**Association of Nepalese Agricultural Professionals of Americas (NAPA)**

Email: napa2072@gmail.com
Website: www.napaamericas.org

Association of Nepalese Agricultural Professional of Americas (NAPA) is a non-profit, non-governmental, nonreligious, and non-political professional organization founded in 2016. NAPA is dedicated to serve mankind through educational, scientific, and developmental initiatives.



Previous publications are available at:
http://napaamericas.org/research-policy-brief-editorial-committee.php
Email: rpb.napa@gmail.com

*Note: Contents of this brief have been drawn from Strategy for Agriculture Adaptation to Climate Change, Nepal report authored by Mr. Gehendra B. Gurung. Another supplementary issue will follow summarizing the remainder of the report.*

# Assess Risks and Potential Impacts of Anticipated Climate Change and Identify Areas for Adaptation

*Gehendra B. Gurung**

## Abstract

Nepal's agriculture depends on natural environment which is highly sensitive to impacts of climate change. Therefore, the agriculture needs strategic adaptation to minimize the effect of climate change. Strategic adaptation include but are not limited to 1) assessment of climate change and the hazards it induces, 2) assessment of effects and impacts of climate change and the hazards on agriculture, and identification of intervention areas, 3) identification and prioritization of adaptation measures, 4) integrating adaptation actions in agriculture development plans, programs and strategies, 5) delivering the adaptation plans and 6) learning from adaptation actions for scaling up in practices and advocating for policy influence. Assessment of climate change and its impacts should be carried out for short- to long-term with scenarios. Identification and implementation of adaptation measures are continuous and iterative processes.

**Keywords:** climate change, agriculture, adaptation, Nepalese context

**Climate Change Adaptation and Disaster Risk Reduction Specialist, Associate Life Member NAPA*
*Email: gehendra363@gmail.com*

## Introduction

In Nepal, agriculture contributed 27.59% and 26.98% to national GDP in 2017/18, and 2018/19, respectively (GoN, 2019). Cultivated and uncultivated lands cover 21% and 7% of total geographic area, respectively (GoN, 2014). Two-third (65.6%) of Nepal's population engages in agriculture. Despite a large number of population involved in agriculture, nationally

48.2% households are food secured with 38.8% in rural areas (Karki et al., 2018).

Nepalese agriculture is subsistence in nature. On average, a farming family owns 0.5 hectare of farmland which is further fragmented into three or more pieces (GoN, 2019). The same report notes that only around 56% of agricultural land has irrigation facility of which 33% has year-round irrigation. Farmers also face problems with supply of inputs, access to markets and postharvest management.
In recent years the area under cultivation is decreasing. Lands are left unattended and fallow, mainly in the hills. Youth population is migrating for employment abroad and for other income generating activities in urban areas. This is posing challenges for increasing agricultural production and productivity.

Agriculture production and productivity in Nepal also depend on natural climate. Adversities in weather significantly affect Nepalese agriculture. The intensity and frequency of such adversities is increasing due to climate change. Increased erratic monsoon pattern is one of the challenges facing Nepalese agriculture (NPC, 2019). The annual direct cost of current climate variability in Nepal, on average, are estimated to be equivalent to 1.5 – 2% of GDP (approximately US$270 – 360 million/year in 2013 prices). In extreme flood events they can be much higher rising to 5% of GDP or more which exclude indirect and macro-economic costs. This is high in comparison to international standards. In the longer term (mid-century and beyond) the impacts of climate change in agriculture has been projected to be as high as 0.8% of annual GDP, with potentially much more severe results in extreme years (IDS-Nepal et al., 2014).

In the context of existing inherent challenges and the new challenges posed by climate change, there is a high and urgent need of agriculture adaptation to climate change. A lack of adaptation is likely to result in severe impacts on agriculture and economy causing suffering to a large portion of the poor population who depend on agriculture.

## Climate change: An overview

It has been reported that by now there is 1$^0$C increase in global average surface air temperature compared to preindustrial era (IPCC, 2018). It is very likely that the global surface air temperature is going to increase by

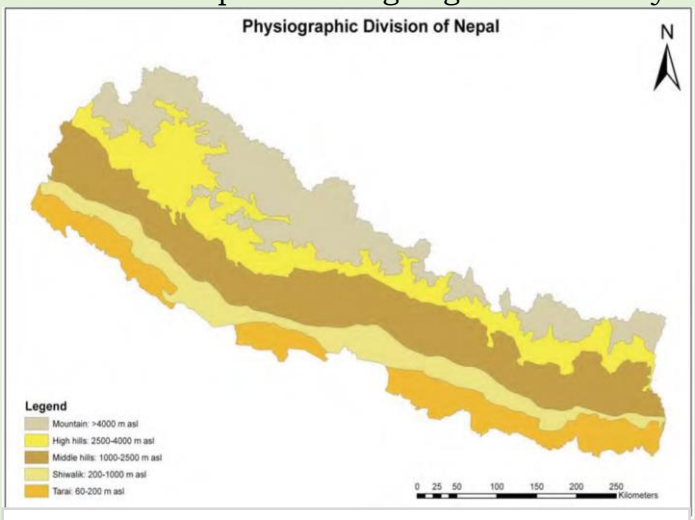


Figure 1: Physiographic regions of Nepal.
Source: Practical Action, 2009.

1.5$^0$C above pre-industrial level between 2030 and 2052 if it continues to rise at the current rate. This increase is going to bring additional risk to natural and human systems than the existing climate risk which has been already observed. There is already a need for adaptation to the ongoing change and the need will increase considerably if the warming increases with increase in emission. Countries like Nepal will be in high risk of impacts of climate change disproportionately due to poor adaptation capacity. Crops and livestock yields are projected to decline with increase in temperature (IPCC, 2018).

In Nepal, the trend of annual maximum temperature rise between 1971 and 2014 was 0.056$^0$C (DHM, 2017). Comparing between the seasons, monsoon has the highest rise (0.058$^0$C per year) and the pre-monsoon has

the lowest (0.051$^0$C per year). Precipitation has a negative trend with -1.3mm per year over the same period.

In the medium-term (2016-2045) and long term (2036-2065) periods, the average annual mean temperatures are projected to increase by 0.92°-1.07°C and by 1.72°-1.82°C, respectively compared to the reference period of 1981-2010 (MoFE, 2019).

Similarly, in the medium-term period, the average annual precipitation change is projected to increase by 2.1% - 6.4%, whereas, in the long-term, it is likely to increase by 7.9% -12.1% with reference period of 1981-2010 (MoFE, 2019). There will be spatial variations in which the central and western regions are likely to be wetter than the eastern regions. The increase in projected precipitation is in contrast to the observed precipitation trend.

The timing of rainfall is important. Although the total annual precipitation increase or decrease are not high, if there is a significant deviation in the timing of precipitation and its characteristics (intensity and frequency), the impacts will be significant. The observed monsoon over Nepal in the past decades shows a delay in withdrawal of monsoon.

## Climate related hazards

Climate related hazards include flood, landslides, soil erosion, drought, hail, windstorm, thunderbolts, cold-waves, heat waves, related wildfires, etc. Most of the disasters in Nepal are due to climate induced

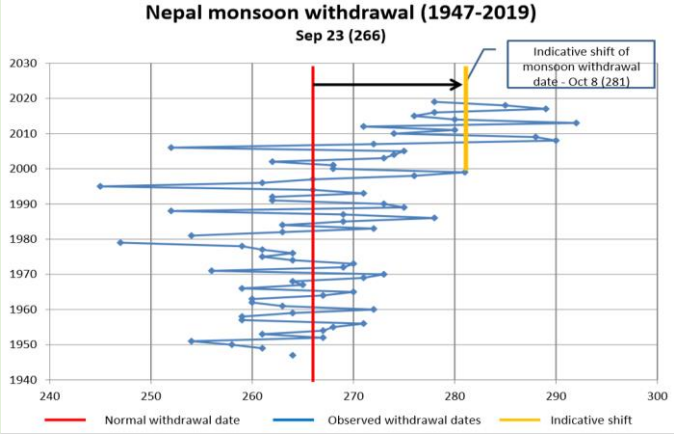


Figure 2: Nepal monsoon withdrawal anomaly. Source: https://www.dhm.gov.np/

hazards. Out of 23 different hazards listed by Ministry of Home Affairs between 2011 April 14 and 2020 April 1 (http://www.drrportal.gov.np/), 10 are weather induced and seven are indirectly related with the weather. Fires, which is indirectly related to climate is the highest in number of events, followed by thunderbolt and landslides. In terms of life loss, earthquake ranked the highest because of 2015 earthquake and it is followed by thunderbolts and landslides. Flood affected the highest number of families. Table 1 shows climate induced disasters dominating the disaster spectrum of Nepal.

The timing of the climate events is also shifting causing communities to be uncertain and unprepared to respond to these events. The capacity of the country and the individual is not adequate to respond and adapt to these new climatic events.

Table 1: Ranking of hazards based on their impacts.

| Ranking of Hazard | Occurrence of events | Life loss | Human injury | Economic loss | Number of family affected |
|---|---|---|---|---|---|
| 1 | Fire | Earthquake | Earthquake | Fire | Flood |
| 2 | Thunderbolt | Thunderbolt | Thunderbolt | Flood | Fire |
| 3 | Landslides | Landslides | Epidemics | Landslides | Windstorm |

Source: http://www.drrportal.gov.np/ (2011 April 14 and 2020 April 1)

## Impacts of climate change on agriculture

Seventy percent of the performance of crop production is explained by climate variability linked with temporal weather conditions (Sherchan et al., 2007). Agriculture in terai, which is the grain bowl of Nepal, is likely to be negatively affected as the temperature rises and rainfall becomes erratic (IDS-Nepal et al., 2014). In the hills and the mountains, there could be some potential positive impacts due to increase in temperature. But due to constraints in other factors of production, and because it takes time to understand the positive impacts, to prepare and to invest for harnessing the benefits, the potential positive impact has no significant implications.

Impact of climate change is the consequence of interactions between 1) climate change and related hazards, 2) exposure of agriculture and agricultural activities and 3) the vulnerability of agriculture sector (IPCC, 2014). Higher the magnitude of these factors, higher the impact. It is vital to understand these factors of risk for effective climate change adaptation. The existing context of Nepal reveals that there is high risk as the magnitudes of these factors are very high over Nepal. To enhance agriculture adaptation to climate change, a systematic assessment of these factors, designing of adaptation actions for different time horizons (short, medium and long) and their effective implementation are a must.

Nature dependent agriculture, fragmented lands, poor market system, weak access to information and technologies and poor adaptation capacity of farmers make Nepalese agriculture highly vulnerable to climate change. The existing poor institutional mechanism for supporting the farmers in research, inputs, technology, and market leaves a huge void against the high need of farmers for adaptation. Limited education and training to farmers for adaptation to climate change leaves a significant gap to meet the required level of capacity. The low capacity of the institutions and that of expertise are also factors of high vulnerability of agriculture to impacts of climate change.

Nearly two-third of population depending on agriculture for livelihood are highly vulnerable to climate change. About one third of the country's economy is at risk of climate change impacts. Significant area of agricultural land with no irrigation facility is highly likely to be adversely affected by erratic rainfall and receding of glaciers.

The agricultural lands in the hills are prone to landslides and in the plain to flood, inundation, siltation, and debris deposition that lead to reduction in physical area and deterioration of productivity and yield of land.

Because of the change in climate, there are already evidences of emergences of pests and diseases. New climate events like strong wind (tornado) are coming into existence that has high damage potential to crops and livestock.

## Strategy for agriculture adaptation to climate change

The overall objective of agriculture adaptation to climate change is to reduce the risk and impacts of climate change on agriculture and make the sector resilient. This requires a systematic and strategic approach and steps (Figure 3).

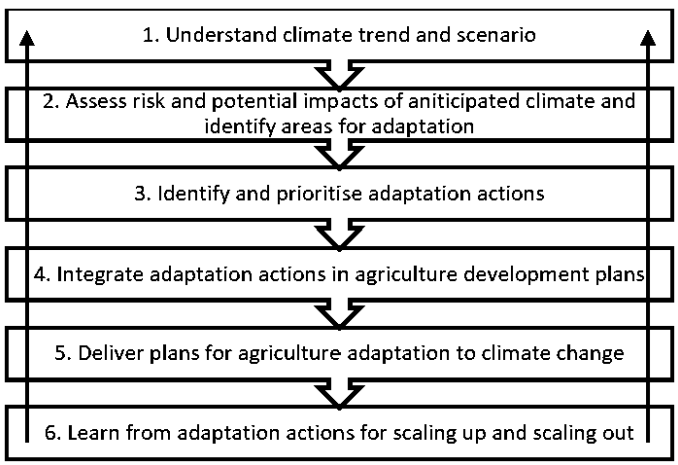


Figure 3: Agriculture adaptation to climate change.

Adaptation to climate change needs a robust understanding of climate trend and its short-term, medium-term, and long-term scenarios.

For climate, short-term may refer to now to 25 years, medium-term refers to next 25 - 50 years and long-term to over 50 years into the future. Adaptation undertakes actions in current time to adjust human and natural systems under the future climate. Unless the future climate change situation is properly assessed and understood, adaptation plans and actions cannot be effective.

Climate change assessment should be carried out for number of climatic and weather variables such as temperature, precipitation, wind, cloud or sunshine hours, air humidity, etc. (Table 2). It is also equally important to assess soil temperature and moisture as the surface climate and weather affect the soil temperature and moisture environment, which play vital role in agriculture. Trends of averages of climate variables are generally studied in climate change. Studies of scenarios of extreme events, frequency and seasonality of the climate variables are also important. Scenarios should be downscaled to smallest grid and shortest time scale as much possible. Such scenarios help in designing specific and localized adaptation measures. The more the adaptation measures are specific, the more they are effective.

Climate scenario should be revisited in intervals, possibly in every 5 years. Data and information from the same meteorological stations should be used while reviewing the scenario in intervals. If data from previous stations is discontinued and it is required to use data from new stations, it is important that their compatibilities be checked.

In case of Nepal, the mountain and high mountain regions have scattered hydrological and meteorological stations which do not sufficiently represent the climate information of those physiographic regions. So, there is a need to establish adequate number of meteorological stations in mountains and high mountain regions at strategic locations so that the density is adequate or optimum to properly represent the climate of these regions. Scenario building is also required for climate induced hazards including floods, landslides, drought, and others which are important for the location or the community.

Table 2: Climate or weather variables that need scenario assessment.

| Climate variable | Areas for scenario building |
|---|---|
| Temperature | • Average values of Maximum, Minimum and Mean temperature<br>• Extreme values of maximum and minimum temperatures<br>• Frequency and seasonality of average and extremes values |
| Precipitation | • Forms of precipitation – rain, snow, hail, dew<br>• Intensity, frequency, duration and intervals of precipitation<br>• Forms and total precipitation and their distribution over geographical areas (small) and across seasons, months and weeks |
| Wind | • Intensity, frequency, direction, timing and location |
| Cloud and fog or sunshine hours | • Duration, location, frequency of cloud/ fog formation across space and time |
| Air humidity | • Humidity over time and space |
| Flood | • Frequency, intensity (extreme), spatial and temporal scales to the smallest geographical area possible |
| Landslide | • Frequency, intensity (extreme), spatial and temporal scales to the smallest geographical area possible |
| Drought | • Frequency, intensity (extreme), spatial and temporal scales to the smallest geographical area possible |
| Cold wave | • Frequency, intensity (extreme), spatial and temporal scales to the smallest geographical area possible |
| Heat wave | • Frequency, intensity (extreme), spatial and temporal scales to the smallest geographical area possible |

## Assess risk, potential impacts of anticipated climate change and areas for adaptation

It is vital to assess risk and potential impacts of climate change on agriculture. The assessment is required for each of the climate or weather variable and climate induced hazards prevalent for the site. The risk and impact assessment are also required for all the individual crops and livestock species. However there is a limit of capacity for assessing risks and impacts of all climate variables on all crops and livestock. So it is important for prioritizing climate variable and specific crop or animal for risks and impacts assessment. A prioritization should look at a historic trend of impacts and the value, the specific crop and livestock that play significant role in the economy and livelihood and magnitude of potential benefits from adaptation.

Looking at the roles of crops and livestock in the economy and livelihood of the country and people, paddy, wheat, maize, millet, buckwheat, barley, oilseed, potato, sugarcane, jute, cotton, coffee, tea, citrus, mango, banana, litchi, and apple could be the priority crops for risk and impact assessment. Buffalo, cattle, sheep, goat, and poultry could be priority livestock for risk and impact assessment. The priority crops and livestock species could be different for different agro-ecological zones or provinces or districts or local government units and the communities.

Risk and potential impacts should be assessed over different time horizons of climate scenario, that is the assessment need to cover next 25 years, 50 years and beyond. Risk could be due to direct effects of climate variables on crops or livestock, such as an increase in temperature could affect the physiological activities of crops or livestock which will directly affect their body performance. As for example increase in temperature in temperate zones may reduce the number of chilling hours which is vital for temperate fruits, due to which plants will not set flower and fruit. Indirect effects could be due to climate induced hazards such as flood or landslide. The technical knowledge on response of crops and livestock to different climate stimuli is vital for such assessment.

Effects of climate on agriculture can be positive as well. But it takes time to understand the positive impacts and harness its benefits whereas the negative impacts take with no understanding. Risk and potential impacts should be assessed over different time horizons of climate scenario, that is the assessment need to cover next 25 years, 50 years and more.

The other risk that needs to be understood is temporal shift of weather or climate events. Even if a variable, say precipitation, has no change in its average or total annual quantity, there could be change in the timing (date) of occurrence. For instant, in last one decade, it has been observed that the monsoon withdrawal date is delaying (Figure 2) and there is a slight delay in monsoon onset over Nepal. It has affected the paddy transplanting activities in the beginning and harvesting towards the end. It is applicable to other climate events like timing of snowfall, hail, wind, thunderbolt, cold-waves, heatwaves, etc.

The form of precipitation has also changed. Observations show more rainfall and less snowfall events in high mountain regions compared to the past thereby changing the form of precipitation. This has affected the hydrology in the regions that pose risk to crop and livestock production. There are evidence of more hail events which are destructive to crops.

At the end of the risk and impact assessment, intervention areas for adaptation need to be identified. Identification of adaptation measures will help reveal the most important climate stimuli and climate induced hazards. It also helps understand the response of the crops or livestock to such climate stimuli and hazard that potentially result into high risk and high impact, and ultimately leads to identification of potential interventions to reduce the risks and impacts, and build and

strengthen the resilience of the system. Based on the potential of the interventions for reducing risk and impacts, they can be prioritized. The prioritization should also consider the capacity of the communities and the farmers to adopt the potential adaptation options. The context of capacity will determine the final options for adaptation options.

## Conclusions

Nepal's agriculture is highly sensitive to climate change. A lack of strategic adaptation of agriculture to climate change will affect the livelihood of nearly two-third of population of Nepal, and one-third of national GDP. Adaptation should be a part of development process. It needs to be integrated and mainstreamed in development plans and programs through a systematic approach. Adaptation is not only for the current climate change and the variables, but the implementation of the current actions need to be in view of the future climate and their potential impacts. Adopting systematic and strategic steps as discussed in this brief will help for effective adaptation of agriculture to climate change, minimize possibility of maladaptation and minimize potential large-scale adverse impacts of climate change to agriculture.

---



---

**References**

DHM. (2017). Observed Climate Trend Analysis in the Districts and Physiographic Regions of Nepal (1971-2014). Kathmandu, Nepal: Department of Hydrology and Meteorology.

GoN. (2014). Statistical Information on Nepalese Agriculture, 2013/2014 (2070/071). Kathmandu, Nepal: Government of Nepal, Ministry of Agriculture Development, Agri-Business Promotion and Statistics Division.

GoN. (2019). Economic Survey 2018/19. Kathmandu, Nepal: Government of Nepal, Ministry of Finance.

IDS-Nepal, PAC and GCAP. (2014). Economic Impact Assessment of Climate Change in Key Sectors in Nepal. Kathmandu, Nepal: IDS – Nepal.

IPCC. (2014). Fifth Assessment Report. Geneva 2, Switzerland. https://www.ipcc.ch/assessment-report/ar5/

IPCC. (2018). Summary for Policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (Eds.), Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, In the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp. https://www.ipcc.ch/sr15/chapter/spm/

Karki, M., Kahdka, S. R., Paudel, P., & Dhakal, A. (2018). Analyzing the Food System of Nepal. Presented at Foresight for Sustainable Food Systems in the Eastern Gangetic Plains (EGP), 27 September 2018, Kathmandu, Nepal.

MoFE. (2019). Climate Change Scenarios for Nepal for National Adaptation Plan (NAP). Kathmandu, Nepal: Ministry of Forests and Environment.

NPC. (2019). The 15th Plan Approach Paper (2019/20 – 2023/24). Kathmandu, Nepal: Government of Nepal.

Practical Action. (2009). Temporal and Spatial Variability of Climate Change Over Nepal (1976-2005).

Sherchan, K., Sharma, A., Regmi, R. K., & Shrestha, M. L. (2007). Climate Change and Agriculture in Nepal, Department of Hydrology and Meteorology, Government of Nepal, Kathmandu, Nepal.