Impact of Climate Change on Tourism Sector in Nepal

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Abstract

Climatic variations might have a negative impact on the activities and services provided by the tourism industry. However, this idea has not yet been investigated in the context of Nepal. This study examines the monetary impact that climate change has had and will continue to have on Nepal's tourism industry and makes projections on such impacts. The economic impact assessment of climate change on Nepal's tourism sector is the first study of its sort to be conducted anywhere in the nation. This research is predicated on a conceptual model that was established on the theoretical foundation, a mathematical model that generated the tourism demand function, and an economic effect analysis that was performed on the tourism sector using secondary data. The findings of the study's analysis have been broken down into three distinct sections: a trend analysis of tourism and its contribution; regression results based on the models that have been established; and a projection of GDP for the years 2020-2030 and 2100. It is abundantly clear from the trend analysis, the analysis of loss and damage from climate-induced hazards, the econometric modeling for tourism function analysis and correlation on tourism GDP, and other research that the tourism sector is extremely vulnerable to the effects of climate change and that it will have significant repercussions. The projection of tourism's contribution to the national GDP shows that this sector has the potential to make a larger contribution, provided that the conditions that could prevent this from happening do not change. On the other hand, the rising trend of climatic factors and climate-induced dangers could potentially lead to a greater overall loss and damage in the tourism industry. As a result, it will have an immediate bearing on the contribution made to the national economy.

Keywords: Tourism GDP; Climate Change Induced Disaster, Tourism Loss and Damages, Tourism Demand Function, Economic Impact Analysis

1. Introduction

The tourism impact of climate change is widely discussed (Berrittella et al., 2006; Scott et al., 2012, 2019; Kompas et al., 2018; Dube et al., 2019). The Intergovernmental Panel on Climate Change [IPCC] (2014) has recognized recreation and tourism as one of the most vulnerable economic sectors to climate change. It is estimated that the economic impact of climate change varies in its coverage of subsets of economic sectors and is dependent on a vast number of assumptions, many of which are debatable. Furthermore, many estimates fail to account for catastrophic shifts, tipping points, and other issues. Taking into account these constraints, it is anticipated that global economic losses will range between 0.2% and 2.0% of total income for every 2°C increase in surface temperature (IPCC, 2014). The tourism sector contributes significantly to such economic losses.

Tourism destinations, notably ski resorts, beach resorts, and nature resorts, will be impacted by climate change, and tourists may spend their vacations at higher elevations and latitudes (IPCC, 2014). The tourism business relies on natural resources, which are particularly vulnerable to climate change extremes and disasters caused by climate change. As its services are accompanied by travel, transportation, and usage of numerous goods and services, the

tourism industry is also an emitter of greenhouse gases (GHGs) and contributes to global warming. By 2035, tourism's contribution to the global total of carbon dioxide emissions is predicted to climb substantially (UNEP-UNWTO-WMO, 2008). Moreover, tourism is especially susceptible to climate change since its services are significantly impacted by climatic extremes and events, such as changes in temperature, precipitation, weather, and climate (UNWTO & UNEP, 2008). Similar implications will be observed for tourism products dependent on forests, mountains, coastal areas, glaciers, bodies of water, biodiversity, and wildlife (Devkota, 2017; Yuxi & Linsheng, 2020). Similarly, climatic conditions can be viewed as a valuable asset for places and a significant tourist draw (Deng et al., 2002; Alexandrakis et al., 2019). The weather is a motivation; bad weather might discourage travel. Long-term, a destination's reputation for terrible weather may discourage visitors (Thapa, 2012).

The tourist industry is one of Nepal's main businesses, contributing significantly to the country's gross domestic product (GDP) and employment (Devkota et al., 2020). It is also one of the most important sources of foreign exchange and revenue. The Nepalese government has given increasing the tourism sector's contribution to the nation's economy the utmost importance in order to achieve its stated objectives of contributing to greater GDP growth and employment, reducing poverty, and increasing sustainable access to foreign exchange for national development (MoCTCA, 2015). Nepal serves as one of the world's richest natural and cultural heritage sites. The extensive natural and cultural heritage draws international travelers.

Nepal has twelve National Parks, one hunting reserve, and five conservation areas at the present time. The United Nations Educational, Scientific, and Cultural Organisation (UNESCO) has designated 10 sites as World Heritage, eight of which are of cultural significance and two as natural heritage sites. The country is a popular destination for mountaineers as it is home to eight of the world's fourteen peaks above 8,000 meters. In addition, trekking routes, particularly in the Annapurna, Everest, and Langtang regions, are among the world's most popular tourist attractions. Over fifty-one percent (51.4%) of all tourists who visit the country visit national parks, making conservation areas particularly appealing locations. The bulk of international visitors to Nepal are there for vacation and enjoyment (65%), although a substantial number also travel for pilgrimage, adventure, business, and other formal reasons (MoCTCA, 2016). March to April and October to November are called high season since the bulk of tourists visit during these months, but June and January are considered low season because fewer tourists arrive during these months.

As the home of eight of the world's highest mountains exceeding 8,000 meters, the country is a major destination for outdoor and adventurous tourism. Nepal has recognized 1,310 peaks above 6,000 meters, of which around a fourth are open to climbing activity. Mount Everest, Annapurna, and Lantang are prominent and popular climbing, expedition, and trekking destinations. In 1971, approximately 1,400 people visited the Everest region, compared to over 37,000 in 2014 (Rai, 2017). Similarly, the nation is home to the world's most exciting rivers for river sports like rafting. The rivers Karnali, Sunkoshi, and Trisuli are the most popular for rafting.

Nepal is also a location for tourism activities not specified above, which fall under the category of other tourism. A substantial number of people travel to Nepal for various formal and informal meetings, incentives, conferences, and exhibitions (MICE). In 2015, over 105,000 guests visited Nepal for MICE, compared to only 36,000 in 2014 (MoCTCA, 2017). Seasonality and environmental conditions have a major impact on the tourism business. Even a minor shift in these conditions might have a negative impact on tourism-related activities and services. The seasonality and environmental conditions, on the other hand, depend on climate variables that have direct and indirect effects on the economic activity and means of subsistence of tourism-dependent people. The rapid changes in climate variables and extreme occurrences can be detrimental to the health and safety of tourists and those directly engaged in tourism-related activities. The sustainability of tourism activities is significantly impacted by an increase in the frequency and severity of climate-induced disasters.

Tourism was one of nine theme sectors to be addressed in the formation of Nepal's National Adaptation Plan (NAP), which was supported by Practical Action through the Action on Climate Today (ACT) program. The tourist stocktaking report in the NAP process has underlined the need for a comprehensive analysis of climate change's effects on tourism. In addition to fostering private sector engagement, the research highlights that policy instruments relating to the tourism sector, especially the Tourism Policy, must incorporate climate change concerns for sustainable and resilient tourism development. This study examines the economic effects of climate change on

Nepal's tourism industry, as well as their projections. The economic impact assessment of climate change on Nepal's tourism sector is the country's first study of its sort. Consequently, this study and its conclusions would have numerous benefits for the development of a climate-resilient tourism industry in Nepal. This report provides diverse recommendations to all key stakeholders, such as collaborating to close data gaps and launching new partnerships to develop a resilient tourist industry in Nepal.

2. Methodology

This section begins by describing the theoretically based conceptual model. It then uses secondary data to model the impact analysis in two dimensions, namely the tourism demand function and the economic impact analysis on the tourism sector.

Conceptual Framework

The tourism industry largely depends on seasonality and environmental conditions (Amelung et al., 2007; Martín et al., 2014). Even a small change in these conditions can have a detrimental effect on tourism activities and services (Butler, 2001). The seasonality and environmental conditions on the other hand depend on the climatic variables that directly and indirectly affect the economic activities and livelihood of tourism-dependent communities (Kajan, 2014). The abrupt changes in climatic variables and extreme events can be damaging to the health and safety of tourists and people directly involved in tourism activities (Scott et al., 2012). An increase in the frequency and intensity of climate-induced disasters negatively impacts the sustainability of tourism activities (Field et al., 2012; Dube et al., 2020).

The conceptual framework (Figure 1) developed for this study considers that changes in climatic variables trigger changes in the frequency and impact level of climate-induced hazards. The increase in such hazards and resulting disasters has a direct and indirect impact on different tourism subsectors and services. It results in the loss of revenue from tourism and an increase in cost for adaptation with direct implications for the country's GDP.

The framework considers that tourism resources are exposed to climate extremes and that tourism activities are highly sensitive to climate variability and change. Considering that each tourism sub-sectors provide different economic opportunities and contributions, and has a different degree of exposure to climate change, this study has categorized these sub-sectors as; a) outdoor and adventure, b) culture and pilgrimage, c) nature and wildlife, and d) leisure and recreation[1]. The study recognizes that there are other purposes to visit Nepal such as for meetings, seminars, and conferences which are categorized as other tourism when required in the analysis. The key economic variables of different sub-sectors that are affected or likely to be affected are broadly explained by different activities such as employment generation, supply and sales of goods and services, establishment of tourism enterprises, investment on infrastructure and spending, and tax and levy generation as socio-economic variables to conceptualize the tourism activities into a single spectrum.

As presented in Figure 1, different climate extremes including temperature and precipitation trigger the frequency of climate-induced hazards such as landslides, flooding, snow storms, and avalanches. Tourism sub-sectors and relevant tourism activities are exposed to such climatic events. For example, climatic events escalate the degree of exposure to different tourism activities and services such as mountaineering, trekking, paragliding, and rafting under 'Outdoor and adventurous' tourism sub-sector. Increasing exposure further triggers impact level on different socio-economic channels such as opportunities of employment generation, tourism enterprises and investment. These channels are directly links to livelihood of engaged human resources including hotel staffs, tour guides, and revenue generation. Impacts on all these activities, good, and services are subject to economic incentives or transactions which cumulatively contributes on GDP. Similar linkage remains for other tourism subsectors. The study has employed the same 'impact theory' while analyzing climate change impacts on tourism, tourism GDP, and on national GDP.

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[1] The Tourism Vision 2020 of the government of Nepal has clustered the tourism products under five major categories as: a) Culture, heritage and people, b) Cities and leisure, c) Outdoors and adventure,d) Religion and pilgrimage, and e) Nature and wildlife (MoCTCA, 2009). However, for the purpose of this study culture and religious tourism were considered a single category as the data availability was limited and overlap between the two categories is high.
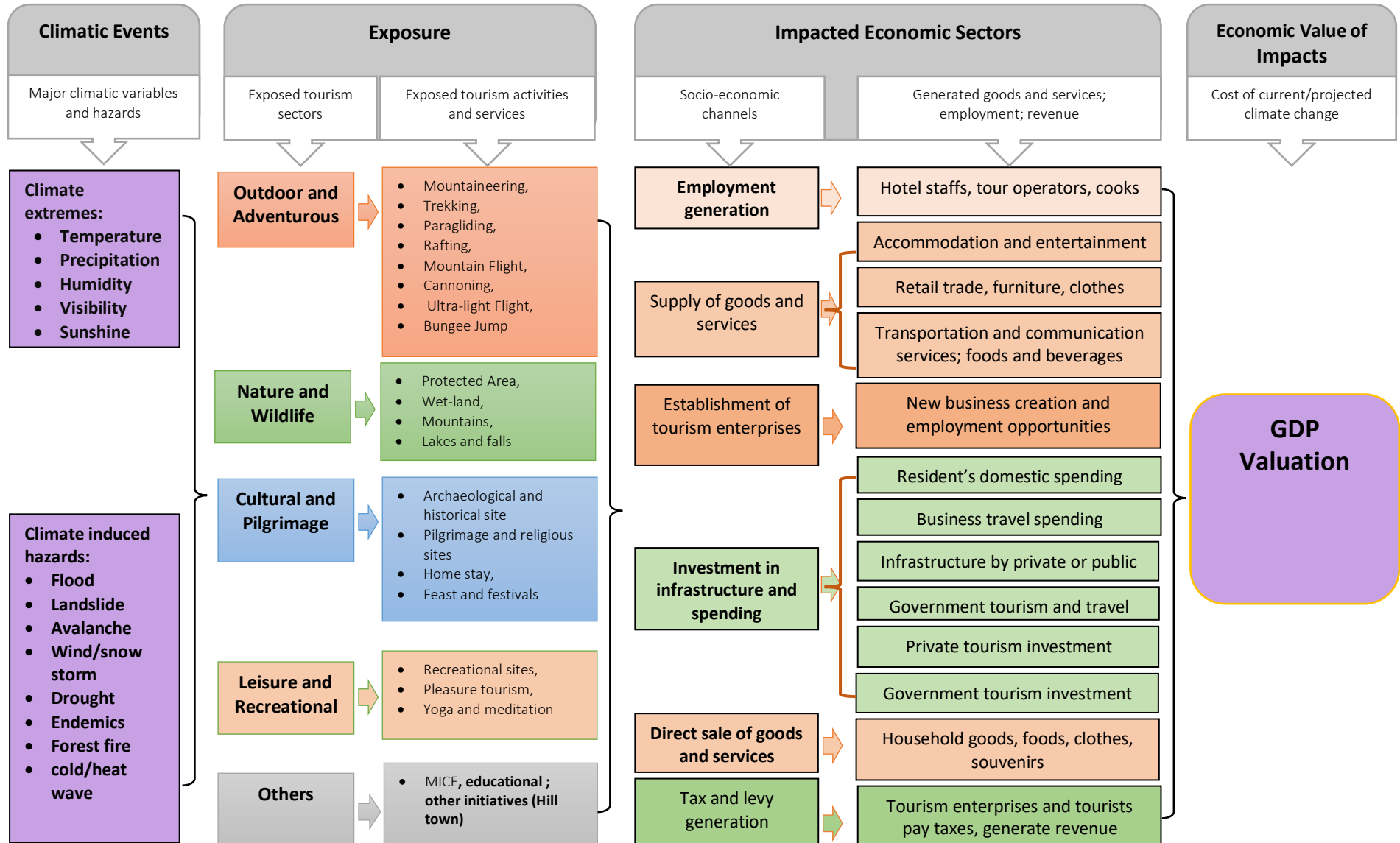
Climatic Events	Exposure		Impacted Economic Sectors		Economic Value of Impacts
Major climatic variables and hazards	Exposed tourism sectors	Exposed tourism activities and services	Socio-economic channels	Generated goods and services; employment; revenue	Cost of current/projected climate change

Climate extremes:
- **Temperature**
- **Precipitation**
- **Humidity**
- **Visibility**
- **Sunshine**

Climate induced hazards:
- **Flood**
- **Landslide**
- **Avalanche**
- **Wind/snow storm**
- **Drought**
- **Endemics**
- **Forest fire**
- **cold/heat wave**

Outdoor and Adventurous
- Mountaineering,
- Trekking,
- Paragliding,
- Rafting,
- Mountain Flight,
- Cannoning,
- Ultra-light Flight,
- Bungee Jump

Nature and Wildlife
- Protected Area,
- Wet-land,
- Mountains,
- Lakes and falls

Cultural and Pilgrimage
- Archaeological and historical site
- Pilgrimage and religious sites
- Home stay,
- Feast and festivals

Leisure and Recreational
- Recreational sites,
- Pleasure tourism,
- Yoga and meditation

Others
- MICE, **educational ; other initiatives (Hill town)**

Employment generation → Hotel staffs, tour operators, cooks

Supply of goods and services →
- Accommodation and entertainment
- Retail trade, furniture, clothes
- Transportation and communication services; foods and beverages

Establishment of tourism enterprises → New business creation and employment opportunities

Investment in infrastructure and spending →
- Resident's domestic spending
- Business travel spending
- Infrastructure by private or public
- Government tourism and travel
- Private tourism investment
- Government tourism investment

Direct sale of goods and services → Household goods, foods, clothes, souvenirs

Tax and levy generation → Tourism enterprises and tourists pay taxes, generate revenue

GDP Valuation

Figure 1: Conceptual Framework for Climate Change Impact in Tourism in Nepal

Data Collection

The study has adopted quantitative information collected through secondary data. Socio-economic data were collected from Ministry of Finance (MoF), National Planning Commission (NPC), Nepal Rastra Bank (NRB) and Central Bureau of Statistics (CBS). Tourism related statistics and data were gathered from Ministry of Culture, Tourism and Civil Aviation (MoCTCA), Nepal Tourism Board (NTB), Tourism Department, and Himalayan Rescue Association (HRA). The data on observed climate change trend and projections were collected from Department of Hydrology and Meteorology (DHM). The data on disaster events relevant to tourism sector and their loss and damage was extracted from the DesInventar dataset in the disaster risk reduction (DRR) Portal of the government of Nepal. The information from different sources was cross-checked to maintain uniformity. The study has also collected information of each activities of tourism sector to figure-out the main physical losses and damages on tourism sectors caused by climate change over the period.

Impact Assessment Methods

The study analysed the current costs of climate variability and extremes to tourism in Nepal based on the current and historical evidence, trend analysis of climatic variables, and economic impact of climate change on tourism sectors. It also has projected the economic costs of climate change in tourism sector for longer term. The impact analysis consist two-folds of data collection and processing methods: a) loss and damage (L & D) estimation from selected disaster events, and b) econometric model.

Loss and Damage (L & D) Estimation: The loss and damage (L&D) in tourism sector incurred by different disaster events is calculated after obtaining narratives and stories from local level. This study has considered four major disasters while calculating L&D at the nation level over last 30 years based on three criteria: a) periodic data availability of disaster events at least for last 30 years, b) direct linkages to tourism activities and services, and c) most frequent disasters occurred in major tourism destinations in the country. Four major disaster events: flood, landslide, avalanche, and snowstorm were shortlisted as the selected disaster events to calculate L&D over past 30 years. The data on frequency of selected disaster events and L&D was extracted from DisInventar data set (http://drrportal.gov.np/home). Both direct and indirect L&D was converted into the economic term while calculating the total annual L & D. The cost of direct loss and damage was used as mentioned in the DisInventar data set. However, the cost of indirect loss such as collapse and damage of private properties, and loss of human lives was calculated and converted into the monetary term based on the current government practice of compensation[2] even though human lives are invaluable. The total L & D is then converted into the portion of GDP.

Econometric Model: The econometric models are used mainly to analyse tourism demand function and impacts on tourism economy and hence on GDP while changing climatic variables. Initially, a baseline model was developed using annual data for the study period (1985-2015) in which econometrical techniques were employed to estimate the correlation between the climatic variables and the tourism activities. Based on this relationship, the tourism demand function was established. Finally, using the regressions value between climate change and tourism activities identified from the historic review, the impact on tourism activities were estimated at different climate change and disaster scenarios. A trend of tourism activities was projected based on the historic data of last thirty years. It was compared with projected climate change for the mid-term (by 2030) and long term (2050). This gave the changes between the growth projection at normal scenario and projected climate scenario. The details specification of econometric model is described in next sub-section. This study has estimated the costs of impact of climate change on tourism sectors based on current plans and tourism outlook. It looked through possible impact of climate change using tourism activities related information and climate variables as stated in the conceptual framework as specified in the following models. It has captured under two model, Model 1 – Tourism Demand Function, and Model 2 – Economic Impact Analysis on Tourism Sector.

Model 1 – Tourism Demand Function: A typical tourism demand function, with tourist arrivals as the dependent variable, was used in the analysis. Several econometrical techniques previously employed to estimate the demand for tourism and to forecast such demand and cost (Lim &McAleer, 1999) were used. Similar toAshworth and Johnson (1990), this model is used to estimate the demand function for the calculation of total cost and GDP contribution in the economy from these sectors in a stipulated time frame. It is necessary to understand the underpinning determinants to makes tourism industries more successful considering tourism sector as an important sector for

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[2] Based on the current compensation practice of Nepal government, the cost of death and missing of human life is considered equivalent to one million NPR; that for house collapse is equivalent to three hundred thousand NPR, and one hundred thousand NPR for structural damage.

economic benefits. However, the scale and underlying determinants of tourism in the country is not analysed through models of demand. This study has utilised the single equation model of demand as itis the most common methodology for the implication of the foreign tourist demand. Such model could offer the statistically more accurate results and provides comprehensive overview of demand model for tourism.

The linear form of single equation demand function utilised in this study is explained as:

$$TA_{it} = f(Y_{i,t}, ER_{i,t}, AC_{i,t}, CPI_{i,t}, P_t, T_t)$$

$$= A_{it}(Y^{\beta 1}_{i,t}, ER^{\beta 2}_{i,t}, AC^{\beta 3}_{i,t}, CPI^{\beta 4}_{i,t}, P^{\beta 5}_{it}, T^{\beta 6}_{it}) \text{ -- (1)}$$

Where,

$TA_{i,t}$	=	Total number of tourists arrival from 'origin' country i in time period t
Y	=	Gross domestic product (GDP) for 'origin' country i in time period t
ER	=	Exchange rate for 'origin' country i in time period t
AC	=	Average cost for visit on 'destination' in period t (per day average income per visitors)
CPI	=	Consumer price index in Nepal
T	=	The *temperature*
P	=	The *precipitation*
$A_{i,t}$	=	Unobserved variable (regression constant)

Model 2 – Economic Impact Analysis on Tourism Sector: As described in conceptual framework, tourism economy is the function of all tourism service sectors and climatic variables which ultimately has implication on GDP. Hence, economic impact assessment (EIA) on Tourism =f (Outdoor and adventurous tourism; Cultural and pilgrimage tourism; Nature and wildlife tourism; Recreational and leisure tourism; Other tourism sectors; and Climatic variables). The study establishes linear functional relationship of tourism activities and services in the country based on national tourism sectors data for 1985 to 2015. This study first quantified the contribution of tourism sector on national GPD in current price on local currency using the entire time series data specifications to take into account the relationship of tourism GDP and climatic variables in the time dimension. This study utilised the model close to that Ashworth and Johnson (1990) to establish such relations. However, instead of using emissions as a proxy for climate change in Ashworth and Johnson (1990) model, we directly use data on temperature and precipitation. This makes it possible to investigate more precisely the impact of these climate variables on each sector of GDP for each year.

Functionally,

$$GDP_{i,t} = f(OA_{i,t}, CP_{i,t}, NW_{i,t}, LR_{i,t}, OTS_{i,t}, T_t, P_t)$$

Where,

$GDP_{i,t}$	=	total *GDP* generated by tourism sectors $i$in time period t
$OA_{i,t}$	=	economy generated from *outdoor and adventure* tourism in time period t
$CP_{i,t}$	=	economy generated from *cultural and pilgrimage* tourismin time period t
$NW_{i,t}$	=	economy generated from *nature and wildlife* tourismin time period t
$LR_{i,t}$	=	economy generated from *leisure and recreation* tourism in time period t
$OTS_{i,t}$	=	economy generated from *other tourism sector* in time period t
T_t	=	The *temperature*
P_t	=	The *precipitation*

As stated in model-2, the temperature and precipitation are the main indicators of climate change which have direct and indirect impact on physical losses and damages and regular economic activities of tourism sectors and hence are considered as the independent variables. Whereas, the total economic valuation of the activities and services under different tourism sector categories, which contribute in GDP formulation, is considered as one of the dependent variables. The impact of climate change on tourism sub-sectors was quantified and then, measured in terms of monetary units3 and its impact on GDP contribution was estimated. Furthermore, the events and activities were measured in terms of monetary value as stated in above equation for this assessment.

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[3] Tourism activities are quantified and measured in terms of the monetary value based on the price of products and services each year.

Table 1: Description of explanatory variables used in the model

Explanatory Variables	Description	Expected Sign	Description
Y	Gross Domestic Product (GDP) for 'origin' country i in period t	+	If GDP of origin country increases, it allows people to have more money and flourishes tourism
TA $_{i,t}$	Total number of tourists arrival from 'origin' country *i* in time period *t*	+	Positive strategies and focused policy help to increased tourism arrival in the nation
GDP $_{i,t}$	total *GDP* generated by tourism sectors *i*in time period *t*	+	The GDP from tourism enhances in time being as tourism activities within the nation flourish
ER	Exchange rate for 'origin' country i in period t	±	If Nepalese currency is less powerful among their currencies, it allows them to have more money which enhance tourism
AC	Average Cost for visit on 'destination' in period t	-	Cost calculated based on per day average income generated by per visitor; Higher the average cost, lower the tourism demand and vice versa
CPI	The consumer price index in Nepal	-	Higher the value of CPI, lower the tourism demand
OA$_{i,t}$	economy generated from *outdoor and adventure* tourism in time period *t*	+	Outdoor activities play positive role on tourism growth in the nation and helps to generate economic activities
CP$_{i,t}$	economy generated from *cultural and pilgrimage* tourismin time period *t*	+	Religious activities play positive role on tourism growth in the nation and helps to generate economic activities
NW$_{i,t}$	economy generated from *nature and wildlife* tourismin time period *t*	+	Adventurous activities play positive role on tourism growth in the nation and helps to generate economic activities
LR$_{i,t}$	economy generated from *leisure and recreation* tourism in time period *t*	+	Leisure and recreational activities in nation play positive role on tourism arrival and generating economic activities
OTS$_{i,t}$	economy generated from *other tourism sector* in time period *t*	+	Other activities play positive role on tourism growth in the nation and helps to generate economic activities
T	The temperature	±	Temperature may vary in major destinations and has implication of tourists flow
P	The precipitation	±	Precipitation may vary in major destinations and has implication of tourists flow

3. Results

The result has divided into three categories. First deals with trend analysis of tourism and its contribution on Nepalese economy. Second section deals with the regression results where result from the both model is presented. The model we adopted for the analysis was Model- 1: Climate change impact on foreign tourist arrival, and Model - 2: Climate change impact on tourism GDP. Sector-wise Climate change impact on tourism GDP is also calculated as per the model. In third section, Projected Economic Costs of Loss and Damages on Tourism Sector is analyzed. Such projections are made for the year 2020-2030 and 2100.

Tourism's Contribution to National Economy

The tourist arrival trend over the period 1985-2016 shows that the foreign tourist arrival in Nepal is increasing rapidly for last few decades. There was a small downfall in the year 2000 to 2006 and 2015 which potentially was due to internal political instability and due to massive earthquake and unofficial blockade along Nepal-India border points respectively. Over the period more than one third (36%) tourists visiting Nepal are visiting for the purpose of

recreation and leisure followed by nature and wildlife tourism (29%). About 12% of total visitor have visited the country for outdoor and adventurous tourism purposes, and 5% visit the destination culture and pilgrimage related tourism. Interestingly, the country is hosting significant number of tourists for other tourism purposes (18%) including for business, meetings, conferences, and educational activities. Majority (roughly 85%) of the tourists are entering by using the flights. The trend of tourists flow over the period shows that about 31% tourist travel in the autumn and about 25% do so in spring seasons. However, significant numbers of tourists are visiting the country even summer and winter seasons despite considering it as relatively-off seasons. It reveals an opportunity to attract tourists round the year offering varieties and seasonal tourism services. On an average, an individual tourists was staying about 11 days per visit in 1985 while it reached about 13 days in 2016. It indicates that there is an opportunity to put more efforts on elongating the total days of stay of tourists visiting Nepal which as equally important as putting efforts to increase the number of tourists.

The relationship between tourism and economic growth has long been studied and recognized (Sahli & Carey, 2013). As it has multi-dimensional effect on the economy, tourism has enormous potential to be an engine of economic growth in the countries and could provide impetus to other sectors through its backward and forward linkages.
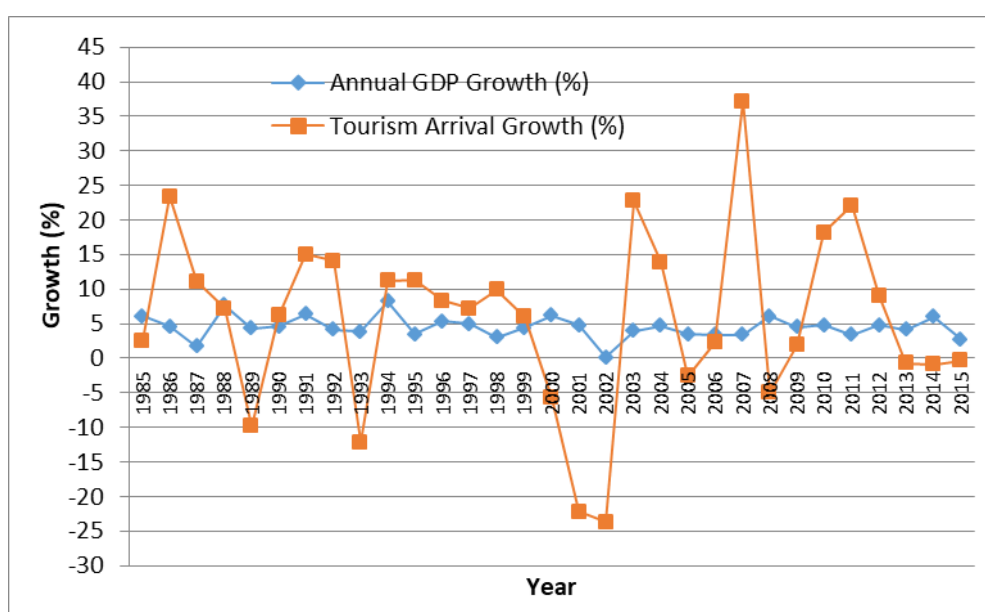

Figure 2: GDP growth and trend of tourists flow over the period in Nepal
Source: Calculated based on MoCTCA, 2017 and IMF, 2017

Figure 1 shows the positive relation between GDP growth rate and the number of tourist arrival. It broadly indicates that the tourism sector has generated different economic opportunities in the country and hence contributing on the GDP growth. However, there are other factors that effects on the GDP growth. Result indicates that, tourists' spending per visit is increasing over the period of last 30 year in Nepal. The average spending of a tourist was about US$ 300 per visit in 1985 while it is reached more than US$ 900 per visit in 2016. The total spending amount is dependent to different factors such as varieties of services and increasing market price. However, it also indicates that the total spending of an individual tourists could be increased offering multiple options such as service diversification so that the number of stay could be elongated. The growth of tourism itself is observed while analyzing its contribution on the GDP. The scope of tourism industry has significantly increased over the study period. The contribution of tourism industry on national GDP was about US$ 0.7 billion while it was about US$ 54.7 billion in 2015. Despite some downfall for 2005 to 2007, it was gradually increasing till 2010. The contribution share of tourism sub-sectors on total tourism GDP over the period of last 30 years (1985-2015) is different (see Table 2).

Table 2: Five years' average GDP contribution by tourism sectors

Years	Entire GDP of Tourism	ADT	CT	RT	EBT	OT
1885-1990	2.05	0.28	0.01	1.31	0.18	0.04
1990-1995	6.82	1.10	0.12	3.00	0.79	0.34
1995-2000	10.75	3.04	0.37	7.38	1.56	0.66
2000-2005	12.27	3.04	1.22	6.06	1.59	3.08
2005-2010	19.13	4.77	2.90	8.51	2.78	5.38
2010-2015	38.48	3.74	3.16	21.81	3.50	6.08

Similarly, the Lost and Danage (L&D) on national GDP because of different disaster events is significant over the last 30 years. Result shows that such trend of overall L&D on national GDP and tourism GDP is increasing. The overall loss and damage on tourism GDP is increased from NRs 0.0778 billion in the period of 1985-1990 to NRs 1.4624 billion in the period of 2010-2015. The share of loss is higher from outdoor and adventure tourism and leisure and recreation tourism sub-sectors within the tourism sector (Table 3).

Table 3: Five years' average loss on tourism GDP by damage

Years	Entire GDP of Tourism	OAT	CPT	RLT	EBT	OT
1885-1990	0.0778	0.0106	0.0004	0.0497	0.0068	0.0015
1990-1995	0.2591	0.0418	0.0044	0.1140	0.0302	0.0129
1995-2000	0.4084	0.1155	0.0141	0.2803	0.0592	0.0249
2000-2005	0.4662	0.1154	0.0462	0.2301	0.0606	0.1169
2005-2010	0.7270	0.1813	0.1102	0.3235	0.1056	0.2043
2010-2015	1.4624	0.1422	0.1199	0.8289	0.1330	0.2311
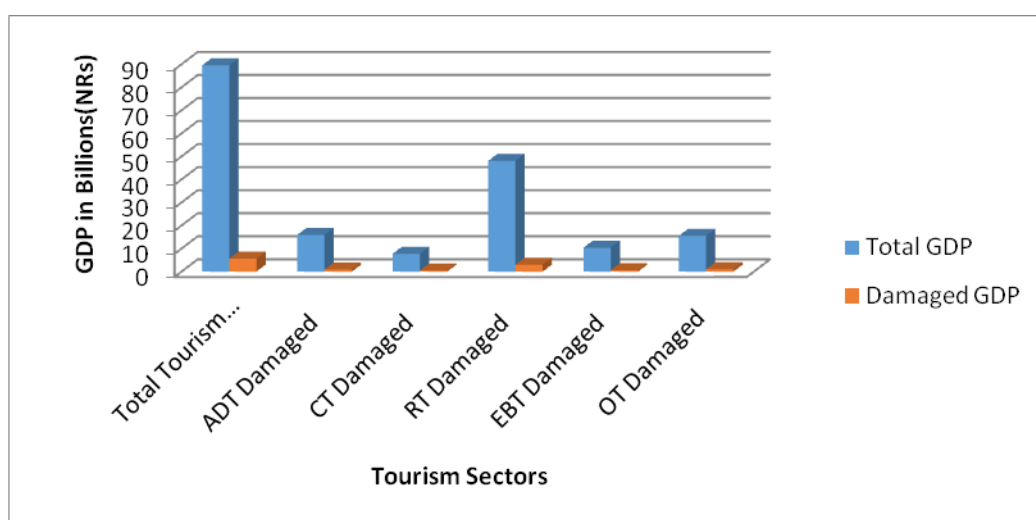
Figure 3: Composition of share of tourism subsector on loss of tourism GDP in over the period in Nepal (1985-2015)

This study also calculates economic loss and damages incurred from climate induced disaster on both national and tourism GDP. As it is well discussed, natural resources and nature-based system of development are more exposed to climate change. As explained earlier, tourism sector in Nepal is more natural resource based and hence is more vulnerable to climate change. The tourism sector is mostly impacted by increasing frequencies of climate induced hazards over the years. Such impact includes significant loss on local and national economy. The calculation reveals that the country has incurred annual economic loss on tourism GDP equivalent to $987,968/year in last 30 years because of identified fours climate induced hazards. It further reveals that the economic loss on both national and tourism GDP is significant due to climate induced hazards over the last 30 years though the heterogeneity consists (Figure 3). The trend of economic loss is more in certain periods. For instance, the economic loss due to climate induced hazards was higher in early 1970s compared to late 1970s. Similarly, the same was higher in early 1980s compared to mid-1980s. However, it is observed that the numbers of higher pitches in the graph are occurred in the recent decades. It indicates that the frequencies of climate induced hazards – in terms of both amplitude and impact level, are increasing, and hence so on economic loss.

Among four major climate induced hazards, flood and landslides have cause more economic losses compared to avalanche and snow storm over the last 30 years. It is potentially due to the omni- occurrence of these two hazards across the geographical zones in the country while avalanche and snow storm are occurred in the high Himalayan regions only. However, the amplitude and level of impacts of all four major climate induced hazards are observed to be more frequent in recent decades and hence increasing the economic loss in tourism sector. The study also analysed GDP loss in tourism based on four major hazards and indicated following losses and damages:

- L&D from Flood: $ 728,036/year in tourism GDP
- L&D from Snow Storm: $ 2,475/year in tourism GDP,
- L&D from Landslide: $237,740/year in tourism GDP
- L&D from Avalanche: $4,031/year in tourism GDP

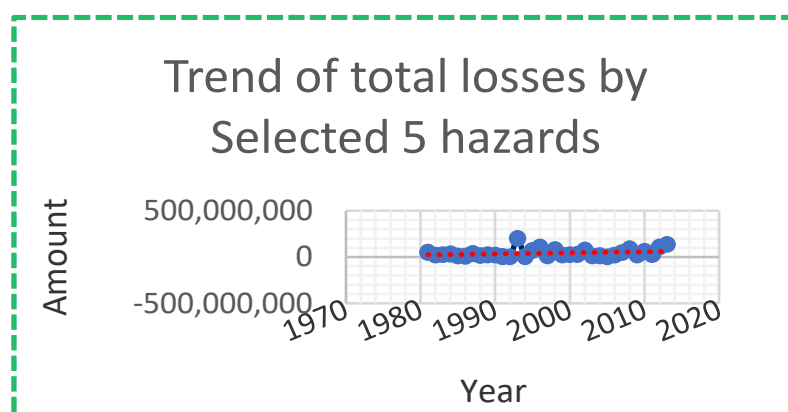**Figure 4: Economic loss on national and tourism GDP due to major climate induced hazards over the period in Nepal**

Different literature has also indicated the increasing impact and economic loss due to climate change and climate induced hazards in the country. The increasing frequencies of landslides and flood have destroyed many bridges and trekking trails in major tourism destinations including Mt. Everest and Annapurna Circuit. Similarly, increasing warmer and drier conduction caused by changes on climatic variable such as increase on temperature further triggers other hazards including wild fires thereby on habitat and biodiversity loss, and risk of extension of endangered species (WRF, 2006; Lal, 2012). It also has implication on the tourism sector.

Regression Result

The possible economic impact of climate change on tourism activities also measured from regression model. The results from Model 1 – Tourism Demand Function, and Model 2 – Economic Impact Analysis on Tourism Sector are presented in this section.

Model - 1: Climate change impact on foreign tourist arrival

When initially regressed, the model shows a very high R-squared and there is no multi-co linearity since VIF is very low. The result shows that 1 % increase in the GDP of the origin country leads to 0.199% increase of total arrival of tourist in Nepal. Similarly, 1% increase in exchange rate and per day average income per visitor will decrease the flow of foreign tourist by 0.464% and 0.459% respectively. Whereas 1% increases in the consumer price index (CPI) will lead to increase on the flow of foreign tourist by 0.749% in Nepal. In addition, the analysis reveals that tourism activities for foreign tourist are sensitive to temperatures and rainfall. As a matter of fact, a 1 % increase in minimum temperature leads to 1.047 % decrease on tourist arrival. It means 0.091 ^{0}C increase on average minimum temperature causes to decrease on tourism flow by 1.047 % in the country. Whilst, 1% increases in maximum temperature leads to 1.533 % increase on the tourist arrival, meaning, 0.091 ^{0}C increase on average maximum temperature causes to decrease on tourism flow by 1.533 % in the country. It indicates that tourists prefer pleasant and warm weather while visiting Nepal. Similarly, tourist arrival seems to be less sensitive to rainfall. The regression model result reveals that 1% increase on precipitation facilitates to increase on total arrival by 0.749%. It means, 13.884 mm increase on precipitation may facilitate to increase on total tourists arrival by 0.749%. However, the regression model cannot sure for these claims as the value generated by the model is not statistically significant. It is potentially because of the fact that more than 80% of the total annual precipitation is recorded in the rainy season in the country which is not considered as the tourist arrival seasons.

Model 1 - **Climate change impact on foreign tourist arrival**		Model 2 - Climate change impact on tourism GDP	
Y	0.199**	ADT	0.572**
ER	-0.464**	CT	0.078**
AC	-0.459*	RT	0.431**
CPI	0.749*	OthT	0.134*
T_{Max}	1.533**	T_{Max}	9.360**
T_{Min}	-1.047	T_{Min}	-3.664
P_t	0.726	P_t	-0.525
Constant (α)	1.103	Constant (α)	-3.624
R-Square	0.943	R-Square	0.932
Adjusted R-Sq	0.943	Adjusted R-Sq	0.910

Model - 2: Climate change impact on tourism GDP

The regression result shows the impact of climate change on entire tourism GDP. All these tests of the equation suggest that the OLS signification is the most appropriate model. Results of the elasticity show that the GDP contribution of tourism sectors significantly depends on that from tourism sub-sectors (i.e. Outdoor and adventure, Culture and pilgrimage, Nature and wildlife, Leisure and recreation, and Other Tourism Sector). The regression module reveals that 1 % increase in the input factors leads to an increase on tourism GDP generation by *0.572% of ADT, 0.431% of RT, and 0.134 % of OthT* despite having *only 0.078% of CT*.In addition, the module further indicates that tourism activities are very sensitive to temperatures and rainfall. It reveals that change on average minimum temperature is inversely dependent to the tourism GDP. It means, a 0.0909^0C (1 %) decrease in minimum temperature leads to increase in total tourism GDP by 3.66 % while it leads to decrease by the same percentage if the average minimum temperature increases by same degree. Similarly, the regression results demonstrated the positive relation between changes on average maximum temperature and tourism GDP in the country. It reveals that increase on average maximum temperature by 1% facilitates to increase on tourism GDP by 9.36%. Moreover, the tourism GDP and changes on precipitation is seen to be inversely correlated. The regression result depicts that 13.884 mm increase on precipitation/rainfall causes to degrease on tourism GDP by 0.525%. However, it seems to be less sensitive compared to that on minimum and maximum temperature regardless to positive and negative correlation.

Regression results on tourism GDP and changes on climatic variables correlate to that obtained on tourism arrival. It means, the number of tourist arrivals increase/decrease with the decrease/increase on average minimum temperature which is the fundamental determinant for tourism GDP. The similar correlation is obtained for average maximum temperature, tourist arrival, and tourism GDP. Moreover, the tourism GDP does not seem significantly dependent to the changes on precipitation as the tourist arrival in this season is low and hence so as on economic contribution. The degree of impact of changes on climatic variables on different tourism sub-sectors is not homogenous. So, the separate recreation module and analysis is demanded to understand the climate change impact on such sub-sectors. As stated in conceptual model, we have hence estimated the extended regression equations to sasses the climate change impact on tourism GDP contributed by tourism sub-sectors.

Sector-wise Climate change impact on tourism GDP

The OLS results also derived to estimate of the average effects of changes on climatic variables on sector-wise GDP per capita. The results are presented as:

Climate Change Impact on outdoor and adventurous tourism: The OLS results provide the estimate of the average effects of changes on climatic variables on GDP per capita generated from outdoor and adventurous tourism (OA). The regression result depicts that 1 % changes on independent factor leads to a proportionate changes on outdoor and adventurous tourism GDP by 1.42%. It means if there is positive change on the independent input factor then the outdoor and adventurous tourism GDP will also increase and vice versa. Similarly, changes on climatic variables are observed to be directly impacted on the outdoor and adventurous tourism GDP irrespective to positively or negatively. As obtained in previous regression results, the impact of changes on average maximum temperature is observed to be positive correlation on outdoor and adventurous tourism GDP. It reveals that changes on 1% of average maximum temperature could facilitate to increase outdoor and adventurous tourism GDP by 14.55%. It seems very significant impact level. However, it clearly reveals that tourists prefer warmer environment for such outdoor and adventurous tourism activities which relates to the tourist arrival and hence on GDP contribution. However, the outdoor and adventurous tourism GDP is negatively correlated to changes on average minimum temperature and precipitation. The regression module reveals that increase on 0.0909°C (1%) on average minimum temperature could decrease on the outdoor and adventurous tourism GDP by 3.37%. Moreover, increase on 13.884 mm (1%) precipitation leads to decrease of outdoor and adventurous tourism GDP by 2.11 %. It clearly indicates the outdoor and adventurous tourism activities are sensitive to changes on minimum temperature and precipitation.

	Outdoor and Adventurous	Culture and Pilgrimage	Leisure and Recreational	Other Tourism
Tourism Sector	1.42***	0.15***	0.61*	0.35***
T_{Max}	14.55*	21.36***	34.45***	18.11**
T_{Min}	-3.37	-8.55*	-11.70*	-8.03**
P_t	-2.11*	0.87	-0.25	-0.72
Constant	-6.01	-12.97*	-21.16***	-6.89
R-squared	0.825	0.860	0.709	0.831
R-Bar Sq	0.797	0.838	0.662	0.804

Climate Change Impact on Cultural and Pilgrimage Tourism Sector: Climate change impact on cultural and pilgrimage tourism sub-sector is considered to be significant. It is determined by the changes on tourist flow and GDP contribution from it while changing climatic variables. The regression model demonstrates the similar correlation between culture and pilgrimage tourism GDP and changes on temperature and precipitation. However, the degree of correlation differs. The regression model results that 0.090^{0}C (1%) increase on average minimum temperature leads to decrease on culture and pilgrimage tourism GDP by 8.55%. Moreover, the positive correlation is observed between precipitations and cultural and pilgrimage tourism GDP though it seems insignificant. The regression module reveals that increase on 13.884 mm (1%) precipitation leads to increase of culture and pilgrimage tourism GDP by 0.87 %. The regression model reveals the similar correlation obtained in the tourist arrival function analysis that indicates that the tourist visiting for cultural and pilgrimage activities also prefer warmer and pleasant environment.

Climate Change Impact on Leisure and Recreational Tourism GDP: This study further analysed the regression model to obtain the correlation between changes on climatic variables and its impact on leisure and recreational tourism GDP. The result of regression model demonstrates that changes on average maximum temperature leads to proportionate changes on leisure and recreational tourism GDP. The regression model reveals that increase of 1% on average maximum temperature leads to increase leisure and recreational tourism GDP by 34.45%. Whilst, increase on average minimum temperature and precipitation leads to decrease on the leisure and recreational tourism GDP. The regression model reveals that 0.090^{0}C (1%) increase on average minimum temperature leads decrease on leisure and recreational GDP by 11.70%. Similarly, increase on 13.884 mm (1%) precipitation leads decrease on leisure and recreational tourism GDP by 0.25% though it is statistically insignificant. The result of regression model for leisure and recreational tourism sub-sector resembles correlation between GDP and climatic variables for outdoor and adventurous tourism though the level of significance differs. It indicates that there is overlap on tourism activities between these two tourism sub-sectors.

Climate change Impact on Other Tourism: Nepal is increasingly being a popular destination for other activities than categorised in above mentioned four tourism sub-sector such as for meetings and conferences. It also contributes on overall tourism GDP. So, this study has analysed the correlation between GDP from other tourism and climatic variables. The regression model reveals that other tourism sub-sector has similar correlation between GDP contribution out of it and climatic variables. The result shows that 1% increase on average maximum temperature leads to increase GDP generated from other tourism sector by 18.11 % which statistically significant. However, it has shown negative correlation with minimum temperature and precipitation. It demonstrates that 0.090^{0}C (1%) increase on average minimum temperature leads to decrease on other tourism sector GDP by 8.03% whilst increase on 13.884 mm (1%) precipitation leads decrease on it by 0.72%.

The over results of regression model reveal that climatic variables have direct co-relation to the total tourism GDP and sub-sector wise GDP contribution in the country. In fact, the tourism GDP contribution is primarily dependent on the number of tourists. So, the analysis demonstrates that the colder and rainy days are not the preferred days for tourist to visit Nepal. So, changes on such days have direct implication on tourist flow and hence on GDP. Broadly, increase on average maximum temperature could offer positive result on tourism GDP. It simply indicates that tourist prefer warmer and pleasant weather condition while visiting different destinations in the country. However, it is still a scope of further research on correlation on abrupt and unprecedented change on climatic variables than in current trend which is being observed in recent years.

Projected Economic Costs of Loss and Damages on Tourism Sector

This section provides the estimation of projection made for economic cost of lost and damages, projected economics cost of loss and damages on tourism sector.

Projected Economic Costs of Loss and Damages in 2020-2030: The analysis discussed in previous section on loss and damage incurred by climate induced disaster, tourism function analysis, and regression model analysis on the climate change impact on tourism GDP reveals that tourism sector is already experiencing climate change impacts. Scholarly literatures have also argued that tourism is likely to affect at the place where already temperature has risen with occurrence of extreme events that makes the place unattractive though it could have some positive impacts in some destinations (Markandya et al. 2017; OECD, 2015). Similarly, tourism economic projections based on climate change impacts are uncertain.
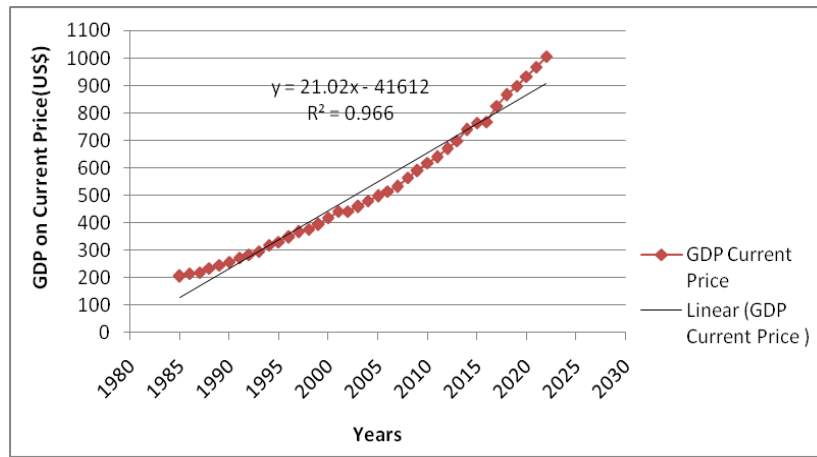
Figure 5: Trend of GDP on Current Price in Nepal

The estimated economic costs of loss and damaged from such climatic impact are equivalent to an annual cost 3.8 % of GDP in Nepal, and projected future economic costs additional to 3.8% of current GDP/year are by mid-century (ref). Climatic impacts on tourism sectors could be much severe with extreme rainfall variability in coming years (IDS-Nepal, PAC and GCAP, 2014). As provided by the data set till 2022 – IMF projection, we have also extracted the values from2022 to 2030 – multiply the baseline data by 3.8% per annum. Applying the same method we have projected the trend and scenario of GDP from 1985 to 2100.
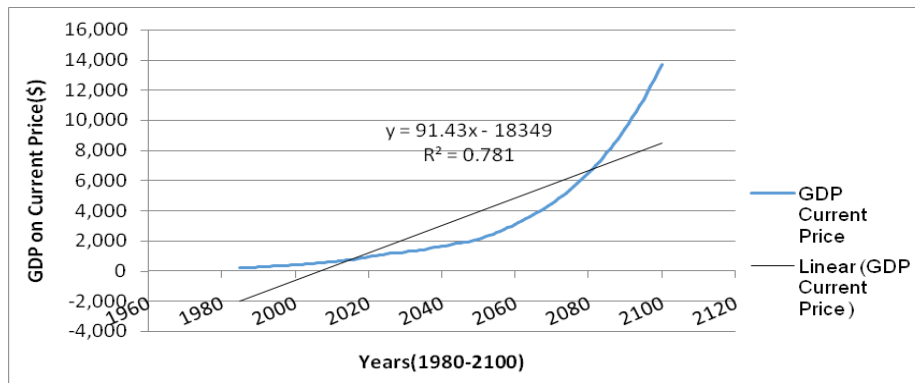

Figure 6: Projection of GDP

Projected Economic Costs of Loss and Damages on Tourism Sector: As discussed in previous section, the tourism sector has significant contribution on economic development in the country. The World Travel and Tourism Council (WTTC) reveals that tourism accounts for 7.5 percent of Nepal's GDP and is forecast to rise 4.3 percent annually to Rs 287.6 billion, or 8.3 percent of the GDP in 2027 (WTTC, 2017). The figure 16 shows the trend of tourism GDP in the country and projects the same till 2050. For the future Projection: from the years 2022 to 2027 – multiplying 2022 data by 4.3% per annum (WTTC: Travel and Tourism Economic Impact 2017, Nepal). And from 2028 to 2040 – multiplying 2017 data by 4.2% per annum (OECD, 2015) and finally, from 2040 to 2050 – multiplying 2017 data by 3.7% per annum (OECD, 2015), we have obtained the full set of data of the years 2017 to 2050.
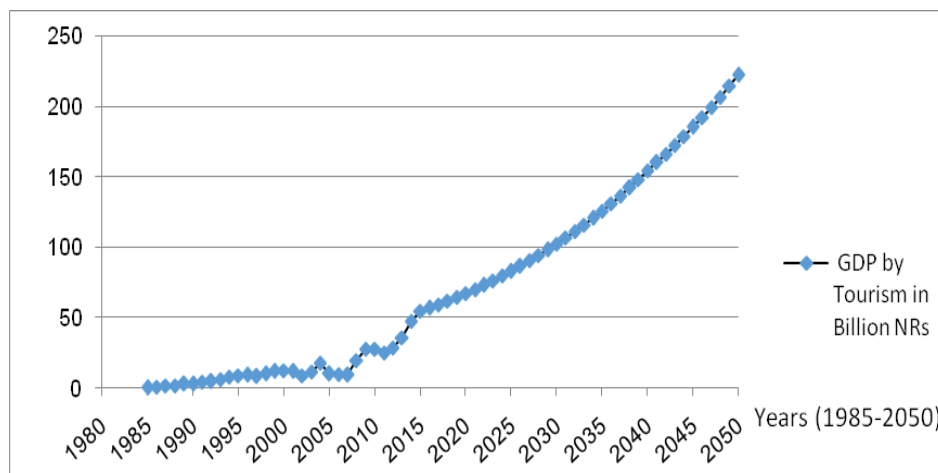

Figure 7: Tourism GDP by Future for Nepal (in billions)

Globally, the economic cost of loss and damages in tourism is calculated to be small and not particularly greater as it ranges from 0.1% to 0.5% of GDP by 2060 (Bosello et al., 2009, 2012; OECD, 2015). However, the degree of loss and damage is estimated to be further triggered by unprecedented climate change (Bigano et al., 2007). The loss and damage triggered by climate change in countries like Nepal where the tourism activities are mostly nature based and is one of the major economic sector – would be significant. The changes on the trend of climatic variables and the climate change extremes have different level of impact to the national and tourism industry and GDP. Changes on the climate variables and extremes impacts on the resources in tourist destinations, contributed on indirect environmental impacts on other relevant resources such as biodiversity, water resources, landscapes, visibility, health, agricultural, and small industries. It further triggers potential societal change such as migration of indigenous community, changes on tangible and intangible culture. Some cases of triggering conflict and political instability are also argued due to climate change extreme like long spell of drought and shortage of drinking water. These impacts are also related to the tourism industry and hence GDP generated from the tourism sector. Moreover, the direct loss and damage on the tourism sector mainly because of climate induced hazards is increasing and predicted to be more significant in forthcoming days.

4. Conclusion and Way Forward

This study analyses the economic impact of climate change in Nepal's tourism industry along with projection of such impacts. To measure the economic impact this study develop two models Model- 1: Climate change impact on foreign tourist arrival, and Model - 2: Climate change impact on tourism GDP and then analyzed the collected secondary data. While analyzing result, it is presented in three different categories, trend-analysis of available data to see the climatic impact on undertaken variables, regression results to identify whether there is impact or not, and forecasting the future based on projection. The estimation from available data demonstrated that the trend of loss and damage (L&D) in the tourism sector is more significant and is increasing since last 30 years. The analysis reveals that the L&D in tourism sector is equivalent to $987,968 per year. The frequencies of flood and landslides incidences are occurring all over the country and are in increasing trend and hence are causing significant L & D in tourism sector.

The regression model for tourism function analysis reveals that changes on minimum average temperature and precipitation leads to decrease of total number of tourist arrival. The result shows that 1 % increase in the GDP of the origin country leads to 0.199% increase of total arrival of tourist in Nepal. Similarly, 1% increase in exchange rate and per day average income per visitor will decrease the flow of foreign tourist by 0.464% and 0.459% respectively. Whereas 1% increases in the consumer price index (CPI) will lead to increase on the flow of foreign tourist by 0.749% in Nepal. In addition, the analysis reveals that tourism activities for foreign tourist are sensitive to temperatures and rainfall. The correlation analysis reveals that increase on average minimum temperature by 0.0909^0 C leads to decrease on tourism flow by 1.047 % in the country. Whilst, 13.884 mm increase on precipitation may facilitate to increase on total tourists arrival by 0.749%. However, the regression model cannot sure for these claims as the value generated by the model is not statistically significant. It is potentially because of the fact that more than 80% of the total annual precipitation is recorded in the rainy season in the country which is not considered as the tourist arrival seasons.

Similar correlation is obtained between tourism GDP and change on climatic variables. It reveals that change on average minimum temperature is inversely dependent to the tourism GDP. It means, a 0.0909^0C (1 %) decrease in minimum temperature leads to increase in total tourism GDP by 3.66 % while it leads to decrease by the same percentage if the average minimum temperature increases by same degree. Moreover, the tourism GDP and changes on precipitation is seen to be inversely correlated. The regression result depicts that 13.884 mm increase on precipitation/rainfall causes to degrease on tourism GDP by 0.525%. However, it seems to be less sensitive compared to that on minimum and maximum temperature regardless to positive and negative correlation. The tourism sub-sector wise analysis also reveals the similar correlation though the level of significance differs. The outdoor and adventurous tourism and leisure and recreation tourism out of five tourism sub-sectors have observed to be more and direct implication of changes on climatic variables. In fact, these two sub-sectors have significant share of contribution on total tourism GDP.

The trend analysis, analysis of loss and damage from climate induced hazards, and econometric modelling for tourism function analysis and correlation on tourism GDP clearly indicates that the tourism sector is very vulnerable to climate change and poses significant impacts. The tourism GDP projection demonstrates that the potential of contribution of tourism sector on national GDP is higher provided the hindering factors remained constant. However, the increasing trend of climatic variables and climate induced hazards potentially would increase the total loss and damage in tourism. It hence will have direct implication on the contribution on national economy.

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