Integrating **Climate Change Adaptation** into **Agriculture Sector Planning** of Nepal

A Handbook

Government of Nepal
Ministry of Agriculture and Livestock Development
Food Security and Food Technology Division
Singhadurbar

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Foreword

Although Nepal's contribution to global greenhouse gas emissions is only 0.027%; Nepal has already observed increasing incidence of climate change related natural disaster over the years which has impacted the overall growth of the economy. Nepal ranks fourth on the Global Climate Risk Index for 2017 with a significant impact on agriculture and consequently on the livelihoods of farmers. The latest climate science has confirmed serious threats are likely in the days to come. Urgent action is needed to address those impacts through development planning and strategic programming for adaptation and mitigation.

The Government of Nepal has formulated and endorsed several climate change policies, plans and strategies, but their implementation has not progressed as anticipated because of poor integration into development plans, programmes and policies. Translating policy instruments into action requires enhancing government officials' knowledge, understanding and capacity to address issues of climate change through regular development programmes.

This handbook is timely. It is designed to support agriculture sector planners, policy makers, extension workers and other concerned people on steps to integrate adaptation concerns through regular agriculture sector plans and budgets. I believe this handbook will provide much needed guidance and advice for government officials to take appropriate action from understanding the agriculture sector climate vulnerability to identify, prioritize and implement climate change adaptation action on the ground. The methods and tools included in this handbook provide strategic guidance to improve planning, budgeting, implementation, monitoring and reporting from a climate change point of view for different tiers of government. I am confident that farmers will be better served by the government as a result of staff applying what they learn in this handbook and will support improvements to agriculture-dependent livelihoods.

This handbook is the outcome of a Ministry of Agriculture and Livestock Development (MoALD) led initiative and assisted by the UNDP and FAO. I am grateful to the project team and partner organizations for their hard work in the timely completion of project activities and production of this valuable handbook. I appreciate the German Government financial support for this initiative. I would like to thank all the professionals involved for their meticulous work in writing this handbook and bringing it into the current shape.

I encourage government staff, particularly those working under the MoALD, to read this handbook carefully along with the separate training manual to improve their knowledge and capacity to ensure learning is reflected in the regular work they do for the many thousands of farmers who keep us alive by producing the food we eat.

Yubak Dhoj GC, PhD
Secretary, MoALD
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Acronyms

ACT	Action on Climate Today
AEZ	Agro-ecological zones
CCAFS	Climate Change, Agriculture and Food Security
CCVRA	Climate change Vulnerablity and Risk Assessment
EDR	Eastern Development Region
FCGO	Financial Controller General's Office
FWDR	Far Western Development Region
GCF	Green Climate Fund
GCM	General Circulation Models
GESI	Gender and Social Inclusion
IPCC	Inter-govermental Pannel on climate change
LAPA	Local Adaptation Plans for Action
LUCF	Land Use Change and Forestry
LMBIS	Line Ministry Budget Information System
MoF	Ministry of Finance
MoFE	Ministry of Forests and Environment
NAPA	National Adaptation Programme of Action
NCVST	Nepal Climate Vulnerablity Study Team
NPC	National Planning Commission
PSC	Project Steering Committee
PTT	Project Technical Taskforce
PWC	Price Water Commission
RCP	Regional Climate Projection
ToT	Training of Trainers
UNDP	United Nations Development Programme
VRA	Vulnerability and Risk Assessment

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Overview

The integration of climate change adaptation actions into government's regular plans, policies and practices could be improved. One underlying reason is the need to update knowledge of extension workers and planners on climate change, vulnerability assessment, selection of adaptation options, integration of climate action into local development plans, and monitoring and evaluation of adaptation actions. Improving capacity is thus imperative to appropriately include climate actions in plans, programmes and practices and creating impact at scale.

This handbook has been prepared to support government staff responsible for managing the process of integrating agriculture into the National Adaptation Plan and managing national sectoral adaptation planning and processes. It provides the background information necessary for policy makers to understand and drive integration and sector planning.

UNDP and FAO have produced a Training of Trainers (ToT) manual on climate change integration into agriculture to support capacity building of government planners and extension workers at different levels of government. The work is a joint project titled Integrating Agriculture into National Adaptation Planning (NAP-Ag) and is implemented with support from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) of the Federal Republic of Germany via the International Climate Initiative (IKI). The ToT manual and handbook were designed to complement each other.

Chapter 1
Overview of National Adaptation Plan

NAP and NAP-Agriculture

The National Adaptation Plan (NAP) process was established in 2010 under the Cancun Adaptation Framework (CAF). It enables Parties to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process which follows a country-driven, gender-sensitive, participatory and fully transparent approach.[1] NAP has two main objectives:

i) reducing vulnerability to the impacts of climate change by building adaptive capacity and resilience, and

ii) facilitating the integration of climate change adaptation in a coherent manner into new and existing policies, programmes and activities, in particular development planning processes and strategies, within all sectors and at different levels, as appropriate (UNFCCC 2012; MoPE 2017). Several envisioned NAP initiatives clearly align with Sustainable Development Goals (SDGs) as shown in Table 1.

Several developing countries have included adaptation components in their Initial Nationally Determined Contributions (INDCs), which became full NDCs after getting ratified by UNFCCC. By July 2016, 190 Parties had submitted 161 INDCs of which 134 included adaptation actions. Moreover, 97 per cent stressed the need for adaptation, 97 per cent referred to crops and livestock, 89 per cent to forests, and 64 percent to fisheries and aquaculture (FAO 2016; Karttunen et al. 2017).

The Integrating Agriculture in NAP programme is a multiyear initiative funded by Germany's Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) through its International Climate Initiative (IKI). It supports partners under a country-driven process to identify and integrate climate adaptation measures for agricultural sectors into national planning and budgeting processes. The programme initially targets eight countries: Kenya, Nepal, Philippines, Thailand, Uganda, Uruguay, Vietnam and Zambia and plans to expand to other countries in the Pacific, Asia, Africa as well as Latin America and the Caribbean.

What is Adaptation?

The IPCC defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate, harm or exploit beneficial opportunities." (IPCC TAR, 2001). Adaptation also includes:

- Practical steps to protect countries and communities from the likely disruption and damage that will result from the effects of climate change. For example**,** flood walls should be built and in numerous cases it would be advisable to move human settlements out of flood plains and other low-lying areas." (Website of the UNFCCC Secretariat).
- A process by which strategies to moderate, cope with, and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005).
- The process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change (UKCIP, 2003).

The concept of adaptation has evolved over time (Figure 1). The first milestone was an agreement to develop a National Adaptation Programme of Action (NAPA) in 2001. The National Adaptation Plan (NAP) was first discussed at the Cancun meeting in 2010 and culminated in a global goal in 2015. Societies have a long record of adapting to the impacts of weather and climate through a range of practices that include crop diversification, irrigation, water management and insurance. But climate change is posing novel risks often outside the range of

1 https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans

peoples' experience. Since new threats are inevitable, adaptation will require adequate information on risks and vulnerabilities to identify needs and appropriate adaptation options to reduce risks. Integration of adaptation options into government plans is vital for sustainable funding and action. Different types of adaptation are summarised below.

Community-based adaptation: Community-based adaptation to climate change is a community-led process, based on community priorities, needs, knowledge, and capacities, which should empower people to plan for and cope with the impacts of climate change. Planned and proactive community-based adaptation is gaining acceptance and support as an approach to enabling communities to build resilience to the impacts of climate change.

Ecosystem-based adaptation: This includes a range of local and landscape scale strategies for managing ecosystems to increase resilience, maintain essential ecosystem services and reduce the vulnerability of people, their livelihoods and nature in the face of climate change. It also identifies and implements a range of strategies for the management, conservation and restoration of ecosystems to ensure they continue to provide the services that enable people to adapt to the impacts of climate change. It involves collective action among governments, communities, conservation and development organizations and other stakeholders to plan and empower local action that increase environmental and community resilience to a changing climate. Ecosystem- based adaptation and community-based adaptations are therefore mutually supportive.

Autonomous and planned adaptation: Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. This is also referred to as spontaneous adaptation. Planned adaptation is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Anticipatory and reactive adaptation: Adaptations that take place before impacts of climate change are observed. This is also referred to as proactive adaptation. Reactive adaptation takes place after impacts of climate change have been observed.

Private and public adaptation: Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's self-interest. Public adaptation is initiated and implemented by government . Public adaptation is usually directed at collective needs.

Maladaptation: Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.

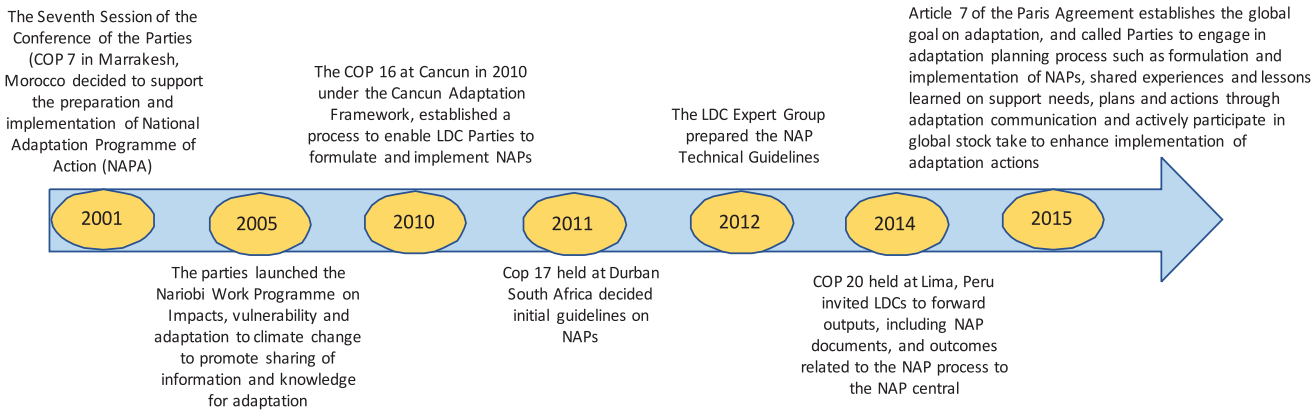


Figure 1. The concept of adaptation evolved over time.

Table 1. Common features of SDGs and NAP goals.

SDG	SDG Indicator	NAP Goal
1	**1b.** Create sound policy frameworks to support accelerated investment in poverty eradication actions.	Creating policy to support investment frameworks for CCA and resilience.
2	**2.4** By 2030, ensure sustainable food production systems and implement resilient agriculture practices.	Mainstreaming CCA in agriculture and prioritizing agriculture adaptation options to increase food security.
3	**3.d** Strengthen the capacity of all countries for early warning, risk reduction and management of national and global health risks.	Gaining a better understanding of health impacts of CCA and building capacities to address these risks through NAP.
4	**4.7** By 2030, ensure all learners acquire the knowledge and skills needed to promote sustainable development.	Engaging primary, secondary and higher education institutions to build capacities for CCA.
5	**5.c** Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels.	Promoting gender-responsive and gender-transformative policies with regards to CCA.
8	**8.3** Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation.	Promoting innovation and engagement of the private sector in CCA planning.
16	**16.6** Develop effective, accountable and transparent institutions at all levels.	Strengthening institutional capacity for CCA coordination including M&E and stakeholder inclusion.

NAP Formulation Process in Nepal

As a party to the UNFCCC, the Nepal government initiated the NAP formulation process 18 September 2015 to advance the National Adaptation Program of Action (NAPA). Overall NAP work was led by the then Ministry of Population and Environment. Prior to NAP, Nepal had prepared a number of policy documents:

- NAPA, 2010
- Climate Change Policy, 2011
- National Framework for Local Adaptation Plans for Action (LAPA), 2011
- Climate Resilient Planning Tool, 2011
- Nepal Development Vision 2030 (concept paper), 2011
- Climate Change Health Adaptation Strategies and Action Plans for Nepal (2016-2020)
- Environment-friendly Local Governance Framework, 2013
- Low Carbon Economic Development Strategy, 2015

The NAP built on learning from the work done in preparing those documents. The NAP process was participatory, integrated, inclusive and informed. Nepal also submitted its Initial Nationally Determined Contribution in which strong commitment to climate change adaptation has been clearly articulated. The NAP goals and strategies in Nepal also align with the Sustainable Development Goals (SDGs). Accordingly, efforts are being made to converge actions for quick and significant impacts and a transformative change. Main milestones in the NAP process are presented in Figure 2.

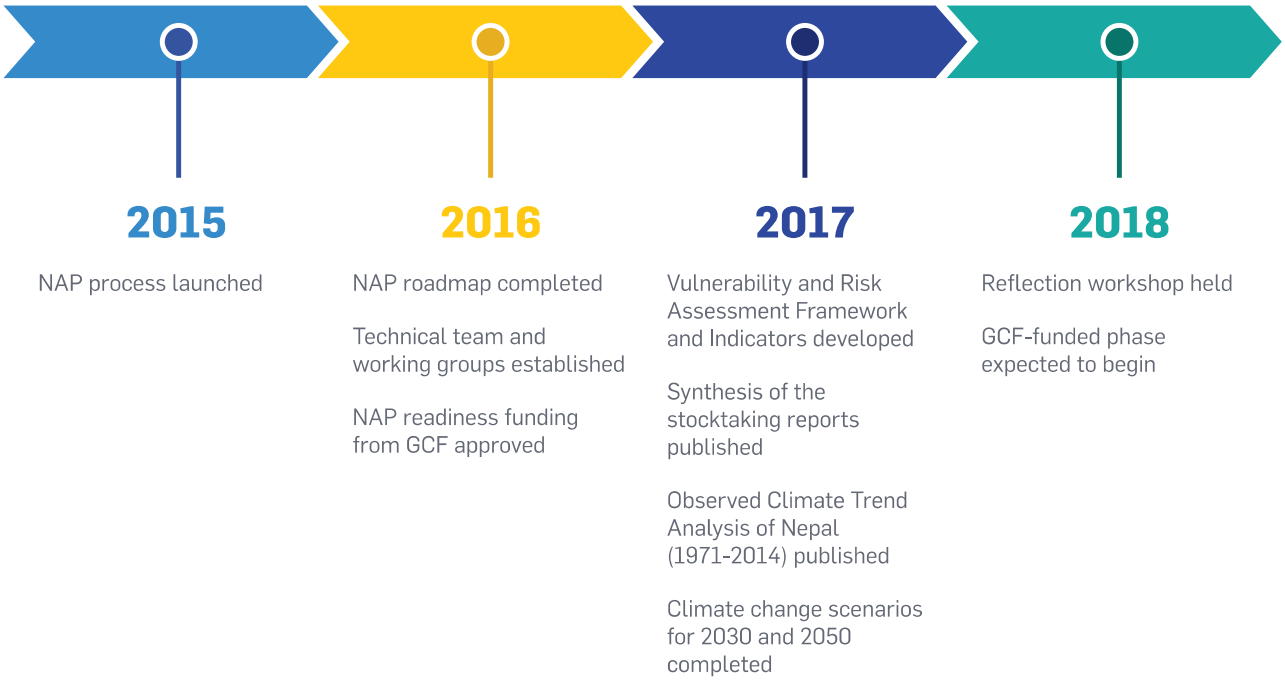


Figure 2. Nepal's NAP formulation. Source: MoFE, 2018.

Formation of Working Groups

NAP formed seven Thematic Working Groups and two Cross-cutting Theme Working Groups. Nine line ministries took the lead in Working Groups as shown in Table 2. The Working Groups identified a number of experts from the themes to produce the deliverables listed in the NAP.

Table 2. Working groups and coordinating ministries providing inputs to NAP. Source: MoFE, 2018.

Working Group	Coordinating Ministry
Thematic Working Group	
1. Agriculture and food security (nutrition)	Agriculture and Livestock Development
2. Climate induced disasters	Home Affairs
3. Forests and biodiversity	Forest and Soil Conservation
4. Public Health (WASH)	Health
5. Tourism, nature and cultural heritage	Culture, Tourism and Civil Aviation
6. Urban settlements and infrastructure	Urban Development
7. Livelihood and governance	Federal Affairs and Local Development
Cross-cutting Working Groups	
8. Gender and Marginalized Groups (social inclusion)	Women, Children and Social Welfare
9. Water resources and energy	Federal Affairs and Local Development

Implementation of NAP-Ag

Nepal chose agriculture and food security (nutrition) as one its themes and formed a Working Group accordingly. The main goal of integrating agriculture in a NAP is to integrate climate change risks and opportunities related to agriculture-based livelihood options into existing national planning and budgeting processes. The reasons are three-fold as highlighted by Karttunen et al. (2017): i) agriculture is among the most sensitive and exposed sectors in the country; ii) crops, livestock, fisheries and forest are among the most important sources of food and nutrition, household and national economy and livelihoods for the most vulnerable populations; and iii) since agricultural production involves the management of natural resources it has a pivotal role to play in the adaptation of ecosystems to climate change.

UNDP and FAO managed the agriculture and food security (nutrition) thematic working group through a joint project titled Integrating Agriculture into National Adaptation Planning (NAP-Ag) supported by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) of the Federal Republic of Germany via the International Climate Initiative (IKI). The NAP-Ag project also secured funding from the NAP readiness funding window of the Green Climate Fund (GCF). Adhering to the NAP roadmap, the NAP-Ag project formulated a Project Steering Committee (PSC) and a Project Technical Taskforce (PTT) to pursue the work (Table 3 and 4). In 2017, the NAP-Ag project developed a Vulnerability and Risk Assessment Framework and indicators for assessment and adaptation planning, did a stocktaking of observed climate trends and developed a climate change scenario for 2030 and 2050. An excerpt from the report is presented in the following section. In 2018, a reflection workshop was held to share progress and receive feedback from stakeholders to improve the report and discuss a way forward.

Formation of Project Steering Committee (PSC): The PSC was formed to review and approve annual project plans, budgets and progress reports; provide policy advice and strategic guidance for implementation; review project targets, set criteria and arrangements to ensure outcomes; ensure inter-agency coordination and policy support; provide guidance on ensuring inclusiveness of the stakeholders in project activities, and supervise overall performance and results delivered. The PSC met bi-annually with its decisions recorded in minutes.

Formation of Project Technical Taskforce (PTT): The PTT was formed for technical oversight and to support project implementation as guided by the PSC. The PTT comprised technical and expert representatives from main stakeholder groups. It had a mandate to meet four times a year with additional meetings if needed. The PTT provided technical oversight and guidance; ensured national ownership; aligned project deliveries with country development priorities; ensured sector priorities were integrated into the NAP process (including crops, livestock, fisheries, forestry and aquaculture); reviewed the project outputs, progress and annual reports; monitored project performance towards achievement of targets; identified synergies and collaborative and strategic partnerships to improve project outreach, scale and impact; and acted as a conduit and multiplier for capacity building of national stakeholders.

Table 3. NAP-Ag Project Steering Committee.

1.	Secretary, Ministry of Agricultural Development*	Chairperson
2.	Joint Secretary, National Planning Commission	Member
3.	Joint Secretary, Ministry of Finance	Member
4.	Joint Secretary, Ministry of Home Affairs	Member

5.	Joint Secretary, Ministry of Federal Affairs and Local Development**	Member
6.	Joint Secretary, Ministry of Population and Environment***	Member
7.	Joint Secretary, Ministry of Forest and Soil Conservation#	Member
8.	Joint Secretary, Ministry of Livestock Development#	Member
9.	Joint Secretary, Ministry of Irrigation	Member
10.	Joint Secretary, Policy and International cooperation and Support Division of MoAD	Member
11.	Joint Secretary, M&E and Statistics Division of MoAD	Member
12.	Joint Secretary, Planning Division of MoAD	Member
13.	Joint Secretary, Administrative Division of MoAD	Member
14.	Representative, Embassy of Germany	Member
15.	Executive Director, Nepal Agriculture Research Council	Member
16.	Director General, DoA	Member
17.	Director General, DoLS	Member
18.	Representatives (3), National Peasant Coalition	Members
19.	Representative, UNDP	Member
20.	Representative, FAO	Member
21.	Joint Secretary, Food Security, Agribusiness and Environment Division of MoAD&	Member Secretary

Current names

*Ministry of Agriculture and Livestock Development

**Ministry of Federal Affairs and General Administration

***Ministry of Forest and Environment

#These ministries doesn't exist now

& Food Security and Food Technology Division

Table 4. NAP-Ag Project Technical Taskforce.

1.	Joint Secretary, Food Security, Agribusiness and Environment Division, MoAD	Chairperson
2.	Under Secretary Level, Ministry of Livestock Development	Member
3.	Under Secretary Level, Ministry of Population and Environment	Member
4.	Under Secretary Level (NAP Focal Person), Policy and International Cooperation and Support Division of MoAD	Member
5.	Under Secretary Level, Gender and Social Inclusion Section, MoAD	Member
6.	Under Secretary Level, Department of Hydrology and Meteorology	Member
7.	Under Secretary Level, Department of Agriculture	Member
8.	Under Secretary Level, Department of Irrigation	Member
9.	Senior Scientist, NARC	Member
10.	Representative, GEF (IECCD, MoF)	Member
11.	Representative, Agriculture and Forestry University, Kathmandu	Member
12.	Representative, Local Initiatives for Biodiversity, Research and Development	Member
13.	Representative, Centre for Environment and Agriculture Policy Research, Extension and Development	Member
14.	Representative, UNDP	Member
15.	Representative, FAO	Member
16.	Under Secretary Level, Environment and Climate Change Section of Food Security, Agribusiness and Environment Division in MoAD	Member Secretary

*The current names is as shown for Table 3.

International Negotiations, Treaties and National Policies

Nepal has been proactive in taking part in negotiations, ratifying treaties and adopting international decisions and has developed several policies and strategies adhering to international agendas, decisions and agreements. A list of national and international initiatives taken by the government is presented in Table 5.

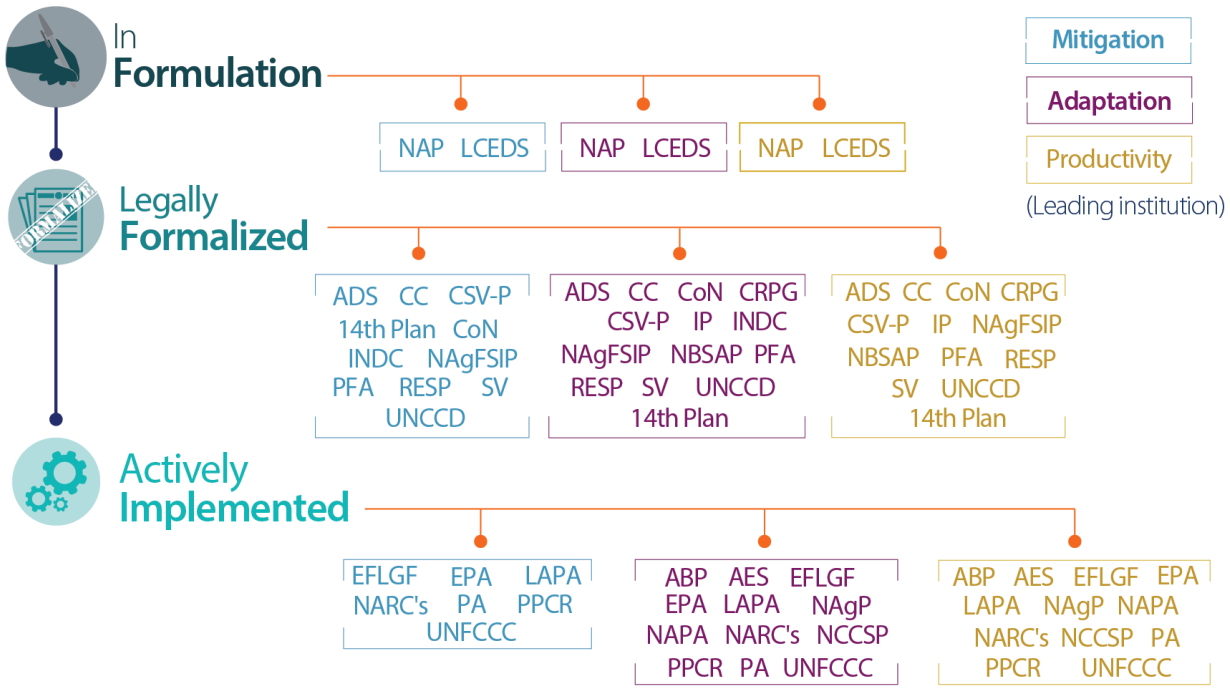
Table 5. National initiatives for change adaptation and mitigation.

Timeline	Initiatives
International negotiations, treaties and decisions	
1992	Nepal signed UNFCCC
1994	Nepal ratified UNFCCC and entered into agreement
1994	UNFCCC entered into force
2003	Sustainable Development Agenda
2004	Submitted Initial National Communication to UNFCCC
2009	Submitted Nepal's position paper for Cop 15 in Copenhagen, Denmark
2009	Nepal joined the UN Collaborative Initiative on REDD in developing countries
2013–2014	Nepal led LDC
2014	Submission of Second National Communication to UNFCCC Secretariat
2015	Submission of main issues for Nepal COP 21/CMP11 Paris, France
National level policies and practices	
1995	Establishment of Ministry of Population and Environment
1996	Enactment of Environment Protection Act
1996	Establishment of Environmental Protection Council
Nov 1996	Establishment of Alternative Energy Promotion Centre
1997	Enactment of Environment Protection Rules
2007	Constituted a 25-member Climate Change Council under the chairmanship of the Prime Minister
2010	Multi-stakeholder Coordination Committee Initiative on Climate Change under the Environment Secretary
2010	Establishment of the Climate Change Management Division
2010	Implemented National Adaptation Programme of Action
2011	Prepared Local Adaptation Plan of Action in selected districts and VDCs
2011	Implemented National Climate Change Policy
2013	Introduced Climate Change Budget Code
2014	Adoption of Environment-friendly Vehicle and Transport Policy
2015	Launch NAP Formulation Process
2016	Adoption of Forestry Sector Strategy (2016–2025)
2016	Submission of Nationally Determined Contributions to the UNFCCC Secretariat
2016-2020	Adoption of Climate Change Health Adaptation Strategies and Action Plans for Nepal
2014-2016	Adoption of green development approach in Thirteenth Periodic Plan
2016-1018	Goal of implementing development programs by adapting climate change in Fourteenth Plan
2017	Climate Financing Mechanism Framework
2019	Revision of National Climate Change Policy

National Policy Initiatives

CIAT, World Bank, CCAFS and LI-BIRD (2017) have grouped Nepal's policies in: i) in formation, ii) legally formalised and iii) actively implemented based on the policy's contribution to adaptation, mitigation and productivity enhancement. The policies are related to one or more of mitigation, adaptation and productivity enhancement.

Policies for CSA in Nepal

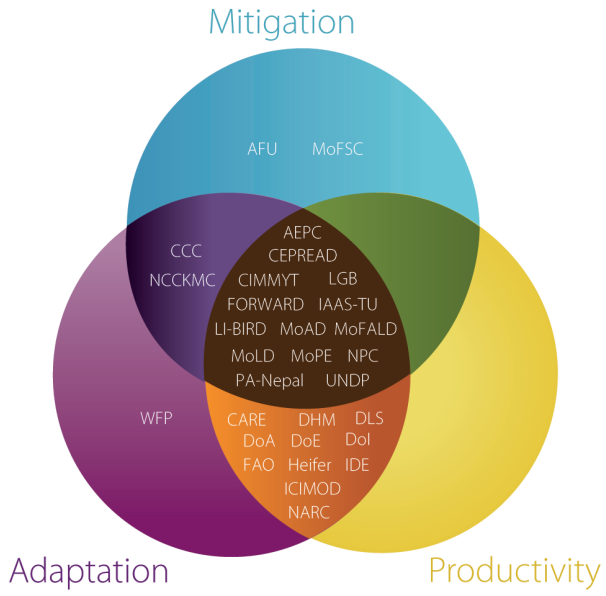


ABP National Agro-Biodiversity Policy (2006) (MoAD) **ADS** Agriculture Development Strategy 2015-2035 (2015) (MoAD) **AES** Nepal Agriculture Extension Strategy (2007) (MoAD) **CC** Nepal Climate Change Policy (2011) (MoPE) **CSV-P** Climate-Smart Village Programme (2016) (MoPE) **CoN** Constitution of Nepal, (2015) (GoN) **CRPG** National Climate-Resilient Planning (2011) (NPC) **EFLGF** Environment Friendly Local Governance Framework (2013) (MoFALD) **EPA** Environmental Protection Act 1996 & Rule 1997 (1996) (MoPE) **INDC** Intended National Deduction Commitment (2016) (MoPE) **IP** National Irrigation Policy (2013) (MOI) **LAPA** National framework for Local Adaptation Plan of Action (2011) (MoPE) **LCEDS** National Low Carbon Economic Development Strategy (2015) (MoPE) **NAgFSIP** Nepal Agriculture and Food Security Country Investment Plan (2010) (MoAD) **NAgP** National Agriculture Policy (2004) (MoAD) **NAP** National Adaptation Plan (2015) (MoE) **NAPA** National Adaptation Programme of Action (2010) (MoPE) **NARC's** NARC's vision for Agricultural Research Policy (2011-2030) (2010) (NARC) **NBSAP** Nepal Biodiversity Strategy and Action Plan (2014-2020) (2014) (MoFSC) **NCCSP** Nepal Climate Change Support Programme (2011) (MoPE) **PA** Paris Agreement (2016) (MoPE) **PFA** Climate Change Adaptation and Disaster Risk Management in Agriculture: Priority Framework for Action (2011-2020) (2011) (MoPE) **PPCR** Pilot Program on Climate Resilience (2010) (MoE) **RESP** Renewable Energy Subsidy Policy (2016) (MoPE) **SV** Seed Sector Development Strategy (2013-25) (2013) (MoAD/NSB/SQCC) **UNCCD** United Nations Convention to Combat Desertification (2012) (MoPE) **UNFCCC** United Nations Framework for Climate Change (MoPE)

Figure 3. National policies at different stages. Source: CIAT, World Bank, CCAFS and LI-BIRD, 2017.

Existing Institutions and Financing

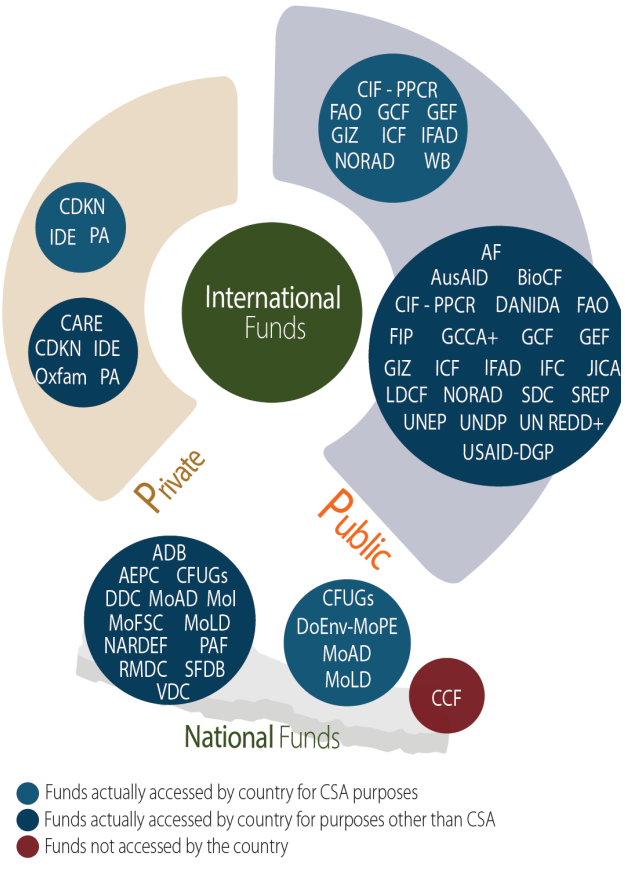
Several organizations have been working on climate change adaptation, mitigation and agricultural productivity enhancement. Some are working on more than one of these three pillars of climate smart agriculture (Figure 4).



AEPC Alternative Energy Promotion Center **AFU** Agriculture and Forest University **CCC** Climate Change Council **CEPREAD** Centre for Environmental and Agricultural Policy Research, Extension and Development **CIMMYT** International Maize and Wheat Improvement Centre **DHM** Department of Hydrology and Meterology **DoA** Department of Agriculture **DoE** Department of Environment **DoI** Department of Irrigation **DLS** Department of Livestock Sevices **FAO** Food and Agriculture Organization **FORWARD** Forum for Rural Welfare and Agricultural Reform for Development **IAAS-TU** Tribhuwan University - Institute of Agriculture and Animal Sciences **ICIMOD** International Centre for Integrated Mountain Development **IDE** International Development Enterprises **LGB** Local Government Bodies (DDC & VDCs) **LI-BIRD** Local Initiatives for Biodiversity, Research and Development **MoAD** Ministry of Agricultural Development **MoFALD** Ministry of Federal Affairs and Local Development **MoFSC** Ministry of Forests and Soil Conservation **MoLD** Ministry of Livestock Development **MoPE** Ministry of Population and Environment **NARC** Nepal Agriculture Research Council **NCCKMC** Nepal Climate Change Knowledge Management Centre **NPC** National Planning Commission **PA-Nepal** Practical Action Nepal **UNDP** United Nations Development Program **WFP** World Food Programme

Figure 4. Institutions working for Climate Smart Agriculture in Nepal.
Source: CIAT, World Bank, CCAFS and LI-BIRD 2017.

Financing climate change adaptation is arranged by national and international public and private organizations (Figure 5). A large number of international organizations are supporting Nepal's adaptation actions and most are public organizations. Within the country, several national funds are provisioned. Nepal is also trying to access the Green Climate Fund (GCF) in collaboration with accredited entities such as FAO, UNDP and the World Food Programme.



ADB Agriculture Development Bank **AEPC** Alternative Energy Promotion Center **AF** Adaptation Fund **ADB** Asian Dev Bank **AusAID** Australian Agencyfor International Development **BioCF** World Bank BioCarbon Fund **CARE** Cooperative for Assistance and Relief Everywhere **CCF** Climate Change Fund **CFUGs** Community Forest User Group Fund **DANIDA** The Danish International Development Agency **DDC** District Development Committee grant **DoEnv-MoPE** Ministry of Population and Environment - Department of Environment **FAO** Food and Agriculture Organization of the United Nations **FIP** Forest Investment Program **GCCA** Global Climate Change Alliance **GCF** Green Climate Fund **GEF** Global Environment Facility **GIZ** German Society for International Cooperation **ICF** United Kingdom International Climate Fund **IDE** International Development Enterprises **IFAD** International Fund for Agricultural Development **IFC** Int ernational Finance Corporation **JICA** Japan International Cooperation Agency **KFW** German Development Bank International Climate Initiative **MI** Ministry of Irrigation **MoAD** Ministry of Agricultural Development **MoFSC** Ministry of Forest and Soil Conservation **MoLD** Ministry of Livestock Development **NARDEF** National Agricultural Research and Development Fund **NORAD** Norwegian Agency for Development and Cooperation **PA** Practical Action **PAF** Poverty Alleviation Fund **RMDC** Rural Micro-finance Development Coorporation **SFDB** Small Farmer Development Bank **SREP** Scaling Up Renewable Energy in Low Income Countries Program **UNDP** United Nations Development Programme **UNEP** United Nations Environmental Programme **USAID-DGP** United States Agency for International Development – Development Grants Program **UN REDD** United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation **VDC** Village Development Committee grant **WB** The World Bank

Figure 5. Financing opportunities for CSA in Nepal.
Source: CIAT, World Bank, CCAFS and LI-BIRD, 2017.

Capacities, Knowledge and Adaptation Gaps and Barriers

Climate change is a challenge for both current and future generations. In response, Nepal has initiated activities to reduce exposure to climate hazards, improve the coping ability of climate vulnerable communities and reduce the risks of climate change on its people, property and natural resources (MoPE, 2016). Despite the commitment to several national and international treaties, formulation of policies and on-the-ground action, a number of challenges and barriers continue to limit the ability of the country to adapt to climate change and build resilience.

Institutional and Policy Gaps and Barriers

The perceived difficulty of changing institutional structures within implementing institutions is creating skepticism among some organizations working on climate change. For example, the recent restructuring of government institutions at all levels has led to ambiguity about the roles and responsibilities of government units and development organizations. Capacity related to climate change and resilience, particularly at the municipal level, is low and will likely remain so until new advisory structures and trained personnel are in place. The ministry needs additional human resources and institutional set up for effective implementation of the policies, plans, strategies and frameworks and to fill the gaps in institutional arrangements, capacity to implement, and mechanisms for adaptation policies and programmes at the local level (Maharjan and Maharjan, 2017). However, this process is an opportune time to mainstream climate change into local planning processes and plans.

Limited institutional capacity due to a shortage of human, financial, scientific and technical resources is constraining the country's ability to effectively and sustainably adapt to climate change. In addition, it hinders research and the adaptation process, leading to limited information and knowledge products on climate change and adaptation options (Egan, 2013). This, in turn, constrains effective decision-making. Institutions play vital roles in initiating, promoting, improving and sustaining adaptation practices (Osman-Elasha et al. 2006) and as climate change is a multifaceted problem, it demands coordinated actions and close institutional collaboration. Several institutions are working on climate change knowledge management, adaptation and mitigation but the current level of coordination and consultations among these institutions have created overlaps and duplication of effort instead of synergy. One of the major reasons for this is the project-based, top-down, resource-dependent nature of climate change knowledge generation and management initiatives.

Knowledge and Technological Gaps and Barriers

Policymakers and development agencies are looking at strong scientific and local evidence that can demonstrate why climate change is an issue and where and how climate change is impacting local livelihoods (NAST and OPML, 2016). Action learning is one approach for project implementation through a collaborative process of learning, research, and critical reflection or 'learning by doing' (Fisher and Jackson, 1999). However, there is a need for more climate change knowledge and information at all levels to better inform decision-making. Regmi et al. (2009) show that innovative technologies currently used by some hill farmers are helping to build community resilience. Others, like Chhetri et al. (2011) show how farmers and their supporting institutions are evolving and co-producing climate sensitive technologies on demand. However, there are limits to these community coping strategies when it comes to dealing with climate extremes. The technologies are based on existing knowledge and limited information. They are short-term and rely on climatic variability but ignore the uncertainties and scale of climate change impacts. These uncertainties impact and the scale of potential change and make local practices less effective and local technologies may not be appropriate because of limited information and technical knowledge.

Communities are looking for answers to their day-to-day problems, particularly how to deal with questions related to critical stress periods within their farming systems and livelihoods as these are affected by the erratic and changing climate. Rural households want knowledge advisories and technology packages to address the concerns of loss of life due to extreme events, declining productivity, crop failure, and additional burdens on farming due to pests and disease outbreaks, water scarcity, family health issues and depletion of resources. In spite of their needs, Nepalese farmers and communities do not always receive sufficient guidance and inputs from the agencies concerned (NAST and OPML, 2016). Moreover, agrometeorological information is not readily available and seasonal forecasts and market information is not used to inform local people as well as it could be. This is partly because the number of manual stations and automatic surface observation systems in Nepal are too few to generate high-quality, reliable data for weather forecasting and long-term projections. There are still a small number of climate stations in the country but there has been insufficient monitoring, maintenance and quality upgrading, leaving several stations functioning poorly and recording inaccurate data. The number of different types of stations are:

- precipitation stations (173)
- climatic stations (72)
- agro-meteorological stations (21)
- synoptic (9)
- aero-synoptic stations (7)
- hydrometric stations (154)
- sediment stations (20)

Practical climate change knowledge and practices are the foremost priority. INGOs and NGOs are creating immediately applicable knowledge of how to respond to climate change impacts, which in turn, underscores the continuing relevance of generating fresh knowledge both on-the-ground and science-based, bringing the two together, and consolidating, sharing and using such knowledge to better prepare Nepal's communities for the changes taking place (NAST and OPML, 2016). However, scaling up needs more advanced technologies (e.g. IT-based) to disseminate information, technologies, and practices. Despite the huge demand for knowledge, the supply side of knowledge management is not keeping up. The numerous operating knowledge centers and networks at the national level could be functioning at a higher level. The absence of learning and sharing mechanisms impedes the information flow among national institutions. Knowledge management at national level is further constrained by limited financial resources and support from both the national government and international agencies (NAST and OPML, 2016).

Financial Gaps and Barriers

Governments have to rely on international support to meet the cost of adaptation and has to move beyond the project-based approach. Unless and until resources are available, promoting meaningful adaptation will be difficult (Regmi and Bhandari, 2013). However, there has been some access by farmers to financial services and incentives to adopt climate resilient practices. Government subsidies could be more precisely targeted as they currently tend to focus on reducing the costs of inputs without accounting for potentially negative spill-over effects. Government has a short supply of staff and financial resources to cover a wide geographic area and current services are often concentrated in accessible areas. Subsidies are often given irrespective of economic wellbeing, causing poor access to finance by smallholders due to their inability to co-finance or secure matching funds.

FAO has also identified several capacity gaps and needs for different types of institutions in Nepal (Table 6). The main requirements are awareness raising and training on appropriate crop and livestock management, resource mobilization, income generation activities, introduction of new technologies and practices; enterprise development, and improving market networking and capacity building, increasing access to credit, and disaster mitigation through ecological conservation, watershed management, and biodiversity conservation.

Table 6. Institutional capacity required for managing climate risks and advancing adaptation.

Type of institution	Capacity requirement
CFUGs	Training on landslide and erosion control and income-generating activities for community forest areas; promotion of skills in nursery cultivation, forest conservation and management and afforestation; awareness raising on the impacts of climate hazards on people's lives and livelihoods; financial transparency for governance; fodder and fruit tree plantations in erosion-prone areas; forest resource-based income generation; rotational grazing; integrated approaches to the use of common property resources
WUAs	External resource mobilization for weir construction and rehabilitation and canal lining; equitable water distribution; plantations around springs and in upper catchments; awareness raising on the impacts of climate variability and change
Farmers' groups	Skills training in fertilizer application, pesticide handling, variety selection and soil fertility management; integrated pest management; management of sprinkle irrigation; easy access to agricultural inputs; awareness raising on the impacts of climate variability and change; organization of Farmer Field schools; skills training in improved farming and optimum use of available resources; provision of crop and livestock insurance
Savings and credit groups	Training in group management, credit mobilization and income-generating activities (off-season); mobilization and management of revolving funds; awareness raising on the impacts of climate variability and change; organization of visits to other groups for experience and knowledge sharing
Cooperatives	Market links (inside and outside the district); management of agricultural inputs; training in cooperative management; identification of potential areas for investment to enhance people's livelihoods; facilitating investments in off-farm activities; improved marketing links; improved farming (vegetable, meat and milk production); small-scale technology transfer
Mothers' groups	Awareness raising on improved farming; training in income generation from goat rearing, vegetable production and small-scale cottage enterprises; training in fertilizer, insecticide, and pesticide use
Youth clubs	Campaigns for disaster risk management, ecological conservation, watershed management and biodiversity conservation; community mobilization for the repair and maintenance of basic infrastructure (water resources, roads, schools, irrigation canals, forest conservation); awareness raising on the impacts of climate hazards

Source: Selvaraju, FAO 2014

Chapter 2
Climate Change Main Concepts, Causes and Trends

What is Climate Change?

Climate refers to the average weather (temperature, wind and rainfall patterns) experienced over a long period, typically 30 years. The term 'climate change' usually refers to changes that have been observed since the early 1900s. Some definitions follow.

- **IPCC**: Climate change refers to a change in the state of climate that can be identified by using statistical tests, by changes in the mean or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.
- **IPCC AR4:** The climate system evolves over time under the influence of its own internal dynamics and because of external forces such as volcanic eruptions, solar variations and anthropogenic forcing such as the changing composition of the atmosphere and land use change.
- **UNFCCC**: A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods.
- **World Meteorological Organization:** Climate is statistical description in terms of the mean and variability of quantities (temperature, precipitation, and wind) over a period of time ranging from months to thousands or millions of years. The classical period is 30 years.
- **McCarthy et al. (2001):** Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This indicates climate change occurs due to natural and anthropogenic causes.

Weather: The behavior of the atmosphere on a day-to-day basis in a relatively local area is known as weather. A description of weather includes daily temperatures, relative humidity, sunshine, wind and rainfall.

Climate: In a narrow sense, is usually defined as the 'average weather', or more rigorously, as the 'statistical difference in terms of the mean and variability of weather over a period of time ranging from months to thousands or millions of years. The classical period is 30 years as defined by the World Meteorological Organization. Climate is determined by the interaction of the components of the climate system (the atmosphere, the hydrosphere, the cryosphere, the Earth's surface and the biosphere) with external factors such as the sun and human activities (Figure 6).

Climate System: The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere ,and the interaction between them. The climate system evolves in time under the influence of its internal dynamics and because of external forcing such as volcanic eruptions, solar variations and anthropogenic forcing such as the changing composition of the atmosphere and land use change (Figure 6).

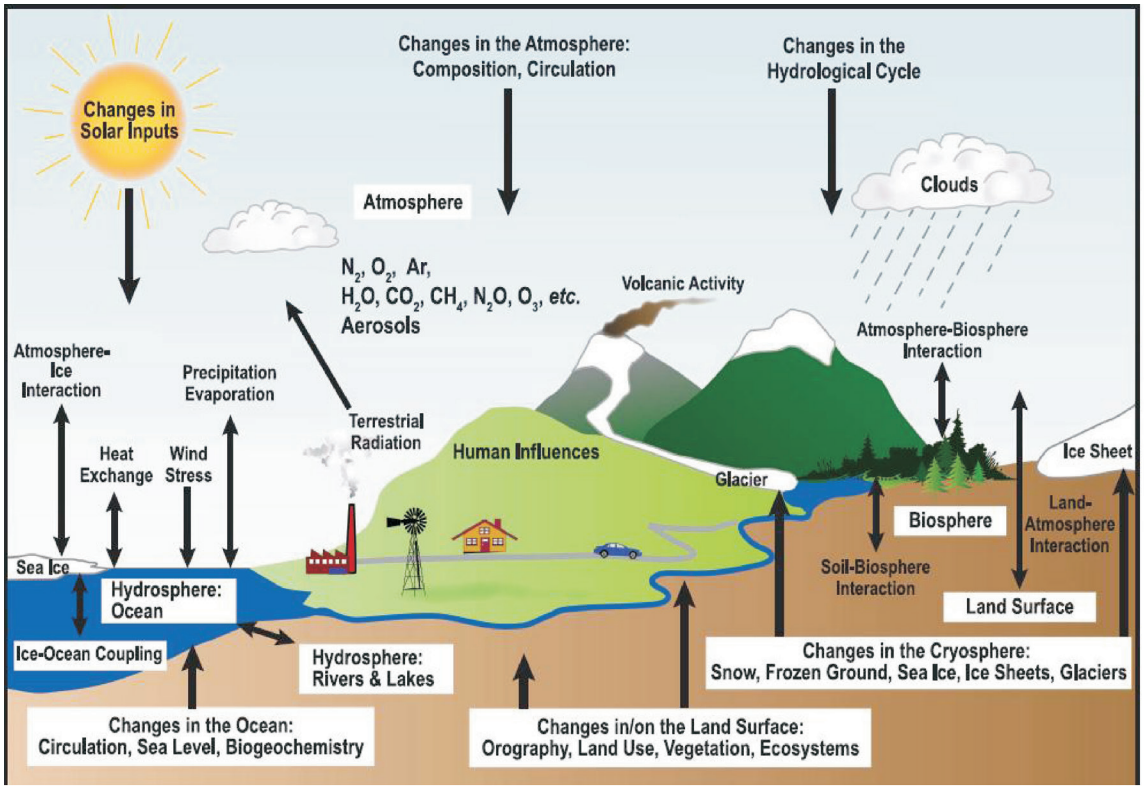


Figure 6. Our climate system showing interactions of different ecosystems and climatic activities.

We must be cautious about linking changes with climate change without understanding causes and effects. For instance, many studies link the single event of observed frequency, intensity, and duration of some extreme weather events with the warming climate system[2] although different regional circumstances play an important role in the alteration of such events. Regional circumstances should thus be taken into account. Such data is, however, limited.[3]

Global temperature has changed many times in response to a variety of natural and human causes. The following drivers play a role in maintaining Earth's system.

1. **External climate forcing:** These are essentially linked to changes in the orbital parameters of the Earth that control the intensity and location of incident solar radiation, and fluctuations in solar energy. These are solar variations and Milankovitch cycles.[4]
2. **External anthropogenic forcing:** Land use and surface changes and Greenhouse gases.
3. **Internal climate forcing:** These comprise all changes that occur within the Earth system itself, in particular volcanic activity, fluctuations in ocean circulations and large-scale changes in the marine and terrestrial biosphere or in the cryosphere.

2 Committee on Extreme Weather Events and Climate Change Attribution et al. 2016, p. 2
3 Hansen et al. 2016.
4 Eccentricity is the Earth's elliptical orbit around the sun, a cycle of around 100,000 years. Tilt or Obliquity is the axis of rotation, currently tilted at 22.5°-24.5°in a cycle of around 41,000 years). Precession is the Earth is wobbling about its axis of rotation like a spinning top in a cycle of around 24,000 years.

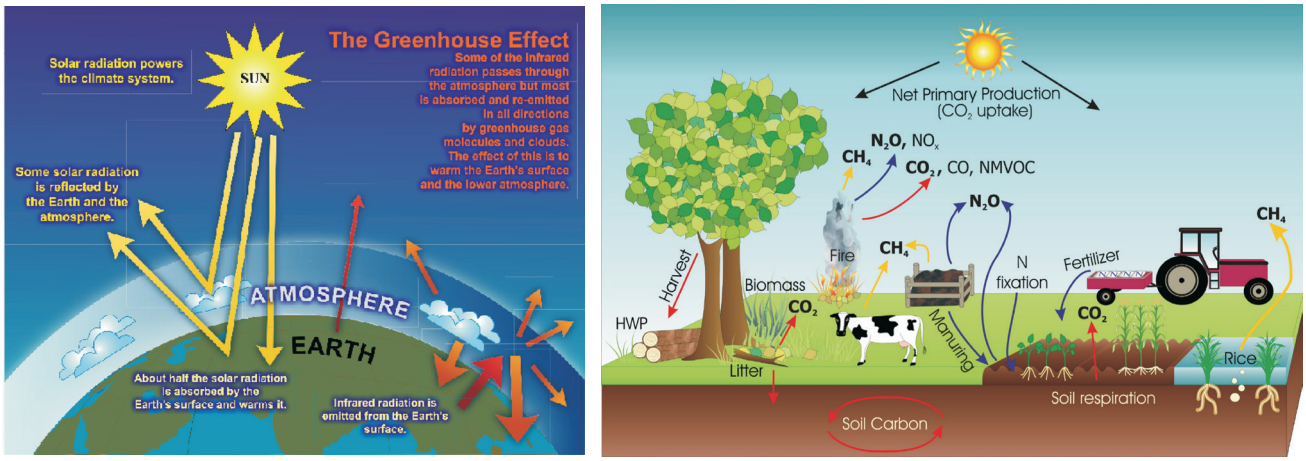
These drivers can be grouped into natural and human-made (anthropogenic) causes as described below.

Natural Causes of Climate Change

Natural variability is an inherent feature of climate. Climate variations can be the result of natural phenomena that influence the balance of energy on Earth. These phenomena include changes in solar radiation and changes in the interactions among different components of the climate system (e.g. changes in the composition of the atmosphere due to volcanic activity or an increase in cloud coverage). The speed of response to such phenomena is different for each component of the system. The troposphere reacts in a matter of days or weeks, the oceans respond over decades, centuries or millennia owing to its thermal capacity, and the biosphere can respond rapidly, especially to extreme events such as droughts, hurricanes or floods, or slowly to progressive variations. The Earth's atmosphere naturally contains greenhouse gases (primarily carbon dioxide, methane and nitrous oxides) that allow solar radiation to pass through and trap heat reflected from the Earth's surface in a manner similar to a greenhouse. The greenhouse effect created by these gases maintains the Earth's surface temperature at about 15^0 C on average. Without some heat trapping, the Earth's global temperature would be closer to -18^0 C. Hence, the greenhouse effect is essential for keeping the world warm enough for human habitation.

Anthropogenic Causes of Climate Change

Although the greenhouse effect is essential to life as we know it, the current effect is much greater than what we need. The greenhouse effect is causing climate change by making atmospheric GHGs trap part of the infrared radiation that the Earth radiates back to space (Figure 7). Since the beginning of the Industrial Revolution in the 18th century, human or anthropogenic activities that produce greenhouse gases have altered the composition of the atmosphere, leading to an enhanced greenhouse effect. These changes in the atmospheric composition have occurred mainly because of fossil fuel burning and changes in land use (e.g. deforestation). Major GHG gases in Earth's atmosphere are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), halocarbons, perfluorocarbons, chlorofluorocarbons (CFCs) and hydrofluorocarbons (including HCFCs and HFCs).



A B

Figure 7. A. Infrared radiation causing a greenhouse effect and B. interactions among the components of agriculture systems and Green House Gas emissions. Source: IPCC 2006 and IPCC 2007.

Greenhouse Gas (GHG) Emissions - Facts

Globally, carbon emissions from fossil fuels have increased almost 100 times between 1900 and 2010. China, the United Sates, Eu-28 and India have been among the biggest contributors of GHG emissions. The USA has the highest level of emissions among all countries. In the agriculture sector, emission of greenhouse gases comes from fertilizer production and use, cattle, rice production, biomass burning and other activities (Figure 7B). Carbon dioxide is the most abundant GHG in the Earth's atmosphere, followed by methane and nitrous oxide. Electricity and heat production contribute the majority of GHG emissions (25%) and agriculture, forestry and other land uses ranks second (24%). Agriculture and land conversion combined contribute up to one-third of emissions leading to the enhanced greenhouse effect. Other facts about GHG emissions are shown in Figure 8.

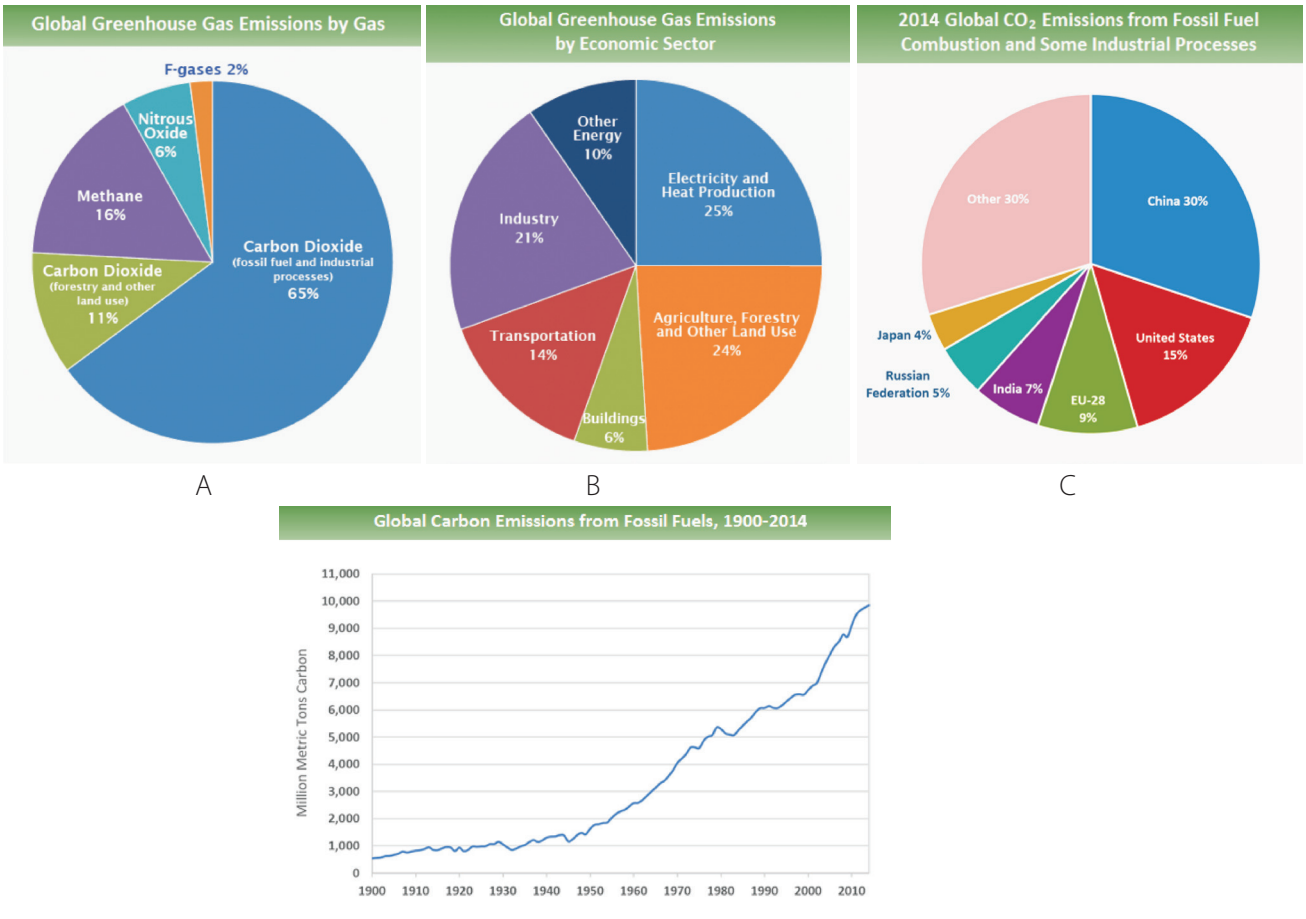


Figure 8. Contribution of Green House Gas emissions by: A: type of gas; B: economic sector; C: country; and D. fossil fuel-based carbon emission between 1900 and 2014. Source: IPCC 2014 and Boden et al. 2017.

Global Trends and Projections of Climate Change

Temperature

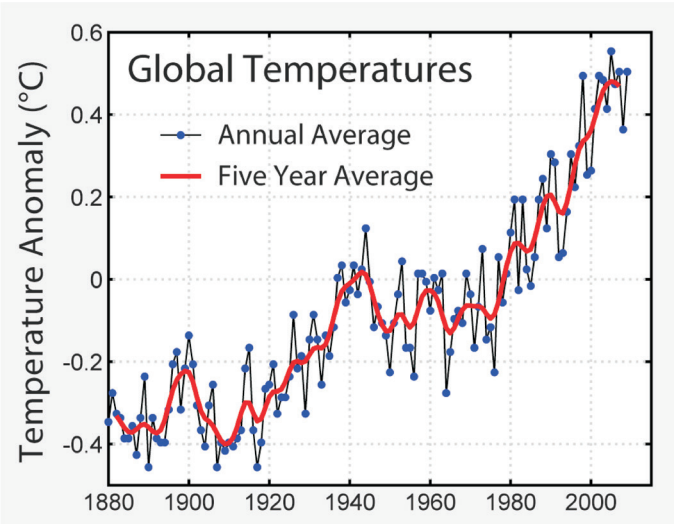
The Earth's climate is not static. Since the 1950s, many of the observed changes are unprecedented over decades to millennia if substantial efforts are not made to address the drivers of change. The atmosphere and ocean have warmed, the amount of snow and ice has diminished, sea level has risen as a result of the increased concentration

of greenhouse gases leading to global warming. Global mean temperature has increased at the rate of 0.74°C for the last 100 years. The temperature increase is widespread over the globe and is greater at northern latitudes. The years 1995 to 2006 ranked among the twelve warmest years in the record of global surface temperature recording since 1850 (Figure 9A). The number of cold days and nights has decreased and the number of warm days and nights increased on a global scale. The frequency of heat waves has also increased in large parts of Europe, Asia and Australia. Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 for all Regional Climate Projection (RCP) scenarios except RCP 2.6. It is likely to exceed 2°C for RCP 6.0 and RCP 8.5, and more likely than not to exceed 2°C for RCP 4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP 2.6 (Figure 9B).

Precipitation

From 1900 to 2005, precipitation increased significantly in western parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has increased since the 1970s (FAO 2010). There are more land regions where the number of heavy precipitation events has increased than where it has decreased. The frequency or intensity of heavy precipitation events has increased in North America and Europe. In other continents, confidence in changes in heavy precipitation events is at most medium. In the future, changes in the global water cycle in response to warming over the 21st century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions.

Under the RCP 8.5 scenario, the high latitudes and the equatorial Pacific are likely to experience an increase in annual mean precipitation. Mean precipitation will likely decrease in many midlatitude and subtropical dry regions, while mean precipitation will likely increase in many midlatitude wet regions under the same scenario. Extreme precipitation events will likely become more intense and more frequent over most midlatitude land masses and over wet tropical regions (Figure 10).



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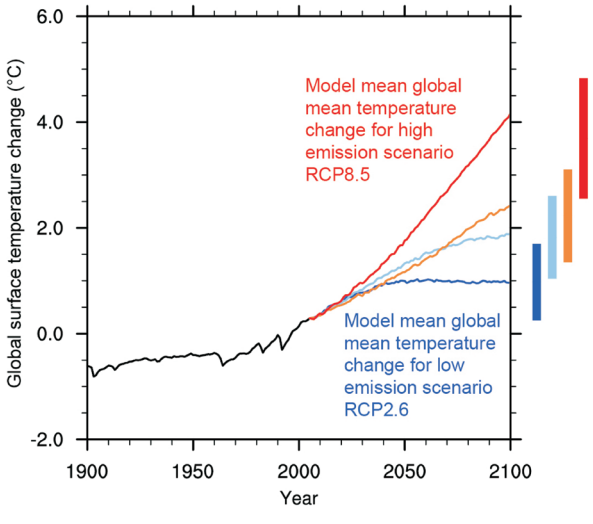


B

Figure 9A: This graph depicts temperature anomalies from 1880–2010 from meteorological stations, showing both annual means and a five-year mean. The anomalies clearly show a trend of increasing temperatures starting in the 1970s. Source: Hansen et al. 2006.

Figure 9B: Observed and projected changes in global average temperature under four emission pathways. The vertical bars at right show likely ranges in temperature by the end of the century, while the lines show projections averaged across a range of climate models. Changes are relative to the 1986–2005 average. Source: Collins et al. 2013.

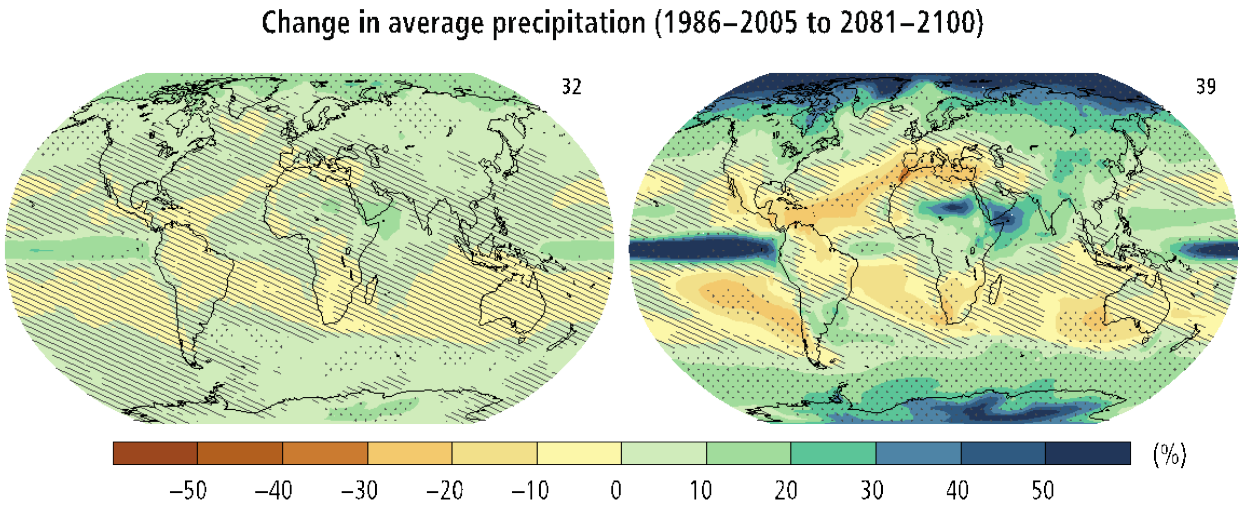
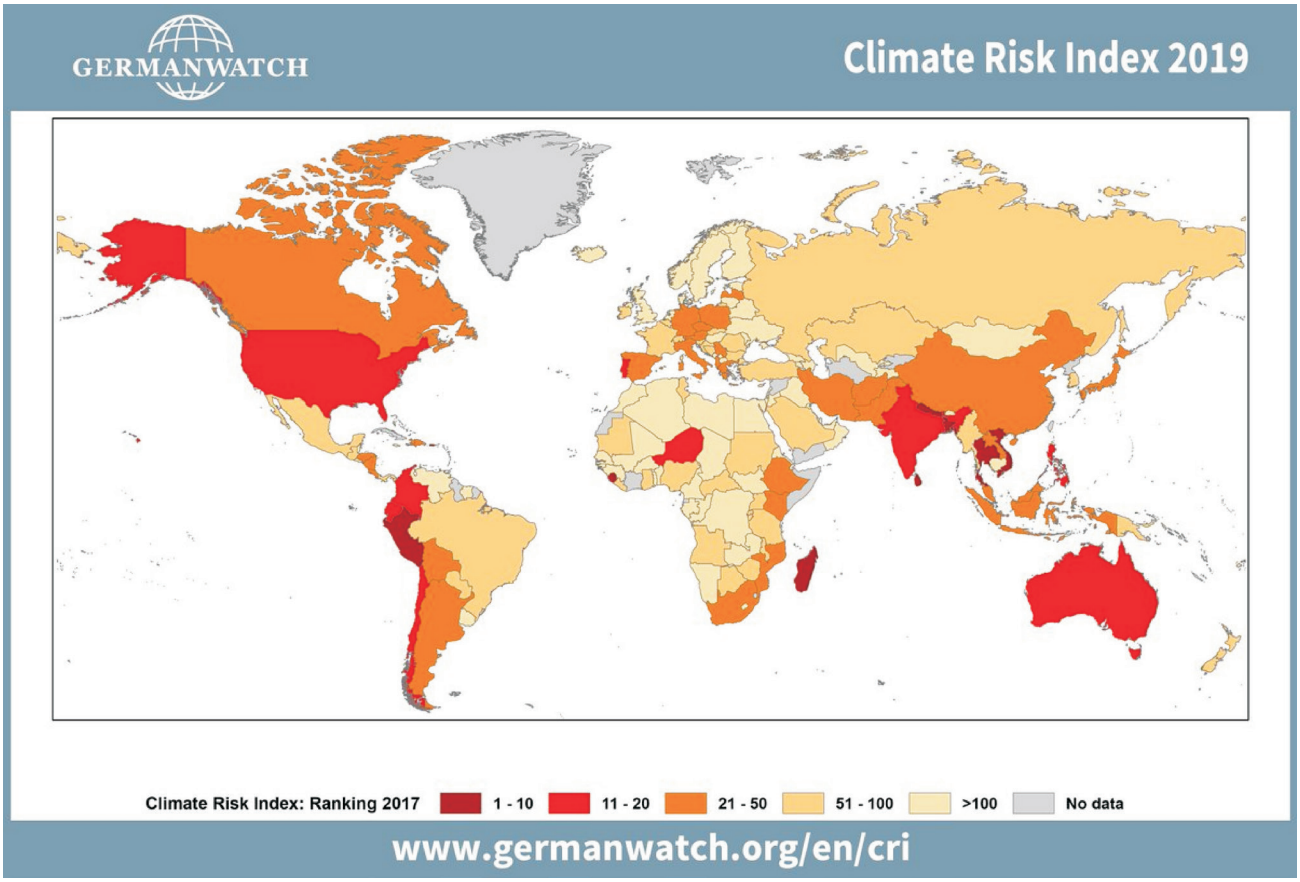


Figure 10. Change in average surface temperature; (a) change in average precipitation (1986–2005) and (b) based on multi-model mean projections (2081–2100 relative to 1986–2005) under the RCP 2.6 (left) and RCP 8.5 (right) scenarios. Source: IPCC 2014.

Climate Change in Nepal

Nepal is highly vulnerable to climate change due to its poor economy and variation in topography, ecology and climate. The risk posed by climate change remains high to very high, but changes over time according to frequency and intensity of hazards. According to the Germanwatch Report, Nepal ranks fourth on the Global Climate Risk Index for 2017 (Figure 11A) with losses estimated at 1,910 million USD Purchasing Power Parity. The same report ranks Nepal 11th in terms of Global Climate Risk Index for the period between 1998–2017 (Eckstein et al. 2019). Nepal's contribution to global GHG emissions is only 0.027% (Figure 12) but the impact the country is bearing is proportionately high. The annual compound growth rate of CO_2 equivalent emissions for Nepal is lower than many other developing countries at minus 2% per annum (MoE, 2011) but there has been about 1.8°C increase in temperature between 1975 to 2006, and the annual maximum temperature trend was significantly positive (0.056°C/yr) between 1971–2014 (MoPE, NAP 2017). The weather data from 1975 to 2009 shows that temperatures have increased by around 1.5°C, mostly during the dry season (December to March) particularly in the mountain region (Krishnamurthy et al., 2013). Climate trends and projections also show serious threats are high, as presented later in this section. The Synthesis Report of the stocktaking for the NAP formulation process in Nepal prepared by MoPE in 2017 also highlights country context, climate change trends and disasters, exposure to the adverse impacts of climate change, climate change vulnerability and main gaps.

A recent study shows the mid and far western hills and mountains (par of Provinces 6 and 7) are most vulnerable while the eastern and central Terai (part of Province 2) are least vulnerable (Figure 11B). However, there is variation within these regions (Mainali and Pricope 2017) and they too vary year by year. The country's agriculture system is predominantly rainfed and is highly susceptible to climate change.



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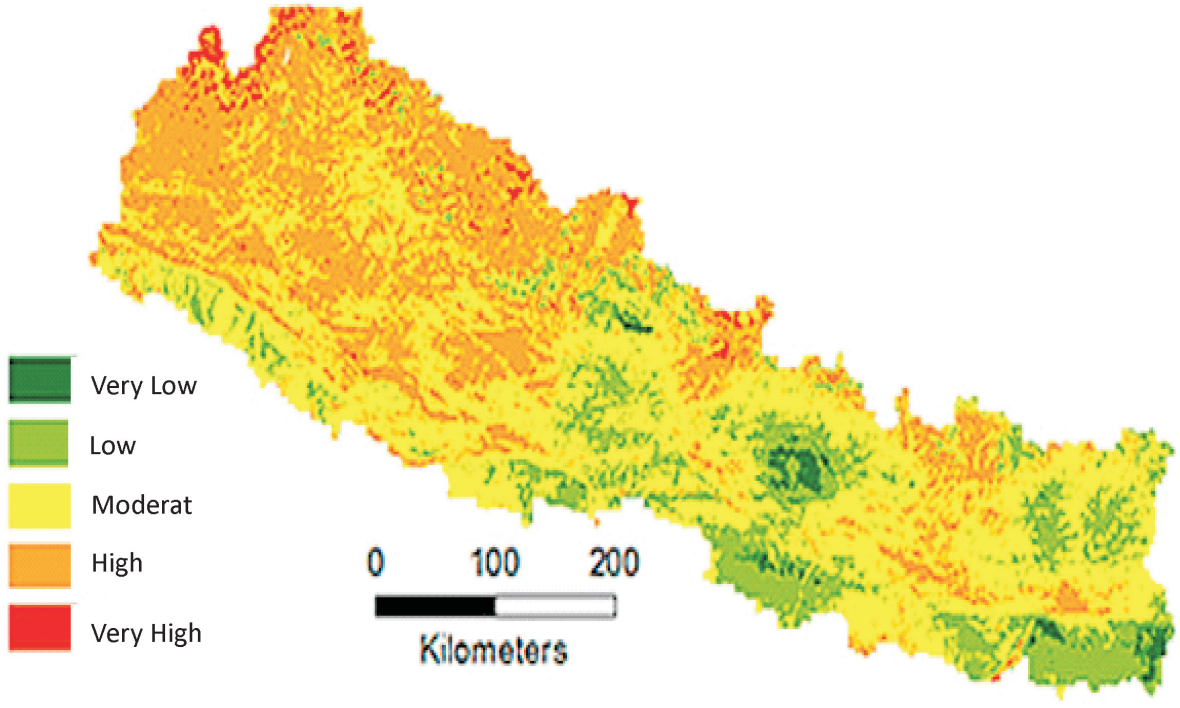


B

Figure 11. World map showing Global Climate Risk Index for 2017 (A) and
Nepal map showing average climate vulnerability across the country (B). Source: Mainali and Pricope 2017.

Agricultural greenhouse gas emissions

Nepal's GHG emissions are estimated at roughly 40 megatons of CO_2 equivalent (CO_2eq) per year, including emissions from Land Use Change and Forestry (LUCF). Per capita annual GHG emissions, including LUCF, are less than a quarter of the world average, at 1.52 tons of CO_2eq (Figure 12A). More than half of the country's total emissions come from the agricultural sector (Figure 12B). Of all agricultural emissions, 60% are attributable to enteric fermentation and manure management from livestock production combined. Approximately 24% of agricultural emissions result from cropping practices including rice cultivation, crop residues, cultivation of organic soils, burning of crop residues, and the use of synthetic fertilizers (Figure 12C). Promotion of practices and technologies geared towards improved efficiency in animal production (e.g., balanced animal nutrition, reduction of disease incidence, and genetic improvement) are therefore crucial for GHG reduction in Nepal. Recent trends in cropland intensification suggest an accelerated increase in agricultural emissions unless adequate measures to apply and manage agricultural inputs (such as precise fertilizer management techniques) are implemented.

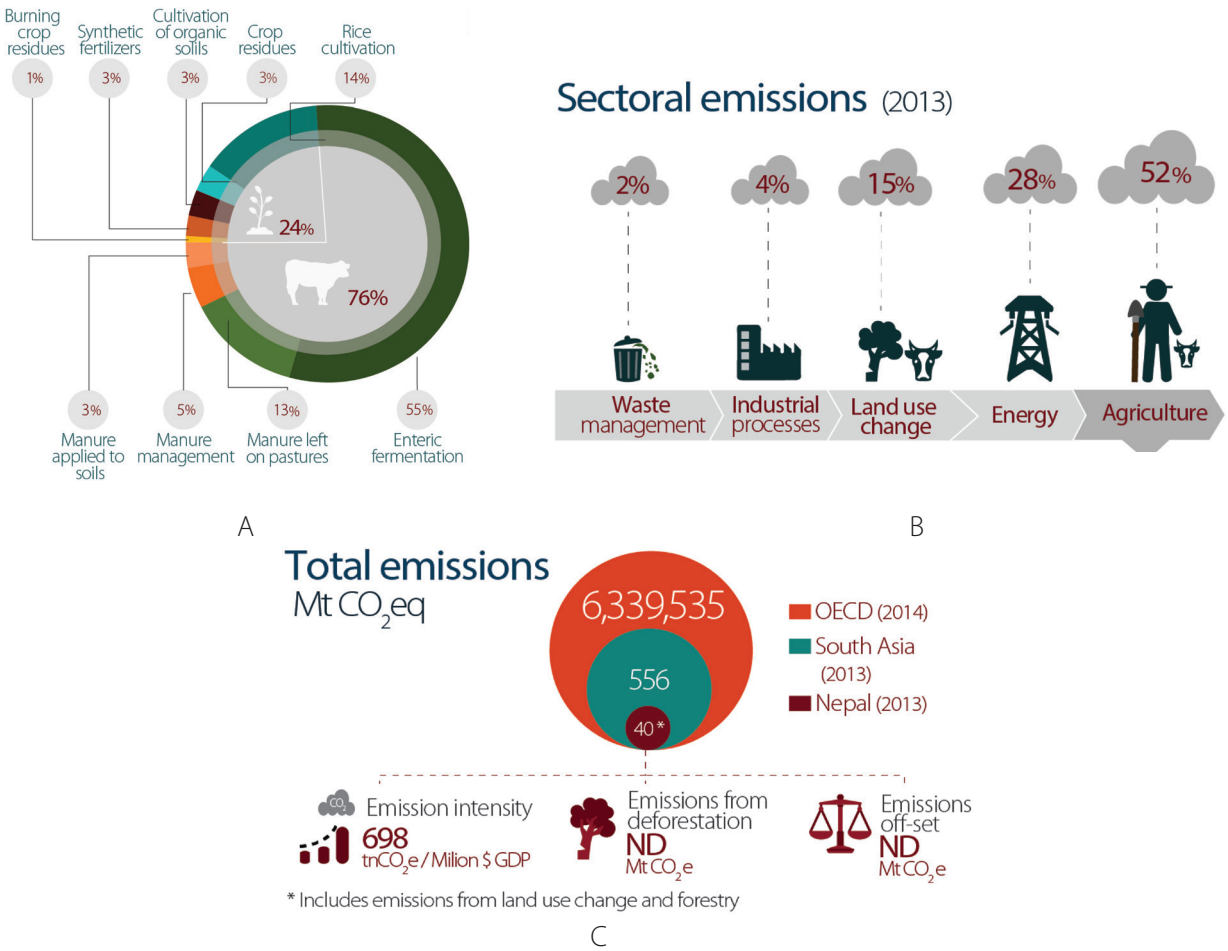


Figure 12. Nepal's GHG emissions. Source: CIAT, World Bank, CCAFS and LI-BIRD 2017 (all three figures).

Climate Trend in Nepal (DHM 2017)

The department of Hydrology and Meteorology published a report on Observed Climate Trend Analysis (1971–2014) in Nepal in connection with the Nepal Adaptation Plan Formulation Process. The report states that maximum temperature trends are higher than minimum trends in all seasons. The significance test shows maximum temperature trends are more robust than minimum temperature and precipitation trends. The main findings of the report include: i) significant positive trends are observed in annual and seasonal maximum

temperature and minimum temperature shows a significantly positive trend only in monsoon season in all Nepal but there is no significant trend in precipitation in any season, and ii) the all Nepal annual maximum temperature trend is significantly positive (0.056°C/yr) and the annual minimum temperature trend is positive (0.002°C/yr) but it is not significant. Other findings are discussed below (Figure 13).

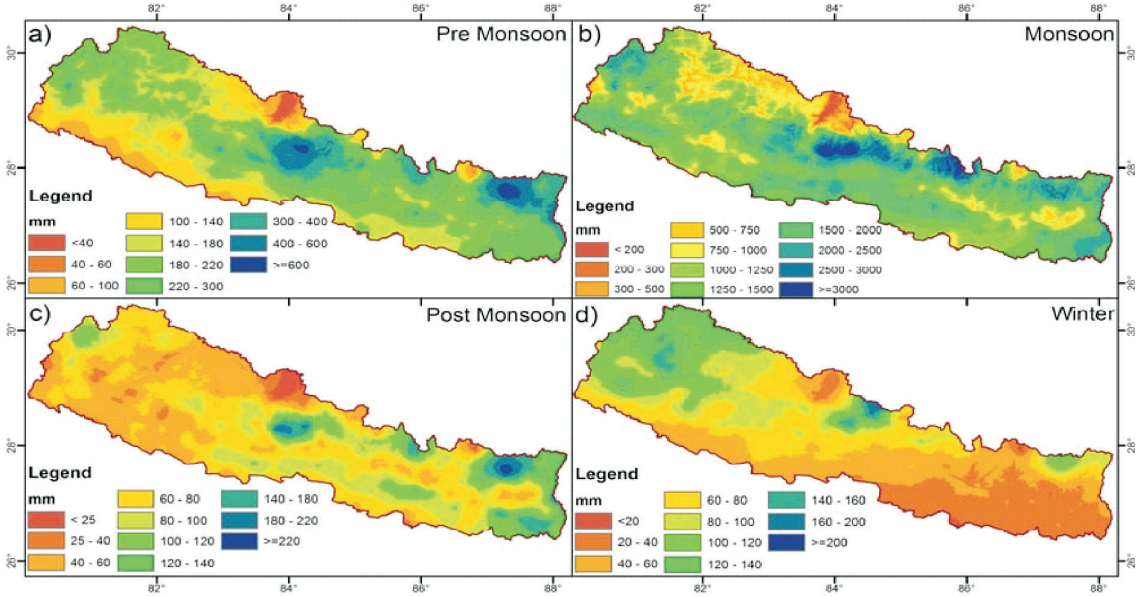


Figure 13A. Spatial distribution of mean seasonal precipitation (mm) for (a) pre-monsoon, (b) monsoon, (c) post-monsoon, and (d) winter season over the period of 1981–2010. Note: Legend scale of all four seasonal maps are different.

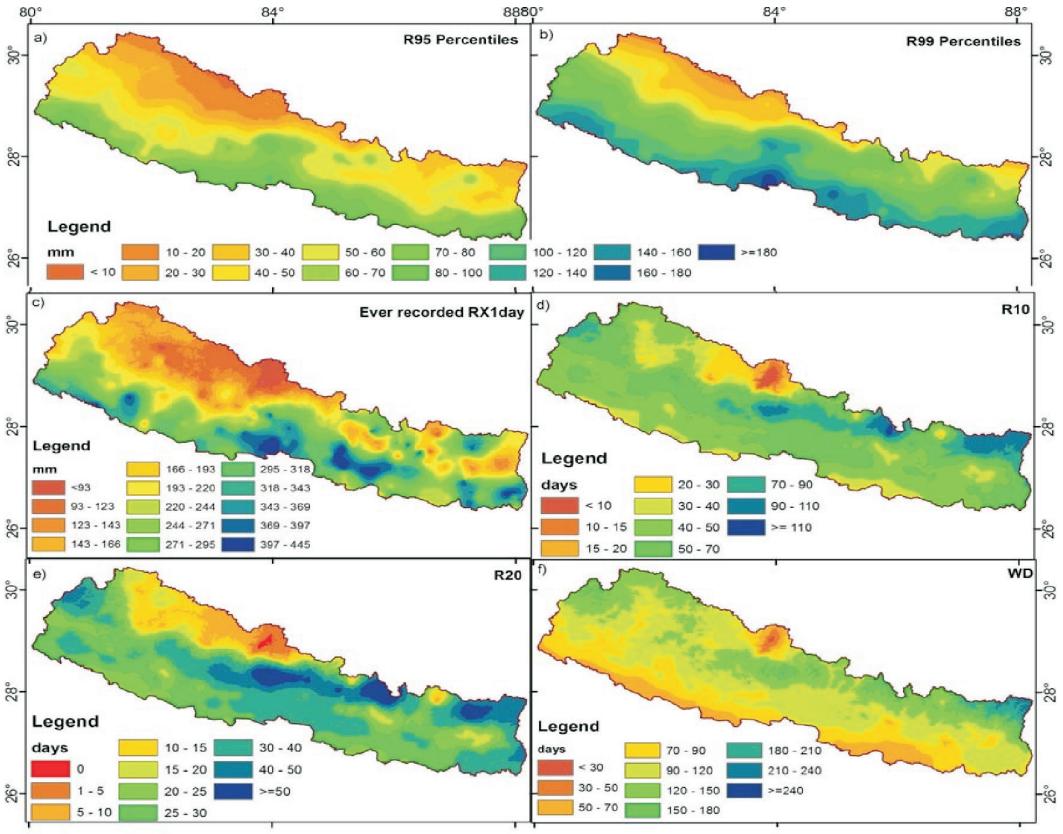


Figure 13B. Spatial distribution of (a) 95th percentile, (b) 99th percentile mean values of daily precipitation, (c) ever-recorded one-day extreme precipitation, (d) mean annual number of days with precipitation ≥10mm, (e) mean annual number of days with precipitation ≥20mm, (f) mean annual number of days with precipitation ≥1mm (wet/rainy days) over the period of 1981–2010. Note: Legend scale of all four seasonal maps are different. Source: Karki et al.2017.

Precipitation trend: At district level, pre-monsoon and monsoon precipitation show significant trends only in a few districts while winter and post-monsoon precipitation trends are not significant in districts. The significantly highest positive rainfall trend is observed in Syangja and Parbat Districts in monsoon season. Only pre-monsoon precipitation shows a significant negative trend in the High-Himalayan region. In other seasons, precipitation trends are not significant in all physiographic regions. Both at district and physiographic levels, three coherent but insignificant patterns are observed: 1) a non-significant positive precipitation trend in the southern districts of Far Western Development Region (FWDR) or Province 7 in winter, pre-monsoon and monsoon, 2) a non-significant decrease in monsoon precipitation in most districts east of 84E longitude, and 3) a non-significant highest decreasing rainfall trend in all seasons in the High Mountains and a non-significant positive trend in all seasons, except post-monsoon in the Terai.

Extreme precipitation trend: The number of rainy days is increasing significantly, mainly in the northwestern districts. Very wet days and extremely wet days are decreasing significantly, mainly in the mountains. Consecutive dry days are decreasing significantly, mainly in the northwestern districts of MWDR (Province 6), while consecutive wet days are increasing significantly in the northern districts of MWDR (Province 6) and central parts of WDR (Province 4 and 5) and EDR (Province 1).

Temperature trend: The positive temperature trend is highly significant in more than 90% of districts and in all physiographic regions in all the seasons, except in the majority of Terai districts in winter. At the district level, the highest significant positive trend (0.12°C/yr) is observed in Manang District in winter. All five physiographic regions show a significant positive trend in all seasons, except in the Terai in winter and pre-monsoon, and in Siwaliks in winter. In the High Mountains and High Himalayas, the highest positive trend is observed in winter and in Terai, Siwaliks and Middle Mountains in the monsoon season. Both at district and physiographic levels, seasonal and annual maximum temperature trends demonstrate a pattern in relation to altitude with a negative trend or a small positive trend in lower altitude districts and regions and a larger positive trend in higher altitude districts and regions.

Minimum temperature trend: The negative minimum temperature trend is significant in most northwestern districts in winter and post-monsoon seasons while a positive minimum temperature trend is significant in most southern districts (Terai to Middle Mountains) in Eastern Development Region (EDR, Province 1), Central Development Region (Province 2) and WDR (Province 4 and 5) in all seasons. Seasonal and annual minimum temperature trends show positive trends in lower elevations and negative in higher elevations, although a majority are non-significant both at district and physiographic levels. Since these patterns are not significant but might be associated with short-term variability in atmospheric phenomena, these results should be used cautiously. At the district level, the significantly highest positive trend (0.046°C/yr) is observed in Dolpa District in monsoon season and the significantly highest negative trend (-0.076°C/yr) in Humla District in winter. At the physiographic level, Terai and Siwaliks show a significant increasing trend in most seasons. The decreasing trend is significant only in winter in the High Himalayas.

Extreme temperature trend: Trends of warm days and warm nights are increasing significantly in most districts. Warm spell duration is increasing significantly and cool days are decreasing in most districts, while cool nights are increasing significantly in a few northwestern and northern districts and decreasing in a few southeastern districts. Cold spell duration is increasing significantly only in the FWDR (Province 7).

Climate Projections in Nepal

Temperature and rainfall will continuously change due to natural and human causes. Projections have been made using different scenarios because we are not sure of the future. Different studies have made the following projections in temperature and precipitation for Nepal.

Temperature: In an study conducted by Organization for Economic Cooperative and Development (OECD), General Circulation Models (GCM) run with the SRES B2 scenario showed mean annual temperature to increase by an average of 1.2°C by 2030, 1.7°C by 2050 and 3°C by 2100. The NCVST (2009) study using GCM and Regional Circulation Models projected the mean annual temperature to increase by 1.4°C although a majority are non-significant both at district and physiographic levels by 2030, 2.8°C by 2060 and 4.7°C by 2090. In terms of spatial distribution, a study by Nepal Climate Vulnerability Study Team (NCVST 2009) showed a higher increment in temperature over western and central Nepal compared to eastern Nepal for the year 2030, 2060, and 2090, with projections for western Nepal being the greatest. Similar trends were projected for the frequency of hot days and nights for 2060 and 2090. For a different time period, the following medium and long-term changes are calculated by another study: temperature increase by 1.3 to 1.82°C in the long- term (up to 2.5°C in some places) and temperature rise across the country.

Precipitation: The OECD projections on precipitation are similar to those presented by the IPCC (2007). In terms of winter precipitation, the model projected almost no change in precipitation in western Nepal and up to 5-10 percent increase in precipitation in eastern Nepal. During the summer months, the projection depicted an increase in precipitation for the whole country in the range of 15-20 percent. The NCVST (2009) study projected both an increase and a decrease in mean annual precipitation with no clear trends. In terms of spatial distribution, the study findings showed an increase in monsoon rainfall in eastern and central Nepal as compared to western Nepal. The projection indicated an increase in monsoon and post-monsoon rainfall as well as an increase in the intensity of rainfall, and a decrease in winter precipitation. For a different time period, the following medium and long-term changes are calculated by another study: change in precipitation by 8-12% in the long-term and precipitation increase in the western region. Trends are shown in Figure 14.

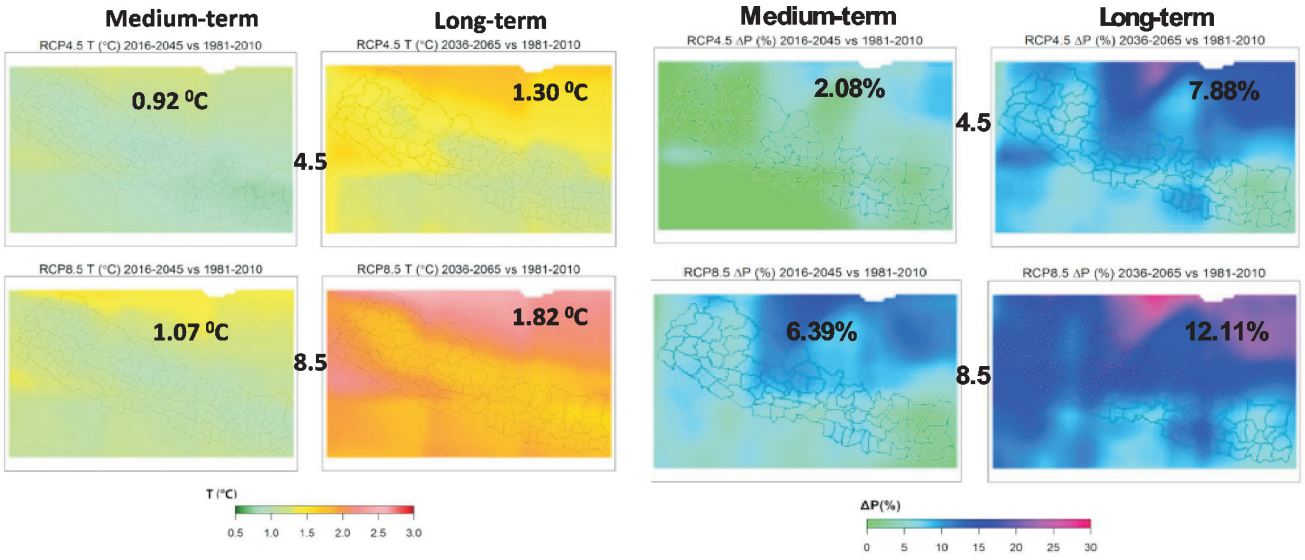


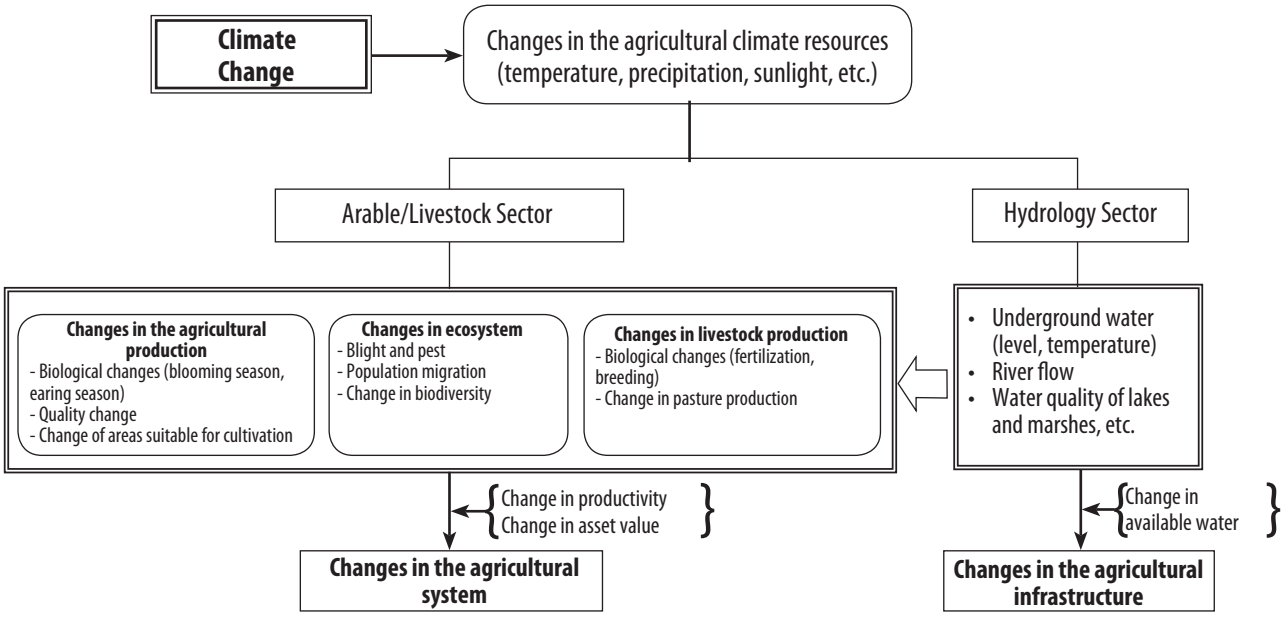
Figure 14. Projection of temperature change (Left) and precipitation change (Right); medium-term and long-term scenarios.

Chapter 3

Impacts of Climate Change on Agriculture Sectors and Livelihoods

Global level Impacts on Agriculture

Climate change and global warming have already affected agriculture and will continue unabated if the current trend continues. Agriculture is highly sensitive to changes in precipitation and temperature. The IPCC Fifth Assessment Report identifies increased food insecurity due to reduced crop yields across the world as a main risk (IPCC, 2014). Higher temperatures not only melt ice that discharges water, but warmer water expands, resulting in rising sea levels and flooding in low-lying areas, which has negative impacts on farm production (Figure 15). Impacts on arable crops are easily seen as biological changes such as changes in flowering and harvesting seasons, quality changes and the shifting of areas suitable for cultivation. It also affects the overall agricultural ecosystem through increased pest and disease attacks, and changes in biodiversity patterns. We can observe biological changes in livestock, particularly in fertilization and breeding. This has implications for livestock feed, for example changes in pasture productivity. In addition to crops and livestock, climate warming has impacts on water level rise which results in low and high water flow. Increase in precipitation by climate change leads to an increased outflow while the temperature rise increases evaporation resulting in a reduction of outflow. In overall, this has implications for agricultural productivity including changes in crop growth and changes in energy and moisture content in fields.



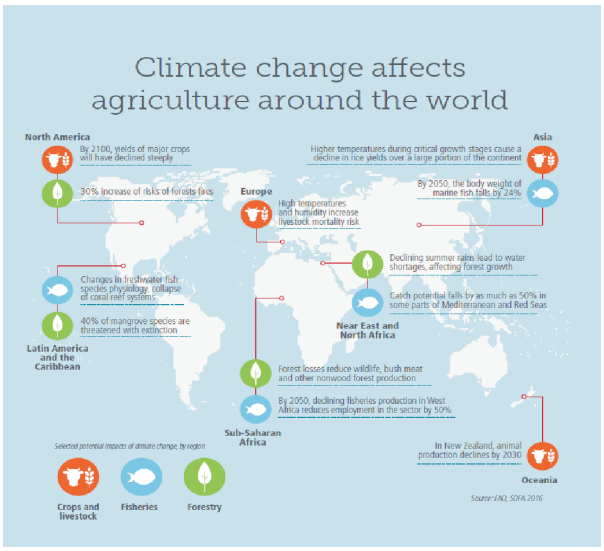
Source: Kim, Chang-Gil and et al. (2009), p.36.

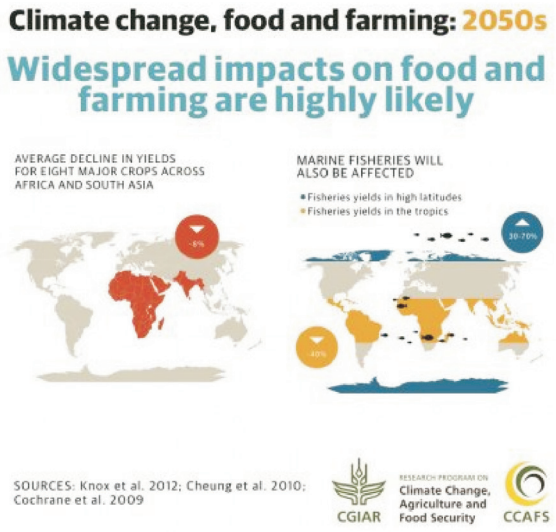
Figure 15. Flow of climate change impacts on agricultural sector. Source: Kim and Lee, 2009.

Impacts on Crops

Changes in temperature and rainfall patterns have significant impacts on crop production which than has implications on reducing yields of major crops like rice, wheat and maize. In mountain areas, where cool temperatures are currently constraining crop growth, an increase in temperature levels may increase plant growth and yields. However, in Terai regions, higher temperatures and too little and too much precipitation will harm crops and reduce yields, posing serious challenges for farmers to ensure productivity. The impact will vary with crops as well as with time and space (Figure 16A). The future climate will have a greater impact on smallholder farmers in poor countries. For instance, Asia will have an 8% decline on average in eight crops by 2050 (Figure 16B). C3 plants such as rice, wheat, soybeans, fine grains, legumes, and most trees will be affected

most but C4 plants such as maize, millet, sorghum, sugarcane and many grasses will be affected less due to differences in photosynthetic efficiency.

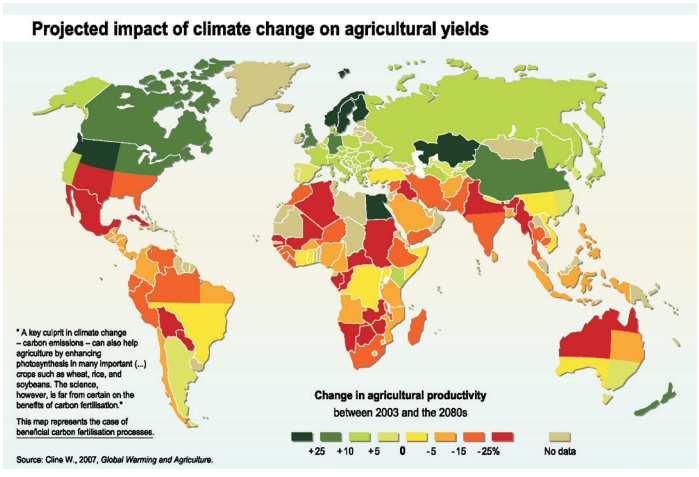


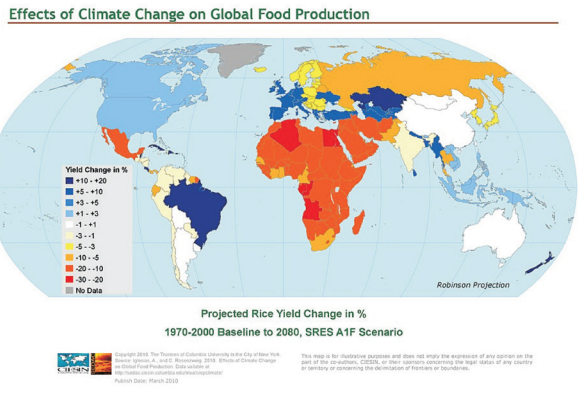


A B

Figure 16. How climate change will affect agriculture in different regions, 2050 and 2080.

Tropical countries are already the hardest hit by climate change. The northern hemisphere will benefit from global warming because more areas will become favorable for agriculture. Mainly, Europe, Eurasia, North America and China will gain from the increase in temperature because the climate will gradually become warm enough to grow more crops and get higher yields. In the Special Report on Emission Scenarios (SRES) A 1F scenario of IPCC, rice yields will drastically decline in almost all African and Mesoamerican countries by 2028 as compared to the baseline (1970–2000) (Figure 17).



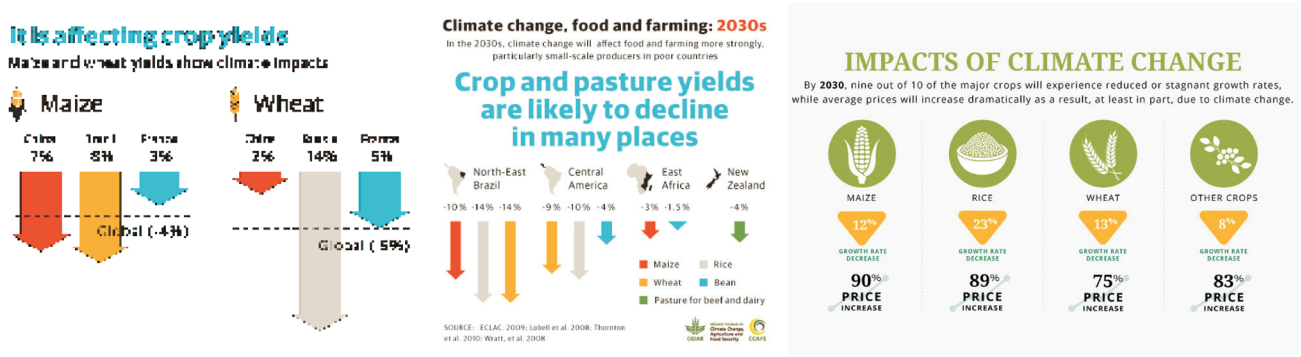


A B

Figure 17. Projected impact of climate change on agricultural yield between 2003–2080s (A) and effects of climate change on global food production between 1970–2000 (baseline) to 2080 (B).

Climate Change, Agriculture and Food Security (CCAFS) estimates show that maize, wheat rice, beans and pasture have been significantly affected by temperature rise. Prices of different crops in Australia, Russia, USA, India, and Argentina are already affected. Estimates show, maize and wheat yield has declined in several countries across the world, mainly in Brazil (8%), China (7%) and France (3%) for maize and Russia (14%), France (5%) and China (2%) for wheat (Figure 18A and Figure 19). By 2030, it is estimated that rice, wheat, maize, beans and pasture yield

will decline in Northeast Brazil, Central America, East Africa and New Zealand (Figure 18B). By 2030, growth rates of nine out ten crops will reduce or stabilize (e.g. 12%, 23%, 13% and 8% decline in maize, rice, wheat and other crops) with implications for average prices of these crops: maize by 90%, rice 80%, wheat 75% and other crops 83% (Figure 18C).



A B C

Figure 18. Impact of climate change on agriculture and crop price: (A) past, (B) trend and (C) projections.[5]

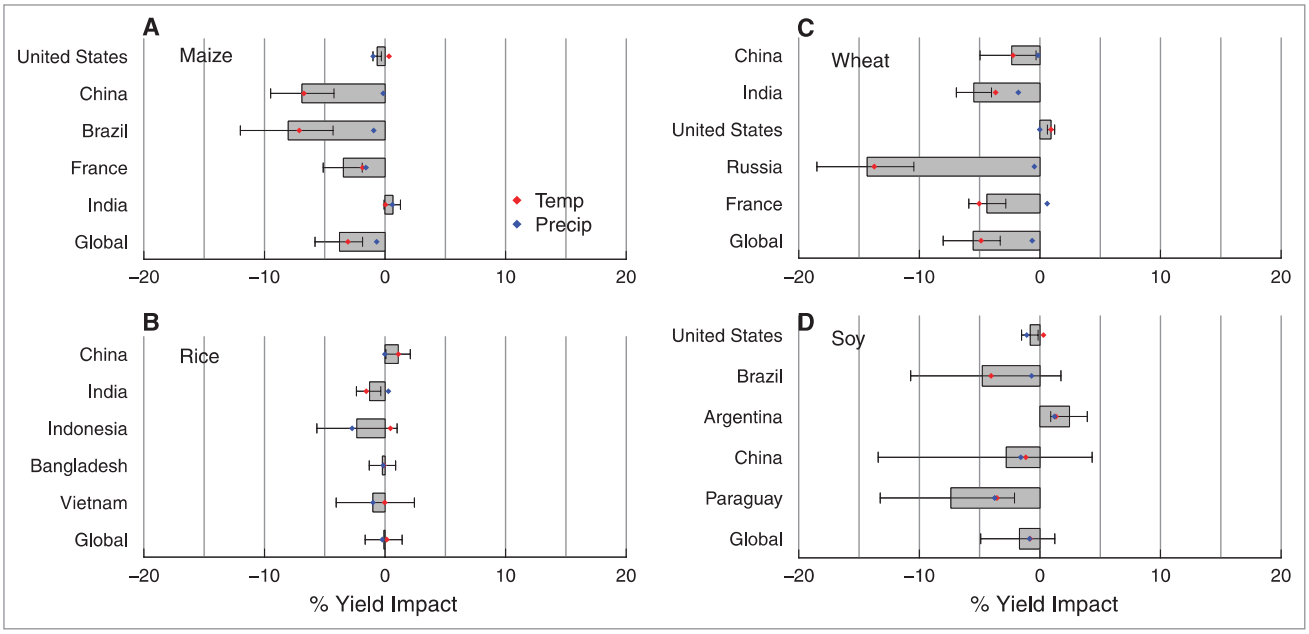


Figure 19. (A to D) Estimated net impact of climate trends for 1980–2008 on crop yields for major producers and for global production (Values are expressed as a percent of average yield. Gray bars show median estimate; error bars show 5% to 95% confidence interval from bootstrap resampling with 500 replicates. Red and blue dots show median estimate of impact for T trend and P trend, respectively).

Drought affects the agriculture sector heavily compared to other hazards. Between 2006 and 2016, about 83% of all damage and loss caused by drought was borne by agriculture (FAO 2017). This was followed by volcanic eruption (30%), storm (23%), flood (17%), tsunami (11%) and earthquake (4%). Another study estimates that with no adaptation, maize yields could decrease by 45 percent, wheat by 50 percent, rice by 30 percent and soybeans by 60 percent, compared with simulations that do not include climate change (FAO, 2016b; Figure 20).

5 Accessed at https://steemit.com/celestialchallenge/@n2ahmed/world-population-and-climate-change-and-agriculture
Original source: Source: Porter J.R., L. Xie, A. Challinor, K. Cochrane, M. Howden, M.M. Iqbal, D. Lobell, M.I. Travasso2014. Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the IPCC. http://www.ipcc-wg2.gov/

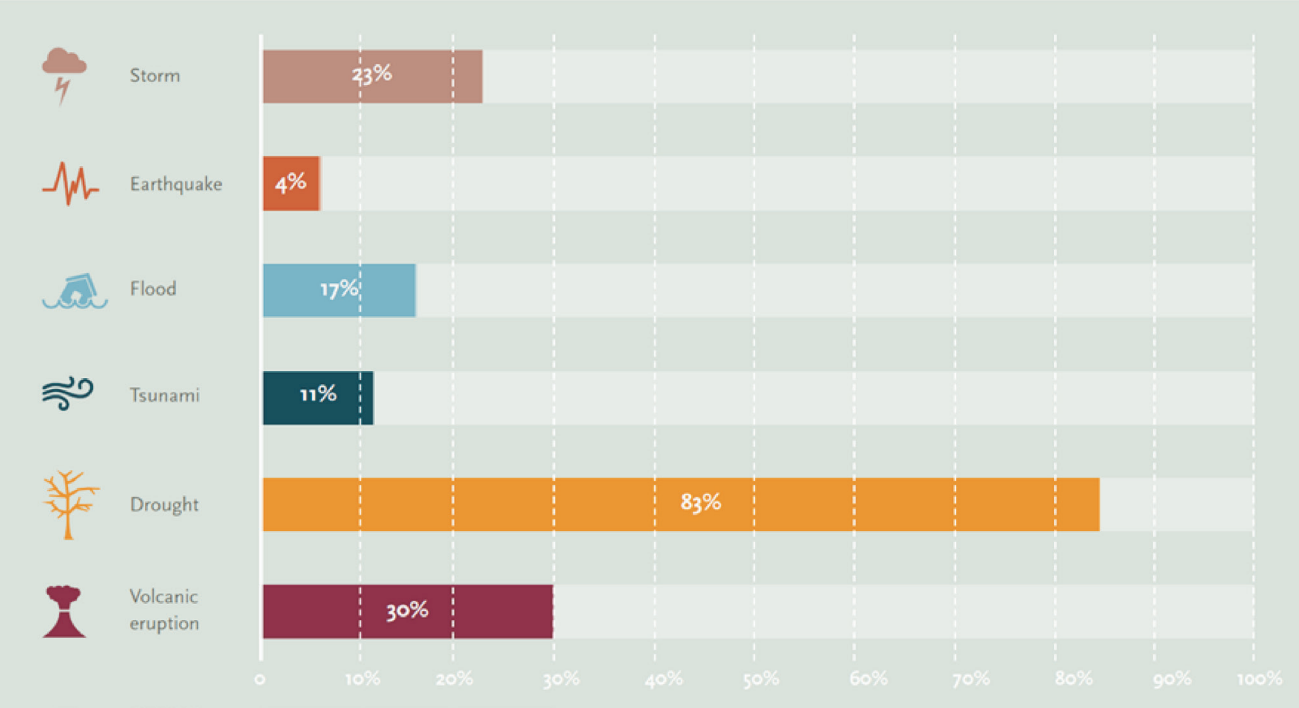


Figure 20. Damage and loss in agriculture as share of total damage and loss across all sectors (2006-–2016), by type of hazards. Source FAO, 2017.

Impact on Livestock

Livestock is an integral part of livelihood support for most households in Nepal. Climate change will increase the vulnerability of livestock and will result in loss of household income and declining crop yields. The direct impact to livestock is through reduced water availability, loss and decline of local fodder and grasses as well as quality of rangeland and pasture. Increased variability in precipitation can lead to water logged ground and to shortages of drinking water, increasing vulnerability to disease. Higher temperatures cause heat stress and make animals less resistant to pathogens (Figure 21).

Livestock provides 17% of global kilocalorie consumption and 33% of global protein consumption (Rosegrant et al., 2009). The sector contributes to the livelihoods of one billion of the poorest people in the world and employs close to 1.1 billion people (Hurst et al., 2005). Livestock production is likely to be adversely affected by climate change, mediated through the competition for land and water, and will have impacts on food security (Thornton, 2010). Climate change will affect livestock production through competition for natural resources, quantity and quality of feeds, livestock diseases, heat stress and biodiversity loss while the demand for livestock products is expected to increase by 100% by 2050 (Garnett, 2009). In Asia, the loss in agricultural production in crops and livestock was high, particularly in 2008 and 2015. The estimated loss was more than 9 billion USD observed mainly in southern Asia due to monsoon floods and earthquakes reported during the time period.

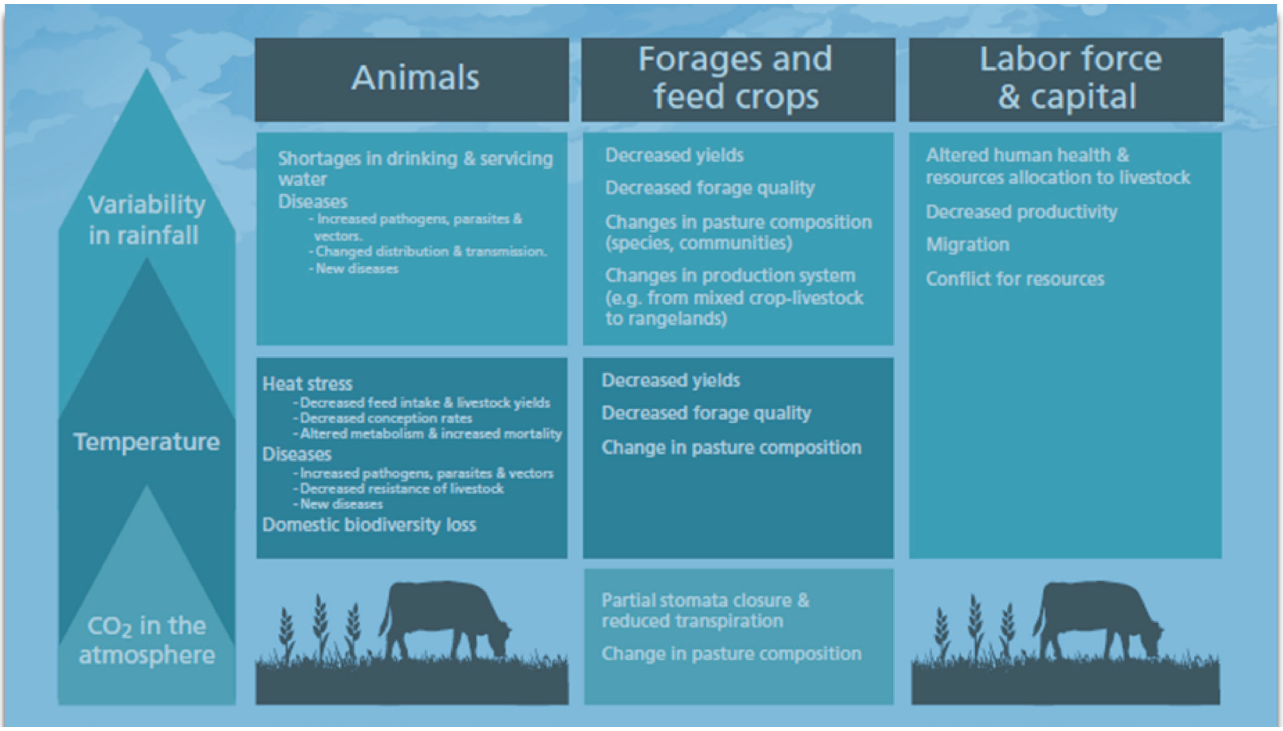


Figure 21. Climate change effects on livestock keepers and production. Source: FAO, 2016d.

Impacts on Fisheries and Aquaculture

Fisheries and aquaculture employ an estimated 200 million people directly and indirectly, of which women account for about 19 percent (primary sector alone) and 50 percent if primary and secondary sectors are combined (FAO, 2018). Total global production from the fisheries sector, excluding aquatic plants, was 171 million tonnes in 2016, with 53 percent of this total coming from capture fisheries (FAO, 2018). Total landed value was estimated at USD 362 billion (FAO, 2018).

Aquatic systems will be affected through: i) changes in the hydrological cycle and rainfall patterns, ii) changes in water temperature, iii) alteration of oxygen content, iv) reduction of ice coverage, v) sea level rise, vi) change in ocean circulation, and vii) ocean acidification (FAO 2018). More specifically, climate change will lead to oxygen deficiencies in water as well as a decrease of aquatic plants and animals which means lower productivity. In rivers and oceans, fluctuations in temperature and other climate trends will alter the habitats of aquatic animals as well as the composition of fish species. Coral reef systems are at increased risk due to the combination of rising seawater temperatures and ocean acidification (FAO, 2016a).

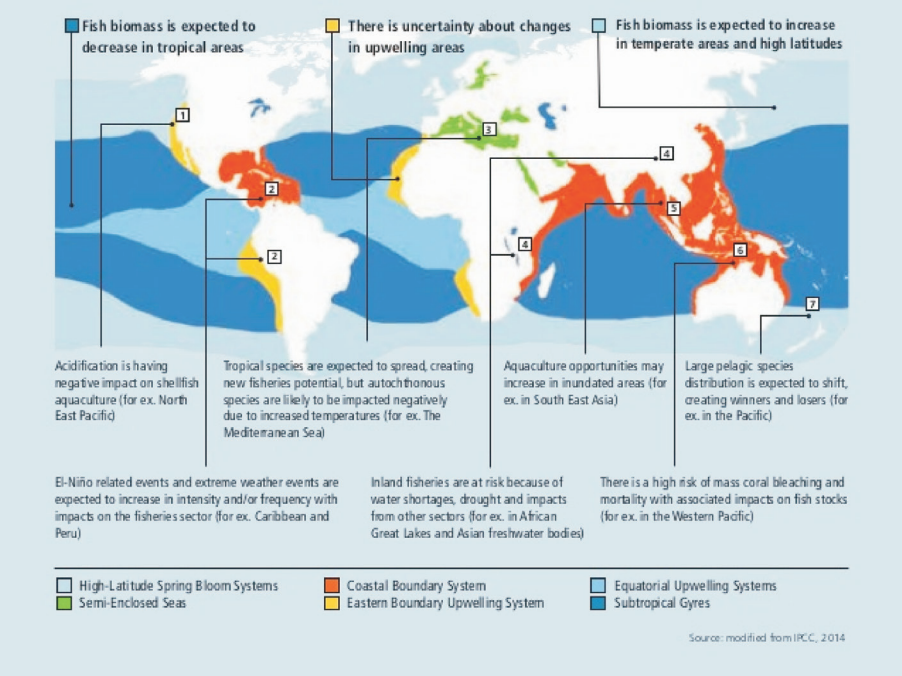
Fisheries are affected both by ocean warming and by acidification. Warming is causing many fish species to move to lower depths and higher latitudes which will likely increase fish populations in subarctic areas and decrease populations in the tropics. It is also likely that species living near the poles and in semi-enclosed seas, may become extinct. A model of global shifts in fish production under climate change (using the SRES A1B scenario of IPCC) projects that catch potential would increase by 30 to 70 percent in northern subarctic areas and decrease by up to 40 percent in the tropics. Norway, Greenland, Alaska, and Siberia would see the greatest gains to potential marine catches, while Indonesia, the U.S. lower 48 states, Chile, and China would see the greatest losses (Cheung et al. 2010).

IPCC scenarios imply that by 2050, global mean surface pH is likely to be lower than at any time in the last 24 million years (Turley et al. 2010).

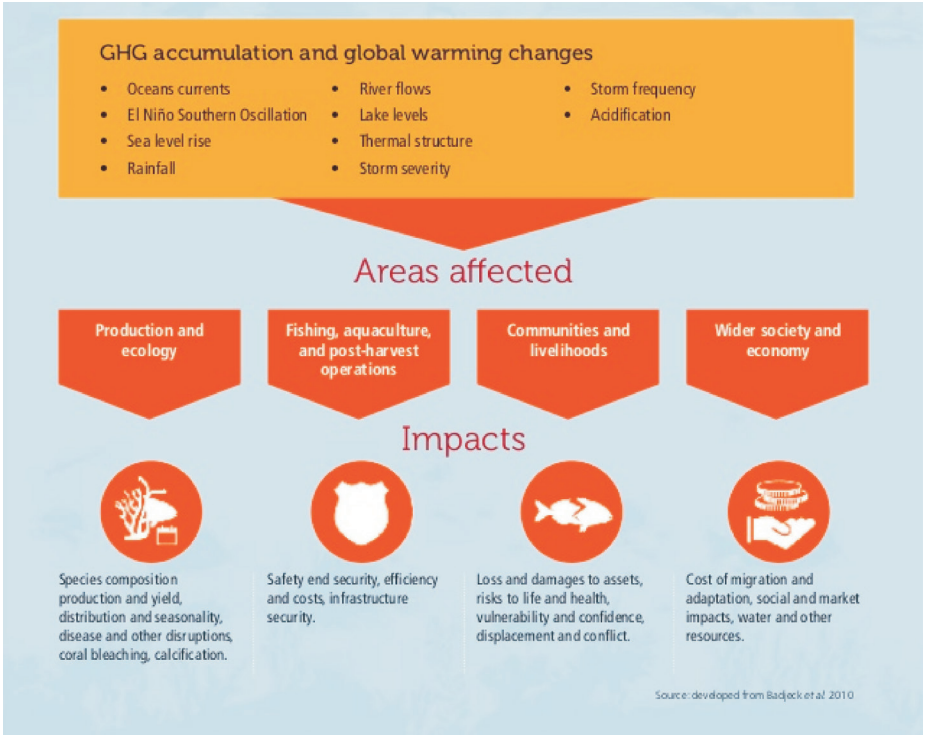
Absorption of CO2 from the atmosphere lowers the pH of ocean water, and acidification will kill many fish, coral reefs being the hardest hit. Slight increases in temperature cause the coral to release or expel algae leading to "coral bleaching" and "eutrophication" which kills fish (Ackerman and Stanton 2011).

On the northeast U.S. coast, the distribution of cold water fish species has already shifted with climate change over the past 40 years (Nye et al. 2009).
Adapted from Ackerman and Stanton 2011.

The changes in light, temperature and nutrition will affect primary production of seas, freshwater lakes, river systems and other water sources. It is estimated that global marine primary production will decline by 6 percent ± 3 percent by 2100 (Kwiatkowski et al., 2017) but there will be mixed results in freshwater lakes. For example, there will be an increase in some arctic and boreal lakes (Michelutti et al., 2005) and a decrease in Lake Tanganyika in the tropics (O'Reilly et al., 2003; IPCC, 2014). Some examples of climate change impacts on fisheries and aquaculture are shown in Figure 22A and Figure 22B.



A



B

Figure 22. Impacts of climate change on fisheries and aquaculture (A) and regional variability of impacts (B).[6]

6 Accessed at https://www.slideshare.net/bakeralan/climate-change-and-fisheries-and-aquaculture

Impact on Agriculture in Nepal

Agriculture constitutes the single most important livelihood source and Nepalese farming communities are highly vulnerable to the impacts of climate change that manifest in the form of untimely monsoon, droughts and higher temperatures. The most severe impacts on agriculture and food security will be the loss of already limited arable land from flash floods and landslides, accelerated soil degradation and loss of soil fertility, outbreaks of new pests and diseases, shortages of water for crop production and uncertainty of precipitation that will directly affect rainfed agriculture, particularly in the mountains. It is predicted that extreme weather events will increase in frequency and intensity and cause negative impacts on agriculture and the lives of vulnerable farming communities.

The figure below is the outcome of the consultative working group meeting of the experts and shows the impacts of a changing climate through its various parameters on biophysical and socioeconomic factors affecting a range of components in the agriculture system.

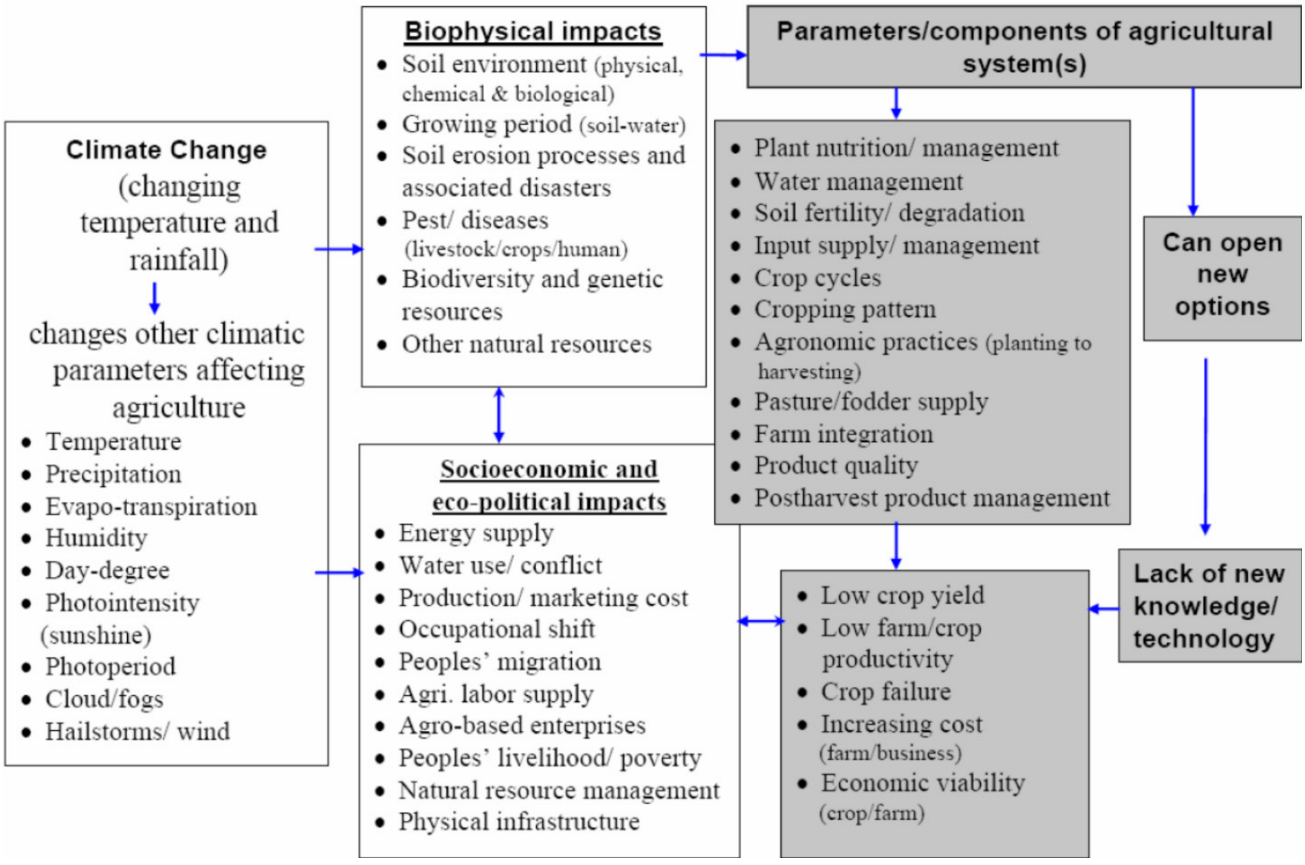


Figure 23. Speculative impacts of climate change on agriculture. Source: Pokhrel and Pandey, 2011.

Agriculture is the backbone of socioeconomic development in Nepal. The agriculture sector involves more than 66% of Nepal's population and produces over one-third of Nepal's GDP.[7] The sector employs more than 70% of the female population.[8] Agriculture covers 4,243,160 ha or nearly one-third of the total land area with a per capita availability of 0.082 ha, which is less than half the world's average. Above 51% of households operate a farm less than 0.5 ha. Nepal's agriculture is mostly smallholder production on rainfed and ecologically diverse land.

7 CBS. (2014). Population Monograph of Nepal. Government of Nepal.
8 ICIMOD, CICERO, et.al. (2014). Women's Empowerment at the Frontline of Adaptation: Emerging issues, adaptive practices and priorities in Nepal.

It is expected that food production will be negatively affected due to early or delayed onset of monsoons, higher variability of rainfall and increased extreme weather events, including drought and heavy flooding (Shrestha et al., 2015a). The Post Flood Recovery Need Assessment Report of the 2017 September flood (NPC 2017) showed that about 58% of the total impact of the 2017 flood affected agriculture, livestock and irrigation. The report also estimated an economic loss of about 69.5 million USD in agriculture (11.9%), 102.7 million USD in livestock (17.6%) and 168.1 million USD in irrigation (28.8%).

Devkota et al. (2017) concluded that rice and wheat yields will decline across the Terai while maize yields will increase in Sunsari and decrease in Nepalgunj and Rupandehi. In the Hills, rice, maize and wheat yields will decline in 2070 compared to 2030. In the mountains, Jumla and Mustang will lose and Solukhumbu will gain in terms of rice yields but lose maize yields in 2070 compared to 2030, whereas wheat yields will increase in Jumla but decline in Mustang and Solukhumbu Districts (Figure 24).

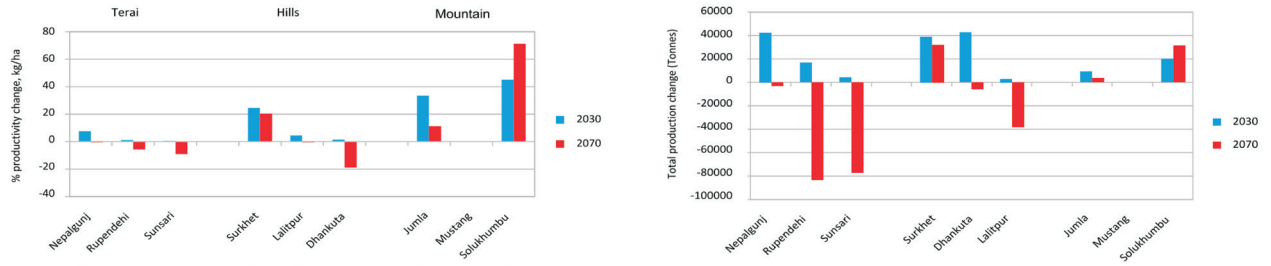


Figure 24A. Percentage change in rice yields from climate change, relative to baseline period (Left) and total change in rice yields from climate change (based on production area), relative to baseline (Right). Source: Devkota et al. 2017.

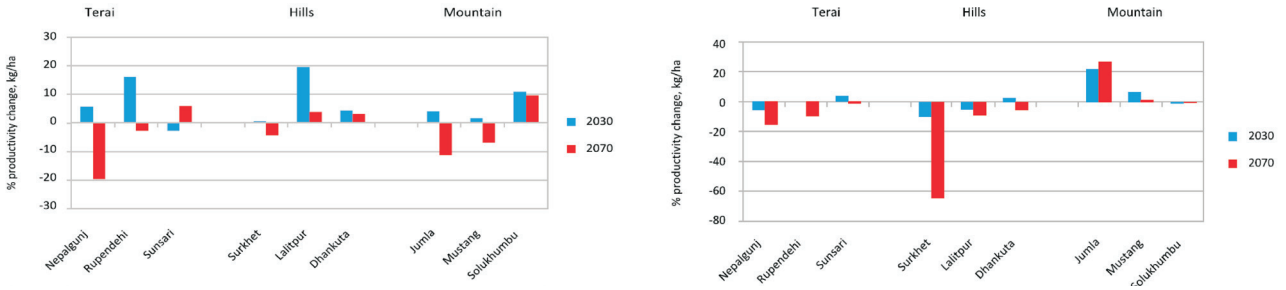


Figure 24B. Percentage change in maize yields (Left) and wheat yields (Right) relative to baseline period.

Livestock plays a pivotal role in household economies, diet and livelihoods, as this sector contributes more to GDP than fisheries and agricultural cash crops combined and makes up 14% of total protein requirements[9]. Aquaculture is one of the fastest growing food sectors in the country and fish is considered the most efficient converter of feed into high-quality protein. Although fish accounts for only 1.7% of total protein supply, it employs 700,000 people (53 per cent women) and contributes USD 154 million (>1.32% GDP) of total national income[10]. The demand for aquaculture and fisheries will reach around 364,000 metric tons by 2032 (94% from aquaculture and rest from capture fisheries)[11], which is a dramatic increase from 46,000 metric tons in 2008[12]. The population of indigenous livestock breeds is in sharp decline mainly because of disease outbreaks linked to a changing climate. However, local breeds of goats and yaks are more resilient to water and fodder and forage shortages (Koirala and Bhandari, 2018).

9 Bhujel R.C., M.K. Shrestha, J. Pant and S. Buranrom (2008). Ethnic Women in Aquaculture in Nepal. Development, 51: (259–264)

10 KC, R.K. 2014. Aquaculture and fisheries development in Nepal: present status, future potential, opportunities and challenges. Paper presented in Terminal Workshop of FAO/TCP/NEP/3303 on Improving National Carp Seed Production System in Nepal. Dhulikhel, Nepal.

11 Mishra, R.N., (2014). DoFD paper on research need in fisheries and aquaculture of Nepal. Paper Presented in Workshop on Programme Planning of Fisheries Research at Fisheries Research Centre, Trishuli, Nepal on 30 December 2014.

12 Bhujel R.C. Small-scale aquaculture: Global and national perspectives. Accessed at http://pubs.iclarm.net/resource_centre/WF_3543.pdf

Chapter 4
Climate Change Vulnerability and Risk Assessments

Climate Change Vulnerability and Risk

Several well-established climate adaptation measures have been practiced by people over the course of human history; however, many individuals and societies remain vulnerable to present-day climate risks. Adaptation involves reducing risk and vulnerability, seeking opportunities and building the capacity of the nation, municipalities, rural municipalities (Gaunpalikas), the private sector, communities, individuals and natural systems. Therefore, adaptation requires information on risks and vulnerabilities to identify appropriate needs and adaptation options.

The concept of vulnerability and risk has evolved over time (Figure 25). Before the new framework developed in Assessment Report 5 (AR5) of the IPCC was widely accepted, the most commonly adopted concept was: vulnerability is the function of exposure, sensitivity and adaptive capacity if the region in question is located in an area with high climate change hazards that are considered to be exposed. If the area or people are likely to be impacted by the hazards, that would be considered sensitive. Both exposure and sensitivity combined comprise an impact. Adaptive capacity is the ability of the area or people to adjust or cope with the impact caused by hazards.

AR5 developed a new framework for risk and vulnerability (Figure 26). In this revised framework, risk is taken as the ultimate factor measuring climate change threat or impact on human lives. Risk is the function of hazard, exposure to hazard and vulnerability to hazard, where vulnerability is the function of sensitivity and adaptive capacity. Risk of climate-related impacts results from the interaction of climate- related hazards with vulnerability and exposure of human and natural systems. Mitigation and adaptation activities are socioeconomic processes that influence both drivers and impacts of climate change.

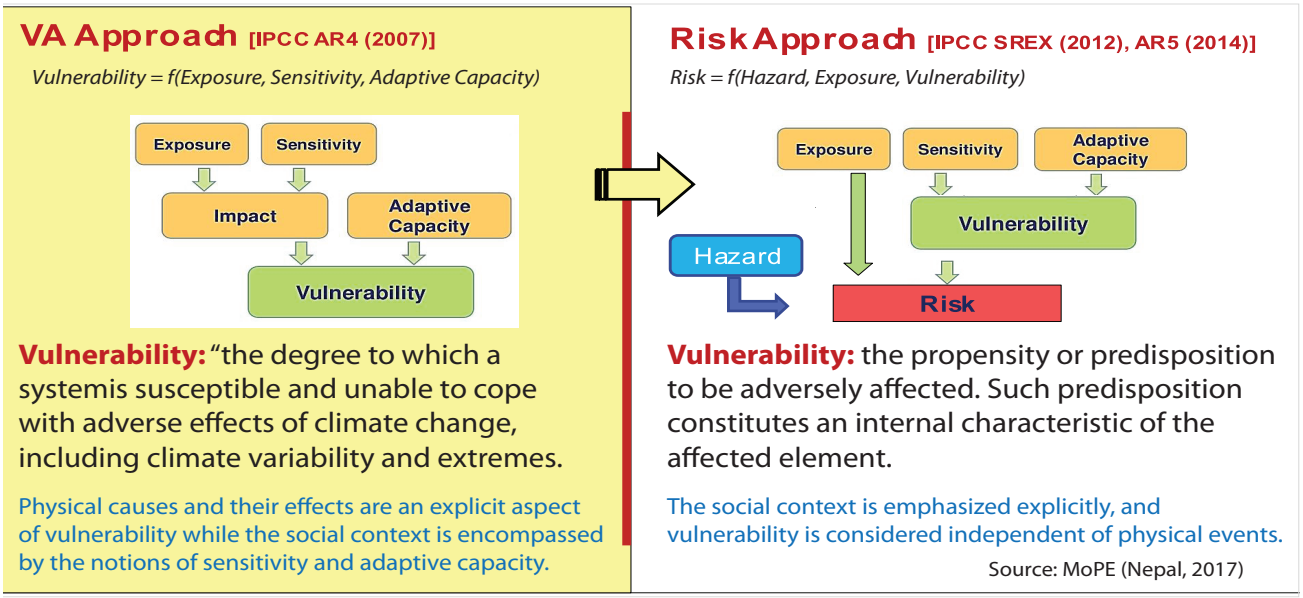
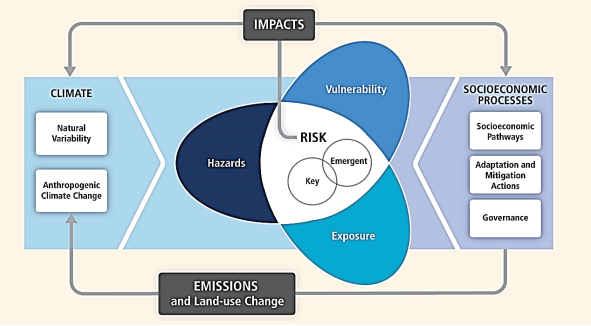


Figure 25. Conceptual framework of vulnerability and risk adopted by AR4 and AR5.



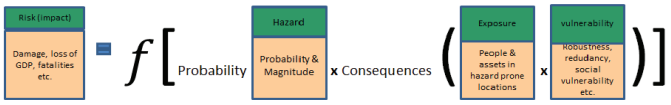


Figure - Composition of Risk

- Risk is a more common concept than vulnerability
- Risk highlights the interlinkage between disaster risk management (DRM) and climate change adaptation (CCA)
- Risk is more widely understood by financial and insurance providers
- May be more applicable for estimating future loss & damage

Source: RESIN, 2015 – Based on Denig et al 2013

Figure 26. Illustration of the core concept of IPCC WGII AR5. Source: IPCC 2014a.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. The term 'risk' is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services, including environmental services, and infrastructure. Examples are listed below.

- **Natural risks:** heavy rainfall, landslides, volcanic eruptions, earthquakes, floods, hurricanes, droughts, strong winds.
- **Health risks:** illness, injury, accidents, disability, epidemics (e.g., malaria), famines.
- **Life-cycle risks:** birth, maternity, old-age, family break-up, death.
- **Social risks:** crime, domestic, violence, terrorism, gangs, war, social upheaval.
- **Economic risks:** unemployment, harvest failure, business failure, resettlement, output collapse, balance of payments shock, financial crisis, currency crisis, technological or trade-induced terms of trade shocks.
- **Political risks:** discrimination, riots, political unrest, coup d'état.
- **Environmental risks:** pollution, deforestation, land degradation, nuclear disaster.

Source: adapted from Holzmann and Jørgensen, 2000; Hoogeven et al. Accessed at http://siteresources.worldbank.org/INTSRM/Publications/20316319/RVA.pdf

The definitions of main terms used in the framework which guide the overall assessment and analysis are presented below (IPCC 2014b):

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In the climate change context, the term hazard refers to climate-related physical events or trends or their physical impacts.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Extreme weather event: An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability

density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

Adaptive capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.

Climate Change Vulnerability and Risk Assessment

These questions can be answered through a vulnerability and risk assessment (VRA):

- What makes one region more vulnerable or higher risk than another?
- In what way do risks vary across regions?
- What regions should get priority based on risk and vulnerability?
- What type of actions are required to address the risks?

VRA has been recognised globally as a critical step in adaptation planning and implementation (IPCC 2014a). It helps pin down current and potential hotspots, identify entry points for intervention, track changes in vulnerability and monitor and evaluate adaptation actions. The attributes of vulnerability and risk assessment may focus on a single sector and one primary impact (for example, sector risk: vulnerability and risk of agriculture, and primary impact: decrease in precipitation or drought) or a wider scope including multiple sectors and impacts (for example, sector: vulnerability and risk of agriculture and biodiversity, and primary impacts: decrease in water availability and increased heat stress). Risk has spatial and temporal dimensions. A spatial dimension determines the units of focus for assessment (spatial or administrative units such as municipalities and Gaupalikas), the level of assessment (regional, national, community, local, ecosystem level, basin-level), and entities to be assessed (one or several communities). The temporal dimension covers a time period during which the vulnerability and risk assessment focuses (e.g. 2018–2030, 2030–2050).

Strengths of VRA (Morchain and Kelsey 2016)

1. VRA employs a comprehensive, gender-sensitive and adaptable understanding of vulnerability.
2. VRA reveals the root causes of vulnerability and leads to improved contextual and systemic understanding.
3. VRA is a creative, participatory and analytical approach that promotes dialogue, strengthens gender and stakeholder relations, and builds capacity.
4. VRA enables knowledge from different sources to be shared, valued and integrated and to shape decision making.
5. VRA informs inclusive programme design and decision making while building accountability.

VRA employs a holistic, landscape-wide approach to vulnerability analysis by engaging actors in identifying and addressing problems. It uses analytical and consensus-building techniques and leads to longer-term resilience. VRA is designed to develop a shared understanding of the links between local, regional, national and global drivers of vulnerability and risk. It aims to build understanding of the root causes and drivers of vulnerability for different people and social groups. VRA also supports the joint identification and prioritization of hazards and issues and their potential consequences (Morchain and Kelsey 2016).

Vulnerability and Risk Assessment Methodologies

There is a range of methods and tools that can be used to assess climate change risk, vulnerability, and impacts. These include quantitative and predictive models, empirical studies, expert judgement, and experimentation. Participatory and qualitative methods are both used to assess vulnerability and risks. Most participatory or community-based vulnerability assessment frameworks avoid mathematical models and quantitative generalizations of community vulnerability. Several examples can be found from the past work of international organizations. Some are similar in several aspects but each tries to add or modify one or more components. The tools are either quantitative or qualitative and either participatory or involve secondary data-based analyses including the use of GIS and remote sensing. Although they were mostly designed before the release of AR5, the tools remain valid mainly when it comes to information collection. The analysis part for AR5 is different from AR4 mainly due to the altered definitions of terms, so caution is needed when data analysis is done. Following Table 7, an agro-ecological zone-based vulnerability and adaptation planning tool is discussed.

Table 7. Main features of vulnerability and risk analysis tools used by different organizations.

Institution	**Main features**	Reference
CARE International	Focuses on the qualitative aspects of addressing the underlying causes of vulnerability at a variety of scales from national to household and individual.	Daze, Ambrose, & Ehrhart (2009)
Care and IIED	Participatory monitoring, evaluation, reflection and learning for community-based adaptation (PMERL) manual designed for local practitioners with a major focus on empowering local stakeholders to articulate their own needs, measuring changes in adaptive capacity, local adaptive management for long-term sustainability and continuous and joint learning reflection.	Ayers et al. (2012)
Practical Action	Vulnerability to Resilience (V2R) framework stresses the dynamic and cyclical nature of building resilience to climate change, which makes numerical measurement difficult.	Pasteur (2010)
IUCN	Assessing vulnerability to climate change focuses on obtaining qualitative data from communities and triangulating it with scientific data.	Marshall, et al. (2009)
Tear fund	Includes the quantification of risks posed by various climate-related hazards, which allows for the prioritization and selection of adaptation options (the greater the risk, the greater the need for adaptation options).	Wiggins and Wiggins (2009)
IISD	CRiSTAL (Community-based Risk Screening Tool – Adaptation and Livelihoods) is an interactive, step-by-step tool for quantifying livelihood components in relation to hazards. It has four important main features: demand-driven, partnership-driven, user-endorsed and dynamic. Major focus is given to community projects to help users identify and prioritise climate risks and develop adaptive strategies based on the livelihood resources they believe are the most important to climate adaptation.	IISD 2012
World Bank	Quantitative vulnerability assessment in the book "Evaluating Climate Change and Development". In the chapter "Vulnerability Assessment as a Tool to Build Resilience among the Coastal Community of Mauritius" the authors quantify vulnerability in terms of existing conditions and assets using a sustainable development framework that takes into account physical, biological, social, economic, and cultural capitals, and the impacts of changes and hazards on those conditions and assets.	Van den Berg & Feinstein (2009); Panray, Noyensing, & Reddi (2009)

WWF	Assessment method based on Livelihood Vulnerability Index and quantitative treatment to IPCC definition to assess vulnerability by setting out indicators that qualifies exposure, sensitivity and adaptive capacity and normalised values for each indicator to come create profiles (climate, demographic, agriculture, ecosystem and socioeconomic). However, this is macro-level analysis based on secondary data, use of GIS application and involves several steps moving from indicators to profiles and ultimately to the final vulnerability index.	
UNDP	Adaptation Policy Framework provides guidance on designing the implementing projects that reduce vulnerability to climate change by reducing potential negatives impacts and enhancing any beneficial consequences of a changing climate.	Burton et al. (2004)
Oxfam	Focuses on vulnerability to disasters rather than long-term climate change impact. However, it has been a useful tool for participatory vulnerability assessments in rural and urban communities. The methodology provides a participatory process of identification and prioritization of existing and future vulnerabilities, risks, capacities and ambitions.	de Dios (2002)
ICIMOD	An analytical framework and a participatory methodology for assessing climate change vulnerability in mountain communities.	Macchi (2011)
PWC	A climate change risk and vulnerability assessment of agro-ecological zones of Nepal and appraising climate change adaptation measure in agriculture. Temperature, moisture index, topography (elevation and slope) and soil order data were used to identify agro-ecological zones. See below for additional details.	

Agro-ecological Zone-Based Vulnerability and Adaptation Planning

Price Water Commission (PWC), with support from UNDP, carried out a climate change risk and vulnerability assessment of agro-ecological zones of Nepal and appraised climate change adaptation measures in agriculture. Temperature, moisture index, topography (elevation and slope) and soil data were used to identify agro-ecological zones (AEZs).

The AEZ approach to vulnerability and adaptation planning developed by the Human Development Network (2013) is shown in Figure 27. First, climate class and moisture regime data are aggregated, which is related to temperature and moisture data. Second, detailed agro-edaphic zone data (landforms, topography and soil order data) is collected from LRMP's digital maps (1986). Third, both the climate class and moisture regimes and agro-edaphic data are combined to develop agro-edaphic zones. Subsequently, the agro-climatic zones and agro-edaphic zones are combined on a GIS platform to delineate the agro-ecological zones for watersheds.

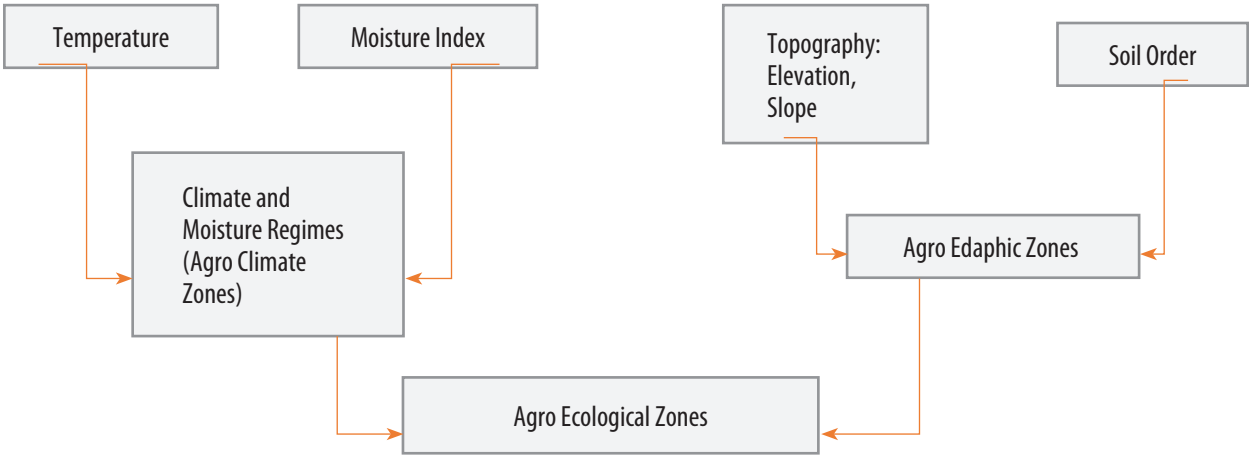


Figure 27. Methodology applied for delineating AEZs. Source: Human Development Network, 2013.

VRA Methodologies Adopted by Government of Nepal

A few attempts have been made to assess climate change vulnerability and risk in Nepal, where a number of biophysical, socioeconomic and accessibility-to-service infrastructure parameters were taken into consideration and the mapping and assessment was done at district level.

- MoE National Adaptation Programme of Action (NAPA) and Local Adaptation Programme of Action (LAPA) projects conducted Climate Change Vulnerability Mapping at district level following the methodology of IPCC AR4 and developed vulnerability maps for GLOF, droughts, floods and landslides (MoE, 2010; GoN 2010a, 2010b).
- National Planning Commission (NPC) developed a climate framework that recognises various issues of climate change, including its drivers and impact vulnerability, and outlines mitigation and adaptation measures to achieve its fundamental goal of sustainable development under anticipated climate scenarios. The report discusses the screening processes to evaluate development projects for their impact. It proposed a sensitivity matrix to identify climate sensitivity of a plan or programme and a disaster risk management framework (NPC 2010).
- Nepal Second National Communication Report (2014) includes Vulnerability and Adaptation Assessment of various climate sensitive sectors including agriculture (GoN, 2014).
- Community vulnerability and risk assessments have been carried out in the country. A community-based disaster risk reduction project has been implemented in selected districts of Nepal with support from UNDP Nepal. It adopts a multi-hazard approach while assessing the vulnerability and integrated watershed management approach while preparing and implementing adaptation plans for action. It is based on a bottom-up approach with close coordination with concerned VDCs and DDCs.
- Government of Nepal has developed and tested community-based vulnerability assessment tools and methodologies and risk mapping in communities in three physiographic regions, Mountain, Hills and Terai. The report discusses methods for collection and analysis of community data and information for vulnerability and risk assessment and a framework for the development of adaptation plans.
- Recently, the government developed Vulnerability and a Risk Assessment Framework and Indicators for National Adaptation Plan (MoPE, 2017).

Methodological Process Adopted by NAP-Ag

There must be some cautions and a broader understanding of the main indicators to be taken into account in vulnerability assessment. It is important to note that the vulnerability assessment in the NAPA process was based on the knowledge provided in the AR4 of IPCC in 2007 which included both stakeholder and expert knowledge

and use of statistics. However, the NAP process in Nepal adopted the concept and knowledge presented in the IPCC AR5 2014, which put forward the concept of 'risk' in addition to 'vulnerability'. The IPCC Framework considers risk as a function of hazard, exposure, and vulnerability. Although there are various methods of VRA, agriculture sector CCVRA assessment has adopted the methodology and framework developed by Nepal's NAP process offered in the report of IPCC AR5 2014 which has put forward a concept of 'risk' in addition to 'vulnerability' and emphasised social context in the view that vulnerability can be independent of physical events. The IPCC Framework considers risk a function of hazard, exposure, and vulnerability.

Table 8. Methodological steps followed for VRA.

Step	Action	Description
1	Scoping vulnerability and risk (unpacking AR5 concepts and terminologies, scoping)	This step sets the boundaries of vulnerability and risk assessment methodology and involves stocktaking of existing methodology, approaches, and frameworks for undertaking vulnerability and risk assessment.
2	Developing the VRA framework	Nepal's NAP process has developed and adopted the following framework (Figure 28) which has to be used for conducting VRA of any sector, geographic region, or ecological zone. This framework can be used for agriculture sector VRA as well.
3	Identifying main indicators for hazard, exposure, and vulnerability (sensitivity and adaptive capacity) for different themes	This step involves the identification of indicators for hazard, exposure, and vulnerability (sensitivity and adaptive capacity) of the given sector. The indicators identified for agriculture sector CCVRA are given in the indicator section.
4	Exploring data sources, nature and character	The sources of data related to climate trends and scenarios, and socioeconomic aspect are identified and explored.
5	Data collection, tabulation, filtering, and normalization	Data is collected from various sources and tabulated, filtered and normalised. Indicator values are in metric, ordinal (ranking) or nominal (descriptive-soil type or land use land cover). On a metric scale, numerical values where the difference between two values is clearly defined and of the same interval, that means that the difference between 2 and 3 is the same as the difference between 54 and 55. In ordinal scales, one given value is greater or less than another, but the interval between values is undefined or unknown. In a nominal scale, we simply name categories our values.
6	Allocation of weight and composite value	Appropriate weight and composite values are given to data for the analysis. The criteria and weight indices are developed based on consultations and expert opinions.
7	Analysis of data	This step involves analysis of data which helps identify trends in variables and indices that could be useful for planning and decision-making.
8	Identifying climate change impact and risk	Impacts and risks are identified and ranked. The ranking of impacts and risks is done through a consultative process. The final mathematical calculation for VRA is the ranking of the assessment results. For big population data, range is a common tool for ranking.
9	Presentation of results in map	Results are presented in maps (Figure 29).

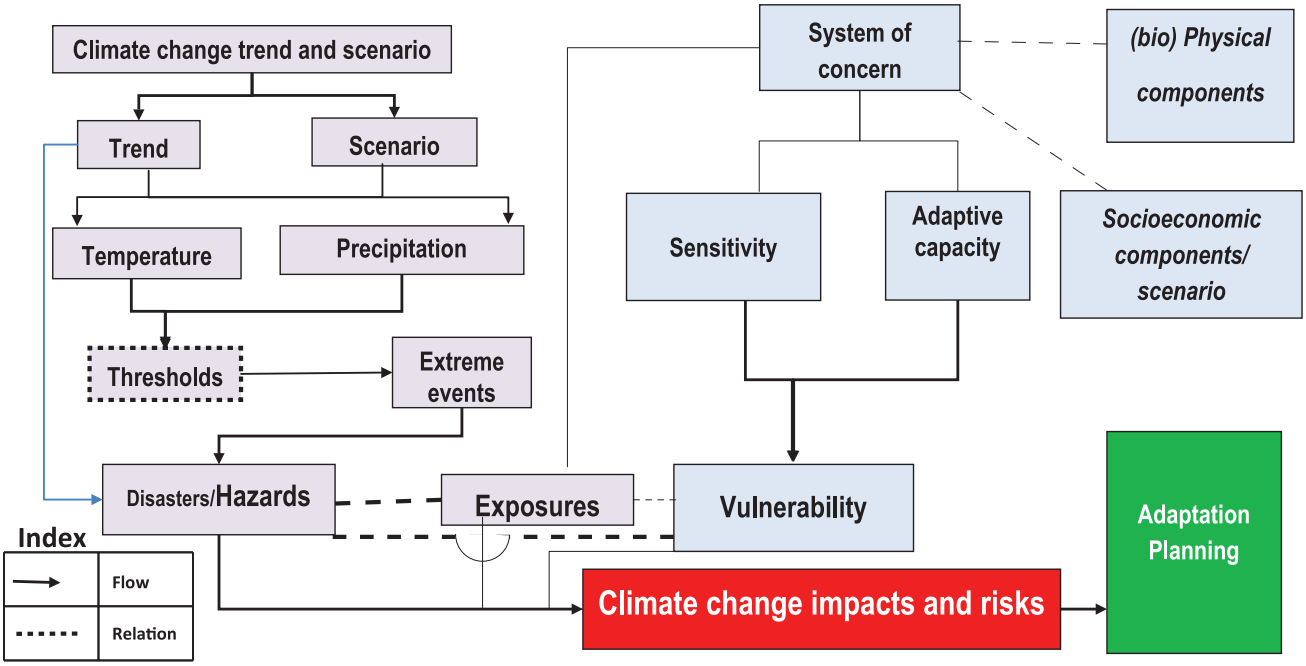
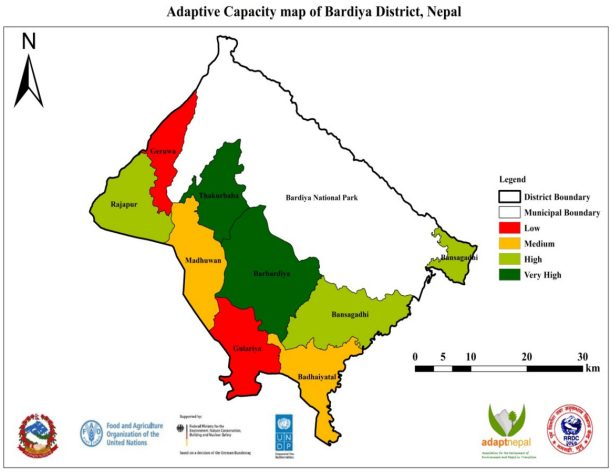


Figure 28. Methodological framework adopted by Nepal's NAP process. Source: MOPE 2017.



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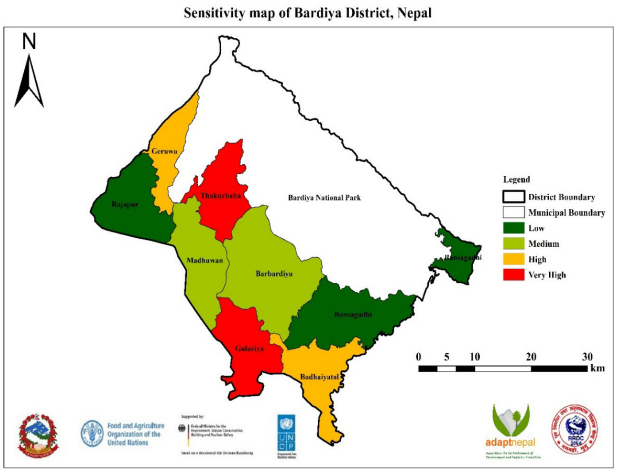

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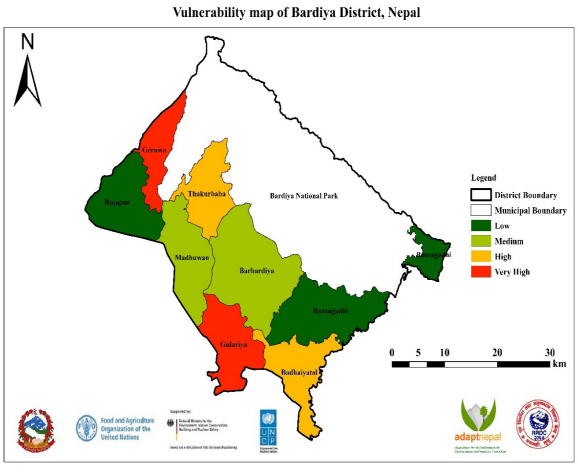

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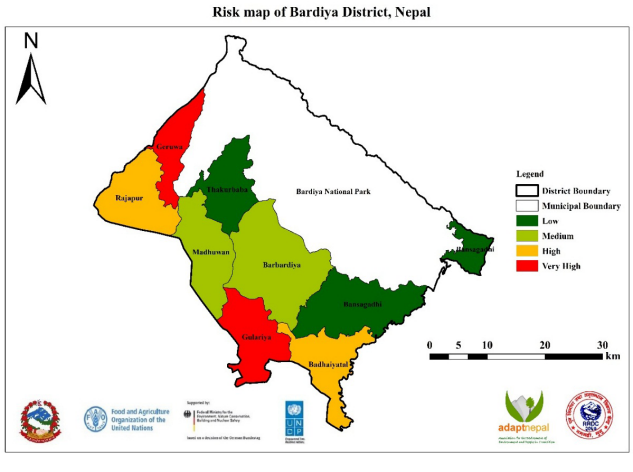

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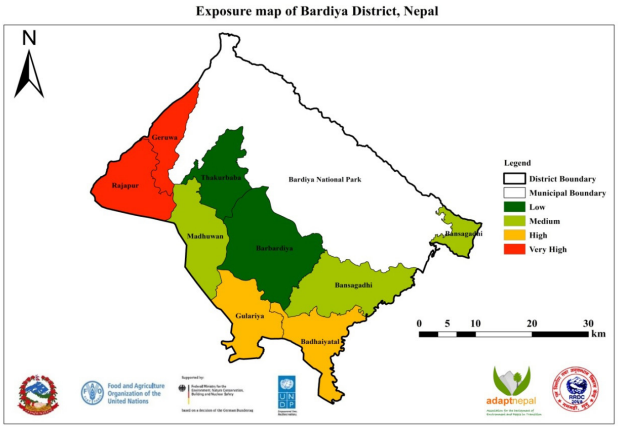

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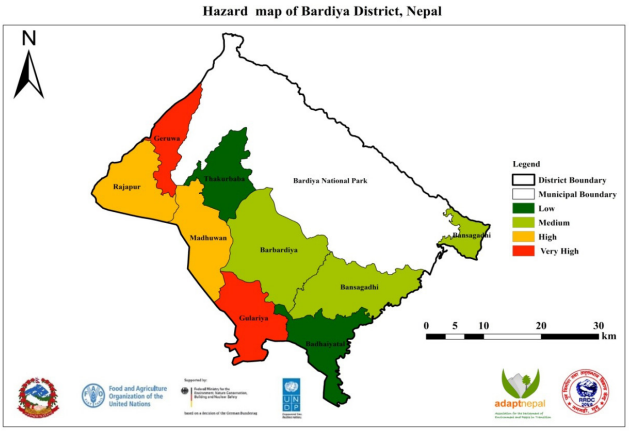

F

Figure 29. Maps generated from the vulnerability and risk assessment. Examples from NAP-Ag from Bardiya District A: Exposure; B: Hazard; C: Adaptive capacity; D: Sensitivity; E: Vulnerability and F: Risk.

Chapter 5

Identification, Prioritization and Integration of Adaptation Options

Identification of Adaptation Options

Adaptation needs lie in the gap between what might happen as the climate changes and what we might desire to happen. In the NAPA, needs were discussed in terms of major vulnerabilities and priority adaptation activities (a hazard-based approach), but more recently, the focus has been on tackling the underlying causes related to vulnerability such as informational, capacity, financial, institutional and technological needs. Approaches might be an incremental change to reduce impacts while achieving co-benefits or transformative changes to address large scale and profound impacts. Local governments, NGOs and civil society organizations are the key actors who can accelerate bottom-up efforts of communities and households in planning and implementing their selected options.

Adaptation actions have been organized into three general categories: structural and physical, social, and institutional. The structural and physical include adaptation options that are discreet, with clear outputs and outcomes. They include structural and engineering options, applying discreet technologies, using ecosystems and their services to serve adaptation needs, and the delivery of services from national to local level. Social options include various adaptation options that target specific vulnerabilities of disadvantaged groups, including targeting vulnerability reduction and social inequities. Institutional options involve enhancing the ability of institutions responsible for climate action. Organizations have adopted different techniques to identify adaptation options.

Examples of Identifying Adaptation Options

UNDP in Pilot Districts (UNDP, 2018)

The study commissioned by UNDP aimed at developing national capacities to identify and prioritize the costs of adaptation options in agro-ecological zones (AEZ) that would reduce climate-induced disaster risks in three pilot districts, Mugu, Dailekh and Bardiya (Table 9).

Table 9. Adaptation practices identified by UNDP.

Category	Examples of adaptation practices
Sustainable Agriculture Management	Plastic tunnels, climate tolerant crop varieties, promotion of zaid crops like watermelon, cucumber, pumpkin and gourds, botanical pesticides combined with integrated pest management, introduction and promotion of pests and disease resistant varieties, promotion of mulching to cover the land with plastic sheets to minimize water from evaporating, improvement of existing gravity irrigation systems, diversifying the farming system, cultivating drought resistant crops in areas that experience decreasing rainfall, the adjustment of planting dates, altering cropping location, improved land management
Sustainable Livestock Management	Fodder banks and storage of dried fodder to provide a steady supply of fodder during droughts and floods, transportation facilities for produce to markets, introduction and promotion of improved breeds (cross breeds) of animals through artificial insemination for higher production of milk and meat, cattle shed management, promotion of poultry farming
Sustainable Forest Management	Agroforestry and measures to reduce forest fires (water recharge zone creation, scientific forest management, systematic management of sand and gravel)
Sustainable Water Management	Construction of water harvesting structures and water channels to increase and ensure better access to water for farmers; construction of river training structures such as gabion wire with boulders, dykes, dams, diversion canals to control floods; snow and rain water harvesting in plastic ponds for irrigation and drinking water; management of spring sources for irrigation and improvement of channels

ADAPT-Nepal N NAP-Ag Pilot Districts (FAO, 2018)

Tables 10 and 11 list adaptation options practiced by farmers, identified adaptation needs and prioritized adaptation options with climate change vulnerabilities and risks in the three pilot districts and eight local level government units (*gaupalika/nagarpalika*). The process involved three steps: i) enlisting the adaptation measures practiced by farmers, ii) enlisting adaptation needs based on the gaps in farmer practices; and iii) identifying adaptation options appropriate for the locality. Examples from other organizations are shown in Figures 30 to 35.

Table 10. Adaptation measures practiced by farmers and adaptation needs in Bardiya based on NAP-Ag project.

Adaptation measures practiced by farmers	Adaptation needs
• Farmers are using flood and drought tolerant varieties of paddy crops such as Sworna Sub 1 and Sukha series 1-6. • Farmers are giving priority to conservation of paddy seeds and cooperative seed banks are in operation. • Early planting of potatoes before the season to protect crops from cold waves. • Using IPM techniques to biologically control pests and diseases. • Embankment of river channels and tree plantations on river bank areas. • Farmers harvest wheat crops before hot air arrives. • Tube well boring is on rise by farmers to irrigate farmland. • Vegetable growing in flood plains.	• There has been support to farmers to increase production and productivity of crops, fisheries and livestock from DADO and DLSO, farmer groups, cooperatives and local government units. • Most farmers are smallholders and have little or no capacity to cope with impacts of climate change. Hence, they need support from farmer groups and cooperatives, NGOs, CBOs, and from governments at all levels that may include financial, technical and institutional support. • Farmers have little technical know-how on impacts of climate change and adaptation measures and practices. Short-term training, visits, observation tours, Krishak-Pathasala, and IPM centres need to be organized to enhance understanding of farmers on climate change impacts and adaptation measures to be adopted.

Table 11. Local adaptation options in Bardiya District based on NAP-Ag project.

District	Local level	Adaptation measures in practice by farmers	Institutional support to farmers
Bardiya	Rajapur	• Farming on uplands is on the rise as it is well-drained land. • More farmers using water pumps to lift water from Karnali River to irrigate farm land. • Flood tolerant varieties of rice such as Sworna Sub 1, Makawanpur 1, Radha 4 and Sabitri are cultivated.	DADO, DLSO, farmer groups, cooperatives, Red Cross, NGO, INGO, community forestry, Base Nepal and local government unit
	Basanghadi	• Tree plantations and river training is on the rise. • More agricultural land is being irrigated by drawing water from irrigation canals using water pumps.	DADO, DLSO, farmer groups, cooperatives, Red Cross, NGO, INGO, community forestry, Tharu Mahila Shangh, Plan Nepal, Hindi Jagar Sama
	Badaiyatal	• River embankment • Deep tube well • Quantity seed production of improved crop varieties through cooperatives • Improved animal sheds	DADO, DLSO, Agricultural Service Center, Agro Vet Center, farmer groups, cooperatives, Red Cross, NGO, INGO

Other Adaptation Options – Examples from Different Sectors

Other examples of climate change adaptation practiced by different organizations across the world are shown below in Figures 30-35.

Figure 30. Some examples of adaptation options in six sectors. Source: FAO presentation by Beau Damen, 2018. Unpublished. This figure outlines various adaptation techniques in DRR and resiliene, crop production and protection, livestock, forestry, water and fisheries sectors. The examples are takne from different countries across the world.

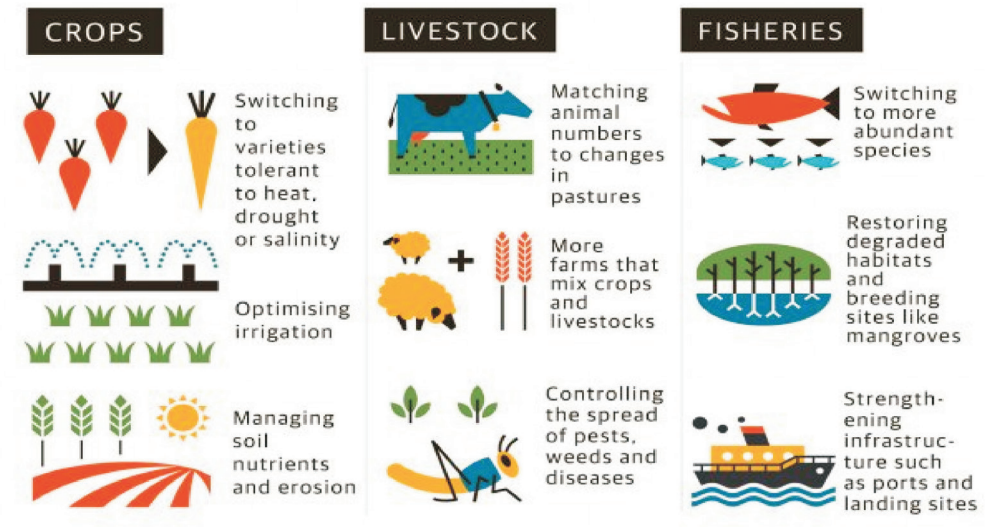

Figure 31. Examples of adaptation options in three sectors. Source: Porter J.R., L. Xie, A. Challinor, K. Cochrane, M. Howden, M.M. Iqbal, D. Lobell, M.I. Travasso2014. Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the IPCC. http://www.ipcc-wg2.gov/

The figure above suggests (for example): farmers need to switch to new varieties or crops that are more tolerant to heat, drought or salinity; livestock keepers need to match animal numbers to changes in pasture; and fisher folks need to restore degraded breeding sites like mangroves to maintain fish populations.

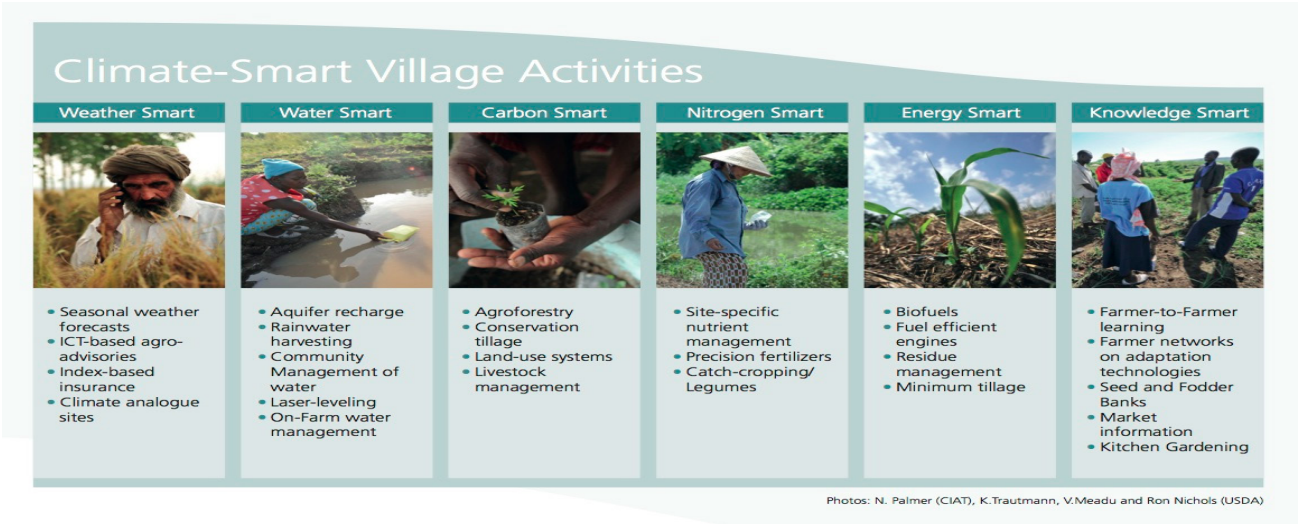

Figure 32. Climate smart agriculture activities practiced in climate smart villages (CCAFS . https://cgspace.cgiar.org/bitstream/handle/10568/33322/CCAFSClimate-SmartVillages2013.pdf?sequence=9&isAllowed=y

The figure above suggests the new adaptation measures to be weather smart, water smart, carbon smart, nitrogen smart, energy smart and knowledge smart because climate change affect weather, water, carbon emission, soil organic carbon and energy use. Knowledge smart is also necessary because new technologies need to be easily adopted and managed by farmers, particularly smallholders.

Champion CSA options	High-hills	Mid-hills	Terai	Smartness
Introduction of new crops, seeds, varieties, seedlings, etc.	✓	✓	✓	Weather and knowledge smart
Home garden	✓	✓	✓	Weather and knowledge smart
Mixed farming (legume integration)	✓	✓	✓	Nutrient and weather smart
Community seed banks	✓	✓	✓	Knowledge smart
Small hand-tools, machines	✓	✓	✓	GESI and labour/energy smart
Agriculture insurance (particularly index based)	✓	✓	✓	Weather smart
ICT-based agro-advisory	✓	✓	✓	Knowledge and weather smart
Cattle-shed improvement	✓	✓	▪	Nutrient and carbon smart
Package of plastic pond, plastic house, drip irrigation and improved cattle-shed	✓	✓	▪	Water, weather and nutrient smart
Plantation and agroforestry	✓	✓	▪	Carbon smart
Plastic house	✓	▪	▪	Weather and water smart
Plastic pond		✓	▪	Water smart
Water-harvesting ponds, multiple-use and water source protection		✓	▪	Water smart
Drip irrigation	▪	✓	▪	Water smart
Solar-based irrigation	▪	▪	✓	Water and energy smart
Conservation agriculture (zero tillage, residue retention)	▪	▪	✓	Carbon, water and weather smart
System of rice intensification	▪	▪	✓	Water smart
Total number of options	**11**	**13**	**10**	

Figure 33. Climate smart agriculture practices recommended for three ecological zones in Nepal. Source: Paudel et al. 2017.

This figure was drawn by a Climate Smart Agriculture (CSA) project implemented by MoALD, LI-BIRD, CCAFS and CDKN. First a portfolio of CSA practices were identified. Among them most promising were tested in farmers' fields in three ecological zones for their feasibility and acceptance. Finally, a list of champion CSA practices were chosen from the tested ones, which is shown in this figure.

Figure 34. Climate resilient and sustainable agriculture practices.[13]

13 Accessed at https://steemit.com/celestialchallenge/@n2ahmed/world-population-and-climate-change-and-agriculture

The technologies shown in the figure directly or indirectly contribute to climate change adaptation in agriculture. Some of them reduce water use and improve its efficiency through effective management. Some of them improve soil management thereby contributing to carbon sequestration.

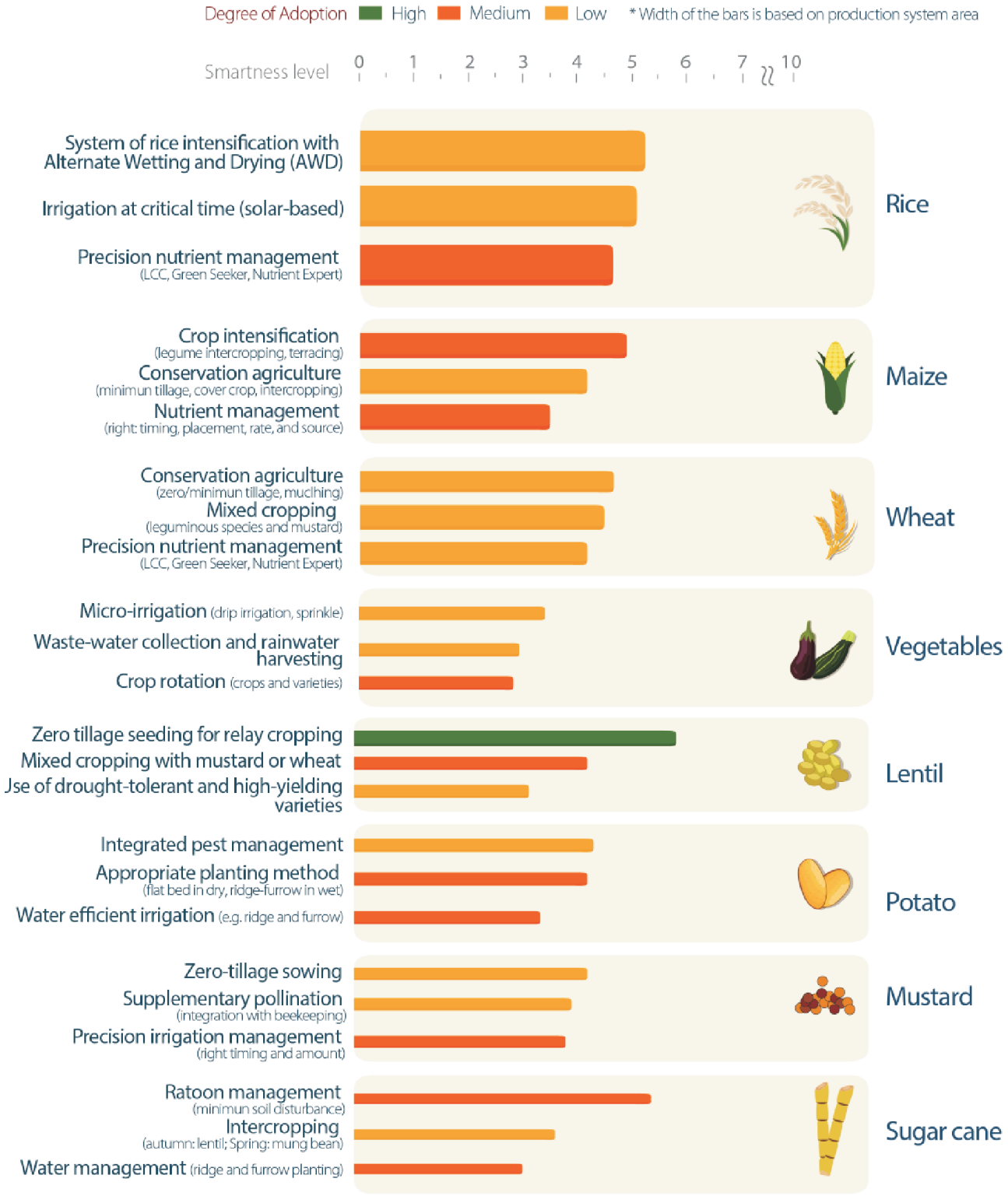

Figure 35. Selected CSA practices and technologies for production systems for food security in Nepal. CIAT, World Bank, CCAFS and LI-BIRD 2017. These technologies were identified through rigorous consultations with experts on specific crops. They were asked to score the technologies with respect to various indicators and the data was finally analysed to produce this figure. For instance, in rice, crop intensification, conservation agriculture and nutrient management are the top ranked CSA practices in Nepal.

Adaptation Needs from GESI Perspective

Since some communities, households or individuals are more vulnerable than others due to differing social, economic and cultural backgrounds, it is important to consider a gender equality and social inclusion (GESI) perspective while identifying adaptation options. This helps identify target activities for the most vulnerable communities, particularly women, marginalized groups and other socially excluded groups deprived of adaptation benefits. The table below shows an example of adaptation needs identification for women.

Table 12. Impact of CC related to GESI, adaptation attempts and support acquired.

Issues related to climate change	Impacts on gender	Existing adaptation practices	Future adaptation needs
Drying up of water sources	• Women have to walk long distances to fetch water for livestock	• Efficient use of water • Tree plantations for conservation of nearby sources • Construction and conservation of cattle ponds	• Support for additional water conservation and harvesting technologies
Productivity and production declining	• Women have to spend more time weeding crops • Women have responsibility of manuring and high demand of manures to increase production	• Use of bio-pesticides • Adoption of organic farming • Use of compost manure	• Training on best weeding practices • Training on compost manure preparation
Scarcity of fodder, grasses and firewood	• Women have to spend a lot of time collecting fodder and firewood	• Fodder and grass plantations on agricultural land • Reduction of livestock and quitting livestock enterprises • Switching to small livestock raising such as goats and sheep	• Development and distribution of new species of fodder and grasses along with technology • Promotion of rotational grazing • Promotion of new breeds of productive livestock and reduction of unproductive livestock

Prioritization of Adaptation Options

There is no one-size-fits-all prescription for addressing climate change challenges. It is therefore important to identify specific options for a locality based on local problems. This also requires identifying different criteria for assessment of options.

Win-win options are often associated with those measures or activities that address climate impacts but which also contribute to mitigation or other social and environmental objectives. Measures include those introduced for reasons other than addressing climate risks, but also deliver the desired adaptation benefits (West and Gawith 2005).

These measures are useful when the risks associated with inaction and the uncertainty and the risk associated with introducing inappropriate adaptation measures are high. In these cases, a flexible or adaptive management approach could be useful. This approach involves putting into practice incremental adaptation options rather than undertaking large-scale and transformational adaptation options all at once. For implementing this approach, measures should be adopted in a sequential manner, based on an iterative evaluation of risks, costs, feasibility and other factors to cater to evolving knowledge, experience and technologies. At this stage, the adaptation team should have established the criteria for the selection and prioritization of adaptation actions. Active involvement of stakeholders should be promoted at this stage. Consider these actions will not, and do not need to, meet all the selected criteria but as a general rule the more criteria met, the more likely the action will help reduce vulnerability (Snover et al., 2007).

The following potential adaptation options may be practical, cost-effective options delivering adaptation and able to minimise risks even with existing uncertainties (UKCIP, 2005):

No-regrets options: Adaptive measures whose socioeconomic benefits exceed their costs whatever the extent of future climate change. This type of measure includes those that are cost-effective and justified under current climate conditions, and are further justified when their introduction is consistent with addressing risks associated with projected climate changes. Focusing on no-regrets options is particularly appropriate for the near-term as they can deliver clear and immediate benefits and can provide experience on which to build further assessments of climate risks and adaptation measures.

Low-regrets (or limited regrets) options. Adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realised under projected future climate change, may be relatively large.

Win-win options. Adaptation measures that have the desired results in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits.

Technology selection is guided by a number of factors:

Emerging technological pathways: guided by the R&D that a nation has invested in to find solutions to climate change impacts on development and on the propensity of the State to transfer similar technologies from other external sources.

Feasibility of technology: depends on the nature of impacts, spatial and geographical characteristics of the vulnerable area and cost of the technology.

Existing technology and practices: are not always necessary to create and adopt new technologies. Existing technologies and practices can be employed to increase resilience. This is particularly true for adaptation, where indigenous knowledge has often proved to be extremely effective. The challenge is to identify these practices and revive or remodel them to address the present issue.

Economic viability of technology and best practices: depends on economic viability. Investors would hesitate to adopt the same technology or practices if adequate returns are not forthcoming during the tenure of the project.

Willingness to adopt technologies: depends on psychological, physical, financial and other barriers that deter target communities from accepting a new technology or practice. To increase the adoption rate for a new system it is important to undertake detailed stakeholder consultations at all levels, spatial analysis, field visits, or focus group discussions.

Prioritization of technologies based on environment and social safeguards and gender assessment: The objective of sustainable development is to maximize social, environmental and economic gains. It is well established that the success of any development strategy, sustainable or otherwise, hinges on its acceptance and adoption by the women of a community, a most vulnerable group. Therefore, between the available technology and practice, the right choice must optimize socioeconomic and environmental benefits. This can be ensured by carrying out environmental, social and gender assessment studies before adopting a new technology or practice.

Source: PwC – Handbook

Criteria for Prioritizing Adaptation Options

These criteria are considered while prioritizing adaptation. Choice depends on the situation, data availability, practitioner skill, interests of communities, and existing policies.

Table 13. Examples of criteria for assessing adaptation options and their impacts.

Criteria	Description
Effectiveness	• It can meet the objectives and the guiding principles of the adaptation process (e.g. reducing impacts, reducing exposure, enhancing resilience or enhancing adaptive capacity) without impeding adaptation elsewhere or in the future. • It is appropriate to the severity of climate change impacts, the options would address other impacts expected in the community, and it is cost-effective.
Efficiency	• The economic and non-economic benefits gained exceed the cost of implementation. • It considers benefits in terms of economic, social and environmental costs.
Equity	• It distributes the benefits of adaptation equally across society. • It considers the effects on vulnerable groups, including economic, social, cultural and knowledge distribution. • It helps allocate risks fairly in social terms. • It can bring advantages to broad parts of society. • It tackles threats for elderly, chronically sick and poor people.
Flexibility	• It allows easily for adjustments and incremental implementation later if climate and non-climate conditions change again or if changes differ from those expected. • It can be adapted, revised or be undone at low cost.
Sustainability, Impacts and Side-Effects	• It is sustainable and contributes to sustainability. • It avoids maladaptation, i.e. it avoids perverse effects and limitations in future adaptations. • It brings benefits in terms of alleviating pre-existing problems (no regrets). • It entails side-benefits for other social, environmental or economic objectives (e.g. to help reduce social inequality, to decrease energy demand, to help raise resilience of ecosystems services). • It avoids affecting other sectors or agents in terms of their adaptive capacity. • It avoids causing or exacerbating other environmental pressures. • It has a potential role in protecting unique environmental or cultural resources. • It should not limit the adaptive capacity of other communities, vulnerable populations, or future generations.
Acceptability	• It is culturally, socially, environmentally and politically acceptable. • It is accepted by those affected and by stakeholders.
Urgency	• It is needed if high danger of significant impacts occurs soon. • It is appropriate in terms of timescale actions needed to be taken regarding the expected climate change impacts (e.g. short, medium and long-term climate change impacts).
External and Internal Coherence	• It is coherent and supports other development goals and priorities (including mitigation), and not just a bolt-on. • The measure is aligned with other local sector policies. • It is coherent with policy, investment, maintenance and other planning cycles. • It includes potential conflicts and synergies within and across sectors.
Robustness	• It reduces vulnerability under climate, low-regrets, incorporates safety margins, mindful of actions by others. • It is robust under different climate scenarios and different socioeconomic scenarios. • It is robust to changes in the frequency or severity of specific climate impacts. • It reflects the range of uncertainty if the climate change is not the expected one (e.g. no regrets measures).
Dependencies	• It complies with actions, legislation, regulatory frameworks, incentives, investments, and externalities needed as prerequisites to implementation.
Deliverability and Feasibility	• It is easily and quickly feasible in legal, technical, social, institutional, political and financial terms and barriers, can be overcome.

Adapted from UKCIP 2018[14]

14 http://www.ukcip.org.uk/adopt/adaptation-options/

Table 14. Indicative adaptation practices prioritized during the transact appraisal exercise of NAPA preparation.

Terai	Mid-hills	Mountain
• Replace shallow wells with deep tube wells and promote water harvesting and small-scale irrigation • Improve rainwater collection and micro-irrigation • Establish plantations to restore natural water supplies • Introduce rapid-maturing and hardy crops adapted to high temperatures • Practise integrated pest management • Reduce inorganic fertilizers and increase use of organic manures • Practise minimum or zero tillage • Address market and production issues through farmer cooperatives • Breed more adaptable varieties and breeds and introduce drought tolerant fruits and vegetables • Introduce insurance schemes for crops and livestock • Conduct capacity building and public awareness • Establish early warning systems • Practise riverbank protection • Introduce alternative energy sources (e.g., biogas)	• Grow vegetable crops instead of potatoes • Select short-duration crop varieties • Practise rainwater harvesting, drip irrigation • Use improved varieties and fertilizers • Establish water conservation ponds • Use groundwater • Increase community awareness on adaptation • Conduct studies on climate change in relation to disease, pest and parasite incidence • Conduct epidemiological studies of the prevalence of plant and animal diseases and parasites • Increase community awareness on crop and livestock insurance, market outlets and seed banks • Establish decentralized buffer stocks and cold storage • Promote agroforestry • Breed adaptive varieties and breeds • Promote seed banks	• Plant trees around farm land and water sources • Replace present crops with hardy varieties • Collect rainwater • Change tree crop types • Tap snow water sources • Introduce small-scale irrigation • Introduce alternative energy sources: improved stoves, solar panels, back boilers, smoke water heaters, micro-hydropower • Establish forest plantations • Introduce micro-irrigation technology • Conduct soil conservation works • Provide training • Establish agro-industries

Source: Government of Nepal, 2010.

Climate Development Knowledge Network (CDKN), LI-BIRD and CCAFS proposed these criteria and indicators for identifying climate smart agriculture technologies and practices (Paudel et al. 2017).

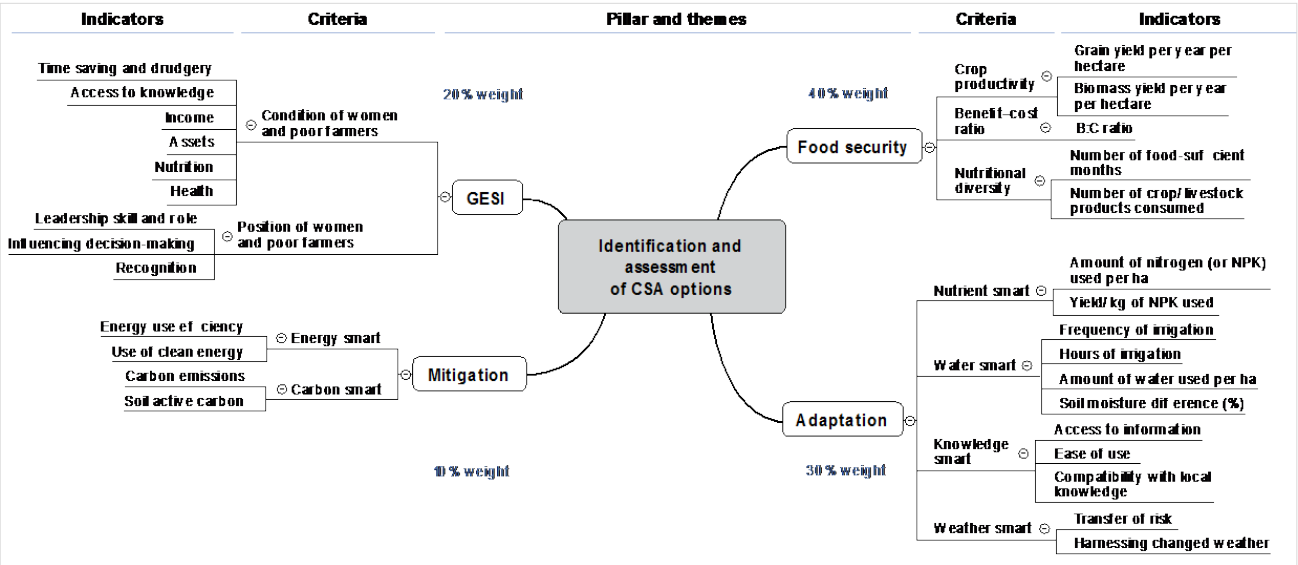

Figure 36. Criteria and indicators for the selection of CSA options.

Adaptation Option Prioritization Tools

Following selection and prioritization of adaptation actions, the next step is choosing, rejecting or postponing actions for implementation.

Table 15. Tools of climate change adaptation options selection and prioritization.

TOOLS	DESCRIPTION
Expert judgment	Assessment by experts in probabilities and risks
Focus groups	Groups of stakeholders who discuss their opinions on specific topics
Brainstorming	Free-flowing lists and diagrams of all ideas and options
Cost-benefit analysis	Assessment of economic efficiency, assigning a monetary value to the measure of effect
Cost-effectiveness	Economic analysis that compares the relative costs and outcomes (effects) of two or more courses of action
Delphi	Iterative, group-oriented, idea-generating strategy
Multicriteria analysis	Examination of more than one and some non-monetary criteria involving subjective judgment
Decision and probability trees	Charts of relationships between decision modes
Influence diagrams and mapping tools	Graphic identification of options

Source: UNDP, 2004.

Mainstreaming and Integration of Adaptation Options into Plans and Policies

Mainstreaming Climate Change Actions

Climate change is a long term environmental issue facing development. Agriculture is the most affected sector by climate change as it depends on both rainfall, availability of water for irrigation, and a temperature regime that suits crops growth. However, with climate change the weather patterns have become more erratic with increased uncertainty. Temperature regimes particularly in the hills and mountains have changed with consequences. As a result, drought, floods, erosion have increased affecting agriculture. Increased insect pests and new diseases have been reported both in crops and livestock. Change in phenology of some crops has also been observed.

Therefore, climate change needs to be an integral part of planning of the agriculture programs, which will ensure that the adverse impacts of climate change are addressed and new approaches are developed to address them in order to maintain sustained production. Mainstreaming climate finance is thus imperative to tackle change-led challenges now and in the future. Mainstreaming helps planners to take informed actions in allocating allocate budget in priority areas. it also helps planners to build understanding of how much funding is made available for tackling different climate change-induced problems and how spending is made and what climate benefits (adaptation or mitigation or both) are achieved.

Integration of Cliamte Change Actions

Addressing climate change requires making systemic responses to climate impacts as part of the regular business of the agriculture sector through agricultural development programs. Separate *ad hoc* actions to address climate change do not bring lasting results. The National Adaptation Plan (NAP) process can serve as a mechanism for integrating climate change adaptation objectives in sectoral strategies. Based on the learning from NAP-Ag, integrating climate change in planning and budgeting at the subnational level needs to be initiated without delay.

Agriculture plans need to be developed and implemented at the subnational level in line with the new federal governance system and SDG roadmap. Efforts made towards integrating climate change in agricultural development plans and budgets need to further extend to the subnational levels. Nepal has made significant progress in integrating climate change in plans and budgets through different entry points in the Public Financial Management systems. This integration allows planners to better address sector-specific climate risk and vulnerability through regular programs and has facilitated inter-sectoral coordination in budget allocation to climate-related programs. These are further elaborated below.

Mainstreaming is necessary to integrate adaptation options into different levels of government plans and policies. Mainstreaming has two purposes: 1) to make certain that all national, subnational and local and sectoral level programs and projects are designed with adaptation measures to reduce the potential risk of climate change, and 2) to make certain that all national, provincial, local and sectoral level development programs and projects do not increase vulnerability to climate change (social, physical, economic and environment). The subnational and local levels matter for a variety of reasons: i) development impacts are best observed and understood at the local level, ii) climate change impacts are felt at the local level, iii) vulnerability and adaptive capacity are context-specific, iv) most adaptation options require implementation at the local level, and v) initiatives pioneered at the local level may be replicated and scaled-up (OECD, 2009).

Reasons for Integration

The benefits of climate change adaptation integration at these strategic planning levels include:

- more integrated responses based on a more comprehensive understanding of linkages, opportunities, risks and constraints,
- more effective responses through better coordination across sectors and between levels of governance, and
- more efficient responses through more enlightened prioritization and allocation of resources, resulting in more sustainable responses.

Main Considerations in Integration

With the adoption of a federal structure of administration coupled with multiple levels of governance, there has been a paradigm shift in the planning process in Nepal. The Constitution of Nepal 2015 mandated each level of government for planning of agriculture development, including climate change adaptation planning. These considerations justify an integrated response at the national and sector levels (OECD, 2009):

- The national government provides the overall guiding policy framework within which lower levels operate. Sector policies and programmes directly contribute to the operationalization and implementation of national policies and strategies. Where the response to climate change is being addressed in national policies and strategies, it is logical and necessary to take similar and complementary actions at the sector level. The national and sector-level plans complement each other and adopt a similar framework.
- National and sector-specific legislation and regulations may affect vulnerability and adaptive capacity and create incentives and disincentives to engage in climate adaptation and mitigation action (e.g. property rights regimes, legal frameworks for insurance and financial services).
- Some functions are best exercised at national level (e.g. collection and analysis of climate-related data, setting up of early warning systems, overall disaster risk reduction planning). However, in the absence of or in parallel with a national response, sector-level initiatives may play a pioneering role in developing capacities and good practices that can later become a model for other sectors and for national development policies.
- The federal government manages international relations, which may be important in relation to shared resource management, implementing international treaties including the UNFCCC, and aid coordination.

Sector-specific bodies are sometimes involved in transboundary cooperation on climate issues (e.g. river basin management and regional research programmes).

- True integration of climate change into national and sector policies and strategies supports wider ownership of the climate response compared with the more limited ownership of a standalone plan, standalone projects or local interventions, allows drawing on a wider pool of financial and human resources for implementation, and promotes more widespread capacity and institutional building.

The integration processes adopted by a climate smart agriculture project jointly implemented by GoN, CDKN, LI-BIRD and CCAFS is presented below (Paudel et al. 2017). The first model suggests immediate, medium and long-term actions involved in integration and scaling up CSA options. The second model presents steps to be followed in identifying, screening, validating and recommending climate smart agriculture options in Nepal.

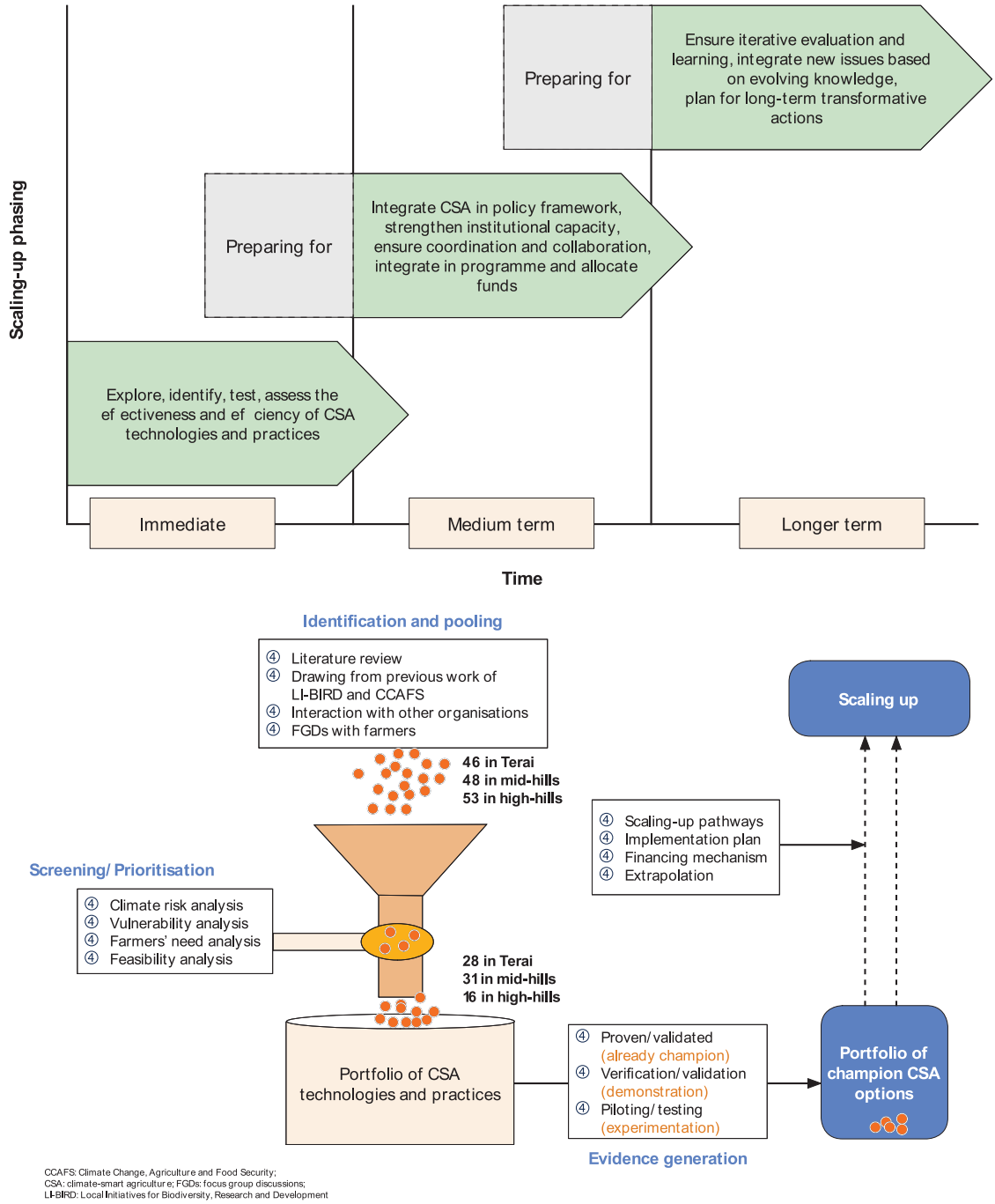

Figure 37. Pathways of integration and scaling up CSA options (Top) and process to be followed in identifying, validating and recommending CSA options for scaling up (Bottom) Source: Paudel et al. 2017.

Climate Change Adaptation in Planning and Budgeting

Nepal was one of the first countries to adopt a budget code for climate change in 2012. Eleven broad criteria are used to identify and classify climate-related programs according to their objective and level of relevance. The GoN publishes the budget allocated to climate-related development programs annually, and the Financial Controller General's Office (FCGO) publishes information about climate budget expenditure in its annual report. The CCFF is also helping link climate policies and strategies with budget allocations, to be supported through the Climate Finance Unit in the Ministry of Finance (MoF).

Several guidelines have been formulated and policy reforms introduced to help the ministries in prioritization, budget allocation and expenditure tracking to support their climate goals. To this end the GoN has recently endorsed a Climate Change Financing Framework 1 (CCFF) and prepared a roadmap to guide mainstreaming climate actions into development plans and budgets and improve accountability and reporting on the effectiveness of climate investments. The roadmap further guides the sectoral ministries in SDG implementation and localization by ensuring that climate actions are well integrated into SDG based plans and monitoring frameworks at all levels

Despite these advances, challenges remain. Budget system reforms at the central level are yet to be effectively implemented within the Ministry of Agriculture and Livestock Development. Existing climate codes for agriculture sector planning and budgeting still cannot capture several climate responses needed to reduce the impacts. Agriculture sector programs should be typically planned as *a priori* climate responses or investments. This requires development of detailed sector-specific climate codes by those who are actually involved in agriculture planning. Methodology related to tagging existing programs to climate budget codes and tracking expenditures to measure progress against climate results needs to be further refined. At present, the methodology overlooks sector-specific nuances and lacks a level of granularity needed for effective planning. As a result, it is likely that climate programs could be over- or under-marked during planning. In addition, the system only codes central or national level programs of the federal ministry and is not useful for subnational level planning and budgeting hence not useful for SDG localization. Budgeting and planning process followed by NAP-Ag project is shown below.

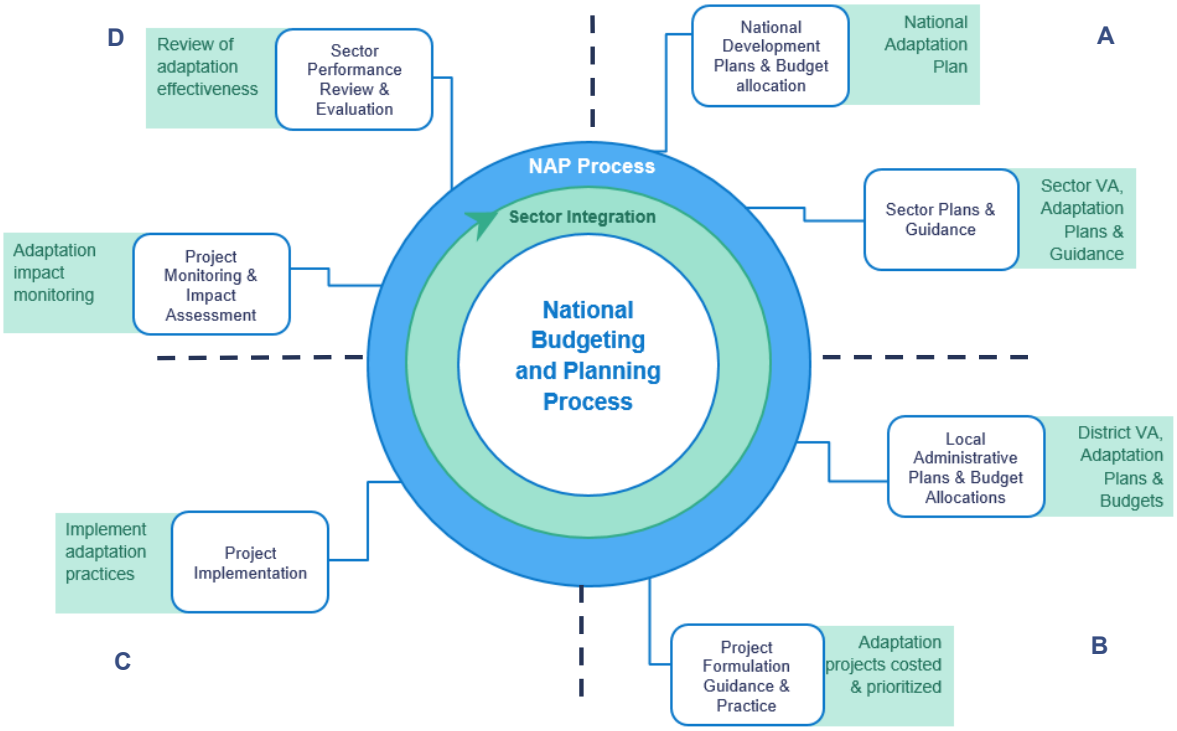

Figure 38. National budgeting and planning process followed by NAP-Ag.

Adaptation planning process at national level: NPC issues budget guidelines and circulars with sector ceilings to all federal line ministries along with budget formats. Federal MoF also issues budget directives, manuals, norms and standards for expenditures. It has introduced the Line Ministry Budget Information System (LMBIS) guidelines to all line ministries. Federal line ministries circulate budget ceilings and guidelines to respective departments, offices and projects with added sector guidelines for annual planning and budget preparation. After preparation, project and federal offices then submit budget proposal to the concerned departments and Project Coordinator Offices. The departments, compile and submit these to concerned line ministries and line ministries who in turn submit budget proposals for review to NPC and MoF. NPC and MoF finalize the draft of the annual budget and plan. It is the Council of Ministers (the cabinet) that finally approves the annual plan and budget of the federal government

Adaptation planning process at provincial level: The planning process at the provincial level is not yet clear since Nepal, for the first time, is planning at the provincial level. Once roles and functions, including organization structures are clarified, it will be easier to follow the planning process. Provincial plans have to be formulated and implemented by provincial governments. Provincial ministries and departments do prepare annual and periodic plans and implement them after getting approval from the provincial cabinet. For agriculture development, the Provincial Agriculture Development Ministry is responsible for making plans and implementing them.

Adaptation planning process at local level: There has been a paradigm shift in the local planning process after restructuring of local government units as per the provisions of the Constitution of Nepal, (2015) The Local Government Operation Act, (2017) has mandated local governments to formulate and implement periodic, annual and sector-specific medium and long-term plans for local development in functional areas of their jurisdiction. The Act requires local government to pay attention to climate change adaptation, disaster management, and gender and social inclusion among others, while formulating such plans and prioritising activities that contribute directly to economic development and poverty reduction, sustainable development, environmental protection and conservation. This requires local government units to prepare a list of medium- and long-term projects. The Act requires local government units to ensure participation of local intellectuals, experts, experienced persons, professionals, marginalized and endangered communities, women, children, Dalit, youth, minorities, disabled and elderly people, including other stakeholders in local planning process to the extent possible. Each local government is required to present an annual budget and programme with estimates for revenue and expenditure within Asar 10 to their respective local assembly and the assembly has to endorse it by the end of Asar.

Local Level Budget and Planning Formulation Guidelines, 2074 issued by Nepal government entails seven steps of budget and planning process for local level government units.

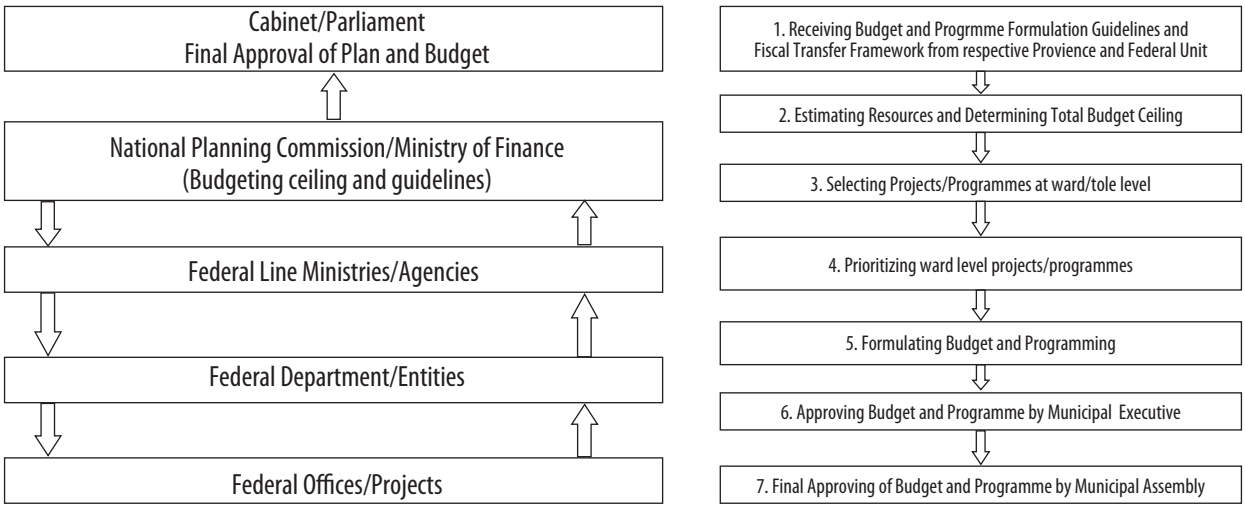

Figure 39. National planning process (Left) and local budget and programme formulation process (Right).

Climate Financing

Planners need to be sensitized to the ministry's climate objectives and trained on the identification of climate change programs at federal and provincial levels. A deeper understanding of common climate risks is needed before budget proposals are prepared. Clearer budgetary guidelines for the sector can facilitate improvements in the coding system and help minimize subjective interpretations of the coding criteria applied to agricultural programs.

For example, current coding criteria excludes regular programmes such as non-conventional irrigation and water harvesting, which are implicated by climate, from being counted as climate relevant. These programmes are budgeted outside the climate code. As an important further step in improving the planning and budgeting, the methods and criteria used to define climate programs in the budget code needs to be modified and customized to cover sector-specific requirements. More refined criteria and granulated typologies are required to better classify climate programs to reflect sector-specific needs.

Integrate climate change agricultural planning and budgeting

Addressing climate change requires making systemic responses to climate impacts as a regular business of agriculture sector through agricultural development programs. Separate ad-hoc actions to address climate change do not bring lasting results. The National Adaptation Plan (NAP) process can serve as a mechanism for integrating climate change adaptation objective in sector strategies. Based on the learning from NAP for Agriculture (NAP-Ag, the process of integrating climate change in planning and budgeting at the sub-national level needs to be initiated without delay. Methods being piloted under NAP-Ag can be used as a basis to assess risk and vulnerability broadly for the sector.

- *The cost and benefits of investments in larger projects need to be assessed systematically. NAP-Ag has established a method for investment appraisal that takes these into account in light of assessed climate vulnerability. Planners need to be sensitized on the ministry's climate objectives and trained on the identification of climate change relevant programs at federal and provincial levels. A deeper understanding of common climate risks before budget proposals should be prepared.*

Improve climate budget code for climate resilient agricultural planning

Clearer budgetary guidelines for the sector can facilitate improvements in coding system and help minimize subjective interpretation of the coding criteria applied to agricultural programs. For example, current coding criteria exclude the regular programmes of agriculture sector such as non-conventional irrigation and water harvesting, which are implicated by climate, from being counted as climate relevant. Such programmes are therefore budgeted outside the climate code.

- *As an important further step in improving the planning and budgeting, the methods and criteria used to define climate relevant programs in the budget code needs to be modified and customized to cover sector specific requirements. More refined criteria and granulated typologies are required to better classify climate-relevant programs to reflect sector-specific needs and nuances. The level of details required for classifying the activities need to be rationalized to fit into the Line Ministry Budget Information System (LMBIS) without much modifications.*

Figure 40. UNDP support in establishing financing mechanism at country level.
Source: MoF, 2017.

All funding provisioned for the implementation of climate change related programmes and projects, either for adaptation or mitigation related activities or both, are considered as climate finance. UNFCCC refers climate finance to "local, national or transnational financing—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change."[15] Compared to the need, the available climate funds are usually limited and therefore a prudent approach has to be adopted to allocate

15 https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance

available fund to priority areas and for intended objectives of climate benefits. A proper tracking method would not only help inform where is the climate finance coming from but also how much is spent on adaptation, how much on mitigation and how much on both? It will also help asses if the climate finance has reached the intended beneficiaries to achieve the intended results. The level of detail required for classifying activities needs to be rationalized to fit the line ministry Budget Information System (LMBIS) with few modifications.

Tracking Climate Finance

Nepal has been using Climate Budget Code (CBC) to track climate financing since 2013. CBC is a budget tool for tracking of climate-related expenditures in the national budget system. The information generated by CBC helps to examine how climate budget is planned, and allocated as well as gaps in climate financing. As Nepal was the first country in the world to develop a method of climate budget coding and introduce it in the national budget system, it is worth providing a brief background of how the concept was developed; method was devised and introduced in the national budget system, and how it has been improved from time to time to capture sectoral nuances. This section aims to briefly describe these.

The National Adaptation Program of Action (NAPA) in 2010 identified areas of immediate concerns and estimated the cost of implementing immediate and urgent projects. The same year, the Government of Nepal (GoN) conducted a study to assess future of climate financing in the country followed by Climate Public Expenditure and Institutional Review (CPEIR) in 2011 to understand the state of climate financing and institutions involved in climate change activities at the national level. Since the GoN through its Climate Change Policy of 2011 had already committed of using 80% of available climate resources to support climate activities at the local level, the CPEIR also examined the gaps in making the public financing management system more climate friendly to address climate vulnerability facing the communities and the natural resources.

The CPEIR found that a total of 83 budget heads with 6% of the national budget under various ministries were climate related. Recognizing the size of the public fund being already channeled through national system to address climate impacts, the study recommended developing a method of tracking climate budget in the national budget. A working group with representatives from five ministries including the Ministry of Agriculture and Livestock Development (MoALD) under the leadership of the National Planning Commission developed the method of Climate budget coding in 2012, which was adopted in the budget of the Fiscal Year 2012/13 to track budget allocation to the climate related plans and programs.

Current status of domestic public climate finance

The information generated by climate budget code shows that a significant amount of budget has been allocated to climate related plans and programs within the MoALD compared to the climate related budget at the national level.

Fiscal Year	Share of climate change related budget relative to total national budget (%)			Share of climate change related budget relative to total budget for MoALD (%)		
	Highly relevant	Relevant	Total	Highly relevant	Relevant	Total
2073/74	5.9	13.32	19.22	1.11	59.35	59.81
2074/75	4.52	26.24	30.76	1.03	59.44	60.47
2075/76	5.26	21.4	26.66	4.12	45.57	49.69

Climate change financing framework

Realizing the need to have long term strategy to ensure fund for climate programs and continue to improve the effectiveness of the climate investments, the GoN formulated a Climate Change Financing Framework (CCFF), which has focused on improvements of the PFM systems in order to help link the climate policy with development planning and budgeting in a coordinated way through budgetary process under the leadership of the Ministry of Finance (MoF). The CCFF aims to ensure that accountability and effectiveness of the climate investments are improved in order to build synergy between and among the climate related sectors in addressing climate change. The CCFF presents a road map that highlights several tasks that needs to be undertaken for overall improvements of the climate finance system. One of the tasks identified was to improve sectoral climate budget coding method to address the sectoral nuances that the original coding method did not capture because it used a set of fixed 11 criteria to define climate activity under all sectors.

Typologies

MoALD was taken as a pilot case for improving sectoral climate budget coding. The typologies have been developed by a taskforce in the MoALD, which was later endorsed by planners through a consultative process. Each typology also has a list of broad programs, called the sub-groups that each typology covers. All current programs of the MoALD fall within one of the typologies, but the typology have been formulated in such a way that it has rooms for potential climate activities that the sector might include in future. The typologies and their details are as follows.

- **Sustainable land management** - rehabilitation of degraded pasturelands; agroforestry; land-use planning/crop shift in cultivation toward more suitable alternatives; conversion of unsuitable cropland to arboriculture; afforestation, cultivation of windbreaks and other measures to prevent erosion and landslides; use of bio char, agro-residues, and other methods for soil quality improvement.
- **Sustainable water management** - flood control and prevention; expanded and improved irrigation infrastructure (i.e. construction of new ponds and water retention facilities and recharging basins); rehabilitation and maintenance of existing irrigation and water storage facilities; watershed restoration/management and participatory irrigation management; water resource optimization including development of water user farming groups and adopting integrated water resource management, catchment management, and non-conventional schemes; improved inputs and effluent management in aquaculture ponds.
- **Food security and promotion of agro-biodiversity** - preservation of crop genetic diversity, including seed development initiatives; seed banks and seed quality control/certification; pest control and disease outbreaks; promotion of biological agents and pesticides; dissemination of drought and flood resistant seeds; training on organic farming and promotion of bio-organic fertilizers and inputs; improved access of climate vulnerable groups to inputs and credit.
- **Livestock** - veterinary health and optimization of artificial insemination; reduction in ruminants through improved cattle feedstock and breeding; flood/storm protection infrastructure.
- **Low-carbon agricultural production** - use of renewable energy (i.e. solar and wind) energy for water pumping and irrigation; soil carbon storage research and development; biofuel/fuel usage optimization in agricultural machinery; on-farm bio digester and biogas generation; promotion of alternative wet dry (AWD) rice cultivation, system of rice intensification (SRI), and integrated rice development; integrated aquaculture and livestock production systems.
- **Disaster preparedness for extreme events** - forecasting and early warning systems including water inundation; participatory education and awareness raising programs for climate adaptation and disaster preparation.
- **Policy, knowledge, extension, communications, research and development** - extension services; knowledge generation and communication policy formulation.

Climate change budget coding process

The 11 criteria used earlier to define climate related development works have been unpacked by MoALD into seven typologies mentioned above to suit its sectoral needs. Each typology also has listed subsets that help define the actual program under the typology. These subsets needs to be identified if they support mitigation, adaptation or both. To begin coding, proposed annual programs of the ministry are listed under corresponding typologies. Each program has several activities of which some are related to climate objectives. The activities that are climate related are then listed under the program. This step is a major shift in the new method because the new method codes the activities rather than the program. At this stage, the planner would have identified all activities that are climate related under each of the proposed programs for the following year. That done, the next step is to determine the level of relevance of climate related activities.

The budget database base of the MoF, which is called the Line Ministry Budget Information System (LMBIS) requires that data for climate related budget is provided either as highly relevant, relevant or neutral and denoted by numbers 1, 2 or 3 respectively. The LMBIS uses neutral as the default value and, hence, the activities that are not listed under any program the typology are registered as neutral. The steps followed for coding including their climate objectives at activity is shown in Figure 41 and a detailed narrative is found in the guidelines issued by the MoALD.

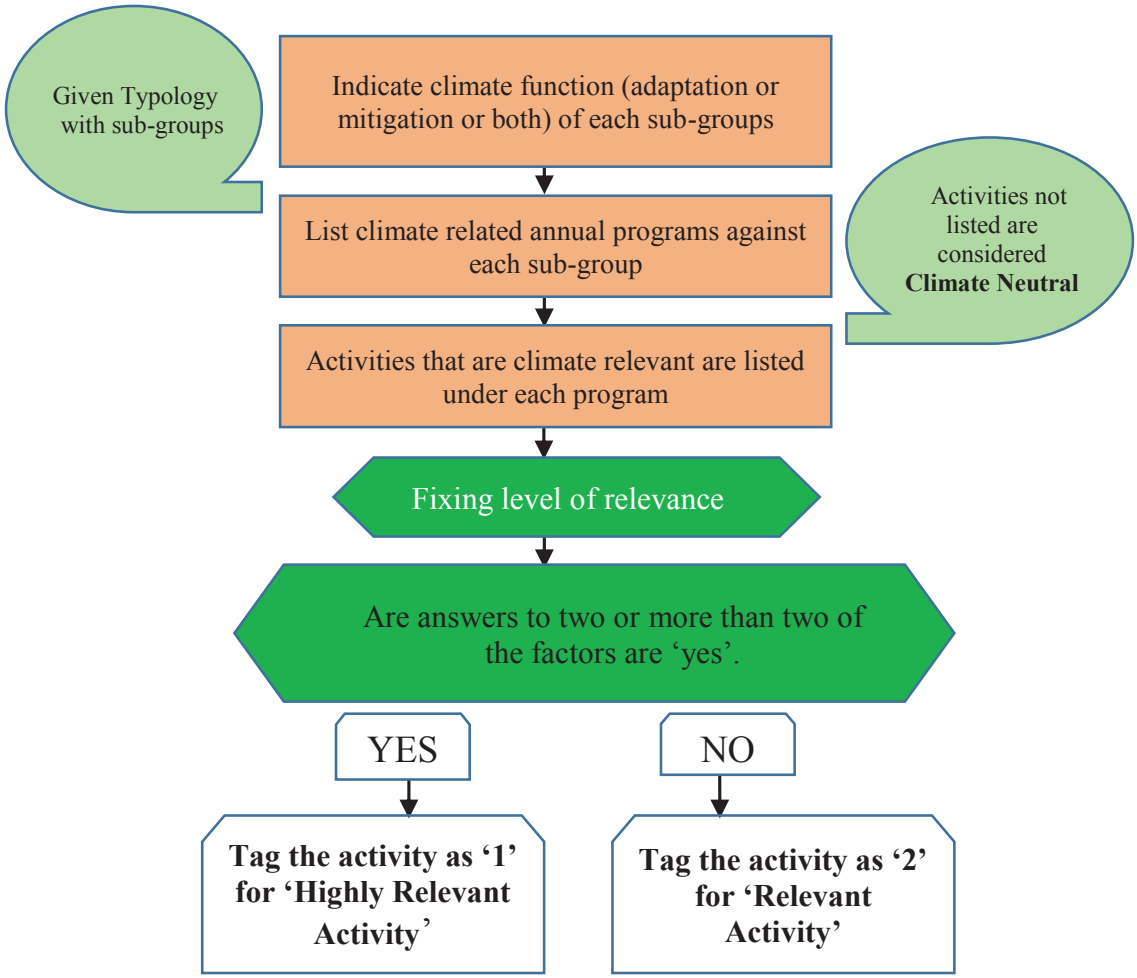

Figure 41: Improved method of climate budget coding adopted by the MoALD

Level of climate relevance

Assessment of the level of climate relevance of the identified activities involves screening each climate related activity against three key questions. The questions are: how is the activity related to climate vulnerability of the area where it is being implemented; whose vulnerability, including gender, does the proposed activity address; and how does it support meeting the national commitments such as the Agenda 2030 and the Nationally Determined Contributions (NDCs)? The screening process is indicated in table 1.

Table 1: Screening questions for level of climate relevance

Parameters to fix level of relevance		Response
i	Are the information about climate vulnerability in areas where the proposed activity will be implemented available and measurable?	Yes/No
ii	Have the beneficiaries, including gender, been identified who will be benefited by the proposed activity in reducing their vulnerability?	Yes/No
iii	Does the proposed activity contribute in meeting the national commitments such as the NDCs, SDGs as well as meeting the objectives of climate change policy and ADS?	Yes/No

If two or more of the answers to the above questions are 'yes', then the activity is coded as 'highly relevant' denoted by '1' in the LMBIS data base. If two of the answers are 'no,' the activity is coded as 'relevant' denoted by '2'.

In addition to this the planner will develop a brief narrative for one or two key program explaining how it was screened against the three questions for climate relevance. An example of a narrative is given in box 1. This narrative will be used to evaluate the performance of the program and make required correction in the following year to improve the effectiveness of the program in addressing gender specific climate vulnerability and ensure its contribution in meeting the national commitments.

Box 1: Narrative example

The following provides an example of how a planner would formulate a narrative for one or two key program to be used for evaluation of the climate investment. This narrative will remain as a record in the planning section or the division from where the program originated. The planner will use the results of evaluation and make required adjustments in the program in the following year to improve the effectiveness of the program.

Typology: Sustainable water management
Sub group: Watershed restoration
Climate objective: Both mitigation and adaptation
Proposed program (2019/20): Integrated water resource management project
Climate activity of the program: Vegetable block demonstration 190 hectares.
Climate relevance: Highly relevant
Short narrative: The activity has been proposed for drought hit area of village X, which has been suffering from drying up of springs since last 5 years. The VRA has been conducted which showed increased vulnerability of farmers with loss of production and farm income. The proposed project of vegetable block will help, among others, 100 women farmers grow off-season vegetables. It will support outcome 2 of Agriculture Development Strategy and contribute to SDG 2.

Climate Measuring Progress Against Climate Benefits

Provision of reporting mechanism on the climate benefits has also been developed, with various templates to be used from local to provincial to the federal levels for climate change expenditure. Five different types of reporting formats have been developed to tag financial and physical progress, including some narrative reports. The narratives will be used to feed into the Economic Survey report published by Ministry of Finance annually.

Monitoring climate finance (Some examples)

The following table can be used to list the activities based on the four points mentioned above.

Typologies	Objectives			Relevance		Relevant programmes	Main activities
	Adaptation	Mitigation	Both	Highly relevant	Relevant		

Some tables to track expenses are shown in shown below.

Activities	Typology	Highly relevant		Relevant		Neutral		Total	
		Approved budget	Actual expense	Approved budget	Actual expense	Approved budget	Actual expense	Approved budget	Actual expense

Activities	Typology	Adaptation		Mitigation		Both A & M		Total	
		Approved budget	Actual expense	Approved budget	Actual expense	Approved budget	Actual expense	Approved budget	Actual expense

Budget line	Activity	Total budget	Total expense	Progress in %		Key outputs	Challenges	Remarks
				Financial	Weightage			

Chapter 6

Monitoring, Reporting and Communicating Adaptation Work

Monitoring and Evaluation of CCA Interventions in Agriculture

What is Monitoring and Evaluation?

Monitoring is "an ongoing process by which stakeholders obtain regular feedback on the progress being made towards achieving their goals and objectives". Monitoring is not only concerned with asking "Are we taking the actions we said we would take?" but also "Are we making progress on achieving the results we said we wanted to achieve?" (UNDP, 2009). It is a periodic tracking of any activity's progress by systematically gathering and analyzing the data and information.

Evaluation is "a rigorous and independent assessment of either completed or ongoing activities to determine the extent to which they are achieving stated objectives and contributing to decision-making" (UNDP, 2009). It is a retrospective assessment conducted normally by internal or external independent evaluators. Evaluation is done periodically and at the end of any project.

Good planning, combined with effective monitoring, evaluation and review can play an important role in enhancing the quality of programmes and projects. Good planning helps focus on the results that matter, learn from experience, and identify better solutions for the future. Monitoring, evaluation and updating the plan are required to determine whether the plan is achieving the intended adaptation objectives, targets and benefits or is creating negative impacts. The aims of both monitoring and evaluation are similar: to provide information for making informed decisions, improving performance and achieving planned results. They are also rigorous in their procedures, design and methodologies, and generally involve extensive analysis. Planning, monitoring and evaluation are different but closely connected steps and have their own distinct characteristics and specifications (Table 16).

Table 16. Basic differences between monitoring and evaluation. Source: NPC, 2013.

Monitoring	Evaluation
Continuous process carried out throughout the implementation period and conceived as an internal function of the project.	Carried out at different stages such as *ex-ante*, ongoing, terminal and ex-post.
Performed only in the formative and operational stages.	Performed from selection stage and after the operation stage.
An institutional process to rectify gaps and weaknesses experienced during the formative and operational stages.	Means for initiating timely, corrective measures during formative and operational stages and drawing lessons from past strengths and weaknesses to inform future interventions.
Directly related with inputs, processes and outputs.	Concerned with the assessment of progress against predetermined goals, outcomes and their effects and impacts on stakeholders.
Part of the management system.	An operational management tool to derive lessons from implemented plans, policies, programmes and projects.
Conducted by the implementing agency.	Conducted by independent individuals and institutions outside implementing agency.

Why Monitoring and Evaluation?

It is important to have a clear understanding of M&E if quality monitoring and evaluation have to be performed and if an M&E system is to be relevant, useful, timely and credible. The purpose of M&E is to determine whether:

i. The community is taking the actions previously decided, agreed and planned.
ii. The measures adopted are effective (e.g. Are the adaptation actions delivering the intended benefits? Are the adaptation actions creating negative impacts and maladaptive developments?).
iii. The information provided can help identify the adjustments eventually needed and inform decisions, improve performance, and achieve planned results (Ribeiro et al, 2009).

Table 17. Purposes of monitoring activity. Adopted from Bruton et al., 2004.

Identify negative effects of a particular strategy so corrective actions might be applied.	Analyze adaptation objectives and indicate the progress towards meeting the goals of adaptation measures, results and impacts achieved and the distance to target.
Provide insights for ongoing policy and decision-making processes.	Verify alignment between internal objectives and specific policy framework (internal coherence).
Help achieve specific adaptation goals, objectives and targets more effectively.	Check the consistency between critical issues in the environmental ex-ante context and objectives and targets of policy intervention (external coherence).
Supporting the learning process (e.g. identifying good practice, improving actions, avoiding maladaptation, finding new opportunities).	Measure the state of implementation in financial, procedural and physical terms.
Provide regular feedback to stakeholders on the progress to be made.	Measure the outputs per unit of inputs used (eco-efficiency). Measure the achievement of the policy or plan objectives at the least costly conditions (cost- effectiveness).

Basic Components of M&E

M&E is used extensively by international and national development agencies to assess progress and effectiveness. While there are no universally set definitions for M&E terms and concepts, typically there are four components (Figure 42).

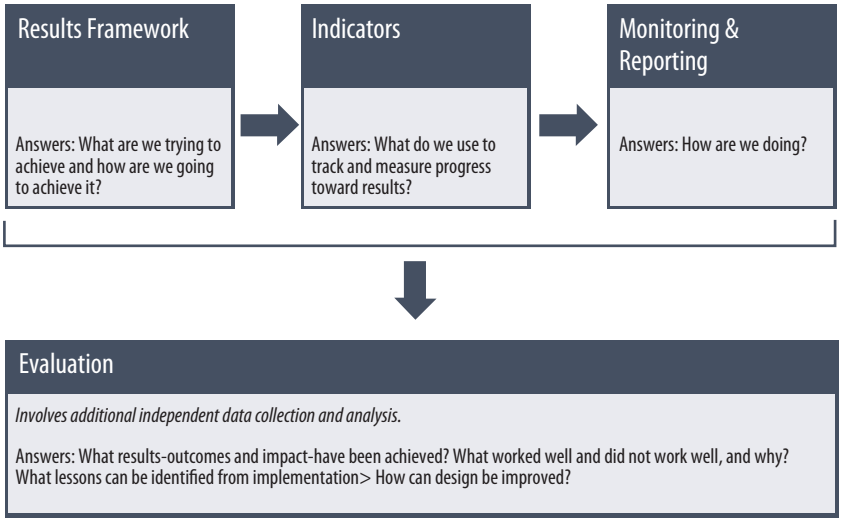

Figure 42. Basic Components of M&E. Source: Williams, 2016. Adapted from STAP, 2017.

Components of Monitoring

Three elements, input, process and outputs, are included in the monitoring framework. The main objective is gather and provide information on a project to make good decisions and timely corrections. Monitoring is carried out by the people involved in the implementations from the field to policy level and funding agencies. Monitoring can be done by visiting the field or collating information from primary and secondary sources and through various means of communications. The three elements of monitoring are:

- **Monitoring the delivery of inputs** as per schedule (financial, technical or other human resources, norms and guidelines, explicit rights and responsibilities, technology, physical goods and other inputs).
- **Monitoring processes** as per the project schedule.
- **Monitoring the expected outputs** as per the schedule (both quantity and quality).

Components of Evaluation

Impact evaluation assesses relevance, efficiency, effectiveness, sustainability and outcomes and impacts of the project or programme (Table 18). This is normally done by hiring independent experts, evaluation teams and concerned subject-matter specialists to validate the project achievements against the goals and objectives.

Table 18. Components of Evaluation.

Components	Brief Description
Relevance	The extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.
Effectiveness	The extent to which an aid activity attains its objectives.
Efficiency	Measures the outputs (qualitative and quantitative) in relation to the inputs. Signifies that the funding uses the least costly resources possible to achieve the desired results.
Outcomes and Impact	This involves the main negative or positive impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators.
Sustainability	Measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally and financially sustainable.

Framework for Monitoring and Evaluation

M&E is a continuous process that needs to be carried out throughout the life of the programme. Monitoring tracks the use of inputs (activities) and outputs, and to some degree tracks intermediate outcomes whereas evaluation tracks changes in the expected outcomes and impacts. Outcomes could be short-, medium- and long-term based on the type of interventions and tangibility of the results (Figure 43).

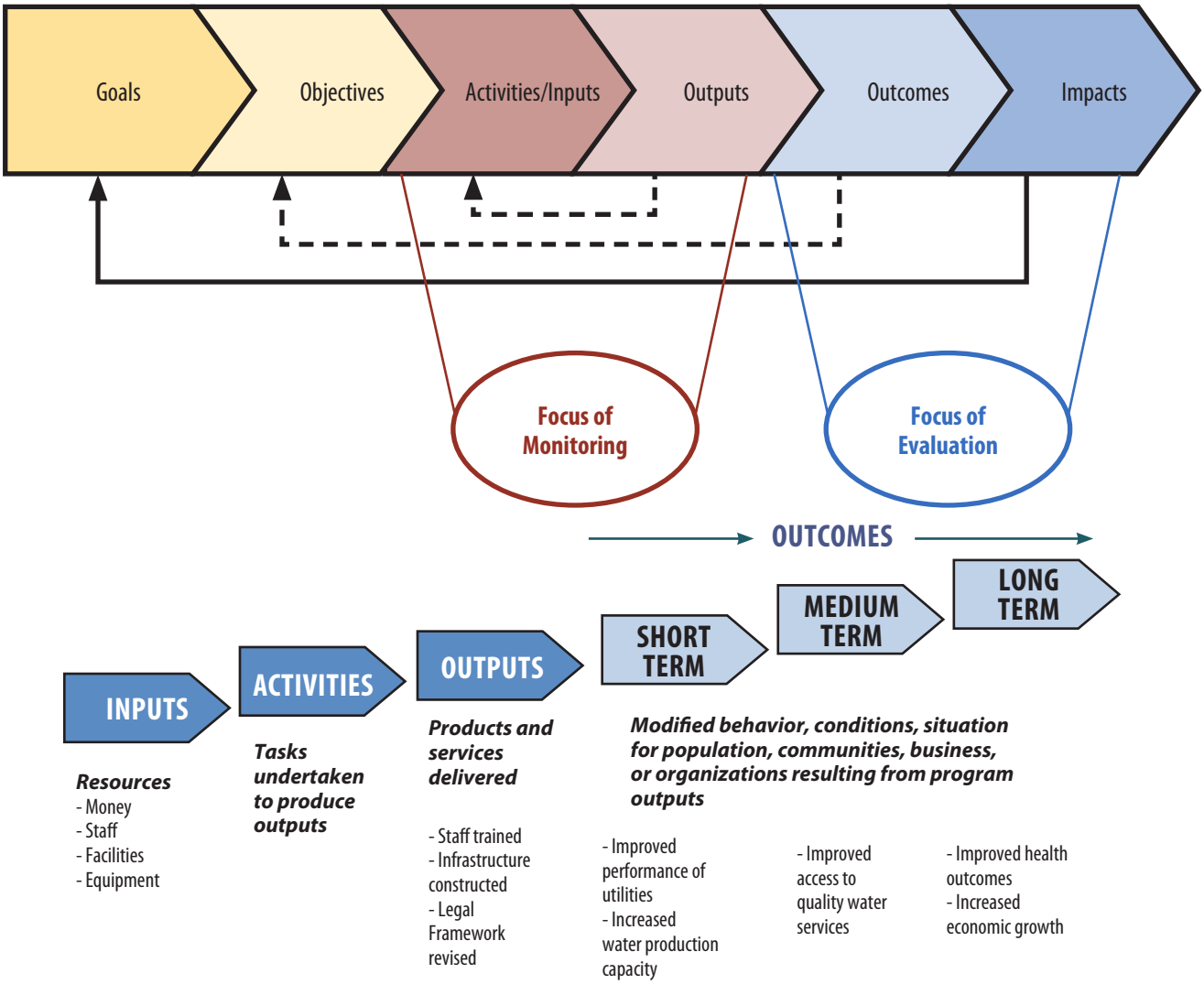

Figure 43. Framework for M&E. Source: Adapted from OPSPQ, 2013.

Types of Monitoring & Evaluation

Different monitoring and evaluation techniques are adopted based on the nature and stage of the project and available resources. Monitoring can be continuous or periodic (Figure 44). Continuous monitoring tracks performance against predetermined inputs, activities, processes and output indicators during the formative phase of a programme or project. Sustainability or periodic monitoring is done to ensure necessary resources and provisions needed for sustainability throughout a programme life cycle and is conducted after completing the formative phase.

Evaluation methods also need to be customised according to what is being evaluated and what aims are to be achieved. To make evaluation effective, it should be planned at the design stage ensuring all the resources required (particularly time, money and human resources) are adequate and all the roles and responsibilities of the actors are clear (Table 19, 20 and Figure 45).

Type of evaluation

Ex-ante: To determine the needs of programme or project continuity and define indicators and clearly articulate the details of a given programme or project.

Mid-term: To review the progress of a programme or project, to revisit and improve pre-determined action plans and make changes in operational modalities.

Final or terminal: To make a summative evaluation towards the end of the implementation phase.

Ex-post: To study how well the initiative achieved the purpose of a summative evaluation since they are undertaken towards the end of the implementation phase.

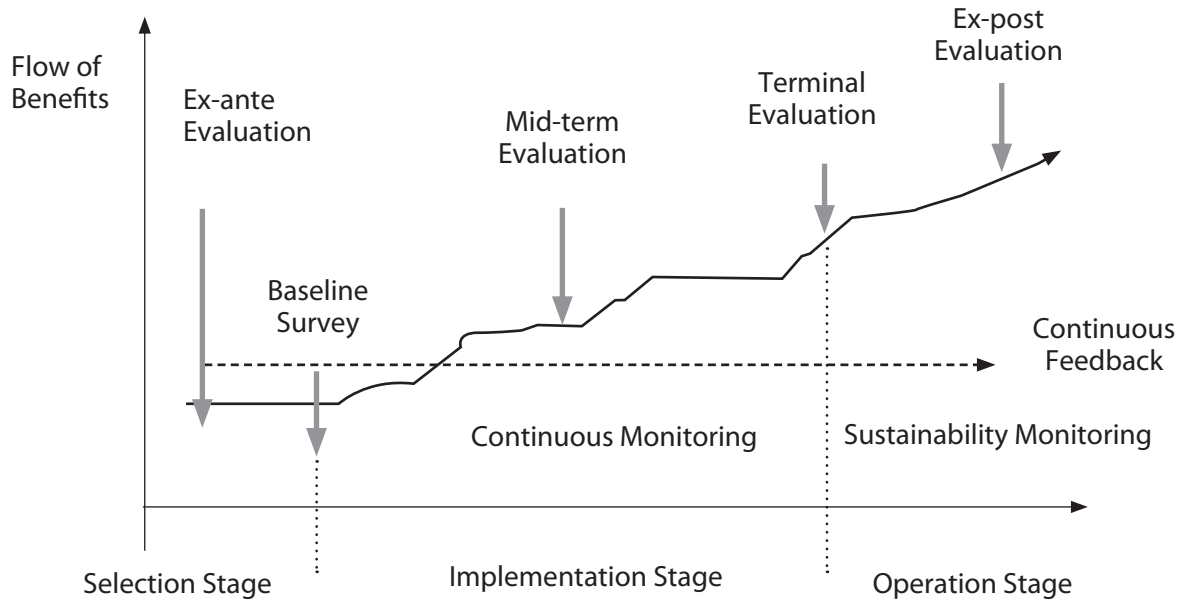

Figure 44. Monitoring and evaluation process during programme or project period. Source: NPC 2013.

Table 19. Types of evaluation.

Types of evaluation	Description
Process	• To measure the activities of the program, program quality and if it is achieving goals and objectives. • To improve implementation, to direct future projects in the same area, or for scaling up a project.
Impact	• Measures how well the programs objectives have been achieved. • Evaluating the effects (positive or negative, intended or not) on individual households and institutions, and the environment. • Assess direct effects on intended beneficiaries. • Includes the full range of impacts at all levels of the results chain, including ripple effects on families, households and communities and on institutional, technical or social systems and the environment.
Outcome	• Concerned with the long-term effects of the program and is generally used to measure the program goal. • Measures how well the program goal has been achieved. • Assess program objectives over time.
Summative	• Conducted at the end of an initiative to determine the extent to which anticipated outcomes were produced. It provides information about the worth of the programme (UNDP, 2009).
Formative	• Conducted at the end of the project to identify areas that need further support and can be included in future programme development.

Evaluations can be performed by procuring the services of external experts or by forming teams of experts within the organization or by constituting a joint team of external experts and organizational staff.

Table 20. Methods of Evaluation. Source: NPC, 2009.

Types	Brief Description
Quantitative methods	• Ways of investigating or measuring whether, or to what extent, a programme or project has produced desired outcomes or impacts through numbers, percentages, or other statistical methods. • Use of tools including national statistics, secondary data and data received from surveys.
Qualitative methods	• Used for generating descriptive data capturing and measuring diverse thoughts, feelings, perceptions, experiences, and level of satisfaction of beneficiaries in diverse contexts. • Use of participatory tools and techniques like direct observation, focus group discussions, interviews, and case studies.
Mixed methods	• Combination of quantitative and qualitative methods. • Useful in assessing the validity and reliability of findings keeping in view the positive aspects and limitations of qualitative and quantitative methods.

Indicators

An indicator is a measurable variable that helps assess the situation and track change over time. Adaptation indicators are essential to: i) monitor progress towards implementing adaptation policies, strategies and actions; ii) target, justify and monitor funding for adaptation programmes; iii) communicate adaptation priorities to stakeholders; iv) compare adaptation achievements across sectors and regions, and v) provide inputs for international climate change related processes and mechanisms. Indicators need to be:

Smart–Specific: Indicators should be simple, clear and easy to understand and communicable.

Measurable: Indicators should be based on readily available data, or on data that can be provided at a reasonable cost.

Achievable: indicators and their measurable units must be achievable and sensitive to change during the life of the project.

Analytically sound: Its validity should be widely accepted.

Relevant: Indicator sets should reflect information that can be used for management or immediate analytical purposes. They should provide a balanced coverage of all key adaptation objectives.

Transparent: The indicators should be transparent and easy to interpret, i.e. users should be able to assess the significance of the values associated with the indicators and their changes over time.

Time bound: Progress can be tracked at a desired frequency for a set period.

Indicators can be process indicators and outcome indicators.

Process Indicators measure progress in implementing adaptation policies, plans, projects or changes in institutional decision-making capacity, which create an enabling environment for adaptation.

Outcome and Results Indicators are used to evaluate whether the activity, plan or policy achieved the intended objectives or results.

Indicators can also be:

- **Quantitative** are the most commonly used and provide information on how much and how many.
- **Qualitative** provide information on how people feel about a situation, how things are done and how people behave.

Results can be measured at different levels:

- **Output results** illustrate the change related directly to the activities undertaken within the programme (e.g. percentage of surface area cultivated with drought resistant varieties).
- **Outcome results** relate to medium- to long-term change (e.g. percentage of poor people in drought-prone areas with access to safe and reliable water).
- **Impact results** measure the long-term effect of programme interventions (e.g. increase in adaptive capacity of farmers in communities, disaggregated by sex of household head*).

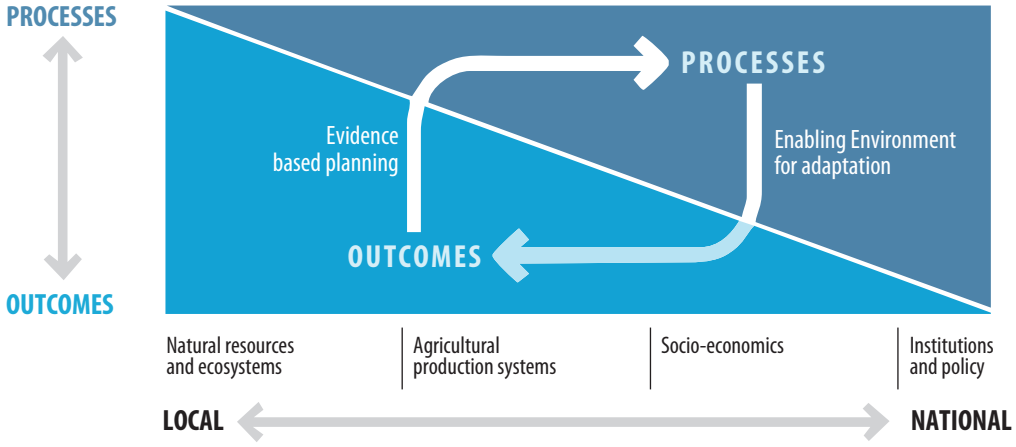

Figure 45. Schematic diagram showing relationship between process and outcome indicators at different levels. Source: FAO 2018. Found in https://www.slideshare.net/napcentral/session-814-adaptation-me-in-the-agriculture-sector-lessons-learned-from-viet-nam

Indicators should be gender-sensitive. COP 23 adopted the Gender Action Plan and the prioritization of monitoring gender issues. Recognizing that gender shapes vulnerability and adaptive capacity, frameworks should include sex-disaggregated and gender-sensitive indicators to monitor gender equality gaps and ensure adaptation efforts reach all groups.

Gender-sensitive indicators assess gender-related change in a condition or situation over time, measure benefits to men and women and changes in relations between and use quantitative and qualitative data disaggregated by sex, age and other socioeconomic variables. Examples of qualitative gender-sensitive indicators include: levels of adoption of high yield varieties amongst male-headed compared to female-headed households; proportion of women compared to men in agricultural organizations; percentage of men and women trainees who feel their knowledge of adaptation practices has increased.

Several examples of hazards, exposure, sensitivities, and adaptive capacities, along with type of data, assumptions and data sources for each indicator are presented in Tables 21–24.

Table 21. Indicators for hazards.

Indicators	Data Type	Assumptions	Data Source
Extreme heat, number of hot days (T max >35oC)	CMIP 5	Increase in extreme heat leads to higher vulnerability	CMIP 5 (projection 1-degree gridded data)
Consecutive dry days	CMIP 5	Increase in consecutive dry days leads to higher vulnerability	CMIP 5 (projection 1-degree gridded data)
Consecutive cold days	CMIP 5	Increase in consecutive cold days; heat leads to higher vulnerability	CMIP 5 (projection 1-degree gridded data)
Heat waves	CMIP 5	Occurrence of frequency of heat waves affects agriculture	CMIP 5 (projection 1-degree gridded data)
Cold waves (fog)	CMIP 5	Occurrence of frequency of cold waves affects agriculture	CMIP 5 (projection 1-degree gridded data)
Extreme weather variability	CMIP 5	Variation in extreme weather leads to higher vulnerability	CMIP 5 (projection 1-degree gridded data)
Agriculture drought/dry spells	Number of events	Increase in agriculture drought affects productivity	District profile
Landslides	Landslide areas	Increase in landslides in agricultural areas leads to higher vulnerability	District profile
Floods and crop inundation	Area and number	Flooding affects productivity	Relief Web/ICIMOD, August 2017
Pest and disease outbreaks	Crops damaged	Disease outbreaks reduce production	KII, FGD and DADO

Table 22. Indicators for exposure.

Indicators	Data Type	Assumptions	Data Source
Farming Population (agriculture, horticulture, apiculture and livestock)	Gender segregated data indicates number of men and women involved in agriculture and livestock raising activities	The higher the farming population, the more people will be vulnerable	CBS, 2011
Irrigation schemes	Length of irrigation canal and number and area of reservoirs	The more irrigation schemes, the lower the vulnerability	DoI, 2016
Farm and soil (LRMP based classification)	Upland and lowland cultivated area and type of soils; productivity of cereal crops	Loamy texture and high organic matter content, the WHC of the soil will be improved	CBS, 2011 and DoI, 2017
Livestock population	Number, type and productivity of livestock	The more livestock, the higher the vulnerability as the carrying capacity of the soil will be decreased	DLSO
Horticulture	Area of horticulture	The project districts are unique to their suitability for crop production. Need to be placed in right site for high productivity	DADO Annual Report
Fisheries	Area, number and productivity of fish ponds	The higher the area under fish production, the higher the income since fish farming is a commercial activity and is less vulnerable	DADO Annual Report
Forest coverage (ha)	Area and type of forest	The more forest area, the lower the vulnerability	DFO's Annual Report

Indicators	Data Type	Assumptions	Data Source
Women in the population	Number of households	Women can have a more difficult time during recovery than men, often due to sector-specific employment, lower wages and family care responsibilities (Cutter et al., 2003)	CBS, 2011
Marginalized and socially excluded populations	The higher the number, the higher the vulnerability	Marginalized and socially excluded populations are more vulnerable	CBS, 2011

Table 23. Indicators for sensitivity.

Indicators	Data Type	Assumptions	Data Source
Livelihood dependency on agriculture	Number of households dependent on agriculture	The higher the dependency on agriculture, the higher the vulnerability	CBS, 2011
Geomorphology (edaphic factor, aspects, altitude, terrain)	Terrain elements such as slope, aspect, relief	The more slopping land the more vulnerable the population	Publications and maps: District profile (DDC), Department of Geology, TU, Dept of Mines & Geology, GoN, Department of Surveys
Farming system (rainfed, year-round irrigated, seasonally irrigated, single, mixed)	Analysis of rainfed agriculture system	The more year-round irrigation, the lower the vulnerability	District profile, NARC publications
Gender inequality (socioeconomic, cultural and political disparities)	Gender Index	The higher the number of women to men ratio, the more vulnerability	CBS, district profile, District Women Development Office, National Women Commission
Seasonal migration	Number of persons	The more seasonal migration the more vulnerability in agriculture because of labor shortages	CBS, AgriStat, District profile
Water stress	Number of water supply schemes	The higher the water stress area, the higher the vulnerability	District profile
Land cover and land use change	Area in (ha)	Land is dynamic, better land use practices followed by more production and productivity and also more area in agriculture leads to less vulnerability	DoI, 2016 and satellite images
Population age structure	Number, density	Population structures with more children, women and elderly people than young, the higher the vulnerability	CBS, 2011
Scarcity of labor, workforce	Number	Nepalese farming is subsistence in nature and labor intensive	CBS
Reservation category	Percentage	The more the reservation policy is implemented the more disparity or vulnerability	CBS

Table 24. Indicators for adaptive capacity.

Indicators	Data Type	Assumptions	Data Source
Availability of irrigation, coverage, type and functional structure	Area of the source, length, type and its functionality	The more the irrigated land cover increases the lower the vulnerability	DoI 2016
Transportation facilities, market structures, collection centres, godowns and networks	Types of roads, number and capacity	The shorter the distance, the more access to market, hence lower vulnerability	District profile, DADO
Farmer groups, cooperatives and networks	Number and types	The higher the number the lower the vulnerability	District profile
Policy, program and project support, disaster risk reduction and CC adaptation plans	sectoral national and district planning and review documents	The more supportive policies regarding disaster risk reduction and CCA, the lower the vulnerability	Publication of government's strategic papers

Indicators	Data Type	Assumptions	Data Source
Availability of stress tolerance genotypes, community seed bank and gene bank (indigenous and underutilized)	Number of stress, stand for inundation condition (Sub1 gene) and stress condition germplasm available	The greater the availability of stress tolerant genotypes and community seed banks, the lower the vulnerability	NARC, district profile
Agro-industries, enterprises and employment	Increased employment opportunity and agro business	Agro-industries, enterprises and employment reduce vulnerability	CBS, 2011; district profile
Community groups, institutions, governance	Increased in number	More cooperatives and better resources mobilized and less dependency outside so less vulnerable	District profiles, consultations
Presence of projects, programmes and development organizations	Number of development projects in the area and coverage activities	Access to development projects and more access to resources and new technologies and services	District profiles, consultations
Availability of forests and forestry resources	Availability and distribution type (ha)	Availability of forests and forestry resource increases adaptive capacity	Ministry of Forest and Soil Conservation
Social protection system (Insurance, savings and credit facilities) in GESI Groups (%)	Percentage of people (also from GESI perspective)	Social protection systems reduce vulnerability	CBS, 2011 and district line agencies

Participatory Approach to Planning, Monitoring and Evaluation

A stakeholder is anyone with an impact and or potentially affected by interventions. A stakeholder is also defined as, "an individual or organization actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion" (PMI, 1996; Smith, 2000).

Participation is defined as "a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them" (Luyet et al., 2012). Decisions are owned and acceptable to stakeholders when a participatory approach is applied in developing climate change action plans. Different participatory approaches have been developed to ensure public participation in resource planning, use and monitoring.

Participatory monitoring and evaluation is a continuum of observations, information gathering, analysis, documentation, and assessment of project results and critical learning and adaptive decision-making by stakeholders at different stages of the research and development process. It helps strengthen learning and change at community, project and institutional levels and improves ownership of the change. The importance of participatory planning and stakeholder engagement is:

- To adapt M&E tools to make them more accessible and relevant to stakeholders.
- To develop an appropriate PM&E system at the community level that can improve the decision-making capacity of local communities.
- To involve communities in monitoring and evaluating progress and impacts of project assessment of achievements and impacts over a long period.
- To enhance the flow of information and provide feedback to different levels (such as, groups, communities, project managers, between farmers and R&D systems; Nijuki et al. n.d)

Approaches for Stakeholder's Analysis for Participatory Planning

Individual and organisational stakeholders have different interests and viewpoints. There is a need for stakeholder analysis to assess the interests and importance of each stakeholder and discover how they can achieve the target objectives. Stakeholder analysis is a technique that can help project team members understand the variety of stakeholders that have an interest in the project, and the individual nuances that can affect project risk.

To carry out stakeholder analysis:

1. Identify project stakeholders
2. Identify stakeholder interests, impact level, and relative priority
3. Assess stakeholders for importance and influence
4. Outline assumptions and risks
5. Define stakeholder participation

These steps are further elaborated below (Smith 2000).

1. **Identify project stakeholders:** Once the project or programme to be assessed is decided, identify the internal and external stakeholders and their engagement in the design, implementation and communicating and scaling up of the findings. Approaches for stakeholder engagement in various stages in participatory planning is explained in participatory planning and stakeholders' engagement section below. Three broad categories of people can be engaged: 1) people directly involved in your project or programme activities, 2) people in the wider community based on their interests, and 3) external actors like donors, policy makers, and research institutions. To be classified as a stakeholder, the person or group must have some interest or level of influence that can affect the project (Figure 46).

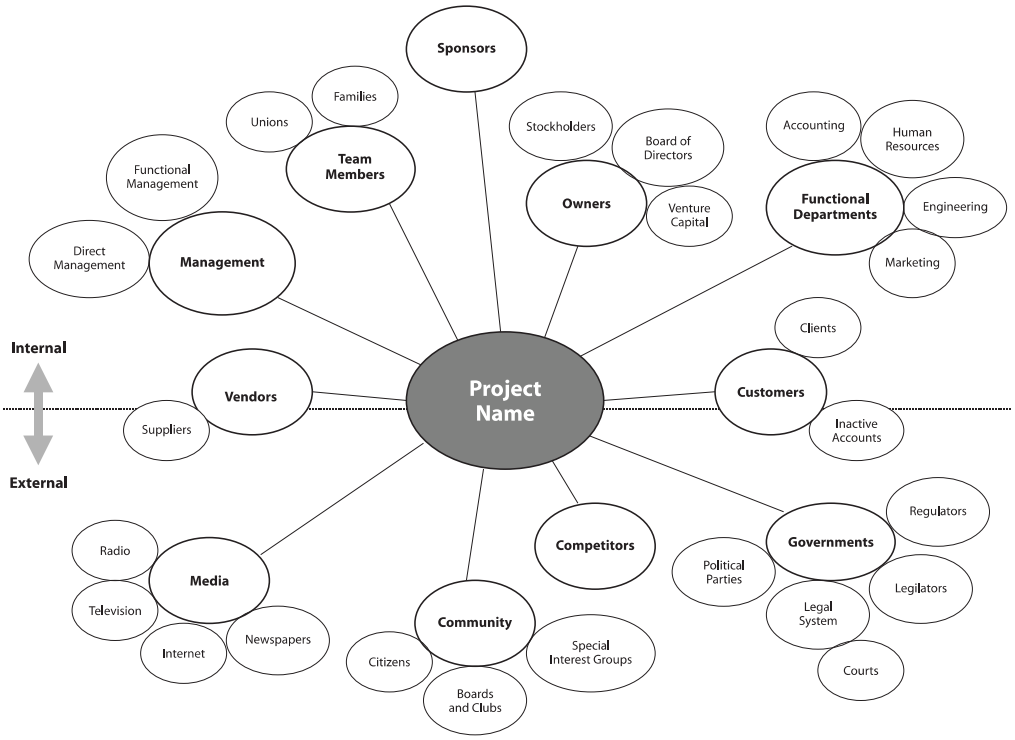

Figure 46. *Example of a stakeholder analysis context diagram. Source: Smith 2000.*

2. **Identify stakeholder interests, impact level, and relative priority:** Stakeholders should be listed in a table or spreadsheet with their interests, potential level of project impact, and priority in relation to other stakeholders.
3. **Assess stakeholders for importance and influence:** Influence indicates a stakeholder's relative power over and within a project. Importance indicates the degree to which the project cannot be considered successful if needs, expectations, and issues are not addressed. A diagram of importance and influence can be useful to understand potential risks and highlight groups of stakeholders whose needs can be addressed in a common manner (Figure 46). Note that stakeholders in the high influence-high importance quadrant would be considered key stakeholders; and the interest-influence measures can be annotated with a range of numbers (0-10) or high, medium and low (Figure 47).

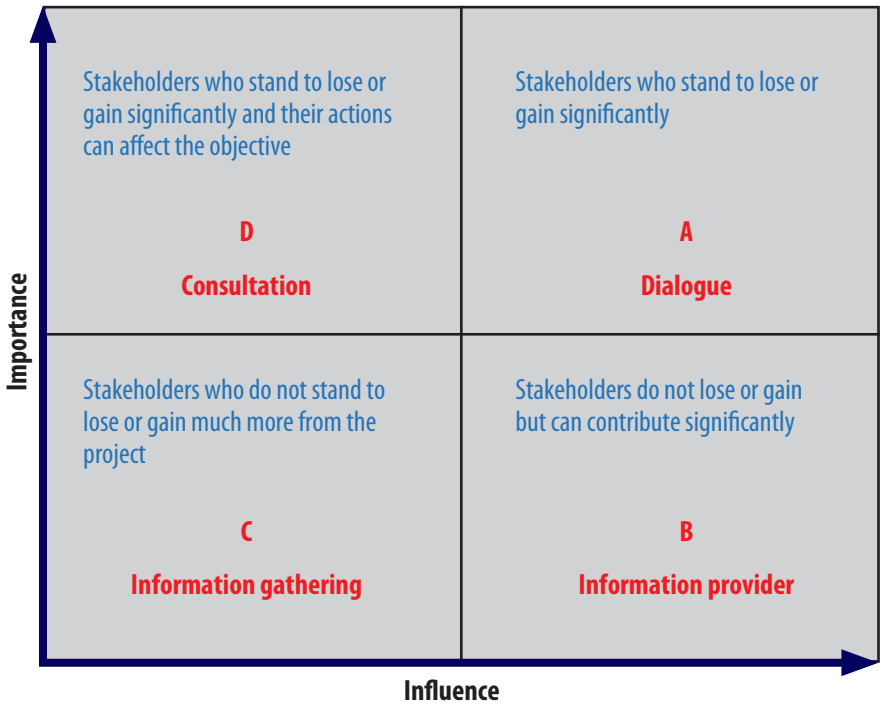

Figure 47. *Importance-Influence classification. Source: APMAS Knowledge Network; cited from* http://www.mspguide.org/tool/stakeholder-analysis-importanceinfluence-matrix

1. **Outline assumptions and risks:** To clarify unspecified stakeholder roles and responsibilities, play what-if scenarios using unfulfilled needs and expectations, and double check the acceptability of assumptions made.
2. **Define stakeholder participation:** To assess their level of participation and information needs, the participation matrix shown in Figure 48 can help project managers in categorizing their strategy for involving stakeholders.

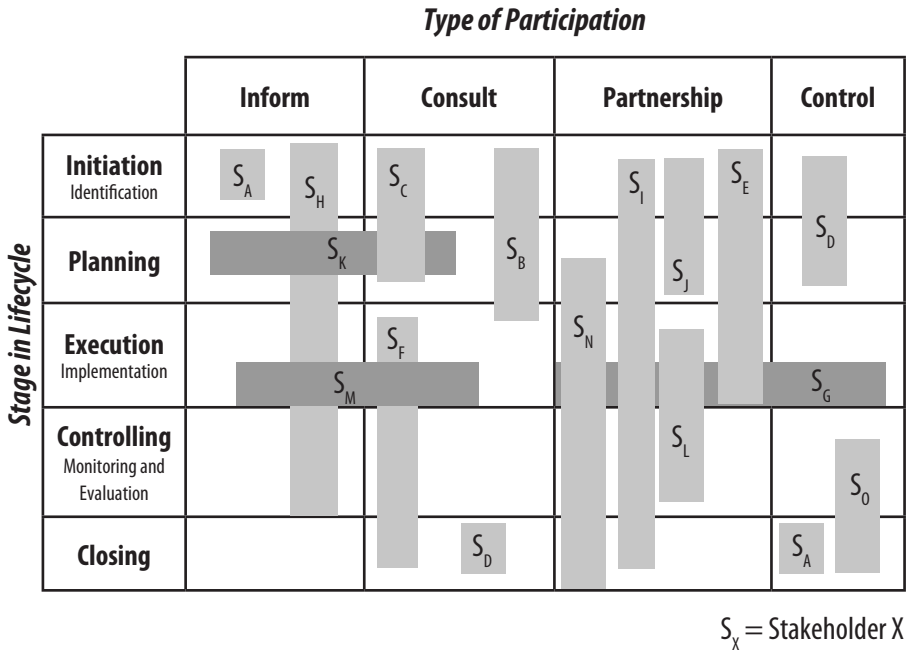

Figure 48. *Stakeholder participation matrix. Source: Smith 2000.*

Data Collection, Documentation and Wider Sharing of Adaptation Outcomes

Communicating climate-related information so stakeholders can understand it and apply in their context is critical for effective adaptation to climate change. Several methods and tools have been developed for effective data collection, documentation and sharing. Common practices are: case study of good practices documentation (particularly the traditional knowledge and practices), available scientific data collection initiatives from experts and expert organisations, and research undertaken by secretariat and national and international organization working in this field. Research reports, scientific peer reviewed publications, multimedia documents, technical reports, and online portals are examples of outputs widely used for sharing.

Data collection and management processes include data collection and storage, analysis, documentation and management. It is the process of gathering and measuring information on variables of interest to answer research questions, test hypotheses, and evaluate outcomes.[16] Systematized data collection and documentation of policies and procedures are essential because they:

- Help provide information about the intended and unintended long-term effects ensued by programmes or policies.
- Provide a basis for monitoring, implementation and evaluation.
- Ensure transparency, accountability and follow-up of research where necessary.
- Draw clear lessons from programmes and facilitate scaling up or replication.
- Help to make informed decisions for further analysis, study, and research.

Data Collection and Documentation Methods

Data collection is a process of collecting information from all relevant sources to find solutions to research problems, test hypothesis and evaluate outcomes. Data collection methods can be divided into two categories: primary and secondary methods (Table 25). Various data collection techniques are presented in Table 26.

Table 25. Data collection methods.[17]

Primary data collection		
Original data source i.e. collected first hand for research and projects		
Quantitative	• Ways of investigating or measuring whether, or to what extent, a programme or project has produced desired outcomes or impacts through numbers, percentages, or other statistical methods • Rely on structured or standardized approaches to collect and analyze numerical data • Methods include questionnaires with closed questions, methods of correlation and regression, mean, mode and median	Advantages: More structured, more precise answers and measures, perceived as more reliable, objective, easier to analyze, based on statistically sound methods for analysis, allows for generalizations, collected through formalised processes and standardised tools, strict definition of sample allows comparability of final results. Disadvantages: Hard to develop rigorous, standardized tools, implementing sustainable data collection systems can be relatively complex and expensive, can simplify reality in an effort to provide hard, objective, numeric data at the expense of understanding the complexity of a situation). Source: UNICEF Toolkit, 2009.
Qualitative	• Methods are used for generating descriptive data capturing and measuring diverse thoughts, feelings, perceptions, experiences, and level of satisfaction of beneficiaries in diverse contexts • Methods include interviews, questionnaires with open-ended questions, focus groups, observations, case studies	Advantages: Gives an in-depth understanding of a situation, captures differences and provides a more holistic approach to reality, easier to collect, costs are relatively low, gives reasons behind the numbers. Disadvantages: Less structured, challenging to analyze, subjective, perceived to be less reliable, generalizations from results are not possible, data may not be comparable to other findings, requires interpretation. Source: UNICEF Toolkit, 2009

16 https://ori.hhs.gov/education/products/n_illinois_u/datamanagement/dctopic.html

17 Source accessed at https://research-methodology.net/research-methods/data-collection/

Mixed	• Combination of quantitative and qualitative methods blended and employed in evaluating programmes and projects. • Combines the strengths of both methods to enhance theoretical aspects such as scientific rigor, the value of data and the knowledge and efficiency of the respondents with practical aspects of evaluation such as credibility of findings, skills of the staff, and constraints of cost and time. • Triangulate the tools and findings of quantitative and qualitative methods. • Useful in assessing the validity and reliability of the findings' and limitations of qualitative and quantitative methods.
Secondary data collection	
Data already published in books, newspapers, magazines, journals, online portals and other publications and platforms.	

Table 26. Possible data collection options.

Options	What it might include	Examples
Retrieving existing documents and data	• Formal policy documents, implementation plans and reports • Official statistics • Programme monitoring data • Programme records	• Hydrological and meteorological data for climate analysis • Review of programme planning documents, minutes from meetings, progress reports
Collecting data from individuals or groups	• Interviews, key informants, individual, groups, focus group discussions • Questionnaires or surveys via email, web, face-to-face, mobile data • Special methods (e.g., participatory rural appraisal tool, hierarchical card sorting, seasonal calendars, hazard ranking)	• Key informant interviews with representatives from government departments, nongovernmental organizations and the wider development community • Community questionnaires
Observation	• Structured or nonstructured • Participant or nonparticipant • Participatory or nonparticipatory • Recorded through notes, photos or video	• Observations of programme activities
Physical measurement	• Biophysical measurements • Geographical information	• Land use classification • Soil test

Source: Peersmen, 2014

Types of documentation are presented in Table 27.

Table 27. Types of documentation.[18]

Files that explain the context	Contain information on how the research was done in the form of: version logs, notebooks such as lab notebooks, or documents setting given methodologies. Examples of context documentation are the context around data collection such as project history, objectives and hypotheses; data collection methods (sampling, the data collection process, measuring instruments, etc.) and information on access, conditions of use and data confidentiality.
Files that describe the structure	Overview of the folders and files that make up the data set. The more elaborate your data set, the more important such documents are. Which folder contains what? Which files must be opened first?
Files that describe the content	Codebooks that explain the concepts and variables in questions and their meaning and the numerical or other values they represent.

According to Patel & Chotai (2011), these points must be considered to maintain the quality of documentation:

- Must be designed, prepared, reviewed, and distributed with care.
- Approved, signed, and dated by the appropriate competent and authorized persons.
- Must have unambiguous contents.
- Must be regularly reviewed and kept up-to-date.
- Must not be handwritten, however, where documents require the entry of data, these entries may be made in clear legible handwriting using a suitable indelible medium.
- Sufficient space must be provided for such entries.
- Any correction made to a document or record must be signed or initialed and dated; the correction must permit reading the original information. Where appropriate, the reason for the correction must be recorded.

18 Accessed at https://www.ru.nl/rdm/processing-data/documenting-data/

- Records must be kept when each action is taken and so all activities about the conduct of preclinical studies, clinical trials, and the manufacture and control of products are traceable.
- Records critical to regulatory compliance or to support essential business activities must be duplicated on paper, microfilm, or electronically, and stored in a separate, secure location in a separate building from the originals.
- Data may be recorded by electromagnetic or photographic means, but detailed procedures relating to whatever system is adopted must be available. If documentation is handled by electronic data processing methods, only authorized persons should be able to enter or modify data in the computer, access must be restricted by passwords or other means, and entry of critical data must be independently checked.
- If data is modified, it must be traceable.

Processing, Analysis and Reporting

The steps shown below are the process of creating, analysing and documenting the data.

Data Collection: It is important to document how you collected the data, including the methodology followed.

Data Processing: Raw data may contain sensitive information such as identifiable demographics or other information. The data are in a proprietary format and need to be exported into another format.

Data Analysis: The analysis carried out may range in complexity from simple to complex, depending on the data and the research methodology. Qualitative and quantitative data analysis, stakeholder analysis, cost-benefit analysis, GESI analysis, SWOT analysis, trend analysis, comparisons of cases of data, tables, graphs, chart preparation, cases into boxes, classification and scoring, use of Excel for presentation, uses of GIS for presentations.

Documentation: Analyzed results are documented in the form of reports. Analytical and logical documentation of reports including periodic progress reports, study reports, baseline, mid-term and final evaluation reports, good practices and lessons learned.

Data management includes developing effective processes for: consistently collecting and recording, storing securely, cleaning, transferring (e.g., between different types of software used for analysis), effectively presenting and making data accessible for verification and use by others. Data should be managed in every step to maintain the quality (Figure 49). Types of data to be collected and approaches to be followed for different decision-making processes are presented in Figure 50 and Table 28.

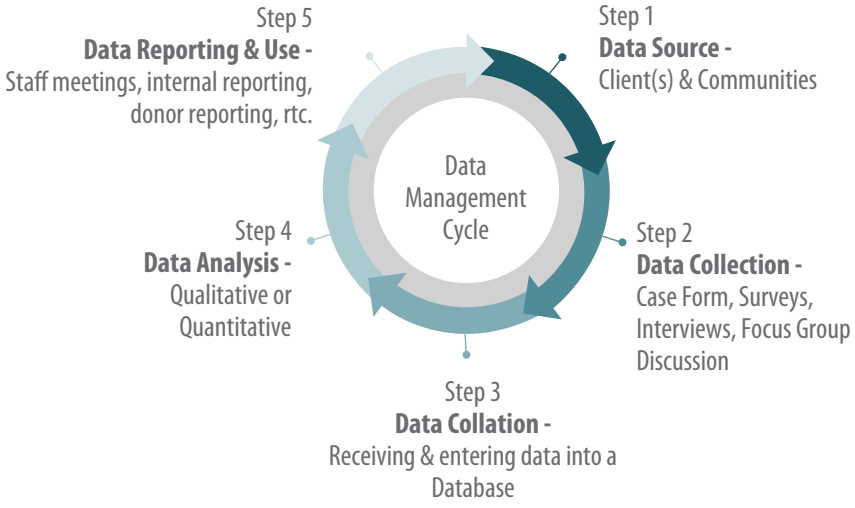

Figure 49. Process of data management.[19]

19 Source accessed at https://community.namati.org/t/key-principles-of-data-quality/42841

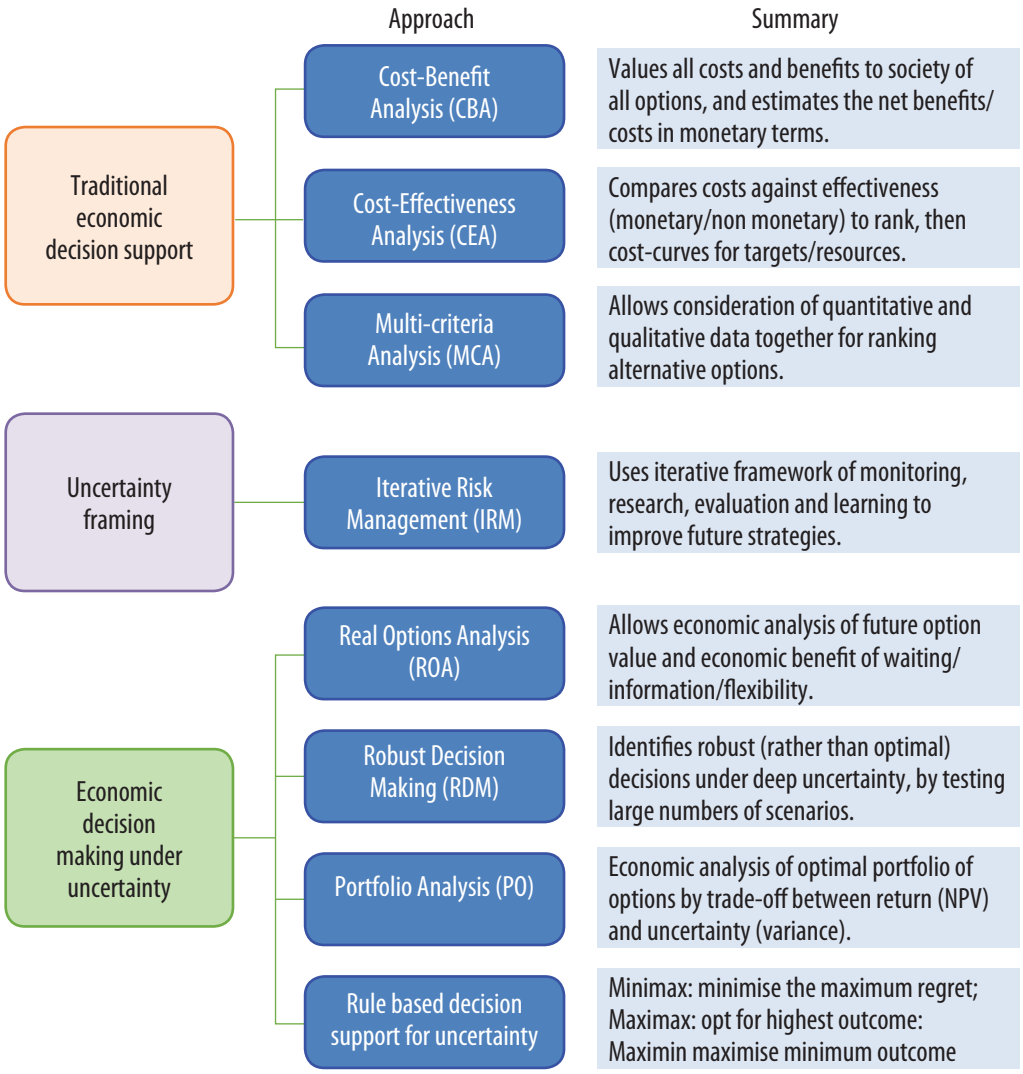

Figure 50. Appraisal tools and types of information to be collected. Source: Watkiss and Hunt 2016.

Table 28. Data gathering and reporting systems.

Written Reporting	Verbal Presentations	Creative Reporting	Critical Reflection Events	Electronic Formats
• Final evaluation report • Executive summary • Interim or progress reports • Human interest, success and learning stories • Short communications such as newsletters, brochures, memos, emails, postcards • News media communications (print media)	• Debriefing meetings • Panel presentations • Broadcast media (radio or television) • Informal communication	• Video presentation • Dramas or role-plays • Poster sessions • Writeshops	• After Action Reviews • Working sessions	• Web site communications • Synchronous electronic communications such as chat rooms, teleconferencing, video and Web conferencing

Sources: Patton 1997; Torres et al. 2005.

Stetson (2008) suggests the following four steps for effectively communicating and reporting on evaluation results.

Step 1. Identify communication and reporting challenges: The first step is to identify communication and reporting challenges so the stakeholders can learn from the results.

Step 2. Define communication purpose: Once stakeholders are identified, learn more about them to see what communicating and reporting strategies best meet stakeholder and other audiences' needs and promote use. To do this, think about individual or group characteristics.

Step 3. Select communication methods: Review the evaluation purpose from the evaluation SOW and consider expectations expressed by the stakeholders.

Step 4. Develop a communication and reporting strategy: With an assessment of stakeholder characteristics and knowledge of their information needs, the next step is to develop a responsive communication and reporting strategy. The strategy should describe who, what, when, and how to communicate.

People with different backgrounds are involved in data management and sharing. They are:

- Project directors designing research
- Research staff collecting, processing and analysing data
- External contractors involved in data collection, data entry, processing or analysis
- Support staff managing and administering research and research funding
- Institutional IT service staff providing data storage and back-up services
- External data centres or Web services archives who facilitate data sharing

Assuring Data Quality

Documentation constitutes an essential part of the quality assurance system. Data quality refers to the accuracy or worth of information collected. It is the ability of data to serve the purposes for which it was gathered. Clearly written procedures prevent errors resulting from spoken communication, and clear documentation permits tracing of activities performed. To maintain the assurance of data, various components of data quality are shown in Table 29 and Figure 51.

Table 29. Aspects of data quality.

Aspects	
Validity	Data measure what they should measure.
Reliability	Data are measured and collected consistently according to standard definitions and methodologies; the results are the same when measurements are repeated.
Completeness	All data elements are included as per the definitions and methodologies specified.
Precision	Data have sufficient detail.
Integrity	Data are protected from deliberate bias or manipulation for political or personal reasons..
Timeliness	Data are up-to-date and information is available on time.
Consistency	All data enumerators have the same understanding about the questions and record information in the same way.
Accuracy	Correct data free of errors.

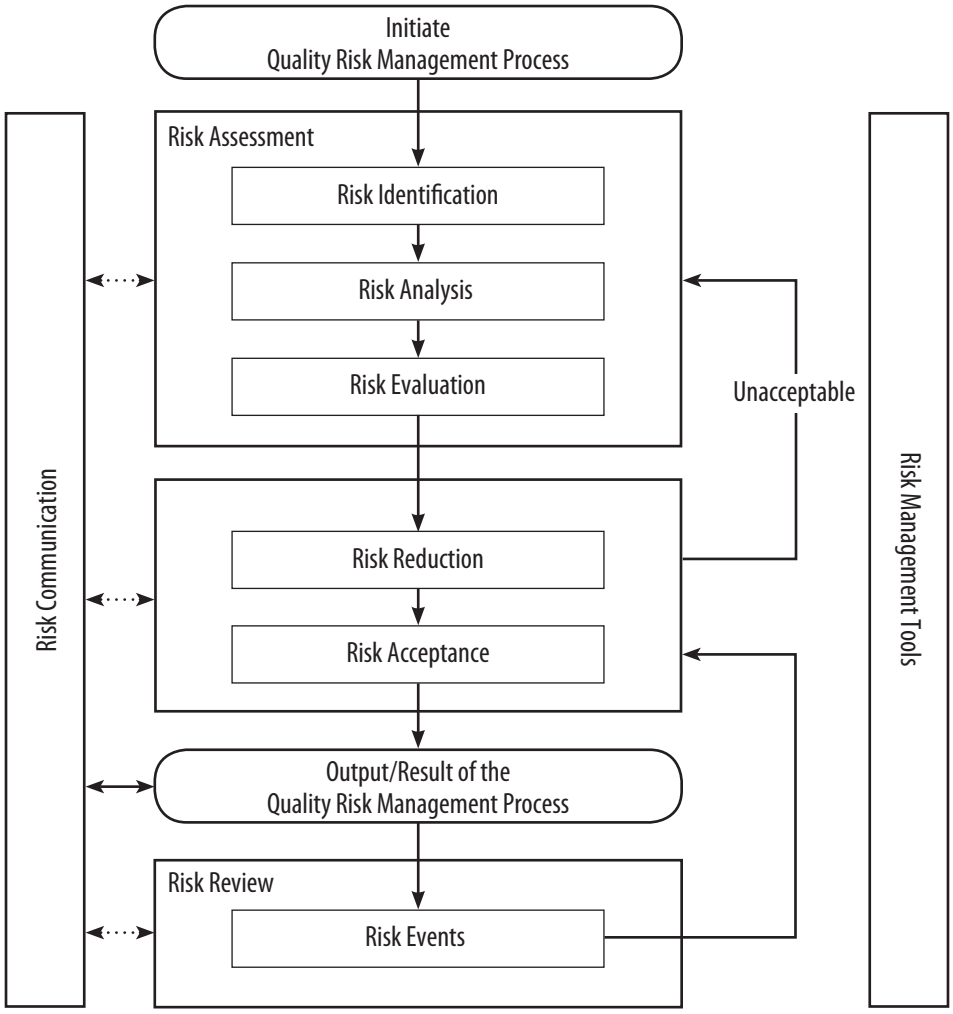

Figure 51. Data quality management process (ICH Q9). [20]

Data Sharing

Data are a valuable resource, usually requiring much time and money to be produced. Many data have a significant value and sharing research or project data has the following benefits:

- Encourages scientific enquiry and debate
- Promotes innovation and potential new data uses
- Leads to new collaborations between data users and data creators
- Maximises transparency and accountability
- Enables scrutiny of research findings
- Encourages the improvement and validation of research methods
- Reduces the cost of duplicating data collection
- Increases the impact and visibility of research
- Promotes the research that created the data and its outcomes
- Provides important resources for education and training
- Informs communities

20 Source accessed at https://extranet.who.int/prequal/sites/default/files/documents/Good_Documentation_Practices.pdf

There are many ways to share research data, including:[21]

- Depositing in a specialist data centre, data archive or data bank
- Submitting to a national or international journal to support a publication
- Depositing in an institutional repository
- Providing it online via a project or institutional website
- Providing it informally between researchers on a peer-to-peer basis
- Audiovisual, broadcasting through FM and TV
- Street dramas, paintings on walls
- Inputs in the international media
- Sharing at national and international conferences
- Workshops

Ethical Issues in Documentation and Data Sharing

Research involves obtaining data from people and from various sources. There is a need to maintain high ethical standards such as those recommended by professional bodies, institutions and funding organisations, both during research and when sharing data. Sensitive and confidential data can be shared and ethical issues can be minimized in documentation and data sharing if attention is paid to the following points:

- Informed consent and data sharing
  - Inform participants how research data will be stored, preserved and used in the long-term.
  - Inform participants how confidentiality will be maintained, e.g. by anonymising data.
  - Obtain informed consent, either written or verbal, for data sharing (Eynden et al., 2011).

- **Anonymising data**
  - Anonymization may be needed for ethical reasons to protect people's identities, for legal reasons to not disclose personal data, or for commercial reasons.
  - Personal data should not be disclosed from research information, unless a respondent has given specific consent (Eynden et al., 2011).

- **Access control**
  - Under certain circumstances, sensitive and confidential data can be safeguarded by regulating use of or restricting access to such data, while allowing data sharing for research and educational purposes.
  - Mixed levels of access regulations may be put in place for some data collections, combining regulated access to confidential data with user access to non-confidential data (Eynden et al., 2011).

The rights of human subjects in an evaluation are protected when evaluators apply ethical practices and simple common sense and courtesy. In communicating and reporting, an evaluation team should try to do the actions in Table 30.

21 Source accessed at https://www.usq.edu.au/library/research-support/data-management/sharing-data

Table 30. Ensuring ethical practices in communicating and reporting.

Action	Example
Understand the cultural and social values of all participants.	Use small groups in evaluation working sessions if subordinate staff are hesitant to speak critically about a program in front of their supervisors.
Ensure communications are in the appropriate language.	Translate the final evaluation report (sent in English to the donor) into the local language, such as French in Senegal, so national staff can easily review the report.
Never disclose identities of participants in reporting evaluation findings.	Use pseudonyms for respondents, not their real names.
Guard against other parties using the collected data for purposes different than those agreed to by the persons who provided the data.	Use common sense in sharing evaluation results with the press; keep original data secure.
Pay attention to disclosing evaluation findings, either through written or verbal communication.	Disseminate written reports in a way they cannot be altered; provide reports fairly to all groups affected by the evaluation.
Protect children's and adolescent's rights.	Invite an independent local stakeholder group to monitor evaluation communication activities with children.

Source: Joint Committee on Standards 2004; Schenk and Williamson 2005; Stetson 2008.

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Annex 1. Important Terms

Climate Extreme Events	The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) end of the observed values of the variable such as high temperatures (e.g., heat waves), or extremely heavy rainfall.
Climate Change Mitigation	Climate change mitigation is the human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs) through the actions that limit the magnitude or rate of long-term global warming and its related effects generally caused by human-caused emissions. Examples of interventions related to mitigation include reducing energy demand by increasing energy efficiency, phasing out fossil fuels by switching to low-carbon energy sources, and removing carbon dioxide from Earth's atmosphere (IPCC 2007; IPCC 2014).
Climate Trends	Patterns in climate variables such as temperature and precipitation observed in historic datasets.
Climate Projection	A projection of the response of a climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions to emphasise that climate projections depend on the emission, concentration, and radiative forcing scenario used, and that these scenarios are subject to substantial uncertainty as they are based on assumptions concerning future socioeconomic and technological developments that may or may not be realised.
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss of property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.
Disaster	Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.
Impacts	Effects on natural and human systems. In this report, the term impact is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction between climate changes or hazardous climatic events occurring within a specific time period, and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are subset of impacts called physical impacts.
Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends were to occur. Risk results from the interaction of vulnerability, exposure, and hazard. In this report, the term risk is used primarily to refer to the risk of climate change impacts.