Chapter 2

Overview of Economy, Agriculture Sector and Climate in Nepal

2.1 Introduction

Nepal is a small mountainous and landlocked country situated in the central part and on southern slope of the Himalayas. The country stretches from 26° 22’ to 30° 27’ North latitude and from 80° 04’ to 88° 12’ East longitudes and covers an area of 147,181 square kilometers; and looks roughly rectangular in shape with the length from east to west of about 885 km and width ranging from 130 to 260 km (Ministry of Population and Environment, Nepal, 2004). The country has an altitudinal range from 60 meters above the sea level in the south at Kechana Kalan\(^1\) to 8,848 meters above the sea level in the north (Aggrawala et al., 2003). It contains 8 of the 10 highest mountain peaks of the world, including World’s highest peak Mount Everest (Aggrawala et al., 2003). The country is bordered by India in the east, west and south, and the People’s Republic of China in the north.

The country is characterized by high geographical and climatic diversities. Within such a short range of about 4° latitude Nepal captures almost all types of climates, from subtropical in the south to alpine in the north. The remarkable differences in climatic conditions are primarily related to the enormous range of altitude within a short north-south average distance of less than 200km.


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\(^1\) Recently Musaharniya of Dhanusha District is identified to be 59 metres above sea level.
varies considerably across the country, as large parts of the country are too harsh for human settlement (Independent Office of Evaluation, 2013). As described, that the Terai region has half the population but less than a quarter of Nepal’s territory makes population density and population pressure on land most in this region. Among the total population about 83 percent live in rural areas (Central Bureau of Statistics, 2012). This population comprises significant ethnic diversity, with many different languages and cultures. Overall literacy rate for population aged 5 years and above is 65.9 percent.

### Table 2.1: Population Distribution, 1981-2011

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>15022839</td>
<td>18491097</td>
<td>23151423</td>
<td>26494504</td>
</tr>
<tr>
<td>Ecological Belt Population in percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>8.7</td>
<td>7.8</td>
<td>7.29</td>
<td>6.73</td>
</tr>
<tr>
<td>Hill</td>
<td>47.7</td>
<td>45.5</td>
<td>44.28</td>
<td>43.01</td>
</tr>
<tr>
<td>Terai</td>
<td>43.6</td>
<td>46.7</td>
<td>48.43</td>
<td>50.27</td>
</tr>
</tbody>
</table>


Administratively the country is divided into five development regions from the East to the West. Each of these development regions comprises all of the three ecological zones (see Table 4.3). Further, the country is divided into seventy-five districts. Each district is further divided into smaller areas, the Village Development Committees (VDCs) and Municipalities. There are 3914 VDCs and 58 municipalities in the country. Each VDC comprises 9 wards, whereas the number of wards of a municipality (urban area) varies from 9 to 35, depending on the size of the municipality. The smallest administrative units are wards (Kayastha, 2012).

### 2.2 Economy and Agriculture

Despite its natural beauty and enormous potential for hydropower and tourism, Nepal is one of the poorest countries in the world, with a per capita GDP $706 per annum in year 2011/12 (Ministry of Finance, 2013). Among the population 25.16% are living below the poverty line (Central Bureau of Statistics, 2011a). It has a human development index (HDI) of 0.463, ranking 157th out of 187 countries (UNDP, 2013). One of the reasons of this high poverty in the country is heavy reliance on agriculture.

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2 By December 2014 Government of Nepal announced other municipalities now there are 191 municipalities and 3276 VDCs.
and low productivity in this sector. The low productivity in agriculture sector is attributed to traditional method of cultivation and limited irrigation facility. The urban poverty is associated to modest growth of industrial sector.

Agriculture sector contributes close to one third of Nepalese Gross Domestic Product (GDP) while about two third of country’s population are active in this sector alone for income (Economic Survey 2013). And it is characterized by a subsistence orientation, low input use and low productivity. Only 16 percent of the total land is cultivable (Joshi, 2011; International Fund for Agricultural Development(IFAD), 2013) out of this only 53% is irrigated (Central Bureau of Statistics, 2013). The role of agriculture is important to the economy mainly because it has been creating employment opportunities to the entire agricultural rural communities and providing food security to the country. The contributions to GDP by Different Sectors in 2011/12 are given figure 2.1.

The features of Nepalese agriculture are unique in the sense of its complex nature of farming systems that are intertwined among the multiplicity of enterprises of crops, livestock, poultry, vegetables, fruits, spices, fisheries, agro-forestry and non-timber forest products. Majority of the farmers produce what they consume and consume what they produce. Paddy, maize, wheat, millet, barley, and buckwheat are major food crops of the country. Oilseeds, potato, vegetables and fruits are important cash crops whereas pulses, sugarcane, tobacco, jute and tea are main industrial crops of Nepal (Ministry of Finance, 2013). Paddy and paddy-based cropping pattern is popular in the irrigated areas particularly in Terai as well as in the in low lying areas of the middle mountain. Maize and millet are mostly grown in the rainfed uplands on middle hills and maize, buckwheat and potatoes on high hills during the rainy season. In winter in low lying area of hills and Terai people cultivate wheat, oilseed and other crops where there is source of moisture. Near to city people grow vegetables as cash crops. (Sharma, 1991).

In Nepal agriculture is in a low development stage. The agriculture sector of the country is traditional in nature and basically subsistence oriented. The basic feature of Nepalese agriculture is crops and livestock are integrated and these two components are highly interdependent (Bhandari, 2006). In general, households cultivate some land to produce food grains and raise livestock for animal protein (milk, meat and
eggs), draft power and manure. The households provide labour for crops and livestock production; crop production provides food for both humans and animals; and animals, in turn, provide protein for humans and manure and draft power for agriculture. Among food grains, households primarily produce cereal crops such as paddy, maize, wheat, millet, and barley. Rice is the most important staple crop, which accounts for 20 percent of Nepal’s agricultural gross domestic product (AGDP) and rice with wheat and maize contribute about 35 percent of Agricultural Gross Domestic Product (AGDP). Other crops contribute 15 percent, livestock 26 percent, horticulture (including fruits and vegetables) 17 percent and fisheries 2 percent in the AGDP (Nepal Agricultural Research Council, 2010).

Agricultural development is slow. Nepal has failed to meet its food requirement as a result it is now dependent on food imports. If hill regions are considered independently, all cereal crops yields have stagnated in the last 30 years due to land degradation (Deshar, 2013). Estimates of growth rate of major food crop yields during 1981-2011 for paddy, maize, wheat, millet and barley were 1.63%, 1.60%, 2.26%, 0.58% and 0.89% per annum respectively. Except wheat, growth rate of all other crops were well below population growth rate. It demonstrates how Nepal turned from food exporting country to a food importing country during the period. Average yield of major food crops and cash crops from 1980 to 2010 are presented in figure 2.2 and figure 2.3 respectively.

Productivity and competitiveness of the Nepalese agriculture sector are low, adoption of improved technology is limited and even though most cultivated area is devoted to cereals, there is a growing food trade deficit. Some subsectors such as dairy, poultry, tea, vegetable seed and fisheries show enthusiasm, but overall, these positive signs are not yet sufficient to lift a large number of people engaged in agriculture out of poverty and make a dramatic reduction in malnutrition and assure food security of the nation (Ministry of Agricultural Development, 2014).
Figure 2.1: Percentage Contribution to GDP by Different Sectors in 2011/12 (At current prices)

Figure 2.2: Yield of Major Cereal Crops in Nepal


Figure 2.3: Yield of Major Cash Crops in Nepal

Nepalese agriculture has improved but the improvement has been too little and the change has been too slow, both in terms of what the country had planned to achieve and relatively to the progress made by its neighbours over the same period of time. In Nepal agricultural growth has been not only slow (about 3%), but also highly variable. Agricultural sector overall is performing better today than in the past; productivity, infrastructure and food security have improved. During the 12-year Maoists armed conflict that concluded in 2006 period had adverse effects on the agricultural sector. Nepal’s youth and some of its most productive labour force have looked for job elsewhere. Hundreds of thousands of rural households left the land behind and moved mostly to the cities and others moved abroad. Migration was viewed as a coping strategy against shocks and crises, Nepalese youth from all parts of the country started migrating abroad because normal life was disrupted during the conflict, both on-farm and off-farm livelihood opportunities were limited in the country, and the demand for labour abroad was conducive for supporting the economy from migrant remittances. Almost all migrants were youth male; this scenario resulted into the agricultural activities in the hands of elderly people, women and children in the village. These movements resulted in a situation of labour scarcity in agriculture sector. For example, about 300,000 migrants have left Nepal in 2010 and there is a growing trend for the past 10 years (Ministry of Agricultural Development, 2014). During the same period, agriculture sector received little priority in policies and programmes, and resources allocation by the government. Besides this, rapidly growing urbanization implied that large tracts of periphery of urban fertile agricultural land have been converted to residential uses. The situation is further aggravated by political instability and lack of stable government.

Labour shortage suggests need for increased mechanization. Mechanization of agriculture, such as the use of tractors, pump sets, and other improved farm implements like threshers, improved ploughs, and sprayers increases yields in agriculture through better soil preparation, better water, pest and fertilizer management, reduced crop loss and timeliness of agricultural activities. Although, the history of agricultural mechanization dates back to the 1960s, when the government first imported tractors and pump sets and made them available to farmers, Nepalese agriculture still depends heavily on human and animal power. Mechanization of agriculture is at a very low stage. A large majority of farmers still use locally made
agricultural tools. About 52 percent of farmers own the most basic equipment ‘a plough or improved type of plough’ whereas only one percent of farmers own tractor or power tiller. Similarly, one percent of farmers own a thresher. Around 7 percent farmer households own a pumping set (Central Bureau of Statistics, 2011). The Terai plain is relatively accessible due to relatively well developed transportation infrastructure and is suitable for mechanization. Therefore, the use of tractors, pump sets, and other improved farm implements is increasing over time in this region. Use of machines and farm implements, particularly in the Hills and the Mountains, is hindered by geographical difficulties and lack of transportation networks.

Farmers’ cultivate small area of land holding. Inheritance practices under Nepalese law has resulted in land fragmentation, land holdings consisting of an average of 3.2 parcels per household and holding size is with average of 0.21 ha per agricultural plot (Central Bureau of Statistics, 2013) often quite widely scattered amid the topographical constraints in hill and mountain areas. This is one of the structural problems inhibiting agricultural modernization. Because of the scattered nature of farm parcels and their small size farmers are hindered from adopting productivity enhancing technologies (for example shallow tube-wells and mechanized cultivation (ANZDEC Limited, 2002). Outmigration might also create the process of increasing farm size, as long as there is an effective land use management regulatory system. As the agricultural sector transforms to a more commercial and competitive industry, it will attract more investment and support more semi-skilled, higher-paid employment.

Providing land with irrigation water for crop production is an important aspect of agricultural modernization. Although Nepal is rich in fresh water resources, the country’s agriculture has very limited access to irrigation water. The total land area under irrigation has steadily increased proportionally and physically since 1981/82. In 1981/82, the total land area irrigated registered at 583,900 hectares. The area under irrigation increased to 882,400 hectares in 1991/92. In 2001/02, the area under irrigation had increased to 1,168,300 hectares and it reached 1,313,406.3 hectares in 2011/12. In 1981/82 out of the total land holdings 23.7% of the area of the holdings had irrigation facility. In 1991/92 the percent increased to 34.0 and by 2001/02 it reached 44.0 percent and 2011/12 it reached 52%.
Table 2. 2: Irrigated Area

<table>
<thead>
<tr>
<th>Region</th>
<th>1981/82</th>
<th>1991/92</th>
<th>2001/02</th>
<th>2011/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain</td>
<td>19.8</td>
<td>41.8</td>
<td>62.1</td>
<td>-</td>
</tr>
<tr>
<td>Hill</td>
<td>119.2</td>
<td>245.5</td>
<td>304.9</td>
<td>-</td>
</tr>
<tr>
<td>Terai</td>
<td>444.9</td>
<td>595.1</td>
<td>801.3</td>
<td>-</td>
</tr>
<tr>
<td>Nepal</td>
<td>583.90</td>
<td>882.40</td>
<td>1,168.30</td>
<td>1313.41</td>
</tr>
</tbody>
</table>

Table 2. 3: Percentage of Irrigated Area

<table>
<thead>
<tr>
<th>Region</th>
<th>1981/82</th>
<th>1991/92</th>
<th>2001/02</th>
<th>2011/12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain</td>
<td>16.2</td>
<td>23.6</td>
<td>28.4</td>
<td>-</td>
</tr>
<tr>
<td>Hill</td>
<td>12.7</td>
<td>23.5</td>
<td>29.4</td>
<td>-</td>
</tr>
<tr>
<td>Terai</td>
<td>31.7</td>
<td>43.3</td>
<td>57.4</td>
<td>-</td>
</tr>
<tr>
<td>Nepal</td>
<td>23.7</td>
<td>34.0</td>
<td>44.0</td>
<td>52.0</td>
</tr>
</tbody>
</table>

Source: Agricultural Monograph 2001/02 & National Census Sample of Agriculture 2011/12

The average holding size is 0.68 ha per agricultural households (Central Bureau of Statistics, 2013) along with low productivity are the major reasons of widespread poverty in rural areas and the greater part of the agricultural population has low income in Nepal. Eighty three percent farmers’ main source of income is agriculture and 60% farmers’ report that the output is not enough for their consumption (Central Bureau of Statistics, 2013). A majority of the agricultural households depend on small farm size for cultivation. Of the total farmers about 53 percent farmers are operating less than 0.5 ha of land are considered “small” and only 4 percent are “large” farmers who are operating in 2 ha and more land in 2010/11. (Central Bureau of Statistics, 2011)

2.3 Geography

2.3.1 Physiographic regions

Nepal is divided into five physiographic regions which are almost parallel to each other, running from west to east. They are: the high Himalayan region, high Mountain, middle Mountain, Siwaliks and Terai. They represent well-defined geographic areas with distinct bedrock geology, geomorphology, climatic,
and hydrological characteristics. Soils and land units within these regions are significantly different from each other.

**High Himalayan region:** This region which is always covered by snow occupies 23.7% of the total land 3447500 ha. Its altitude ranges from 3000 m to 8848 m. The mountains are very steep with active glacier systems. The geology consists of gneiss, schist, limestone and shale of different ages. Physical weathering predominates and soils are very stony. This region falls largely within the alpine and arctic climate regimes, so there are active glacier systems where there is enough precipitation in high catchments. The climate is dependent on elevation and location in the mountain massifs. The few pockets of arable land of Solukhumbu, Mustang, Manang and Dolpa are the result of a unique combination of aspect, shelter from wind and availability of water for irrigation. Less than 1% of the region has soil and climate suited to crop production and then only where irrigation is available.

**High Mountain region:** This region borders the Middle Hills to the south and the high Himal to the north. The boundaries are defined by changes in geomorphic processes, bedrock geology and climate. The altitude of this region ranges from 2000m to 2500m and it lies below the permanent snow line. This region occupies 2899500 ha making up 19.7% of the country. Mountain slopes are very steep but there are some flat valleys as well. The geology is characterized by phyllite, schists, gneiss and quartzite of different ages. Soil formation on the slopes is slow and they are rocky. This region has more metamorphosed and structurally consolidated rocks. Gneisses and garnetiferous mica schists are common. Agriculturally this region is of lesser importance. It has a cool climate and receives heavy to moderate snow in winter. After the snow melts the mountains are covered with thick grasses and livestock like sheep, yak, and other mountain animals graze in this region. In the valleys, in summer, one crop a year can be harvested. The crops are potato, naked barley, buckwheat, and maize. Food grown here is not enough to support the population and more has to bring in.

**Middle Mountain region:** This region includes an area of 4350300 ha about 29.5% of the area of the country. Mountain peaks in this region range up to 2000m with narrow river valleys. The mountains are the Mahabharat range. The geology consists of a complex of phyllite, schists, quartzite of Cambrian to Precambrian ages and
granites and limestone of different ages. The climate ranges from warm subtropical to warm temperate. The higher peaks receive occasional snow whereas some lower parts receive occasional frost in winter, which causes damage to crops. Soils are extremely variable because of the differences in bedrock, geomorphology and microclimate. The southern margin mostly consists of a prominent belt of uplifted mountains known as Mahabharat Lekh. This belt is made up of deeply weathered granite, limestone, dolomite, shale, sandstone, slate and quartzite. The region is intensively cultivated and it produces most of its food, yet food is always transported from surplus regions to this area. Subtropical dense forest occupies the non-agricultural land.

**Siwalik region:** The Siwalik region rise from the Terai plain in the south to the foot of the Mahabharat range in the north. Its area is 1888600 ha; 12.7% of the total land. The region is sparsely populated. The fragile soils and steep slopes make the land unsuitable for cultivation. The geology mainly consists of tertiary mudstone, sandstone, siltstones and conglomerate. Soils vary depending on the materials from which they are developed. But, there are several inner valleys or duns, which are densely populated and because of alluvial deposition these valleys are very fertile. The landscape is very rugged and unstable, consisting of weakly consolidated Tertiary sediments with gentle to strongly sloping dip slope. Siwalik soils are unable to retain high precipitation which frequently occurs resulting in flash floods. Duns, a very important part of the Siwalik landscape, are structurally stable. The major dun valleys are: Chitwan, Dang, Deokhuri, Surkhet, Trijuga and Kamala. Climate in the duns is modified by the regular occurrence of winter fogs; otherwise it is very dry.

**Terai region:** The Terai, is low flat land of some 10 to 50 km wide extending east to west along Indian boarder; it is the northern extension of Indo-Gangetic plain, occupies 2142200 ha, 14.4% of the country. It lies at an altitude of between 60 m to 300 m. The region enjoys a warm sub-tropical climate and fertile alluvial soils. It is the granary of Nepal. An approximately 15 km wide belt of rich agricultural land stretches along the southern edge, whereas the northern section adjoining the foothills is more marshy. Wherever irrigation is available the land is intensively cultivated. It consists of recent and post-Pleistocene alluvial deposits forming a piedmont plain adjacent to the Himalayan ranges. Although the whole length of the Terai has a common geomorphology, it has obvious differences in land use due to presence of
different land systems and land units. The obvious difference is the increased amount of rice cultivation in the eastern Terai indicating a greater proportion of higher quality alluvial soils and more availability of water/rainfall compared to the west. During monsoon season the region experiences frequent flooding.

Table 2.4: Characteristics of physiographic regions of Nepal

<table>
<thead>
<tr>
<th>Features</th>
<th>Terai</th>
<th>Siwaliks</th>
<th>Middle Mountain</th>
<th>High Mountain</th>
<th>High Himal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>Quaternary alluvium</td>
<td>Tertiary sandstone, siltstone, shale and conglomerates</td>
<td>Phyllite, quartzite limestone and islands of granites</td>
<td>Gneiss, quartzite and mica schists</td>
<td>Gneiss, schist, limestone and Tethys sediments</td>
</tr>
<tr>
<td>Elevation</td>
<td>66-300 m</td>
<td>200-1 500 m</td>
<td>800-2400 m, Relief 1500m with isolated peaks to 2700 m</td>
<td>2200-4000m High relief 3000m form valley floor to ridges.</td>
<td>4000m above</td>
</tr>
<tr>
<td>Climate</td>
<td>Sub-tropical</td>
<td>Sub-tropical (but warm temperate in higher hill spurs)</td>
<td>Sub-tropical, warm temperate, cool temperate on high ridges</td>
<td>Warm to cool temperate, alpine</td>
<td>Alpine to arctic (Snow 6-12 months)</td>
</tr>
<tr>
<td>Moisture regime</td>
<td>Sub humid in FW+MWDR; humid in W+C and EDR</td>
<td>Sub-humid in most of the area, humid in N-aspect of W+C+EDR and dun valleys</td>
<td>Humid, per humid above 2000 m</td>
<td>Sub humid to per humid</td>
<td>Semi and benid Himal</td>
</tr>
<tr>
<td>Rainfall intensity</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Sal + mixed hardwoods</td>
<td>Sal + mixed hard woods + pine forest</td>
<td>Pine forest+mixed hardwood and oak forest</td>
<td>Fir, pine, birch and rhododendron</td>
<td>Open meadows +tundra vegetation</td>
</tr>
<tr>
<td>Soils</td>
<td>Ustrocrepts, haplustolls, haplaquepts, haplulstafsls, ustifluvents &amp; ustorthents</td>
<td>Ustrocrepts, haplustolls, Rhodulstafsls, ustothents, Dystrocrepts, Haplaquepts and Ustifluvents</td>
<td>Ustrocrepts, haplulstafsls, rhodulstafsls, haplumbrepts, ustorthents and ustifluvents</td>
<td>Eutrocrepts, dystrocrepts, haplumbrepts, cryubrepts, cryorthents and ustorthents</td>
<td>Cryubrepts, cryorthents and rock</td>
</tr>
<tr>
<td>Crops</td>
<td>Rice, maize, wheat, mustard Sugar cane Jute, Tobacco, Cotton and Tea</td>
<td>Rice, maize, wheat, millet, radish, potato, ginger, tea.</td>
<td>Rice, maize, wheat, millet, barley, pulses, sugar cane, ginger, cardamom</td>
<td>Oat, barley, wheat, potato, buckwheat, yams, amaranthus, medicinal herbs</td>
<td>Grazing (June to Sep)</td>
</tr>
</tbody>
</table>
Horticulture
Mango, litchi, pineapple, jackfruit, imli, potato, tomato
Mango, papaya, banana, potato
Mango, papaya, banana, orange, lime, lemon, peach, plum, potato, cauliflower
Chestnut, walnut, apple, peach, plum, apricot, potato

Transport
Good road linkage
Good road linkage within dun valleys
Road linkages around major centres
Very few road linkages
No road linkages

Note: FW= Far Western, MWDR= Mid Western Development Region, WDR= Western Development Region, CDR= Central Development Region, EDR= Eastern Development Region


Figure 2. 4:Ecological Zones and Physiographic Regions of Nepal
Source: Agriculture Development Strategy (ADS), 2014
2.3.2 Administrative Ecological Regions

For administration Geographically, Nepal can be divided into three broad regions. From south to north they are Terai, Hill, and Mountain or Himalayas. Each region stretches in an east west direction across the country and differs from the others in many ways. The elevations rise successively as one move from Terai to Hill and Hill to mountain. Because of marked differences in terrain and elevation, climatic conditions differ from region to region. With their different climates, they present a variety of ecosystems, including a wide range of plant and animal life, soils, and so forth. They also differ in terms of natural resources and land use practices. The government uses these regional divisions for planning and administration development. The 16 Mountain Region districts represent the most remote and difficult terrain. The 39 Hill districts have comparatively gentle slopes and less remote areas. The 20 Terai districts are more accessible and lie in the flat land of Terai.

Terai Region

The Terai region is the southernmost strip of Nepal, the land is dominated by a low lying, relatively flat plain. It is bordered by India in the south and by the hill to the north. Initially, this region was covered with dense, subtropical forests. Today, much of the forest is vanished. Now, this is Nepal’s most densely populated region and also it is most productive agricultural region therefore it is called the breadbasket of the country. Paddy rice, wheat, maize, millet, potatoes and mustard are major foods crops. Primary cash crops include sugarcane, tobacco, cotton and jute.

Hill Region

North to Terai, the central strip is called the Hill region. It is formed by the Mahabharat chain, a range of low, rounded Hills that reach elevations of approximately 2,000 to 3,000 meters asl. The Hills are extensively terraced, giving them a striking staircase appearance. Rice is the primary crop raised on terraced land, although wheat, maize, and tea also are grown. Some animals are raised in addition to crops. The south-facing slopes are more densely populated and agriculturally productive than those with a northern exposure; this is because they receive more
direct rays of the sun as well as more rainfall. The Hill region includes several valleys and plateaus.

**Mountain Region**

The mountain region, formed by the Himalayas, stretches across the northernmost part of the country. It is bordered by the Hill region to the south and by the Tibetan Plateau to the north. The mountain region, which ranges from about 2,000 to 8,848 meters asl, includes 8 of the world’s 10 highest peaks and most of the region is covered with permanent snowfields. (Bhattarai, 2008). The region’s inclement climate and harsh topography limit human habitation and make economic activities extremely arduous; therefore, the region is very sparsely populated, with less than 7 percent of Nepal’s total population live in the region.

In view of the requirements of the present study, the natural physiographic divisions proposed by the Land Resource Mapping Project (LRMP) would have been ideal. Unfortunately, the data related to crop cultivation and production at the national level are collected on the basis of the districts boundaries which are delineated on administrative considerations. The statistics division of the Ministry of Agriculture collects data on the basis of 75 districts. Therefore, the study adopts a system based on both district definition (the 75 districts) and ecological belts (three ecological belts Terai, Hills and Mountains).

**2.3.3 Soil Characteristics**

Soil depth, texture, drainage, nutrients, acidity are some important general properties of soils in Nepal relevant to agriculture. The depths of the Nepalese soils vary greatly from shallow (less than 50 cm) to deep (more than 100 cm). In general, soils on the Terai is alluvium, have mostly deep horizons, with no restrictions to rooting. Soils in the Hill and Mountain areas range widely from shallow to deep. The majority of Nepalese soils falls into the loamy texture class and are well suited to vegetable and fruit cultivation. The texture of Terai soils are fine loamy and generally stone free. The Hill and mountain soils are mostly stony. The texture of Hill and Mountain soils varies from coarse loamy to fine loamy surface over boulders and skeletal. With elevation the intensity of stones in the soils increases. The stony soils are difficult to cultivate and have low water retention capacity. Such soils are not suitable for root
and tuber crops. But perennial fruit trees can be productive on stony soils. Soil drainage is important for vegetable, fruit crops cultivation and for many commercial crops. Generally, Hill and mountain ecological zones are well drained. The low-lying areas of Terai are subject to inundation and flooding problems during monsoon. Nepalese farmers use farmyard manure and compost for improvement of physical properties of soils. They are aware that coarse textured soils can improve through application of organic matter.

Agriculture sector is adversely affected by the loss of top fertile soil due to soil erosion, landslides, and floods. Therefore, soil loss is one of the major causes of decline in agricultural production in Nepal. The negative effects of climate change may further aggravate this situation. Therefore, attention has been focused to visualize the food scenario in the light of climate change (Ministry of Population and Environment, Nepal, 2004).

2.4 Climate and climate projection

Nepal has a great deal of variation in climate and contains almost all types of climates. The remarkable differences in climatic conditions are primarily related to the enormous range of altitude within a short north-south distance. The presence of the east-west-trending Himalayan massifs to the north and the monsoonal alteration of wet and dry seasons also greatly contribute to local variations in climate. Generally, the spatial variation of temperature is determined by the difference in altitude. Temperature increases from north to south with the exception of mountain valleys. The temperature is lowest during December or January and then after temperature increases and reaches maximum in May or early June (Marahatta, Dangol, & Gurung, 2009). Then, as the monsoon rain arrives normally in June checks the increase in temperature. From October onward the temperature starts decreasing.

Monsoon which comes from southeast i.e. Bay of Bengal brings the main precipitation in the country. About 80 percent of the annual precipitation in the country occurs during June to September under the influence of the summer monsoon (McSweeney, New, & Lizcano) and it covers whole country except northern Mountain region. The amount of summer monsoon rains generally declines from southeast to northwest. This difference in annual rainfall distribution may be due to topography and partly to late onset and early retreat of summer monsoon in the west.
Westerly weather systems bring occasional rains during winter and early spring in the western part of the country. During the winter, rainfall is more reliable in the west than in the east.

The annual mean precipitation is found to be 1,857.6 mm and average annual rainfall trend of the country was nearly 4 mm/year in Nepal over the period (Marahatta, Dangol, & Gurung, 2009). Overall, eastern, central, western and far western development regions demonstrated positive trend in annual rainfall. However, most of the mid western development region showed decreasing annual rainfall trend. But the interpolated climate data 1980-2009 shows the average annual rainfall is 1667.82mm and do not demonstrate any significant trend. Average rainfall in Terai is 1776.7mm, in Hill it is 1786.9mm and in mountain it is 1463.2mm. The amount of precipitation varies considerably from place to place because of the non-uniform rugged terrain. Annual rainfall varies from 143.6mm in the rain-shadow area at Lomanthang, Mustang district in the north-west to 5,402.8mm at Lumle, of Kaski district (Marahatta, Dangol, & Gurung, 2009). The windward sides of the mountains receive more rainfall than the leeward side. The monsoon precipitation occurs in the form of snow in the high mountains which plays a vital role in nourishing the glaciers.

The study for 1976 to 2005 (Marahatta, Dangol, & Gurung, 2009) found national mean temperature of 19.5°C and general increasing trend in temperature has been found over Nepal. The maximum temperature was found to be increasing at a greater rate (0.05°C/year) than the minimum temperature (0.03°C/year). The analysis of 1980-09 data on annual average temperature of this study show an increasing at the rate of 0.014°C/year but trend is not significant, while from 2000 to 2009 trend shows temperature is increasing significantly at the rate of 0.18°C/year. National annual mean temperature is 18.29°C. Average temperatures of Terai, Hill and Mountain region are respectively 23.06°C, 19.07°C and 14.12°C.

The Terai belt or the southernmost part of the country, where extreme maximum temperature reaches more than 45°C is the hottest and mountain belt or the northernmost part is the coldest regions of the country. Mean maximum temperature in Terai belt reaches above 30°C which gradually decreases towards north as altitude increases and reaches below 22°C in the mountains.
General increasing trend is found in temperature in most part of Nepal (Marahatta, Dangol, & Gurung, 2009). Higher temperature and higher, but changed pattern of precipitation, as well as increasing occurrence of extreme climate events; such as prolonged draught, floods and inundation are projected climate in Nepal for future. The mean annual temperature is projected to increase by 0.8 to 2.2°C by 2030s, by 1.3 to 3.8°C by the 2060s, and 1.8 to 5.8°C by the 2090s (McSweeney, New, & Lizcano). Increase in the frequency of hot days and hot nights and decrease in the frequency of cold days and cold nights, compared to present climate, are the projection of climate in the future.

Mean annual projected rainfall averaged over the country from different models indicate increases in rainfall over Nepal. The mean monthly precipitation is projected to change by -12 to 15 mm per month by the 2030s, by -13 to 32 mm per month by the 2060s, and -14 to 59 mm per month by the 2090s (McSweeney, New, & Lizcano). The projection shows increases in summer (JJA) and fall (SON) season rainfall and decreases in DJF (winter) rainfall. Large variation in precipitation in many areas is likely in response to global warming due to its complex topography (Christensen, et al., 2007). Projections also indicate that the possibility of dramatic increase in the maximum 1-day and 5-day rainfalls in the future. There is moderate confidence that the monsoon might intensify and contribute to enhanced variability of river flows under climate change (Aggrawala, Raksakulthai, Aalst, J., & Reynolds, 2003). The observed interpolated seasonal and regional patterns of rainfall for 1980 to 2009 are portrayed in figure 2.5 and 2.6. The seasonal and regional pattern of temperature are shown in figure 2.7 and 2.8 respectively.
Table 2. 5: Climate projection for Nepal

<table>
<thead>
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<th>Year</th>
<th>Scenario</th>
<th>Change in Temperature °C</th>
<th>% change in precipitation</th>
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<td>2060</td>
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<td>A1B</td>
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<tr>
<td>DJF</td>
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<td>1.6</td>
<td>3.4</td>
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<tr>
<td></td>
<td>B1</td>
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<td>1.9</td>
</tr>
</tbody>
</table>

Source: McSweeney, New, & Lizcano, UNDP Climate Change Country Profiles: Nepal (McSweeney, New, & Lizcano)
Figure 2.5 Observed seasonal rainfall from 1980 to 2009 based on the interpolated data (for detail see section 4.4.2 and section 6.2.2)

Figure 2.6: Observed regional and national rainfall from 1980 to 2009 based on the interpolated data (for detail see section 4.4.2 and section 6.2.2)
Figure 2. 7: Observed seasonal temperature from 1980 to 2009 and fitted values based on the interpolated data (for detail see section 4.4.2 and section 6.2.2)

Figure 2. 8: Observed regional and national temperature from 1980 to 2009 based on the interpolated data (for detail see section 4.4.2 and section 6.2.2)
References


