subsistence or semi-commercial with only 15 percent of gross outputs being sold in 2003/04. Self employment in agriculture and agricultural wage employment are the country's most important source of household income.

Thus through a combination of landscape features characteristic of mountainous countries, a largely subsistence agrarian sector, high poverty levels, and limited government capability Nepal has been ranked as the fourth most at risk country according to one Climate Change Vulnerability Index (CCVI).[2] Natural disasters – especially landslides and droughts in the mountains and hills and floods in the Terai – accentuated by extreme weather events are argued to be likely to have a significant impact on agricultural production and livelihoods, especially for marginal locations farmed by the more food insecure households.

Two main themes run through this paper. First and as discussed in the next section, Nepal's mountainous and complex landscape makes it difficult to make wide generalizations about climate change impacts, risks and effects. Related to this, effects of climate-linked disasters and change may often, although not always, be localized and of small scale with respect to human impact in the mountains and hills although not in the plains. Second, the absence of a political settlement and the weakness of the state, a significant presence and influence of donors juxtaposed against a dynamic and increasingly contentious civil society leads to an extremely complex, often muddled and context specific institutional landscape at all levels. This is discussed in section 3. Section 4 moves on to outline the key policies and mandates with respect to climate change, and the paper concludes with a final discussion.

2. THE IMPACT OF CLIMATE CHANGE IN NEPAL

2.1 Changes in temperature and rainfall

Nepal is considered to be one of the world's most sensitive countries to the effects of climate change. This is largely due to its low level of development, a problematic governance and institutional environment, the poverty of its largely rural population combined with the effects of topography, and heavy monsoon rains (Sudmeier-Rieux et al. 2012:123, MoHA 2009 :17).

About 83 percent of Nepal is mountainous, and the remaining 17 percent lies in the northern part of the Ganga Basin plain or Terai (MoHA 2009 :5). The hottest part of the country is the southern Tarai belt and the coldest parts lie in the high mountain and the Himalayas in the north (Practical Action 2009:5;19, Agrawala et al. 2003:11). The climate types within Nepal range from subtropical in the south to arctic in the north. The climate is essentially dominated by the South-Easterly monsoon, which provides most of the precipitation during the rainy summer months in June until September. Depending on the location, about 70-85 percent of the annual precipitation in the country falls during this period (Shrestha and Aryal 2011:66-67).

About 20 percent of total area of the country is used for agricultural activities. The agricultural sector largely relies upon the annual monsoon rainfall since the irrigation system only covers a small area of the country (Shrestha and Aryal 2011:66-67). Due to its high dependence on rain-fed agriculture, Nepal is highly sensitive to changes in rainfall (Ministry of Environment 2010).

[2] http://maplecroft.com/about/news/ccvi.html (accessed /2/07/12)

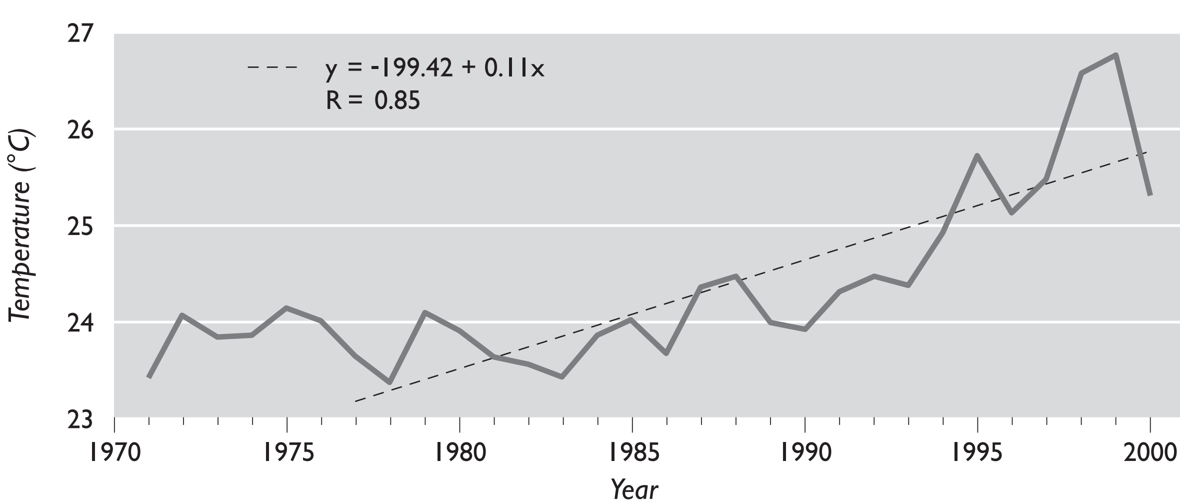
Key climate change impacts on Nepal will most likely include significant warming, particularly at higher elevations, leading to reductions in snow and ice coverage and thus flow of snow fed rivers. There will be an increased frequency of extreme events, including floods and droughts, and an overall increase in precipitation during the wet season (Ministry of Environment 2010), shorter monsoon seasons (typically June, July, August), more intensive rainfall patterns, and drought (Sudmeier-Rieux et al. 2012:123). In addition a variety of different non-climate factors will have varying but negative effects on water resources and agricultural systems in the region, including pervasive resource mismanagement and rapid population growth. This will confound the effects of climate change making it more difficult to disentangle what change is related to external global climate changes, and what is due to local land-use and development issues (Bartlett et al. 2010:4).

2.1.1 Temperature

According to McSweeney et al. the annual mean temperature has not increased in Nepal, in the observed climate period of 1960 to 2006 (McSweeney et al. 2008:1). This conclusion contradicts findings in the Shrestha et al. (1999) study on temperature records in the country. The latter study shows that, based on data from 49 stations in Nepal for the period 1971–94, there is a warming trend after 1977, ranging from 0.06°C to 0.12°C increase per year in the higher altitudes such as the Middle Mountain and Himalayan regions, while the southern, lower plains, i.e. the Siwalik and Terai regions, show warming trends of less than 0.03°C per year (Shrestha et al. 1999:2775). Warming seems to be more pronounced in the winter season (ibid. 2775; 2779). The study was later extended with more recent data, which shows that the warming trend is still continuing in Nepal (Shrestha and Aryal 2011:69):

The Nepalese National Adaptation Programme of Action (NAPA) prepared by the Ministry of Environment indicates that there has been an annual, non-uniform increase in temperature, of 0.04-0.06°C, with higher altitudes warming at a faster rate than the southern, lower plains (Ministry of En-

Figure 1. Nepal annual mean-maximum temperature trend, 1970–2000



Source: Shrestha and Aryal 2011:70.

vironment 2010:ix). In line with this, the IPCC report concludes that Nepal's annual temperature has increased by 0.04°C in the Terai region, more in the winter months, and 0.09°C per year in the Himalayas (Cruz et al. 2007:475).

Even if McSweeney et al. (2008) did not find any evidence of annual temperature increase, the study does conclude that there is a small increase in the frequency of hot nights together with decreases in number of cold days and nights between 1960 and 2003 (McSweeney et al. 2008:1-2), thus indicating a warming trend in Nepal.

One plausible reason to why findings on Nepal temperature increase are conflicting is that analysis of observed temperature and precipitation data in Nepal is limited to the relatively short length of records of about 30 years (Shrestha and Aryal 2011:68-69), making it difficult to draw solid conclusions. In addition, Nepal's unique physiographical and topographical distribution presents enormous climatic and ecological diversity (Shrestha and Aryal 2011:66-67), adding to the challenge of projecting impact of climate change on ecosystems in the country.

McSweeney et al. (2008) predict that the mean annual temperature will increase by 1.3 to 3.8°C by 2060, and 1.8 to 5.8°C by 2090. The range of projections by 2090 under any one emissions scenario will be 1.5□ 2°C. The number of hot days will continue to increase, and days and nights considered cold will by 2090 vanish completely in some parts of the country (McSweeney et al. 2008:3).

The Ministry of Environment concludes in the NAPA report that, based on the SRES B2 scenario, General Circulation Models (GCM) show a mean annual temperature increase with an average of 1.2°C by 2030, 1.7°C by 2050 and 3°C by 2100, compared to the pre-2000 baseline (Ministry of Environment 2010:X). The NAPA included projections offer a higher projection rate than the McSweeney report. The NAPA report also offers temperature projections based on experiments with Regional Circulation Models (RCMs), which show higher mean annual temperature projections: 1.4°C by 2030, 2.8°C by 2060, and 4.7°C by 2090. Higher increments of temperatures are projected over western and central Nepal, compared to eastern Nepal for these years (Ministry of Environment 2010:X).

There is difficulty in scaling down GCMs to the Nepalese geography, which has extreme topography and complex reactions to the greenhouse effect. GCM outputs lack sufficient spatial resolution to provide information on changes across the different elevation zones. Even high-resolution climate models cannot give reliable projections of climate change in the Himalayas (Jianchu et al. 2007:49, Bartlett et al. 2010:4).

2.1.2 Rainfall

According to McSweeney et al. (2008) a significant decrease in precipitation, averaging 3.7mm per month per decade, has been observed in annual precipitation in Nepal in the last few years; mainly due to average decreases in the summer rains (June, July and August) (McSweeney et al. 2008:2-3). The IPCC report however concludes that there are no distinct long-term trends in precipitation, based on the existing records between 1948 and 1994 (Cruz et al. 2007:475).

Either way, future projections indicate that mean annual rainfall will increase in the country, largely due to increases in rainfall during the wet season (June until November). The proportion of total rainfall that falls in heavy events is projected to increase as well (McSweeney et al. 2008:2-3; Ministry of Environment 2010:X). Nepal's adaptation plan suggests that the summer months will see an increase in rainfall for the whole county of 15-20 percent (Ministry of Environment 2010:X). A report by Sudmeier-Rieux et al. (2012) concludes that less monsoonal rain across the high mountains and more monsoonal rain along the southern hills is to be expected (Sudmeier-Rieux et al. 2012:121).

In summary, Nepal can expect increases in mean annual rainfall during the wet season, with decreases in rainfall during the winter months. Monsoon and post-monsoon rainfall and the intensity of rainfall will increase (Ministry of Environment 2010:X). However, the complex topography in Nepal will mean that local precipitation variations in response to global warming will be large and many areas will vary from the regional trend (McSweeney et al. 2008:2-3).

2.2 Disasters triggered by extreme climate events

A total of 64 out of Nepal's 75 districts are prone to some type of disaster. Nepal is ranked number 23 in the world when it comes to total natural hazard-related deaths, from 1988 to 2007, with total deaths reaching above 7,000. In addition, the country ranks 7th for the number of deaths resulting from all floods, landslides and avalanches and in 8th position for flood-related deaths alone. Globally, Nepal therefore ranks very high in terms of relative vulnerability to earthquakes and water-related disasters, respectively (MoHA 2009:17). In 2010 alone, casualties from natural disasters totaled 837 people, respectively caused by floods (27), landslides (67), fire/forest fires (61), epidemics (130), other hydro-meteorological reasons (161) and other causes (391). In that year 4259 houses were destroyed and 8453 houses were damaged due to disasters (MoHA 2011: 54). These figures indicate that climate-related disasters remain signifiant.

Given Nepal's small size and relatively low population density, in comparison to the other countries such as Bangladesh, Indonesia, China and India featuring at the top of the natural hazard-related deaths score, these rankings are particularly high and emphasize the high annual human toll of disasters such as floods, even during events that

Table 1. Number of floods and landslides and resultant casualties in the three districts, 1900-2005

Region	*No of floods*	*No of flood casualties*	*No of landslides*	*No of landslide casualties*
Mountain	163	9344	555	14 397
Hill	903	388 745	1610	31 610
Terai	1674	2 856 193	113	14 226
Total	2740	2 904 282	2278	60 233

Source: Aryal 2007:32.

Box 1. Perceptions of climate-related extreme events

Informants in the hill districts have strong perceptions of climate-related extreme events (landslides, floods, hailstorms, forest fires etc.) although the effects of these are usually highly localised. An increase in forest fires has been noted but the most frequent hazards are flood and landslides. Landslides are reported to be one of the major causes that induced hills people migrate to the Tarai over the last decades. When Nepal's planned development began in 1950s, *"badhi pidit"* – literally flood victims – comprised a particular category of people who deserved government support in the form of being provided free land in the Tarai. In Lamjung, some respondents suggested that some villages were entirely relocated to the Tarai due to landslides or related food problems in the 1970s.

On the other hand, people in Terai district appeared to have less sense of climate-induced extreme events although floods occur and have general impacts. Two distinct characteristics of flood prevail in Rupendehi: floods in the Tinahu river which affects the population living along the river banks (particularly landless people); flooding in the southern part of the district due to embankment and road construction in India which does not allow flood waters to drain away.

are considered "normal" for the country, and not exacerbated by changes in the climate (MoHA 2009:17).

As noted earlier, NAPA ranks two districts (Dolakha and Lamjung) as amongst the most climate-vulnerable and Rupandehi the least vulnerable of Nepal's 75 districts. However a review of the historical record (Aryal 2007:22) suggests that it is the floods in the Terai (table 1) that have given rise to the greatest number of casualties from natural disasters (reflecting probably higher population densities there) although the hills have reported over 50 percent of the casualities due to landslides. Nevertheless the perceptions of climate-related extreme events seem to be greater in the hills rather than in the plains (see box 1)

The risk of natural disasters in Nepal is likely to be exacerbated by the increase in the intensity and frequency of weather-related hazards, induced by climate change. One area which will probably be exacerbated by climate change, is the frequency of water-induced disasters (MoHA 2009:25-26). The other important disaster likely to be exacerbated by climate change is forest fires[3] – which in addition to causing fatalities and damages to property, reduces forest stock for use by local inhabitants (NCVST 2009).

Floods and landslides take their toll every year, resulting in loss of human life, crops and infrastructure (MoHA 2009:21). Since 80 percent of Nepal's rainfall occurs during the monsoon period (June-September), more intense monsoon rainfall periods are likely to lead to landslides and floods, especially in fragile environments near the mountains and mountain valleys (Sudmeier-Rieux et al 2012:121, Agrawala et al. 2003:16). Table 2 provides a historical record of the frequency of disasters due to landslides in Dolakha (showing both their frequency and relatively small casualty rates) while Box 2 presents a story of the genesis of a landslide and its effects. According to the Nepal Risk Reduction Report, the trend of increased intensity in rainfall has already led to an increase in the frequency and magnitude of water-related

[3] In the recent past, forest fire was particularly prominent in the spring of the year 2009 (see NCVST 2009:22-26).

hazards such as floods, debris flows and landslides (MoHA 2009:26).

Another consequence of increasing temperature is the loss of snow and ice in the mountains. Glaciers in the Himalayas have diminished in volume over the past few decades, with many of the glaciers retreating faster than the world average. Estimates conclude that the glaciers are thinning at a rate of 0.3-1 meter per year (Jianchu et al. 2007:49).

Table 2. Disaster History in Dolakha

Year (BS)	*Month*	*Disasters*	*Impacts*
1986	July	Floods/landslide	4 people died in Suspa-ward 7 and 4 Loss of physical assets
	August	Floods/landslide	16 people lost their lives, 7 houses destroyed, 50 houses displaced in Boach-ward 1
1988	July	Floods/landslide	4 people lost their lives, 1 house destroyed and 26 houses affected in Gairimudi- ward 1 5 people died, loss of physical assets in Suspa-ward 2,5,7 affected 7 people died in maize field, 50 m road destroyed in Malu ward 3
1992	June	Lightening	3 people died in Mali-ward 3
	July	Floods/landslide	15 people died due to landslide in Lapilang
1995	June	Epidemics	4 people died and many affected in Gairimudi-wards 7,8,9
	July	Flood/landslides	8 people died, land and property destroyed in Sunkhani-ward 1 14 people died, missing, property destroyed due to landslide in Vyaku
1988	June	Epidemics	8 people died in Lamabagar
2000	August	Landslide	7 people died, land and physical assets destroyed in Thulopatal-ward 5
2001	June	Landslide	11 people died, 5 missing, 18 house affected and 22 livestock killed due to landslide in Chankhu
	August	Landslide	3 people died, physical assets destroyed in Babare
2002	August	Epidemic	8 people died in Gujipa, Laduk-ward 4
2004	June	Epidemic	4 people died due to diarrhea in Khopachangu-ward 1, 3
2006	July	Lightening	5 people died in Khare wards-4, 5
2008	June	Lightening	2 people died in Chetrapa
2011	July	Flood/landslide	11 people died, 5 injured in Gaurishankar VDC (Sipring Khola)

Source: DDRC Dolakha 2012:27-28.

Significant areal expansion of several glacial lakes has also been documented in recent decades, with an extremely high likelihood that such impacts are linked to rising temperatures (Agrawala et al 2003:13).

Valley communities surrounding the mountains depend on the ice masses for water supply. The melting will therefore decrease water supplies for rural populations. Another catastrophic consequence is the creation of gla-

Table 3. List of GLOF events recorded in Nepal

Date	*River Basin*	*Name of Lake*
450 years ago	Seti Kola	Machhapuchhare
1935 August	Arun	Taraco
1964 September 21	Sun Koshi	Gelhaipu Co
1964	Trishuli	Zhangzangbo
1964	Arun	Longda
1968	Arun	Ayaco
1969	Arun	Ayaco
1970	Dudh Koshi	Ayaco
1977 September 3	Tamur	Nare
1980	Aun	Puncham
1981 July 11	Sun Koshi	Zhangzangbo
1982 August 27	Arun	Jinco
1985 August 4	Dudh Koshi	Dig Tsho
1991 July 12	Tama Koshi	Chubung
1998 September 3	Dudh Koshi	Sabai Tsho

Source: Rana et al. 2000:563.

Box 2. An account of the history of a landslide in Dolakha

The households in Ward 8 Bhirkot in Dolakha described a specific intense rainfall event of August 8th 2012 that led to mass land slumpage, house damage and in two cases physical destruction although no deaths. However they traced the root causes of the landslide back to a feeder road wrongly sited and badly constructed in the 1990s. The feeder road was built by a contractor with Nepali Congress party affiliations who through bribery of district officials and the use of gangs to break up a three months protest at the road by villages (who also filed a court case), shortcut the route the road should have taken to avoid damage and in the process undercut the underpinnings of the village lands. Small-scale landslides and subsidence appeared within a few years after this construction and a feeder road constructed by the VDC at the top end of the slope in 2008 (driven to all appearances by rent seeking-practices of the VDC APM members) further contributed to the events of August 8th 2012.

cier lakes that is closely linked to the glaciers' retreat. Melting glaciers create depressions in the mountain areas, which are filled with the melted water. This will cause, sometimes rapidly, the formation of glacial lakes. The loose moraine dams retaining glacial lakes are structurally weak and unstable, therefore they are deemed catastrophic, as failure to keep the water inside the dams could cause something called "glacial lake outbursts floods", also known as GLOFs, which have happened (table 3). GLOFs have the potential of drowning large areas and destroying infrastructure. Currently, there are 2315 glacier dammed lakes in Nepal and 20 are considered dangerous (Jianchu et al. 2007:50, Bartlett et al. 2010:5).

In the short term, higher temperatures will lead to an increase in annual discharge in rivers since a great proportion of river water comes from snow and ice. However, in the long run the annual discharge may decrease, and the discharge in dry season decline, affecting livelihoods and ecosystems widely (Jianchu et al. 2007:51, Bartlett et al. 2010:5). The melting of Himalayas' glaciers could impact the Indus and Brahmaputra rivers in the upper reaches where glacial melt is important throughout the year. For other rivers, such as the Ganges, discharge is important during the non-monsoon seasons. Climate change and its impacts on deglaciation are likely to have serious implications for hydrology including agriculture and hydropower generation in Pakistan, Nepal and India (Jianchu et al. 2007:51).

2.3 Gradual environmental change

As noted in section 2.1 there is some evidence of national-level gradual change in temperature and rainfall environments but given the complexity of Nepal's geography the specific effects of these cannot be easily assessed. There is as yet no evidence of such changes leading to tipping points in agroecological systems, and these, if they are happening, are likely to be location-specific rather than generalisable. That said, communities in the study districts reported gradual changes in climate patterns which they stated were affecting their lives directly or indirectly.

As summarised in Table 4, informants in both Dolakha and Lamjung reported warmer weather, changing rainfall patterns and longer drought periods. These, they reported, have caused decreased availability of water both for drinking and irrigation and reduced agricultural productivity. The Programme Officer of DDC Lamjung for example reported that local communities from northern Lamjung (Glale Gaun) had told him that agriculture productivity has declined in recent years due to decreased precipitation (including snowfall). The Chairperson of the Irrigation Federation of Dolakha stated that: 'water sources are drying and availability of water for irrigation has declined'. (Interview Notes 2012)

Rupandehi has also been experiencing change in weather pattern, for example prolonged winter cold waves and prolonged drought. There have also been reports that the availability of water for irrigation is gradually decreasing. For example the DADO of Rupandehi commented (Interview Notes 2012) that "rainfall patterns have been changing over recent decade. During my childhood (30 years back), we could see very heavy and continuous rainfall for even a week. However, these days there is very short duration of heavy rainfall and then prolonged drought. This has affected agricultural productivity." Such decreased water availability could also be attributed to increased demand for water due to rapid population growth and the commercialization of agriculture.

Table 4. Gradual climatic changes in the three districts

Dolokha	*Lamjung*	*Rupandehi*
Warming	Warming	Cold periods (prolonged fog in winter affecting winter crops, particularly legumes)
Drought	Drought	Drought
Changing rainfall patterns	Changing rainfall patterns	Irrigation water scarcity
Drinking water scarcity	Drinking water scarcity	

Source: Field Interviews

Many of those interviewed during the field visit in Dolakha and Lamjung identified recent changes in weather, making particular reference to the emergence/growth of crops grown in warmer weather and change of flowering/fruiting season of wild flowers or vegetables. They also referred to changes in rainfall patterns – high intensity rains or prolonged droughts. Droughts hit particularly hard those areas where agriculture is rainfed, and in the hills ground water extraction is unavailable. In the Tarai district of Rupandehi, respondents suggested that there has been a drop in the ground water table. However increased human settlement (leading to use of ground water for drinking water and other purposes) and several decades of irrigation based on ground water extraction, linked to the commercialization of agriculture in this district are likely to have contributed to this decline. There is some evidence that the technical changes in agriculture may in part be attributable to climate change (box 3)

Informants at the district level consistently commented on gradual change and did not refer to any particular 'extreme event' or tipping point, although the perception of extreme events may be more pronounced in the hills/mountain districts of Dolakha and Lamjung, perhaps because of the fears of GLOF. The flooding in Rupandehi, however, occurs at some scale almost every year, and there has been a big flood and inundation every decade or so. Similarly foggy days in the

Box 3. Changing agricultural practices in Rupandehi and Dolakha

In Rupandehi fertilizers, improved/hybrid seeds, and pesticides are available in the Agrovet shops and farmers are switching into new practices. One major change in the rice-wheat system has been to favour a high yield shorter duration rice varietiesvariety, in place of traditional varieties. The change is partly a response both to market needs and declining demand for higher priced traditional varieties. These autonomous modes of adaptation may help offset stresses related to temperature and precipitation. This process has been primarily facilitated through community groups – the farmer groups/cooperatives in Rupandehi. In Dolakha, on the other hand, local NGOs such as Tuki promote leader farmers who serve as resource persons to diffuse agricultural technology. Tuki officials mentioned that these resource persons are helping communities to introduce crop varieties that are suited to specific climatic and socio-economic contexts.

winter in Rupandehi plains last for one to a few weeks every year, and the longest was in 1995, when the district experienced 52 continuous foggy days. Such winters result in the damage of the onion crop in particular, and reduction of productivity in other crops, in addition to the difficulties of extended cold periods for the old and sick and children.

3. CLIMATE CHANGE AND INSTITUTIONS IN NEPAL

3.1 The institutional landscape

3.1.1 A 'failing' state? The elusive political settlement

The roots of Nepal's current predicament date back to the establishment of an absolute monarchy when Nepal was unified in the 18th century and the capture of that monarchy by the Ranas by the middle of 19th century. Even after the overthrow of the Rana regime in early 1950s, there has been a process of 'punctuated equilibrium' where windows of opportunity for change have emerged but been thwarted by the elite who have largely remained unaccountable. The effect has been a gradual increasing awareness and agitation for democratic rights that have fuelled increasing political contention over political representation at multiple levels.

The Ranas who remained in control from 1846 to 1950 established an effective rule of hereditary prime ministers for over 100 years and created a repressive regime based on social hierarchy, reinforcement of the caste system and patriarchy with heavy taxation of the rural population. From the 1950s when an alliance of the Congress Party of Nepal and the monarchy toppled that rule, there was a brief period of democratic possibility and the creation in 1959 of a multi-party system. However this was blocked by the king of the time who in 1962 banned political parties and instituted a multi-level *panchayat* system from village to national level. This arrangement remained contested and during the 1980s there was a rise of a pro democracy movement. Eventually in 1990 under pressure, including the effects from a trade conflict with India, a multi-party democratic system was enacted as a compromise between the left and centrist parties and the monarchy. With the establishment of a constitutional monarchy, democratic elections were finally held giving way to a series of unstable governments. In part this has been due to political parties lacking a democratic culture to handle differences and play the game of competitive politics. At the same time they have taken a liberal view in addressing the issues of social exclusion and inequality that exist in the country.

Frustrated by the lack of progress on reform, the Communist Party (Maoist) declared war against the government in 1996,and for the next 10 years a major insurgency in rural areas took place although there were periodic phases of truce and negotiation. In 2005 the King dismissed the government and took control, but the combined opposition of all political parties led ultimately to the transfer of power to parliamentary parties, the Comprehensive Peace Agreement (CPA) with the Maoists and the stripping of the King of his powers. With the Maoists brought into government, steps were taken by the newly elected constituent assembly to abolish the monarchy and in 2008 Nepal was declared a republic. Since 2008 there has been a long drawn out process of drafting a new constitution. This was planned to be completed within two years but conflict between the major political parties over the state restructuring