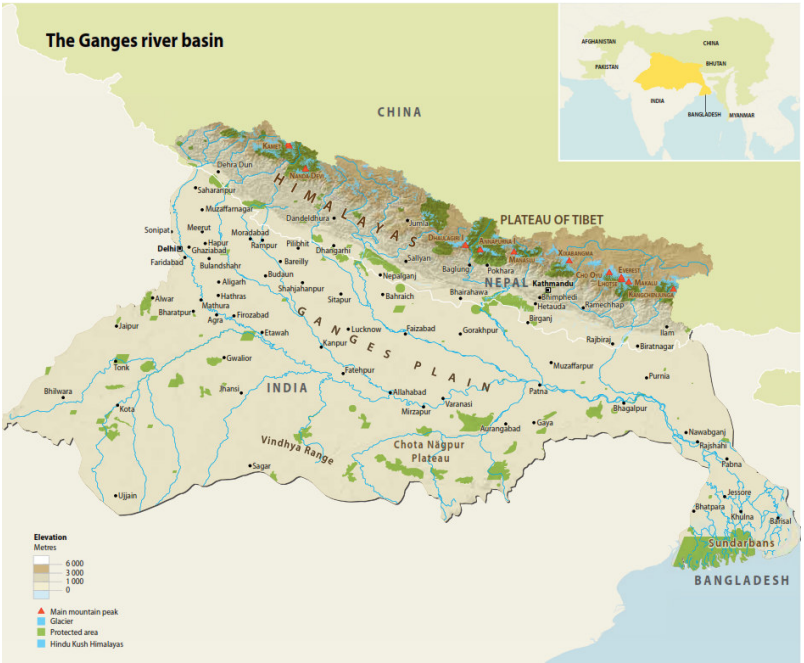

Figure 8: The Ganges basin where Nepal is located

Source: ICIMOD 2015

33. Besides the large and medium categories of the rivers, there are also a large number of small rivers in Nepal, mostly in the Terai, of which many originate in the Churia range. They are typically seasonal with little or no flow during the dry season, making them unsuitable for year-round irrigation or hydropower generation without seasonal storage. The rivers of this category often experience flash floods during the monsoon season.[39]
34. The agricultural sector is largely dependent on the monsoon rains due to lack of adequate modern irrigation facilities. Only 40% of agricultural land in Terai can be irrigated throughout the year.[40] Agriculture is the largest consumer of water in Nepal, accounting for about 96% of total annual water use.[41] There is intense pressure on the water resources being used in Nepal due to the limited availability of water in time and space with respect to demand.

[39] CBS 2016
[40] GoN Office of the Investment Board 2018
[41] ADB and ICIMOD 2006

2.2.2 Observed trends of climatic variables

Temperature

35. During the past decades, minimum temperatures have increased during the winter months (December to February) across the Hindu Kush Himalaya (HKH) region. Such trends are especially pronounced within the southern-most areas of the basin.[42] There has been a sharp decrease in minimum temperatures in several areas along the northern high-altitude regions of the basins.[43] At the same time, many of these areas are also experiencing higher maximum temperatures.
36. Historical analysis of climate data indicates that a large part of the Eastern Himalayan region is undergoing warming.[44] One study from 1970-2000 found that the Eastern Himalayas have experienced widespread warming within the range of 0.01°C to 0.04°C per year.[45] The highest rates of warming are found in the winter months, whilst the lowest, or even cooling, occur in the summer.[46] Average temperatures in the Eastern Terai Madhesh and the Mid-Terai Madhesh regions have increased by 0.03°C to 0.05°C and 0.02 °C to 0.03°C per year respectively during the same period.[47] Another study by ICIMOD focusing on the Ganges basin, further demonstrated similar increases in temperatures using data from 1951-2007.[48]
37. Studies on the Koshi Basin further found increasing temperatures. One study found increases in the maximum temperature by a rate of 0.058°C per year and the minimum temperature by a rate of 0.014°C per year from the period 1969-2009.[49] Another study found the frequency and intensity of weather extremes increased from 1975-2010, with the daily maximum temperature increasing by 0.1°C per decade and the minimum by 0.3°C a decade.[50]
38. Figure 9 (below) shows historical changes from 1950-2015 in Nepal.

[42] ICIMOD 2015
[43] Ibid;
[44] World Bank Climate Change Portal 2018; Shrestha et al. 2017; ICIMOD 2015; Sheikh et al. 2015; ICIMOD 2009
[45] ICIMOD 2009
[46] Ibid.
[47] Ibid.
[48] ICIMOD 2015
[49] Nepal 2016
[50] Shrestha et al. 2017

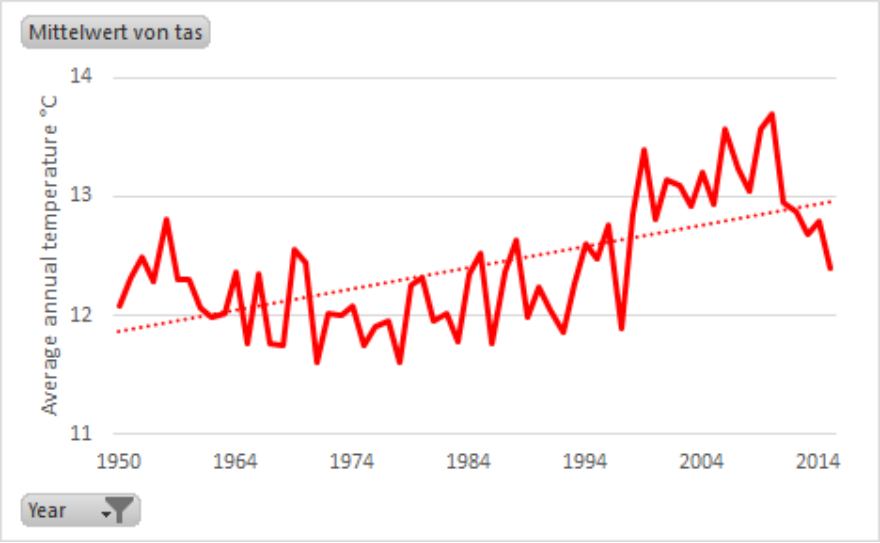

Figure 9: Historical average temperature changes from 1950 to 2015 in Nepal

Source: Climate projection data from The World Bank Climate Change Knowledge Portal (2018)

39. In short, climate change is widely considered to have increased average annual temperatures (in summer and winter) in Nepal over the past several decades, including in the Churia region. Available data does not consistently identify whether seasonal extremes – differences between maximum and minimum temperatures – are getting bigger or smaller. Nevertheless, these observed changes in average annual temperatures have had noteworthy impacts on Churia inhabitants (more information further below).

Precipitation

40. Precipitation patterns in Nepal vary over time and across the country, with localized patterns and trends. The following Figure demonstrates the variability in average annual precipitation in Nepal from 1950-2015.

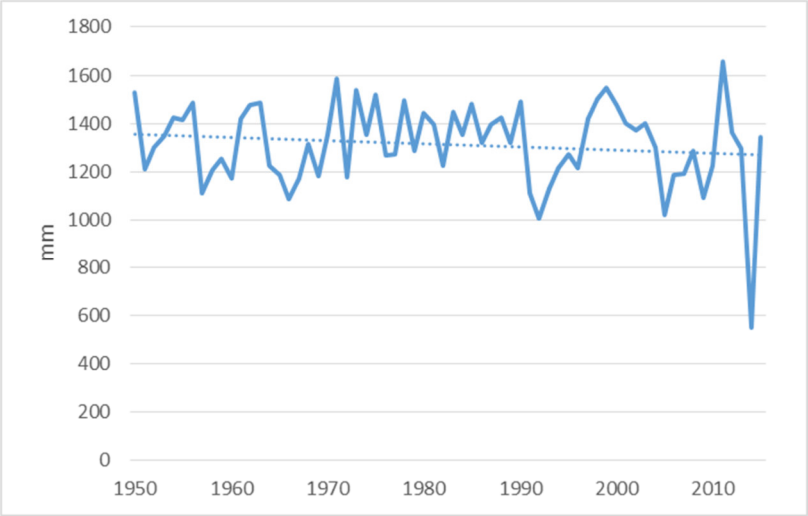

Figure 10: Historical changes in average annual precipitation in Nepal (1950 – 2015)

Source: Climate projection data from The World Bank Climate Change Knowledge Portal 2018[51]

41. For Nepal, long-term historic trends in monsoonal and annual precipitation (1970 – 2012) indicate significant increases over the middle mountains and hills within the western region of Nepal, and over the high mountains within the central region.[52] They also indicate that monsoonal and annual precipitation have decreased over the whole central and eastern regions, except for the eastern middle-mountains and hills.[53]
42. Winter precipitation features a decreasing trend over most of Nepal. A significantly decreasing trend in the post-monsoonal precipitation has also been observed across Nepal.[54] The number of consecutive dry days is increasing, whereas the number of consecutive wet (rainy) days is decreasing, implying an increase in prolonged dry spells in Nepal.[55]
43. Within the Bagmati River Basin – a basin that crosses through the Churia range – increasing trends in the rainfall recurrence interval and increase in the intensity of rainfall within the monsoon season have been observed from 1975 to 2008.[56]
44. Focusing on the Koshi River Basin, annual total precipitation increased from 1970-2010.[57] A recent study found that the number of heavy precipitation days and number of extremely heavy precipitation days increased at 62% and 64% of weather stations over this 30-year period.[58] The number of consecutive dry days increased at a rate of 6.7 days per decade at most

[51] ICIMOD 2009
[52] Karki et al. 2017
[53] Ibid.
[54] Ibid.
[55] Ibid.
[56] Dhital and Kayastha 2013
[57] Shrestha et al. 2017
[58] Ibid.

stations, whereas the number of consecutive wet days only increased by 0.5 days per decade.[59] Ultimately, the study demonstrated a tendency towards shorter and more intense rainfall during this period. Furthermore, there was an increasing tendency towards prolonged dry periods during this time period within the basin.

45. The timing and length of the monsoon period is also changing in Nepal. Monsoons typically begin on June 10 and last until September 23 (106 days).[60] From 1968 to 2014, there was no significant change regarding monsoon arrival.[61] However, within the same period, monsoon departure became delayed by half a day per year (i.e. by 5 days every decade).[62] In 2017, Nepal had the third longest monsoon on record, which lasted 127 days.[63] Despite its length, the monsoon provided 8% less precipitation than expected (mean average rainfall in monsoon period is 1,450mm).[64]
46. In the 2016 National Climate Change Impact Survey, households reported significant changes in monsoon, winter rainfall and temperature over the period of past 25 years. [65] As a whole, 91% of respondents said that monsoon precipitation is decreasing. Similarly, 90% of the respondents said winter rainfall has been decreasing.[66] Likewise, 89% of the respondents reported that they have felt increasing temperatures over the past 25 years.[67]
47. In short, although available data (which is at times sparse) does not provide a uniform picture of shifting precipitation patterns in the Churia region over the past several decades, several studies suggest that: (i) post-monsoon and winter precipitation have decreased; (ii) consecutive dry days have increased; and (iii) extreme precipitation events have become a more regular feature.

2.2.3 Extreme Weather Events

48. The Himalayan range is regularly affected by recurrent climate induced disasters. It is characterized by the fragility of its terrain, and is tectonically active and seismically sensitive[68]. The whole range is prone to geological or climatically induced hazards of various forms. It is popularly known as the world's *´third pole´* for containing the third largest fresh water reserve, which is vulnerable to climate change, like many other mountainous regions.[69]
49. In the 2016 National Climate Change Impact Survey, households reported the perceived impacts of climate change in Nepal with climate extremes of drought and flooding (inundation and floods being the most prevalent).[70]

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[59] Ibid.
[60] MoSTE 2015a
[61] Ibid.
[62] Ibid.
[63] Himalayan Times 2017
[64] Ibid.
[65] CBS 2017
[66] Ibid.
[67] Ibid.
[68] Nepal is ranked as the 11th most at-risk country in the world in terms of seismic vulnerability
[69] Giri et al. 2012
[70] CBS 2017

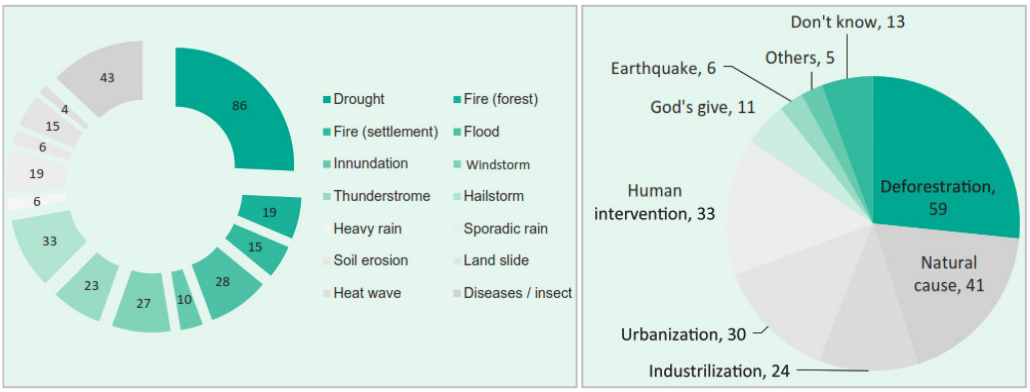


Figure 11: Perceived impacts of climate change in Nepal (left), and people's perception on reason of climate change in Nepal (right)

Source: CBS 2017

Floods

50. Flooding is the most prevalent natural disaster in Nepal. During the monsoon season (June – September), rivers swell and flooding causes damage to low-lying areas. Each year many flooding events in Nepal result in huge economic and human losses.[71]

51. Figure 12 (below) shows that the number of flooding events has been increasing since 1971.[72] From 1971-2013, 3,953 flooding events were reported, many of which are reported in Southern Nepal, with over 3,538 deaths attributed to flooding (**Error! Reference source not found.**13).[73] This works out to an average of 94 flooding events and 98 deaths per year attributed to flooding. The statistical record on flood duration and intensity is limited and inconsistent.[74]

[71] DesInventar/ UNISDR (no date); Karki et al. 2017; Center for Excellence in Disaster Management and Humanitarian Assistance 2015

[72] Shrestha et al. 2003

[73] Center for Excellence in Disaster Management and Humanitarian Assistance 2015

[74] DesInventar/ UNISDR, No Date; Note: Flood duration information in Nepal is largely inconsistent or incomplete for the time period 1971-2013. For more information refer to: https://www.desinventar.net/DesInventar/profiletab.jsp

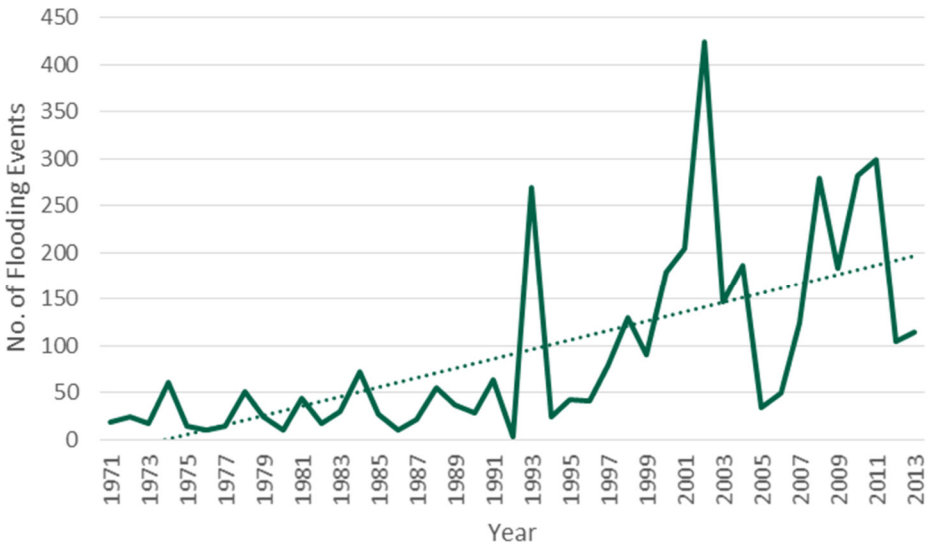


Figure 12: Number of flooding events recorded from 1971-2013 in Nepal

Source: DesInventar/ UNISDR (No Date)

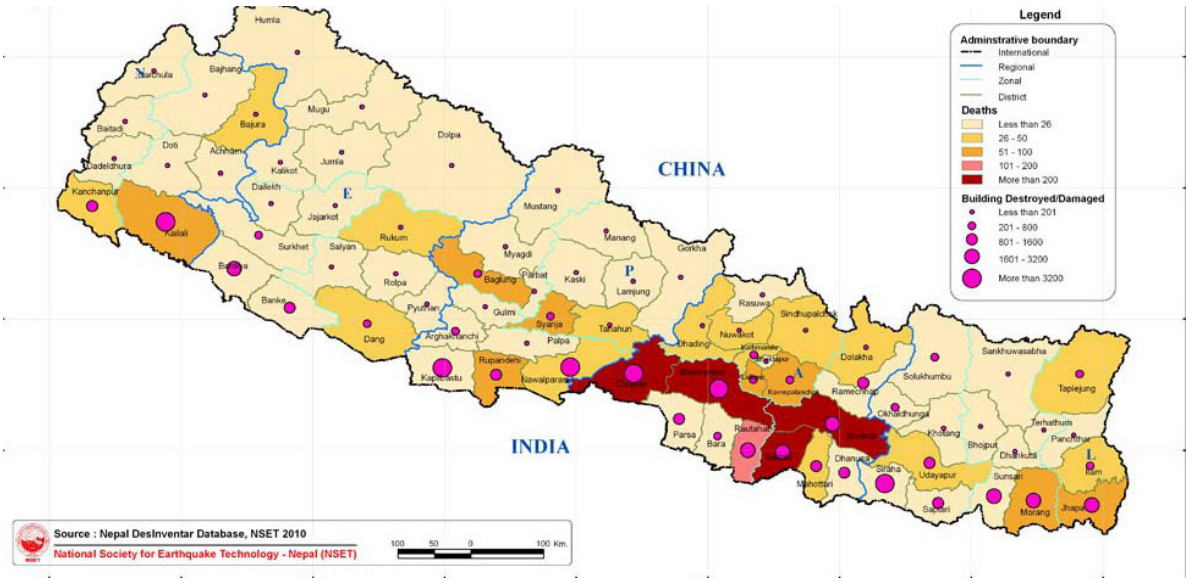


Figure 13: Human Death and Other Losses due to floods in Nepal, 1971 -2009

Source: NSET 2010

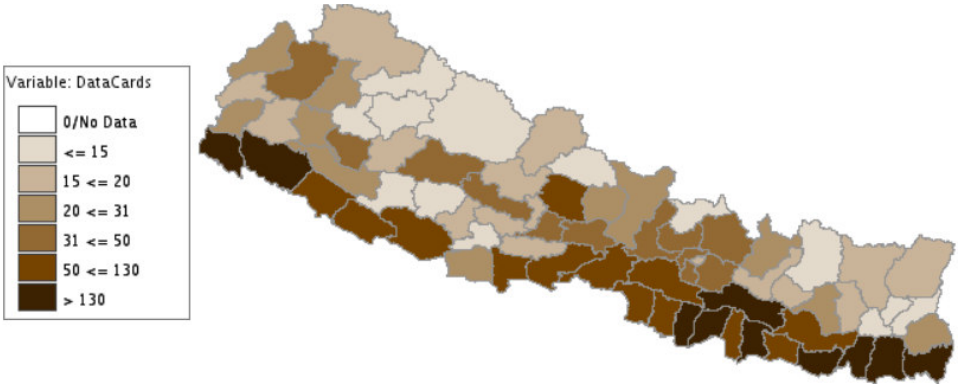


Figure 14: Distribution of recorded flooding events from 1971-2013

Source: DesInventar/ UNISDR (No Date)

52. Annual economic damages from floods and landslides exceed US$ 10 million.[75] In 2017, Nepal experienced the most significant flooding event in the last 15 years that impacted over 1.1 million people.[76] Floods had a major impact on livelihoods, food security and nutrition and led to losses in lives, assets and agricultural production. In flood affected districts, there were 940,000 people that were food insecure and requiring assistance.[77] Direct losses and damages for livestock and agriculture were estimated at USD 69.5 million.[78] In addition, 43,000 houses were destroyed, and 192,000 were partially damaged.[79]
53. As observed in the maps above, the Churia range and Terai plains are particularly vulnerable to flooding. The rivers/streams that originate from the Churia region are ephemeral in nature with surplus water flow during the four wet months, and very little or no water flow during rest of the year. These streams are characterized by flash floods. Churia is made up of highly fractured sedimentary rocks and have low groundwater retention potential. During wet season, rainfall amount exceeds by far the infiltration rate in the Churia hills. Coupled with its slopy land, this generates flash floods, and retains little water to discharge during dry season. Accelerated deforestation and forest degradation in upstream areas, as well as the use of inappropriate agricultural practices that lead to reduced vegetative cover and soil degradation, have led to accelerated erosion and sedimentation, resulting in riverbed rise downstream that increases the risk of flash flooding, as well as landslides.[80] These effects have been compounded by the observed increases in precipitation intensity and extreme precipitation events, contributing to the increasing incidence of flooding events.

[75] MoHA 2009
[76] United Nations Office of the Resident Coordinator 2017
[77] Ibid.
[78] Ibid.
[79] Ibid.
[80] Karki et al. 2017; Dhital and Kayastha 2013

Droughts

54. Analysis of precipitation records reveals a decreasing trend in the number of rainy days. Conversely, the days with more intense precipitation has been increasing, i.e. more precipitation occurred in fewer days. This changing precipitation pattern indicates that the drought period has become longer, with increasing periods of consecutive dry days.[81]

55. The analysis of consecutive dry days indices suggests a widespread increase in the dry period over the whole country (see Figure 15 below). Around 80% of the analyzed stations exhibit an increase in consecutive dry days over the period of 1970–2012.[82]

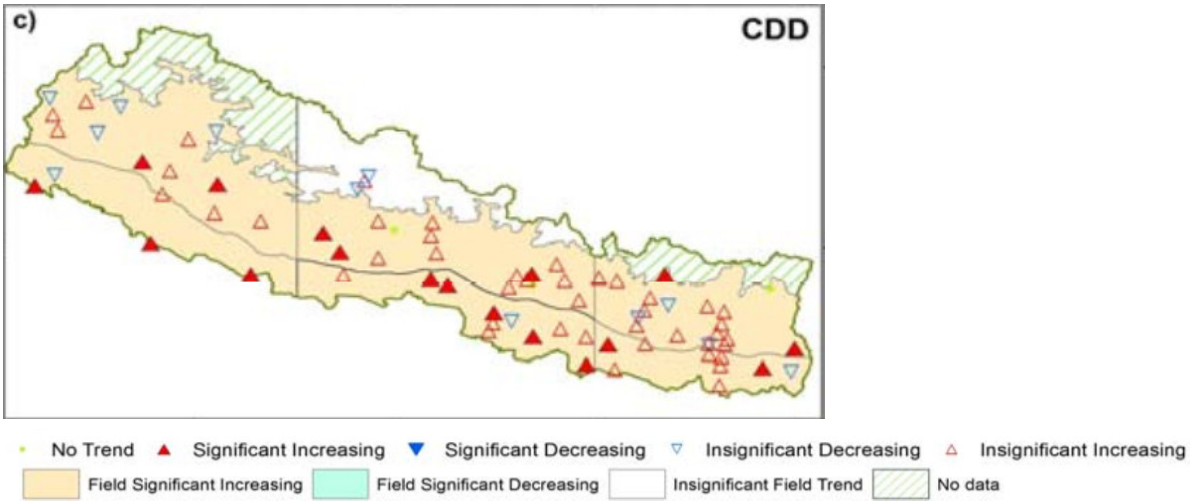


Figure 15: Station wise and field significant trends for consecutive dry days (CCD) in Nepal 1970-2012

Source: Karki, et al. 2017

56. While the impacts of flooding are dramatic, immediate and widespread, extreme heat and increasingly variable precipitation leading to aridity and drought – exacerbating existing seasonal dynamics – are becoming considerable challenges for agriculture in Nepal. The impact of the 2008-2009 winter droughts on farming and local food security were particularly severe.[83] Many communities, especially in the Churia Terai-Madhesh region, have become more exposed to seasonal water scarcity as a result of extreme heat and seasonal precipitation, as well as reduced groundwater recharge.

[81] Shrestha et al. 2017; Shrestha et al. 2003
[82] Karki, et al. 2017
[83] MoAC et al. 2009

2.2.4 Observed trends of geological events and hazards

Landslides

57. Landslides in Nepal are caused by steep slopes, loose soil and heavy rainfall – the latter of which has become more common in Nepal and the Churia region over the preceding decades as a result of climate change. Anthropogenic factors are also increasingly contributing to this, including deforestation, hill cutting, and removal of natural drainage systems. From 1971-2013, a total of 3,208 landslides were reported, resulting in the death of 4,658 people.[84] As outlined in Figure 16, the average number of landslides per year increased over this period.

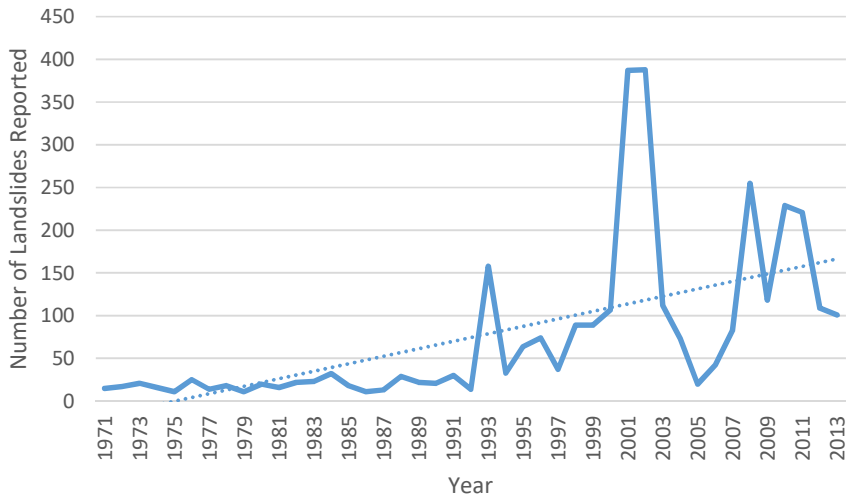


Figure 16: Number of reported landslides per year from 1971-2013 in Nepal

Source: DesInventar/ UNISDR (No Date)

58. Landslide hazards vary from region to region (see Figure 17). Increased melting of snow and ice including permafrost can induce an erodible state in the mountain soil which was previously non-erodible. This has increased the likelihood of landslides in the mountains. In the Churia Range, the unstable geological conditions and heavy rainfall both contribute to landslide susceptibility.[85] Landslides in the Churia region are further linked to deforestation and forest degradation, as well as the use of unsustainable agricultural practices on sloped hills, which increase the vulnerability of the region to landslides.

[84] DesInventar/ UNISDR (No Date)

[85] Center for Excellence in Disaster Management and Humanitarian Assistance 2015

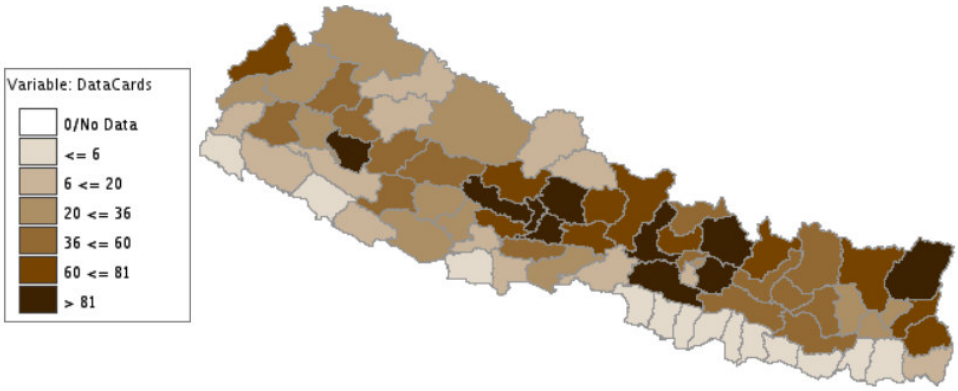


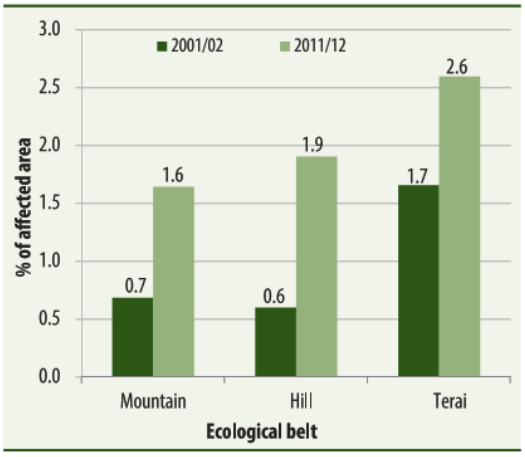
Figure 17: Map of districts in Nepal where landslides were reported from 1971-2013

Source: DesInventar/ UNISDR (No Date)

Erosion and Sedimentation

59. Due to steep slopes and intense monsoon rainfall – the frequency of which has increased due to climate change – soil erosion is a major land degradation process prevalent in Nepal. Sedimentation with high flood discharge results in abrupt river channel change which may cause complete loss of fertile farm land due to deposition of eroded material or slumping of river banks. In some cases it destroys human settlements. Almost all parts of the country are affected by soil erosion (Figure 18).[86] The area of previously arable land that was rendered uncultivable due to flooding and soil erosion has increased between 2001/2 and 2011/12, rising from 0.7% to 1.6% in the high mountains, 0.6% to 1.9% in the hills and 1.7 to 2.6% in the Terai.[87] Additional historical data going back multiple decades is not available. Nevertheless, the project design team is confident that these increases are largely the result of: (i) the observed increases in extreme precipitation events during monsoon season over the past several decades; and (ii) increasing rates of deforestation and forest degradation, and the use of unsustainable land and forest management practices.

[86] CBS 2016
[87] Ibid.



Area	Location and Characteristics	Land Use	Erosion Rate (ton /sq. km/yr.)
Siwalik Range	Eastern Nepal, South aspect, sand stone foot hills	Different land use ranging from forest to grazing	780 - 3680
	Far Western Nepal, South aspect sand stone foot hills of Surkhet	a. Degraded land	2000
		b. Degraded forest, gullied land	4000
		c. Severely degraded heavily grazed forest, gullied land	20000
Mahabharat Lekh	Central Nepal, steep slope on Metamorphic and Sedimentary Rocks	a. Degraded forest and agriculture land	3150 - 14000
		b. Gullied land	6300 - 42000
Middle Mountain	Northern foot hills of Katmandu Valley	a. Degraded forest & shrub land	2700 - 4500
		b. Over grazed shrub land	4300
		c. Severely gullied land	12500 - 57000
	South of Katmandu	75 percent dense forest	800
	Phewa Watershed	a. Protected pasture	920
		b. Overgrazed grass land	2200 - 34700
		c. Gullied overgrazed grass land	2900

Figure 18: Area of Land Made Uncultivable due to Flooding/Soil Erosion in Different Ecological Regions from 2001/02 to 2011/12 (left); Estimated Soil Erosion Rate at Selected Sites in Nepal (right)

Source: CBS 2016

Wildfires

60. Linked with extreme heat as well as anthropogenic factors, wildfires are progressively becoming an issue for Nepal, especially in view of the increase in the frequency and intensity of droughts and prolonged dry periods. Historical data on wildfires is inconsistent and was previously under-reported, limiting insight into historical wildfire patterns.

61. Information from 2000 to 2014 shows no clear annual pattern, with annual burnt-areas within the range of 163,000 ha to 760,000 ha, and peak burnt-areas in 2001, 2009 and 2012.[88] In 2016, at least 268,618 ha of forests in Nepal were damaged by forest fires, impacting 50 districts and 12,000 community forests.[89] In comparison with areas with extensive vegetative cover, areas affected by fire and drought generate far higher sediment loads because they are more vulnerable to landslides, erosion and debris flow after intense precipitation and because they exhibit ´flashy´ runoff patterns.[90]

[88] Khanal 2015
[89] Ghurung 2017
[90] Center for Excellence in Disaster Management and Humanitarian Assistance 2015

2.3 Climate change projections for Nepal and Churia region

2.3.1 Existing projections of climatic variables

Temperature

62. Based on Global Circulation Models and Regional Circulation Models, average temperatures are projected to continue increasing in Nepal.[91] The World Bank Climate Change Knowledge Portal reports that this increase could range from 1.3-3.8°C by 2060, and 1.8-5.8°C by 2090 compared to the reference period (1986-2005).[92] The following Figure demonstrates monthly average temperature projections of change from 2080-2099.

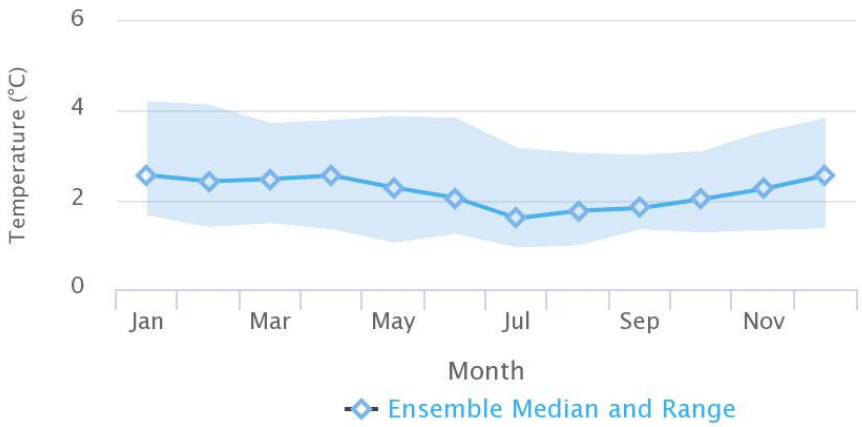


Figure 19: Monthly average temperature projection of change 2080-2099; CMIP5; RCP4.5 Scenario; median and range of 16 climate models

Source: Climate projection data from The World Bank Climate Change Knowledge Portal 2018

63. A recent study, employing Global and Regional Circulation Models, projects that mean annual temperatures in Nepal will increase by 1.4°C by 2030, 2.8°C by 2060, and 4.7°C by 2090.[93] Studies from the Koshi basin came to a similar conclusion, in line with NAPA predictions.[94]
64. Under RCP 4.5, the Ganges basin is projected to become warmer in the summer by about 2°C, with a higher increase projected in the north along the mountain range of up to 3°C for the period from 2021-2050.[95] In winter, a projected increase of 2–3°C is widespread across

[91] MoE 2010a,b
[92] World Bank Climate Change Knowledge Portal 2018; Nepal 2016
[93] MoE 2010b
[94] Agrawal et al. 2016 ; Nepal 2016
[95] ICIMOD 2015; Compared to the baseline period from 1961 to 1990. The scenarios used by ICIMOD include RCP¨4.5 and RCP 8.5.

the basin, and of up to 4°C along the mountain range.[96] As further noted in the assessment, RCP 8.5 generally results in projections of higher temperature changes than RCP 4.5.[97]

Precipitation

65. Future precipitation projections are more inconsistent than projections for temperature, although for south-east Nepal there is more consistency.[98] Projected data indicate that monsoonal precipitation is more likely to increase in the future, whilst winter precipitation is more likely to decrease. However, the magnitude of the projected changes vary, primarily due to differences in the driving GCMs and the study domains.[99]
66. In the Ganges basin during the summer, both RCP 8.5 and 4.5 project a 10–25% increase in rainfall over most of the basin, exceeding 25% over the central north of the basin.[100] RCP 8.5 results in projections with pockets of lower increases (i.e. up to 10%) within the central and eastern parts of the basin.[101] In the winter, both scenarios project a decrease in precipitation of up to 10%.[102] RCP 8.5 shows a decrease extending south through the central and eastern parts of the basin, while the rest of the basin would see an increase in precipitation ranging from 5–25%.[103] During monsoon season, rainfall in the Basin is projected to increase by 15% and 14% for RCP 4.5 and RCP 8.5, respectively.[104]
67. A study from the Koshi River basin predicts an increase in the number of dry days, consecutive dry days and very wet days, with greater increases expected in the Terai.[105] Declines in moderate rainfall days and the number of consecutive wet days are expected in most of the basin.[106] Another study from the same basin concluded that the regional climate model data suggests that average annual precipitation will increase by 13% and 14% by mid to late century, respectively.[107]
68. A study from the Bagmati River Basin expects more extreme precipitation events during the monsoon season, and less precipitation in other months, although these models include substantial differences in magnitude.[108]
69. Such trends imply more frequent flooding in the monsoon season, and more frequent droughts in the winter (see following sub-sections).[109] Decreased precipitation in winter

[96] ICIMOD 2015
[97] Ibid.
[98] World Bank Climate Change Knowledge Portal 2018; Rajbhandari et al. 2017; Nepal 2016
[99] World Bank Climate Change Knowledge Portal 2018; Nepal 2016; Nepal and Shrestha 2015
[100] ICIMOD 2015
[101] Ibid.
[102] Ibid.
[103] Ibid.
[104] Ibid.
[105] Rajbhandari et al. 2017; Modeled using baseline data from 1961-1990, PRECIS simulation
[106] Ibid
[107] Nepal 2016; Based on baseline data from 2000-2010 and modeled with PRECIS input data from 1995 to 2096.
[108] Kumar Mishra and Herath 2015
[109] World Bank Climate Change Knowledge Portal 2018; Kumar Mishra and Herath 2015

months could also lead to reduced winter and spring crop production, affecting food security.[110]

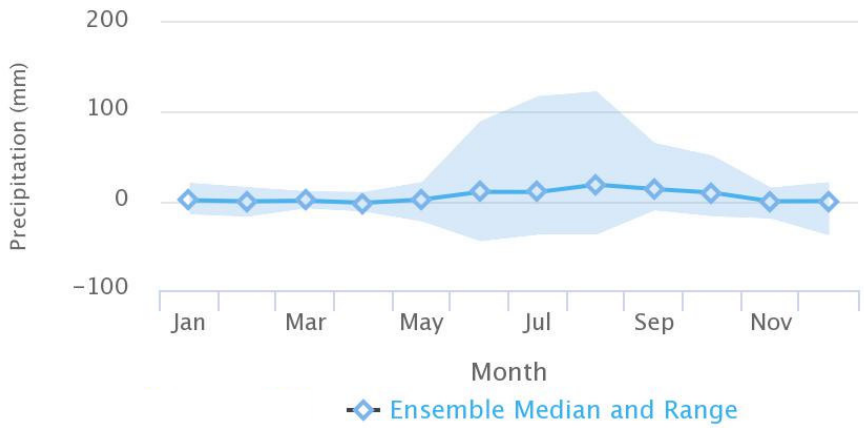


Figure 20: Monthly precipitation projection of change 2080-2099; CMIP5; RCP4.5 Scenario; median and range of 16 climate models, compared to the reference period (1986-2005)

Source: Climate projection data from The World Bank Climate Change Knowledge Portal (2018)

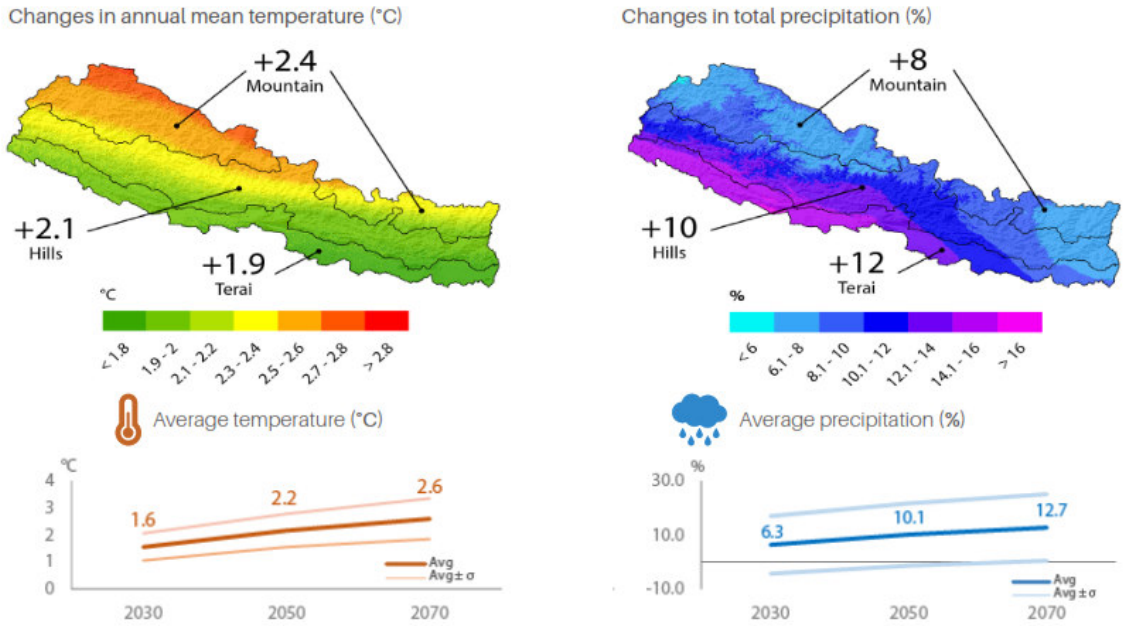


Figure 21: Projected changes in temperature and precipitation in Nepal by 2050

Source: Collins et al. 2013 in CIAT et al. 2017

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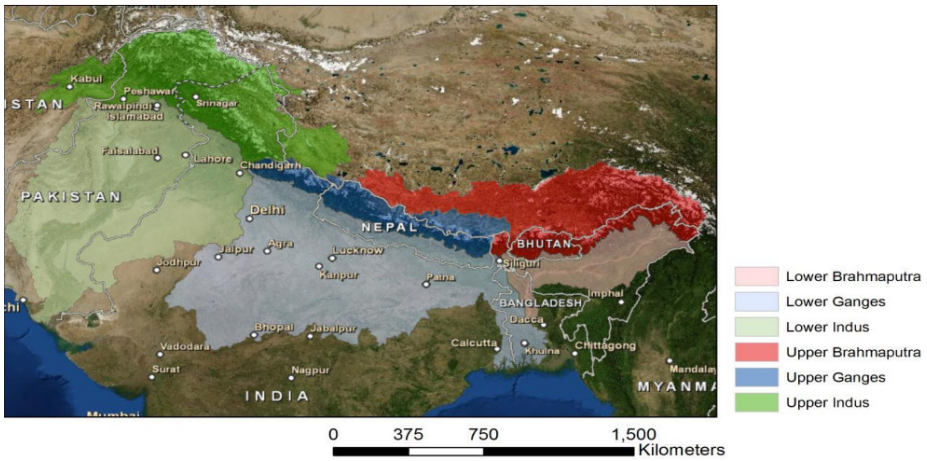
[110] Murphy 2011; For instance, monsoon rain declined by 16% in 2006/7 that lead to reduced rice cultivation by 21-30% (World Bank 2011)

2.3.2 Projected changes in extreme weather events

Floods

70. Based on the projected precipitation changes, it is likely that both droughts and floods will occur more frequently into the future.[111] Assessments on future flood frequencies in a number of river basins spread across the world, including the Indus, Ganges (where Nepal is located) and Brahmaputra River basins of the Himalayan region, found that in the Ganges and Brahmaputra river basins, a future 100-year flood (i.e. equivalent to discharges with a 100-year return period in the 20th century (1901±2000) will occur once every 26.1 years (Ganges) and 3.8 years (Brahmaputra) by the end of the 21th century.[112] Such flooding can be further exacerbated by unsustainable natural resource management, leading to accelerated soil erosion, sedimentation and exposed soils.[113]

71. A recent study which investigated the impacts of climate change on future hydrological extremes in these river basins using an ensemble of 8 downscaled General Circulation Models (GCMs) that are selected from the RCP4.5 and RCP8.5 scenarios concluded that high flow conditions will occur more frequently in the Indus, Ganges and Brahmaputra river basins in the future.[114] The Figure below shows the mean and the standard deviation of the relative change in the 50-year return period over the river network under RCP4.5 and RCP8.5 scenarios. In most parts of the Indus, Ganges, and Brahmaputra River basins, the 50-year return level is projected to increase with relative increases up to about 305% under RCP8.5.[115]



[111] Wijngaard et al. 2017; Kumar Mishra and Herath 2015
[112] Hirabayashi et al. 2008
[113] Paudyal et al. 2017; Neupane 2015; Ghmire et al. 2013
[114] Wijngaard et al. 2017
[115] Ibid.

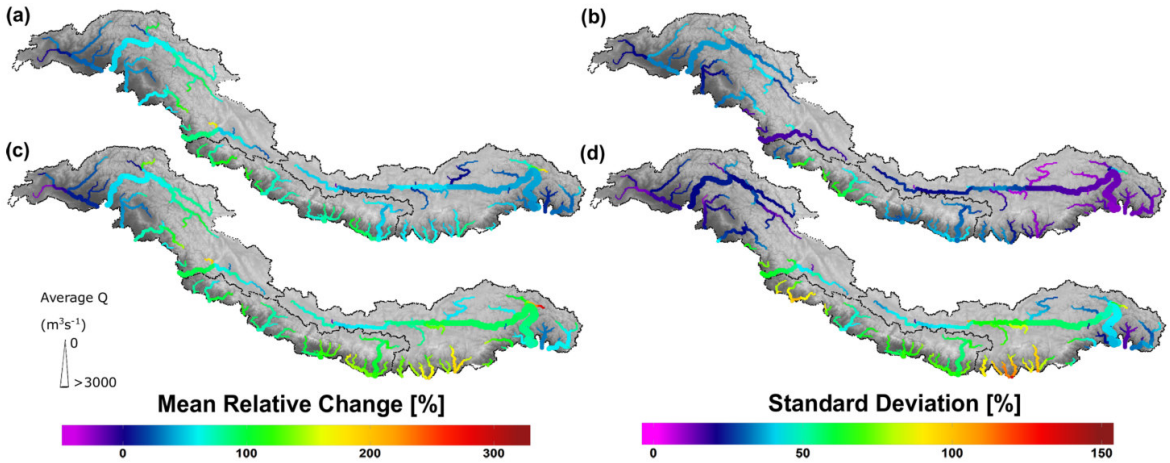


Figure 22: Relative changes in 50-year return period discharge level. Maps showing the mean relative changes (left) in 50-year return period discharge levels and their standard deviations (right) at the end of 21st century (2071±2100) under RCP4.5 (upper row) and RCP8.5 (lower row) scenarios. For orientation, the upper maps of the river basins are shown.

Source: Wijngaard et al. 2017 upper map Futurewater.nl, 2013

72. Climate change is not only projected to increase the frequency of flooding events in Nepal and the Churia region in the future, but is also expected to increase the severity of floods and associated damages. A study from the lower region of the Rohini river basin in Uttar Pradesh (Northern India)[116], selected due to its similarities with Nepal´s Terai region, found that the annual cost per household could nearly double between 2040 and 2070 based on B1R3 climate change projections – increasing from NPR 2,813 to NPR 5,581 per household per year.[117] In addition to increasing flooding and damages under climate change projections, on average 40% more households will be affected by flooding due to climate change.[118] Already with ten-year historical floods, household losses amount to a third of annual household income.[119] Increasing frequency of historic flooding events in the context of climate change is projected to cost households over 50% their annual income.[120] Thus, climate change and increasing flooding will have devastating impacts on average Nepali households, especially in the Terai region and in downstream areas in India. Accelerating anthropogenic activities, such as deforestation and forest degradation, can catalyze the impacts of climate change and further increase the vulnerability of both ecosystems and communities to flooding. [121]

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[116] The lower regions of the Rohini Basin in Uttar Pradesh was used for this assessment due to its: i) physical proximity to the Terai region in Nepal; ii) validity of the climate downscaling model in the basin for the Terai region, and the similarity of land-use, livelihoods and settlement patterns (NCVST 2009).
[117] NCVST 2009; Annual cost per household was determined using information from 1970-1999.
[118] Ibid.
[119] Ibid.
[120] Ibid.
[121] Ibid.

ELEMENTS	HISTORICAL/CURRENT CONDITIONS	B1R3 CLIMATE CHANGE PROJECTIONS
Projected basin-wide damages /km² in million rupees	0.464	0.938
Per head	541	1,094
Average household size	5.21	5.21
Per household	2,813	5,581

Figure 23: Projected damage to an average family (in NPR) in the Rohini basin in Uttar Pradesh, India

Source: NCVST (2009)

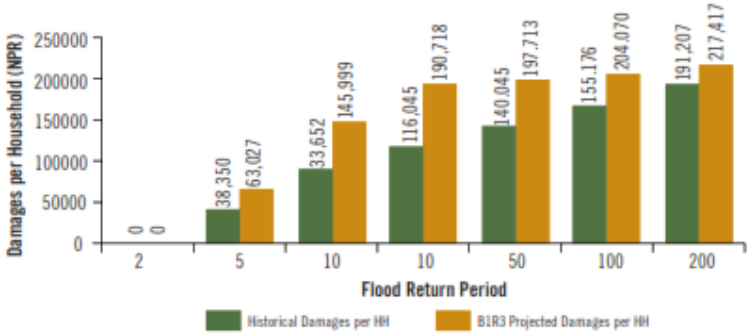

Figure 24: Impact of climate change on flood damages in the Rohini basin in Uttar Pradesh, India

Source: NCVST 2009

Droughts

73. Climate change projections for Nepal suggest shifting and increasingly variable precipitation, greater climatic variability, as well as increases in temperature and the number of consecutive dry days. This in turn suggests that the frequency of winter droughts will increase.[122] The increasing prevalence of droughts in Nepal is a matter of great concern as they illustrate the vulnerability of the country's agricultural sector[123]
74. The average number of drought days were found to increase by a factor of 1.17 and 4.05 in the Ganges and Indus basins, respectively (shown as ratio between drought days of 2071–2100 and drought days of 1901–2000).[124]
75. Global Circulation Model outputs (15 selected models) suggest that extremely hot days (the hottest 5% of days in the period 1970-1999) are projected to increase by 15-55% by the 2060s and 26-69% by the 2090s.[125] This includes significant increases in the post-monsoon and winter months, when overall precipitation is generally expected to decline.

[122] Bartlett et al. 2010
[123] NCVST 2009
[124] Hirabayashi et al. 2008
[125] NCVST 2009

EASTERN NEPAL					
Time Period	Annual	Pre-Monsoon	Monsoon	Post-Monsoon	Winter
2060s	16 (12, 35)	26 (16, 45)	24 (10, 66)	24 (10, 66)	26 (19, 80)
2090s	22 (14, 45)	43 (29, 62)	35 (8, 84)	35 (8, 84)	53 (31, 91)

Figure 25: Change in frequency of hot days in Eastern Nepal (%, relative to mean of 1970-1999) from GCM projections[126]

Source: NCVST 2009

76. While projections indicate that overall average annual rainfall *may* increase as a result of climate change, studies have noted that the increasing intensity of precipitation events and lack of water storage or harvesting infrastructure may limit the ability of communities to sustainably manage (and thus utilize) this rainfall. [127] The current lack of planning and suitable infrastructure (e.g. conservation ponds and rainwater harvesting infrastructure) will have to be address to better equip households to adapt to these changing conditions.
77. Given the above-mentioned past trends (Section 2.2) and future projections (Section 2.3), this confluence of climate change challenges and anthropogenic factors pose a major threat to soil fertility and can catalyze land degradation in the Churia region – a threat that is expected to become even more pronounced in the decades to come. This is described in more detail in Section 2.4 on climate impacts on agriculture, land use and ecosystems.

2.4 Trends of climate impacts on land uses and ecosystem

2.4.1 Agriculture and Livestock

78. Climate change is one of the most challenging issues for a country such as Nepal where more than 80% of people are dependent on the agriculture sector for their livelihood.[128] Agricultural production depends on favorable weather conditions and seasonal production systems. Only 26.5% of cultivable agricultural land in Nepal is irrigated, of which less than 50% has access to a year-round water supply.[129] Thus changes in precipitation and temperature regimes can threaten both food and water security in the country. Current costs associated with the impacts of climate variability and extreme events are already estimated at US$ 270-360 million/year, representing 1.5 to 2% of the country's GDP.[130]
79. Nepal has already been experiencing considerable changes in precipitation patterns, which has a direct impact on overall agricultural productivity in the country. Planting and harvesting seasons have been slowly changing in Nepal due to the shifting monsoon season, and such

[126] The following models were selected under this study: bccr_bcm2_0; cccma_cgcm3_1; cnrm_cm3; csiro_mk3_0; csiro_mk3_5; gfdl_cm2_0; gfdl_cm2_1; giss_model_e_r; inmcm3_0; ipsl_cm4; miub_echo_g; mpi_echam5; mri_cgcm2_3_2a; ncar_ccsm3_0; ukmo_hadcm3
[127] Bastakoti et al. 2016 ; Synnot 2012 ; Bartlett et al. 2010
[128] Ibid.
[129] Dhakal et al. 2016
[130] IDS-Nepal et al. 2014

shifts are becoming more erratic under a changing climate. A late or erratic monsoon quickly translates into crop losses and subsequently into food insecurity. For instance, the late start of the monsoon in 2009 significantly impacted rice crops, as many seedlings were lost due to the delay in rainfall, and many did not have enough time to mature enough for a viable yield.[131] On the other hand, increased precipitation when rice is in a nursery stage damages rice yields, while increased morning humidity can also damage rice production and yields.[132]

80. In addition to the aforementioned direct impacts, intense monsoon rains contribute to top soil loss and erosion, contributing to sedimentation, river bank rise and riverbank cutting.[133] Widespread use of unsustainable agricultural practices further reinforces these negative impacts, which can cause extensive damages and losses. Flooding in 2017 alone lead to agriculture and livestock damages and losses exceeding US $69.5 million.[134]
81. The impacts of less water during the dry months are much easier to visualize, as recent winter droughts have continued to show the effects of low water supply. During the drought of fall 2008 to spring 2009, agricultural systems experienced significantly reduced crop yields, resulting in food insecurity for millions.[135] Increased water scarcity, among other factors such as labor shortages, have caused some farmers to switch from seasonal crop production to biannual or perennial crops.[136]
82. Of particular importance is the ´rice basket´ of the country, the Terai plains.[137] A significant non-linear relationship has been observed between maximum daily temperatures and rice yields, where rice yields are particularly sensitive to increasing temperatures.[138] Productivity declines and yields are harmed when daytime maximum temperatures exceed 29.9°C.[139] In the Terai it was determined that the average maximum temperature from 1999-2008 was 30.8°C, indicating that rice yields may have already been affected by increasing maximum temperatures.[140]
83. Increasing temperatures also pose a threat for many other crops, especially in the Terai region where over 50% of the country´s cereals are produced.[141] Increased temperatures are affecting soil moisture and nutrient levels in the soil through evapo-transpiration and soil erosion. Already, decreases in soil moisture have been observed in Rathaut district and Dhading district (Salyantar village) in Nepal over 15 and 20 year periods, respectively.[142] Soil moisture availability prior to the monsoon season determines the planting date of maize, and

[131] Malla 2008
[132] SANDEE 2014
[133] FAO 2014; Das and Bauer 2012; Bartlett et al. 2010; Malla 2008
[134] United Nations Office of the Resident Coordinator 2017
[135] Bartlett et al. 2010
[136] CIAT et al. 2017
[137] Shrestha et al. 2017
[138] SANDEE 2014
[139] Ibid.
[140] Ibid.
[141] CIAT et al. 2017
[142] Dhakal et al. 2016 ; Paudyal et al. 2015

rising temperatures are likely contributing to declines in productivity.[143] Soil moisture availability is closely linked with climate change and the natural fragility of ecosystems in Nepal, however the application of unsustainable agricultural practices can further contribute to these challenges. Business-as usual practices in Nepal tend to further exacerbate soil moisture loss and erosion.[144] While conservation agriculture practices are able to reduce such losses, such practices have not been adopted at scale.[145]

84. Climate change is also likely to contribute to the development and spread of crop diseases, pests and weeds with a substantial impact on farming systems.[146] Studies have reported increasing occurrence of pests with climate change, including pests such as leaf blight (potatoes, wheat), rhizome rot (ginger), and yellow rust (wheat), among others.[147]

85. Climate change also poses a risk to livestock production in Nepal, although the specific vulnerability varies depending on the socio-economic context, eco regions and production systems.[148] Changes in temperature, rainfall patterns and humidity are directly related to increased incidences of livestock disease and productivity losses (e.g. thermal stress, reducing growth and inducing sub-optimal behavior in animals).[149] Productivity declines are also attributed to prolonged dry periods and droughts.[150] Pasture degradation is further attributed to droughts and dry spells, along with a loss of soil nutrients, water and biomass.[151] Floods also pose a direct risk to livestock, largely through direct losses in animals and infrastructure. In 2017, floods led to an estimated direct livestock loss of NPR 1.25 billion (>US$10.7 million) and indirect losses of NPR 10 billion (>US$ 86.2 million).[152]

86. Already studies in Nepal indicate that communities have noted the prevalence of new livestock diseases, increases in disease/ pest frequency, decreases in quality of forage and decreases in productivity due to climate change.[153] A climate change survey conducted in Nepal noted that in the last 25 years, 66% of respondents observed new pests that affected crops while 45% observed new livestock diseases.[154]

87. Farmers in Nepal have already begun to adapt to climate change by planting different crops, and in some instances shifting the agro-ecological zones for certain crops. For example, orange cultivation in Nepal has shifted production zones from 900m altitude to higher altitudes such as 1400m.[155] At the original production zone (900m) farmers realized orange quality and

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[143] Synnott 2012
[144] Das and Bauer 2012
[145] CIAT et al. 2017; Das and Bauer 2012
[146] Govinda 2013; Synnott 2012;
[147] CBS 2017 ; Poudel 2015;
[148] Hussain et al. 2018; CBS 2017; CIAT et al. 2017; Koirala and Shrestha 2017; Gurung et al. 2011
[149] Hussain et al. 2018; Gurung et al. 2011; Sirohi and Michaelowa 2007; Singh et al. 2000
[150] Hussain et al. 2018
[151] Ibid.
[152] United Nations Office of the Resident Coordinator 2017; US rates determined using an exchange rate of 1 NPR to US$0.0086.
[153] Koirala and Shrestha 2017
[154] CBS 2017
[155] Barrueto et al. 2017

yields greatly declined with earlier flowering and ripening.[156] The following Table provides an overview of perceived disasters for key production systems in Nepal:

Table 1: Perceived climate-related impacts affecting select production systems in Nepal

Affected by…	Changes/ phenomena	Production Systems						
		Banana	*Charcoal*	*Coffee*	*Macadamia*	*Orange*	*Riverbed Vegetables*	*Walnut*
Changing temperature	Increased temperature	■	■	■		■		■
	Diurnal Variation in Temperature	■						
	Seasonal Variation in Temperature	■	■			■		
Changing precipitation	Decreased precipitation		■	■		■		■
	Seasonal variation in precipitation		■					
Changing humidity	Increased humidity			■				
Storms	Hail				■		■	■
	Wind	■	■		■		■	■
Floods	Floods						■	
Drought	Droughts	■		■		■	■	■
Wildfire	Forest fire		■					
Epidemic	Viral disease	■			■			
	Fungal disease	■		■		■		
Insect Infestation	Insect Infestation	■		■		■	■	■

Source: Adapted from Barrueto et al. 2017

2.4.2 Forests and ecosystems

88. It is important to note that research about the impacts of climate change on ecosystems (e.g. forests, water, agricultural resources) is still in its infancy in the Himalayan Mountains[157].
89. The region is particularly vulnerable to climate change due to its ecological fragility and more limited economic development. The high level of poverty linked with pervasive livelihood challenges has already brought indicative changes in forest quality. Land use and land cover changes contribute to local and regional climate change and global climate warming, as well

[156] Ibid.
[157] Negi et al. 2012. Impact of climate change on the western Himalayan mountain ecosystems: An overview. Tropical Ecology

as having a direct impact on biotic diversity, influencing the reduction in species diversity. These changes also affect the ability of biological systems to support human needs.[158]

90. It has been estimated that a quarter of the country's forest area is heavily degraded, leading to increased landslides and soil erosion that add to regional sedimentation impacts, reducing the life spans of reservoirs and posing a threat to all infrastructure on or along the rivers.[159] Accelerated erosion and sedimentation leads to increased river bank cutting and riverbed rise downstream, and ultimately increases the vulnerability of downstream communities and ecosystems to flooding.
91. The Eastern Himalaya Region is rich in threatened and endemic species with restricted distribution or narrow habitat ranges and are therefore more vulnerable to climate change and more likely to face extinction in the face of expected changes. Increased precipitation can lead to increased seasonal flooding causing extensive damage to ecosystems. Floods in Chitwan national park led to many animals being swept downstream into India, including endangered one-horned rhinos, as well as the destruction of critical habitat.[160] Floods in 2008 destroyed old growth grassland habitat of the Rufous-vented Prinia (*Prinia burnesii*).[161] Increasing droughts and prolonged dry periods can also have diverse impacts on ecosystems and biodiversity in Nepal. Increasing dry periods can increase the risk and severity of wildfires. Increasing temperatures and droughts also have implications for habitat and biodiversity.
92. The table below presents an overview of the impacts of climate change on biodiversity in this region[162]. The table shows both the observed/ documented impacts (black circles) and the projected impacts (white circles).

Table 2: Observed and projected impacts of climate change on ecosystem diversity in the Eastern Himalaya Region

[158] ICIMOD 2009
[159] NCVST 2009
[160] https://www.hindustantimes.com/world-news/floods-sweep-rhinos-to-india-nepal-prepares-to-bring-them-back/story-ERFiSDbgftAMqPQKBlWwWI.html
[161] Thapa et al. 2015
[162] NCVST 2009

Biodiversity impact	System		Level			Range			
Description	Terrestrial	Freshwater	Ecosystem	Species	Genetic	Local	Widespread	Impact Mechanism/ Hypothesis	Climate Change Driver
Loss and fragmentation of habitat	●		●				●	Ecological shift, land use change, exploitation	Temp change
Vertical species migration and extinction	○			○		○		Ecological shifts	Temp change
Decrease in fish species (in Koshi river)		●		●		●		Less oxygen, siltation	Temp change, extreme weather events
Reduced forest biodiversity	○●		○●				○●	Ecological shift, habitat alteration, forest fire, phenological changes	Temp change, precipitation change, land use change, overexploitation
Change in ecotone and micro-environmental endemism	○		○	○		○		Ecological shifts, microclimate	Temp change
Peculiar tendencies in phenophases, in terms of synchronisation and temporal variabilities	●			●		●		Phenological changes	Temp change
Wetland degradation (Umiam Lake, Barapani in Meghalaya) (climate attribution is strongly contested)		●	●		●			Siltation	Precipitation change
Degradation of riverine island ecosystems (Majuli) and associated aquatic biodiversity (refuted, but not overlooked)		●	●		●			Flooding	Extreme weather events
Loss or degradation of natural scenic beauty	○	○	○				○	Drought, reduced snowfall	Less precipitation
Reduced agrobiodiversity	○●		○●				○●	Monoculture, inorganic chemicals, modern crop varieties, degeneration of crop wild relatives	Higher temp and more precipitation
Change in utility values of alpine and sub-alpine meadows	○		○			○		Biomass productivity, species displacement, phenological changes	Higher temp and more precipitation
Loss of species	○	○		○			○	Deforestion, land use change, land degradation	Higher temp and more precipitation
Increase in exotic, invasive, noxious weeds (mimosa in Kaziranga)	●			●		●		Species introduction and removal, land use change, tourism	Higher temp and more precipitation
Decline in other resources (forage and fodder) leading to resource conflicts	●		●				●	Reduced net primary productivity	Higher temp and less precipitation
Successional shift from wetlands to terrestrial ecosystems and shrinkage of wetlands at low altitudes (Loktak Lake, Deepor Beel)	●○		●○			●○		Habitat alteration, drought, eutrophication	Higher temp and less precipitation
Increase in forest fires (Bhutan)	●		●			●		Forest fire, land degradation	Higher temp and extreme weather events like long dry spells
Invasion by alien or introduced species with declining competency of extant and dominance by xeric species (Mikania, Eupatorium, Lantana, etc.)	●○			●○			●○	Species introduction, land use change	Higher temp and less precipitation
Increased crop diversity and cropping pattern	○			○		○		Demographic and socio-economic change	Variable temp and variable precipitation
Drying and desertification of alpine zones			○				○	Drought, overgrazing	Higher temp and less precipitation

Change in land use patterns	●		●				●	Development policy, socioeconomic change	Variable temp and precipitation
Soil fertility degradation	●		●				●	External inputs, land use intensification, desertification	Higher temp and less precipitation
High species mortality	○	○		○		○		Range shift, pollution, deforestion	Higher temp and less precipitation, less days/hours of sunshine
More growth/biomass production in forests, variable productivity in agriculture (orange)	○●		○●			○●		Carbon enrichment, external input, reduced grazing	Increased CO_2 level, higher temp
Net methane emission from wetlands (Thoubal, Vishnupur)		○●	○●			○●		Resource use, drainage, eutrophication, flow obstruction	Increased CO_2 level, higher temp
Increased degradation and destruction of peatlands (bog, marshland, swamps, bayou)		○	○		○			Land conversion, drainage, removal of ground cover	Higher temp and less precipitation
Land use change that increases soil degradation	●		●				●	Overpopulation, unsustainable agriculture	Variable temp and variable precipitation

● Observed/documented response; ○ Projected/hypothesised response

Source: ICIMOD 2009

2.5 Projected climate impacts on land uses and ecosystem

2.5.1 Agriculture and Livestock

93. Climate change is expected to have pronounced and long-lasting impacts on the agricultural sector over the coming decades. Based on climate projections described above, climate change will likely cause increased water stress and prolonged dry periods and droughts, increased flooding and extreme precipitation events.[163] Beyond this, climate change is likely to contribute to accelerated erosion and land degradation (including reduced soil fertility) – trends that are reinforced by the widespread use of unsustainable land use practices.[164]

94. Changes in precipitation patterns are likely to affect rain-fed agricultural activities, causing significant annual yield variability and higher production risks. Climate change is also expected to increase the frequency of weather-related hazards (e.g. droughts and floods), further affecting croplands and yields[165].

95. The overall magnitude and specific consequences of climate change on agriculture are currently highly uncertain in Nepal because of the extreme complexities of downscaling global climate models (GCMs) and projecting climate variables for high elevations and in monsoonal geographies.[166] For instance, a study on the Indrawati River Basin in Nepal used 3 GCMs (CCSM4, EC-Earth and ECHAM6) to model the impact of climate change on water resources and crop yields. Potential changes in crop production ranged from -36% to +18% for wheat, -17% to +4% for maize and -17 to +12% for rice, indicating great uncertainty and variability.[167]

[163] CIAT et al. 2017
[164] Ibid.
[165] CIAT et al. 2017
[166] Dhakal et al. 2016.
[167] Palazzoli et al. 2014

96. Another study analyzed the impacts of climate change on net trade, yield and area (for crops), and animal numbers (for livestock products) over the period of 2020-2050. The study concluded that climate change will have mixed effects on agricultural production.[168] Climate change is likely to increase rice, vegetable and sugarcane crop areas as a result of shifting agro-climatic conditions, while reducing the suitable area for maize, wheat, lentil and potato production.[169] In terms of yield levels, maize, potato, sugarcane and lentil are likely to be most negatively affected by climate change, with yields in 2050 projected to be -16.1% (maize), -8.9% (potato), -8.0% (sugarcane) and -4.9% (lentil) relative to a scenario without climate change (Figure 25).[170] Future scenarios indicate that between 2020-2050, climate change could also negatively influence the number of cattle and buffalo kept for dairy and milk production (by -0.46 and -0.32%).[171]

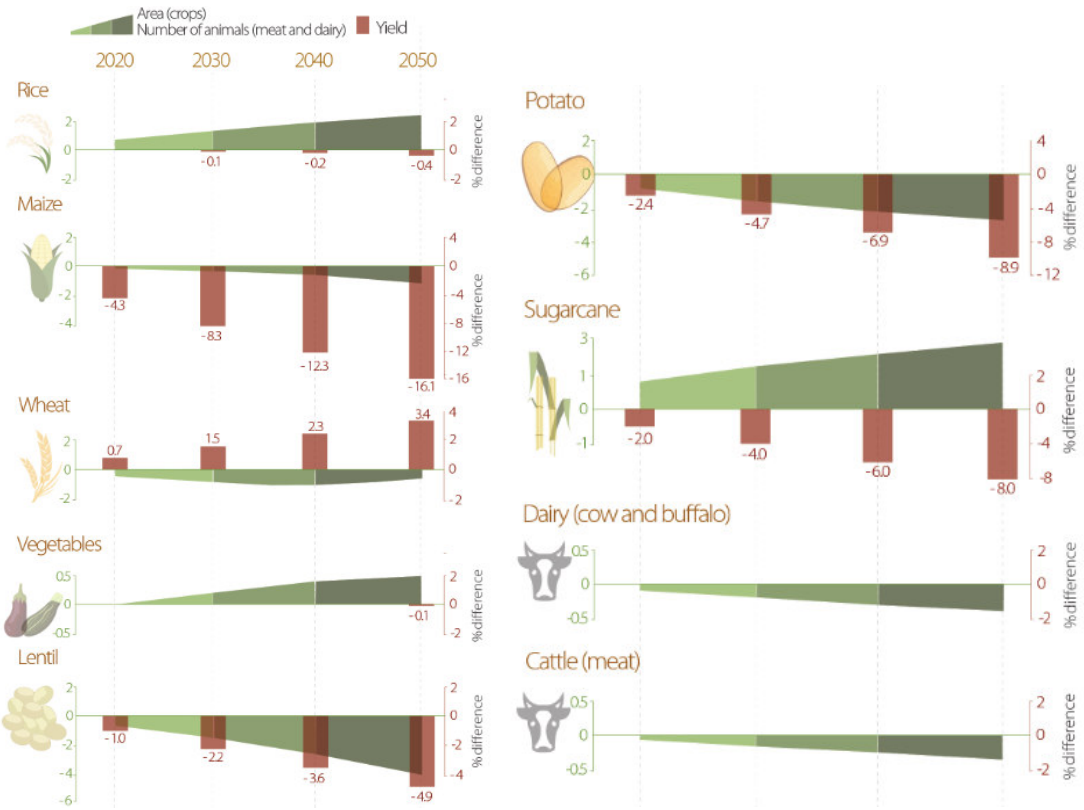

Figure 26: Climate change impacts on yield, crop area and livestock numbers in Nepal[172]

Source: CIAT; World Bank; CCAFS and LI-BIRD 2017. Climate-Smart Agriculture in Nepal

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[168] CIAT et al. 2017
[169] Ibid.
[170] Ibid.
[171] Ibid.
[172] Robinson et al. 2015

97. Crop losses associated with the negative impacts of climate change also pose a major risk for many Nepali households. The average household could lose almost half its income because of the complete failure of one crop in an area with 200% cropping intensity. Partial failures or mixed cropping would incur proportionally smaller losses.[173] Nepali families who derive their primary income from agriculture will suffer more. Areas with single rather than diversified crops will be most likely to fall victim to the predicted impacts of climate change, including (inter alia) increases in heat stress, diseases and pest loads.[174]

2.5.2 Forests and ecosystems

98. Climate change will have a significant effect on all natural ecosystems in the decades to come, but the impacts will be far greater on the already-stressed forest ecosystems of the Eastern Himalayas. The ecosystems are layered in the form of narrow bands along the longitudinal axis of the mountain range, and are thus easily impacted by climatic variations. These impacts are closely interlinked, ranging from biodiversity impacts and related effects on ecosystem goods and services, through impacts on water balance and availability and hazards, to socio-economic and health impacts on the population.[175] Table 2 in Section 2.4 presents projected climate change impacts on Nepal´s diverse ecosystems.
99. It is highly likely that climate change will affect the composition and distribution of vegetation types throughout the Greater Himalayas. Assessing the potential response of Greater Himalayan life zones to an increase in temperature of 5◦C along elevational gradients (without considering precipitation), projections show a significant decrease in alpine zones, oak forest, and evergreen forest. These ecosystems have the greatest biological diversity in the region (Figure 26).[176]

[173] NCVST 2009
[174] Ibid.
[175] ICIMOD 2009
[176] Xu et al. 2009

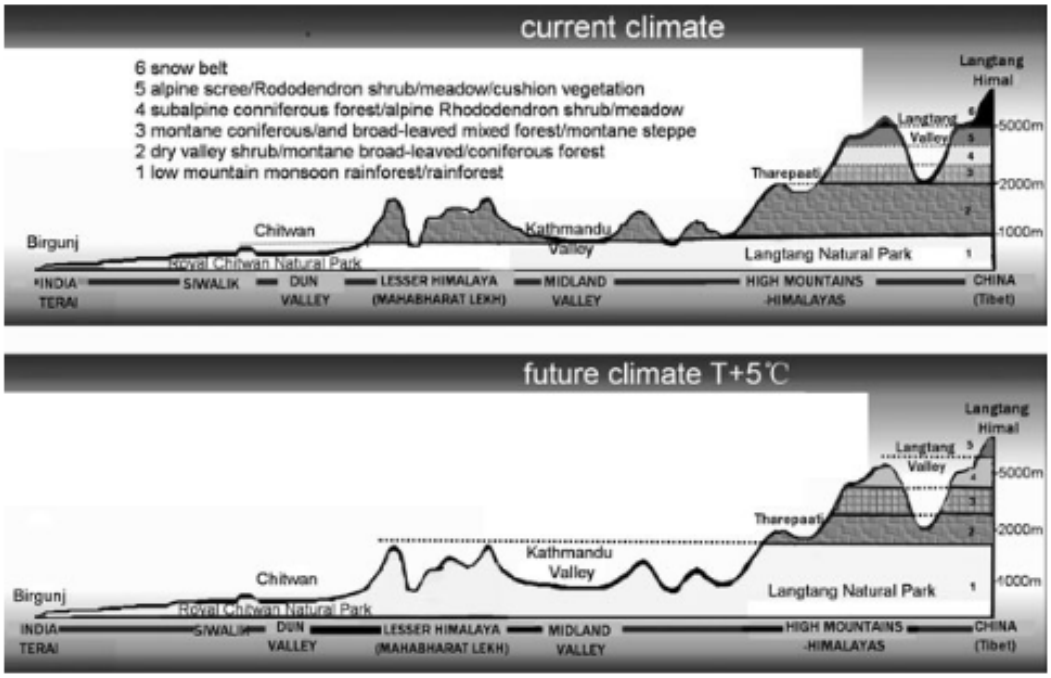

Figure 27: The current elevational distribution of life zones in the Himalayas and their distribution with a 5°C temperature rise

Source: Xu et al. 2009

100. Under projected climate change scenarios, both forest function and structure are likely to change substantially. Due to an increase in temperatures, changes in vegetation, rapid deforestation and scarcity of drinking water, habitat destruction and corridor fragmentation may threaten extinction of wild flora and fauna.[177] Thapa et al. (2015) note that lower and mid-hill forests in the subtropical and tropical zones of the country will be more vulnerable to climate change than montane and subalpine forests. Subtropical broadleaf forests are to become increasingly fragmented in the Chitwan-Anapurna Landscape by 2050.[178] Increasing fragmentation will lead to greater losses in habitat and ultimately biodiversity.

101. In the case of many dominant forest species of the region like sal (*Shorea robusta*), tilonj oak (*Quercus floribunda*) and kharsu oak (*Q. semecarpifolia*), seed maturation and seed germination coincide with monsoon rainfall. In wet conditions these species show vivipary. A rise in temperature and water stress may advance seed maturation, which might result in the breakdown of synchrony between monsoon rains and seed germination.[179]

[177] Negi et al. 2012.
[178] Thapa et al. 2015
[179] Singh et al. 2010

102. Spread of alien invasive species such as Lantana, Eupatorium and Parthenium spp. in the natural forests has also been linked with climate change, which will have a competitive impact on existing species.[180]

103. Unsustainable human interventions, including unsustainable harvesting of timber and non-timber forest products (NTFPs), among others, may also catalyze future impacts of climate change – increasing the vulnerability of local communities and ecosystems. Increasing dry conditions may cause land clearing practices with fire to rapidly spread, increasing the risk and scale of wildfires. Degradation and deforestation further result in accelerated erosion that can lead to land degradation and increased vulnerability to landslides and floods, as well as land degradation and biodiversity loss.

104. Such changes will all have major impacts on local livelihoods, since many people are dependent on forests for fuelwood, fodder, forage, timber, and non-timber forest products. They will further have a strong impact on indigenous peoples, who have strong cultural ties to nature, including forests. Inevitably, any change in the forest (distribution, density and species composition) under climate change would immensely influence economies like forestry, agriculture, livestock husbandry, NTFPs and medicinal plants-based livelihoods, among many others.[181]

[180] Ibid.
[181] Ibid.

3 STRATEGIC PROJECT CONTEXT

3.1 Landscapes, livelihood and production systems

105. Nepal is a low-income economy with a per capita income of $766.182. In 2014, Nepal achieved a score of 0.116 according to the multidimensional poverty index[183] (MPI), with an estimated 26.9% of the country´s population affected by multidimensional poverty, equivalent to around 7.5 million people.[184] Focusing on income-related poverty, approximately 15% of the population is considered to be living below the poverty line of $1.99 per day.[185]

106. The country has experienced rapid development in the last two decades and the government has made substantial progress in working toward its goal to graduate to a lower-middle-income country by 2022. The government is committed to tackling poverty, and has been committed to the implementation of measures to meet the Sustainable Development Goals (SDGs), in addition to national targets. Nepal has made large strides in addressing poverty at the national level; the country´s Human Development Index (HDI)[186] value has improved from 0.476 to 0.558 from 2005 to 2015.[187]

107. The livelihoods of the people living in the Churia Terai-Madhesh region of Nepal are heavily dependent on natural resources. Many households depend on subsistence and commercial agriculture for their livelihoods, and many households directly depend on forests for a variety of resources including fuelwood, timber, fodder and other NTFPs.

Agricultural Land[188]

108. The agricultural sector in Nepal was responsible for approximately one third of the country´s gross domestic product (GDP) in 2016.[189] Half of the agricultural GDP comes from crop production, followed by livestock (25%), vegetable production (10%), forest products (8%), and other products (7%).[190] Farming systems in the project area are primarily characterized by integrated crop and livestock subsistence farming. Livestock production includes goats (50% of livestock population in Nepal), cattle (29%), buffalo (14%) and other species (7%).[191]

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[182] MoF 2016

[183] MPI considers three core dimensions as a measure of poverty: i) health (nutrition, child mortality), ii) education (years of schooling, children enrolled) and iii) standard of living (e.g. cooking fuel, toilet, water, electricity, floor, assets). Additional information can be found at: http://hdr.undp.org/en/content/multidimensional-poverty-index-mpi

[184] UNDP 2016

[185] Ibid.

[186] HDI takes into account three dimensions to provide an estimation of to assess the development of a country. It is based on three dimensions: long and healthy life (life expectancy at birth, knowledge (expected ears of schooling, mean years of schooling), a decent standard of living (GINI per capita). Additional information can be found at: http://hdr.undp.org/en/content/human-development-index-hdi

[187] UNDP 2014

[188] Appendix B provides more detailed information on agricultural land in Nepal.

[189] World Bank Indicator Database; https://data.worldbank.org/indicator

[190] Adhikary 2017

[191] CBS 2014 in Adhikary 2017

Production of cash crops (especially maize, barley, sugarcane and vegetables) is present in the Terai region.

109. Agriculture is the main source of livelihoods in this region, where 84.3% of the female labor force and 62.2% of the male labor force were primarily employed in the sector (72% average).[192] The proportion of women´s employment in the agricultural sector has grown since 2011, due to the closing of other industries that employed women (especially carpet and garment industry), and due to the migration of male household members to urban centers or to other countries for labor.[193] This trend is referred to as the ´feminization´ of agriculture, which represents a major barrier to women as the sector offers ´low-return employment´, and is relatively labor intensive which has helped contribute to growing time-poverty for women. The abandonment of agricultural land has also increased as a result, where communities are no longer able to manage the same amount of agricultural land as before due to migration and other trends.

110. The project areas extend from the Churia hills all the way downstream to the upper Terai region. With regards to agriculture this means that there are different conditions and impacts of agriculture and land use which are linked, as land use patterns in the hills cause downstream effects in the plains of the Terai.

111. The Churia hill region as a whole accounts for 42% of Nepal's total land area and is home to 44% of the population. However, it produces about 16% less food than it actually needs[194]. The Terai, on the other hand, where about half of Nepal's population lives, is the granary of the country with an overall surplus of almost 125% and produces normally 56% of the national grain supply.[195]

112. All areas have in common that the crops are mostly grown under rainfed conditions (almost 67% of agriculture) and with very little use of commercial fertilizers. Because more than 80% of total precipitation falls during the monsoon (from June to September), the annual agricultural output in the dry season is highly dependent on weather conditions. The crop yield varies from year to year depending upon the weather conditions and is therefore highly susceptible to climate change impacts[196].

113. Most of the terrain in the Churia hills is not suitable for agriculture, yet many households continue to farm in this area, often for subsistence and using unsuitable agricultural practices that are not well suited to the local terrain. For agricultural crops, many households cultivate on sloped land without crop cover, and without terracing or other soil and water conservation measures that could otherwise help reduce erosion and improve water retention and soil health. Most of the households have small-livestock, especially goats, sheep, rams and pigs. Most households conduct open grazing, which contributes to forest degradation and soil compaction that catalyzes erosion and sedimentation from upstream to downstream areas, thereby further degrading fertile agricultural land in the Terai.

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[192] ILO 2017
[193] Ibid.
[194] Regmi 2007
[195] Ibid.
[196] Shresta et al. 2013

114. In the Terai, even though wheat and maize are considered as priority crops in the Agricultural Priority Plan of Nepal, the present rates of increase of crop yields have slowed. Soil erosion, organic matter depletion, acidification, degradation of forest and marginal land, crop intensification and insufficient and unbalanced use of chemical fertilizer have been reported as the main reasons for declining soil fertility[197]

115. Heavy reliance on rainfed farming, limited irrigation facilities, and a significant lack of water conservation and harvesting practices mean that extreme events can prove disastrous for agricultural output. Furthermore, rising temperatures will have a significant impact on the moisture and nutrient level of soil through rapid evapotranspiration, soil erosion, and landslides[198].

116. Unsustainable practices limit the resilience not only of households living in the Churia hills (e.g. by contributing to soil degradation and increasing the risk of landslides or erosion events), but also of downstream communities who are increasingly vulnerable to floods due to increasing river beds due to sediment loads from upstream areas.

117. In areas prone to flooding in the Bhavar, dun valley and Terai, agricultural practices are not well-adapted to this risk. Farmers are rarely aware of climate-resilient agriculture practices.

Forests

118. Inhabitants of the BRCRN project area are heavily dependent on forests for diverse products and socio-cultural services. Forests provide communities with timber for construction, fuelwood, livestock fodder and other NTFPs. Despite being located primarily in the Churia hills and Bhavar regions, these forests are also used by mid- and distant users from the Terai region – given the lack of forest resources in the Terai region and communities´ continued reliance on forest resources for their livelihoods.[199]Many poor households sell firewood and other forest products in order to supplement their income from other sources for meeting their subsistence requirements – thus serving as a safety net for many families. Forests further serve as an area for recreation and eco-tourism (e.g. picnic spots, walking trails). Many communities, especially indigenous communities, have a strong cultural link to the natural environment.

119. This dependence on natural resources makes these populations highly vulnerable to the effects of climate change, especially considering the exposure of such communities to climate-induced natural disasters including floods, landslides and droughts.

120. Additional information about baseline farming, forest and land management practices in the four biophysical zones targeted by the BRCRN project is included in Table 6 in Section 4.1 of this Feasibility Study.

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[197] Ibid.
[198] Synnott 2012
[199] Satyal Pravat and Humphreys 2013

Box 1. Extension Services in Nepal[200]

Extension and training services are extremely important for reaching smallholder farmers whose livelihoods are dependent on the agriculture and forestry sectors in Nepal. Currently there are six main approaches applied in Nepal:[201]

- **Conventional Education Approach**: Local champions and farmers are trained on new approaches, and then continue to disseminate the practices and lessons learned to other farmers based on farmer-to-farmer networks. Substantial examples of this are present in rural areas, e.g. where farmers have adopted conservation ponds and ecotourism plans based on practices adopted by neighboring communities or CBOs.
- **Pocket Package approach**: Focuses on extension for specific commodities in areas that are considered production ´pockets´. Such an approach is oriented towards more commercial practices.
- **Projectization approach**: Often linked to pocket package approaches although developed within the framework of a project – with limited time, budgets and a concrete expected output by the end of the project.
- **Farmer Field Schools (FFS):** FFS are schools focused on adult learning for farmers that improves their access to knowledge and skills for improved agricultural practices. This seen as an effective approach to extension in Nepal, and is favored due its democratic, inclusive and participatory process.[202]
- **Partnership approach:** Based on partnerships between government entities and CBOs, CSOs, and private organizations to support the delivery of extension services. The quality of such extension services may differ based on the capacities and interests of partners.

While advances in the quality of extension services have occurred with improvements in FFS and partnership approaches, the latter especially due to the success of community-based organizations for natural resource management, various challenges persist:[203]

- **Lack of motivation and engagement of rural youth**: The insufficient access to agricultural knowledge was identified as a major challenge in attracting the younger generation to agricultural activities.
- **Natural resource degradation and climate change:** Losses in agricultural productivity are linked to ongoing trends of unsustainable natural resource management and climate change, as described above. Agricultural extension services have not been fully adapted to address such risks and to raise awareness of climate change risks and appropriate risk reduction practices. Further, the lack of appropriate integrated management practices, particularly in upstream areas, increases the vulnerability of communities downstream – that can also reduce the effectiveness of extension support downstream (e.g. if investments are increasingly destroyed by climate-related hazards).
- **Inadequate ratio of extension workers, and limited qualifications and skills:** While the exact ratio of extension workers to the rural population is not known, it is thought to be very low. Skill development and trainings for extension workers is needed to improve their awareness

[200] Adapted from Dhital 2017
[201] Dhital 2017
[202] Sharma 2011, Dhital 2017
[203] Dhital 2017

of modern technologies, improved practices and climate-resilient land use planning and management approaches. Extension workers also need to improve skills on commercial topics including marketing and climate-resilient value chains to help strengthen local livelihoods through extension support.

- **Inadequate infrastructure and capacity for use of information communications technology among local extension workers:** Investments in ICT technology are seen as crucial to improve the effectiveness and sustainability of extension services, however investments in such technologies and appropriate trainings has not been sufficient. Additional support is needed to strengthen the link between such technologies and knowledge management and monitoring systems, to collect data on agricultural practices and conditions to improve and provide more targeted extension services, while also generating key knowledge that can contribute to sustainable development and land use planning.
- **Low level of education of farmers:** Many farmers within the project area may have low levels of education, and do not have up-to-date information on the most sustainable or appropriate practices. Extension approaches need to take into account potential challenges, including illiteracy, focusing on targeted approaches for knowledge dissemination and education.
- **Insufficient budget** for investments to support smallholders to scale up sustainable practices, and to invest in extension activities (both reach of services, and development of extension materials). Diminishing public budgets for extension services, and insufficient mobilization of private sector actors to support privatized extension services.
- **Inadequate extension services related to marketing and value addition**, creating fragmented value chains.

3.2 Policy Commitments

121. The Government of Nepal is committed to addressing issues of climate change mitigation and adaptation, especially in line with livelihood improvement, as demonstrated by the country's ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Nepal ratified the Kyoto Protocol (2002) and the Paris Agreement (2016), and has submitted its 1st and 2nd National Communication Reports of greenhouse gas emissions (2004 and 2014) and Nationally Determined Contributions (NDC) to the UNFCCC. Within the country´s NDC, measures to support climate change mitigation and adaptation are described, including efforts to support institutional strengthening, policy mainstreaming, knowledge management, as well as mitigation and adaptation-specific actions. Nepal´s NDC however notes that while it is one of the most vulnerable countries to climate change, that given its LDC status and ongoing recovery from the devastating 2015 Earthquake, the country requires additional bilateral and multilateral grant support to meet its climate change targets and commitments for both climate change mitigation and adaptation.

122. Nepal is a signatory member of various other relevant international conventions and initiatives, including the Convention of Biological Diversity (CBD), United Nations Convention to Combat Desertification (UNCCD), and the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW). Nepal also voted in favor of the United Nations Declaration on the Rights of Indigenous Peoples. In addition, Nepal has taken proactive steps toward achieving the global Sustainable Development Goals since their development in 2016

through forming three high-level committees to steer, coordinate and implement relevant national programs, with the aim of becoming a middle income country by 2022.[204]

123. Nationally, Nepal has initiated various national strategies, policies and plans to support climate change mitigation and adaptation, including the elaboration of its Climate Policy (2011) and the mainstreaming of such topics across sectors through sector strategies and development plans. Nepal´s Climate Change Policy (2011) aims to improve livelihoods by reducing climate change impacts, adopt a low-carbon economy development strategy and reduce greenhouse gas emissions through clean energy and sustainable natural resource management. These priorities are also highlighted in the Fourteenth and Thirteenth National Development Plans, which recognize the role of forests in contributing to both climate adaptation and mitigation efforts, and calls for the conservation, sustainable management and use of forests and watersheds. They further emphasize the development and dissemination of environmental friendly agricultural technologies and agro-biodiversity conservation and promotion.

124. The National Adaptation Programme of Action (NAPA) identifies a number of priority actions for adaptation and reducing land degradation, including: i) sustainable land and forest management; ii) improved agricultural value chains; iii) restoration of degraded areas; iv) climate-related research, information and awareness generation; and v) disaster preparedness.

125. On a national level, Nepal's Forestry Sector Strategy (2016-2025) aims to, among other things, supports the adaptive capacity of local communities and forest ecosystems, and promotes biomass-based renewable energy. The Strategy has a goal of enhancing Nepal's forest carbon stock and to decreasing the mean annual deforestation rate in the Churia Hills. Nepal's Forest Sector policy (2015) envisions contributing to local and national development (improved livelihood opportunities) through sustainable management of forests, biodiversity, as well as watersheds. Nepal's Forest Act (1993) and Forest Regulation (1995) are core legislative instruments to regulate forest tenure and management, and to empower communities to sustainably manage their resources.

126. Nepal is in the process of developing its National REDD+ Strategy, which aims to reduce emissions from deforestation and forest degradation. Substantial research and consultations have been conducted within the framework of REDD+. Nepal's National REDD+ Strategy calls for the formulation of Policies and Measures (PAMs) that would achieve emission reductions within the energy, infrastructure, forestry and agriculture sectors. Examples of PAMs that it supports include: reducing GHG emissions from deforestation and forest degradation caused by the extraction of fuel wood and promotion of efficient cooking stoves, improved management practices in community and collaborative forests, localizing forest governance through the transfer of national forests to community and collaborative forest user groups, expanding private sector forestry operations, scaling up pro-poor leasehold forestry, improving integrated land use planning and strengthening capacities for protected area management. Participatory approaches used to develop District REDD+ Action Plans (DRAPs) for the country´s Emissions Reduction Program (ER-PD) also have served as an innovative approach to balance

[204] National Planning Commission 2017

top-down and bottom-up land use planning and policy design (providing key insight for Activities 1.2 and 1.3). Several institutions within Nepal have also supported and implemented various REDD+ initiatives and activities, and the development of REDD+ has provided key lessons learned and experiences for scaling up low-carbon land use practices.

127. The Government of Nepal has also enacted various policies, programs and strategies focusing on the Churia region of Nepal, recognizing its fragility and the unique challenges faced by the region. The Government of Nepal enacted the *´President's Chure-Tarai Madhesh Conservation Development Board´* (PCTMCDB) on July 17, 2014, with the objective to support integrated and coordinated efforts for conservation in the Churia region. The board supported the elaboration of the 'President's Chure-Tarai Madhesh Conservation and Management Master Plan' (hereby referred to as the *´Churia Master Plan´*), which aims to provide strategic direction for conservation in the Churia. More specifically, it aims to support the integrated management of upstream and downstream land use activities, promoting an integrated landscape approach. The Churia Master Plan is in line with Nepal's constitution, the aim of this plan is to support poverty reduction - in pursuit of the national goal of *´prosperous Nepal´* - through conservation and sustainable management of the Churia region´s resources and improvement of ecosystem services.

128. The Government of Nepal further aims to support access and adoption of alternative renewable energy sources to mitigate climate change, reduce pressure on forests, reduce the reliance on energy imports and ultimately support sustainable development within Nepal. About 77% of energy consumption in Nepal is supplied by traditional biomass energy, including the firewood, cattle dung and agricultural residues.[205] Within the Churia hills around 75% of households rely on fuelwood as their main energy source, whereas households in the Terai/Madhesh region primarily use cow dung for their household energy.[206] The unsustainable harvesting of fuelwood is leading to increased forest degradation that has a major impact on both ecosystem integrity and communities´ livelihoods. The use of cow dung as an energy source may not have a major impact on forest health, but nonetheless is considered a major source of GHG emissions in the region and the emissions have a negative impact on human health. Aware of ongoing challenges, the Government of Nepal developed an Alternative Energy Subsidy Policy in 2012, and revised the policy again in 2016 to support the uptake of such technologies. The Renewable Energy Subsidy Policy (2016) aims to "reduce dependence on traditional and imported energy by increasing access to renewable energy for improving the livelihoods of people and creating employment opportunities, especially in rural areas".[207] Subsidies differ depending on the technology and region, however in general subsidies cover around 40% of costs, where 30% often come from credit and 30% from private sector, community funds or households.[208]

129. Appendix C includes a more detailed table with a summary of the major policies strategies, plans and acts in Nepal that demonstrate Nepal´s commitment´s to climate change action and safeguarding natural resources.

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[205] MOPE 2017
[206] PCTMCDB 2016
[207] Ibid.
[208] Ibid.

130. It should be noted that with the political and institutional transitions ongoing in Nepal due to the 2017 elections, that many of the aforementioned policies, strategies and acts will need to be revised and adjusted in accordance with the new political and governance system. Thus, the project comes at a unique and opportune moment to mainstream climate change and SNRM into policies, and strengthen institutional capacities on such topics at the local and provincial level.

3.3 Relevant Existing and Past Projects

131. Since the late 1980s several specific initiatives have focused on natural resource management and development in the Churia region have been implemented.

3.3.1 FAO Projects

132. FAO has been working in Nepal since 1951 and works on diverse projects and programs in the agriculture and forestry sectors of Nepal. FAO also supports various emergency projects in Nepal, especially focusing on restoring agricultural-based livelihoods and emergency assistance after the devastating earthquake in Nepal in 2015.The Country Partnership Framework for Nepal highlights four priority areas where the FAO is focusing its efforts:

i) Food and nutrition security and safety
ii) Institutional and policy support
iii) Market orientation and competitiveness
iv) Natural resource conservation and utilization

133. While FAO is working on numerous global, regional, country-level and sub-national projects, the following Table provides examples of projects that are pertinent to the proposed project.[209]

[209] For more information, refer to: http://www.fao.org/nepal/programmes-and-projects/project-list/en/

Table 3: Examples of project from FAO Nepal related to the agriculture and forestry sectors in Nepal

Name of the Project / Programme	Duration	Development Objective	Geographic Coverage	Total Assistance (US $)	Donor country / Institutions
TRUST FUND PROJECTS					
GCP /NEP/070/LDF: Reducing Vulnerability and Increasing Adaptive Capacity to Respond the Impacts of Climate Change and Variability for Sustainable Livelihood in Agriculture Sector	01 Oct 2015 - 30 Sep 2019	To increase technical and institutional capacities in agriculture and livestock sector to respond to the impacts of climate change and variability; To promote transfer and adoption of sustainable, climate-resilient and environment friendly agriculture practices and technologies to increase adaptive capacities of rural livelihoods to climate change and variability; and To promote awareness raising, knowledge and education on climate change adaptation among local communities and stakeholders.	Udayapur; Siraha; Kapilvastu; Argakhachi	2,689,498	GEF /LDCF
UNJP/NEP/074/UNJ: Accelerating Progress toward the Economic Empowerment of Rural Women in Nepal: A Joint Pilot Contributing to the Implementation of the Agricultural Development Strategy	15 Feb 2015 - 30 Jun 2018	The overall objective of the programme is to secure rural women empowerment and rights to promote their livelihoods in selected districts of Nepal, ensuring sustainable development in the post conflict context of Nepal	Sindhuli, Rautahat and Sarlahi	433,283	UNDP Administered Donor Joint Trust Fund
UNFA/GLO/616/UND: Supporting Developing Countries to Integrate the Agricultural Sectors into National Adaptation Plans (NAPs)	01 Jul 2015 - 31 Dec 2018	The overall objectives of the project is to build technical capacities of MoAD and other relevant ministries to integrate climate change concerns into relevant national and sectoral plans and budgets	National	420,000	UNDP
EP/NEP/075/UEP: Promoting transformative and climate resilient agriculture (CRA) in Nepal-Preparation FP for GCF	01 Oct 2017 - 31 Mar 2018	The overall objective of the project is to promote transformative and climate-resilient agricultural practices	National	230,907	UNEP/GCF readiness fund
TCP Projects					
TCP/NEP/3503: Building Agribusiness Capacity of Smallholder Farmers to Market Safe Produce of Good Quality	01 Apr 2015 - 31 Mar 2017	The project will contribute to improving smallholder incomes and enhance access to safe produce of good quality, thereby improving food security and nutrition.	Dhading; Kavre; Kapilvastu; Bara	350,000	FAO
TCP/NEP/3601: Landslide prevention and stabilization of slopes in the most earthquake affected districts of Nepal	01 Oct 2016 - 30 Sep 2018	The project will contribute to implement landslide treatment and mitigation measures as well as improved land management practices by applying the low-cost techniques suitable for adoption by local communities in Dolakha District	Dolakha District	406,000	FAO

Name of the Project / Programme	Duration	Development Objective	Geographic Coverage	Total Assistance (US $)	Donor country / Institutions
TCP/NEP/3602: Enhancing Rural Livelihoods in Abandoned/ Under-utilized Agriculture Land through Agroforestry	01 Oct 2016 - 30 Sep 2018	Contribute to an increased area of productive agriculture land and its productivity through utilization of under-utilized/abandoned agricultural land with significant contribution to livelihood enhancement of the target population	Kaski and Parbat	311000	FAO
Emergency Projects					
OSRO/NEP/602/USA-Building Resilience to Landslides and the Establishment of Early Warning Systems in Nepal	02 Sep 2016 - 31 Aug 2018	Protection of landslide prone households and crop land in the targeted areas and reduce the loss of life due to such hazards.	Nepal (Nuwakot district)	490,074	OFDA/USAID
OSRO/NEP/701/CHA Rapid response to the severely flood affected farming communities for the enhancement of food security	12 Sep 2017 - 31 Mar 2018	To support flood affected farming house hold in the most worst affected districts through provision of critical inputs in order to resume the disrupted agricultural production activities.	Rautahat, Sarlahi	400,003	CERF
Regional Projects					
TCP/RAS/3620: Strengthening One-Health Programme in the Asia Pacific Region	01 Jan 2018 - 30 Sep 2019	To strengthen One-Health Programme in the Asia Pacific Region and to generate concrete evidence on improved collaboration for solving problems with multiple facets such as pesticide residues in food, the lack of food safety and hygiene leading to malnutrition and environmental pollution and other risks affecting plant health, animal health and the safety of the food that is produced through these value chains.	Nepal, Papua New Guinea, Viet Nam	490,000	**FAO**
Global Projects					
GCP/GLO/495/MUL: Forest and Farm Facility Nepal	01 Jun 2013 - 30 Sep 2018	To increase household income of the smallholder, women, community and indigenous peoples groups by sustainable management of forest and farm resources	Kavre; Nawalparasi	500,000 (Nepal component)	Government of Finland
UNJP/GLO/386 UNJ: Baby -1 UN REDD	01 Nov 2011 - 31 Dec 2017	Assessment of national Policies, Laws and Regulations (PLRs) and institutional arrangements pertaining to REDD+ and to identify gaps and overlaps for REDD+ implementation	National	51,760 (Nepal component)	UN REDD Program UNDP/UNEP

3.3.2 Other Projects/ Programs

134. Various lessons learned have been generated from projects and programs piloted in the Churia and Terai region of Nepal. Main lessons are summarized in the following table.

135. Many past projects in the Churia have not had a central focus on climate change, but have included measures with climate change benefits within the project. Ecosystem-based adaptation measures are relatively limited, and many projects have had a stronger focus on mitigation, especially REDD+. There is a need for projects to improve awareness on climate change threats and risk reduction practices, including climate-resilient land use practices.

136. In terms of forestry interventions, important results have been achieved in areas where projects were implemented – providing key lessons learned for CFUGs and CoFM, including how to engage local communities and distant users in different natural resource management models. However, as mentioned above, key barriers have limited the ability of the Government to scale them up, limiting the effectiveness of these projects to reduce environmental degradation and vulnerability at scale.

137. The BRCRN project thus aims to build on the successful experiences and lessons learned from diverse projects related to natural resource management and climate change, and scale up proven effective measures to reduce emissions from deforestation and forest degradation, while also improving the resilience of critical ecosystems and vulnerable communities. There is no overlap with existing large projects, and there are substantial synergies with proposed and planned projects, such as the UNDP GEF Project, Hariyo Ban Phase II, FIP and Nepal´s ER-PD. Building on synergies with these other planned projects, there is the potential to contribute to transformational change within the entire Churia and Terai region of Nepal towards low-carbon land use.

Table 4: Overview of past projects in the Churia region of Nepal and key lessons learned

Project Name	Brief description	Key Lessons Learned/ Considerations
Churia Forest Development Project (ChFDP)	GTZ project (1992-2005) The program aimed to increase the productivity of forests, reduce consumption of forest products and decrease poverty while improving environmental stability	Key lessons on how to adapt CFU management to the context of the Churia (integrating soil and water conservation, agroforestry, and generation of alternate incomes). Main challenge was finding budget for scaling up piloted measures. Important for piloting key measures with climate benefits, especially related to soil and water conservation, although the main objective was not focused on climate change.
Livelihood and Forest Program	DfID (2000-2007) Implemented similar projects to GIZ in 2 districts in Western Churia, in addition to piloting CoFM.	Strengthened CF and CoFM approaches, focusing on improving community engagement in forest management and strengthening benefits. Focus was not on climate change, although measures promoted had climate change adaptation and mitigation benefits.
Biodiversity Sector Program for Siwaliks and Terai	Piloted measures in collaborative forests from 2002-2007	The program introduced an effective method to manage a large block of Terai forests while engaging the local population and distant users in forest management, and allowing for considerable income for the central government. Demonstrated the effectiveness of CoFM, and the ability to engage distant users from the Terai in sustainable forest management together with local communities, and share benefits among users and government authorities. Again, the focus was not on climate change, where climate benefits were only a co-benefit.
Various Programs of the Department of Soil Conservation and Watershed Management	Ongoing programs implemented by the department to support watershed management and mitigate land degradation as part of the water strategy of Nepal	Substantial experiences piloting check dams, contour bunds, stone walls, conservation ponds, among other measures, to improve water security and reduce sedimentation and erosion in the fragile Churia Region. Largely positive experiences piloting these practices, where additional co-benefits are highly visible (e.g. improved resilience to natural hazards). Major challenges to scaling up such measures include: i) limited budgets for investment support and extension; and ii) lack of integrated planning (led to uncoordinated/ fragmented upstream/downstream investments). Also, planning is often focused on current risks, and does not take into consideration climate change.

Project Name	Brief description	Key Lessons Learned/ Considerations
Nepal Gold Standard Biogas VER (WWF)	500 biogas plants were installed in the Terai-Arc Landscape with the objective to reduce the consumption of fuelwood	Provided key lessons learned in how to effectively scale up domestic biogas use, through cooperation with CBOs. Program raised awareness of REDD+ within project area. Project successfully safeguarded 617 acres of forested land (equivalent to 33,000 tons of fuelwood), [210] and based on this success aims to scale up the project to 20,000 biogas plants.
Renewable Energy for Rural Livelihoods (UNDP)	The project aims to support the implementation of the National Rural and Renewable Energy program, and has so far supported the preparation of the Government´s revised Renewable Energy Subsidy Policy (2016), and Subsidy Delivery Mechanism (2016).[211]	Scaling up renewable energy, establishing government subsidy policy Scaling up domestic biogas and the adoption of other renewable energy technologies Focus on capacity building, cooperation with CBOs including participatory mapping and targeting measures based on household characteristics, including targeted measures for engaging marginalized and female-headed households. Biogas investments are not linked to agricultural extension, and there is room to improve the synergies between livestock as a driver of deforestation and the need for targeted extension to improve livestock management along with biogas investments
Churia Livelihood Improvement Programme in Sarlahi, Mahottari and Dhanusha districts (2007-2013),[212] and the SAKCHAM I and II projects (2007-2015)	The projects aimed to ensure gender responsive policies and their implementation through women's participation, to enhance women's wellbeing and influence over decisions at the household and community level, and improving the economic condition of women by	While the core focus of the CARE project was not on climate change, it provided key lessons learned for engaging women in natural resource management, improving their access and control over resources, and strengthening womens engagement and influence over decisions at the household and community level. Lessons learned related to women´s empowerment serve as guiding principles for the development of gender and capacity building components of the BRCRN project. These experiences have been integrated into the applied extension, capacity building approach, gender action plan and indigenous peoples planning framework. Since climate change was not a strong element of the project, with the foundation established by the project there is a major potential to continue empowering women and raising their engagement on climate change threats and climate-resilient land use.

[210] http://www.wwfnepal.org/what_we_do/climate/gold_standard_biogas/
[211] UNDP 2017
[212] Ørnemark and Thapa 2013

Project Name	Brief description	Key Lessons Learned/ Considerations
	increasing their capacity to assess/ use public resources.	
Hariyo Ban (USAID, WWF and other actors)	Focused conservation and climate change adaptation efforts on the 12 districts from the Far Western to Central region known as the Terai Arc Landscape (TAL) since 2012, focusing primarily on the Churia hills on the northern side.	Supported local communities to prepare and implement community adaptation plans in line with National Adaptation Plan of Action (NAPA) and National Framework on Local Adaptation Plans for Action (LAPA. Project demonstrated the importance of participatory processes, working with organizations to balance environmental conservation with local livelihoods. The project supported measures aimed to enhance biodiversity conservation, REDD+ policies and strategies, the adoption of alternative renewable energy to reduce fuelwood consumption and the use of unsustainable energy sources, elaboration of community forest operation plans, establishment of forests, as well as various measures related to livelihood support (including the elaboration of livelihood improvement plans, skill-based training, support for ecotourism).
FIP	Endorsed in December 2017, the program will promote SFM through CBOs, sustainable forest value chains, private land forest development, fodder banks, nature-based tourism, watershed management in Sun Koshi and Kali Gandaki river	Aims to scale up successful lessons learned from aforementioned projects.
Connecting the TAL with the Chitwan-Annapurna landscape (CHAL)	Small WWF GEF project in development to build on Hariyo Ban, and connect the TAL with CHAL.	Aims to strengthen conservation and climate adaptation components, scaling up many practices from Hariyo Ban.
Emission-Reduction program (not approved)	Developing ER program for FCPF that will cover almost half	Measures proposed include: improved management practices for existing community and collaborative forests, building on traditional and customary practices; localized forest governance through the transfer of national forests to community and collaborative forest user groups; expansion of private sector forestry operations through improved access to extension services and finance; expansion of private sector forestry operations through improved access to extension services and finance; expansion of access to alternative energy

Project Name	Brief description	Key Lessons Learned/ Considerations
	of the entire Churia region- primarily in central and western Nepal.	(biogas and cookstoves); scaling up pro-poor leasehold forestry; improving integrated land use planning to reduce forest conversion with infrastructure development; strengthening capacities on protected area management. Builds on successful experiences from aforementioned projects.

4 PROJECT LOCATION AND BENEFICIARIES

4.1 Project Location

138. The BRCRN project area is comprised of 26 vulnerable river systems in the Central and Eastern Churia Terai-Madhesh region of Nepal (methodology for their selection described in Appendix D). The impacts of climate change and unsustainable NRM are not only felt by those living within the project area, but both nationally and internationally. With the Terai region serving as the grain-basket of Nepal, and the Bhavar and Churia hills serving as the water reserve for the Terai and downstream areas in India, the Churia region plays a critical role in terms of both national economy and integrity, as well as transboundary-water management.

139. In total the project area covers 702,011 ha, excluding settlements and bodies of water. Within the BRCRN project area, cultivated land covers around 390,000 ha, followed by forests with 227,276 ha (**Error! Reference source not found.**). Roughly 50,000 ha is considered as degraded or marginal land. More than 35,000 ha of open riverbeds in these river systems underpin the dramatic changes, and loss of productive land due to sedimentation and widening of river beds.

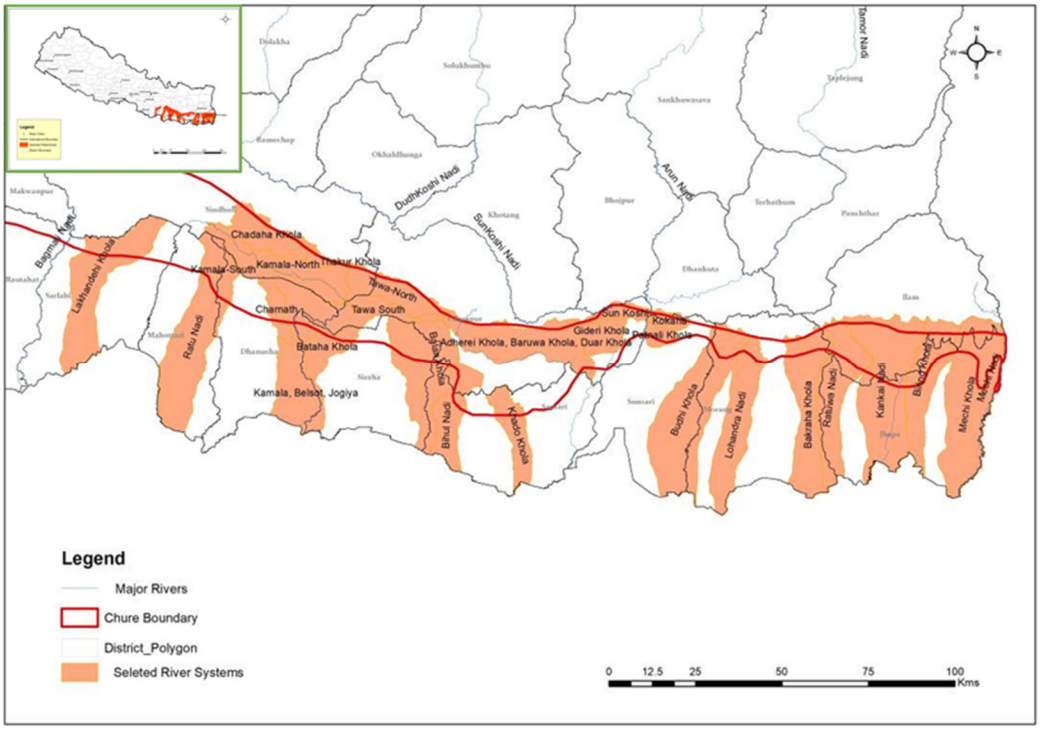

Figure 28: Selected river systems for the BRCRN project. The red boundary shows the core intervention zone within the river systems

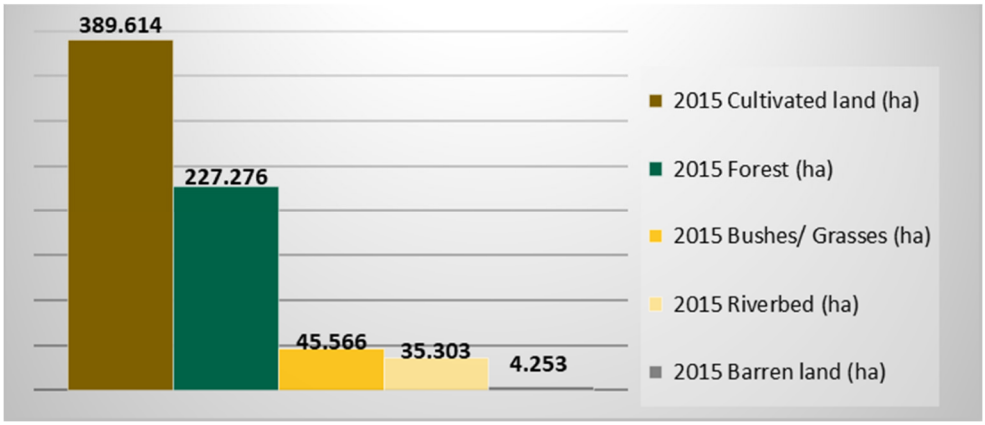

Figure 29: Total land use areas of the selected 26 river systems excluding settlement areas and water bodies in 2015

140. The following Table summarizes some of the characteristics of this total project area consisting of the selected 26 river systems, while a more detailed Table can be found in Appendix C. The population according to the latest census in 2011 is over 3.2 million, of which more than 700,000 people are settled in areas that are highly susceptible to flooding during the monsoon season. In the Churia hills, almost 96,000 people live in areas with slope conditions considered highly susceptible to erosion and landslides. In total, more than 96,000 ha of the project area is prone for flooding and 150,000 ha of the area is classified as having 'high' or 'medium' slope instability.

Table 5: Summary characteristics of the BRCRN project area

Population 2011	3,216,248 people
Population 2011 prone to flooding	705,876 people
Total no of settlements	5,083 settlements
No of households susceptible to erosion/ slope instability	19,661 households
Area prone to flooding (ha)	96,311 ha
Area with slope instability classified as medium and high	150,642 ha

Biophysical Zones

141. Within each of the river systems in the BRCRN project there are four distinct bio-physical zones, with shared land use characteristics, land use changes and socio-economic activities:

- Churia Hills (33% of project area)
- Bhavar (18% of project area)
- Dun Valleys (Inner-Terai; 3% of project area)
- Terai (46% of project area).

142. The following Table provides an overview of the terrain in each zone, key land use practices and a description of how baseline land use practices influence vulnerability to climate change in each zone. Additional information on climate, soils, water, vegetation and biodiversity can be found within Section 2.

Table 6. Overview of the four main biophysical zones in the project area

Zone	Description of Terrain	Agriculture	Forests	Land Use and its Impact on Vulnerability
Churia Hills (33% of project area)	▪ Hilly terrain with steep slopes, typically located at higher altitudes. ▪ Made of coarse-grained, soft conglomerates that are very prone to erosion. ▪ Communities are highly dependent on forests for their livelihoods (for subsistence and income). ▪ Within the Churia hills, forests play an essential role in preventing land erosion, with estimates showing that in the absence of forest cover, around 13% of the total Siwalik range would be converted into desert within a year.[213] Top soil loss from the mountainous regions has led to an estimated annual rate of 15-30cm riverbed rise in the Terai region, contributing to increasing exposure to (and impacts of) floods, and damage to infrastructure (e.g. irrigation canals, dams/ hydropower sites), and land (e.g. erosion, reduced soil fertility). On average, soil loss in well managed forest areas is estimated to be about 10t/ha/year and in fragile areas 30t/ha/yr.[214]	▪ 13% cultivated land. ▪ Majority of terrain unsuitable for agriculture, nonetheless many poor households cultivate on steep slopes for subsistence. ▪ Agricultural production is characterized by rain-fed, primarily low-yield fallow agriculture with different crops including upland rice, maize, vegetables and mustard, among other crops.[215] ▪ Many households have small-livestock, especially goats/sheep/rams, pigs, and some households have buffalos who are often raised for subsistence using traditional practices, including free-grazing in forested areas (contributing to forest degradation). Such systems have low productivity. ▪ Erosion is a major challenge for agricultural activities, and many households apply unsuitable agricultural practices (i.e. do not apply soil or water conservation measures).	▪ 76% forest cover. ▪ Majority of households use fuelwood for household energy needs. Forests provide not only fuelwood, but also fodder, forage, timber and non-timber forest products for forest-dependent households in the Churia. ▪ 75% of deforestation and forest degradation in the BRCRN area occurred in the Churia hills. ▪ Drivers of deforestation and forest degradation include encroachment, uncontrolled grazing, agricultural expansion, unsustainable harvesting of forest products.	▪ Deforestation and degradation as well as inappropriate agricultural (incl. livestock) practices increase the risk of erosion and landslides in the Churia Hills. ▪ Such activities further increase sedimentation and erosion that reduce agricultural productivity in the Churia hills, and ultimately increase the vulnerability of downstream communities to flooding. ▪ Increased sedimentation and erosion will also contribute to declining agricultural productivity and increased land degradation, which could further accelerate deforestation and forest degradation (vicious cycle). ▪ Alarming trend of decreasing soil fertility due to low input (organic matter) farming practices.

[213] MoPE 2000
[214] Ibid.
[215] MoFSC 2014

Zone	Description of Terrain	Agriculture	Forests	Land Use and its Impact on Vulnerability
Bhavar Zone (18% of project area)	▪ An intermediate or transition zone between the Churia and Terai. ▪ This zone has its own distinct geo-morphology, and is characterized by the deposition of primarily rough sediments. ▪ The Bhavar region is an important zone for ground water recharge given its unique geological characteristics and soils. ▪ The Bhavar zone is characterized by the low availability of drinking and irrigation water. ▪ Land use in the Bhavar region includes a mixture of forest and agriculture activities.	▪ 35% cultivated land. ▪ Agricultural production is limited due to the unsteady supply of water. Traditionally, the Bhavar is mainly forest land and is thought to be relatively unsuitable for agricultural practices. ▪ In the Bhavar region, surface water is declining due to the deposition of sediments on the river-beds. This limits agricultural production in the region. ▪ Many households have small-livestock, especially goats/sheep/rams, pigs, and some households have buffalos who are often raised for subsistence using traditional practices, including free-grazing in forested areas.	▪ 49% forest cover. ▪ Majority of households use fuelwood for household energy needs. Forests provide not only fuelwood, but also fodder, forage, timber and non-timber forest products for forest-dependent households in the Bhavar region. ▪ Drivers of deforestation and forest degradation include encroachment, uncontrolled grazing, agricultural expansion, unsustainable harvesting of forest products.	▪ Deforestation and degradation increase the risk of erosion and landslides in the Bhavar region, as well as increased sedimentation and erosion that reduce agricultural productivity in the Bhavar region. Such land use trends further increase the vulnerability of downstream communities to flooding through accelerated sedimentation and erosion. ▪ Gully erosion leads to significant loss of land. ▪ Reduced vegetation cover (from deforestation and inappropriate agricultural practices) further limit ground water recharge, increasing the vulnerability of downstream communities to extreme heat and water deficit.
Dun Valleys (3% of project area)	▪ The Dun valleys, also known as the ´inner Terai´, are valleys surrounded by the Churia hills. ▪ Among the most fertile and productive lands in Nepal with steady groundwater supply. ▪ Settlements are often found in these valleys.	▪ 40% cultivated land. ▪ Major areas for the production of staple foods such as paddy, cereals, pulses, and oilseeds. ▪ Many households have small-livestock, especially goats/sheep/rams, pigs. Some households have buffalos who are often raised for subsistence using traditional practices, including free-grazing in forested areas.	▪ 37% forest cover. ▪ Drivers of deforestation and forest degradation include encroachment, uncontrolled grazing, agricultural expansion, unsustainable harvesting of forest products.	▪ Deforestation within the Dun Valley, as well as in the Churia hills, increases the vulnerability of local communities and ecosystems to extreme flooding events. ▪ Deforestation and erosion in the Bhavar region further limits water infiltration/ groundwater recharge, increasing vulnerability of communities and ecosystems to extreme heat and challenges related to water deficit.
Terai-Madhesh	▪ The Terai-Madhesh are the low-lying plains that cover the south of the country.	▪ 83% cultivated land. ▪ The Terai is known as the *´Rice bowl´* of Nepal, where farmers produce the	▪ Forest cover (3%).	▪ Distant-forest users from the Terai contribute to deforestation and forest

Zone	Description of Terrain	Agriculture	Forests	Land Use and its Impact on Vulnerability
(46% of project area)	▪ This region was created due to the deposition of fine sediments, and has a high suitability for agricultural activities. ▪ Cow dung is main source of energy in Terai, although some households still use fuelwood. ▪ The Terai is more heavily populated than the other three regions. Population growth occurs in the region, which puts increased pressure on agricultural lands and forests in the Terai, as well as in other bio-physical regions. ▪ Many households experience seasonal food and water insecurity. ▪ Declining soil fertility has been reported in the Terai, attributed to: soil erosion, organic matter depletion, acidification, forest degradation and marginal land, among other factors.[216]	majority of the country´s grains (wheat, maize, rice, among other crops). ▪ 40% of agricultural land in Terai can be irrigated throughout the year. [217] ▪ Constraints in dry season are often water availability and soil fertility. ▪ Many households have small-livestock, especially goats/sheep/rams, pigs, and some households have buffalos who are often raised for subsistence using traditional practices, including free-grazing in forested areas. ▪ Commercial livestock production often includes stall feeding, and attention to animal nutrition and feed. ▪ Commercial agricultural practices in the Terai increasingly use mechanization. ▪ Relatively low-adoption of soil and water conservation practices.	▪ With limited forest resources, many people in the Terai are dependent on the Churia for forest products (fodder, NTFPs, timber), as they lack local alternatives. ▪ Many inhabitants of the Terai are considered ´distant forest users´ due to their reliance on the Churia forests. Distant users are associated with deforestation, as there is limited incentive for such communities to benefit from the sustainable management of these resources.	degradation upstream, with impacts described in the rows above. ▪ Inappropriate agricultural practices do not apply soil or water conservation practices that leave areas vulnerable to soil erosion, flooding, extreme heat and challenges related to water deficit. ▪ Combined factors from upstream deforestation and forest degradation, as well as the continued use of practices contributing to soil degradation and water-scarcity will lead to further constraints in dry-season crop production in the Terai within the context of climate change.

[216] Shrestha et al. 2013
[217] http://ibn.gov.np/agriculture

4.2 Description of Target Beneficiaries

143. The population in the BRCRN project area is over 3,216,428 - around 11% of Nepal´s population. There are 670,052 households in the project area, with an average household size of 4.8 members – slightly larger than the national average (4.5 people/ household).[218] There are more female inhabitants than male inhabitants in the project area, where women make up 51% of the population.[219] This is partly due to migration trends, where 25% of households in the project area are considered '*absentee households*,' with household members (88% of which are male) migrating to larger cities or neighboring countries for economic purposes.[220]

144. Diverse cultural, ethnic and caste groups inhabit the project area:[221] Indigenous Peoples (Janajati/ Adivasi; 31%), Terai-Origin Madheshi peoples (28%), hill-origin high caste (19%), Terai Dalits (9%), Hill Dalits (4%) and Muslims (5%), among others (4%). At least 77% of inhabitants within the area are considered to have experienced inter-generational socio-economic exclusion (Indigenous peoples [*Janajati/Adivasi*], Dalits, Madheshis, Muslims).

145. While all target beneficiaries of the project live in highly and moderately vulnerable river systems, there is differentiated vulnerability within river systems, where some inhabitants are considered more vulnerable due to their socio-economic situation, location of settlement (e.g. in high risk areas for flooding or landslides), or due to inter-generational exclusion/ marginalization, among other factors. During project consultations it was mentioned that women, poor households, indigenous peoples and Dalits are particularly vulnerable to climate change. These groups are often more vulnerable to climate change and climate-related natural disasters for various reasons, including the barriers they face as a result of inter-generational discrimination (social and economic exclusion) and socio-cultural barriers, among other factors.[222] Many of these groups are heavily dependent on natural resources (agricultural land, forests) to maintain their livelihoods, but often lack the resources and activities to invest in SNRM – often leading to a cycle of poverty and environmental degradation which exacerbates their vulnerability to climate change. In addition, often poor households and highly marginalized groups (especially Dalits) live in high risk areas that are often along river beds or in susceptible landslide or erosion areas.[223]

146. The main project beneficiary will be local CBOs/ user groups (described in detail in Table 8). In terms of direct beneficiaries, the project will target at least 750 local CBOs/ users groups. Based on average membership figures in the project area, this will equate to at least 200,681 households representing over 963,268 people (~26% of inhabitants in BRCRN project area).

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[218] CBS 2014

[219] Ibid.

[220] CBS 2014 - Based on district-level data; Remittances comprise 31% of Nepal´s Gross Domestic Product (GDP), with many Nepalese workers having temporarily migrated Dubai, Qatar, Malaysia, Saudi Arabia, and Kuwait among other countries, for employment (World Bank Online Database).

[221] CBS 2014 – based on VDC level data (Ward level data unavailable for 2014; and 2011 ward-level data does not include information on caste/ethnicity/cultural groups.

[222] Social Inclusion Action Group 2015; Maharjan et al. 2017

[223] BRCRN Consultations; Maharjan et al. 2017

At least 50% of beneficiaries will be women, and the project will promote proportional representation of indigenous peoples, Dalits and other marginalized groups. All 3.2 million people living in the BRCRN project area will indirectly benefit from the project through the elaboration of a climate-resilient strategy for the BRCRN area and the elaboration of action plans for each of the 26 vulnerable river systems. All inhabitants will indirectly benefit from strengthened capacities of CSOs, local and provincial government authorities and CBOs on climate-resilient land use planning and management, which will have a long-term impact to continue to build the resilience of ecosystems and communities.

147. The following describes the logic in how the number of direct beneficiaries was determined:

- Within the project districts, the average number of people per household is 4.8 people per household (slightly higher than the national average of 4.5).[224]
- The project aims to reach 750 community-based local groups. On average this will imply ~28-29 user groups per river system, while in practice some river systems may have more groups than others based on their size. The following assumptions were made in terms of the composition of groups and number of beneficiaries:

Table 7: Calculation of beneficiaries

Type of Community-based Organization (CBO)	Average membership (# of households per CBO)	Number of CBOs to Target	Households engaged in BRCRN project
CFUG	180	557	100260
CoFM	32,227	3	96681
Farmer Groups and Soil Conservation User Groups	40	50	2000
Public Land Forest User Groups	15	100	1500
Pro-Poor Leasehold Forest Groups	6	40	240
Total	**N/A**	**750**	**200,681**

- In total, the 750 CBOs are expected to include at least 200,681 households within the project. Based on average household size within the project district (4.8 members per household), the total number of beneficiaries would be around 963,268 people.
- Specific community-based groups (direct beneficiaries) will be identified within Activity 2.7, and it is possible that there could be a slight difference in membership composition, or other community-based groups could be involved with the group. The assumptions used are conservative, and take into account that there will be variation among community-based groups with some larger and smaller groups engaged in the project. The roughly 750 CBOs/ user groups with which the project will work constitute *most* of the number of such groups that are active in the project area.
- The number of women within communities is based on ward level population information from CBS (2011) that identified 51% of project inhabitants as female. Population statistics on indigenous peoples, Dalits and other ethnicities and/or castes are based on averaged district-level data for the project districts from CBS (2014).

[224]CBS 2014, District Level Data

Table 8: Overview of CBOs

Beneficiary	Brief Description
Community Forest User Groups	▪ The community forestry system was established in Nepal in the late 1970s, and is defined as the control, protection and management of forest resources by the rural communities who depend on the trees and forests for their livelihoods.[225] Community forests, and their association community forest user groups, have significant control in the management and use of forest resources as provisioned in the Community Forest Act of 1993. As of June 2013, 18,133 community forest user groups have been established, with a total membership of 2,237,195 households and covering a total of 1,700,048 ha of forest area.[226] This represents a 99% increase in forest area under community control since 2002, and the promotion of Community forests and community forest user groups continues to be a priority of the Ministry of Forests and Environment.[227] ▪ Community forest user groups are made up of members of a community coming from a variety of economic backgrounds. Monthly membership fees, fines and penalties, along with donations from various outside groups, are used to raise the group income of a community forest user group, which can then be used to implement development activities ▪ Community forestry has significantly contributed to the protection of forests in the middle hills of Nepal.[228] Most of the CFUGs are able to manage forests and generate a group fund. Such funds are being used for local community development activities such as school building construction, road and trail maintenance and construction; provide irrigation facilities, constructing community buildings, etc.[229] CFUGs have developed policies to support poor and disadvantaged members in a community in a variety of ways. For example: special preferential quota for membership of the executive committee and benefit sharing for Dalits and poor, obligatory 50 percent women participation in all executive committee, and providing funds to support income generating activities.
Farmer Groups and Soil Conservation User Groups	▪ Agriculture and Livestock development office organize farmers to develop collective plans and implement Agriculture and livestock improvement activities in their communities. Such farmers groups are informal and often targeted to certain commodities focused pocket groups and terminate after project activity is over. However, success achieved by such groups from collective decision often motivates them to emerge as registered farmer cooperatives. ▪ Soil conservation user groups are formed by District soil conservation offices to involve local communities in conservation related activity implementation. These groups are not officially registered though but play important role in developing soil conservation plan, activity implementation, and maintenance.
Leasehold forestry Groups	▪ Leasehold Forestry first appeared in Nepal through the Hills Leasehold Forestry and Forage Development Project (HLFFDP) in 1992, with the objectives of alleviating poverty and improving the ecological conditions of the hilly region. ▪ Leasehold forestry emerged as a result of poor households being excluded and unable to benefit from community forests and is designed to lease degraded forest lands to groups of poor households for their exclusive use, leading to both forestland regeneration and income generation. Although HLFFDP was a 10

[225] Gilmour and Fisher 1991
[226] MoFSC 2014
[227] Ibid.
[228] Kanel and Dahal 2008
[229] Dahal and Chapagain 2008

Beneficiary	Brief Description
	year project introduced in 10 districts by the government of Nepal with support from IFAD, ADB, and Dutch funded FAO, after seeing the resulting benefits, the Government of Nepal continued the leasehold forestry mechanism. ▪ Although leasehold forestry for poor is not visualized in the Forest Act of 1992, the Forest Regulation of 1995 makes a strong legal backing for Leasehold forestry and makes a special provision for the leasing of forests to disadvantaged groups. Beneficiaries of leasehold forestry are households living under the poverty line with limited land and/ or annual income. ▪ Leaseholder forest user groups are arranged by grouping several of these households together and are then allocated land. Land can only be used for leasehold forestry if the community is not willing to take parts of it into the community forest and are often shrub land, land recovered from forest encroachers or natural calamities, forests with limited crown cover or areas vulnerable to soil erosion.[230] ▪ Despite its limited coverage, leasehold forestry has become popular amongst poor households because it has helped to improve forest condition and contributed to the livelihoods of the members. However, due to procedural complexities and limited ability of leasehold groups to access financial and technical assistance from the involved organizations the progress in terms of scaling up of this model has so far been relatively slow compared to the expansion of community forestry. Furthermore, the progress is constrained as most of the forests allocated to leasehold groups are degraded and demand intensive and costly restoration efforts. ▪ As of June 2013, a total of 7,413 households are households who are living below the poverty line, leading to the management of 42,773 hectares of forest.[231] The leasehold forestry programme has been implemented in 39 districts and have contributed to restoring degraded forestlands, conserving biodiversity and alieving poverty.
Collaborative Forest Management Groups	▪ Collaborative forest management (CFM), a joint forestry management strategy between government and community, was introduced in Nepal through a cabinet decision in May 2000 in response to the continued deforestation within the Terai region.[232] CFM designates the management modality for 'contiguous large blocks' of productive Terai and Inner-Terai national forests.[233] ▪ Although the community forestry strategy had taken hold in the hilly regions of Nepal, leading to increased forest conservation in these areas, the Terai area remained mostly under government management and experienced severe forest degradation through programs such as the malaria eradication programs and East-West highway construction. ▪ The argument for CFM creation to manage forests in the Terai despite already existing CF systems was four-fold. First, it was argued that CF and government-managed forest modalities were not sufficient in patrolling and preventing forest encroachment and crime in the high-value forest systems of the Terai. CFMs were, therefore, needed to increase forest productivity through professionally managed silvicultural interventions and forest management to both fulfil the

[230] Laudari and Kaini 2013
[231] MoFSC 2014
[232] Bampton *et al.* 2007
[233] Bampton *et al.* 2007

Beneficiary	Brief Description
	need for forest products and conserve biodiversity, while also promoting local livelihoods and poverty reduction. Another argument was that 'scientific' management of these forests was lacking. Third, CFs were argued to be insufficient to provide equal benefits to the geographically distant and more traditional Madheshi forest users of the Terai and to ensure that any groups that may have been excluded in the CF scheme are included. Finally, CFMs are intended to serve as a link between community forests and the local government, and in this way CFMs ensure that the local government also benefits from forest management. The local government is included as a stakeholder in forest management and thus CFM generated income can also be used for local development activities. Benefits made by CFMs are divided, with 25% to the district level for local development projects and 75% to the central government.[234] ▪ The key objectives of collaborative forestry are to meet local demand of users and demand for commercial use of forest products, and to reduce poverty by creating employment while enhancing biodiversity. Local residents living within 5 km from the forest are considered as primary users of collaborative forestry. Collaborative forestry also follows the principles of participatory forest management and has been trying to maintain equity by providing preferential treatment to poor households (discounted price on timber purchase etc.), and encouraging women to participate in decision making. As the regime is relatively new, the economic, social and environmental outcomes are yet to be understood. ▪ According to the 2014 Nepal Biodiversity Strategy Action Plan (BSAP) since 2004 twenty collaborative forests, covering a total land area of 56,637 hectares in ten Terai districts have been established. Eight more collaborative forests, adding to a total of 26,608 hectares are planned to be created.[235]
Private Forest Users	▪ Private forest users include all trees and forests growing on private lands, including leasehold forests that are leased by private institutions for commercial raw material production. The cultivation of NTFPs on private lands also fall under this category.[236] ▪ The area of land falling under private forests has increased throughout the country and in August 2013, there were 2,458 registered private forests accounting for a total of 3,329,885 trees covering an area of 2,361 ha of land. Between 2000 and 2013, there has been a 9.3% increase in the number of trees falling within private forests and a 12.9% increase in private forest area.[237] ▪ The scale of private forests in Nepal is insignificant so far, making up only 0.01% of total forest area, but slowly people are being encouraged toward establishing registered private forests as per Forest Act 1993. Some have started doing agro forestry within their private agriculture land or renting other people's land for private forestry with an arrangement of having tree tenure. Private forests provide direct economic benefits to the individual ¿ ▪ These days' farmers with abandoned agricultural land are shifting their priority from agriculture farming to tree farming due to a shortage of labour for farming and better income from trees.238 The complicated process of private forest registration at District Forest Office and regulatory barriers often demotivate private landholders from growing forest trees in their farm land. Registration of private forestry is a legal requirement to have rights to harvest timber and to sell timber commercially. Nevertheless, increasing interest in private forests, as they are perceived to contribute to livelihoods and income generation

[234] Rai *et al.* 2017
[235] MoFSC 2014
[236] MoFSC 2016
[237] MoFSC 2014
[238]Gilmour 2016

5 PROJECT FRAMEWORK

5.1 Project approach and design considerations

Rationale

148. Through the BRCRN project the Government of Nepal aims to enhance the climate resilience of ecosystems and vulnerable communities in Nepal´s Churia region through integrated sustainable natural resource management approaches. GCF grant resources, in addition to government co-financing, will invest in strengthening institutional capacities, investing in climate-resilient land use practices, and enhancing awareness, knowledge and capacities of vulnerable communities on climate change. Investments will further improve the resilience of ecosystems to climate change threats, based on holistic integrated management considering upstream and downstream dynamics.

Design Considerations:

149. The Churia region represents one of the country's most fragile ecosystems with friable soils, high vulnerability to flash flooding, and frequently changing watercourses. While naturally fragile, human activities leading to deforestation and forest degradation, accelerated sedimentation and land degradation have accelerated environmental degradation, and increased the both communities´ and ecosystems´ vulnerability to climate change.

150. When assessing climate risks and vulnerability it is necessary to consider the extent to which hazards and risks are due to climate change versus natural changes based on the Churia´s fragile and unique bio-geophysical composition. Through the assessment described in Section 2, changes in climatic variables, particularly increasing temperatures and shifting precipitation patterns are leading to increased seasonal water stress, prolonged dry periods and increasing frequency and intensity of floods. Such changes in climatic variables, combined with unsustainable activities driving deforestation and forest degradation in upstream areas, will further catalyze soil erosion, sedimentation and riverbed rise that increases the vulnerability of communities downstream. Based on the growing threat that climate change poses for the Churia region of Nepal, appropriate adaptation measures are required.

151. Climate change coupled with the impacts of unsustainable land use practices are increasing the vulnerability of ecosystems and ultimately local communities to climate change. Deforestation and forest degradation are key drivers of land use change in the project area, especially in upstream areas within the Churia hills and Bhavar regions, where deforestation rates have increased in recent years. Investments in soil and water conservation and DRR have, however, tended to focus on more populated downstream areas. As a result, there are insufficient investments in upstream areas where soil and water conservation measures can play an important role in mitigating flood impacts downstream. Measures to address the major drivers of deforestation and forest degradation in the Churia and Bhavar forests, which are major drivers of vulnerability, are also limited. Thus, the project needs to provide a targeted-**ecosystem-based approach to improve resilience** and reduce greenhouse gas emissions, while addressing key drivers of land use change.

Land Use Planning

152. Investments are often uncoordinated across administrative boundaries (formerly districts), reducing the effectiveness of implemented measures for reducing flooding risks and supporting soil and water conservation. The project should promote provincial and river system level planning, to raise awareness of climate-resilient land use planning, and create plans based on integrated spatial planning that promotes integrated management targeting the most vulnerable ecosystems and communities. It is important that such an approach focuses on providing guidance and orientation for local-level actors to adapt, while focusing on integrated management within river systems to improve the efficiency and effectiveness of investments to improve climate resilience. Such an approach will raise awareness on the importance of such practices, strengthen the capacities of government officials and support the orientation and medium-to-long-term implementation of such practices.

153. Positive experiences developing sub-national REDD+ action plans demonstrated the relevance of balancing top-down integrated spatial planning with bottom-up participatory land use planning. Such an approach allows for validation at the local level, while building capacities and supporting communities to translate overarching strategies to practical local-level activities. In Nepal such an approach is seen as of critical importance, especially within CBOs who have a strong sense of ownership over the natural resources that they manage.

154. Before the government transition, some pilot districts elaborated DRR plans at the district level to set priorities to support the adoption and mainstreaming of DRR. Such processes and the resulting plans, including efforts from FAO to implement planning processes in Udayapur among others,[239] were successful in providing increased attention to DRR and providing orientation at the district and local level to support disaster preparedness and risk reduction processes. Districts no longer exist under the current government structure, and thus the project aims to build on these experiences and develop such plans at the Provincial level for provinces 1-3 to make climate-resilient and sustainable land use a priority, increase awareness of climate risks and DRR measures, reduce risk and improve preparedness and response for natural hazards and disasters.

Land use and livelihoods

155. Predominant land use in the BRCRN project area is small-holder agriculture, for the production of staple grains and small-scale livestock production. Forests further cover 32% of the project area, and are key for providing forest products and resources for inhabitants of the Churia and Terai. The project must target key sectors and ensure that people are able to maintain their livelihoods, providing incentives to adopt sustainable practices that strengthen both ecosystem resilience as well as the resilience of local communities. Many past projects focused primarily on natural resource management instead of climate change, and aware-

[239] MoAC and FAO 2011

ness of climate change and in particular threats that climate change poses to local ecosystems and communities is limited. Synergies with climate-resilient value chains and private sector coordination have often been overlooked.

Service Provision and Extension Support

156. Extension services, information dissemination and technology transfer are additional areas to be considered. Limited budgets, as well as capacities on climate change risks and climate-resilient land use and management has led to limited extension and technology transfer support.[240] This is reflected in the limited capacities on climate change and climate-resilient land use seen in various community based organizations (e.g. community forest user groups, water user groups, etc.). Without appropriate and successful demonstration of climate-resilient land use practices and restoration of ecosystems, communities may not realize the potential of these interventions to support livelihood practices in the face of future climate change. The engagement of these groups in natural resources management and the diverse members of the groups, including people from diverse socio-economic and cultural backgrounds, highlights the necessity to strengthen and expand the reach of extension services, information dissemination and technology transfer.

157. Simultaneously, there remains the need to build the capacities of local communities and front-line government institutions to contextualize climate change induced impacts at the local level to facilitate the understanding and mainstreaming of resilience building measures.

Institutional Considerations

158. Institutionally, the Government of Nepal is currently undergoing a transformation in the governing system from a constitutional monarchy to a democratic republic. This entails restructuring of government institutions, resulting in local level institutions gaining greater responsibilities in overseeing the management and control of natural resources. This transition is an ongoing and gradual process as government entities adjust to their new roles and responsibilities and exact coordination mechanisms continue to be clarified. Although becoming the relevant authorities to oversee forest and agriculture management, the climate-resilient land use planning and management capacities at the provincial and local levels need to be strengthened.

159. In terms of research, monitoring, assessing and addressing climate-induced disasters, there remains limited technical capacities within provincial and local institutions to effectively monitor and assess the impacts of climate change and climate-change induced disasters in a timely manner. There is still a need to invest in and increase the capacity of institutions to systematically approach, assemble and manage climate data. Not only do capacities on collecting data in a timely manner need to be increased, but also ICT to support knowledge management and dissemination.[241] Capacity gaps in the use of climate information for decision making and planning also needs to be addressed.

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[240] Amatya and Lamsal 2017; Dhital 2017; DoF 2015;
[241] Dhital 2017

Social Inclusion and Taking into Account Differentiated Vulnerabilities

160. Special attention needs to be paid to ensure that indigenous peoples, Dalits and other marginalized groups are engaged in the design, operations, monitoring and knowledge management activities of the project. Project activities should include targeted approaches that take into consideration the differentiated vulnerabilities of project beneficiaries.

161. Given indigenous peoples' and Dalits' strong reliance on natural resources for their livelihoods, especially related to agriculture and forests, measures focusing on improving ecosystem resilience were well received by consulted communities.

162. Indigenous peoples consulted highlighted the importance of integrating local indigenous knowledge for adaptation into the project. It was mentioned that a gap is the lack of guidelines and consolidated information on such practices, and that the project should also generate knowledge related to these practices and promote information dissemination and upscaling.

163. A gender assessment was conducted to understand the impacts of climate change on women within the project context, and a gender action plan was developed to promote gender equality and empowerment. Such measures build on best practices and lessons learned from key experiences described in the previous section.

Technological Considerations

164. It is important that project activities address drivers of land use change that lead to accelerating the vulnerability of ecosystems and ultimately communities to climate change. Agricultural activities in the Churia hills need to be targeted as the use of unsustainable practices (e.g. without soil and water conservation measures such as terracing or contour farming, exposed soils/ lack of soil cover, among others) as such practices lead to accelerated erosion and sedimentation, resulting in riverbed rise and sedimentation downstream that increases flooding risks.[242] Uncontrolled grazing is a key driver identified in literature and in stakeholder consultations that is a major contributor to deforestation and forest degradation in uphill areas, also catalyzing erosion and risks of flooding.[243]

165. Given the importance of local ecosystems to strengthen climate change resilience, measures should focus on enhancing ecosystem functions to better withstand and prepare for climate risks. Measures including forest restoration, gully and riverbank stabilization, water and soil conservation measures have been effectively piloted, yet need further resources to scale up such successful practices.[244]

166. Tree planting and plantations are further needed to reduce pressure on natural forests for timber, fodder and fuelwood among other products. Highly marginalized households do not

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[242] UN-REDD 2014

[243] Ibid.

[244][244] E.g. Promoted practices and working strategy for soil conservation and watershed management activities are described in the following MoFSC Document (2015): http://www.dscwm.gov.np/images/pdf/greenbook_whitebook_version3.pdf

have the resources to invest in such plantations, and may need support for plantation establishment combined with inputs and technical trainings. The formalization of public land forest user groups would be an effective measure to engage such households, supporting them to establish planted forests on degraded, sub-utilized or abandoned land.

167. In order to not crowd out private finance, investments in tree plantations (with the exception of marginalized households and CBOs) should focus on addressing barriers for scaling up plantations. There has been increasing interest in private forests and forestry activities, however studies have found that various barriers persist and that enabling conditions must be strengthened.[245] For instance: producers often have limited opportunities to access good quality planting material and seeds; registration with authorities may be challenging and policies complex; and there are limited extension services and demonstration activities available. There is further weak coordination and cooperation with private sector actors, including weak information on market opportunities and value adding opportunities.[246]

Options Considered, but Rejected:

168. Various technologies and investments were considered during the design of this project, and assessed based on their relevance to address the main barriers identified while taking into account the design considerations described above. Many of the alternative investments assessed either focused too closely on farm-system adaptation instead of broader ecosystem adaptation, whereas other technologies and practices did not have a direct link to key drivers of land use change. All of the assessed measures remain important considerations for Nepal, but were identified as being beyond the scope of the proposed project. The following are examples of some of the alternate options that were considered, but ultimately not integrated into the proposed project:

- **Solar energy technologies** were initially considered to target low-income and marginalized households to reduce fuelwood consumption, especially in areas that are not connected to the electricity grid. Ultimately, solar technologies were not included within the project as the link between their adoption and fuelwood is complicated given the strong socio-cultural dynamics of fuelwood use, including the preferred use of fuelwood for cooking, heating and other uses. Investments in biogas and bio-briquettes were instead integrated within the project as they are more suitable given their strong link to other activities promoted within the project, mainly improved livestock management and forestry activities that have a clear link to improving ecosystem resilience and reducing unsustainable natural resource management.
- **Early Warning Systems (EWS)**, particularly for flooding events, was considered in the initial project concept given the catastrophic impacts that flooding has caused not only in Nepal, but also in Northern India. EWS are extremely important for Nepal to improve preparedness and management for disaster risk reduction, including within the Churia.[247] However, EWS require

[245] Amatya and Lamsal 2017; DoF 2015
[246] Dhital 2017; DoF 2015
[247] PCTMCDB 2016

substantial investments, especially considering the limited density of hydrological and metrological monitoring systems in the country and need for the installation of upstream equipment such as water gauges in upstream areas.[248] While community-based EWS has been piloted and seen as a promising approach, it requires substantial capacity building on monitoring and maintenance of such systems. It was decided to not include EWS within the proposed project as it would require substantial resources, and by only dedicating a small-share of project resources it would risk the scale and overall effectiveness of interventions focusing on the implementation of climate-resilient practices. Nonetheless, planning processes for DRR at the provincial level included within the project will be able to identify needs for EWS.

- **Flood control infrastructure** was not selected for inclusion within the project. Nepal has substantial positive experiences implementing bio-engineering approaches for soil and water conservation.[249] Such bio-engineering approaches have been piloted by regional governments, and represent cost-effective and efficient investments to help stabilize river banks, gully areas and support flood control within river systems. They are further seen as ´no-regret´ approaches, where construction/ establishment and maintenance costs tend to be lower than grey-infrastructure, which is particularly suited for Nepal´s socio-economic context. Materials for bio-engineering can also be locally sourced, and bio-engineering measures can be implemented using local labor and through the engagement of local CBOs.[250]
- **Investments in climate-resilient rice production** practices was considered to reduce emissions from rice production in the Terai, known as the rice-basket of Nepal. While piloted practices to reduce emissions, improve resilience to climate change (particularly water scarcity and extreme heat), and improve the sustainability of rice cultivation have proven effective,[251] the targeted measures would have limited impact on broader ecosystem resilience, and would have a stronger focus on strengthening farm-level adaptation. Such measures are important for the Terai region and are relevant under climate change projections, however the project aims to focus on ecosystem-based adaptation and addressing ecosystem resilience, where rice production systems will benefit from proposed practices that aim to improve ecosystem resilience both upstream and downstream.
- **Agronomic practices** such as improved seeds and pest management for main crops were considered to increase the resilience of farm households to climate change. While climate change is expected to impact main crops and production systems in the region,[252] the majority of agricultural land is located in the Terai – an area that is highly affected by unsustainable land use upstream. Furthermore, broader unsustainable agricultural practices in both the Churia hills and Terai catalyze the vulnerability of ecosystems and communities to climate change (cf. Appendix A for an overview of baseline farming systems and a description of their impact on the overall climate resilience/ vulnerability of the region). It was thus considered more pressing to address the challenge of broader ecosystem resilience through ecosystem-based adaptation and integrated SNRM, which has adaptation benefits and environmental co-benefits that will improve the resilience of agricultural activities to climate change, (examples of such measures are described in Activity 1.1 of the proposed project, as well as in Appendix A of the feasibility study). Given the importance of agricultural activities for local communities, and the role that unsustainable practices have in exacerbating vulnerability and reinforcing the vicious cycle

[248] Zurich 2015 in Smith et al. 2017
[249] Dhital et al. 2013;
[250] Ibid.
[251] E.g. Carrijo et al. 2017; Howell et al. 2015
[252] CIAT et al. 2017

that contributes to further natural resource degradation, agricultural measures focusing on farming practices to increase ecosystem resilience are included within the proposal. In addition, the project team decided that an effort to address all negative climate change impacts on baseline cropping systems (e.g. heat stress on predominant baseline crops, shifting agro-ecological zones) would have required a significantly expanded project – in terms of scope, size and the number/types of stakeholders involved – that would have undermined the implementability of the project. FAO is committed to ensuring that the project remains focused and manageable, which reinforced the decision to focus on the types of climate change challenges (and response measures) currently included in the BRCRN project.

5.2 Summary of barriers and the project´s approach to address them

169. The following Table briefly outlines the barriers currently inhibiting the Churia region from transitioning toward a climate-resilient and sustainable development pathway, as well as the project´s approach to address these barriers.

Table 9. Overview of barriers and the project´s approach to address them

Barrier	Approach to Address Barrier
Poverty, inappropriate land management practices, the lack of alternative livelihood activities to implement SNRM	
▪ Up-front costs of investing in climate-resilient land use practices are too high for many CBOs and their members. In Nepal, 26.9% of the country´s population is affected by multidimensional poverty, equivalent to around 7.5 million people.[253] Focusing on income-related poverty, approximately 15% of the population is considered to be living below the poverty line of $1.99 per day ▪ Insufficient government resources for large-scale investments in climate-resilient SNRM, large-scale restoration of ecosystems and DRR ▪ Weak government and private sector support on marketing and value adding opportunities for CBOs and producers[254]	▪ Measures to improve awareness on climate risks, the connection with unsustainable NRM and climate-resilient SNRM will help raise awareness of the impacts of unsustainable practices ▪ Activities target unsustainable land use driving vulnerability. Provision of technical support and up-front investments in climate-resilient SNRM technologies applying a targeted approach (targeting different CBOs and households based on their contexts) ▪ Promoted activities are designed to further address sector specific barriers which can further limit incomes or limit the ability of CBOs and households to invest in such practices (e.g. poor quality planting material for forestry). Build off of best-practices and lessons learned ▪ Close link between support with up-front measures and support with strengthening related sustainable value chains (including private sector engagement) to support alternative income opportunities ▪ Where possible the project builds on existing structures, and a clear exit strategy has been developed
Limited awareness of climate change and climate-resilient land use practices to enhance resilience	
▪ While poverty is a barrier, many CBOs also have limited awareness of future climate threats and climate-resilient land use approaches. ▪ Weak extension services limit awareness (due to limited budgets that limit the reach of services and input support, lack of youth engagement, inadequate use of ICT, outdated curricula (including limited information on climate-change and value chains/ marketing), low-education level of participants, limited capacities of trainers, poor cooperation with private sector, among others).[255] Climate-change has not been sufficiently mainstreamed into extension services/ trainings ▪ Women and marginalized groups experience additional barriers to access trainings due to various factors (economic, socio-cultural, geographic, among others) ▪ Limited awareness on climate change leads to the lack of consideration of climate-change within land use planning at CBO, rural municipality and provincial-government level.	▪ Project activities will strengthen extension services (improved reach of services, improved materials and approaches, training trainers) ▪ Emphasis on trainings to build capacities of CBOs and local and provincial government officials ▪ Activities include measures to promote knowledge to support innovation, including compiling guidance on effective local indigenous practices for climate change adaptation and best practices and lessons learned to support scaling-up ▪ Measures include sub-activities to engage youth on climate change and climate-resilient land use ▪ Support the development of strategies and action plans on climate-resilient land use to raise awareness and promote scaling up ▪ Emphasis on improving knowledge, educational materials and knowledge dissemination pathways to engage diverse stakeholders ▪ GESI approaches mainstreamed into each component and supporting activity ▪ Participatory land use planning at the local level to raise awareness of climate change within local CBOs, and implement suitable land use practices to enhance ecosystem and community resilience
Weak inter-sectoral horizontal and vertical coordination	

[253] UNDP 2016
[254] Dhital 2017
[255] Ibid.

▪ Weak inter-sectoral coordination is an issue that is experienced in the Churia region.[256] ▪ Horizontal coordination: Often programs do not fully build upon synergies and often have a sectoral focus ▪ Uncoordinated investments in river system management leads to an inefficient and reduced effectiveness of investments to strengthen ecosystem resilience. ▪ Improved coordination is needed both within and between diverse institutions and stakeholders, especially at the local and provincial level given the political transition	▪ Project management structures are designed to promote regular communication and improved coordination with key stakeholders. Multi-stakeholder engagement promoted throughout the project. ▪ Elaboration of Provincial and river-system level strategies and action plans to promote integrated planning, considering upstream and downstream interactions, to improve coordination of investments and activities with a focus on improving the effectiveness and efficiency of investments, and ultimately the overall resilience of ecosystems. ▪ DRR strategies at the provincial level will provide a framework to orient local governments, and improve coordination and planning.
Weak institutions and limited capacities to plan, implement and monitor measures for climate-resilient SNRM	
▪ While improved coordination is needed, weak capacities on climate change and climate-resilient land use is an additional challenge which limits coordination and action on climate change, especially at the local and provincial level. ▪ Also, there has been weak integration of climate change considerations into local CBO-level land use planning and management plans. This is due to limited awareness (described above) as well as weak institutional capacities.	▪ Nepal´s ongoing political transition is an opportunity to strengthen local and provincial capacities on climate change risks, climate-resilient SNRM and DRR from an early stage. The project places an emphasis of engaging local and provincial actors throughout project implementation, building capacities and developing strategic guidance and policy documents to promote climate-resilient SNRM ▪ Strengthen land use planning by balancing integrated spatial planning with participatory land use planning, accompanied by capacity building for local and provincial governments and CBOs
Limited capacity to monitor assess and address climate-induced disasters	
▪ Limited technical capacity within provincial and local institutions to monitor and assess the impacts of climate change and climate-induced disasters. This is exacerbated by the absence of systematic approaches to assemble and manage climate data. This results in limited generation of early warnings for climate-induced disasters and implementation of few proactive measures for DRR, leading to the continued loss of lives and damage to valuable national assets. ▪ The lack of a comprehensive and effective mechanism for sharing knowledge and information, including information on monitoring of climate risks, limits the use of climate information in decision making and planning	▪ Establishment of Churia Knowledge Centre (CKC) to facilitate improved knowledge management, dissemination and monitoring. Investments in improved technology and tools for monitoring and knowledge sharing will be promoted, along with trainings for CSOs and local and provincial government staff. ▪ Project activities on knowledge sharing, generation of information and capacity building will help increase the generation and use of climate-related data and information in decision making and land use planning, and will strengthen the capacities of government officials at the local and provincial level, as well as CBOs, CSOs and other key stakeholder to understand and plan for climate-risks

[256] MoFSC 2015

5.3 Theory of Change: Project Objective

170. The following Theory of Change demonstrates how the project will address the identified barriers for the adoption of cross-cutting climate-resilient land use practices, supporting the transition towards low-carbon and climate resilient development pathways in the land use sector.

Figure 30: Theory of change for the BRCRN project

171. The project will directly benefit 750 local CBOs/ user groups, containing at least 200,681 households with over 963,268 people (at least 50% of which are women, with proportional

representation of indigenous peoples, Dalits and other marginalized groups[257]), in 26 of the most vulnerable river systems in the Churia Region in Nepal. Together with reduced deforestation and forest degradation resulting from project activities, the BRCRN project will result in lifetime emission reductions that exceed 11,897,256 million tCO_2eq. Over 202,747 ha of critical ecosystems (forests, wetlands and grasslands) will be restored through project implementation. In total (directly and indirectly) over 3.2 million inhabitants of the project area will benefit from the project through the elaboration of climate-resilient strategies and action plans as well as capacity development of local and provincial government authorities, CBOs and CSOs on climate change risks, and climate-resilient land use planning and management.

5.4 Mitigation and Adaptation Impacts

5.4.1 Mitigation Impacts:

172. The variety of identified project interventions contributes to the utilization of a low carbon land use approach on a landscape level with diverse mitigation impacts. The following Figure summarizes these multiple mitigation impact strategies. Some of these strategies offer significant synergies with other non-carbon impacts.

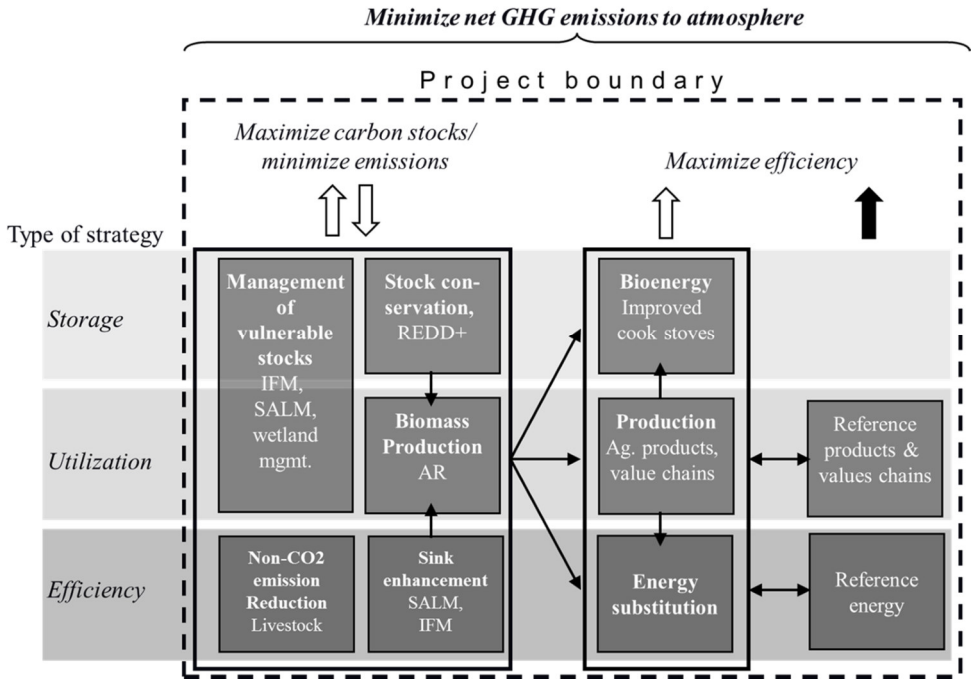

Figure 31: Low carbon land use mitigation potentials within the BRCRN project area

Source: Adapted from Obersteiner et al. 2010

[257] Refer to Section 2.3´s ´note on vulnerability´ for more information on excluded groups.

173. The majority of interventions with impacts related to mitigation are focusing on either maximizing carbon stocks or minimizing emissions from land use activities, in particular forests. This includes the reduction of deforestation and degradation within forests (REDD+ approach), as well as the active improvements of forest carbon stocks within degraded forests as a result of improved forest management planning and implementation. Outside existing forests, new commercial timber plantations as well as horticulture and other multipurpose use trees will lead to enhanced sequestration within the landscape. Also wetlands will be restored/ rewetted within selected communities which has significant mitigation potentials. Even the improved management of livestock, in particular with regards to better grazing management and improved feeding systems, will reduce methane emissions. In addition, the project also promotes improved emission efficiency since improved and alternative energy pathways as well as more climate-resilient agriculture agricultural value chains will reduce the emission intensities per Component compared to the baseline conditions. Overall, the mitigation impacts of the BRCRN project are projected based on the river system risk analysis with the identification of the 26 critical river systems. In summary, the following mitigation impacts are considered:

Mitigation potential from reduced deforestation

174. The logic for the calculation of the mitigation potential within the BRCRN project area of 26 critical river systems follows the overall logic for ex-ante assessment of REDD+ activities. First the deforestation rate is determined based on a historical period, i.e. the last 15 years which is then projected to represent the baseline (or reference) scenario. This is usually done by developing the land use change matrix in the project area for this period. By assigning average carbon stock densities to each land use class the land use change matrix also allows for the assessment of the overall carbon changes within the whole landscape. Next, a particular effectivity of project interventions is derived to reduce deforestation rate in the project scenario. The difference between the baseline scenario and the project scenario under reduced deforestation results in the mitigation potential. A default period of 20 years is assumed for the mitigation potentials of the BRCRN area. Since only one forest class could be applied in the historical analysis, the change of carbon stocks within forests as a result of forest degradation could not be assessed.

175. The results of the forest specific changes of the selected 26 river systems are:

a) Forest area declined from 275,867 ha in 2000 to 271,340 ha in 2010. This represents an annual deforestation rate of -0.16% for this 10-year period.

b) Using the latest forest loss assessment during 2010 and 2015, a dramatic increase of deforestation can be experienced. Forest areas has decreased to 227,276 ha which represents an annual deforestation rate of -3.2%;

c) Over the whole historical assessment period of 15 years, the average deforestation rate is -1.2%

Note: The land use change was assessed against the modified FRL of Nepal which was submitted to the UNFCCC in May 2017. The FRL identified for the assessment period 2000 – 2010 an annual deforestation rate of -0.1% for the two physiographic zones Churia (referred to as Siwalik in the FRL) and Terai. This is consistent with the annual deforestation

rate for the same period based on the land use data available for this feasibility study considering all river systems. The specific rate for the 26 critical river systems identified for the BRCRN is slightly higher (-0.16%). Therefore, the underlying data sets and derived land use change matrix used in this study can be assumed to be consistent with the modified FRL of Nepal with regards to deforestation. However, the dataset of 2015 results in a steep increase of the deforestation compared to the FRL period 2000-2010. As a consequence, this feasibility study considers the historical deforestation rate derived from the period 2000 – 2015, i.e. -1.2%.

176. Each land use pixel in the GIS study was assigned a representative average carbon stock density (in tCO_2/ha). Regarding forests only aboveground tree biomass was considered. The forest density of 305 tCO_2/ha was derived from the FRA assessment reports for Churia[258] and Terai[259]. In comparison to this, this emission factor is lower than the 370 tCO_2 assumed for the Churia hills in the modified FRL of Nepal which includes also belowground biomass. For agriculture an average value of 44 tCO_2eq/ha is assumed based on recent default value for South Asia[260].

177. REDD Scenario for the project: It is assumed that project activities which reduce deforestation will have an impact from project year 3 onwards. Further, between project year 3 and 7 it is assumed that deforestation rate is reduced to -0.5%, from year 8 onwards the deforestation rate reaches -0.16% representing the deforestation in the early 2000-2010 assessment period. This was discussed and confirmed with national experts during the field consultations.

178. A mitigation potential of 7,149,259 million tCO_2eq is estimated over 20 years for the 26 critical river systems that make up the BRCRN project area (**Error! Reference source not found.**). This leads to an annual impact of 357,463 tCO2eq or 1.9 tCO2eq/ha/year. The avoided area of deforestation in the project area would be 27,357 ha.

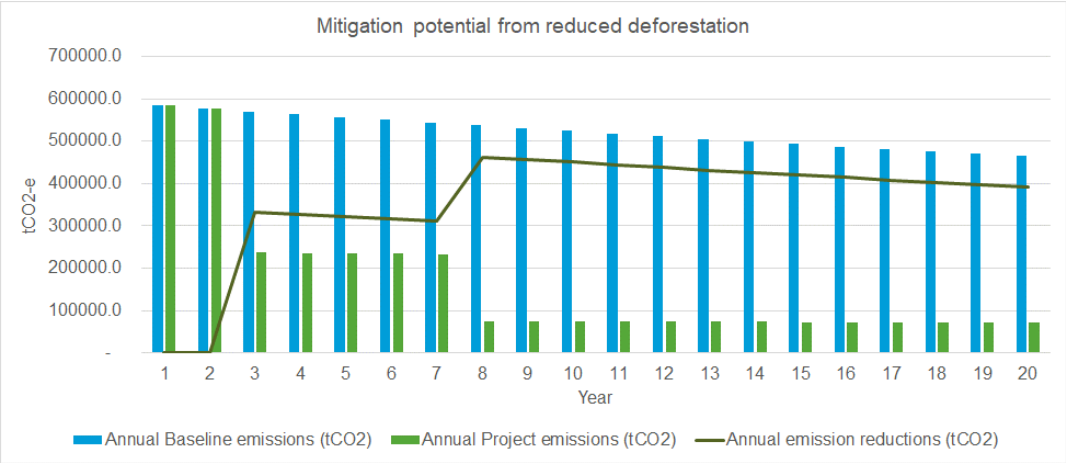

Figure 32: Annual mitigation potential from reduced deforestation in the BRCRN project area

[258] MoFSC 2014a
[259] MoFSC 2014b
[260] Zomer et al. 2016

179. As a comparison, by applying the EX-Ante Carbon balance Tool (EX-ACT)[261] with Tier 1 values using the same assumptions for baseline deforestation rates and reduction within the project, the tool calculates 8.6 million tCO_2eq over 20 years, therefore the estimated results for this component can be considered conservative.

Emission reductions and removals (sequestration) from low carbon interventions

180. There are various other field interventions with direct mitigation impacts. Most of them are related to carbon sequestration, i.e. the removal of CO_2 from the atmosphere into tree biomass and soils. Based on the feasible activities outlined above and detailed in Appendix A, the following carbon relevant practices have been identified and included into this mitigation assessment with the assumed per ha mitigation potentials based on impact factors (emission factors) from representative verified carbon projects, research studies and mitigation potential studies in similar agro-climatic conditions.

Table 10: Project activities and applied removal/ emission impact factors for different interventions

Activity package	Project area considered for implementation	Emission factors (tCO2/ha/year) for carbon pools considered	Reference and justification
Climate resilient agriculture (residue, nutrient, tillage mgmt., agronomy, on-farm soil & water conservation)	60,965 ha	*Residue, nutrient management, agronomy and on-farm soil and water conservation:* 0.74 for soil organic carbon	Ex-post monitored factor from the Kenya Agricultural Carbon Project[262] after 7 years of implementation of very similar practices. Project falls into the same IPCC climate zone. Similar baseline subsistence smallholder farming systems
		Improved grassland management: 1.2 for tree biomass 0.7 for soil organic carbon	Carbon study in North-East India in the frame of an Indo-German Cooperation project. For reference, the SOC value for various agroforestry systems in India is 0.01 – 1.9[263]. The biomass value for silvipasture in the Himalayan is 8.0[264]
		Tree shading of perennial crops:	Derived from shade coffee project in Eastern Ghats of India; see also Sirvi et al. 2016

[261] http://www.fao.org/tc/exact/ex-act-home/en/
[262] http://www.vcsprojectdatabase.org/#/project_details/1225
[263] Table 3 in Dhyani et al. 2016
[264] Ibid. Table 1

Activity package	Project area considered for implementation	Emission factors (tCO2/ha/year) for carbon pools considered	Reference and justification
		4.6 for tree biomass 1.1 for soil organic carbon	
		Trees in agriculture system: 5.1 for tree biomass for 1.1 soil organic carbon	Biomass ex-post verified value from the agroforestry project in Araku valley, India[265] ; same SOC value as above
Enrichment planting with native tree species	15,990 ha	1.5 for tree biomass 1.1 for soil organic carbon	Carbon study in North-East India in the frame of an Indo-German Cooperation project; same SOC value as above
Conservation plantation (bamboo, Acacia, Dalbergia etc.)	1,000 ha	6.3 for tree biomass 1.1 for soil organic carbon	Carbon study in North-East India in the frame of an Indo-German Cooperation project; for reference the biomass value for similar plantations in the Himalayan region ranges between 4.1 and 11.3[266]; same SOC value as above
Fruit orchards (horticulture)	5,000 ha	6.3 for tree biomass 2.9 for soil organic carbon	Both values ex-post verified from the agroforestry project in Araku valley, India[267] ;
Plantation of commercial timber species	1,300 ha	10.2 for tree biomass 2.9 for soil organic carbon	Biomass value from carbon study in North-East India in the frame of an Indo-German Cooperation project; SOC value as above from the Araku project; see also Sirvi et al. 2016
Sustainable management of forests	93,124 ha	1.5 for tree biomass	The total annual carbon sequestration in Sal dominant community forest through vegetation biomass increment[268]

181. Based on the implementation strategies of the project, all activities are assumed to be actually implemented from project year 3 with a roll-out plan of 5 years. The areas of implementation shown in the table above represent the planed areas for investment. Overall, an 80% adoption of the interventions is assumed in the project.

[265] http://www.vcsprojectdatabase.org/#/project_details/1328
[266] Table 1 Dhyani et al. 2016.
[267] http://www.vcsprojectdatabase.org/#/project_details/1328
[268] Thakuri 2009. A report on Economic Valuation of Carbon Sequestration in Community Forest of Dang District

182. The annual and total mitigation impacts over 20 years are shown in the following Table in tCO_2eq.

Table 11: Mitigation impacts from various low carbon land use interventions in the BRCRN project area

Year	Deforestation	Climate Resili-ent Ag	Tree planting	Forest mgmt.	Total	80% adoption
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	332,581	36,493	25,635	27,937	422,647	338,117
4	326,928	72,987	51,270	55,874	507,058	405,647
5	321,350	109,480	76,905	83,811	591,546	473,237
6	315,847	145,974	102,540	111,748	676,109	540,887
7	310,419	182,467	128,175	139,685	760,746	608,597
8	462,605	182,467	128,175	139,685	912,932	730,346
9	456,283	182,467	128,175	139,685	906,610	725,288
10	450,038	182,467	128,175	139,685	900,365	720,292
11	443,869	182,467	128,175	139,685	894,196	715,357
12	437,775	182,467	128,175	139,685	888,102	710,482
13	431,756	182,467	128,175	139,685	882,083	705,666
14	425,810	182,467	128,175	139,685	876,137	700,909
15	419,936	182,467	128,175	139,685	870,263,	696,211
16	414,135	182,467	128,175	139,685	864,462	691,569
17	408,404	182,467	128,175	139,685	858,731	686,985
18	402,743	182,467	128,175	139,685	853,070	682,456
19	397,151	182,467	128,175	139,685	847,478	677,983
20	391,628	182,467	128,175	139,685	841,955	673,564
Total	7,149,259	2,919,472	2,050m795	2,234,964	14,354,490	11,483,592
					717,724	574,180

183. In total, the project will contribute to mitigation over 20 years by 14.35 million tCO_2 equivalents, or 11.5 million tCO_2 equivalent under the 80% adoption assumption. The results in annual mitigation impacts of 717,724 and 574,180 million tCO_2 equivalent, respectively.

5.4.2 Adaptation Impacts:

184. The project applies a multi-faceted approach to strengthen ecosystem resilience, based on scaling up the implementation of climate-relevant SNRM, improving planning and capacities of provincial and local governments as well as CBOs, and improving knowledge, awareness and communication on climate change risks and risk reduction measures. Specifically, the project will contribute to the following adaptation-related impacts:

185. **Improved resilience of the most vulnerable people, communities and regions:** The BRCRN project will increase the resilience of at least 200,681 households with approximately

963,268 people (50% women, 31% indigenous peoples, 13% Dalits and proportional representation of other marginalized groups), living in 26 of the most vulnerable river systems in the Central and Eastern Churia region of Nepal. Targeted activities will help the project reach groups of people who are particularly vulnerable, including poor households, women, indigenous peoples and marginalized minority groups, including Dalits, among others.

186. Project beneficiaries will develop **improved awareness of climate threats, as well as risk-reduction practices** and climate-resilient land use practices that can improve their resilience to climate change. Education and outreach measures will aim to reach diverse beneficiaries including women, indigenous peoples, Dalits and other marginalized minority groups, as well as youth. The GAP, Indigenous Peoples Planning Framework (IPPF) and ESMF developed for this project provide clear measures to ensure the engagement of diverse beneficiaries, especially those who are highly vulnerable to climate change.

187. **More resilient land, ecosystems and ecosystem services:** The BRCRN project will support more resilient land management practices on 60,965 ha of agricultural land, and support increased resilience of ecosystems and ecosystem services through the restoration of 202,237 ha of critical forest, wetland and grassland ecosystems. In addition, project-supported bio-engineering structures will contribute to further increasing resilience to observed and projected climate change impacts on an estimated 23,100 ha of land (estimate based on typical land holding size).

188. Apart from living biomass, **BRCRN land use interventions will significantly increase SOC stocks** within the landscapes. SOC plays a crucial role in soil ecosystem functioning and global warming. SOC (as part of the topsoil soil organic matter) is critical for the stabilization of soil structure, retention and release of plant nutrients and maintenance of water-holding capacity, thus making it a key indicator not only for agricultural productivity, but also environmental resilience. Soil organic carbon as the basis of soil fertility is important for all three aspects of soil fertility, namely chemical, physical and biological fertility.[269] As an indicator for soil health, SOC is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs).

189. **Improved response to climate-induced natural disasters:** DRR provincial plans for three provinces will improve the preparedness and response of provinces to climate-induced natural disasters. This will support communities to enhance their response to climate change, and can help limit the loss of human life and productive assets from climate-induced natural disasters.

190. **Strengthened institutions and policies for climate-responsive planning and development:** At least 750 local CBOs/ users groups will mainstream climate-resilient land use planning into their management plans. Capacities of local people as well as local institutions will be strengthened on climate risks and climate-resilient SNRM, which will help to ensure the long-term sustainability of the measures and support a transformational change towards climate-resilient development pathways.

191. All of the BRCRN project Components include measures to strengthen the capacities of local and provincial governments on climate-resilient land use planning and management. Given

[269] Chan 2008

the ongoing political transition, it represents an opportune moment to mainstream climate-resilient land use planning and management into local policies, plans and processes. Local institutions in 3 provinces will be strengthened on climate-resilient land use planning for project implementation. In addition, 1 strategy covering the entire BRCRN project area will be elaborated to guide the implementation of climate-resilient land use planning and SNRM in the project area. This strategy will cover an area of 720,620 ha home to over 3.2 million inhabitants who will indirectly benefit from improved consideration of climate change mitigation and adaptation by local and provincial decision makers. Furthermore, 26 action plans will be developed to guide the implementation of the BRCRN strategy, supporting the mainstreaming and implementation of climate-resilient planning and SNRM at the river system level.

192. **Increased generation and use of climate info in decision making:** The project will promote improved knowledge dissemination channels, strengthen local networks, and promote improved multi-stakeholder vertical and horizontal coordination. The development of guidelines, educational modules and other information through the BRCRN project will help improve access to information on climate-risks, climate resilient SNRM and DRR measures. The CKC will help to disseminate information, and will serve as an important tool to monitor climate change, and support information exchange. It will serve as a key platform for local and provincial governments to access information about climate change and good climate-resilient practices, which will enable them to mainstream such information into local strategies and policies. Over 3.2 million people will indirectly benefit from mainstreaming climate-resilient land use practices into government strategies, plans and policies.

193. The project further aims to engage local schools and youth to become engaged on climate change and climate-resilient SNRM. It supports the establishment of eco-clubs in schools, will develop modules for high-school students on climate resilient land use and climate change, and will engage schools with the CKC to support information collection and dissemination.

6 FINANCING AND SUSTAINABILITY

6.1 Value Addition of Proposed GCF Investment

194. GCF support will be instrumental for enhancing the climate resilience of ecosystems and vulnerable communities in Nepal's Churia region through integrated sustainable rural development and natural resource management approaches. The measure will improve local people's resilience to climate variability, increasing temperatures, erratic rainfall and climate-induced natural disasters through the adoption of climate-resilient agricultural practices, sustainable forestry and ecosystem restoration.

195. Without GCF support, it is unlikely that Nepal´s adaptation need will be addressed through government expenditure alone. In 2016, Nepal had a current account surplus equal to 6.2% of GDP and the trade deficit narrowed by 1% to 30% of GDP. The government's reserves are still barely sufficient to cover one year's worth of public services and imports of essential goods[270]. The country is further still recovering from a devastating earthquake in 2015 that led to substantial loss of life and damage to productive assets. Budget constraints due to post-earthquake recovery continue to limit the ability of the government to finance key interventions in climate change in the Churia region in Nepal.[271]The country´s economy is further still recovering from the fuel crisis as well as extreme flooding in 2017 as mentioned in Section C.1.Thus, Nepal will need considerable grant financing to fund development priorities and addressing climate risks in the medium term. Nepal´s NDC discusses the country´s strategy and commitments to climate change, yet also notes the need for additional technical and financial support to fully implement its NDC and reach its proposed targets.

196. Nepal's daunting social and economic development challenges further exacerbate the vulnerability risks of its population. The Gross National Income per capita (purchasing power parity) is $2,500 compared to the global average of ~ $15,000[272] and 25% of its population lives below the poverty line[273]. Over 70% of its population lives in rural areas and approximately 46% are unemployed[274]. While about one sixth of Nepalese are food insecure, the situation is particularly acute in hilly regions such as Churia. The effects of food insecurity are especially severe among women and children[275]. The vulnerability situation is further compounded by the extreme dependence of rural communities on a fragile/deteriorating natural resource base. Over 70% of Nepal's 28 million people depend on the primary sector as their major source of livelihood. Overall, the economic costs of climate change in Nepal for the primary sector could be equivalent to 2-3% of current GDP per year by mid-century.

197. **GCF financial support would allow Nepal to invest in climate change adaptation and mitigation at an opportune time**, and avoid predicted higher costs associated with delayed responses to climate change. As much of the population is dependent on natural resources, the

[270]ADB 2017
[271] IMF 2017
[272] World Bank 2014
[273]https://www.adb.org/countries/nepal/poverty
[274]https://www.cia.gov/library/publications/the-world-factbook/geos/np.html
[275]http://www.nnfsp.gov.np/PublicationFiles/d405d609-bb00-4708-831c-149dea4b4f49.pdf

proposed project will support local people and governments to adopt climate-resilient land use practices, strengthening their resilience to climate change through improved adaptive capacities and reduced exposure.

198. **The project will target vulnerable communities living within vulnerable river systems.** In the project design phase 26 vulnerable river systems were selected due to their vulnerability to climate change. The vulnerability assessment showed that these areas are particularly vulnerable to heat stress, water stress, flooding, forest fires and landslides. These river systems comprise over 3.2 million people, of which 51% are women. Indigenous peoples, Dalits and other marginalized groups as well as poor households will further be targeted within program activities, as these groups are often particularly affected by climate change due to their reliance on natural resources. Project activities will target the most vulnerable people and areas, with measures targeted for differentiated local contexts and vulnerabilities, as well as different drivers and underlying causes of land use change.

199. GCF support will be instrumental for establishing climate-resilient land use planning and management as the central paradigm for promoting climate resilience in broader national, provincial and local policymaking and planning. By providing an opportunity to incentivize and scale up Nepal's flagship, broad-based, transformational community-based natural resource management models across the Churia, the project will add further momentum to Nepal's current efforts to transition towards resilient, inclusive, low-carbon development. Given Nepal's political transition, the project further represents an opportune moment to establish capacities on climate-resilient land use planning and management and DRR, as well as mainstream climate change mitigation and adaptation into provincial and local policies and plans.

200. The GCF support is also noteworthy in terms of the catalytic impact it will have in bringing together cross-sectoral landscape-level climate-resilient planning across a region comprising more than 720,620 ha and a population of over 3.2 million men and women (of which 51% of inhabitants are women, 31% indigenous peoples and 13% Dalits).[276] Sustainable climate-resilient land use practices will be implemented on 398,515 ha through the project, improving local communities´ adaptive capacities and enhancing their resilience to climate change. This total adoption area includes also overlapping areas where multiple practices are adopted, in particular with regards to resilient agriculture and agroforestry. Interventions are targeted based on the context and priorities of the different bio-geographical zones and local contexts and differentiated vulnerabilities within the project area.

201. BRCRN project activities will crowd-in public financing and mobilize community- and farm-level investments for climate-resilient land use. Government co-financing demonstrates the government's commitment to invest in climate-resilient land use. Improved extension modules and support, knowledge dissemination and demonstrable activities will encourage community-based organizations and farmers to invest in improved practices. Public-private-CSO platform will support opportunities for the private sector to become engaged in climate-resilient value chains, and strengthen coordination with the public sector, CSOs and community-based organizations.

[276] Note: Excluding water bodies and settlements, the project area covers 702,011 ha.

202. Strong linkages between water resource management, ecosystem-based adaptation, and disaster risk management will be established to demonstrate how these can contribute towards strengthened environmental sustainability and improved livelihoods while at the same time contributing to greater climate resilience. This paradigm would link the adaptive capacities of local communities with climate-resilient, ecosystem-based adaptation and disaster risk reduction, reducing the vulnerabilities of local communities to the impacts of climate change. It thus represents the first attempt at large-scale, integrated adaptation within the country.

203. Successful demonstration of this **landscape-scale, ecosystem-based approach** in the Churia region will provide a model for integrated, cross-sectoral climate change adaptation at scale for adoption in the other regions as well. Improved planning at the provincial and local level will promote **improved coordination between upstream and downstream communities**, ensuring that a holistic management approach is promoted that takes into consideration the inter-connectedness of ecosystems and land use systems.

204. The BRCRN project serves as an **innovative approach that is integrative and cross-sectoral** linking various development objectives and sectors that are all threatened by climate change. It will also help to bring together the efforts of a number of climate change related projects operating in the broader region into a comprehensive implementation framework for better synergies and impact. It is highly complementary to the Forest Investment Program (FIP), as well as the proposed REDD+ Emissions Reduction Program, among others.

205. The BRCRN project will have a **trans-boundary impact**, providing positive environmental, social and economic benefits to downstream communities, including in Northern India where many of the Churia´s rivers flow. Particularly in the monsoon season, the degree of runoff and sedimentation from the Churia hills and swells in river flows can be controlled leading to reduce the impact of floods. Thus, the effective long-term management of the Churia hills has a trans-boundary impact, improving the resilience of downstream communities in Nepal as well as India.

6.2 Financial and Economic Analysis

206. A financial and economic analysis was conducted to assess the project's socio-economic benefits including reduced climate change risks and to support investment decisions by Government and the Green Climate Fund. The analysis puts a monetary value to the social benefit (positive welfare) and to the costs (negative welfare) as effects of the project by applying a discounted cashflow analysis.

207. For the analysis the **Net Present Value (NPV) and Economic Rate of Return (ERR)** are used as performance indicators.

208. **The NPV** is the result of a discounted cash flow that accrues to the beneficiaries (public and private combined) due to the implementation of the project. NPV takes into account the time-value of money. Since waiting for profits is less attractive than obtaining profits now, the "value" of future profits and costs is discounted by a specific percentage rate, the discount rate.

209. **The ERR** is an indicator expressed in % at which the cost and benefits of a project, discounted over its life, are equal. In other words, the ERR is the discount rate that makes the NPV of all cash flows from the project equal to zero.

6.2.1 Financial Analysis

210. The purpose of the financial analysis of the project is to: (i) evaluate the financial viability of the climate resilient investment and interventions promoted by the project; (ii) assess the incremental costs and revenues resulting from project interventions; and (iii) provide a basis for the economic analysis of the project.

211. **Project timeframe:** The project will be implemented over a period of 7 years. For the financial analysis a duration of 10 and 20 years is used to reflect the expected full revenue stream and cost recovery. For agricultural and ecosystem based adaptation infrastructure investment a time period of 10 years is applied. A period of 20 years is used for the forestry related models.

212. **Approach:** Cost-benefit analysis (CBA) was performed for the without project and for the with project scenarios. Both scenarios are compared and the incremental cost are quantified - the difference of with project cost and benefit minus the without project cost and benefits.

213. The technical information and underlying data and assumptions were collected from official sources as well as by information generated by the formulation team. For each land use category costs, yields, revenues and cash flows were compiled on a comparable unit for the without and with project scenarios. These models are then aggregated and used in the economic analysis considering the scale and assumed adoption rates of the project.

214. The financial analysis is also used to quantify the incremental investment costs of the project that are used to prepare the project budget.

215. For the financial and economic analysis, we differentiate between two major zones - Churia and Terai. Both zones are distinct while the intermediate Bhavar zone lays in between, and the Dun valleys are similar to the Terai. The latter two zones are excluded from the assessment for simplicity purposes considering that the Bhavar zone has features from the Terai and Churia, thus the models are applicable to both zones, whereas the Dun Valleys are comparable to Terai.

216. A **discount rate of 10%** was used for the financial analysis and in the economic analysis which reflect the opportunity cost of capital. This assumption is based on the most recent World Bank and Asian Development Bank funded projects in Nepal. It ranged between 10-12%. A more conservative 10% was assumed for the financial and economic analysis.

217. The following representative financial models were considered in the financial analysis and in the economic analysis:

Table 12: Baseline and project scenario production models in financial analysis

Churia		**Terai**	
Baseline	Project scenario	Baseline	Project scenario
Agricultural land			

1.Mixed agricultural farming (maize and vegetables)	1.Transition to climate resilient mixed farming system (maize and vegetables	1.Mixed agricultural farming (maize and vegetables)	1.Transition to climate resilient mixed farming system (maize and vegetables
	2.Transition to horticulture systems (e.g. mango production)		2.Soil conservation measures ponds and irrigation infrastructure rehabilitation
	3.Soil conservation measures ponds and irrigation infrastructure rehabilitation		
2.Agricultural land loss due to erosion and reduction of agricultural land	4.Gully stabilization	2.Agricultural land loss due to erosion and reduction of agricultural land	3.Gully stabilization
Forest land			
1.Unsustainable management of natural forests under degradation	1. Natural Forest Management and enrichment planting with native tree species	1. Non-forest land along river banks subject to erosion and land loss	1.Protection forest establishment (e.g. bamboo)
			2. Commercial forest plantations (Teak)
Non-land interventions			
Unsustainable extraction of fuelwood	Adoption of small-scale biogas plants at household level	-	-

218. The following underlying assumptions are used in the financial analysis:

219. The analysis considers only the land-based costs and revenues from a land user perspective. The broader investment package for each land use will include e.g. improved extension and training and benefit from improved institutions. These are assessed as part of the economic analysis and not integrated in the financial analysis.

220. The financial analysis of the project is based on prices, costs and yields collected during project preparation, and a review of published literature on Nepalese forestry and agriculture. The prices of farm products used in the analysis are farm gate prices. A detailed analysis is presented in the supporting Excel-file "*2018-08-27_Financial economic analysis Nepal.xls*"

221. For all activities, a financial rural daily wage rate of NPR 400 was assumed, under the assumption that labor market is unrestricted and there is availability of labor opportunities in the project area. Labor in most models is the key input factor. Largely the models will be developed by the provision of family labor which is also valued at NPR 400 per day.

222. The area unit is based on 1-hectare production models for forestry and agricultural EbA measures as further explained:

223. **Climate resilient agricultural farming system**: In the without project scenario the prevailing farming practices are assumed to be affected by an increasing frequency and intensity of floods and droughts.

224. **In the Churia and Terai area** prevailing without project scenario is mixed farming which will be subject to climate change-related extreme events such as extreme heat, water scarcity and landslides, following the Think Hazard assessment tool for the target region. In the financial analysis it is assumed one or more of such events occur every four years on average and reduces the yields by about 50%. On average this results in a yield loss of about 12.5% per year which is integrated into the analysis.

225. In addition, the slow-onset effect of climate change is predicted to reduce agricultural yield by about 1% for maize and about 0.5% for vegetable[277] which are taken into account in the without project scenario.

226. Productivity increases under climate resilient agriculture practices will be generated by strengthening integrated climate resilient institutional mechanisms, adoption of best practice management practices, increased labor inputs and minimal additional inputs. Increased yields will be the main driver for increasing cash flows. In the project scenario, we assume that yields will increase by about 65% for maize and 14% vegetable compared to the without project scenario with the adoption of best practice climate resilient management practices, as has been demonstrated by comparable projects over a period of 10 years (annually 6%). This yield increase is a combination of improved ecosystem services of improved soil fertility, water retention capacity and improved management practices.

227. The extreme event related risks can be expected to halve under the with project scenario resulting in an average annual per ha loss of 6%. While the frequency of extreme weather events remains the same, the intensity of damage is assumed to be reduced resulting in less yield losses compared to the without project scenario.

228. All climate resilient agricultural models are profitable compared to the without project scenario (as shows in table below), thus the adopters will have an inherent incentive to maintain the promoted climate resilient practices.

229. **Forest sector land use models:** In the without project scenario forest in the **Churia** are under pressure due to overutilization and forest degradation, and it is assumed that annual yields (firewood and NTFPs) will reduce by 10% per year. In the project scenario, highly degraded forests will be subject to assisted natural regeneration and increase annual firewood and NTFP yield by 3%. The assessment of the forestry models is based on 1 ha models that is later aggregated to the project level for the economic analysis. The investment per ha will be mainly for seed material, planting and maintenance and require an upfront investment of USD 200/ha.

230. Sustainable natural forest management that are not degraded are assumed to increase yields by 1.5% compared to the without project scenario and increase the availability of commercial wood, firewood and NTFPs in the long-run.

[277] CIAT et al. 2017

231. Conservation forests are assumed to result in increased growth and the combination of management planning, capacity development, strengthened control and ownership of forest resources by training CBOs resulting in improved law enforcement will ensure that forest are protected. Limited investment in tools and equipment will be required and both model will need an average of USD 15 per ha Targeted trainings on fire management and sustainable forest management will highlight the benefits and demonstrate to CBO members how to sustainably manage forest resources. Pandey et al. (2016) have further demonstrated the ability of CFUGs to reduce impacts from fire as they are better incentivized to take care of forest resources.

232. As shown in the table 18 below, the forestry models are all more profitable compared to the without project scenario and will incentivize adoption.

233. In the Terai area intervention models will occur on non-forest land thus the without project scenario is assumed to be zero.

234. For the model "protection forest establishment (e.g. bamboo) a low intensity use of the forest is assumed that will generate household income from year 3 onwards. However, the forest establishment will require high upfront investment valued at USD 1,516 over the first three years of which the project is expected to finance USD 1,072 /ha. The remaining will be provided by in-kind labor.

235. For the commercial forestry investment, a Teak model was quantified assuming a conservative annual average mean annual increment of 17 m^3/ha/year and an average timber price of USD 37 m^2. Positive cash flows will be achieved after 10 years. Interested land users will provide their in-kind labor to this model. The project is expected to finance the upfront seed material and equipment costs over the first three years' worth USD 530 per ha.

236. For **soil and water conservation EbA measures**, a village-based approach was used that assumes an average investment per pond constructed, and rehabilitation of irrigation infrastructure that impacts about 30 ha of agricultural land. A GCF investment of USD 13,863 is assumed per village/settlement and will target at least 130 CBOs

237. With access to irrigation a second rotation per year can be realized leading to an average assumed yield increase of at least 60%. The increased yield will result in an incentive to maintain the established pond and irrigation structures that will be managed by the community groups after the EbA investment. The maintenance of the pond will be financed by the community groups and will be financed by the increased cash flows of the beneficiaries.

238. **In the gully stabilization investment case**, on average 80 ha of agricultural land will be affected directly (upstream) and indirectly (downstream). It is assumed that this investment will agricultural land will be maintained in a productive stage compared to a 50% reduction in productive land in the without project scenario. An average investment of USD 52,288 per village/settlement is assumed.

239. In total, the project will target at least 86 CBOs and implement the gully stabilization measures.

240. The community based organization will maintain he established structures in the long-run, by developing improved institutional structures and the inherent incentives related to increase production level and maintaining of productive land from climate risks and extreme events.

241. **Biogas unit investment:** This investment is assumed to be adopted in the Churia region only and reduce the pressure on unsustainable fuelwood extraction and forest degradation. On average each household consumes about 3.06 t/fuelwood[278] worth about USD 100/year, while the value of family labor is about USD 200 per year (assuming a minimum wage rate of 400 NPR per day and 1.5 days of labor per week).

242. In line with the project scenario, it was assumed that middle income households will invest in a ~2 m³ biogas plant that will substitute about 50% of the household fuelwood needs and labor inputs. In total, the project will facilitate the installation and implementation of about 500 biogas unit and middle income households. The cost recovery and incremental benefits will be achieved in the second year with the current subsidy levels of 20,000 NPR (USD 184) per biogas plant. The achievement of incremental benefit after year 1 will incentivize adoption by households and reinvestment into technology.

Summary of financial analysis and GCF investment needs

243. For the financial analysis, the agriculture related models were assessed for a period of 10 years. For the forestry models an assessment timeframe of 20 years was used due to the longer cost recovery timeframes that is typical for forestry projects.

244. Results of the financial analysis are summarized in the table below and available in greater detail within the Excel file "*2018-06-15 Financial and economic analysis"* as a supplementary document to the feasibility study and the GCF Funding Proposal.

245. The investment needs per unit for each EbA measure and respective scale in the project is presented in the table 19.

Table 13: Net Present Values of production models with and without the BRCRN Project

	Churia		Terai	
	Without project	**With project**	**Without project**	**With project**
Agriculture (10 years)	**NPV (USD/ha)**		**NPV (USD/ha)**	
Climate resilient farming practices	-576	735	301	2,002
Horticulture management practices	-576	687		
Forestry (20 years)				
Sustainable Natural Forest Management with enrichment planting with native tree species	233	257		
Sustainable natural forest management model - commercial utilization (per ha)	233	412		
Conservation of natural forests (only NTFP use) (per ha)	233	159		

[278] Kandel et al. 2016

Protection forest establishment - Bamboo on riverbanks			0	883
Commercial forest plantation (Teak)			0	1,674
Infrastructure - Soil and water conservation (10 years)				
Rehabilitation of ponds and small-scale irrigation infrastructure	-576	906	301	2,065
Gully stabilization	-576	173	301	1,440
Non-land based investment				
Biogas promotion and investment (per household)	-843	217		

246. **Analysis, justification for GCF investment and exit strategy:** The analysis demonstrates that all project scenario models are profitable from a farmer/land user perspective ranging between USD 159 /ha and USD 2,506 /ha. The GCF is expected to finance only the material investments, while the maintenance costs of models and climate-resilient infrastructure will be covered by the responsible institutions and adopters of climate resilient land use practices. Adopters of the climate resilient agricultural and forestry practices will have an incentive to maintain the practices due to the increased yields and revenue stream that can be realized from year 2 onwards. In addition, land users and community groups will be supported with trainings, knowledge transfer and improve their institutional strength. This combined package of investment into a viable business case from an adopter perspective and capacity development will ensure sustainability beyond the project lifetime and a smooth exit.

247. The increased profitability of the climate-resilient interventions compared to the without project scenario serve as the key incentive to continue adoption beyond the project lifetime and investment. The strengthened institutional capacities of local organizations and project beneficiaries will support the exit of the project and is likely generate spill-over effects to a wider audience due to a demonstration effect.

248. For the determination of the GCF investment needs the cash flow profiles were assessed and the needed material investments identified. The climate resilient farming practices will not require additional land-based investment by GCF and the yield increase can be realized by increased labor inputs and limited inputs, and improved extension. Also the biogas investment will not require project investment due to the existing subsidies and middle income families' own financial capacity to invest in the technology.

249. The remaining models will require GCF investment in the first years as these do not result in immediate cost recovery and need timeframes of up to 7 years to recover the investment costs. The following table shows the scale, the unit investment costs and the aggregated investment needs for the implementation of the different models. The total GCF investment needs amounts to **USD 21.4 million** (excluding the institutional and training and extension costs of component 1-3).

Table 14: GCF project scale, investment costs and GCF investment needs for agricultural and forestry model implementation (extracted from the financial and economic analysis Excel file "2018-09-28 Financial economic analysis Nepal".

Scales of project implementation and financing needs										Land-based investment needs from GCF										
Years	Unit	1	2	3	4	5	6	7	Total	Yea	Unit	Unit cost	1	2	3	4	5	6	7	Total
Churia project interventions																				
Agriculture																				
Climate resilient farming practices	ha			5,500	7,000	7,500	7,500	7,757	35,257		USD	0	0	0	0	0	0	0	0	0
Establish pubic land forests and horticulture on public lands	ha					1,250	1,600	2,150	5,000		USD	1,054	0	0	0	0	1,317,179	1,685,989	2,265,548	5,268,715
Biogas investment and implementation	units /households			50	50	100	150	150	500		USD	0	0	0	0	0	0	0	0	0
Forestry																				
Sustainable Natural Forest Management with enrichment planting with native tree species	ha			1,710	3,230	4,470	3,290	3,290	15,990		USD	200	0	0	342,000	646,000	894,000	658,000	658,000	3,198,000
Churia sustainable forest management	ha			10,000	18,655	22,400	23,700	18,369	93,124		USD	15	0	0	150,000	279,825	336,000	355,500	275,528	1,396,853
Conservation natural forests	ha			10,000	18,655	22,400	23,700	18,369	93,124		USD	15	0	0	150,000	279,825	336,000	355,500	275,528	1,396,853
Infrastructure - Soil and water conservation																				
Rehabilitation of small-scale irrigation canals and ponds	units /settlements			8	13	22	23		65		USD	13,863	0	0	103,974	173,290	298,059	318,854	0	894,177
Gully stabilization	units /settlements			8	12	17	8		43		USD	52,288	0	0	392,160	601,312	862,752	392,160	0	2,248,384
Terai																				
Agriculture																				
Climate resilient farming practices	ha			3,000	4,500	6,000	6,000	6,208	25,708		USD	0	0	0	0	0	0	0	0	0
Forestry																				
Protection forest establishment - Bamboo on riverbanks	ha					250	350	400	1,000		USD	1,516	0	0	0	0	378,928	530,499	606,285	1,515,712
Commercial forest plantation (Teak)	ha					350	450	500	1,300		USD	1,798	0	0	0	0	629,262	809,052	898,946	2,337,261
Infrastructure - Soil and water conservation																				
Rehabilitation of small-scale irrigation canals	units /settlements			8	13	22	23	0	65		USD	13,863	0	0	103,974	173,290	298,059	318,854	0	894,177
Gully stabilization	units /settlements			8	12	17	8	0	43		USD	52,288	0	0	392,160	601,312	862,752	392,160	0	2,248,384
										Total investment needs	USD		0	0	1,634,268	2,754,854	6,212,992	5,816,568	4,979,834	21,398,516

6.2.2 Economic Analysis

Purpose and Assumptions

250. **The Purpose of Economic Analysis** is to evaluate the expected welfare and climate risk reduction contribution of the project to the society. The economic analysis takes into account the full costs of the project and assesses the benefits from a society perspective. Incremental cost and benefit are quantified as a result of comparing the ´with´ and ´without´ project scenario. The analysis intends to provide a justification whether the proposed interventions of the project are justifiable.

251. **Timeframe:** For the timeframe of the economic analysis, a period of 7 years, 10 years and 20 years is used. The 7 years' period reflects the GCF project length. Considering that many project investments will generate benefits after a few years, a longer assessment time period is justified to capture the total benefits of the project.

252. **Scope of the analysis**: An economic analysis was performed to assess economic performance of the project. In addition, the economic analysis is compared with the cost and benefit of the without project scenario and provides the **incremental cost and benefits and economic performance of the project**.

253. As an economic indicator the **economic rate of return (ERR) and the net present value (NPV)** is used. For the net present value an economic discount rate of 10% is used**.**

254. The **project economic costs and benefits**. The cost include all investment and production costs as estimated in the financial analysis. The costs were converted to economic cost using the standard conversion factor of 1 for production models. In addition, non-land-based investment cost requested from GCF and the governmental co-financing is integrated in the economic analysis. After the project further institutional costs are assumed to operate the established operations, while the land based investment costs stop from year 8 onwards (see supplementary Excel file Financial economic analysis Worksheet: FIN-Econ Analysis Column 44).

255. As shown in the table above, the project will directly target 60,965 ha of agricultural land (212,930 households), 202,237 of forest land, and create about 7,300 ha of new (agro)-forests. The water and soil conservation infrastructure investment will target about 130 villages / settlements that which is equivalent to at least 23,100 ha of agricultural land affected by the project. Biogas is expected to be adopted by at least 500 households.

256. All traded inputs and outputs are valued at farm-gate prices as of December 2017.

257. Family labor is valued at an opportunity cost equivalent to market wage rate of NPR 400/day

258. In the economic analysis an average **adoption rate of 80%** is assumed. The analysis assumes the total investment costs for 100% (and 80% of the costs after the end of the project). The benefits are counted only to 80%.

259. **Other ecosystem services:** For the economic analysis the cost and benefit of the financial analysis are taken into account valuing inputs and products and market prices. In addition, non-market benefits associated with the provision of greenhouse gas emission reductions estimated at **574,180 tCO_2/year (11.48 million tCO_2 over 20 years). This reflects an 80%**

adoption rate of the interventions. The mitigation starts from years 3 and valued with a conservative **social carbon price USD 40 /tCO_2**[279]. The detailed methodology of quantifying the GHG emission is presented in the 3.4 Mitigation Impacts.

260. The project will also result in additional ecosystem services such as soil erosion control and reduction of flood risk, improved water holding capacity of soils. These benefits are integrated in the assessment of the financial analysis as well as in the economic analysis. Reduced soil erosion and water holding capacity and the reduced flood risk will directly result in increased farm and forestry level revenues and the reduced exposure to extreme events and the slow-onset climate change impacts.

261. The project will generate additional non-marketable ecosystem services such as biodiversity protection that are conservatively excluded from the analysis due to the lack of well justifiable monetary values for these non-market services.

262. **Other benefit**: Additional economic benefits are likely to occur beyond the project scale. This is mainly due to the project interventions related to the strengthened institutional capacities on national level and national ability to manage its natural resources while considering climate change risks. These were not taken into account in the analysis, thus the analysis is conservative. Additional benefit are likely to occur due to the demonstration effect of the project which is likely to increase adoption of the proposed land-based interventions beyond the project scope, which is excluded from the analysis and makes it conservative.

Results of the Economic Analysis

263. For the economic analysis two scenarios are analyzed: One that integrates the social value of carbon and one that one that excludes the social value of carbon. Considering that the GHG mitigation is a global good, but does not directly results in an economic in-flow to the country a domestic view of the project excludes the value of carbon. The global view that integrates the social value of carbon and reflects the global Green Climate Fund perspective on the project.

264. In both scenarios the incremental cost and benefit of the with-project compared to the without-project scenario are quantified.

265. From a country perspective the analysis, table 20 shows that the project is profitable in the long run, but result in a negative NPV over the project lifetime of 7 years with an a negative NPV of USD -39.65 million. After 10 years the project has a NPV of USD -16.2 million and an Economic Rate of Return (ERR) of -2%. After 20 years the project result in an attractive return with an NPV of USD 45.8 million and an ERR of 20%.

266. From a global perspective the project is highly profitable resulting in a positive NPV of USD 6.5 million after 7 years (ERR: 41%) and USD 169.6 million after 20 years (ERR: 81%). In total the carbon value contributes USD 75.7 million (14%) of the total incremental project revenues after 7 years and USD 367.5 million (21%) after 20 years.

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[279] This price assumptions are based on the World Bank guidance note on shadow price of carbon in economic analysis (September, 2017) which suggest to use price ranges between USD 40 – 80 /tCO_2 for the year 2020. To be conservative the lower carbon price was used in the economic analysis.

267. This clearly justifies the GCF investment into the project from an economic point of view.

Table 15: Results of economic analysis (Economic Rate of Return and Net Present Value at 10% discount rate) with GHG emission reduction (valued at USD 40/tCO2)

	Governmental perspective without social value of carbon		Global perspective with a social value of carbon (USD 40/tCO_2)	
	NPV (USD)	**ERR (%)**	**NPV (USD)**	**ERR (%)**
7 years	-39.6 million	Not quantifiable	6.5 million	41%
10 years	**-16.2 million**	**-2%**	**59.6 million**	**77%**
20 years	40.9 million	20%	169.6 million	81%

6.2.3 Sensitivity analysis

268. The sensitivity analysis assesses the impacts of the most sensitive factors on the project economics. The analysis focuses on negative scenarios analysis and assesses project cost increase, revenues decrease, the adoption rate of the proposed ecosystem-based adaptation measures and the social value of the carbon prices is assessed (Table 16).

269. Compared to the base case, project cost increases by 20% will more than half the NPV (10 years) from USD 59.6 million to USD 20 million and reduce the ERR from 77% to 27%. A cost increase of 30% would still maintain the NPV and ERR positive at 10%.

270. The sensitivity of revenues reduction on the overall project performance is stronger than cost increases. A reduction by 20% of project revenues will reduce the NPV (10 years) to USD 9.1 million and the ERR to 19%. A 30% reduction leads to a negative NPV (USD -16.2 million) and a ERR of -5%.

271. Considering that the social value of carbon contributes to 21% of the total incremental revenues this individual factor is highly sensitivity on the project economics. A reduction by USD 10 (to USD 30/tCO_2) reduced the NPV (10 years) to USD 40.6 million and ERR to 49%. A price increase by USD 20 /tCO_2 (USD 60/tCO2) will increase the NPV to USD 97 million and the ERR to 156%

272. The adoption rate is less sensitive to the overall project economics. A 10% reduction or increase in adoption rate will increase/reduce the project ERR by 8-10 % and the NPV value by about USD 8 million after 10 years.

273. In conclusion, the analysis shows that despite the potential project cost increase or project revenues decrease the project remains profitable and should be considered for investment from an economic perspective.

Table 16: Results of sensitivity analysis

Sensitivity analysis	Change factor	NPV (USD) 10 years)	NPV (USD) 20 years	ERR (%) 10 years	ERR (%) 20 years
Base case		59,582,538	169,591,969	77%	81%
Cost increases	**10%**	39,807,221	136,719,057	49%	57%
	20%	20,031,903	103,846,144	27%	41%
	30%	256,586	70,973,232	10%	29%
Revenues reduction in project scenario	**-10%**	34,326,400	121,673,536	46%	55%
	-20%	9,070,262	73,755,103	19%	34%
	-30%	-16,185,876	25,836,669	-5%	18%
Social value of carbon (USD/tCO2)	**60**	97,479,642	233,935,452	156%	157%
	50	78,531,090	201,763,711	114%	115%
	30	40,633,986	137,420,228	49%	57%
Adoption rate compared to base case (80%)	**90%**	67,560,471	187,442,572	87%	90%
	70%	51,604,606	151,741,367	67%	72%
	60%	43,626,673	133,890,764	57%	64%

6.3 Concessionality

274. The activities supported by GCF funds will entail no direct revenue generation or cost recovery for the Government of Nepal. Thus, an overview of financial markets is not applicable for this project.

275. Nepal's daunting social and economic development challenges further exacerbate the vulnerability risks of its population. The Gross National Income per capita (purchasing power parity) is $2,500 compared to the global average of ~ $15,000[280] and 25% of its population lives below the poverty line[281]. Over 70% of its population lives in rural areas and approximately 46% are unemployed[282]. While about one sixth of Nepalese are food insecure, the situation is particularly acute in hilly regions such as Churia. The effects of food insecurity are especially severe among women and children[283]. The vulnerability situation is further compounded by the extreme dependence of rural communities on a fragile/deteriorating natural resource base. Over 70% of Nepal's 28 million people depend on the primary sector

[280] World Bank 2014
[281] https://www.adb.org/countries/nepal/poverty
[282] https://www.cia.gov/library/publications/the-world-factbook/geos/np.html
[283] http://www.nnfsp.gov.np/PublicationFiles/d405d609-bb00-4708-831c-149dea4b4f49.pdf

as their major source of livelihood. Overall, the economic costs of climate change in Nepal for the primary sector could be equivalent to 2-3% of current GDP/year by mid-century.

276. In general, poor and vulnerable households and communities suffer most from climate change, because of their higher exposure and sensitivity (of assets and livelihoods) to climate change risks, their low capacity to manage risks and prevent negative impacts[284]. To cope with these pressures, and for their survival and subsistence, poor people rely on their surrounding natural resources, resulting in their further degradation and, ultimately pushing them into a perpetual cycle of poverty and environmental degradation. Thus the impending impacts of climate change will have significant negative impacts on their basic survival and subsistence needs, for example quality and availability of water resources, agricultural productivity, animal husbandry and ecosystem integrity[285]. This will in turn have an adverse impact on the overall social development of Nepal.

277. It is unlikely that Nepal's adaptation needs will be able to be addressed through government expenditure. In 2016, Nepal had a current account surplus equal to 6.2% of GDP and the trade deficit narrowed by 1% to 30% of GDP, but the government's reserves are still barely sufficient to cover one year's worth of public services and imports of essential goods[286].

278. The country has further experienced several shocks in the last three years that have had a substantial impact on the country's economy, including the devastating 2015 earthquake, trade disputes that lead to a fuel crisis shortly after the earthquake and devastating floods in 2017 that impacted over 1.1 million people.[287] Budget constraints due to post-earthquake recovery and other shocks continue to limit the ability of the government to finance key interventions in climate change mitigation in Nepal.[288]

279. **Nepal´s NDC** discusses the country´s strategy and commitments to climate change, yet also notes the need for **additional technical and financial grant support** to fully implement its NDC and reach its proposed targets. Of particular relevance to the proposed project, Nepal´s NDC highlights the need for external financial and technical support on:[289]

- Formulating and implementing national adaptation plans, national adaptation plans of action and local adaptation plans of action
- Conducting research and studies on loss and damage associated with climate change impacts, and implementing measures to reduce climate vulnerability
- Creating an enabling environment to promote private sector investments and foreign direct investments in low carbon technologies (energy efficiency and renewable energy)
- Addressing the drivers of deforestation and forest degradation to enhance carbon sequestration

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[284] Mearns and Norton 2010
[285] WB FIP Inception Workshop 2016
[286] ADB 2017
[287] http://www.worldbank.org/en/country/nepal/overview
[288] IMF 2017
[289] MoPE 2016

- Enhancing the agricultural sector by adopting climate-friendly technologies and reducing climate change impacts
- Capacity building at institutional level to plan and implement adaptation and mitigation programs and projects, among other priority areas.

280. Thus, Nepal will need considerable grant financing to fund development priorities in the medium term, especially in low-carbon and climate-resilient measures for the land use sector.

6.4 Alignment with GCF Investment Criteria

281. The proposed project is well aligned with the GCF Investment criteria, and provides a cross-cutting approach that will strengthen both climate change adaptation and mitigation in the Churia Region in Nepal. More detailed information on this alignment can be found in the GCF Funding Proposal within Section E.

6.5 Sustainability and Exit Strategy

282. The proposed project has been developed through **ongoing consultations and inputs with relevant government representatives** from relevant ministries and departments to ensure ownership over the project and ensure that it is closely aligned with government policies and plans, and that project activities support medium- and long-term planning to ensure the project´s sustainability and continued progress towards mainstreaming climate-resilience in Nepal.

283. By **aligning the project with key national climate policies, priorities, and commitments**, including Nepal´s NDC and the 20-year Churia Master Plan, the chances of its continuity after GCF investment are very high. Improving natural resource management, adapting to and mitigating climate change, and enhancing livelihoods of local communities are explicit goals of Nepal's political leadership. As such, the Government of Nepal is a strong proponent of the project's interventions and continuity.

284. The long-term sustainability of project interventions is further enhanced by the project's focus on **individual and institutional capacity building** with key stakeholders at all levels. Measures focused on **institutional strengthening at the provincial and local level** are essential given the political transition, and the increasing role and influence of such organizations over land use planning and management. It represents an opportune time to establish required capacities and expertise early on, and mainstream climate-resilience into local policies and plans as they are being established. Such institutional actors will have improved awareness of climate-resilient land use planning and measures, and it is likely they will continue to support such measures after project completion. Such interventions will further enhance the sense of ownership of provincial and local governments during the project life-cycle as well as the ongoing implementation of such activities after project closure.

285. Effective stakeholder engagement is a key element to ensure social sustainability. **Local empowerment through climate-resilient and improved natural resource governanc**e promoted by the project will serve as the main motivation for active engagement and participation of all key stakeholders. The project applies an innovative approach that aims to empower

local communities by strengthening the capacities of local community-based organizations on climate-resilient SNRM and supporting them to implement measures that are suitable based on their local context and priorities. This will not only increase the awareness of climate change risks by such groups, but will also support them to increase their adaptive capacities and to strengthen the resilience of local communities and critical ecosystems, taking into account differentiated vulnerabilities within community-based organizations. The project will make proactive measures to ensure inclusion of the priorities of all community members and equitable sharing of ensuing project benefits.

286. **Improvements in extension services**, e.g. through strengthening extension materials/ modules, training trainers and improving access to extension and demonstration activities, will improve access to knowledge on climate change and climate resilient land use. Additional support consolidating local and indigenous knowledge on adaptation will further promote innovation in the land use sector, and identify feasible locally adapted measures that can also be integrated into extension modules along with examples from past projects building on lessons learned and key experiences. Such educational modules and approaches can be scaled up in a cost-effective way, and be used to reach diverse community-based organizations, NGOs and households not only in the project area but in Nepal as a whole.

287. The co-financing of the government of Nepal is largely devoted to the **improved extension system implementation such as the salaries of the extension workers and their mobility.** The Government of Nepal will be encouraged to maintain this enhanced level of financing to the extension system after the project and will ensure that extension continues beyond the project and EbA measures are adopted. Investments such as farmer field schools and nurseries will be operated by the CBOs after the project ends and will be supported by governmental extension systems and technical support. The elaboration of user-friendly materials, including picture books, will help CBOs and extension agents to maintain knowledge and strengthen capacities on climate-resilient SNRM. Given trainings, improvements in communication pathways and extension resources (including training materials), maintenance costs are low. FFS provide demonstrable results and multiple benefits for communities, further encouraging CBO members to request such services and adopt SNRM.

288. CBOs benefiting from the project will sustain investments in maintaining and sustainably managing investments. A recent study of CFUGs identified that on average ~30% of CFUG community-raised funds are unused, yet that substantial support is needed to demonstrate effective practices and technologies to support communities to invest in them in the long-term.[290] Investments in capacity building, knowledge and learning (e.g. CKC and extension materials), will facilitate access to information and knowledge.

289. Economic sustainability is achieved through **the project's support for viable, cost-effective and climate-resilient measures** that provide tangible socio-economic and environmental benefits that will enhance resilience to climate change.

[290] Personal communication with MoFE staff

290. As shown in the financial analysis, all the proposed EbA and infrastructure measures are financially attractive with a positive NPV value which will incentivize long-term implementation, especially if the GCF covers the short-term capital needs to invest. Initial returns are often low, whilst medium- to-long-term returns are often equal or higher to BAU practices, providing longer term incentives for farmers to maintain or continue to adopt such practices. To overcome initial investment costs/ low-returns, additional technical and financial support is required for CBO members to adopt such practices.[291] The forest plantation models utilized provide cash flow from year five onwards with the use of short rotation plantations (e.g. bamboo), and additional income from cuttings.

291. Thus, the adoption of the proposed practices will have an inherent incentive to continue with the implementation of the business cases. The operational management and maintenance of agricultural and forestry models is mainly related to the in-kind or hired labor and inputs purchase will be paid from the cash flows of the models. The demonstration plantation and protection forest will be maintained by the community based organizations and will require limited labor inputs until the revenues occur. Beyond project lifetime, the land use models operational and maintenance costs and will be covered by the revenues generated from the implementation of the climate resilient land use practices. The demonstration of financial benefits to the individual household will incentives the maintenance and operations of the propose measures.

292. In addition, the improved knowledge level and capacities of communities on improved climate resilient practices of the implemented measures will ensure that community member continue the adopted management practices beyond the project lifetime.

293. The water and soil conservation infrastructure investments will be operated and maintained by the affected community based organizations if it is on community managed land. The operational cost will be paid from the members of the community based organization the direct beneficiaries of the services. Incentives to maintain the infrastructure will be delivered by the increased revenue levels to individual household and a strengthened ownership level of the implemented infrastructure. A recent government assessment indicates that on average 30% of CFUG funds are unused,[292] and all costs for supported investments, including maintenance costs and plans, will be communicated up-front. Investments on public land will be maintained by the responsible government institutions responsible for the infrastructure.

294. Additional income and livelihood opportunities will create a cascading effect and maintain the low-carbon and climate-resilient development trajectory triggered by the project. The project financial and economic analysis demonstrates that the proposed activities are all financially viable, with positive net present values as well as many other social, economic and environmental co-benefits.

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[291] Das and Bauer 2012; They assessed the adoption of practices to reduce soil erosion from conventional maize cropping systems (incl. agroforestry, intercropping and minimum tillage). Despite providing clear benefits and positive returns for longer periods than conventional systems, short term investments and low-or-negative short-term returns are major barriers for farmers to adopt these technologies. Thus, they determined sufficient incentives are required to facilitate the adoption of technologies that promote climate-resilient SNRM.

[292] Personal communication with MoFE staff.

295. The project recognizes that women are vital stakeholders in managing and using natural resources and they will need to play an active role in implementing project interventions. The project will proactively seek to ensure meaningful participation of women, taking into account the specific constraints and barriers they face. For instance, training sessions targeted at women will be designed and organized at times and in locations that women can easily access, and will use tools and methods that are mindful of different literacy levels and language barriers. Furthermore, awareness raising and gender sensitization activities will be organized at community level to facilitate enhanced participation of women (for more detailed information on specific measures refer to the Gender Action Plan in Annex 5).

296. **Social inclusion** is a cross-cutting principle within the project´s outputs and activities. The BRCRN project aims to promote an inclusive approach, ensuring indigenous peoples, Dalits and other marginalized groups are included within the project and that specific measures are included that target their participation and promote their empowerment within the context of the project. A social inclusion plan has been developed to strengthen the engagement of such groups within project design (refer to the ESMF in Annex 4). By promoting an inclusive approach, it will create ownership within diverse communities, encouraging diverse actors to continue to support project-activities after project-end, and to increase awareness of climate change and climate-resilience. Social inclusion measures, such as including trainers from diverse socio-cultural backgrounds, will improve information dissemination to diverse communities and ethnic groups on climate change and climate-resilient SNRM.

7 MONITORING AND EVALUATION

297. The BRCRN project's approach to evaluation and monitoring & reporting are explained in Section H.2 of the Funding Proposal. The following sub-section provides a more detailed overview of how the project will use the Churia Knowledge Centre (CKC) to support monitoring of project activities and the achievement of the envisaged project results that are outlined in Section H.1 of the Funding Proposal. The Churia Knowledge Centre constitutes one Means of Verification (MoV) to be used in the overall project monitoring system, and is referenced in Section H.1 of the Funding Proposal as "Reporting by CBOs via the Churia Knowledge Centre". As outlined in Section H.1 and H.2 of the Funding Proposal, additional MoV will also be used, including: baseline and completion surveys; maps and remote sensing; ground-truthing exercises; workshop/training records; other project reports; and in-person assessments administered by trainers and project-recruited personnel, among others. Collectively, this suite of MoV – which includes both primary and secondary data sources, and is geared toward reducing the potential for bias when assessing results – will enable effective and efficient monitoring and reporting of project progress and results.

7.1.1 Use of the Churia Knowledge Centre (CKC) to support project monitoring

298. The overall methodological structure of the CKC monitoring system is illustrated in the figure below. The overarching system features a combination of activity-based proxy indicators and scientific models that will be used to demonstrate performance in measurable ecosystem services as well as project´s overall performance. The system design is based on a combination of field-based surveys and user group self-monitoring and digital data collection, communication and information technologies. It guarantees cost-efficient, robust, transparent and verifiable reporting of impacts on a sustainable basis, providing multiple ways of communication through the CKC.

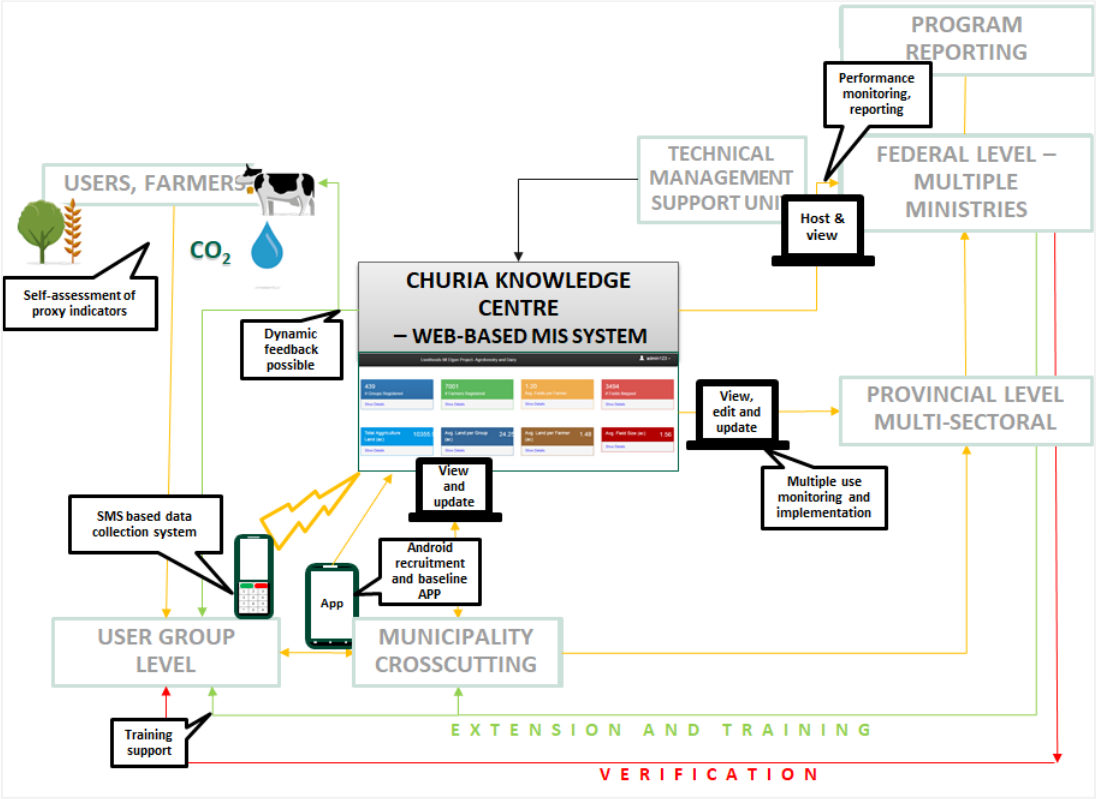


Figure 33. CKC Multiple Benefit Monitoring System

299. The system will be directly developed as an integral part of the CKC, representing a prime communication-innovation hub in this project. To support monitoring of the project's performance as well as climate benefits, the key approach is that beneficiaries in the project perform periodical self-assessments (using easy self-assessment sheets) using proxy indicators that directly monitor the activities performed in the project. On a user group level, the individual self-assessment data will be aggregated and submitted to the central database system (i.e. CKC) by means of different communication technology. Before the activity-based monitoring system is functional, an in-depth phase of training is required, including trainings at the federal level, provincial-level, local extension level as well as CBO level to define roles and responsibilities, quality control procedures and verification procedures.

300. System design will be based on the following principles:

- **Accountability**
- **Appropriate to national context**: ensuring compatibility with existing systems and institutional structures, designed based on national context, conditions and priorities
- **Data aggregation structures are key:** e.g. household-group-ward-province-national
- **Bottom-up approach:** User group monitoring data complemented by top-down verification/ research data to evaluate project, adaptation & mitigation performance
- **Activity-based approach:** Proxy indicators used to assess adaptation & mitigation activities

- **Ownership:** Owned by user groups, informs extension & self-learning structures, increases buy-in for adaptation & mitigation activities
- **Activities accurately quantified with known levels of uncertainty:** Sampling approaches
- **Quality control & assurance:** SOPs for training, surveys, data collection & processing, analysis, archiving & reporting
- **Cost effective design:** Cost efficient & MoFE-driven: Based on existing data & multiple uses of data
- **Strengthen existing national structures** by introducing reliable (statistically robust) results
- **Multiple benefit monitoring system:** Adaptation, mitigation performance, project performance, livelihoods monitoring; attracting private sector and other blended finance opportunities; enhancing capacity building & informed planning (transparency); provides mutual benefits for future project implementation and impact monitoring; MRV system as management Tool – higher incentive for smallholders to maintain system

301. Based on the design and data requirements of the monitoring system and the multiple project interventions, each community member[293] will be trained in conducting a self-assessment on an annual basis. For every 5-10 registered CBOs, one community member is selected as the Community Group Leader (CGL) for the purpose of supporting capacity building and communication for the CBO, coordinating support with project extension services and management.

302. The group leader is trained on how to total the specific data from individual self-assessment forms for group members into the group record considering the specific data requirements of interventions and how to manage potential error sources.

    Summarized data of each group will be collected and entered into the web-based CKC monitoring system. This will allow to accelerate the data entry on a more standardized basis. The web-based system includes a data entry module which can work offline and data can be synced to the project server when internet is available. The module has several mathematical and logical validations to avoid data entry mistakes as well as control mechanisms to ensure the quality of data. The data sent to the server is immediately available for further processing using different web-based interfaces. All the calculations to monitor the project performance as a whole and to provide the parameters needed for climate change benefits (adaptation and mitigation) and other calculations related to the project impact indicators will be integrated into the CKC system.

[293] Registered through the CBO

303. **SOPs and quality control (QC) and quality assurance (QA) procedures** undertaken for data monitored: As stated in the IPCC GPG for LULUCF (page 4.111) monitoring requires provisions for quality assurance (QA) and quality control (QC) to be implemented via a QA/QC plan. A QC/ QA Plan will be elaborated which covers procedures for:

- Collecting reliable field measurements and verifying methods used to collect field data;
- Verifying data entry and analysis techniques; check for Duplicate values, outliers, and wrongly entered values with support of the newly established CKC system;
- Data maintenance and archiving. Especially this point is important, as time scales of project activities are much longer than technological improvements of electronic data archiving.

304. The CKC system has, apart from the central database, in-built procedures to calculate results of the key project level indicators (usually summarized in a dashboard).

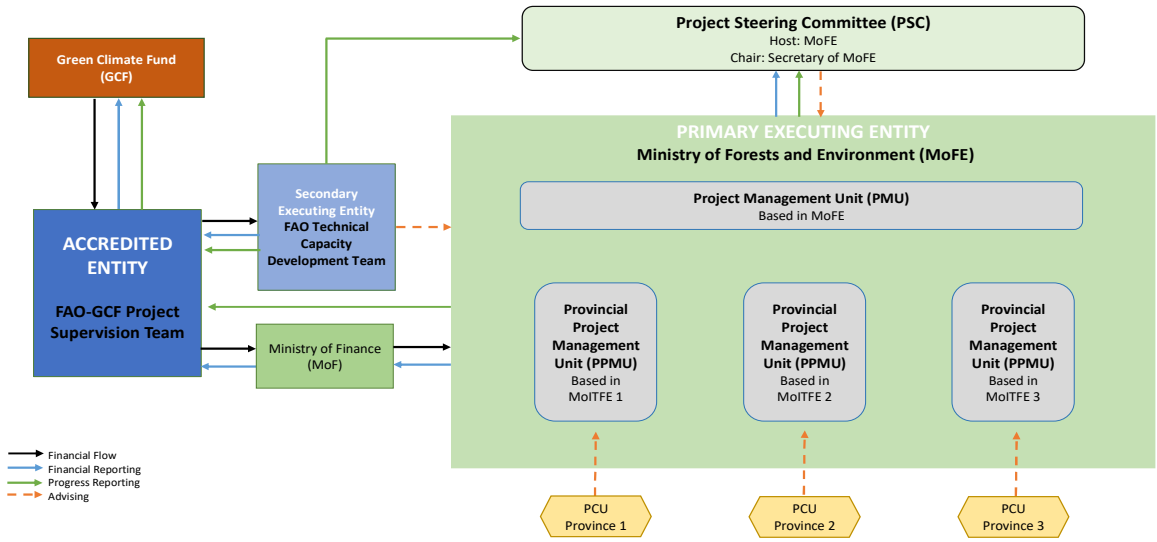
8 MANAGEMENT AND IMPLEMENTATION ARRANGEMENTS

8.1 Project delivery

305. As per Article 56 of Constitution of Nepal (2015); the Federal Democratic Republic of Nepal shall have three main levels of structure: federal, provincial and local; and state powers shall be used by the federal, provincial and the local level in accordance with the constitution. The provincial assembly, village council and municipal council have full authority to make independent laws being consistent to federal law. In line with this constitutional provision, Nepal has designed its governance structure to have three tiers (i.e. local, provincial, national), with fully devolved authority to local governments to conserve, monitor, regulate and use natural resources within their jurisdiction.[294]

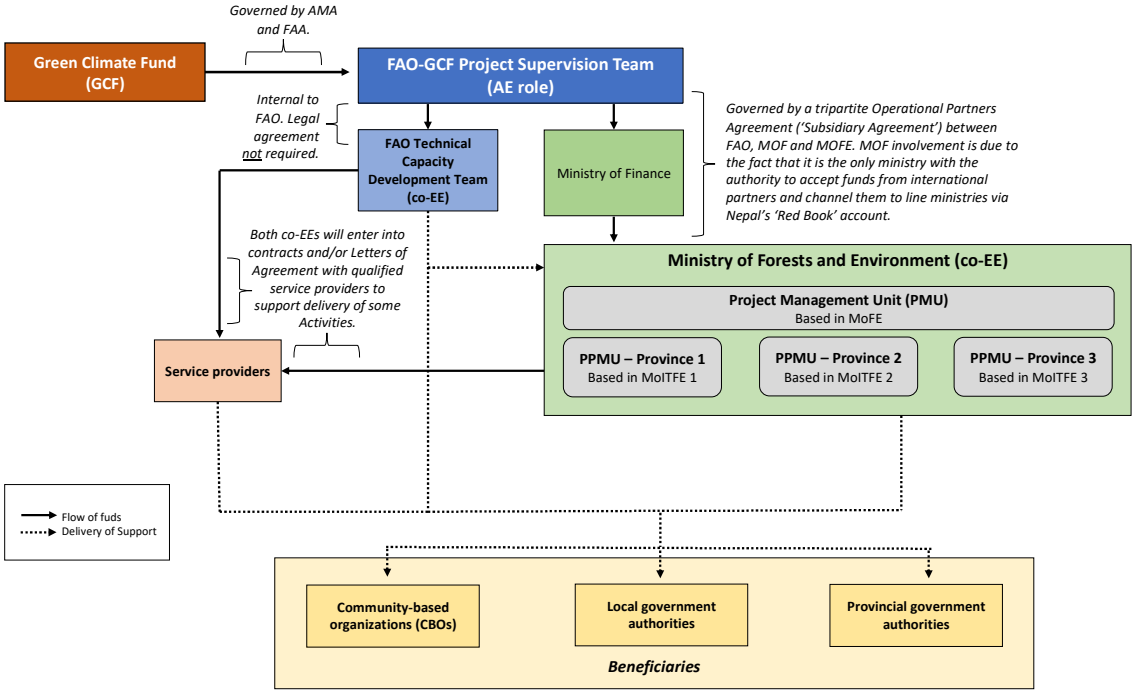
306. The BRCRN project´s proposed management and implementation arrangements are a direct result of ongoing discussions between FAO and relevant national authorities, including MoFE and the NDA among others, and further feedback has been provided by provincial and local stakeholders in project consultations. The institutional framework for this project will engage a wide range of stakeholders, ensuring their sustained engagement from project design to implementation, to M&E. These arrangements are designed to clearly take into account the potential roles and responsibilities of diverse actors based on their interests and capacities, while (i) ensuring consistency with the new governance framework and (ii) ensuring project management remains smooth, effective and efficient. Project governance and reporting arrangements, as well as project implementation and management arrangements, are briefly summarized in the following two figures and described in detail further below.

Figure 34: Project governance and reporting arrangements



[294] LGOA 2017, Article 11 (3) (4) clarifies the role of local governments in Schedule 9; however, these provisions have yet to be translated into provincial and federal acts.

Figure 35: Project management, financial flow and contractual arrangements



Accredited Entity role

307. FAO will serve as the Accredited Entity for the BRCRN project. As such, FAO will be resposible for the overall management of this project, including: (i) all aspects of project appraisal; (ii) administrative, financial and technical oversight and supervision throughout project implementation; (iii) ensuring funds are effectively managed to deliver results and achieve objectives; (iv) ensuring the quality of project monitoring, as well as the timeliness and quality of reporting to the GCF; and (v) project closure and evaluation. FAO will assume these responsibilities in accordance with the detailed provisions outlined in the Accreditation Master Agreement (AMA) between FAO and GCF. Accountability on the use of financial resources will be facilitated through the review of annual and bi-annual project reports, as well as through audit and monitoring reports.

308. To perform these Accredited Entity functions, FAO will set up a dedicated FAO-GCF project supervision team comprising relevant staff from the FAO Country Office in Nepal, the FAO Regional Office for Asia and the Pacific, and FAO Headquarters. Members of this project supervision team will perform the necessary supervision and oversight functions, including supervision and back-stopping missions during the entire implementation period, as required. The project supervision team will remain independent of the Executing Entity functions also performed by FAO (see below). In line with the GCF policy on fees adopted through GCF Board Decision B.19/09, the above-mentioned segregation of responsibilities within FAO will ensure that the Organization can independently and effectively perform the types of Accredited Entity functions listed in the GCF

General principles and indicative list of eligible costs covered under GCF fees and project management costs.

Project Coordination and Management

309. MoFE will serve as a co-Executing Entity for the BRCRN project. In this capacity, MoFE will establish a national **Project Steering Committee (PSC)** chaired by the Secretary of MoFE. This committee will be comprised of joint-secretary level representative members from relevant federal ministries, provincial ministries, FAO (in its role as Accredited Entity), as well as a member secretary of PCT-MCDB. PSC will also invite representatives from relevant CSOs, the private sector and academia as necessary to discuss thematic issues as well as partnership opportunities. PSC´s main responsibility will be to provide strategic guidance and support coordination among government institutions, and will provide general oversight for the implementation of the project. The committee will further be responsible for revising and approving annual working plans and budgets, and mobilizing relevant technical expertise where necessary. They will approve the Project Implementation Manual (PIM) and Project Reporting Guidelines (PRG) during the inception phase. PSC meetings will be held twice a year: prior to annual budget planning and after the closure of fiscal year.

310. MoFE will also establish and host a **Project Management Unit (PMU)** at the federal level. It will be headed by a full-time National Project Director (NPD), appointed by MoFE in consultation with the PSC, and will include three provincial-level support teams, termed **Provincial Project Management Units (PPMUs)** – one in each of Provinces 1, 2 and 3. The PMU will be responsible for implementation of project activities according to annual work plans and budgets submitted to, and approved by, the PSC. The PMU will also prepare and submit to the PSC annual progress reports to track performance against project targets, and against the targets of the Gender Action Plan, Indigenous Peoples Planning Framework and ESMF. In the inception phase, the PMU will develop a detailed work plan and monitoring framework for the full project duration, and the PIM and PRG, for submission and approval by the PSC. These will govern the roles of all responsible institutions and project stakeholders, including in terms of procurement, monitoring, reporting and auditing.

311. The PPMUs will be hosted in the provincial Ministries of Industry, Tourism, Forests and Environment (MoITFE), but will remain accountable to the PMU under MoFE at the federal level, and operate according to the regulations and guidance set out in the PIM and PRG. PPMUs will be responsible for coordinating the development of provincial work plans, in consultation with the Provincial Coordination Units (see below), for delivery and oversight of project activities at the province and local level, for development of quarterly progress reports and their submission to the PMU.

312. In addition to the above project coordination and management structures, FAO will establish a Technical Capacity Development Team to support effective and technically sound delivery of the BRCRN project. The **FAO Technical Capacity Development Team** will serve as a co-Executing Entity delivering targeted technical assistance and maintaining responsibility and/or controls over international tenders and (non-expendable) procurement requiring expert/requiring technical oversight. This team will function independently of the FAO-GCF project supervision team (described above) to ensure FAO's Accredited Entity and Executing Entity functions are kept separate from one another. Detailed information on the specific activities and budget items for which the FAO Technical Capacity Development Team will be responsible is included in the detailed budget in Annex 3 – Integrated Financial Model.

Multi-stakeholder Coordination Units

313. **Provincial Coordination Units (PCUs)** will be established in each of the three provinces, and will be chaired by the Secretary of the provincial MoITFE**.** Each PCU will include representative members (Under Secretary level) from other relevant provincial ministries, departments, CSOs (including women´s organizations, indigenous people's federations and representatives, and Dalit organizations, among others) and private sector representatives, with the coordinator of the PPMU acting as PCU Secretary. PCUs will serve as multi-sectoral and multi-stakeholder committees to develop proposals for provincial work plans, with guidance from the PMU and PPMU and according to the PIM and PRG. Each PCU will convene on a quarterly basis to review project progress against provincial targets, ensure coordination of project activities with those of provincial institutions and provincial policy and legislative priorities, and communicate provincial-level concerns and issues to the PMU. The PCUs are a key part of the project's exit strategy. During the second half of the project timeframe, and based on the recommendations of the independent mid-term evaluation, the PPMUs will work with provincial stakeholders towards handover of project technical and operational support structures to the PCUs.

8.2 Institutional Analysis

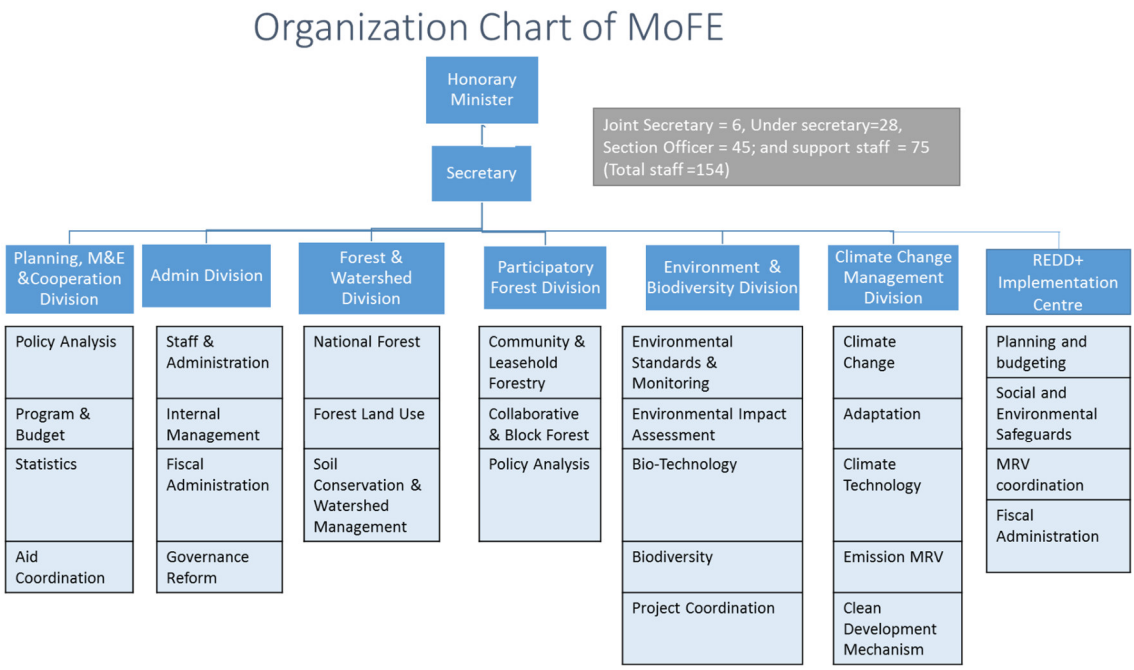
8.2.1 Key Institutional Actors

National Actors

314. The **Ministry of Forests and Environment (MoFE)**[295] will be a co-Executing Entity (EE) for the project. MoFE is responsible for the conservation, development, use, and sustainable management of forests (which is the predominant land use category in the Churia). The Ministry is also in charge of REDD+ in Nepal, and hosts the REDD+ Implementation Centre (RIC). In addition, MoFE has experience and expertise in successfully implementing projects related to the main thematic areas of intervention under this project, for example, SNRM and ecosystem restoration in the Churia region. MoFE is thus well placed to play a central role in the delivery of the project. Through the Project Steering Committee (PSC), the ministry will coordinate with other relevant sector Ministries to ensure synergies for transformational change. The following figure provides an overview of the organization of MoFE.

Figure 36. Organizational structure of the Ministry of Forests and Environment (MoFE)

[295] Formerly the Ministry of Forests and Soil Conservation



315. The **Ministry of Finance (MoF)** is the National Designated Authority (NDA) for the GCF in Nepal. All international investment to Nepal's public sector must be channeled through the MoF, according to the constitution. FAO, as the AE for this project, will transfer GCF grant finance for project execution by government to MoF, which will in turn channel this finance directly to MoFE, according to the latter's role as a co-EE for the project.

316. The **Ministry of Agriculture, Land Management and Cooperatives (MoALMC)** will play an important role supporting interventions targeted at the agricultural sector. It is the Ministry that oversees agricultural land management, the establishment of cooperatives and agricultural extension, which will have an important role in planning processes for climate-resilient SNRM, the implementation of climate resilient land use practices in the agricultural sector, and in supporting the activities within Output 3. The Ministry has successfully implemented several large projects with funding from international donors and technical assistance from FAO, such as the Nepal component of the Global Agriculture and Food Security Project (GAFSP) and the Climate Change Adaptation in Agriculture Project funded through the Least Developed Countries Fund (LDCF) window of the GEF. Together with FAO and other development partners, the Ministry has also developed and implemented Nepal's Agriculture Development Strategy (ADS), and the Food and Nutrition Security Plan of Action (FNSP). Other emblematic programs of the ministry include the High Value Agricultural Project In Hill and Mountains (HVAP), the Decentralized Science, Technology and Education Program, the Value Chain Development Program, and the Innovation and Agro-entrepreneurship Program.

317. The **Ministry of Energy, Water Resources and Irrigation (MoEWRI)**[296] will support interventions related to sustainable water resource management and alternative renewable energy (biogas). In

[296] Formerly the Ministry of Energy and the Ministry of Water Supply & Sanitation

terms of watershed management, the Ministry has implemented several successful projects including the Kulekhani, Fewa and Begnastal/Rupatal (BTRT) watershed management projects, among others.

318. In terms of energy, the MoEWRI promotes the adoption of sustainable renewable energies in Nepal. In 2016, the Ministry developed a subsidy scheme for renewable energy technology based on the ´Renewable Energy Subsidy Policy´. The Ministry also coordinates with the **Alternative Energy Promotion Centre (AEPC)**. Since 1996, AEPC promotes renewable energy technologies in Nepal and aims to make such technologies more accessible to the population of Nepal. AEPC has developed guidelines to support the planning and adoption of renewable energy in rural communities,[297] as well as guidelines to support business development in local communities related to sustainable energy technologies.

319. **The Ministry of Federal Affairs and General Administration (MoFAGA)** will contribute to improving coordination between national ministries and local and provincial governments, especially ensuring alignment with the BRCRN and provincial level policies and decision-making.

320. The Disaster Management Section of the **Ministry of Home Affairs (MoHA)** is responsible for disaster risk reduction planning and will therefore provide a source of advice and support for DRR-related activities within Output 3 of the project. MoHA led the elaboration of the national policy for disaster risk management in Nepal, and is highly experienced in local level DRR planning. Before the transition to a federal structure, MoHA supported the elaboration of district DRR plans, including in Arghakhanchi and Udayapur districts together with FAO and the MoALMC, as well as guidance for local level planning.[298] The ministry also elaborates and publishes annual reports on disasters and disaster risk reduction, including guidance on policies, practices and lessons learned. Such insight will also be important to ensure that key knowledge is integrated within the CKC, as well as in guidelines and educational materials developed under Output 3.

Provincial Governments

321. Prior to September 20, 2015 Nepal was structured into five development regions, fourteen administrative zones and 75 districts. With the revised constitution of Nepal (2015) and the completion of the country´s transition from a constitutional monarchy to a federal state, the previous system was replaced by seven provinces.[299] While temporary headquarters have been identified, there is still an ongoing transition to establish the institutional and governance infrastructure in the provinces, and the related provincial-level legislation and operational acts.

322. As per the Provincial Powers/Jurisdiction stated in Schedule 6 of the Constitution, the management of national forest, water resources and ecology will be under provincial jurisdiction. In provinces 1, 2 and 3, a Ministry of Industry, Tourism, Forests and Environment (MoITFE) has been established, which is responsible for the sustainable management, utilization and conservation of forests, ecosystems, water resources and biodiversity within their jurisdictional boundaries. Provincial governments from Provinces 1, 2 and 3, particularly the MoITFEs, will have an important role in the BRCRN project as hosts of the PPMUs, chairs of the PCUs, the focus of institutional capacity building efforts at the provincial level and the sustainability of project outcomes and impact.

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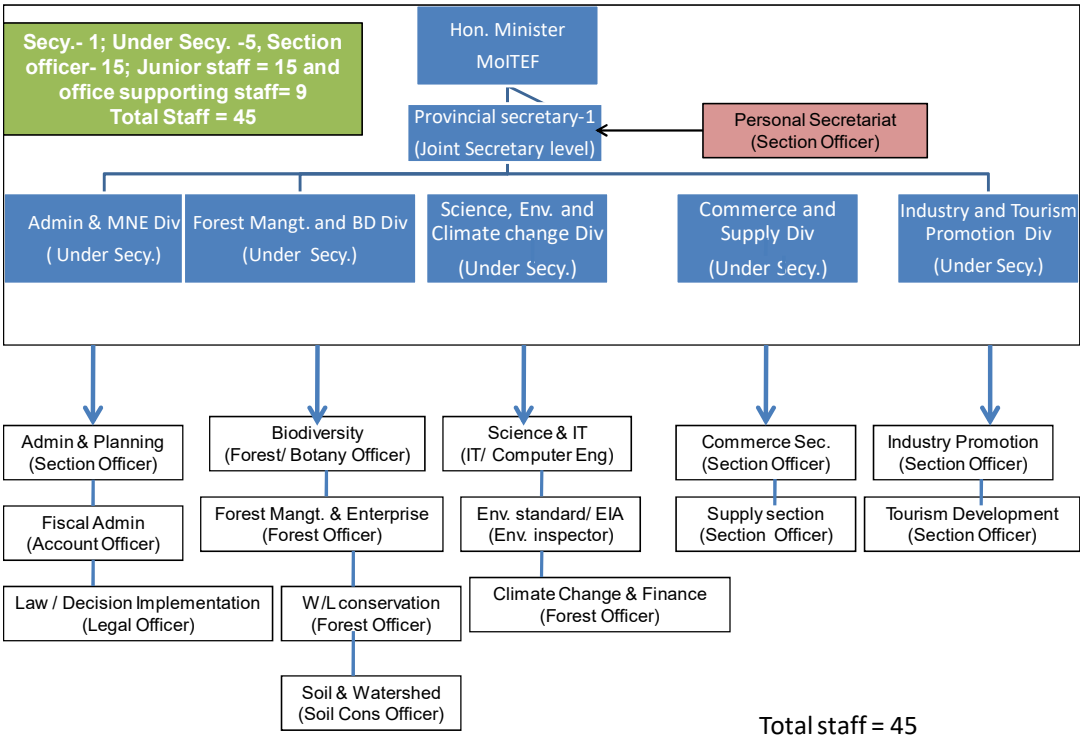
[297] Guidelines can be found at: http://www.aepc.gov.np/?option=resource&page=resgfm&sub_id=24
[298] MoAC and FAO 2011
[299] Section 4, Constitution of Nepal (2015)

323. The organizational structure of the **MoITFEs** (see Figure below) demonstrates that their multidisciplinary composition enables successful implementation of complex initiatives, and is aligned with the expertise required for supporting coordination efforts and enhancing the sustainability of the BRCRN project. Senior technical and administrative officers from MoFE and other line ministries have been deputed to serve in MoITFEs and have already taken up these posts. This will strengthen the provincial ministries´ capacity to support project interventions related to SNRM and ecosystem restoration in the Churia region and ensure that they are familiar with the management and operation of large-scale investment projects through their experience at federal level. MoITFEs will be direct beneficiaries of the project through technical support for institutional capacity building on climate-resilient land use planning.

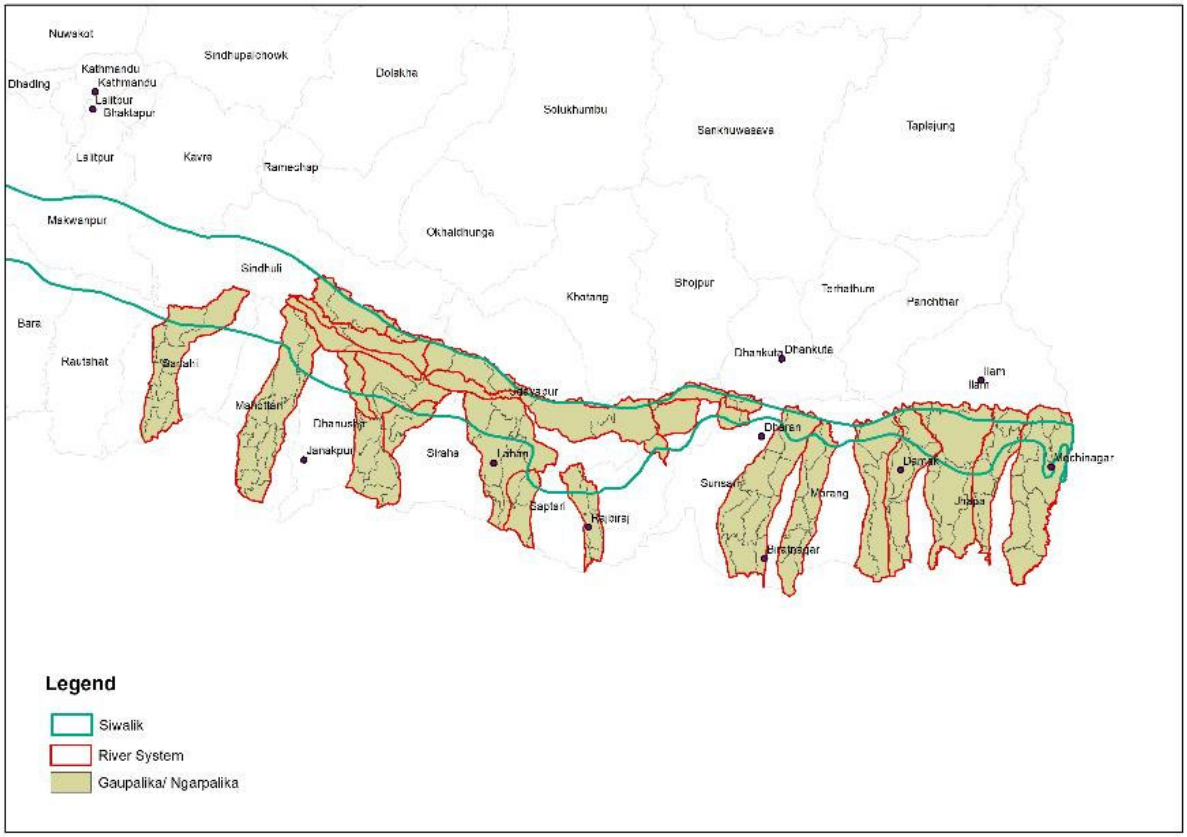
Figure 37. Organizational structure of Provincial Ministries of Industry, Tourism, Forests and Environment (MoITFE)



Local Governments (i.e. Rural Municipalities)

324. The third tier of government, according to the 2015 Constitution, are local government entities termed *gaunpalikas*, translated into English as 'Rural Municipalities' and *nagarpalikas* (cities). Rural Municipalities officially replaced the former Village Development Committees (VDCs) in 2017. Their size and their boundaries are roughly equivalent to amalgamations of three or four of the former VDCs. Many of the roles and administrative functions of the new bodies have been directly taken up by former VDC office holders so, whereas provincial entities have no close equivalent from the former governance system and will require concerted institutional development efforts to adopt their functions, the office holders of Rural Municipalities are expected to be comparatively familiar with their new roles. The target river systems within the BRCRN project area coincide with 121 Rural Municipalities (see figure below). However, it is anticipated that project-funded interventions will take place in up to approximately 70 of these. These bodies, along with provincial ministries and entities, will be the direct recipients and beneficiaries of capacity building interventions of the project, in order to develop their competence in planning and implementation of climate-resilient SNRM and DRR. They will further provide support to the BRCRN project management entities (e.g. PMU and PPMUs) for coordination of project activities at the local level, and facilitate alignment of project activities with local development plans and budgets.

Figure 38. Map of municipalities located within the BRCRN project area



8.2.2 Capacity of Accredited Entities and Executing Entities to Deliver

ACCREDITED ENTITY (AE)

325. FAO will serve as the project´s Accredited Entity (AE) to the GCF. FAO is a specialized technical agency of the United Nations whose main goals are the eradication of hunger, food insecurity and malnutrition; the elimination of poverty and the driving forward of economic and social progress for all; and the sustainable management and utilization of natural resources, including forest, land, water, air, climate and genetic resources for the benefit of present and future generations.

326. FAO has supported projects for climate adaptation and mitigation worldwide, and has led and managed numerous climate change related projects. FAO's accreditation to the GCF was confirmed in October 2016 and the first full-size project for which FAO is AE, developed with the Government of Paraguay and focusing on reducing rural poverty, combating deforestation and mitigating greenhouse gas emissions, was endorsed by the GCF Board in March 2018.[300]

327. Agriculture and forestry are integral Components of FAO's mandate and the organization has a proven track record of providing technical assistance to this sector since its inception in Nepal in 1951. FAO works with countries according to periodic Country Programming Frameworks (CPFs). Having successfully completed the 2013-2017 CPF, FAO Nepal is currently in the process of finalizing the new CPF for 2018-2022 to support the emerging priorities of the Government of Nepal. From 2013-2017 the country´s CPF supported four main priority areas: i) food and nutrition security and safety, ii) institutional and policy support, iii) market orientation and competitiveness, and iv) natural resource conservation and utilization. FAO programs during this period have included diverse measures to enhance sustainable production and land use practices, including climate-resilient agriculture, sustainable forest and watershed management, improve institutional and technical capacities for climate change adaptation in the land use sector, and strengthened climate-resilient value chains, among others. As a neutral knowledge partner, FAO can provide specific technical support not only to Governments but also to other stakeholders and project partners in assessing and defining future strategies within the broader parameters of the development of the Churia region.

328. As AE, FAO will be resposible for the overall management of this project, including: (i) all aspects of project appraisal; (ii) administrative, financial and technical oversight and supervision throughout project implementation; (iii) ensuring funds are effectively managed to deliver results and achieve objectives; (iv) ensuring the quality of project monitoring, as well as the timeliness and quality of reporting to the GCF; and (v) project closure and evaluation. FAO will assume these responsibilities in accordance with the detailed provisions outlined in the Accreditation Master Agreement (AMA) between FAO and GCF. Accountability on the use of financial resources will be facilitated through the review of annual and bi-annual project reports, as well as through audit and monitoring reports.

EXECUTING ENTITY (EE)

329. The **Ministry of Forests and Environment (MoFE)[301]** will be a co-Executing Entity for the BRCRN project. MoFE is responsible for the conservation, development, use, and sustainable management

[300] http://www.fao.org/news/story/en/item/1104366/icode/
[301] Formerly the Ministry of Forests and Soil Conservation

of forests (which is the predominant land use in the Churia). The Ministry is also in charge of REDD+ in Nepal, and hosts the REDD+ Implementation Centre (RIC). In addition, MoFE has experience and expertise in successfully implementing projects related to the main thematic areas of intervention under this project, for example, SNRM and ecosystem restoration in the Churia region. MoFE is thus well placed to play a central role in the delivery of the proposed project. As co-Executing Entity, MoFE will manage a large proportion of the GCF grant resources, as well as the co-financing that it is mobilizing for the BRCRN project. MoFE has considerable experience managing projects of this size and nature, including: the Multi-Partner Forestry Project (MFSP); Hariyo Ban project; Building Climate Resilience of Watersheds in Mountain Eco-Regions; Adaptation for Smallholder in Hilly Areas (ASHA); Sustainable Land Management in Churia region; and the Terai Arc Landscape Program. In addition, MoFE is the lead EE for the implementation of the USD 24 million World Bank Forest Investment Programme (FIP) in Nepal.

330. In line with its internal procedures, FAO commissioned a capacity assessment of MoFE during the preparation of the BRCRN project. This assessment found MoFE to be a low-risk partner, and thus very well placed to serve as a co-Executing Entity for the project. In accordance with the results of this risk assessment, FAO is able to proceed with negotiation of an Operational Partner Agreement (OPA) with MoFE that establishes the specifics of the relationship between FAO (as AE) and MoFE during BRCRN implementation. The OPA will also determine the nature of the activities that MoFE can implement directly under this project, the technical, operational and administrative support that FAO will put in place for it to do so, including procurement, and the activities which will constitute the project's technical capacity development services, which the FAO Technical Capacity Development Team will implement directly.

331. No GCF grant finance will be transferred from MoF to any other entity for implementation of activities under the project, and therefore MoFE is the only entity with which FAO will negotiate an OPA. The Ministry is used to the establishing separate project offices for implementation of donor funded projects and have a ready model for establishment of the PMU structure for BRCRN. Recruitment of personnel for the PMU will follow the procedures of the Public Service Commission for additional posts. If current staff secondment is used to fill key positions, this will be subject to the approval of the PSC. Project capacity can be supplemented with national consultant recruitment according to Government of Nepal procurement procedures.

332. A **FAO Technical Capacity Development Team** will support execution of the project as a co-Executing Entity. The Technical Capacity Development Team will deliver targeted technical assistance to support delivery of project activities by MoFE (as co-Executing Entity), and maintain responsibility and/or controls over international tenders and procurement requiring expert/requiring technical oversight. Under this arrangement, project execution will benefit from FAO's considerable technical expertise while ensuring that most project management responsibility remains with MoFE, thus ensuring efficient project delivery. In addition, this arrangement will reinforce efforts to build the technical capacity of MoFE and other entities involved in project delivery, improving their ability to sustain benefit streams and scale up support after project closure. The work of the FAO Technical Capacity Development Team will be kept separate from FAO's Accredited Entity functions.

8.3 Structure of flow of funds

333. Every year the PMU will prepare the annual work plan and budget, including a procurement plan, which will be approved by the PSC. The work plan and budget will draw on the discussions at provincial level and proposals of the PCUs, as communicated to the PMU by the PPMUs. Based on the approval of this plan, FAO will transfer funds according to its covenants, rules and standards, to MoF. MoF will confirm these funds in the 'Red Book' system of budget management and transfer to MoFE accordingly.

334. According to FAO internal procedures and the Operational Partners Agreement (OPA) negotiated with MoFE, FAO will maintain controls over any funds related to international tenders, provision of expert advisory services, and goods or equipment for which technical specifications or quality assurance is required. Such procurement will be conducted or technically overseen by the FAO Technical Capacity Development team directly as part of the TA services to the project.

335. GCF grant finance allocated to the PMU within MoFE according to annual 'Red Book' Government accounts, will be the responsibility of the NPD and PMU staff. As part of MoFE and the PMU structure, PPMUs will have access to funds for implementation of provincial and local-level interventions according to provincial work plans. These funds will be mobilized directly by PPMUs, in their capacity as outposted units of MoFE, and will not be transferred for any purposes to other government or non-government entities at provincial or local levels.

Table 17: Roles and responsibilities of individuals involved in the PMU and PPMUs

Position	Role	Responsibilities
PMU		
National Project Director	In charge of project implementation	▪ In charge of the Project Management Unit; ▪ Member secretary for PSC; ▪ Lead PIM/PRG drafting process; ▪ Responsible to FAO (as AE) and PSC for general results of the project, both financial and operative ▪ Ensures final results established in the project results framework
Procurement Officer	Provide the final guarantee of the fulfillment of the purchase rules according to GCF and FAO specifications	▪ Prepare procurement plan for BRCRN; ▪ Propose personnel for charges related to purchases ▪ Structure guidelines regarding procurement policies and regulations. ▪ Monitor purchases, acquisitions and hiring.
Financial Officer	Manage the financial and accounting processes of the project	▪ Ensure the detailed record of accounting operations. ▪ Manage and safeguard financial and accounting management. ▪ Record operational and financial operations, related to cash flow. ▪ Responsible for the preparation and supervision, control and monitoring. ▪ Development of financial plans and control of disbursements.
Administrative Assistant	Administrative and logistical support to the management staff	▪ Verify for the adequate fulfillment of the distribution of resources and logistical elements related to the project ▪ Coordination of activities regarding territorial work ▪ General follow-up on execution dynamics and work plans. Support in the administrative requirements of the areas ▪ Archive documentation ▪ Definition of routes and establishment of visit plans ▪ Logistic arrangement for workshop, meeting or events ▪ Organizes and advises the traveler regarding the process and any other requirement
Monitoring and Reporting Expert	Guarantee the fulfillment of the results according to the annual programming and the logical framework of the project.	▪ Establishment of measurement indicator management and progress documents. ▪ General planning of activities linked to components and subcomponents. ▪ Monitoring of the operations plan, coordination of purchase of materials from external suppliers, supervision of work in progress and completed works, support in the execution of components ▪ Ensure the achievement of the proposed general project objectives, not losing the logic of the components and goals established

Position	Role	Responsibilities
		▪ Monitoring the implementation of ESMF, GAP, IPPF and related plans, overseeing the implementation of the grievance mechanism.
Driver	Support in the transportation of project staff and material resources	▪ Know and implement regulations for the use of parking vehicles, use of 4x4, use of VHF radios in vehicles, inventory of tools in vehicles, administrative provisions regarding the care and use of official vehicles, maintenance of vehicles, and procedure in case of emergencies related to official vehicles, etc. ▪ Responsible for transporting people to the corresponding territorial places ▪ Responsible for transporting material resources
PPMUs (X3)		
Provincial-level Coordinators	Coordinate project implementation with provincial and local level actors	▪ General follow-up on execution dynamics and work plans. Support in the administrative requirements of the areas ▪ Data update and coordinating/ supporting reporting needs at local level ▪ Organize PCU meetings ▪ Coordinating with PCU and other relevant stakeholders ▪ Receive grievances and operate grievance redress mechanism at local level
Provincial Technical Support Officers	Support implementation of technical activities with provincial and local level actors	▪ Two officers for each province between years 3-7 ▪ Provide technical advisory support for implementation of forestry and watershed management activities ▪ Monitor implementation and impact of project technical activities, and prepare data and information for reporting to PCU, PMU and other relevant stakeholders ▪ Coordinate with PMU technical officers and FAO TA units
Provincial Admin/Finance Officers	Administrative, financial and logistical support to PPMU	▪ Logistical arrangement for field missions, workshops, meetings or events at provincial and local level ▪ Handling and disbursement of finances for provincial level activities, and maintenance of transparent accounts ▪ Archive documentation ▪ Communication, media relations and office management
Provincial Safeguards Officers	Monitoring of project environmental and social impact at local level	▪ Develop social and environmental monitoring approach for all project activities and provincial and local levels ▪ Prepare social and environmental data and information, including gender-related, for reporting to PCU, PMU and other relevant actors ▪ Manage regular communication with representatives of indigenous peoples, Dalits and other vulnerable groups ▪ Prepare adaptive management recommendations in response to safeguards monitoring
Driver	Support in the transportation of project staff and material resources	▪ Know and implement regulations for the use of parking vehicles, use of 4x4, use of VHF radios in vehicles, inventory of tools in vehicles, administrative provisions regarding the care and use of official vehicles, maintenance of vehicles, and procedure in case of emergencies related to official vehicles, etc.

Position	Role	Responsibilities
		▪ Responsible for transporting people to the corresponding territorial places ▪ Responsible for transporting material resources

Table 18: Roles and responsibilities of individuals involved in the FAO Technical Capacity Development Team

Position	Role	Responsibilities
Technical Assistance Project Manager	In charge of implementation of FAO TA component	▪ Responsible for final results of FAO TA components of the project, financial and operational reporting to FAO (as AE) ▪ Co-ordinate with and support NPD in reporting to PSC ▪ Manage FAO TA personnel, including development of terms of reference, contracts and performance assessment of international and national advisory services ▪ Organise technical backstopping support from FAO (as AE) to PMU and overall BRCRN project implementation
Safeguards Officer	Manage implementation of project's approach to environmenal and social impact monitoring, reporting and adaptive management	▪ Manage and monitor project implementation of Environmental and Social Management Framework (ESMF), Indigenous Peoples' Plan (IPP) and Gender Action Plan (GAP) ▪ Develop and manage data management and reporting framework on safeguards to PMU and other relevant stakeholders ▪ Prepare and oversee adaptive management recommendations in response to safeguards monitoring ▪ Manage national level consultations with representatives of key stakeholder groups, including indigenous peoples ▪ Monitor and advise on implementation of grievance redress mechanism for the project
Procurement Officer	Manage procurement under FAO TA component according to GCF and FAO specifications	▪ Prepare procurement plan for FAO TA component ▪ Monitor purchases, acquisitions and hiring ▪ Coordinate with PMU procurement officer in preparation of procurement guidelines
Operations Officer	Manage operation of FAO TA component according to FAO regulations and processes	▪ Liaise with FAO regional and HQ offices for management of technical and advisory services ▪ Ensure quality control of FAO TA component ▪ Provide advisory and training services to PMU staff on project implementation and quality control ▪ Advise NPD in preparation of PIM and ensure FAO backstopping and oversight of technical services and operational management of BRCRN project, in accordance with PIM ▪ Review, advise and record procurement and operational decisions undertaken by PMU

Position	Role	Responsibilities
Administrative and Finance Assistant	Administrative and financial support to FAO TA compo-nent	▪ Record keeping and archive documentation ▪ Management of project in FAO internal system ▪ Support PMU in organisation of events, workshops and missions involving FAO TA ▪ Services to FAO personnel and consultants
Office assistant	Logistical support to FAO TA component	▪ Transport, logistical and security arrangements for FAO TA personnel and consultants ▪ Driving, and arrangement for use of FAO vehicles ▪ Llaison with FAO representation on a daily basis

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APPENDIX A – DETAILED INTERVENTION INFORMATION SHEETS

The descriptions and illustrations of project interventions are compiled based on various field manuals and guidance documentation from Nepal and elsewhere. If not referenced otherwise, illustrations related to climate resilient agriculture and agroforestry was taken from (with permission of the copyright holder, email dated 27.04.2018):

- Amos Wekesa and Madeleine Jönsson 2014. Sustainable Agriculture Land Management - A Training Material. We Effect and Vi Agroforestry.

The illustrations for tree planting, nursery management and sustainable forest management framework are adapted from:

- Guido Kuchelmeister and Le Quoc Huy (eds.).2004 Vietnamese-German Financial Cooperation Smallholder Forestry Project. Training Manual Volume 1
- W. Schindele, S. Mann, W. Grüneklee, Y. Lu, G. Hui, E. Gao, C. He, Z. Dai, M. Chen. 2011. Medium-term Forest Management Planning: Toolbox for Multiple-Use and Close-to-Nature Forest Management.

A1. Climate-resilient Agriculture (Activities 1.2 and 1.3)

Impacts of climate change in agriculture are associated mostly with high or low temperatures, shifting of seasons, drought, storms and flooding as well as damages caused by frost and wind.

In order to ensure food security and sustain livelihoods it is becoming increasingly important for farmers and other stakeholders to find ways of adapting to and/or reducing the negative impacts of changing climates, and improving their farming practices through Sustainable Agriculture Land Management (SALM) activities. The strategies that can be used in climate change adaptation for smallholder agriculture may be divided into the following categories:

1. Nutrient management
2. Soil and water conservation
3. Agronomic practices
4. Tillage and residue management
5. Trees on agriculture land (agroforestry I)

Additional practices will be presented on integrated and improved livestock systems. An integrated livestock system usually consists of different mixed components, for example, livestock with crops, or livestock with bees and crops, or livestock with crops and fish. These components work together in a natural cycle to maximize resource use. The products or by-products of one component (e.g. manure from livestock) are used as a resource for another component (e.g. crops). Several components: land or soil, water, crops/vegetation, feeds, livestock, manure and waste are considered to achieve efficient livestock production.

The following tables provide detailed information about climate-resilient agricultural practices including SALM and integrated livestock management promoted within the context of the BRCRN project.

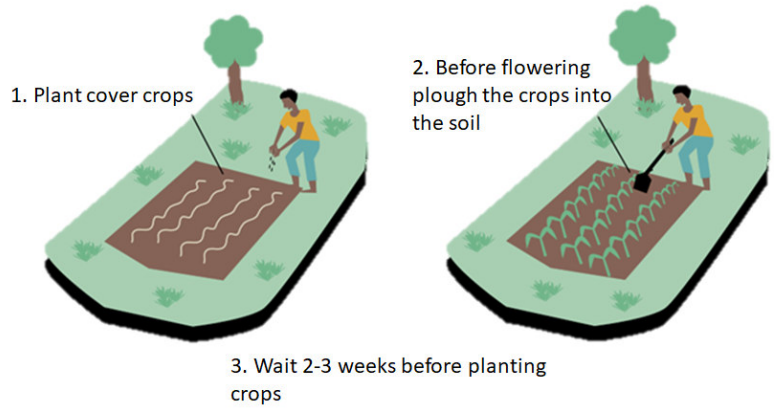
Table A1.1 Overview of agricultural activities within the project area, and promoted climate-resilient practices

	Churia Hills	Bhavar	Dun Valley and Terai Plains
Agricultural Land Use	▪ 13% cultivated land, majority of terrain unsuitable for agriculture ▪ Rain-fed low-yield fallow agriculture, with different crops including maize, upland rice, vegetables and mustard, among other crops[302] ▪ Some production in upland terraces. ▪ Some cultivation also occurs on sloping land that is unsuitable for agriculture leading to accelerated erosion and sedimentation. ▪ Low-adoption of soil and water conservation practices ▪ Inappropriate agricultural practices accelerate erosion and sedimentation, which lead to productivity losses and increase the vulnerability of down steam communities to climate change	▪ 35% cultivated land ▪ Maize, millet, grains, potato, ginger, cardamom, and temperate fruits, particularly citrus, are the main crops grown. ▪ Agricultural production is limited due to unsteady supply of water (primarily rain-fed), and increasing soil degradation. ▪ Soil fertility declining due to soil erosion, organic matter depletion, acidification, forest degradation and cultivation on marginal land. ▪ Surface water availability declining due to deposition of boulders and sediments on riverbeds. ▪ Low-adoption of soil and water conservation practices. ▪ Inappropriate agricultural practices accelerate erosion and sedimentation, which lead to productivity losses and increase the vulnerability of down steam communities to climate change.	▪ 40% of Dun Valley and 83% of Terai cultivated within BRCRN area ▪ Rice bowl of Nepal, is the center of grain production in Nepal, and a key contributing area to the agricultural GDP of Nepal. ▪ Highly fertile soils allow for the cultivation of rice, wheat, chickpeas, lentil, oilseeds, sugarcane, among other crops. . Lentil and mustard are the main crops cultivated in the winter season[8] and a key income source in the Terai region, along with sugarcane. ▪ Constraints in dry season are water availability and soil fertility. Declining soil fertility is attributed to: soil erosion, organic matter depletion, acidification, forest degradation and cultivation on marginal land among other factors.[303] ▪ 40% of agriculture in the Terai can be irrigated throughout the year ▪ Commercial agricultural practices in the Terai increasingly use mechanization ▪ Low-adoption of soil and water conservation practices
Livestock	▪ Many households have small livestock (goats, sheep, rams or pigs), some families have buffalos. Majority of production is for household subsist-	▪ Many households have small livestock (goats, sheep, rams or pigs), some families have buffalos. Majority of production is for household subsist-	▪ Many households have small livestock (goats, sheep, rams or pigs), some families have buffalos. Majority of production is for household subsist-

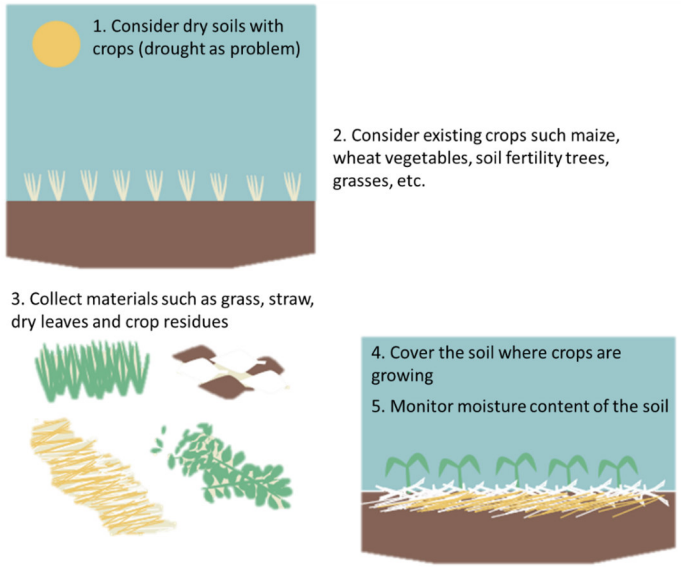
[302]MoFSC 2014
[303]Shrestha et al. 2013

	Churia Hills	Bhavar	Dun Valley and Terai Plains
	ence using low-yield traditional practices, including free-grazing in forested areas (contributing to forest degradation and erosion)	ence using low-yield traditional practices, including free-grazing in forested areas (contributing to forest degradation and erosion)	ence using low-yield traditional practices, including free-grazing in forested areas (contributing to forest degradation and erosion) ▪ Some commercial production occurs that includes stall feeding and attention to animal nutrition and feed.
Climate change impacts	▪ Extreme heat, changing precipitation patterns, water stress, drought/ prolonged dry periods, landslides.	▪ Changing precipitation patterns and extreme heat, flooding, water stress, drought/ prolonged dry periods, landslides.	▪ Extreme heat, changing precipitation patterns, flooding, water stress, drought/ prolonged dry periods, silt accumulation on agricultural land.
Focus of climate resilient agriculture practices within the BRCRN project	▪ Green-manure/ cover-crops ▪ Mulching ▪ Composting (in areas with severe nutrient deficiency) ▪ Terracing ▪ Contour bunds ▪ Rainwater harvesting ▪ Conservation agriculture (maize) ▪ Agroforestry – shade cropping and intercropping ▪ Improved livestock management	▪ Green-manure/ cover-crops ▪ Mulching ▪ Composting (in areas with severe nutrient deficiency) ▪ Terracing ▪ Contour bunds ▪ Rainwater harvesting ▪ Intercropping ▪ Conservation agriculture (maize, wheat) ▪ Agroforestry – alley cropping, shade cropping and intercropping ▪ Improved livestock management	▪ Green-manure/ cover-crops ▪ Mulching ▪ Composting (in areas with severe nutrient deficiency) ▪ Rainwater harvesting ▪ Intercropping, relay-cropping ▪ Conservation agriculture (maize, wheat) ▪ Agroforestry – alley cropping, shade cropping and intercropping ▪ Improved livestock management

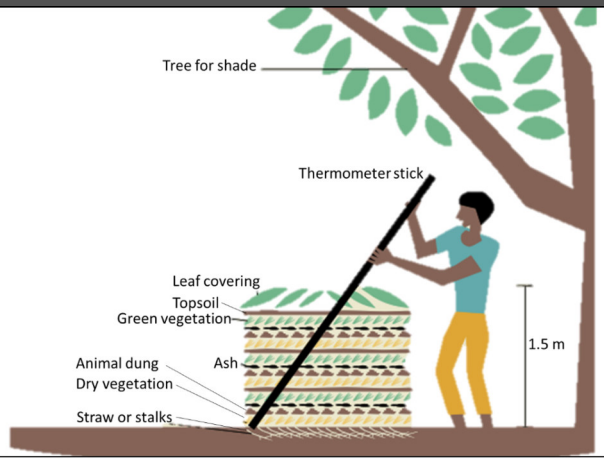
Table A1.2. Overview of Practices related to Nutrient Management (Activity 1.2)

Climate resilient agriculture (CRA)	Nutrient management	
Overall approach	Soil is fertile when it can supply different forms and amounts of nutrients to plants in a balanced way. Nutrient management is the process of maintaining and/or enhancing soil fertility, and it is done through the use of the nutrients already in the soil or adding nutrients through organic fertilizers. The purpose of nutrient management is to increase soil and crop productivity, and increase climate resilience (improved soil moisture, reduced erosion/ improved soil stability and enhanced soil carbon storage).	
Practice	**1. Use of green manure (cover crops)**	
Description	Green manure refers to plants (i.e. cover crops,) that are grown to improve (enhancing soil moisture/ moisture retention) or protect the soil (reduces erosion by precipitation and wind). It further increases carbon storage in soils and can reduce the need for synthetic fertilizers. These plants tend to grow fast, cover the ground, and have deep roots, but are not left to flower or harvested for food. The deep roots bring – to the surface – nutrients that the plants with shallow roots cannot reach. Some of these plants also take nitrogen from the atmosphere and deposit this in the soil. These nitrogen-fixing crops, are either leguminous or non-leguminous crops with green manure properties that are able to absorb atmospheric nitrogen and fix it organically into the soil to increase nutrients and conserve soil. The plants can also be cut and placed on the compost heap. More than 20 indigenous plant species having green manure values have been identified and studied in Nepal (including agroforestry tree species which will be introduced under agroforestry). For instance, rice bean (*Vigna umbellata*) represents a relevant leguminous crop fixing nitrogen. It is an important green manure with prolific modulating potential, rice bean can be grown as a sole crop in a rice-wheat system and incorporated into the soil after	

	the wheat harvest. Or, it can be grown as a relay crop under maize and ploughed under after the maize harvest to serve as a green manure for normal rice planting.
Main zones and productions systems	Whole range from the Terai to Churia hills. Dominant production systems for cover crop/ green manure interventions include maize and wheat small- as well as medium farm scale.
Climate benefits	**Adaptation**: • Increases moisture retention due to cover crops (improves resilience in prolonged dry periods) • Reduces soil erosion caused by heavy downpours (improves soil stability, and reduces soil erosion and ultimately sedimentation and riverbed rise) • Reduces the risk of total crop failure under unfavorable conditions due to crop diversification (improves resilience to changing climatic conditions) **Mitigation**: • Cover crops increase soil organic carbon capture (SOC) and Soil Organic Matter (SOM) (improves carbon storage in soils) • Legume integration increases soil Nitrogen, reducing use of synthetic fertilizer (reduces GHG emissions from fertilizers)
Co-benefits	**Productivity**: • Higher profits due to increased crop yields and reduced production costs • Green manure increases the levels of organic matter in the soil. Cover crops can add over thirty tons of organic matter and two hundred kilograms of nitrogen per hectare of land in a year. • For instance, the use of rice bean increases rice yield by 21% over the farmer's practice and is comparable to the use of inorganic fertilizer 60:30:30 kg NPK / ha **Pest and disease control**: • By covering the ground, these plants also prevent the growth or spread of weeds, and can be used to break disease cycles; some have beneficial microbes • Reduces use of fertilizers with negative environmental (e.g. soil and water contamination) and social impacts (e.g. exposure to harmful chemicals)

Practice	**2. Mulching**	
Description	The basic principle of mulching is to maintain a cover on the soil surface of residues (mulching) or vegetation that helps retain soil and water (improving the resilience of soils to extreme precipitation, and prolonged dry periods/ droughts). The improved soil and water conservation results in the preservation of top soil and soil organic matter Common mulches include: cut grass, crop residues, straw and other plant material. The best time to start a mulch is near the end of the rainy season. By this time there is still moisture in the soil to help the mulch break down into the soil. This moisture will be conserved by the mulch, and be useful for the crops for many weeks or even months – strengthening the soils ability to withstanding changing climatic conditions.	
Main zones and productions systems	Whole range from Terai to Churia hills. Dominant production systems for mulching include maize and wheat, and is particularly effective for small- as well as medium-scale farms.	
Climate benefits	**Adaptation**: • Residues help to retain soil moisture (improves resilience in prolonged dry periods) • Reduces runoff flows, reduce evaporative losses, reduces wind erosion • Controls soil temperature • Permits the use of residual moisture for sowing - allowing for sowing to occur up to 15 day early to avoid terminal heat in late winter **Mitigation**: • Mulching increases soil organic carbon (SOC) capture and Soil Organic Matter (SOM)	

Co-benefits	**Productivity**: • Higher profits due to increased crop yields and reduced production costs • Mulching feeds and protects the organisms in the soil (earthworms, bacteria, etc.) **Pest and disease control**: • By covering the ground, mulch prevents the growth or spread of weeds • Mulching helps to prevent spread of pests and diseases

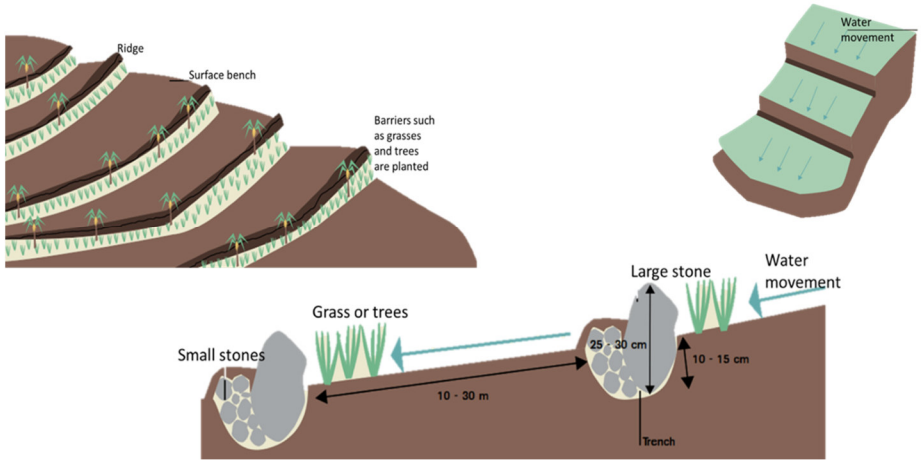
Practice	**3. Composting**	
Description	Composting is the natural process of turning organic materials such as crop residues and farmyard manure into plant food or humus. Compost is a cheap and effective organic mulch that can be used as an alternative to commercial fertilizers to improve the soil (reducing emissions from fertilizers). It will help to retain soil moisture, increasing the infiltration capacity of the soil and reducing runoff and wind erosion. It can further buffer soil reactions and moderate soil temperature. Humus is the organic matter component of soil that is being destroyed and eroded throughout much of the project areas. The illustration above sketches a cheap way for smallholder farmers to produce their own compost. Most farmers in the hills of Nepal use compost and other forms of organic manures as supplements to mineral fertilizers. However, compost prepared by traditional methods is not well-decomposed and has a poor nutrient content. Well-decomposed compost will reduce weeds and insects. Also, there are serious insect and weed problems when undecomposed compost is used. (The average nitrogen content of the compost prepared by farmers is 0.5%. Using improved methods can increase the nitrogen content of the compost to 1.5%). For a video of demonstration on how to compost rice straw please visit: https://www.accessagriculture.org/compost-rice-straw	

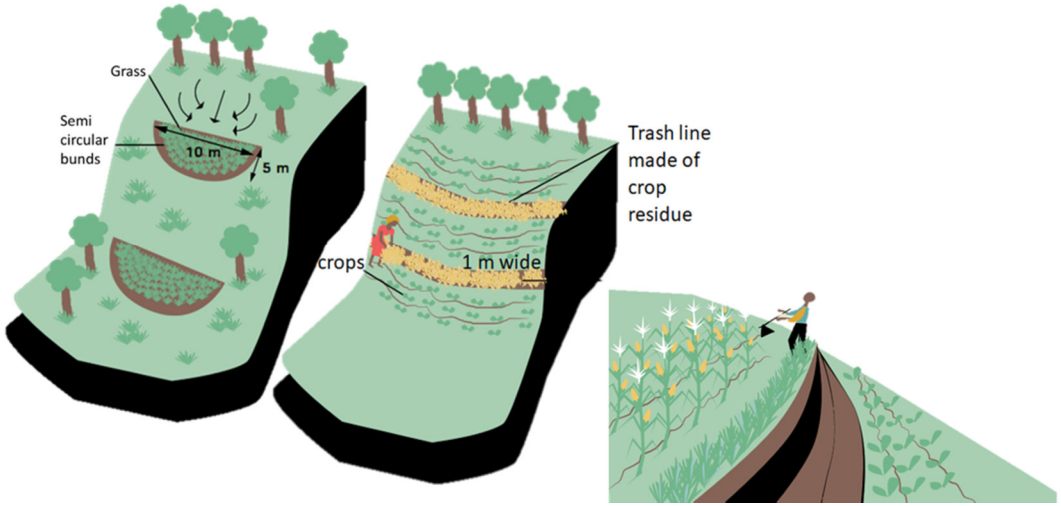
Main zones and productions systems	Potentially all interventions zones and production systems with severe nutrient deficiencies. Different types of composting practices are suitable for different farm scales, e.g. cost-efficient compost heaps for subsistence farmers and more advanced composting methods (biodynamic composting, effective microorganisms (EM) technology and EM composting, Pusa vermicomposting) for medium scale farming systems.
Climate benefits	**Adaptation**: • Compost helps to retain soil moisture, strengthening resilience in prolonged dry periods or in areas with reduced precipitation. • Increases the infiltration capacity of the soil, thus reducing surface runoff and ultimately sedimentation (particularly during intense precipitation events). • Well-decomposed compost buffers soil reaction and controls soil temperature, increasing resilience to temperature extremes. **Mitigation**: • Composting increases soil organic carbon (SOC) capture and Soil Organic Matter (SOM)
Co-benefits	**Productivity**: • Maintains soil fertility level, strengthening food security and reducing land degradation. • Increases the nutrient level of the soil or improve the soil's physical condition by improving soil structure and aeration. • Helps to retain plant nutrients and moisture. • Increases soil microbial activity which helps mineralization of applied chemical fertilizers, making them more available to crops **Pest and disease control**: • Well-decomposed compost will reduce weeds and insects

Table A1.3. Overview of Practices related to Soil and Water Conservation for CRA, Activity 1.2

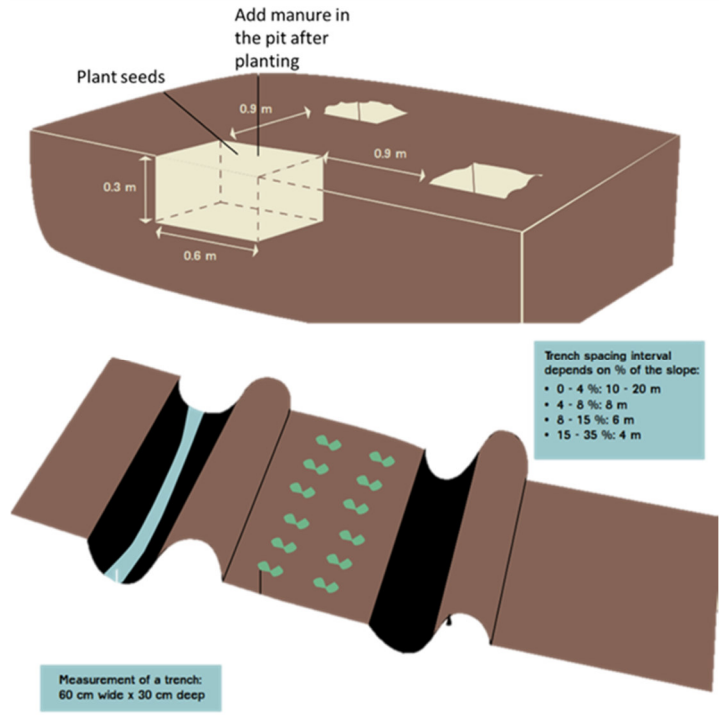
Climate resilient agriculture (CRA)	Soil and water conservation
Overall approach	Water is one of the basic necessities for life, and water scarcity is one of the most important limiting factors for sustainable agriculture productions systems in the project zone. Rural communities not only need clean water for drinking and basic hygiene, they also need water for growing crops and watering animals. Nepal has stark differences in seasonal water availability, where majority of the country´s precipitation occurs during the monsoon season. Poor harvesting and storage infrastructure / capacity limits the ability of many villagers to manage these differences. Winter agriculture is particularly prone to water stress and droughts, where many farmers remain dependent on rain-fed agriculture. Thus, water and food security becomes a greater challenge within the winter months. At the same time, water has a destructive potential. Heavy rainfall over short periods (increasing precipitation intensity) can lead to massive erosion of soil, particularly on slopes where the soil is exposed. Effective soil and water management practices can improve soil fertility and increase yields in a sustainable way while conserving soil and water, preserve soil moisture and/or drain water sustainably to avoid soil erosion, land sliding and depletion of soil nutrients. Such practices will improve the resilience of agricultural land to projected climate change impacts, including increasing precipitation and intensity of rainfall events in the monsoon season, changing timing of the monsoon season, increasing temperatures and increased extensions of dry periods.
Post-project sustainability	The promoted practices include simple and low-cost techniques that will have demonstrable benefits (environmental and economic) in the short- to medium-term, improving the uptake and maintenance of practices. An emphasis on user-friendly extension materials (including picture books) will provide farmers with resources to sustain and adopt practices. The focus of working with CBOs will include members of the CBOs who will keep copies of picture books and support members of the CBO. Inclusion of different crops planting along the edge of terraces (differing on soil characteristics, crop interactions, slope, season/ climate), will support income diversification. This work will build on the successful experiences of MoAC, ICMOD and IDRC in Nepal, among others. [304] Municipality and provincial agricultural offices will also be able to provide additional technical support and information as needed. CBOs will also ensure that members who benefit from such measures will contribute to their maintenance costs, based on CBO membership rules.

[304] http://idrc.canadiangeographic.ca/blog/agricultural-kit-nepal-terrace-farmers.asp; http://www.icimod.org/?q=10306;

Practice	**1. Soil moisture conservation techniques - Terraces**	
Description	Terracing is the process of reducing the length and/or steepness of a slope in a planted zone using soil embankments and channels that are constructed across the slope. The change in slope profile reduces runoff speed - especially on erosion-prone areas - thus reducing soil erosion, which is especially relevant during the monsoon season. BAU practices lead to extensive erosion and sedimentation, and terracing can greatly reduce such trends – enhancing the resilience of downstream communities (e.g. reducing river bank rise and cutting). It also allows some water to sip into the soil (infiltration), improving soil for more vegetation cover. Various forms of terracing are promoted depending on the specific land use requirements and land conditions (slope, parent material etc.): • **Bench terraces**: A conservation structure where a slope is directly or slowly converted into a series of level steps (looking like staircase on slope) and ledges. The flat area between the terraces (the horizontal step) is used for growing crops such as grass and legumes (which capture water and nutrient runoff), and for animal feed • **Water terraces**: Built in flood-prone areas to help the farmers to cope with flowing water, to deal with water masses, water speed and/or change the water direction. Furrows are constructed under the benches to catch runoff water • **Stone terraces**: stones are used to create strong embankments on steep slopes. The stone terraces have the potential to slow down runoff, increase water infiltration, and form the basis for improved production in semi-arid areas. By using the contours of low slopes, water harvesting is improved and crops can be grown in low rainfall years Terracing will always be combined with additional soil conservation practices, such as the maintenance of a permanent soil cover	
Main zones and productions systems	Terracing mainly in sloping land, i.e. the Churia hills and Bhavar zones. Types of terracing depending on slope gradients. Bench terraces more on moderately sloping agriculture land; stone terraces on steep slopes. Water terraces particularly in areas prone to flooding.	
Climate benefits	**Adaptation**:	

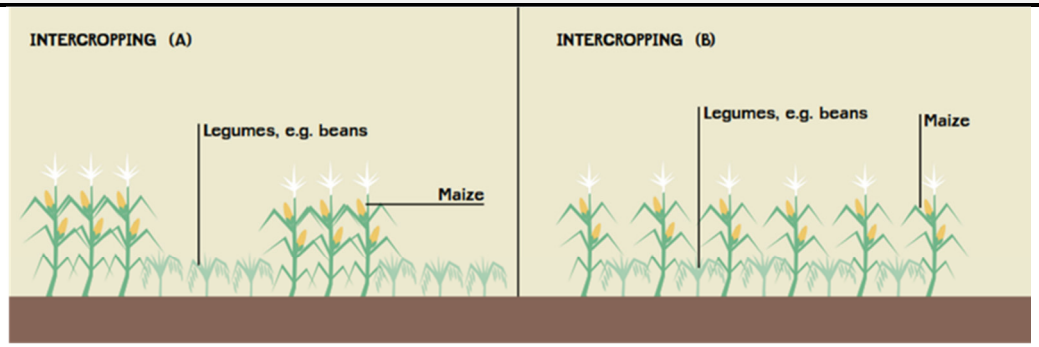
	• Terraces harvest water and prevent soil from being eroded from the slopes, thus reducing surface runoff (particularly during intense precipitation events) • Terraces in erosion-prone landscapes result in the recovery of SOM which increases resilience of the soils against periods of water deficit • Reduces downstream siltation, and ultimately reduces rising river beds and riverbank cutting. **Mitigation**: • Increases soil organic carbon (SOC) capture • Maintains Soil Organic Matter (SOM) at higher levels
Co-benefits	**Productivity**: • Maintains soil fertility level • Fewer chemical inputs may be required to sustain yields as terraces help preserving valuable topsoil rich in SOM, which have evident positive environmental and economic effects (higher productivity)
Practice	**2. Soil moisture conservation techniques - Contour bunds/contour farming** 
Description	Contour farming involves ploughing, planting and weeding along the contour, i.e, across the slope rather than up and down. Contour lines are lines that run across a slope such that the line stays at the same height and does not run uphill or downhill. As contour lines travel across a hillside, they will be close together on the steeper parts of the hill and further apart on the gentle parts of the slope. Contour bunds are permanent ridges of soil that are built by excavating a channel on a slope along a contour line (line joining points on same altitude). Contour bunds are important in sloping terrain and in drought

	prone areas and are mostly used to harvest water, enhance the retention of runoff water, and prevent soil erosion and flooding. For slopes steeper than 10%, other measures should be combined with contour farming to enhance its effectiveness. • **Semi-circular bunds:** These bunds made by digging holes on the tips of the contours, in the form of half-circles. Semi-circular bunds are used to harvest water, conserve oil and water, and improve soil fertility (when manure or compost is added).The dimension of the holes and spacing of the contours are determined by the type of crop or the farming system (see demonstration video: https://www.accessagriculture.org/slm07-demi-lunes) • **Trash lines**: Trash lines are created across the slope along the contour using previous seasons' crop residues (millet, maize and sorghum stalks), grasses, litter and other dead vegetative organic materials. Trash lines control surface runoff, soil erosion and enhance infiltration. Instead of res-tudies also permanent grass strips can be established • **Contour drainage/ infiltration ditches**: These structures drain excess water out of the field, and if closed at the end, retains water for use or infil-tration into the downslope fields. These can stop downslope water movement as the water falls into the ditch. These structures are some of the most useful for small-holder hillside farming since these require less work than terraces, are simple to build, and can be used to either divert or to retain water.
Main zones and produc-tions systems	Contour bunds/contour farming mainly in sloping land, i.e. the Churia hills and Bhavar zones. Types of structures depending on slope gradients
Climate benefits	**Adaptation**: • Harvest of water, enhance the retention of runoff water, and prevent soil erosion and flooding. Contour farming alone can reduce soil erosion by as much as 50% on moderate slopes. • Diversion of excess water to protected drainage ways, reduce soil erosion and leaching of nutrients. Very important if a great deal of water enters from above the fields (e.g. during intense precipitation events) • Reduced downstream siltation **Mitigation**: • The use of trash lines or grass strips in combination with other practices (e.g. composting) will increase soil organic carbon in the topsoils
Co-benefits	**Productivity**: • Maintains soil fertility level • Fewer chemical inputs may be required to sustain yields as contour farming helps preserving valuable topsoil rich in SOM, which have evident positive environmental and economic effects (higher productivity)

Practice	**3. Soil moisture conservation techniques - Rainwater harvesting techniques**	
Description	Rainwater harvesting is the slowing down, collection and concentration of runoff water for productive purposes such as growing crops, fodder, pasture or trees, and to supply livestock or/and for domestic water supply, especially in drought prone regions. The runoff water that collects on the ground and around rocks is channeled to farms or stored in ponds, tanks and dams for future use. • **Pitting**: Pitting is the digging of holes of various sizes to grow crops such as maize and wheat. The pit acts as a water harvester and a conserver of both moisture and fertility. Manure is added to increase fertility in the pit for a long time. Various forms of pits exist, for instance Zai pits. These pits are shallow, wide pits in which cereal crops such as maize are planted. Topsoil from the excavation or compost is mixed with manure and put back in the pit where a few cereal seeds are then planted (see demonstration video: https://www.accessagriculture.org/slm06-zai-planting-pits) • **Trenches:** Trenches are short ditches or pits dug across the slope to trap water. Embankments of trenches are planted with grasses, legumes and trees. • **Road runoff harvesting**: Runoff water from areas such as roads is caught and channeled into fields or stored in systems such as tanks, dams and ponds for future use. Runoff water from roads can give an extra boost to crops during the rainy season, or if it is stored in ponds can be used for irrigating horticultural crops (see demonstration video: https://www.accessagriculture.org/slm04-road-runoff-harvesting)	

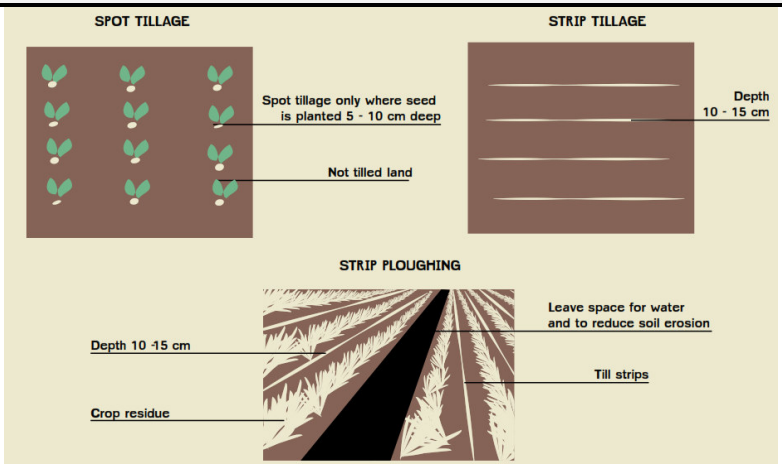
Main zones and productions systems	Rainwater harvesting techniques in particular in those areas prone to winter droughts and heat stress. Interventions to focus primarily in the Churia hills, and Bhavar zones, and to a lesser extent in the Dun Valleys and Terai.
Climate benefits	**Adaptation**: • Sustainable harvesting of water, including rainwater, can contribute markedly to addressing water deficit challenges for the hill households • Recharge underground water and maintain a supply of water for wells and springs, protect the soil down slope from erosion and enable trees to grow quickly in dry land • Reduced downstream siltation **Mitigation**: • If combined with tree and grass planting leads to both biomass and soil carbon increase
Co-benefits	**Productivity**: • Maintains soil fertility level • Stabilizing soils and enhancing vegetation grows higher long-term productivity of sites

Table A1.4. Overview of Practices related to Agronomic practices (Activity 1.2)

Climate resilient agriculture (CRA)	Agronomic practices	
Overall approach	Agronomic practices are designed to manage crops on croplands to increase yields, productivity, adapt to climate change and increase the resilience of the crop land.	
Practice	**1.Intercropping and relay cropping**	
Description	Intercropping is the planting of two or more crops in the same field at the same time such as maize and legumes (beans), wheat and leguminous species and mustard. Relay cropping is the planting of temporary crops within the main crop before the main crop is harvested. Relay cropping ensures the land is used continuously. It reduces the cost of subsequent cultivation while ensuring the availability of organic matter for the new crop.	

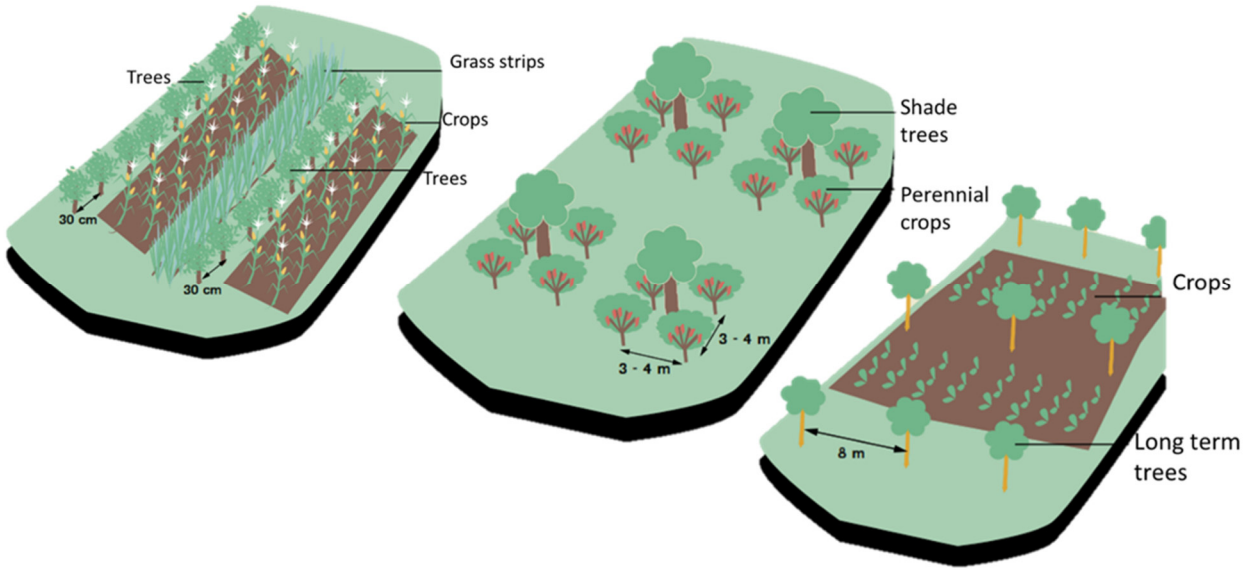
Main zones and productions systems	Throughout all zones in the project, mainly focusing on maize and wheat production systems. Relay cropping in lentil production systems mainly in the Terai
Climate benefits	**Adaptation**: • Stabilizes soils and reduces the risk of soil erosion, including during intense precipitation events. • Reduces the risk of total crop failure under unfavorable conditions due to crop diversification. • Use of residual moisture for sowing, allows 15 day early sowing to avoid terminal heat in late winter. Residues helps to retain soil moisture. • Relay cropping allows seed sowing even under water scarcity conditions. Allows early sowing, helping to escape terminal heat. **Mitigation**: • Ensures long-term soil cover and conserves SOM. Legume integration increases soil Nitrogen, reducing use of synthetic fertilizer • It provides a lot of biomass form residues to be returned as organic inputs to the soil in form of mulch and compost, hence increasing soil organic carbon
Co-benefits	**Productivity**: • Increases total production and productivity per unit of land. Harvests of multiple crops increase income and food security; provides shade and fixes nitrogen. **Pest and disease control** • Controls weeds

Table A1.5. Overview of Practices related to Tillage and Residue Management (Activity 1.2)

Climate resilient agriculture (CRA)	Tillage and residue management	
Overall approach	Conservation agriculture is the way in which crops can be grown in a sustainable way while conserving the environment. Conservation agriculture is based on three core principles: ▪ Permanent soil cover with mulch or crops residues (residue management), to protect the soil ▪ Minimal soil disturbance during tillage ▪ Crop rotation.	
Practice	**1. Conservation agriculture**	
Description	Residue management refers to the sound handling and utilization of plant and crop residues that combines mulching, composting, integrative manure and livestock management. Plant residues are a major source of carbon in soil. The residue should be distributed uniformly over the soil surface. The residues can be used as trash lines or mulch (see also contour farming). But residues can also be used for feeding livestock. Manure from the livestock can then be collected and used on the farm. Tillage is the preparation of soil conditions by digging, stirring, overturning and/or any other appropriate method to facilitate seed germination, root development, weed eradication, and crop growth. Tillage can be achieved using hand tools, animal drawn-implements or machines such as tractors. Conventional tillage in the project area is the ploughing done at the beginning of the planting season before crop establishment. It is usually done using: a hand hoe, moldboard plough (buffalo-drawn), disc plough, rotator or various harrows. However, there are several risks (leaves less than 15% residue on the soil surface after planting; compressing the soil layer of many soils (to a depth of 15 cm) leaving a fine seedbed that caps easily; this layer can form a hard pan after several seasons of ploughing, preventing water percolating down and increasing water runoff on the surface; this can inhibit root growth deeper than 15 cm; involves a higher degree of soil disturbance, leading to the mixing of top soils and sub soils associated with conventional tillage). To avoid these risks, conservation tillage is promoted in this project. Conservation	

	tillage is a planting system that ensures minimal soil disturbance. It leaves at least 30 - 50 % of the field surface covered with crop residues such as mulch and stubble after planting has been completed. The top and sub soils are not mixed in the process (see demonstration video: https://www.accessagriculture.org/slm12-conservation-agriculture)
Main zones and productions systems	Throughout all zones in the project, mainly focusing on maize, wheat, and lentil production systems
Climate benefits	**Adaptation**: • Enhance soil moisture retention and infiltration, thereby increasing resilience against prolonged dry periods (water deficit) • Reduce soil disturbance and hence reduce soil erosion • Reduces water pollution in rivers and lakes (siltation) • The conditions created in the soil form resource capital bases for farmers to adapt to climate risks and hazards **Mitigation**: • Reduces fuel requirements for tillage and increases soil organic carbon
Co-benefits	**Productivity**: • Increases crop productivity • Reduce cost of production • Improve soil conditions such as structure and nutrients. **Pest and disease control** • Reduce weeds

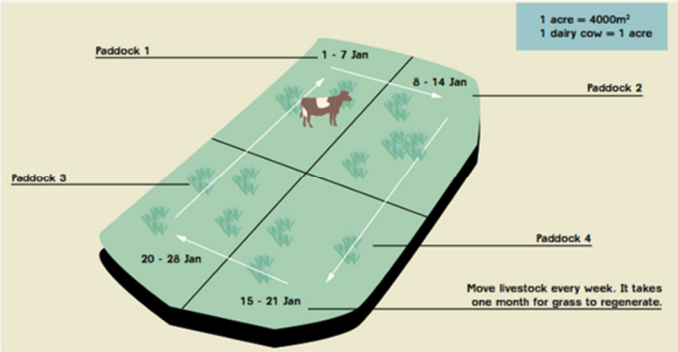
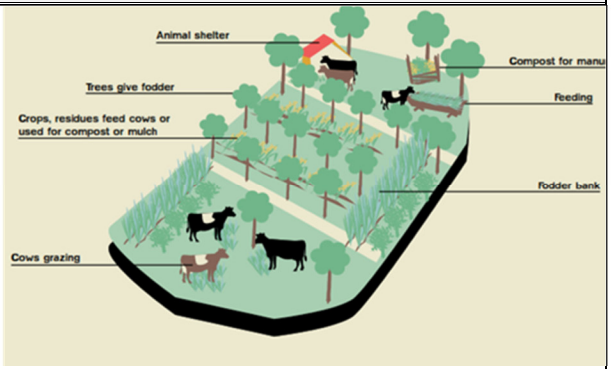
Table A1.6. Overview of Practices related to Agroforestry (on agricultural land; Activity 1.3)

Climate resilient agri-culture (CRA)	Trees on agriculture land (agroforestry I)	
Overall approach	Agroforestry is the deliberate growing of woody perennials (trees, shrubs) as agricultural crops alongside other crops and/or livestock in the same land. It improves productivity and mitigates the impacts of climate change (adaptation and mitigation). This agroforestry component (agroforestry I) will focus interventions directly on cropland.	
Practice	**1. Planting tree among crops**	
Description	Existing trees will be protected and managed, or/and new ones planted. One of the bases for establishing resilient and sustainable farming systems is to integrate trees into the system. In mountain areas, the most common farming approach is to use a mixed crop livestock agroforestry system. This can be made considerably more successful if nitrogen-fixing plants (NFPs), especially those that occur naturally in the environment, are deliberately incorporated into the system. NFPs are one of the cheapest and best sources of organic manure, they add nitrogen to the soil through the action of the microbes or microorganisms in their specialized root nodules and through the decay of their nitrogen-rich foliage. Examples of practices are dispersed interplanting, trees with perennial crops and alley cropping. The table below exemplarily lists potential species and their main purposes:	

	<table><tr><td>Soil erosion control</td><td>Calliandra calothyrsus</td></tr><tr><td></td><td>Accacia spp.</td></tr><tr><td></td><td>Albizia spp.</td></tr><tr><td></td><td>Bamoo spp.</td></tr><tr><td>Soil fertility improvement</td><td>Calliandra calothyrsus</td></tr><tr><td></td><td>Albizia spp.</td></tr><tr><td></td><td>Adhatoda vasica</td></tr><tr><td></td><td>Artemisia vulgaris</td></tr><tr><td></td><td>Satrium insigne</td></tr><tr><td>Shade trees in crop land</td><td>Grewia oppositifolia</td></tr><tr><td></td><td>Alnus nepalensis</td></tr><tr><td></td><td>Gmelina arborea</td></tr></table> Alley cropping is the growing of annual crops or forage between rows of trees or shrubs to form hedgerows. Trees will be grown in combination with other perennial crops such as coffee, sugarcane and tea. This system provides land use with strong build-up soil, organic matter, multiple or intercropping, mulch and extended rotation. Because crops are permanent there is little replanting. Hence there is minimal disturbance of soil and thereby, more carbon is sequestered in the soil. In dispersed inter-planting, trees are grown in a systematic way in fields alongside crops to provide food, fuel wood, building poles, fodder etc. The trees also provide nutrients and organic matter for the soil, and shade for crops and livestock
Main zones and productions systems	Alley cropping will be done in areas with flat to gently rolling terrain, i.e. Terai, Dun and Bhavar zones. Shade trees are promoted in areas with perennial crops such as fruit trees, coffee, etc. Dispersed inter-planting is promoted throughout the project zones.
Climate benefits	**Adaptation**: • Trees increase biodiversity, reduce deforestation and enable climate change adaptation • The trees reduce runoff speed, increase infiltration, increase vegetation cover, control soil erosion • Trees stabilizes the ground and reduces soil erosion • Trees on cropland enhance soil moisture and water retention, contributing to increased resilience during prolonged dry period (water deficit) **Mitigation**: • Trees largely sequester carbon into living biomass • Trees increase soil organic carbon sequestration
Co-benefits	**Productivity**:

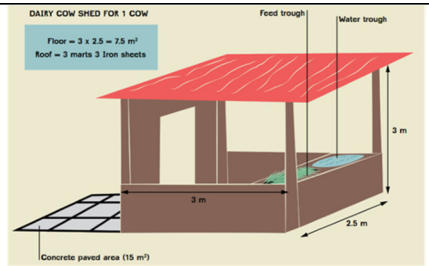
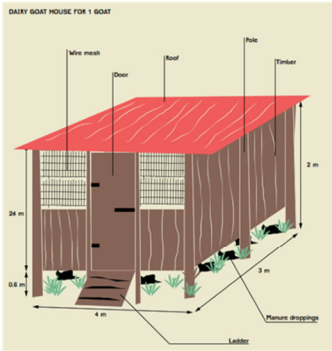
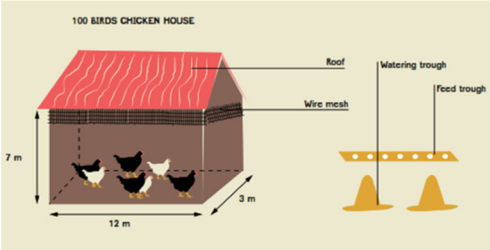
	• Trees improve soil fertility and crop productivity • Nitrogen fixed by the trees enhances soil fertility leading to higher crop production without fertilizers • Trees provide firewood, timber, nuts, poles, and sometimes have medical properties • Tree provide fodder for animals and increase livestock productivity while reducing grazing pressure on land **Other** • Trees provide shelter and act as windbreaks and have cultural and psychological values • Diversified income

Table A1.7. Overview of Practices related to Improved Livestock Management (Activity 1.3)

Integrated livestock management	Improved feeding (diet) and watering
Overall approach	Livestock are one of the main drivers of forest degradation in the Churia hills and contribute to accelerating erosion and sedimentation. Such trends increase the vulnerability of downstream communities and ecosystems to floods and intense precipitation events. Degradation in the hills reduces forest health, carbon sequestration, and also soil quality. Degradation in the Churia hills further increases the vulnerability of communities to climate change, contributing to nutrient loss and can increase the susceptibility to landslides in highly degraded sloped areas. Livestock mainly feed on pasture (perennial fodders, pastures and legumes) found either on grazing land, or bought from specialist outlets (shops or distributors). Efficient pasture management is therefore necessary for improving livestock nutrition. Pasture management involves selective sowing of improved varieties of pasture to enhance livestock grazing. There are three main livestock production systems: • Land-based grazing system • Mixed system • Landless system
Practice	**1. Improved feeding (diet) and watering**  
Description	**Land-based grazing system:** The land-based grazing system involves grazing livestock on the grazing grounds or pasturelands through tethering, paddocking and rotational grazing. The effective strategy under grazing management is rotational grazing. Rotational grazing is more effective than tethering or paddocking as it ensures quality and digestibility of forage thereby improving livestock productivity. Pasture production will also be increased through the rehabilitation and restoration of degraded grazing land, or through intensification process by fertilization, cutting regimes and irrigation practices.

	Mixed systems: The mixed system involves raising both crops and livestock on the same farm. Animals feed on crop residues, fodder from established pastures or fodder banks (in a cash and carry strategy) and feeds (produced on the farm or bought from external sources). Crops such as grass that are grown on fodder banks (see agroforestry II) provide food for grazing livestock, and mulch. Examples of mixed systems are soil-crop-water management (combination of selected agronomic practices with multiple benefits), crop-water-livestock management and feed, water and animal management. **Landless system**: The landless system involves managing waste or manure and enteric methane (methane produced in the rumen chamber of a cow) especially in pig, dairy and feedlots. Landless systems improve the small-holder farming through composting, improved manure handling and storage (covering manure heaps), temperature control systems, disease surveillance, energy use efficiency, improved feeding practices (e.g. precision feeding), and building resilience along supply chains. **Water**: Water, considered to be the source of life, is a very important part of a healthy animal's diet. In fact, an animal can die faster from lack of water (dehydration) than from the lack of any other feeding need.
Main zones and productions systems	Integrated livestock management systems will be promoted in all zones, in particular in areas with high livestock numbers, or in erosion prone areas or areas with high pressure of free-grazing animals on forest ecosystems
Climate benefits	**Adaptation**: • Fodder banks minimize the loss of runoff moisture and soil nutrients, improving resilience to dryer conditions • Grazing livestock also enrich the soil through reduced tillage and manure • Resources are used efficiently (land, water, soil) – sustainable intensification • Reducing land use change (via forest and land degradation due to uncontrolled grazing, ultimately reducing erosion and sedimentation • Contributes to the restoration and rehabilitation of degraded or eroded land **Mitigation**: • Reducing the emission of enteric and manure methane (CH4) gases • Enhancing soil organic carbon sequestration • Reduced free grazing in forests will reduce emissions from forest degradation
Co-benefits	**Productivity**: • Increases livestock and farm productivity; enhancing crop production **Other** • Reduced cases of pests and diseases • Conservation of biodiversity
Practice	**2. Livestock nutrition (diet)**

Description	Animals need appropriate food to supply them with essential nutrients for overall health and productivity. For example, a well fed cow provides more milk than a cow fed on crops with low protein. The main food groups important for livestock are: **Carbohydrates**: To provide energy. Sources include: green grass, roughage, green grass, pasture and hay **Proteins**: For body-building. Sources include different type of harvested feeds such as crushed maize, cereal grains, various silages (e.g. fermented grass), plant sources meals made from sunflower, maize, wheat, and Calliandra leaves, and meals based on animal proteins such as blood meal, fish meal and feathers meal **Vitamins**: Animals require different kinds of vitamins, which in some cases are added as supplements **Minerals**: There are two main kinds of minerals: macro minerals (required in large amounts) and micro (required in small amounts) minerals
Main zones and productions systems	Livestock nutrition improvement will be promoted in all zones, in particular in areas with high livestock numbers, erosion prone areas and areas with high pressure of free-grazing animals on forest ecosystems.
Climate benefits	Contributing to the overall benefits from integrated livestock management, see above. Feeds are produced as part of the sustainable intensification of the farms, thereby contributing to climate adaptation as well as mitigation benefits.
Co-benefits	**Productivity**: • Increased livestock productivity and performance • Increase growth and development, increase reproduction and fertility • Control of diseases

Practice	**Animal housing, stall management systems**	  
Description	Poorly constructed animal housing stalls exposes animals to pests and diseases, restricts movement, is uncomfortable, and reduces productivity and resilience to the negative effects of climate change. For example, a low level of hygiene and dirty animals housing can lead to animals producing less milk. It is also important for animals to have access to shade and not be exposed to the UV-light too heavily during daytime since animals tend to use more energy conserving body temperature than producing milk.	
Main zones and productions systems	Stall management systems will be promoted in all zones, in particular in areas with high livestock numbers, erosion prone areas and areas with high pressure of free-grazing animals on forest ecosystems. Main livestock types include cows and goats.	
Climate benefits	**Adaptation**: • Reduces animal's stress during extreme climatic conditions by reducing exposure • Reduces forest degradation due to fodder collection and free grazing, enhancing soil moisture and fertility and reducing soil erosion and sedimentation **Mitigation**: • Reduces pressure on grazing land and forests contributing to its preservation and promoting carbon capture • Allows for better manure management, thereby reducing related GHG emissions	
Co-benefits	**Productivity**: • Increases livestock productivity • Faster growth and higher feed conversion ratio due to proper housing	

	Other • Reduced cases of pests and diseases • Reduced forest degradation enhances biodiversity conservation and habitat restoration • Synergies with household biogas production

Climate-resilient agriculture	**Biogas (Activity 1.4)**
Overall approach	Targeting 500 middle-income farmers (2-3 buffalo per household) will be targeted in the ten river systems with the highest deforestation rate to access government subsidies for domestic biogas systems. Technical support and information will be provided to CBOs to facilitate farmers to access subsidies and invest in such technologies. The project will only support the adoption of domestic biogas plants, not commercial biogas plants, institutional biogas plants for public institutions, community biogas plants or municipal scale waste-to-biogas energy systems. A description of the subsidy and its conditions is described in the Renewable Energy Subsidy Policy (2016).

Practice	**Biogas**
Description	The project will provide technical support for these farmers to access government subsidies, through the following approach: ▪ Assessment and demand mapping at the local CBOs level, to understand the demand and priorities within local user groups. AEPCs guidelines will support this process, where different technologies will be promoted based on the local context and priorities of the user groups. ▪ Technical support to develop agreements between local CBOs and companies for the installation of alternative renewable energy technology, considering subsidies provided by the Government of Nepal. ▪ Training of local resource persons to support maintenance and monitoring. Related to biogas subsidies are available for the technologies: Gobar Gas Company (GGC) Model 2047, 2047 modified model and other efficient models of various capacities. Subsidies per plant per household, using animal dung as the main input are summarized in the following table:

Region	Subsidy (Nepalese Rupees NPR)		
	2 cubic meters	4 cubic meters	>6 cubic meters
Hill districts (as specified by the Government of Nepal)	20,000 NPR	25,000 NPR	30,000 NPR
Terai Districts (as specified by the Government of Nepal)	16,000 NPR	20,000 NPR	24,000 NPR

Source: MoPE 2016

	Subsidy amounts for biogas technology with a capacity greater than 6 cubic meters will be reduced by 5% every year up to 3 years. An additional 10% of the subsidy amount specified above per plant per household will be provided to the targeted beneficiary groups. For further information on subsidies, refer to the Government of Nepal´s Renewable Energy Subsidy Policy (2016). Project management staff will ensure co<mpliance with the Renewable Energy Subsidy Policy, and will use guidelines developed by the Alternative Energy Promotion Center (AEPC)[305] to facilitate awareness raising and support for local beneficiaries to adopt domestic biogas technologies.
Main zones and productions systems	Based on the risk assessment the river systems with the highest pressure on forests within the selected project area include Adherei; Baruwa; Duar; Balan; Budhi; Chadaha; Kamala; Kankai Nadi; Lakhandehi; and Ratuwa; these river systems experienced the highest deforestation over the 15-year assessment period 2000-2015 (-18%) and at the same time comprise still the largest forest area with 110,489 ha (49% of the total forest area in the 26 selected river systems). Interventions will target households with 2-3 buffalos (middle-income households).
Climate benefits	**Adaptation** Improved resilience due to reduced deforestation and forest degradation (reduced erosion and sedimentation, improved groundwater recharge) Reduced exposure to climate-induced natural hazards **Mitigation** Reduced emissions from deforestation and forest degradation
Co-benefits	• Biodiversity conservation from reduced deforestation • Improved soil fertility and reduced land degradation • Improved energy security • Major human health benefits (reduced inhalation of harmful emissions), • Reduced time poverty for women and girls responsible for fuelwood collection • Promote improved livestock production through stall grazing (e.g. via biogas), leading to a reduction in uncontrolled grazing

[305] http://www.aepc.gov.np/

A2. Ecosystem Restoration and sustainable management in the BRCRN project

The interventions will focus on a paradigm shift towards principles of sustainable management of all forest and natural resources in the project region as well as protective physical measures (bio-engineering) to reduce the vulnerability of the regions against the most threatening climate hazards, i.e. flooding, erosion and sedimentation. It takes a holistic view of the natural conditions of the river systems, mainstreaming climate change into river system protection and management as well as developing a SFM framework for the entire forest area with overarching principles and guidance for management decisions and operational silvicultural measures within the different forms of forest management units in the project area. The following interventions are described in detail in the following tables:

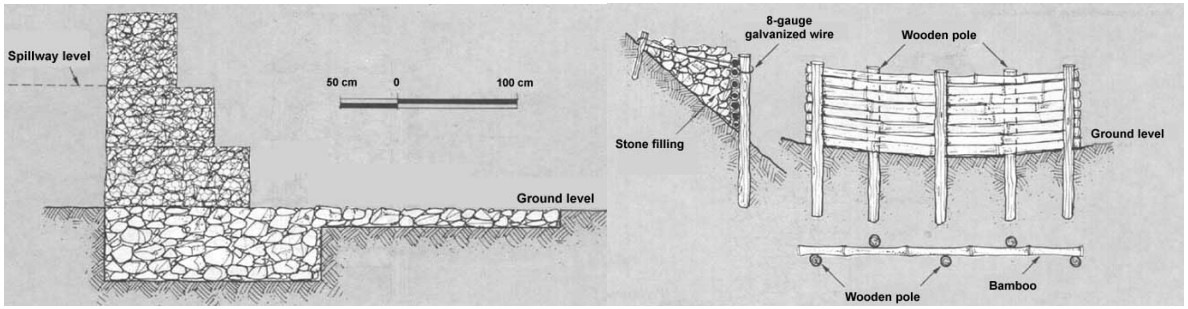
1. Soil and Water Conservation (bio-engineering)
    a. Siltation prevention measures of river tributaries (check dams)
    b. Gully stabilization through contour bunds (large-scale) and stone walls
    c. Riverbank stabilization (Physical structures)
    d. Conservation Ponds
2. Restoration and rehabilitation of degraded forest ecosystems
3. Sustainable Management of Forest Resources

Table A2.1 Overview of interventions for ecosystem restoration and sustainable management in the BRCRN project

	Churia Hills	Bhavar	Dun Valley and Terai Plains
Land Use	▪ Deforestation and forest degradation are increasing, resulting in accelerating erosion and sedimentation, and increased vulnerability to climate change both upstream and downstream ▪ Deforestation leads to higher risks of landslides, wildfires upstream, and increases flooding risk downstream	▪ Deforestation and forest degradation are increasing, resulting in accelerating erosion and sedimentation, and increased vulnerability to climate change both upstream and downstream ▪ Deforestation leads to reduced groundwater recharge, increasing vulnerability to water scarcity and extreme heat downstream ▪ Also leads to increased sedimentation, river bed rise, river bank cutting and increased impacts from floods	▪ Grassland and wetland biodiversity threatened climate-change hazards, growing degradation due to human impact ▪ Forests have been largely deforested and degraded within the Terai ▪ Upstream deforestation increases the vulnerability of downstream communities to various climate-induced hazards
Climate change impacts	▪ Extreme heat, water deficit, erosion and landslides	▪ Extreme heat, water deficit, flooding, debris deposition	▪ Extreme heat, water deficit, flooding, silt accumulation on agricultural land
Focus of ecosystem restoration and sustainable management practices & structures within the BRCRN project	▪ run-off water harvesting dams, drainage and contour bunds to reduce sedimentation and improve water infiltration ▪ Gully stabilization ▪ Protective measures in forests ▪ Measures to accelerate forest recovery ▪ Supporting natural regeneration of forests	▪ Check dams, stone walls to reduce erosion and sedimentation and improve water infiltration ▪ Conservation ponds ▪ Gully stabilization ▪ River bank stabilization ▪ Protective measures in forests ▪ Protective measures in forests ▪ Measures to accelerate forest recovery ▪ Supporting natural regeneration in forests	▪ Conservation ponds ▪ Protective measures in forests ▪ Measures to accelerate forest recovery ▪ Supporting Agro-forestry, commercial tree planting, public land forests and restoration of natural degraded forests; ▪ River bank stabilization

Table **A2.2 Overview of interventions related to soil and water conservation (bio-engineering, Activity 1.5)**

Ecosystem Restoration & Sustainable Management	Soil and Water Conservation (bio-engineering)
Overall approach	▪ The implementation of soil and water conservation measures (bio-engineering) will focus on particularly vulnerable areas that are degraded, or highly susceptible to flooding and landslides due to increased precipitation (seasonal trends and intensity), and to enhance areas that are prone to seasonal water scarcity (e.g. improved water harvesting/ storage). Measures will aim to enhance the resilience of ecosystems to key climate risks, with targeted measures based on the local context and degree of vulnerability. Main beneficiaries will be CBOs, as well as local and provincial governments (i.e. investments on community- and government-managed public land). ▪ Promoted measures will be closely linked to vulnerability assessments, targeting areas that are highly susceptible to flooding and landslides, as well as other climate-induced natural hazards. Measures will be closely linked to river system-level action plans to ensure that appropriate interventions are implemented in at risk areas (ensuring holistic river system planning to coordinate upstream and downstream land use and vulnerabilities). Soil and water conservation experts will review all plans for bio-engineering within the BRCRN project prior to approval (including civil engineers, forest, soil and agriculture experts, as needed).
Post-project sustainability	▪ The proposed bio-engineering measures and structures are expected to be maintained by the CBOs beyond project closure. The project-supported bio-engineering measures and structures are mostly made from locally available materials, and thus operations & maintenance (O&M) costs are expected to be modest. In addition, the structures are all considered to be durable, thus further contributing to ensuring that O&M costs to be borne by CBOs remain sufficiently modest that they can cover such costs beyond project closure – particularly given the anticipated increases in revenue among CBO members due to project-supported practices, as well as the anticipated reductions in climate change-related losses and damages due to the below bio-engineering structures, as well as other resilience-building practices, measures and structures promoted through the BRCRN project.

Practice	Siltation prevention measures of river tributaries (check dams)	 Sketches of a gabion check dam and a bamboo check dam in Nepal[306]
Description	These types of measures will reduce disaster risks and other negative impacts on land use systems emerging from water bodies and sediment accumulation. This will be achieved by providing technical assistance to the construction and maintenance of siltation prevention measures, also known as check dams. Check dams are small and low structures built over water bodies to reduce the water flow impacts. In the long run siltation management and prevention will protect the hydrological functions of natural resource and land use systems. • Dredging: Mechanical dredging works • Hydrologic design: Altering areas in water bodies that have a reduced sediment transportation capacity • Integration of vegetation into check dam structures • Enhancing institutional capacities for joint basin management to prevent siltation accumulation • Strategic construction and maintenance of locally adapted check dams to regulate water flow • Strategic construction and maintenance of locally adapted check dams to trap deposits	
Main zones and productions systems	The construction of check dams will focus on uncultivated streambeds or on areas with less or no land use. This approach will foster acceptance amongst local residents and does not interfere with local land use. Other siltation prevention measures will also focus on areas under land use, which will require a high degree of local participation. The previously outlined measures against erosion and deforestation are essential to reduce siltation in the first place.	
Climate benefits	**Adaptation:** • Check dams can be controlled or opened during droughts, increasing agricultural resilience	

[306] See FAO: http://www.fao.org/docrep/u1510e/u1510e04.htm

	• Reduce water run-off speed, reducing erosion and sedimentation • Reducing the risk of flash floods • In combination with water harvesting (irrigation), increasing the availability of water in increasingly long dry season(s)	
Co-benefits	• Protection of both up- and downstream infrastructure, livestock and agriculture and aquaculture systems, leading to socio-economic benefits • Siltation that is extracted can even be utilized • Improved aquatic biodiversity conservation through reduced siltation	
Practice	**Gully stabilization through contour bunds and stone Walls**	Gullies are a highly visible form of soil erosion created by running water. They are deep-sided water courses, several meters to tens of meters in depth and width, gouged out by surface water flow. Gully formation can start with the formation of rills by surface water flowing down a slope, especially where soil is exposed. Water flow is concentrated and accelerated down the rills, leading to increased erosion and eventually formation of a full gully. Gullies channel and accelerate runoff, and thus contribute to flood and flash flood development, as well as causing damage to the surrounding area and infrastructure, reducing the productivity of farmland, and contributing to sediment flow and sedimentation of downstream lands, streams, channels, and reservoirs. The major causes of gully erosion are: • erosion in the catchment, • channel erosion by unmanaged runoff resulting in downward or sidewards scoring, • steep unprotected slopes and drainage channels, • gully head expansion, and • side slope failure due to toe cutting of the gully channel embankment[307]
Description	The techniques for improvement of the catchment above a gully are the same as those recommended to prevent gully formation. Essentially, they include all the methods recommended for controlling surface runoff by increasing infiltration and trapping moisture, as well as soil protection measures and slope stabilization. Measures include bioengineering approaches such as contour farming, strip farming, mulching, and afforestation, as well as physical measures such as bunding, terracing, levelling, and trenching, and building structures for diversion of surface runoff such as grassed waterways and weirs. Contour bunds (1m wide and 3-30 m from bund to bund) are a structural soil and water conservation measure using dead biomass and soil. They fulfill protective functions for sensitive marginal areas and steep, hilly areas and slopes. Oftentimes it is practiced within shifting cultivation systems with low productivity. It is a low cost and simple solution to prevent erosion, retain water and increase productivity. In a first step the existent vegetation is partially cut down and will start to decompose on the ground. In a second step the remaining harder biomass is rolled into bundles that form the contour	

[307] ICIMOD 2008

	lines secured by stones and tree stumps. Subsequently the rest of the litter is fixed between the bunds and plants and terraces will start to form through soil retention and formation. It is important to stabilize the gully head and prevent it from advancing. This can be done by diverting the runoff to stop it from entering the gully, or by allowing the runoff from upstream to enter the gully safely by installing drop structures. Stone walls contribute to gully stabilization and are a part of water conservation infrastructure, stabilizing river banks and reducing the impact of water flow.
Main zones and productions systems	In steep slope terrain with a high risk of gully formation (either existing or new formation)
Climate benefits	**Adaptation:** • Harvest of water, enhance the retention of runoff water, and prevent soil erosion and flooding. Contour farming alone can reduce soil erosion by as much as 50% on moderate slopes. • Diversion of excess water to protected drainage ways, reduce soil erosion and leaching of nutrients. Very important if a great deal of water enters from upstream or uphill areas, including during intense precipitation events. • Reduced downstream siltation • River bank stabilization limits the impact of flooding • Improved groundwater recharge due to reduced sedimentation/ erosion, improving resilience to water deficit downstream **Mitigation:** • Reduced erosion and stabilization of soil carbon sinks
Co-benefits	**Productivity:** • Increased water retention and infiltration • Increased productivity of agricultural systems

Practice	**Riverbank stabilization (Physical structures)**	
Description	This physical structure will always be implemented in combination with the rehabilitation of river banks with vegetation (see Appendix A.3 under protective plantations). To reduce the river impact on the riverbanks, physical structures such as gabion walls is a common practice in the project region and forms part of various government flood risk management programs including the Churia Masterplan. A gabion is a heavy duty basket-like structure made in the shape of a box from welded or twisted galvanized iron wire mesh, divided by wire diaphragms into cells, and filled with heavy material (typically rocks or broken concrete) that cannot escape through the mesh openings. Gabion structures are generally used as construction blocks, and are tied together with galvanized iron binding wire to form larger structures. Gabion walls are constructed using gabion boxes of various sizes stacked next to and on top of each other before tying. Good quality stone should be used to fill the boxes, with dimensions preferably not less than 10 cm, or at least greater than the mesh size. Stones should be packed as tight as possible to increase the density of the gabion wall. The gabion structures are flexible and provide good drainage due to the dry stone packing	
Main zones and productions systems	Focus areas for this approach are sensitive parts of water bodies such as bottlenecks or especially steep or shallow areas.	

Climate benefits	**Adaptation:** • Reduce riverbank erosion and sedimentation of nearby cultivated land, protection from river cutting in high-intensity rainfall situations • Reduced impact from unforeseen flash floods (stabilized banks) • Provides protection for reclamation of land for plantations or agriculture	
Co-benefits	• Protection of land use systems from landslides, flooding, erosion and sedimentation/siltation	
Practice	**Conservation Ponds**	**Degraded water pond** **Rehabilitated water pond**

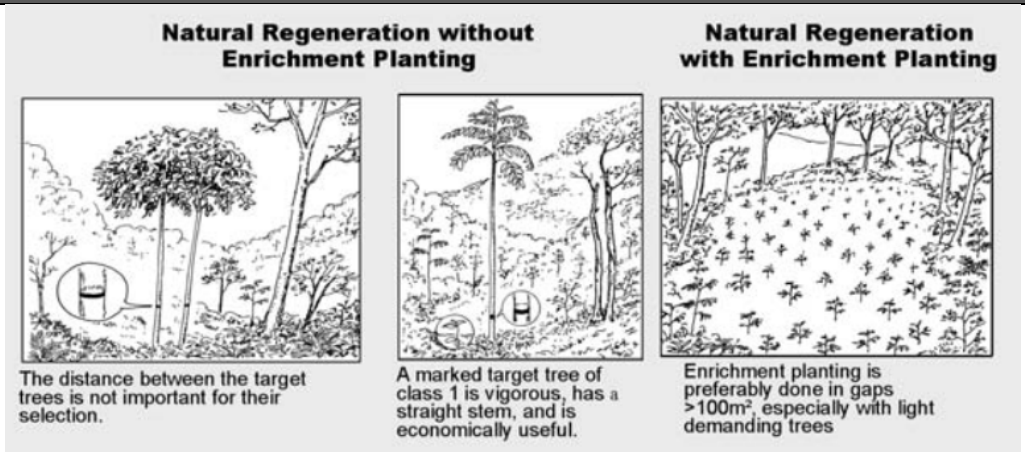
Description	Conservation ponds, also known as farm ponds, are small water reservoirs constructed for the purpose of collecting and storing water from surface runoff. Storing water runoff during excessive rainfall helps to reduce the peak flow and surface erosion and thus reduce the probability of floods. It is also useful for providing supplemental irrigation for agriculture, water for domestic purposes, and fish farming. Conservation ponds play a significant role in areas with rain fed agriculture, and construction of a large number of ponds in a catchment area can have a significant effect on downstream flow and control of floods. Water storage is a topic of increasing importance in the project region as the focus turns toward adaptation to climate change, and conservation ponds and other storage mechanisms are likely to play an increasing role in future development activities[308]. Conservation ponds can be broadly classified into embankment type ponds and dugout type ponds. The project will focus on the rehabilitation also of existing degraded water ponds which can be found throughout the project region. This rehabilitation will always be combined with suitable agroforestry practices (see above) in order to create an integrated tree – water pond – system with multiple benefits including aspects of recreation and tourism. Studies have assessed why such the adoption of ponds had limited success in the past, and have identified key success factors that we will replicate to ensure the long-term sustainability and maintenance of ponds. CBOs should develop clear rules for pond users related to water allocation and contributions to the maintenance of the	

[308] Vaidya, RA (2009) 'The role of water storage in adaptation to climate change in the HKH region.' ICIMOD, Sustainable Mountain Development (56): 10–13; Upadhya, M (2009) 'Traditional technologies for water harvesting.' ICIMOD, Sustainable Mountain Development (56): 24–26

	ponds. CBO committees will help to overcome past shortcomings, which were largely attributed to the lack of a coordination body (committee) responsible to establishing rules for the maintenance and allocation of the pond and water. Studies have found that CBOs, such as farmers groups and other CBOs, can be an effective approach to establish pond supervision, management and maintenance in a community.[309]
Main zones and productions systems	Water ponds can be found downslope in the Bhavar and Terai regions (that can be rehabilitated), however, small dugout ponds will also be located and designed in all regions in order to reduce the dependency on erratic rainfall
Climate benefits	**Adaptation:** • Increased resilience during periods of water deficit, including by improving water availability during increasingly long dry season(s) • Storing water runoff during excessive rainfall helps to reduce the peak flow and surface erosion and thus can help to manage intense rainfall and the probability and severity of floods, and improves water availability in monsoon season (e.g. with decreasing no. of consecutive rainy days) • It is also useful for providing supplemental irrigation for agriculture, water for domestic purposes, and fish farming. • Conservation ponds play a significant role in areas with rain fed agriculture, and construction of a large number of ponds in a catchment area can have a significant effect on downstream flow and control of floods. **Mitigation:** • If water from ponds used for agriculture, it increases also the potential sequestration and management of soil organic carbon stocks within agriculture fields
Co-benefits	• Increase land productivity as a results of water availability also in dry seasons • Increased income generation from fish farming and other benefits (e.g. ducks) • Possibility for additional income generation from eco-tourism

[309] Bastatakoti, R.C., Prathapar, S.A., Okwany, R.O. 2016. Community pond rehabilitation to deal with climate variability: A case study in Nepal Terai. Water Resources and Rural Development, 7: 20-35.; UNDP - https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=21818; IUCN. 2014. Restoring Community Ponds: Green Infrastructure to Combat Cliamte Change Impact in the Panchase Area. Kathmandu, Nepal.

Table A2.3 Overview of interventions related to restoration and rehabilitation of degraded forest ecosystems

Forest restoration	Restoration and rehabilitation of degraded forest ecosystems	
Overall approach	Encouraging natural regeneration is an ecologically sound way of establishing forests within heavily degraded areas in the project area which requires comparatively low investment. Natural regeneration can create economically valuable forests that fulfill both production and protection functions with the long-term goal of establishing permanent forest cover. The ultimate objective is to establish stands resembling natural forest with a broad mixture of species, products and services. For this reason, natural regeneration plays a very important role in the project. On degraded forest sites, natural regeneration with and without enrichment planting is used as much as possible to create mixed forest stands. However, these concepts require long-term planning related to future management (e.g. cuttings/ silvicultural applications, monitoring forest health, etc.) and utilization (e.g. harvesting rules - see also the activity description of SFM below). Its recommended detailed management plans are developed to support such measures in the short- medium- and long-term.	
Practice	**Natural regeneration with and without enrichment planting**	
Description	**Assisted natural regeneration** involves promoting tree seedlings and favorable species that were once destroyed. Another way would be to produce fodder banks or produce fodder for livestock. After a while, grass or other fast-growing crops are planted. With time the quality of the soil on this land improves, and the land becomes more productive. The emphasis of silvicultural measures is on forest protection. These protection measures are considered important preconditions for acceptance by the project: • No removal of trees or shrubs; • No cutting of trees, bark or branches; • Ground vegetation to be fully protected; • Grazing animals to be completely excluded;	

	• Any fires to be extinguished immediately; • Harvesting fuelwood to be avoided. CBOs are expected to oversee their own forests and ensure compliance with the rules of the CBOs. Studies have shown CBOs, including CFUGs and CFM groups, are largely effective at managing forest resources and have developed substantial ownership of the sustainable management of forest resources.[310] All participating CBOs must comply with the associated guidelines and regulations associated with each type of CBO (e.g. Community Forestry Guidelines), and the country´s forestry policy. CBOs make their own operational rules on the protection, utilization and infractions. Prior to joining the project all CBOs will be consulted based on the principles of FPIC, where participation in the project is voluntary. Rules will be revised and discussed by CBOs, utilizing their norms and forums, and technical support will be provided to address questions or discuss mitigation measures and/or how to solve potential conflicts. In areas where users may be excluded, alternative support will be targeted to provide alternatives based on a consultative and transparent process (e.g. fodder banks, etc.). **Enrichment Planting** is a method used to restore over-exploited forest dominated ecosystems especially along waterways. It involves additional planting of economically valuable trees in stands that have been defined as suitable to the specific site conditions. The following basic principles have to be applied: • Tree species selection for enrichment planting has to avoid the selection of pioneer species or species with predominantly pioneer characteristics; • Enrichment planting is limited to gaps in the natural succession. In these gaps the density of planted trees is between 2 m x 3 m and 3 m x 3 m, depending on the size and number of gaps. Gaps smaller than 100 m^2 are not to be enriched; • Fixed planting schemes are avoided and instead gap planting is favored • Micro site conditions and heterogeneous site conditions are taken into account in species selection
Main zones and productions systems	Throughout the three zones, wherever heavily degraded forest sites exist. Since most of the forest is located in the hilly zone, this intervention will take place predominantly in the Churia hills.
Climate benefits	**Adaptation**: • Stabilize the ground and reduces soil erosion, reducing river bank rise downstream • Trees and other vegetation act as bio-shields against flooding events, stabilizing river banks and creating a green buffer zone • Reduces river sedimentation and loss of productive land (e.g. river bank cutting and riverbed rise)

[310] Gautam, A.P., Webb, E.L., Eiumnoh, A. 2002. GIS Assessment of Land Use/ Land Cover Changes Associated with Community Forestry Implementation in the Middle Hills of Nepal. Mountain Research and Development, 22(1): 63-69.

	Mitigation: • Trees sequester carbon into living biomass • Trees increase soil organic carbon sequestration
Co-benefits	**Productivity**: • Functioning forest ecosystems provide protection of cropland against flooding and sedimentation • Multi-purpose forests provide many products including timber, poles, fodder, and other non-wood forest products on a long-term if harvested in a sustainable way **Other** • Trees provide shelter and act as windbreaks and have cultural and psychological values

Table A2.4 Overview of interventions related to Sustainable Management of Forest Resources

Forest ecosystem Management	Sustainable Management of Forest Resources
Overall approach	Nepal has a long history of promoting community forestry. Within the project region, various existing community forest management units exist that apply principles of sustainable forest management. For this, various guidance materials and manuals are available detailing the formation, planning, implementation and monitoring of community forests through the institutional concept of CFUGs – community forest management user groups[311]. This

[311] See for instance: https://assets.publishing.service.gov.uk/media/57a08d62ed915d3cfd0019ce/R6918innovative_forestry_guidebook.pdf
http://forestaction.org/app/webroot/vendor/tinymce/editor/plugins/filemanager/files/images/stories/pdfs/journal_of_forest_and_livelihood/vol6_2/2_Community%20forestry-final.pdf
https://www.eda.admin.ch/dam/countries/countries-content/nepal/en/resource_en_206126.pdf

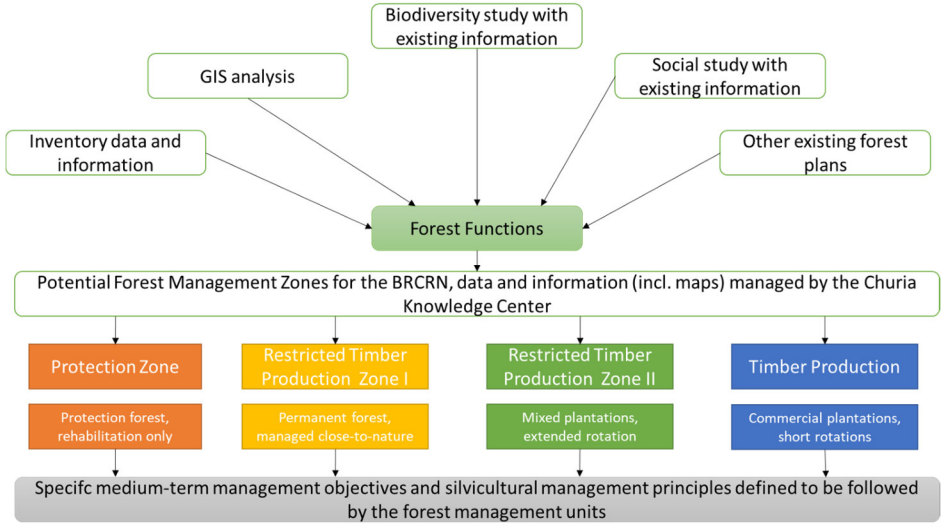
	successful concept with proven practice of more than 30 years is also seen as a cost-efficient way for the implementation of REDD+ in Nepal.[312]. This project will draw upon this vast experience to further develop community based forest management approaches. To manage a forest ecosystem such as the forest in this project to fulfil the required multiple functions, in particular the adaptation-focused function of reducing soil erosion and water protection, a holistic Sustainable Forest Management (SFM) framework will be established for the entire project area in which the different forms of public and private forest management regimes need to be embedded. This framework hast to take a broader view on the up-stream and downstream linkages between the forest in the hills and the Bhavar and Tarai zones to maximize the multi-functional dimensions of the forest resources. The SFM framework will bring into practice principles, procedures and means of medium-term forest management planning for sustainable forest management (SFM) integrating Forest Management Units (FMU) of different regimes including community forest, leasehold forest, and collaborative forest management regimes, etc. A precondition for planning is a clearly determined outer boundary. The principle of sustainable forest management is defined by the Food and Agricultural Organization (FAO) as follows: "Sustainable forest management is the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems."

[312] see for instance: https://theredddesk.org/sites/default/files/resources/pdf/2013/cf_redd_nepal_final.pdf; http://www.ansab.org/publication/guidelines-for-measuring-carbon-stocks-in-community-managed-forests/

Practice	**Development of a SFM guidance framework for the entire forest resources in the project region**	
Description	The transition towards practical application of SFM requires equal consideration of social, ecological and economic functions, resulting in a shift from demand-driven and commercially focused production of industrial timber towards multifunctional management of all forest resources by means of silvicultural diversification. For instance, forests of high ecological and social value will have to be managed either close-to-nature or will be strictly protected. Furthermore, forest management planning must adhere to the precautionary principle[313] so as to make it functionally equivalent to both, an Environmental Impact Assessment (EIA) and a Social Impact Assessment (SIA). All of the foregoing has a direct impact on medium-term forest management planning. It requires the introduction of new planning concepts and components, such as multifunctional zoning and the implementation of control forest inventories (CFI). In particular, the multi-functional zoning represents a core activity within the elaboration of a BRCRN SFM Framework being an essential tool for multiple-use forest management planning, aiming to define ecological, environmental, social and other functions for all	

[313] Where the outcome of FM practices is unknown, uncertain or irreversible, activities must either not be undertaken or with full mitigation of their potentially adverse effects on the human and natural environment. This implies application of practices that (i) sustain forest health and soil fertility (e.g. no clear cuts on steep slopes beyond prescribed thresholds); (ii) enhance landscape, biodiversity and climate protection values (e.g. no forest conversion and zero-burning of logging debris); (iii) reduce environmental pollution to the lowest practicable level (e.g. no unregulated industrial and human waste disposal); (iv) minimize dependence on non-renewable resources (e.g. fuel-efficient machinery) and (v) conservatively calculate forest production based on reliable minimum estimates (i.e. lower end of the confidence interval), but never be based on statistical means

forest areas within the project region and within the individual operational forest management units with a view to balancing the sometimes divergent objectives of timber production, societal needs and nature conservation. It reliably determines the net production area (operable area) and provides planners and managers alike with specific management prescriptions for particular forest sites depending on the identified forest functions. Based on the occurrence and restrictive nature of the various forest functions, four different management zones are identified for future management pursuant to different silvicultural systems: protection zone; restricted timber production Zone I; restricted timber production Zone II; and timber production. Management zoning results in a re-classification of the forest. The process of multifunctional zoning and the sources of information required are illustrated in the Figure below. The project will use existing information as much as possible to perform the multi-functional zoning of the forest areas.



For each Forest Management Zone specific medium-term management objectives will be defined and specific silvicultural management principles derived which are to be followed by the different forms of forest management units within the BRCRN project area. These management objectives guide all technical measures. Silvicultural treatments are the means of implementing the defined objectives. Long-term objectives have to be able to respond to changing markets, ecological conditions, social requirements, and the conditions of the economic framework. In view of this, efficient forest management calls for dynamic and flexible objectives, particularly in terms of species composition. Natural processes and changes of species composition have to be accepted according to the natural production potential of forest management. The ultimate objective of the concept being presented is a permanent forest estate resembling natural forest with a broad mixture of species, products and services. This form of management leads to forest stands rich in species and structure. The permanent forest estate is able to fulfill economic requirements and other forest functions, such as watershed protection,

	erosion control, biodiversity, etc., as well. Furthermore, it is particularly suited to smallholder forest management on small area units. Because of its uneven-aged structure, usable volumes and products are permanently available.
Main zones and productions systems	The SFM planning framework will be elaborated for all forests in the project area
Climate benefits	**Adaptation**: • Forests, if well and multi-functionally managed provide one of the best low-cost adaptation measures for this particular region under such extreme vulnerability also to climate induced disasters. • Forest ecosystems with healthy structure and permanent cover maximize ecosystem services including eater protection, water recharge, erosion control, wind control, 'sponge' effect against heavy rainfall events, reduction of gully formation, reduction in water runoff, biodiversity enhancement and conservation and various socio-economic services for the rural population and local beneficiaries. **Mitigation**: • Reduction of emissions from deforestation and forest degradation • Sequestration of additional carbon in forests under protection and improved forest management • Forests increase soil organic carbon sequestration
Co-benefits	**Productivity**: • Functioning forest ecosystems provide protection of cropland against flooding and sedimentation • Multi-purpose forests provide many products including timber, poles, fodder, and other non-wood forest products on a long-term if harvested in a sustainable way **Other** • Trees provide shelter and act as windbreaks and have cultural and psychological values

A3. Tree planting on private and public lands – Agroforestry systems II and plantation establishment

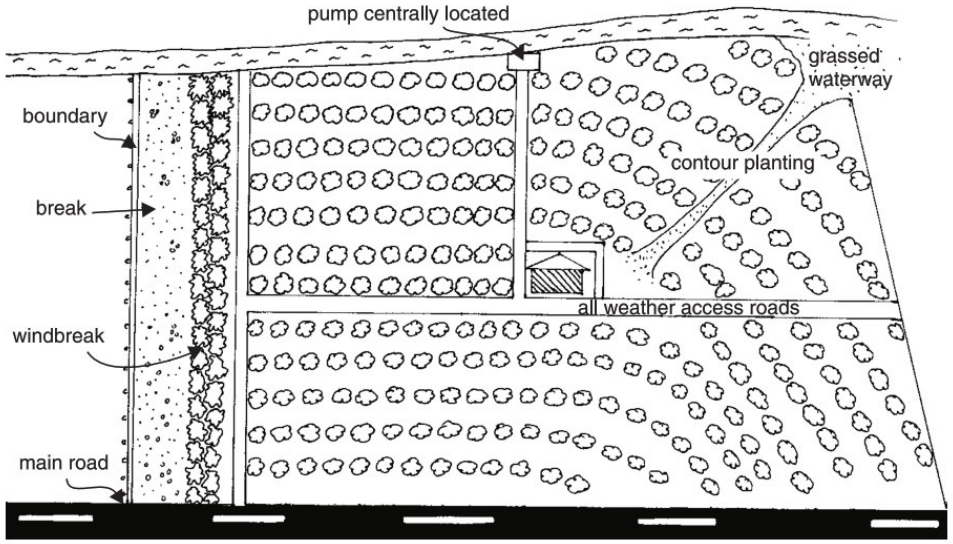
Under agroforestry I above (Appendix A1), systems will be promoted which are located on existing cropland, i.e. trees protected or planted to support the productivity of the crops being grown. For the practices presented here in Appendix A3, agroforestry and other tree planting systems will be introduced which are basically new land use systems on marginal or degraded land. Certainly also crops can be intercropped under these systems, but the prime objectives are newly introduced tree based systems. These practices offer important solutions to the region's growing, interconnected challenges with a right mixture of forest rehabilitation and market-based agroforestry systems, which revitalizes the soil, forests, and performance of smallholder farming systems. The tables below distinguish the following systems which will be implemented:

1. Fruit orchards (horticulture)
2. Smallholder woodlots
3. Contour tree/ boundary planting
4. Fodder banks as support for integrated livestock management
5. Commercial tree plantations
6. Protective plantations
7. Nursery and seed management

Table A3.1 Overview of interventions for tree planting on private and public lands

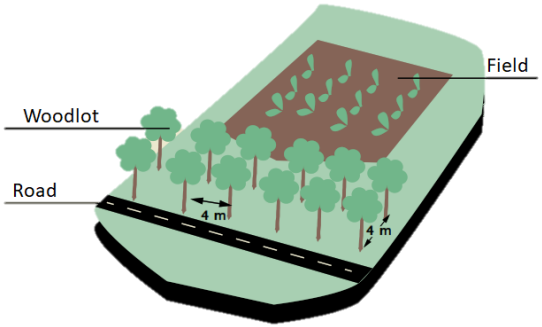
	Churia Hills	Bhavar	Dun Valley and Terai Plains
Land Use	▪ Deforestation and forest degradation are increasing, resulting in accelerating erosion and sedimentation, and increased vulnerability to climate change both upstream and downstream ▪ Deforestation leads to higher risks of landslides, wildfires upstream, and increases flooding risk downstream ▪ High dependence on forest products (fuelwood, fodder, timber, NTFPs, etc.)	▪ High dependence on forest products (fuelwood, fodder, timber, NTFPs, etc.) ▪ Deforestation and forest degradation are increasing, resulting in accelerating erosion and sedimentation, and increased vulnerability to climate change both upstream and downstream ▪ Deforestation leads to reduced groundwater recharge, increasing vulnerability to water scarcity and extreme heat downstream ▪ Also leads to increased sedimentation, river bank cutting and increased impacts from floods	▪ Forests have been largely deforested and degraded within the Terai ▪ High dependence on forest products, many households are distant forest users, yet they do not have incentives to benefit from sustainable management of churia forests. ▪ Leasehold and public land forests are highly degraded in Terai. ▪ Private forestry becoming increasingly attractive with land abandonment trends, however there are capacity gaps, weak link with private sector. ▪ Upstream deforestation increases the vulnerability of downstream communities to various climate-induced hazards
Climate change impacts	▪ Extreme heat, water deficit, erosion and landslides.	▪ Extreme heat, water deficit, flashflood, debris deposit and riverbed rise.	▪ Extreme heat, water deficit, erosion and landslides, silt accumulation on agricultural land
Focus of tree planting practices within the BRCRN project	▪ Focus on natural regeneration and sustainable forest management; ▪ Supporting conservation planting; ▪ Focus on CFUGs and pro-poor leasehold forests; ▪ Agroforestry and improved livestock feeding promoted within agricultural areas (cf. Appendix A1), fodder banks, horticulture, shade trees	▪ Providing technical support for investments in commercial forestry, woodlots and horticulture ▪ Supporting to supply quality seedling (nursery development) ▪ Focus on CoFUG/CFUGs, private land owners, public land forest user groups, leasehold forestry groups	▪ Direct investments for public land forest groups and pro-poor lease hold forestry groups, with high membership of highly vulnerable households, in highly degraded areas (improving access to forest products for distant forest users) ▪ Providing technical support for investments in commercial forestry, woodlots and horticulture ▪ Supporting to supply quality seedling (nursery development; ▪ River bank stabilization plantation ▪ Focus on collaborative forest management groups, CFUGs, private land owners, public land forest user groups, leasehold forestry groups

Table A3.2 Overview of interventions related to Agroforestry systems II and plantation establishment

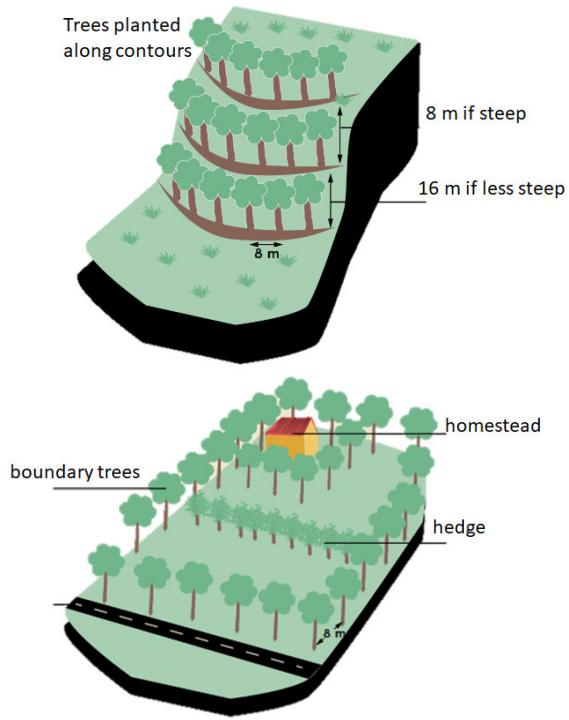
Tree planting systems	Agroforestry systems II and plantation establishment	
Overall approach	Under this practice presented here, agroforestry and other tree planting systems will be introduced which are basically new land use systems on marginal or degraded land. These practices offer important solutions to the region's growing, interconnected challenges with a right mixture of forest rehabilitation and market-based agroforestry systems, which revitalizes the soil, forests, and performance of smallholder farming systems	
Practice	Fruit orchards (horti-culture)	 Example of a typical fruit orchard design plan[314]
Description	Fruit trees can be planted as orchards (cluster of fruit trees) or scattered in the farm for home use or for selling. The leaves, seeds, fruits, nuts of fruit trees provide food with high nutrition value, medicine and other products. Fruit orchards will be established on marginal land or suitable	

[314] Meurant, N. and Holmes, R. and MacLeod, N. and Fullelove, G. and Bally, I. and Kernot, I. (1999) Mango Information Kit. Agrilink, your growing guide to better farming guide. Manual. Agrilink Series QAL9903. Department of Primary Industries, Queensland Horticulture Institute, Brisbane, Queensland

	land reclaimed from sedimentation. In addition, existing degraded fruit tree plantations will be enriched to increase productivity. Short duration crops like legumes, vegetables, groundnut etc. can be raised during pre- bearing age of the young fruit tree plantations. Examples of suitable fruit trees include: mango, papaya, pineapple, litchi, arecanut, coconut and melon, among others. Specific tree species will be promoted based on the principles of site-species matching, aiming to plant tree species with growing characteristics that are suitable for soil and environmental conditions as well as the priorities and needs of local people.
Main zones and productions systems	The main zone for this practice is the Bhavar zone as well as the inner valleys of the Churia region. This is traditionally the zone with better soil conditions (compared to the hills) suitable for the establishment of horticulture plantations. Some of the plantations will also be established within the Terai zone based on land availability within the 26 river systems
Climate benefits	**Adaptation**: • Trees increase biodiversity, and enable climate change adaptation (improved soil coverage, income diversification, reduced pressure on forested land) • Enhance water recharge in soils that support ecosystems to withstand extended dry periods. Can prevent water springs from drying up and helps to maintain stream flows • Trees on cropland enhances soil moisture and create favorable microclimatic conditions to enhance the resilience of soils under increasing temperatures and prolonged dry periods. They can enhance soil physical, chemical and biological properties through increasing soil organic matter and releasing and recycling nutrients. • The trees reduce runoff speed, increase infiltration, increase vegetation cover, control soil erosion • Trees stabilize the ground and reduce soil erosion from wind and water • Income diversification **Mitigation**: • Trees sequester carbon into living biomass Provides alternative sources of forest products (timber and non-timber forest products) and income (e.g. fruit production, etc.) that contribute to reduced forest degradation and the enhancement of carbon stocks • Trees increase soil organic carbon sequestration
Co-benefits	**Productivity**: • Trees improve soil fertility • Fruits provide diversification of income to communities. Increases in household income and profit due to harvesting of multiple crops • Trees provide fodder for animals **Other** • Trees provide shelter and act as windbreaks and have cultural and psychological values • Provide alternatives that limit forest degradation and biodiversity loss

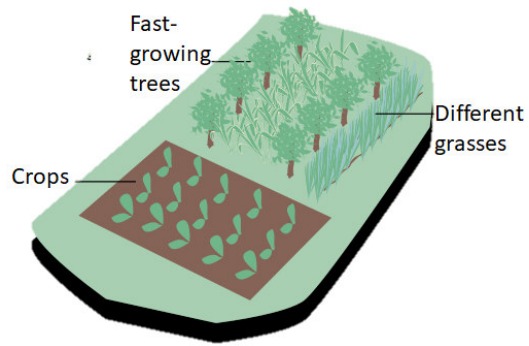
Practice	Woodlots	
Description	Woodlot refers to a cluster of trees grown together to produce timber, poles, or fuel wood (firewood and charcoal) and support other systems like bee-keeping, livestock and crop production. Woodlots are grown on agricultural land. Woodlots form high carbon pools (made of tree stems, roots, litter and organic matter). In this project a variety of indigenous tree species will be promoted for high carbon sequestration and to conserve biodiversity. As a complement, some exotic agroforestry trees will also be planted if they are adaptive to the local setting. Typical woodlot multi-purpose tree species promoted: *Terminalia alata*; *Bauhinia vahlii*; *Acacia catechu*; *Lagerstroemia parviflora*; *Phyllanthus emblica*; *Diploknema butyracea*; *Bauhinia purpurea*; *Dalbergia sissoo*; Ficus spp.	

Main zones and productions systems	Woodlots will be established strategically in all zones, in particular in those locations with high pressure on existing forests (in terms of wood fuel and other non-forest product needs)
Climate benefits	**Adaptation**: • Protect agricultural fields from soil erosion (cover/ protect soil, soil stabilization to prevent from water and wind erosion) • Enhance water recharge in soils that support ecosystems to withstand extended dry periods. Can prevent water springs from drying up and helps to maintain stream flows • Trees on cropland enhances soil moisture and create favorable microclimatic conditions to enhance the resilience of soils under increasing temperatures and prolonged dry periods. They can enhance soil physical, chemical and biological properties through increasing soil organic matter and releasing and recycling nutrients. The incorporation of nitrogen fixing trees can help improve soil quality **Mitigation**: • Trees sequester carbon into living biomass • Increases soil organic carbon sequestration • Reduces emissions from forest degradation due to reduced timber and fuelwood harvesting in natural forests
Co-benefits	**Productivity**: • Trees improve soil fertility and crop productivity • Nitrogen fixed by the trees enhances soil fertility leading to higher crop production without fertilizers • Trees provide firewood, timber, poles, and sometimes have medical properties • Tree provide fodder for animals

Practice	Contour tree/ boundary planting	
Description	Contour trees are planted on sloping land for the purpose of soil and water conservation. Boundary planting involves planting selected trees along field boundaries, hedges, borders and roadsides. Mainly multi-purpose trees are planted which include fruit trees as well as other trees providing other products including timber, biomass, fuelwood and fodder. The same species are suitable as for the woodlots, however, for contour planting trees with deep root systems are preferred to increase the soil stabilization ability. In addition, bamboo species are also well-suited for this practice	
Main zones and productions systems	Contour planting is done mainly in steep slope conditions in the hill zone while boundary planting is suitable in all zones, including more intensive agricultural systems such as rice in the Terai zone.	

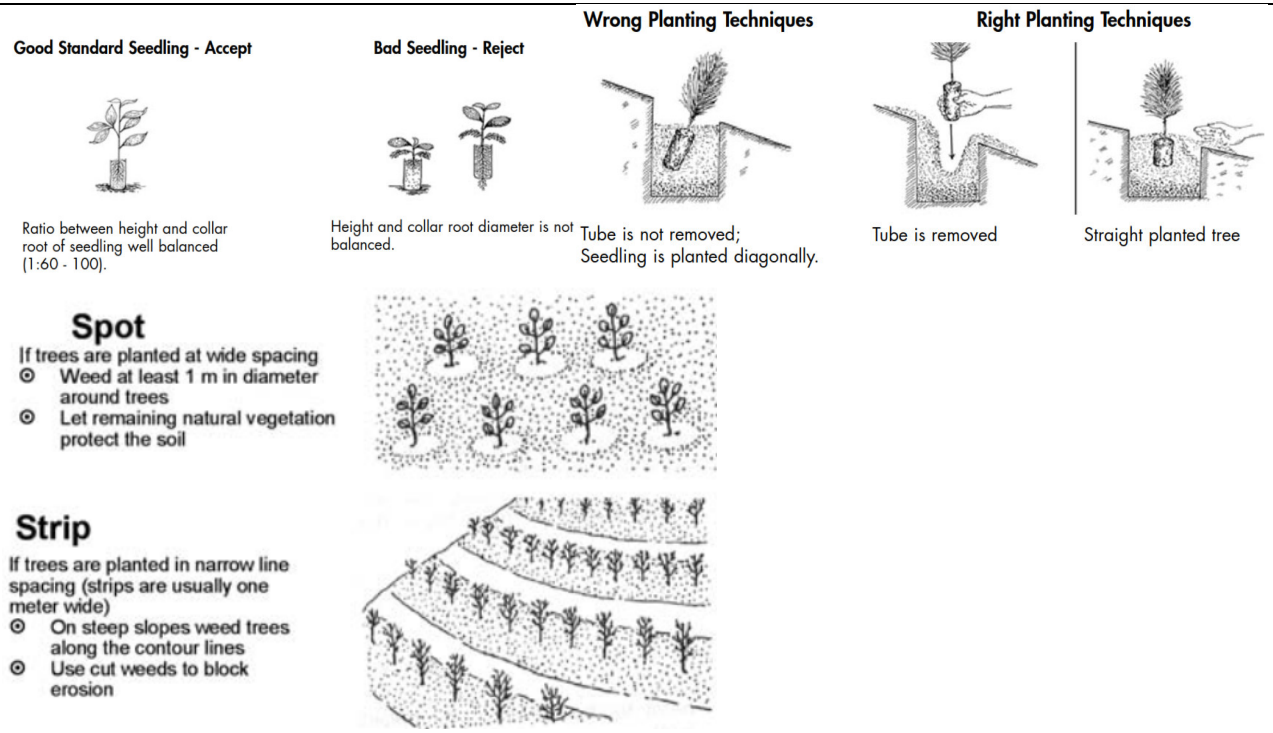
Climate benefits	**Adaptation**: • Increase biodiversity, reduces deforestation and forest degradation that support climate change adaptation • Can support micro-climate buffering (reducing incident solar radiation, buffering air and soil temperatures)[315] and regulation of water flows • Stabilizes the ground and reduces soil erosion • Reduces runoff speed, increase infiltration, increase vegetation cover, control soil erosion • Trees on cropland enhances soil moisture and creates favorable micro-climatic conditions • Trees also act as windbreaks (reducing wind erosion and wind-damage to crops and infrastructure) • Income diversification **Mitigation**: • Trees sequester carbon into living biomass • Increase soil organic carbon sequestration • Depending on tree properties / use – can reduce emissions from forest degradation (e.g. fuelwood, fodder, biomass, timber)
Co-benefits	**Productivity**: • Trees improve soil fertility and crop productivity • Nitrogen fixed by the trees enhances soil fertility leading to higher crop production without fertilizers • Trees provide firewood, timber, nuts, poles, and sometimes have medical properties • Tree provide fodder for animals and increase livestock productivity while reducing grazing pressure on land **Other** • Trees provide shelter and act as windbreaks and have cultural and psychological values

[315] Mbow, C., Smith, P., Skole; D., Duguma, L., Bustamante, M. 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, 6: 8-14.

Practice	Fodder banks	
Description	Fodder bank is a crop field with a variety of suitable and highly nutritious grasses, leguminous crops, trees and shrubs planted in a systematic way to feed livestock such as dairy cows for high quality milk. It is a fodder agroforestry system that involves establishing trees into hedges, blocks or strip cropping, grass planting, vines, grass and paddocking (for zero grazing). Fodder banks can be established through direct seeding or cuttings. Typical species for fodder banks include: Soil fertility improvement and fodder trees and grasses: *Calliandra calothyrsus*; *Albizia spp.*; *Adhatoda vasica*; *Artemisia vulgaris*; *Satrium insigne*; *Different grass species*; *Indigoferra and Leucaena leucocephala*	
Main zones and productions systems	This production system is relevant in combination with integrated livestock management, therefore the system will be promoted in areas with high livestock populations, in particular in the hill zones where a lot of pressure from open grazing on existing forest ecosystems exist.	
Climate benefits	**Adaptation**:	

	• Established trees provide feed and manure, litter, humus, fix nitrogen into the soil, improve soil structure and fertility, and control erosion. • Can support micro-climate buffering (reducing incident solar radiation, buffering air and soil temperatures)[316] and regulation of water flows • Stabilizes the ground reducing erosion and sedimentation • Reduces forest degradation, increasing the resilience of ecosystems to climate change, and reduces erosion and sedimentation • The relatively deep roots of the woody perennials allow the trees to reach soil nutrients and moisture not available to grasses and herbaceous plants. This characteristic enables the grasses and plants to retain fresh foliage into the dry season reducing the effects of heat waves and droughts **Mitigation**: • Reduced forest degradation due to fodder collection and/or free-grazing livestock (a major driver of forest degradation in the project area) • Trees sequester carbon into living biomass • Increases soil organic carbon sequestration • Fodder banks manage the agricultural GHG emissions (especially methane) produced by livestock since better feedstock provided reduce the emissions from enteric fermentation of ruminants (improved feed that reduces methane emissions)
Co-benefits	**Productivity**: • Some trees can provide essential feeds and improve the diet of livestock, which if well managed can increase livestock productivity e.g. milk production, as a result of feeding on improved fodder, i.e. increased protein and water intake through the plants • The ability of some legumes to fix atmospheric nitrogen makes them protein-rich feeds • Tree provide fodder for animals and increase livestock productivity while reducing grazing pressure on land

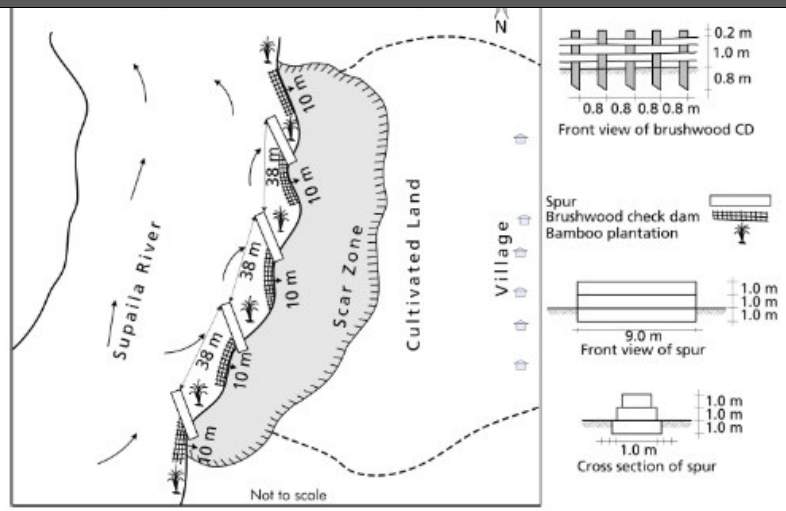
[316] Mbow, C., Smith, P., Skole; D., Duguma, L., Bustamante, M. 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, 6: 8-14.

Practice	Commercial tree plantations	
Description	Tree plantations are abundant on legal forest land in the project region. Also private plantations can be found in the Terai zone. However, high survival rate and good growth is already difficult in plantations managed by the forest department that must also be economic and serve a protection function in ecologically fragile areas. To meet desired multi-functional requirements new plantations must be established with high standards of site preparation, with quality seedlings, with good tree planting practices and by paying strict attention to tending and protection. In recent years not enough emphasis has been paid to these operations. Many planted areas have failed to become established as productive, economically viable forest. Therefore, also the Churia Masterplan has identified the promotion and commercialization of private forest through production, plantation and management of seedlings on private/social lands. The BRCRN project will support better management of commercial plantations mainly by setting up demonstration plantations in strategically selected locations within the 26 river systems. These plantations will act as demonstration sites for optimal plantation establishment, planting and maintenance to achieve high quality timber as well as considering important protective functions of the trees.	

	Main commercial tree species for plantations: *Dalbergia sissoo*; *Eucalyptus camaldulensis*; *Gmelina arborea*; *Tectona grandis*; *Anthocephalus chinensis*
Main zones and productions systems	Main areas for this intervention are suitable site and soil conditions in mainly flat terrain to produce easy accessible, high yielding timber. Therefore, commercial plantations are mainly planned in the Terai and lower Bhavar zones.
Climate benefits	**Adaptation**: • Increase biodiversity, reduces deforestation and forest degradation that support climate change adaptation • Stabilizes the ground and reduces soil erosion and sedimentation. • Can support micro-climate buffering (reducing incident solar radiation, buffering air and soil temperatures)[317] and regulation of water flows • Income diversification **Mitigation**: • Reduces deforestation and forest degradation • Trees sequester carbon into living biomass • Trees increase soil organic carbon sequestration
Co-benefits	**Productivity**: • Trees provide firewood, timber, and shade for livestock (livestock grazing can be included after establishment of the plantation) • Trees provide fodder for animals • High value timber provides financial security for communities **Other**

[317] Mbow, C., Smith, P., Skole; D., Duguma, L., Bustamante, M. 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, 6: 8-14.

	• Trees provide shelter and act as windbreaks and have cultural and psychological values
Practice	Protective plantations



A low cost riverbank protection scheme that can be implemented using mostly local materials[318]

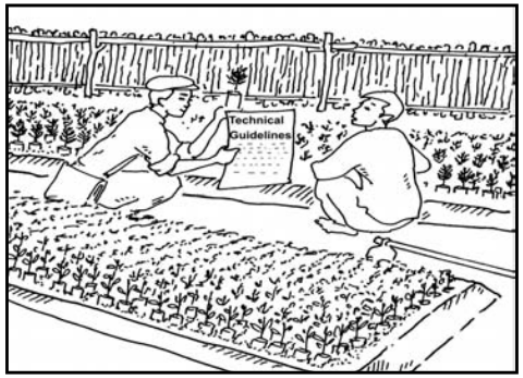
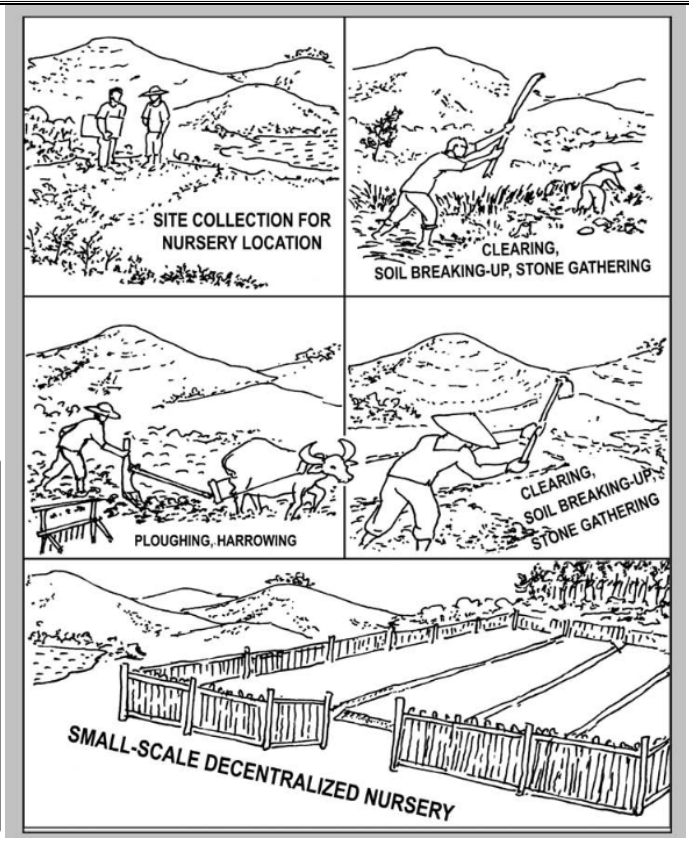
Description	This form of plantation will be implemented in combination with the riverbank stabilization measures. It is a well-established practice which is part of the river system planning and implementation of government development programs including the Churia Masterplan. Trees, bushes and shrub species will be planted and protected in buffer zones along riverbanks in combination with physical protection measures such as gabion dams. The sides of the river are called river banks. The banks should have natural vegetation called riverine which are supposed to be protected. Farmers sometimes destroy the banks of the river by growing crops or naturally heavy rainfall, river flooding and landslide erode river banks. When the banks are destroyed the river can flood causing river bank erosion, loss of soil, crops and livestock, as well as depositing sand, silt and boulders on cropland. River banks can be protected using live barriers (plants) and gabion wires. River banks will be rehabilitated and protected and not be cultivated by farmers for riverine vegetation and biodiversity. Communities will rehabilitate the damaged river banks by not cultivating, allowing natural regeneration, as well as actively planting mainly bamboo species, other fast-growing trees (*Dalbergia sissoo*, etc.), shrubs

[318] ICIMOD 2013

	and grasses. Often grasses are planted immediately along the river bank, followed by shrubs and bamboo, and later with tree species (including horticultural trees, e.g. melon).
Main zones and productions systems	Mainly in the Bhavar and upper Terai zone where changing watercourses and breaches of riverbeds is an abundant threat
Climate benefits	**Adaptation**: • Stabilizes the ground and reduces soil erosion and sedimentation • Trees and other vegetation act as bio-shields against flooding events, stabilizing river banks and creating a green buffer zone • Reduces river sedimentation and loss of productive land (e.g. river bank cutting and riverbed rise) • Fruit trees can provide alternate or additional income to local communities, providing incentives to sustain these green buffer zones **Mitigation**: • Trees sequester carbon into living biomass • Trees increase soil organic carbon sequestration
Co-benefits	**Productivity**: • Bio-shields provide protection of cropland against flooding and sedimentation • Reclamation of productive land as a result of better river flow management • Nitrogen fixed by the trees enhances soil fertility leading to higher crop production without fertilizers • Trees and bamboo provide firewood, timber, nuts, poles, and sometimes have medical properties • Tree provide fodder for animals

Table A3.3 Overview of interventions related to nursery and seed management

Tree planting systems	Nursery and seed management
Overall approach	Seedling production in a nursery is a chain of activities, where each step has to be properly planned and implemented. Seedlings grown in a nursery are more likely to survive than seeds sown directly. This is because the seedlings are already established. To ensure high quality of forest seedlings and to provide more opportunities (income, technology transfer) for local communities, this project will encourage villagers to establish small scale decentralized nurseries with performance fee based contract for nursery owners and project staff. These incentivized performance contracts (with defined indicators) aim at motivating these decentralized nurseries owners to implement enhanced practices leading to higher quality seedlings provided to the project. The main training and extension support given by this project will focus on advantages and drawbacks of small-scale container nurseries, steps in setting-up nurseries, role of

	nursery owner, site selection, layout of nursery, activity calendar, soil mixture, water and seed supply. The objective is that within the 26 river systems an established network of decentralized small-scale as well as already established private and public large-scale trees nurseries is developed which offer ready access to new tree seedlings at a low cost for all beneficiaries.	
Practice	Promotion of community based decentralized tree nursery establishment	 
Description	The training provided during this BRCRN project will focus on the following steps which need to be considered for a successful community based tree nursery: • Location of tree nursery: Reliable water supply; accessibility and near the farm; availability of good soils; protection from strong wind; direct sunlight (shade) and livestock; gentle slope for water drainage; area free for expansion	

	• Soil preparation: Nursery soil should be fertile and well-drained • Potting: Potting is the process of putting soils into the containers or bags for the purpose of raising and protecting seedlings to maturity. • Sources of seeds: The quality of seeds is of crucial importance. Good seedling quality is the basis for tree planting success. The most important goal of project nurseries is to produce high quality trees for multi-purpose uses with protective functions. The project only accepts high quality seedlings. Improving seedling quality means they will give superior survival, growth and productivity. Seedling quality is governed by the genetic make-up of the parent trees, and the physical growth of the seedlings Seeds can be collected from healthy trees, from other farmers or acquired from relevant institutions such as local district forest nurseries and private nurseries (with quality certificates) • Seed sowing: The time for sowing a specific type of seed depends on the time it takes to attain plantable size, this takes normally 1-3 months depending on tree species. It is important that seeds are sown in time to attain plantable sizes 20-30 cm by the onset of the rainy season • Seed germination bed preparation. A seed germination bed is a place where seed are sown for purposes of germination. There are several types of beds: sunken beds, raised beds, and other containers • Pricking out. Pricking out is the process of transferring young and tender seedlings from seedbeds into potting containers following this sequence of activities • Shading and watering: Both during germination period and raising the seedling, shading and watering is necessary • Weeding: Weeds are a threat to healthy seedlings development as they compete with seedlings for nutrients, water and light. Weeds also cause diseases to the seedlings • Root pruning: Root pruning is the cutting of the roots to control the root system development beyond the container • Hardening off: Hardening off is the gradual preparation of seedlings for field conditions. Hardening-off should be done 2 - 3 weeks before transplanting • Grafting: Grafting is a rapid vegetative propagation technique to multiply plants identical to the desired parent tree. Grafting is important in particular for fruit tree seedlings to increase the overall quality: For instance: grafted mango trees take a shorter time to start flowering and produce fruits. More trees can be accommodated per unit of land as trees grafted on a dwarfing rootstock grow less vigorously. Given the many mango varieties available, farmers have good opportunities to graft desired varieties with great market and domestic consumption potential. • Tree planting: For most trees, the right time to plant is during the long rainy season. A standard step-wise procedure has to be followed for all trees planting activities.

Main zones and productions systems	At strategic locations in the entire project zones always under consideration of locations and networks of already established seed providers and large-scale tree nurseries
Climate benefits	**Adaptation**: • This promoted practice is a pre-condition to achieve the adaptation benefits of trees planted within the different agroforestry and plantation systems **Mitigation**: • Precondition to achieve mitigation through carbon sequestration in trees and soils
Co-benefits	**Productivity**: • Income generation opportunities for communities and single households from selling seedlings • Availability of seedlings throughout the year. • Possibility of using locally available materials for planting. • Nurseries can be used as teaching material for schools and groups

APPENDIX B – ADDITIONAL INFORMATION ON AGRICULTURAL SYSTEMS IN NEPAL

Agricultural land in Nepal

Agricultural land in Nepal accounts for 28.8% of total land, of which 21.25% is arable land, 12.5% are permanent pastures and 1.2% are permanent crop trees (CIA World Factbook Website). About 1.0 million ha of this agricultural land is uncultivated (FAO, 2014). Integrated crop and livestock subsistence farming system, along with predominance of smallholder farmers (defined as less than 0.5 hectares of land holdings) are the main features of agriculture in Nepal. Most production is achieved through rain-fed agriculture, with the vast majority of farmers operating on smallholder farms (FAO, 2014). Those families who have no land, use other people's land for sharecropping or land rentals.

Relevance of the agriculture sector to Nepal's GDP and employment

The agriculture sector employs over 65% of the country's population. The contribution of the sector to the national GDP was 33% in 2016 (World Bank Data). Of the total agricultural GDP, the crop sub-sector accounts for almost half, while livestock accounts for a quarter, followed by the vegetable sector (10%), forest (8%) and fruits and spices such as ginger and cardamom (7%).

Agriculture production system

Land tenure

Of the total number of households (5.42 million) in Nepal, 71% legally own agriculture holdings with livestock and birds, with almost 80 % of households possessing some form of agricultural holding[319]. According to the 2011 Agriculture Census, the total agriculture holdings area stands at 2,520,000 hectares. This number has decreased by 1,290,000 hectares (ha) over the last decade. On the other hand, the total number of agriculture land holders has increased by 4,670.000 over the same period of time.[320]

The average agricultural land area in the country is 0.7 hectare, comprising an average of 3.2 parcels. The holding size is smaller in urban areas (0.5 hectare) compared to rural areas (0.7 hectare). Agricultural land distribution is uneven; the majority of small farmers operate only 18% of the total agricultural land, with an average holding size of less than 0.5 hectare, which is less than the average national land holding size (0.7 hectares). 22% of the land is operated by "large" farmers, and the remaining 60% of land is owned or operated by "medium" farmers with an average agricultural land parcel between 0.5 and 2 hectares.[321] National statistics of 2014 shows

[319] CBS, 2014c
[320] CBS, 2013
[321] CBS, 2011

that the average size of land owned by women is almost half (0.4 hectare) of that owned by men (0.7 hectare).

Grain production

Rice, maize and cereal are the major cereal crops of Nepal and account for over 96% of all food grain produced in the country (Shrestha et al., 2013). However, the present rates of yield increases are reported to be lower than in previous years. The growing cereal demand in Nepal is fulfilled partially through imports.

In recent years, there has been a gradual shift from subsistence cereal farming to an intensive vegetable-based farming system to meet the increased demand for diverse food.

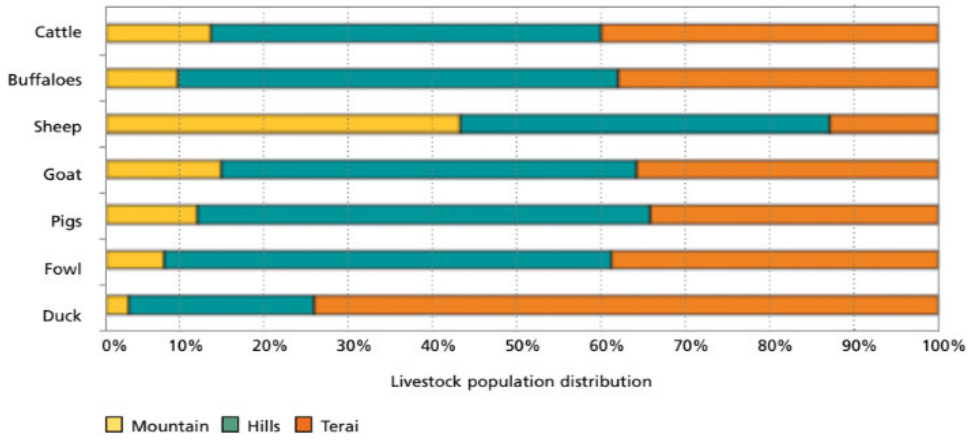
Livestock sector

Livestock is an integral part of the Nepalese farming system. In most cases, livestock is kept as an asset, as well as for manure and draft usage. The livestock sector is the fastest growing subsector of agriculture in Nepal (MoAC, 2010). Livestock production systems in Nepal are characterized broadly by their multi-purpose and multi-species nature, and their close integration with cropping systems. In rural areas, by generating bio-gas from dung, livestock also serves as a source of energy for lighting, as well as cooking. According to the 2014 CBS database, cow and buffalo dung serve as cooking fuel for more than 15% of total rural households.

As per the 2011 Census, the total livestock headcount (small and large) is 22.4 million (not including mules), of which goat accounts for half of the total population. The population of larger livestock, i.e. cattle, buffalo, and *chauris,* has decreased as compared to the last decade, while a significant increase in the number of goat (+59%), pigs (+30%), and sheep (+29%) has also been reported (CBS, 2013). Likewise, the total number of poultry and duck went up by 49% and 9% respectively. Farmers with greater resources typically raise large livestock, whereas smallholders tend to raise small livestock such as goat, pig and poultry.

The figure below, taken from FAO 2014, shows the livestock population distribution in major ecological regions of Nepal, namely the mountains, Churia hills and the Terai region.

Livestock population distribution in major ecological regions of Nepal



Credit and Finance

Meat oriented-livestock credit programmes were established in 2010/11, which may have caused the slight increment in meat production in recent years. The introduction of milk-oriented livestock credit programmes in 2014/15 have also showed an ascending trend in milk and meat production in recent years.

Gender Aspect

Irrespective of province or region, women in general are more involved in crop production and post-harvesting activities than men. However, men generally perform tasks that require heavy physical labour such as ploughing. Women are more commonly involved in activities such as weeding, harvesting, threshing, and milling (FAO, 2005). However, this trend has recently been shifting in rural areas, due to migration of men from agricultural fields. Women have now also taken up responsibilities traditionally performed by men, such as ploughing, and they work significantly more in all major cereal crops and vegetables production, as well as post-harvesting activities in relation to men (Joshi 2000, cited from Baral 2016). The shortage of labour force within agricultural activities has resulted in women focusing on high value but less labour-intensive crops such as vegetable production. Men's roles are mostly focused on land preparation, digging pits for orchard, ploughing, irrigation, application of fertilizers and pesticides/insecticides. They take on a limited role in food preservation and processing activities.

According to NDHS (2011) and MoHP (2012), more than three-quarters of women in Nepal are engaged in agriculture work as unpaid family labour, 10.4% receive only in-kind payment, and 13.2% receive both cash and in-kind payments.

TERAI

The Terai-Madhesh region consists of low-lying plains that are highly suited for agricultural activity.

Agriculture production system

83% of Terai is classified as cultivated land. This region is known as the ´*Rice bowl*´ of Nepal, as farmers in the Terai produce a majority of the country´s grains (rice, wheat, maize, among others), which contributes to 56% of the total national cereal production. A large number of farmers in the region perceive horticulture to be no longer a profitable livelihood activity. Women in the *terai* and mid-hills in particular grow rice, wheat, mustard and vegetables, and raise livestock.

There is potential to expand the rice–wheat cropping system even further (Shrestha et al., 2013). Although the Terai has high potential for winter and spring maize, it occupies only 20% of the production area (FAO, 2001). These cereals are grown under rain-fed conditions, and only 40% of agricultural land in Terai can be irrigated throughout the year (GoN, Office of Investment Board Website, 2018).

Unlike traditional production practices, commercial agricultural practices in the Terai increasingly use mechanization. Traditional production practices also make little use of commercial fertilizers.

In the Dun valley region in particular, 40% of the land is cultivated. It is one of the most fertile and productive lands in the country, with steady ground water supply. Dun Valley is a major producer of staple foods such as paddy, cereals, pulses, and oilseeds in the country.

Livestock

Many households in Terai have small livestock, especially goats, sheep, rams, and pigs. Some households also have buffalos, which are often raised for subsistence purposes using traditional practices, including free-grazing in forested areas. Commercial livestock production, done on a smaller scale, often includes stall feeding, and attention to animal nutrition and feed.

Many households in the Dun Valley area also have small livestock such as goats, sheep, rams, and pigs, which are similarly raised for subsistence using traditional practices. Most households have livestock to enhance their incomes, but livestock rearing is affected by controls on grazing on community lands, especially through community forestry, and the shortage of grazing lands.

BHAVAR

Agriculture production system

Agricultural production in Bhavar is limited due to unsteady water supply, which is further exacerbated by the deposition of sediments on riverbeds. Additionally, this region consists mainly of forest land, and is thought to be relatively unsuitable for agricultural practices.

Livestock

Many households have small livestock, especially goats, sheep, rams and pigs, and some households have buffalos, which are often raised for subsistence using traditional practices such as free grazing in forested areas.

CHURIA HILLS

Agriculture production system

13% of the land in Churia is cultivated land. A majority of the terrain is deemed unsuitable for agriculture. However, many poor households without alternative livelihood options cultivate on the steep slopes of Churia for subsistence purposes. Agricultural production in this region is characterized by rain-fed, primarily low-yield fallow agriculture with different crops including upland rice, maize, vegetables and mustard (MoFSC, 2014).

Erosion is a major challenge for agriculture in this region, which limits crop productivity. This problem is exacerbated by many households not applying suitable practices such as soil or water conservation measures.

Livestock

More than half of the ruminant population of Nepal is concentrated in the hill region. Many households have small-livestock, especially goats, sheep, rams and pigs, and some households have buffalos, which are often raised for subsistence using traditional practices such as free-grazing in forested areas. Such systems are characterized by low productivity.

Appendix B References

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APPENDIX C - ADDITIONAL TABLES AND FIGURES

Table C1. Overview of key policies and regulations related to the project

Relevant policies, strategies, plans & acts	Key features
14th Development Plan of Nepal	▪ Country´s development plan to support sustainable development in Nepal ▪ Promotes gender equality and social inclusion across sectors, promoting inclusive and equitable development ▪ References key challenges in the Churia region including upstream downstream connections, and the risks to downstream communities due to the fragile, unsustainable development of the Churia region, and the need to improve access to benefits from forest, and to control deforestation and forest degradation. Further stresses the need to support climate change mitigation and adaptation to reduce deforestation, enhance livelihoods and support disaster risk reduction. ▪ Promotes the implementation of integrated conservation activities within river systems, with an emphasis on upstream and downstream impacts/ planning
Local Government Operation Act (2017)	▪ Provides detailed information on the roles, responsibilities and coordination mechanisms. Rural municipalities and municipalities shall make rules required under its defined domains or jurisdictions to operate the given responsibilities and regulate procedures, while complying with provincial and national laws. ▪ Local Governments in charge of natural resource management at the local (rural municipality) level (Article 18) ▪ Local government can implement climate change mainstreaming into local plans, including GESI, and building institutional capacities through making operational guidelines, procedures and criteria.
President Chure-Tarai Madhesh Conservation and Management Master Plan (2017)	▪ Provides strategic direction for the conservation of the Churia area ▪ Promotes the integrated management of upstream and downstream land use activities and an integrated landscape approach ▪ Includes measures to strengthen the participation of women, Dalits, indigenous groups and marginalized communities including skill (e.g. skill oriented capacity building, participation in CBOs, etc.) ▪ Supports poverty reduction in pursuit of the national goal of *'Prosperous Nepal'* through conservation and sustainable management of resources and ecosystem services
Nepal's Nationally Determined Contributions (2016)	▪ Describes impacts of climate change across sectors including water resource management (stressing reduced water availability and increased droughts and floods), agriculture, food security and renewable energy ▪ Prioritizes climate-resilient sustainable land and forest management, ecosystem rehabilitation and restoration, strengthening community-based NRM, and improving agricultural techniques ▪ References the legitimate rights of all Nepali people, including disadvantaged social groups over biological resources

Relevant policies, strategies, plans & acts	Key features
Forest Policy 2015, National Forest Strategy (2016)	▪ Focuses on forest productivity and the sustainable provision of forest products and services, while improving biodiversity, watershed and ecosystem services, entrusting forestry sector organizations, ensuring climate resilience, and improving livelihoods ▪ Provides system for equitable distribution of timber and firewood from government and community managed forests, particularly to forest-dependent poor households, socially marginalized groups and families affected by natural disaster ▪ Measures to enhance participation and capacities of women, Dalits, ethnic minorities and indigenous peoples (promoting proportionate representation, improved representation in leadership positions within forest institutions, etc.), ultimately promoting gender equity, inclusive development and socio-economic development, particularly for poor households, women, Dalits, indigenous persons, and other marginalized groups.
Renewable Energy Subsidy Policy (2016)	▪ Aims to reduce the dependence on traditional and imported energy by increasing access to renewable energy to improve the livelihoods of local people and create employment activities ▪ Policy provides an overview of the specific subsidies and conditions provided, depending on technology, region and local context
Constitution of Nepal (2015)	▪ Guarantees people's welfare and all-round-progress through economic, social and cultural transformation, while defending and strengthening political achievements and their development ▪ Maintains the rule of law by protecting and practicing human rights and implements international treaties and agreements ▪ Guarantees good governance by ensuring equal access to services provided by the State and making public administration clean, competent, impartial, transparent, accountable and participatory ▪ Requires maintenance of national forest area goals and incorporation of state policies to control forest encroachment
Revised Land Use Policy (2015)	▪ Re-categorizes the country into various land use zone and devises Federal, Provincial, & Local-level land use plans ▪ Ensures the use of land and land resources follow guidelines set in land use plans to mitigate natural and human created disastrous hazards ▪ Applies minimum property valuation and progressive tax system
Agriculture Development Strategy (2015-2035)	▪ Sets forth priorities to move toward self- reliant, sustainable, competitive, and inclusive agriculture sector that drives economic growth and contributes to improving livelihood, food and nutrition security leading to food sovereignty ▪ Includes strategies for poverty reduction, agricultural trade competitiveness, and establishing higher and more equitable income and rights for farmers ▪ Includes various measures targeted at the most disadvantaged rural population including poor households, women, indigenous peoples, Dalits and other marginalized communities, especially with a focus on improved food security.

Relevant policies, strategies, plans & acts	Key features
Churia declared as Environment Conservation Area (2014)	▪ Based on the stipulation in the Environment Protection Act (1997) 10 (1), declares Churia area as a conservation area due to the area's geological fragility and sensitivity, rich biodiversity, watershed conservation needs and importance to several endangered species
Climate Change Policy (2011)	▪ Promotes clean energy and sustainable natural resource management to improve livelihoods by mitigating climate change impacts, adapting a low-carbon economy development strategy and reducing greenhouse gas emissions ▪ Includes measures aimed to promote gender equality and social inclusion, including ensuring the participation of poor people Dalits, marginalized indigenous communities, women, children and youth in the implementation of climate change-related programs.
President Churia Conservation Program (2011)	▪ Integrates land, water, and forest management to ensure ecological balance ▪ Includes provision of livelihood support for people through appropriate management of resources, promoting social harmonization and the strengthening of local people engagement in resource management and building upstream-downstream linkages
Forest Encroachment Control Strategy (2011)	▪ Prohibits the conversion of forests into other land-use systems, with the exception of forests utilized for nationally prioritized projects ▪ Provides strategies to control forest encroachment
Nepal National Adaptation Programme of Action (2010)	▪ Promotes community-based adaptation through integrated management of agriculture, water, forests and biodiversity; building and enhancing adaptive capacity of vulnerable communities; community-based disaster management for facilitating climate adaptation; and empowering vulnerable communities through sustainable management of water resource and clean energy supply ▪ Specifically sets priority actions for reducing land degradation through sustainable land and forest management, improved agricultural value chains, restoring degraded areas and promoting climate related research, information and awareness
Churia Area Program Strategy (2008)	▪ Establishes local ownership over non-biological natural resources (water, sand, boulders) with negotiated rights & responsibilities to ensure effective resource management ▪ Promotes people-led biodiversity conservation by involving rural households and their CBOs to strengthen the tie between conservation and sustainable livelihood opportunities
Water Resource Strategy (2002)	▪ Recognizes the connection between human activities, natural factors, and risks of severe flooding and environmental deterioration, economic loss, and displacement of people and that this calls for improved holistic watershed management ▪ Provides roadmap to strengthen institutional capacities, implement watershed and aquatic ecosystem programs, and meet long-term requirements for social and ecological sustainability
Land Use Policy (2002)	▪ Establishes zone divisions for agriculture farm, forest, pasture, settlement, urban development, industrial state, wasteland, wetland, herbal production area etc. and provides land use plans based on zonation

Relevant policies, strategies, plans & acts	Key features
Buffer Zone Management Guidelines	▪ Clarifies the the roles, functions, duties and responsibilities of community institutions (user groups, functional groups, user committees, sub-committees and buffer zone development committees) related to community and forest development.
Environment Protection Act (1997), Environment Protection Regulation (1997)	▪ Makes compulsory to produce Environment Impact Assessment (EIA) and Initial Environment Examination (IEE) for any proposed projects/ interventions to ensure no significant adverse impacts and that potential impacts are controlled
Buffer Zone Management Regulation (1996)	▪ Ensures that the rights of local people over their land and resources are respected during the establishment of buffer zone areas. User committees can be formed to manage and use certain forest products in buffer zone areas and Buffer Zone CFUGs and Buffer Zone Religious Forest User Groups (RFUGs) are allowed to manage allocated forest lands based on an approved management plan.
Forest Act (1993), Forest Regulations (1995)	▪ Serves as the core regulations that guide forest tenure and forest management ▪ Designates prohibited activities in all types of forests and gives Community Forest Users groups the authority to control illegal harvest of timber in community forests ▪ Gives the government ability to declare any part of national forest as community forests or protected forest given 'special environmental, scientific &/or cultural importance' ▪ 2016 amendment of Forest Act states that management, utilization and benefit sharing of environmental services (including carbon services) will be prescribed in the 6th amendment of the Forest Regulation
Fourth Amendment of National Parks and Wildlife Conservation Act (1992)	▪ Created the provision of Buffer Zones in order to address local livelihood needs and involve local communities in national park conservation activities.
National Environment Policy & Action Plan (1993)	▪ Stipulates Churia hills as a fragile and sensitive region that should be conserved and designated as a Protection Forest
Wildlife Reserve Rules (1977)	▪ Determines the access and activities allowed within reserves. Without written permission from designated authorities, building any infrastructure, occupying any land, grazing, cutting or obstructing any trees, plants, or bushes, retrieving any meat and mining or disturbing any stones, sand, mineral, river or water body is considered illegal. Other rules related to fines, vehicle use, permits and waste are also laid out.

Table C2: Overview of the selected 26 river systems for the BRCRN project

#	Name of River System (RS)	Risk rating	(Former) Districts Covered by RS	RS Total Area (ha)	RS Area without settlements and water bodies	Population 2011*	Annual Deforestation Rate 2000-2015	Forest Cover 2015	Degraded Area	Area under Slope Instability	Percentage of Settlements located in the Churia Hills	Area prone to flooding	Area in Churia Hills	Population Density Increase 2001-2011
1	Kokaha	High	Sunsari	3312	3309.472707	5,090	3%	44%	9%	66%	82%	3%	77%	5%
2	Gideri Khola	High	Udayapur	11694	11596.27167	13,549	1%	61%	23%	24%	48%	8%	61%	35%
3	Patnali Khola	High	Sunsari	5,185	4,994	8,912	1%	64%	5%	16%	53%	5%	57%	10%
4	Thakur Khola	High	Sindhuli	2423	2422.51262	6,957	2%	71%	7%	41%	91%	2%	83%	38%
5	Sun Koshi	High	Udayapur	4,829	4,818	6,657	3%	72%	3%	66%	71%	0%	72%	32%
6	Chadaha Khola	High	Sindhuli	16,118	16,083	34,833	2%	63%	2%	39%	85%	4%	87%	35%
7	Kamala-North	High	Sindhuli	17,070	16,775	35,478	1%	55%	1%	18%	41%	16%	61%	47%
8	Tawa-North	High	Sindhuli	18,564	18,516	43,667	1%	57%	1%	12%	50%	10%	66%	29%
9	Tawa-South	High	Sindhuli	9,119	8,970	12,282	1%	66%	9%	10%	47%	12%	60%	41%
10	Kankai Nadi	High	Ilam	56,578	55,657	164,140	2%	29%	0%	24%	21%	17%	31%	17%
11	Ratuwa Nadi	High	Ilam	36,689	35,396	174,593	1%	21%	0%	15%	19%	17%	27%	41%
12	Adherei Khola, Baruwa Khola, Duar Khola	High	Udayapur	37,146	36,516	97,233	1%	63%	0%	14%	24%	11%	44%	36%
13	Lakhandehi Khola	High	Sarlahi	47,611	46,006	284,033	1%	24%	0%	5%	25%	13%	24%	20%
14	Kamala-South	High	Sindhuli	14,854	14,673	27,575	1%	62%	3%	53%	2%	13%	52%	60%
15	Biring Khola	Medium	Ilam	26,952	26,485	106,496	2%	27%	1%	19%	11%	21%	18%	14%
16	Balan Khola	Medium	Siraha	52,255	50,921	179,215	0%	40%	2%	5%	33%	16%	51%	29%
17	Charnath	Medium	Dhanusha	8,485	8,351	22,053	1%	51%	0%	21%	4%	13%	61%	38%
18	Bataha Khola	Medium	Udayapur	12,327	11,827	67,387	1%	15%	5%	3%	0%	13%	16%	40%
19	Budhi Khola	Medium	Sunsari	62,057	59,389	456,343	1%	18%	0%	6%	8%	5%	10%	26%
20	Lohandra Nadi	Medium	Morang	36,111	34,773	171,347	1%	22%	2%	4%	5%	7%	10%	10%

#	Name of River System (RS)	Risk rating	(Former) Districts Covered by RS	RS Total Area (ha)	RS Area without settlements and water bodies	Population 2011*	Annual Deforestation Rate 2000-2015	Forest Cover 2015	Degraded Area	Area under Slope Instability	Percentage of Settlements located in the Churia Hills	Area prone to flooding	Area in Churia Hills	Population Density Increase 2001-2011
21	Kamala, Belsot, Jogiya	Medium	Dhanusha	53,042	51,102	242,845	0.40%	30%	1%	14%	2%	25%	31%	30%
22	Ratu Nadi	Medium	Mahottari	58,539	56,841	391,732	1%	18%	0%	11%	0%	16%	15%	13%
23	Mechi Khola	Medium	Ilam	59,326	58,292	310,479	2%	20%	0%	8%	7%	10%	8%	18%
24	Bakraha Khola	Medium	Ilam	38,448	37,534	161,374	1%	22%	1%	9%	8%	15%	11%	6%
25	Bihul Nadi	Medium	Saptari	14,542	14,144	87,611	1%	6%	2%	1%	0%	6%	8%	13%
26	Khado Khola	Medium	Saptari	17,344	16,621	104,367	0.30%	25%	11%	3%	0%	18%	26%	14%

Source: Feasibility study for the BRCRN Project

**Note: Population is determined by the aggregated ward-level population statistics for those wards located within each river system. The most recent ward-level data available is from 2011*

APPENDIX D - ANALYSIS TO IDENTIFY PROJECT INTERVENTION AREAS

336. Based on the assessment of climate change vulnerability described above and availability of existing spatial and statistical datasets, a multi-criteria analysis was performed to define and rank intervention areas within the Churia Landscape. The unit of assessment used is the river system. For the development of the President's Chure-Tarai Madhesh Conservation and Management Master Plan' (hereby referred to as the *´Churia Master Plan´*) the Government of Nepal conducted a consolidated and up-to-date spatial as well as statistical feasibility study on the Churia region. For their assessment, they identified river systems as the main unit of analysis and planning of interventions. Altogether, 164 river systems have been inventoried in such mapped out river systems.

337. This BRCRN feasibility study uses primarily the spatial datasets from the Churia Master Plan´s spatial and statistical feasibility studies, including also other official datasets to perform the river system vulnerability risk ranking.

338. The step-wise procedure of this analysis to derive river systems with high priority for interventions within the BRCRN includes:

339. Compilation of available spatial datasets to perform river system based analysis for the Churia region. The following spatial as well as statistical dataset were used:

340. National land use dataset 2000, 2010 (both from ICIMOD), 2015 (from Churia Masterplan)

341. Spatial layers for area under degradation, area prone for flooding, area susceptible to erosion, elevation, physiographic zones within the Churia (Dun, Hills, Bhavar, Terai), distance to roads, distance to settlements, distance to grids (from Churia Masterplan)

342. River system statistics such as population density/ population increase (extrapolated from ward level statistics); population prone to flooding in 2001 and 2011; total No of Settlements; No Settlements in Churia hills; area under slope instability/ susceptibility categorized as high; medium or low; No of susceptible households with regards to slope instability; No of wetland of ponds (all from Churia Masterplan)

343. Elaboration of a river system database (in Excel) with information on land cover, land cover changes and specific data on all above mentioned variables

344. Filtering the river systems according to the location within the whole Churia range; based on overall vulnerability assessment above as well as consultations during this feasibility study the BRCRN is implemented within river systems located in the central to eastern parts of the Churia. Therefore, all further analysis is limited to only these river systems. The land cover map below shows the overall potential BRCRN intervention area extending from the district of Sarlahi to the East.

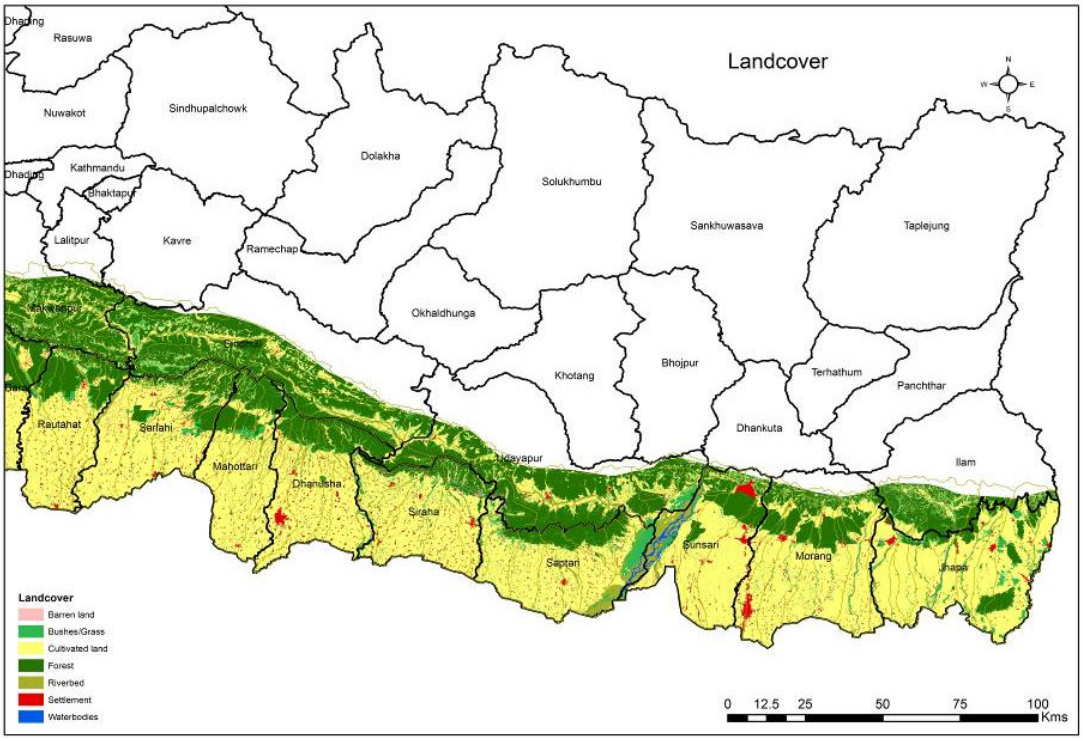

Figure 39: Overall potential BRCRN intervention area in the Churia region

345. Performing a statistical analysis (Pearson correlation) to understand the correlation of the different variables, in particular in view of deforestation (independent variable) in this selected Churia region. Deforestation is perceived by the local stakeholders as the main driver for overall eco-system degradation in the project region. Furthermore, people's perception on reason of climate change in Nepal ranks deforestation by far the highest (59% of all respondents)[322], see also Table 11 above.

346. Source:

Variables	Defor annual % 2000- 2015	Stable forest share %	Degradation %	Area under slope instability suceptability %	No Settlements in Churia Hilles %	Flood population increase 2001 - 2011 %	Area prone to flooding %	Area share upper Tarai %	Area share hills %	agri in 2015 per individual	Pop density increase
Defor annual % 2000- 2015	1	0,348	0,083	0,586	0,544	0,012	-0,064	0,327	0,435	0,101	0,212
Stable forest share %	0,348	1	0,107	0,640	0,721	-0,220	0,111	0,941	0,910	-0,050	0,366
Degradation %	0,083	0,107	1	0,152	0,251	-0,135	-0,265	0,118	0,176	0,068	0,015
Area under slope instability suceptability %	0,586	0,640	0,152	1	0,736	-0,273	-0,137	0,634	0,746	0,145	0,297
No Settlements in Churia Hilles %	0,544	0,721	0,251	0,736	1	-0,319	-0,259	0,691	0,846	0,120	0,202
Flood population increase 2001 - 2011 %	0,012	-0,220	-0,135	-0,273	-0,319	1	0,311	-0,247	-0,218	-0,027	0,257
Area prone to flooding %	-0,064	0,111	-0,265	-0,137	-0,259	0,311	1	0,149	0,031	-0,062	0,088
Area share upper Tarai %	0,327	0,941	0,118	0,634	0,691	-0,247	0,149	1	0,911	-0,003	0,295
Area share hills %	0,435	0,910	0,176	0,746	0,846	-0,218	0,031	0,911	1	0,062	0,378
agri in 2015 per individual	0,101	-0,050	0,068	0,145	0,120	-0,027	-0,062	-0,003	0,062	1	-0,284
Pop density increase	0,212	0,366	0,015	0,297	0,202	0,257	0,088	0,295	0,378	-0,284	1

Figure 40: Correlation matrix (Pearson) for selected variables to assess correlation with regards to deforestation and land degradation. A number close to +- 1 indicates a strong correlation.

[322] National Climate Change Impact Survey 2016; GoN 2017

347. As shown in the correlation matrix, two variables are correlated with deforestation rate (considering correlation of more than 0.5), namely the share of area in a river system which is considered as highly susceptible for erosion and the share of settlements compared to the total No of settlements in a river system located within the hill zones. Interestingly these two variables are also correlated with existing forest area (stable forest share in %) shares in a river system. Basically this means that the higher the share of existing forest areas in a river system is, the higher also the share of settlements in hills and areas susceptible for future degradation. For the BRCRN interventions this means that it is important to also prioritize also on the protection of larger forest areas still existing in order to prevent future degradation.

348. Selection and weighting of criteria which are used to assess the risk of the river systems in terms of future deforestation. Based on the statistical analysis the criteria taken into consideration include:

349. Annual deforestation rate in % 2000- 2015 of each river system

350. Existing forest area share (in % of the total land area of a river system)

351. Area share in % of the total land area of a river system under slope instability/ susceptibility for erosion

352. % of settlements located in the Churia hill zone compared to the total No of settlements in the river system (basically downstream in the Terai plains of the river system)

353. In addition, two more criteria were considered which did not correlate in the statistical analysis, however, which are important for other reasons:

354. Area share in % of the total land area of a river system which is identified as degraded land according to the Churia Masterplan. This criterion is important to identify potential restoration areas (tree restoration plantation, protective plantations, etc.), therefore river systems with proportionally higher shares of degraded land should be prioritized.

355. Origin of rivers: Broadly rivers in Nepal belong to three broad categories based on source and discharge of water. The major perennial rivers, such as the Koshi, Gandaki, Karnali and Mahakali river systems, originate in the Himalayan Mountains and carry snow and ice melt water with significant discharge even in the dry season. Others originate in Mid-hills region that are fed with precipitation and ground and spring related flows. These have large seasonal variation in their discharge. They include the Mechi, Kankai, Kamala, Bagmati, West Rapti and Babai, and Mohana rivers. The third category of river systems, which originate in the Churia region and flow through the Terai, are seasonal, with little or no discharge during dry season, and are characterized by a high rate of sedimentation and river bank scouring and cutting. Based on the consultations during this feasibility study and the review of existing documentation, the BRCRN interventions should prioritize river systems which originate mainly from the Churia region. The main reason for this is that the nature of the BRCRN project is aiming for a holistic river system approach with specific project interventions designed to address degradation and erosion within the source zones of rivers as well as interventions along the rivers in terms of river bank protection, riverbed restoration, etc. For rivers originating well outside of the Churia range (Mid-hills or even high Himalayan range) this approach would not

be possible. Further, there are already other programs designed and planned to address similar issues within the source zones of the two other river origins. Consequently, those river systems originating within the Churia were ranked with higher priority for this risk assessment. It has to be noted that in the final selection of the 26 highest ranking river systems selected for this BRCRN project, many are also originating in other zones simply because the other criteria were ranking very high.

356. In terms of weighting, all criteria selected were weighted with the same weight of 20%, apart from the last two criteria which were ranked both with 10% (The total has to be 100% for this weighting exercise). The following ranking process was conducted:

357. Ranking of river systems for each criterion: By using a percentile method each river system was ranked as ´high´, ´medium´ or ´low´ for each of the criteria. This means that, for instance for the criterion of annual deforestation the different % deforestation rates of the river systems were categorized into three 'bins' representing one 'bin' of high deforestation rate (classified as 'high'), one 'bin' representing the average deforestation rates (classified as medium') and one 'bin' representing low deforestation rates (classified as 'low').

358. Combined ranking of the river system: A combined ranking into ´high´, ´medium´ or ´low´ was assigned to each river system by a simple 'sum-product' calculation in Excel considering the specific ranks and weightings of each of the criteria. This resulted in a list of river systems ranked from high to low and the selection of those river systems prioritized as project areas for the BRCRN project.

359. As already mentioned above, this river system risk assessment was done only for those located in the central to eastern regions of the Churia. However, including all river systems in the whole Churia region, this assessment confirms the pattern that river systems in the Eastern and Central region of the Churia can be regarded as highly vulnerable to climate change which is in line with the vulnerability map above. The Figure below on the left provides an overview of the number of river systems in the entire Churia ranked as high, medium or low risk within the five development regions. In comparison, the Figure on the right presents the results from the same analysis that was done on a district level.

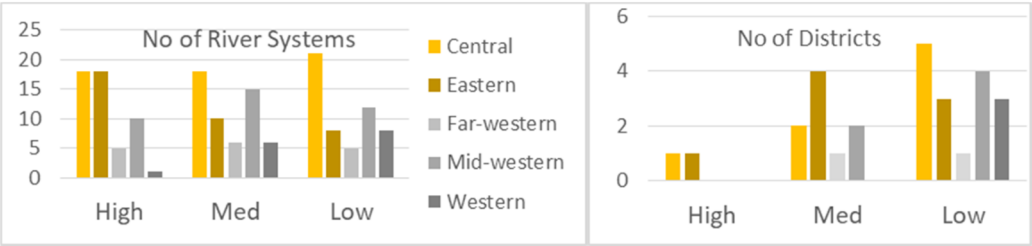

Figure 41: Number of river systems (L) and districts (R) ranked as high, medium and low risk

BRCRN intervention zones and project boundary

360. As already outlined above the main landscape unit for planning and implementation of BRCRN activities is the river system following the classification of the Churia Masterplan. This is crucial to acknowledge the strong interlinkages between up-stream and down-stream land use activities and the impacts such activities have within a particular river system. Most of

the assessed literature follows this logic, and institutional planning and the implementation of government and other donor initiatives and programs is also conducted in view of this river system stratification. The Churia Master Plan presents the integrated conservation plan based on these river systems, in particular acknowledging that:

> "…the conservation of the Churia region is only possible through a multi-stakeholder, multi-disciplinary, interdisciplinary as well as multidimensional effort. The solution of the problems here is not possible through the conservation of the forest resources of the Churia region alone. Hence, conservation, improvement in agriculture system, management of animal husbandry, river control, wetland management, water conservation and so on along with forest management are found to be necessary for the purpose. Among these, coordination and team-work of the upstream and downstream communities are indispensable".

361. Based on the river system risk assessment, a prioritized list of river systems has been identified with regards to project design and implementation serving as the project boundary (see next section). The available GIS information allows directly identifying priority areas within river systems which need to be addressed with specifically tailored interventions in the project. For instance, the two maps below show the locations of flood prone areas as well as the locations of susceptible households to erosion and slope instability. During the early phase of the project these areas will be assessed leading to specifically designed interventions to mitigate and address such risks.

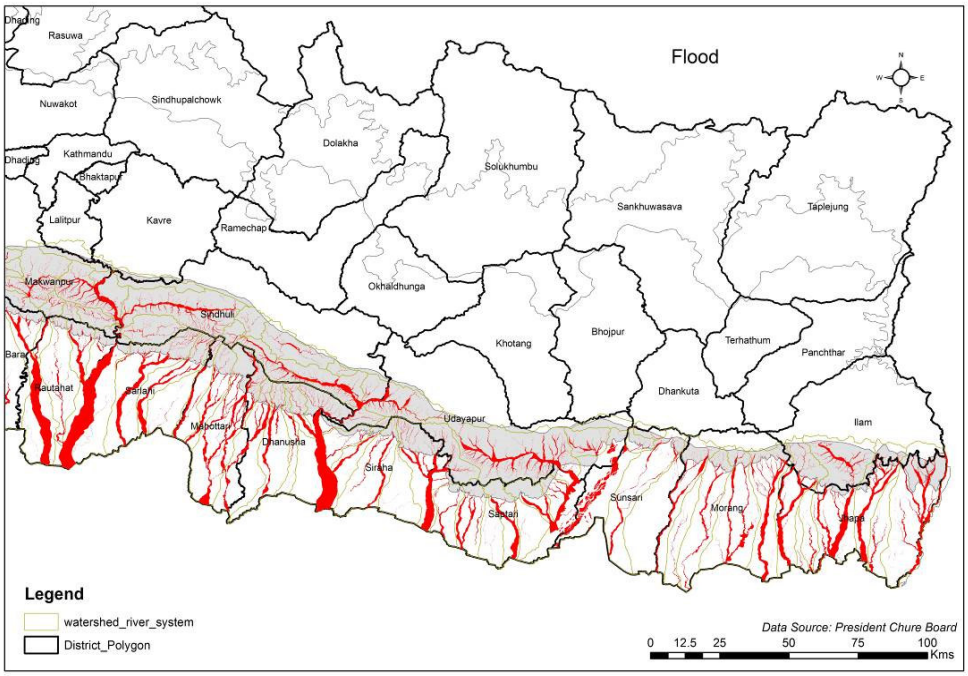

Figure 42: Flood prone areas (in red). The grey area shows the Churia region excluding the downstream Terai areas

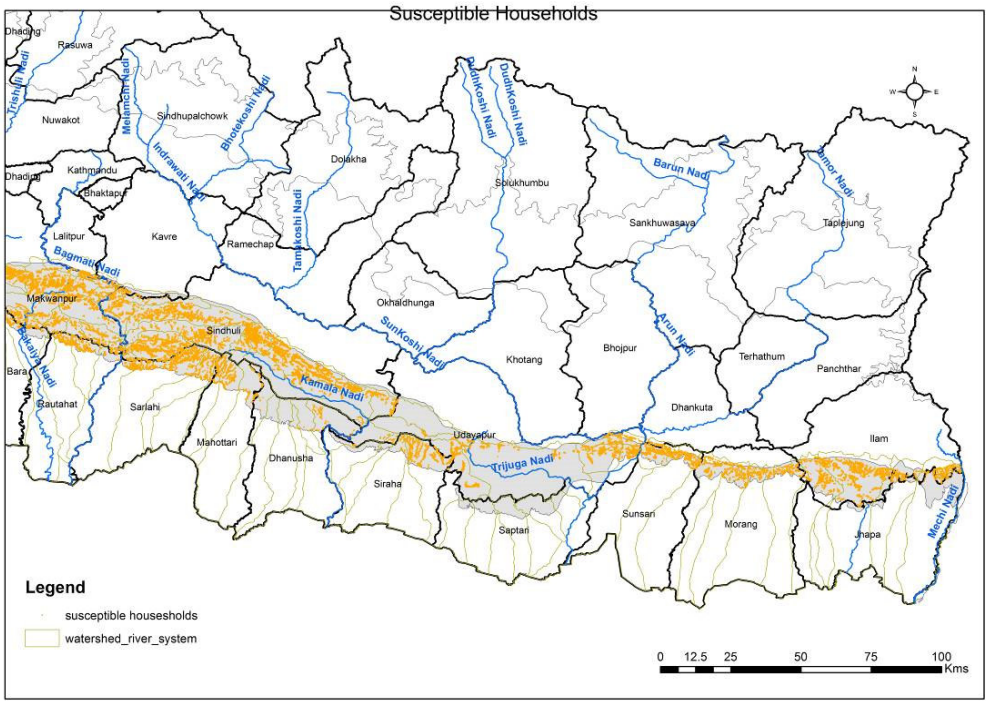

Figure 43: Households susceptible to erosion due to slope instability. The grey area shows the Churia region excluding the downstream Terai areas

362. Within a particular river system, a second layer of zonation is required with regards to a systemic planning and implementation of the BRCRN. This is referred to as physiographic zonation. The Churia has distinct zones with specific land use characteristics, land use changes as well as socio-economic conditions. Along the altitudinal gradient the Churia region should be subdivided into the Churia hills, the Bhavar region and the Terai (Madhesh) (Section 2.1.3 provides a more detailed description of the different biophysical zones).

363. In addition, the narrow gorges created by the rivers and the Dun valleys within this landscape are also an integral part of the Churia region. The Bhavar is part of the Terai, however, there is a clear difference in its geomorphology. This zone is created due to the deposition of rough sediments whereas the Terai was created due to the deposition of fine sediments. Similarly, the Churia hills are also different in terms of their geomorphology and represent mainly hilly terrain with steep slopes and typically located at higher altitudes. The schematic outline shows the location of the East-West highway which divides the Terai into upstream and downstream Terai. While this is not in line with the official terminology and names of the landscape, this distinction is made here to differentiate between the intervention area of the BRCRN and the wider impact area of project activities. The downstream Terai represents the area where in particular those impacts appear as direct consequences of the land use and changes implemented upstream up to the hill zone of the Churia.

364. In summary, the whole assessment and process all the way from the vulnerability assessment, the specific river system based risk assessment and the physiographic zonation conducted to finally identify the specific project intervention areas is presented in the Figure below.

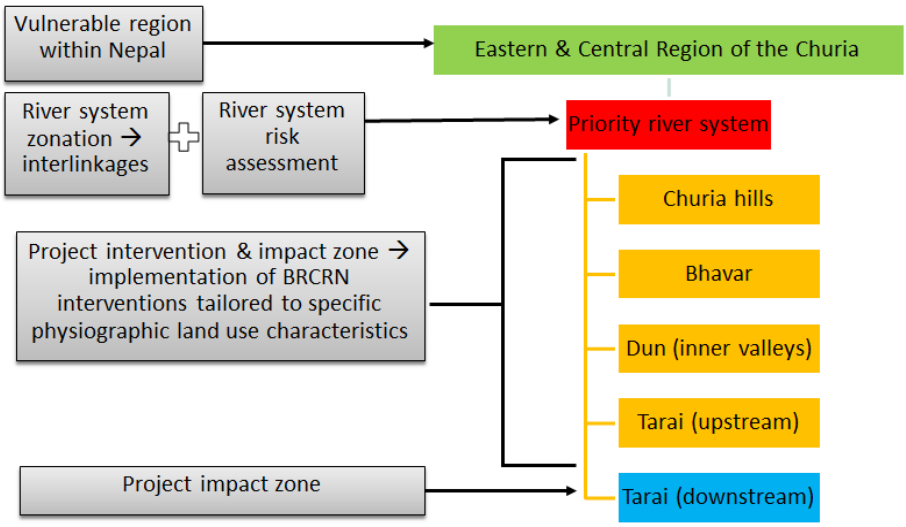

Figure 44: Schematic outline of the vulnerability assessment, river system prioritization and identification of BRCRN intervention zonation and project areas

APPENDIX E – DEFORESTATION IN THE PROEJCT AREA

365. According to the datasets, deforestation in the project area has dramatically increased in the recent years; from 2000-2010 annually by 0.2% and from 2010-2015, annually by 1.9%. The direct drivers of land use change in Churia can be split into four categories:

366. **Unsustainable extraction of forest products:** This can include illegal logging (for timber or coal), destructive NTFP harvesting methods or over-harvesting, fuelwood collection and uncontrolled grazing.[323] Cattle and goat grazing is common in the Churia hills, and uncontrolled grazing is problematic as it leads to the loss of shrubs and felling of small to medium sized trees for fodder, leading to increased soil erosion and reduced water filtration. In many forests that have been handed over to community forest user groups (CFUGs), grazing controls by the community have improved forest resources due to improved management and awareness raising. Nonetheless, communities have reported challenges with the encroachment of distant communities, including settlers from the Terai, who are dependent on forest resources in the Churia hills and Bhavar regions.

367. **Agricultural expansion and degradation:** Agricultural land has remained relatively stable over a 15-year period, with a total decline of 2.1% within the project area. While agricultural land has remained relatively stable in terms of overall area, it is still considered a driver of deforestation and forest degradation.

    There is a gradual encroachment of existing and new cultivators into forestland, which is being converted into farmland.[324] Shifting cultivation and growth of *sukumbasi* (squatters) settlements also contributes to this issue in many parts of Nepal. The use of inappropriate agricultural practices further contributes to land degradation. For instance, in the Churia hills agricultural practices on sloped land without the use of soil or water conservation practices can lead to accelerated erosion, reducing soil fertility and reducing the productivity of land, causing more frequent clearing of land. Livestock are a major driver of forest degradation, given the impact of uncontrolled grazing and unsustainable fodder harvesting (described in more detail within the following section on drivers)

368. **Development or expansion of infrastructure and need for building materials**: Road networks decrease the distance between forest and human settlements. As a result of resistance from private land owners, roads can be built through forest areas. Several national roads and transmission line corridors are in various stages of development in the Churia region, sometimes without adequate planning.[325] Pressures from urbanization also contribute to the clearance and modification of natural habitats in this area.

369. **Natural land use change and bio-physical conditions:** The fourth identified direct driver of land use change is not anthropogenic but natural. However, it should be noted that unsustainable human activity can further exacerbate natural causes of forest degradation. Forest

[323] MoFSC 2014; UN-REDD 2014
[324] UN-REDD 2014
[325] Bhattarai et al. 2009; FCPF 2017

fires are a common occurrence in Churia due to dry weather and friction, however, human activity or carelessness can increase the likelihood of these events. Secondly, Churia experiences events of extreme accumulated rainfall over 24 hours,[326] which causes soil erosion in a region that is already unstable on account of being the geographically newest mountain range in the Himalayas. Critical deforested river systems and reduced vegetation caused by humans further aggravates the situation by causing landslides, flash-floods and sediment flow increase downstream. Natural meandering and eroding of rivers due to high flow velocity, and invasive species are additional natural causes for land use change. Of particular relevance in the BRCRN area is *Mikeniamicrantha*, a vine which has invaded forested areas in the region.

The following Figure is a summary of the proximate and underlying causes of deforestation and degradation related land use change in the Churia region:

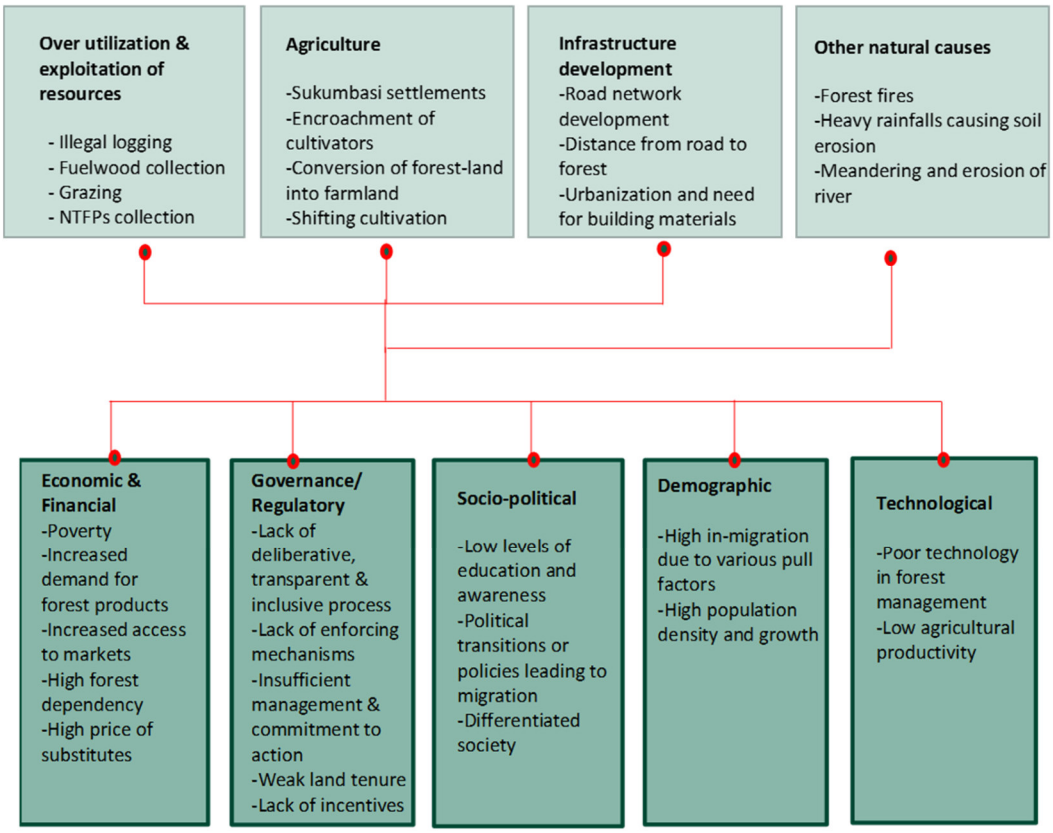

Figure 45: Proximate and underlying drivers of land use change in the Churia region

Source: Adapted from UN-REDD 2014

[326]MoSTE 2015a

Underlying causes of deforestation & forest degradation

370. The underlying causes of deforestation and forest degradation can be separated into the following interlinked categories:

- **Economic/ Financial Factors:** Poverty in the Churia hills impacts land use due to a lack of adequate income opportunities outside of farming and harvesting of primary resources.[327] This has several repercussions in the Churia region where many people are directly dependent on forests and other natural resources to maintain their livelihoods. Forests act as a safety net for many households living in the project area, providing timber, fodder, fuelwood, forage and NTFPs. Dependency on forestland remains high, as value addition on alternative climate-resilient commodities remains low. Distant forest users in the Terai region of Nepal still depend on forests for their livelihoods, however deforestation and degradation of forests in the Terai region have made such households highly dependent on forests in the Churia and Bhavar areas, contributing to accelerating deforestation upstream.[328]

  Improved market access due to better roads and a supportive liberalized economy further fueling the demand for forest products. Unsustainable exploitation and illegal timber markets have emerged as a side-effect.

- **Policy, Institutional and Governance-related Factors:** Contested policies at national and local levels have resulted in varying perspectives of ownership among stakeholders, and has created land use conflicts between authorities and some communities in the Churia region. These problems are compounded by weak land tenure and uneven land distribution, which enables encroachment by landless people, creating forest fragmentation.[329]Finally, a low level of appreciation and understanding of the economic value of ecosystem goods and services among decision-makers translates to a lack of incentives and rewards for proper management by communities living upstream.[330]

- **Socio-political Factors:** Low levels of education and awareness among the population regarding the ecological impacts of inappropriate land use contributes to deforestation.[331] Many communities apply traditional low-productivity practices which limit livelihoods, but also have a growing impact on the land given climate change, as well as population and land use trends. While compounded by poverty, many communities are not aware of alternative practices. Many groups in Nepal have been exposed to inter-generational exclusion[332] which has limited their access to resources and engagement in decision making processes. While efforts to promote social inclusion have been strengthened in recent years, the engagement of women, indigenous peoples and ethnic minorities in decision making processes and accessing resources and opportunities varies among user groups and communities. Marginalized groups are highly dependent on natural resources to maintain their subsistence.

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[327]GTZ 2004
[328] Satyal Pravat and Humphreys 2013
[329]UN-REDD 2014
[330]Karn 2007
[331]Adhikary 2017
[332] Refer to section 2.5 for a more detailed discussion on vulnerable and excluded groups.

- **Demographic Factors:** Churia is also experiencing high population growth and has a population density of 191.56 persons/km^2.[333] There is a high degree of in-migration to the Terai area due to various pull factors such as soil fertility, better market access, and better public services in comparison to other parts of the country.[334]Increasing population increases the demand for forest resources in the region, and in the Terai many households are dependent on forests in the upstream Bhavar and Churia Hills.

  On the other hand, the out-migration of men and youth represents a challenge as many people are migrating to urban areas or neighboring countries for economic reasons, leading to increasing labor shortages and increased time poverty of local people (especially women). Many family members send home remittances, where investments are made on household farms in agriculture, livestock, among other areas, which in turn contribute to deforestation and forest degradation.
- **Technological Factors:** The use of traditional low-yield agricultural practices are predominant within the project area, especially in the Churia hills and Bhavar region. In the Terai region there is increased use of irrigated agriculture and mechanization in some regions, however predominant systems are oriented towards low-yield systems. Many practices are unsuitable given increased human pressure on the environment resulting in accelerated land degradation, as well as climate change impacts. Few households apply soil and water conservation practices that have substantial potential to improve their resilience to extreme climate events such as extreme heat, seasonal water scarcity, or flooding. Other practices for forests and agriculture support improved production systems that are able to produce more using less land and appropriate practices and technologies.[335]Many practices are known to be effective[336] but have yet to be scaled up at scale (barriers limiting the uptake of such practices are described in Section 1.6).

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[333]DFRS/FRA 2015

[334]GTZ 2004

[335]Forests can be sustainably managed to further enhance both incomes and productive functions. Agro-technology can be further used to manage cultivation on river bank during dry seasons, create green belts along rivers, improve terrace stability, introduce SNRM practices, to mitigate land degradation.[335]

[336] For instance, examples of good practices for soil and water conservation can be found in the Soil Conservation and Watershed Management Working Strategy from MoFSC (2015): http://www.dscwm.gov.np/images/pdf/green-book_whitebook_version3.pdf