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Vulnerability to Climate Change of Nature-Based Tourism in the Nepalese Himalayas

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ABSTRACT *Given their unique natural attractions, including the highest mountain range in the world, the Nepalese Himalayas have long been a Mecca for trekkers and mountaineers. Nature-based tourism in the Nepalese Himalayas, however, is highly vulnerable to change in climatic conditions. This paper proposes a conceptual framework based on Jodha's mountain specificities, which include inaccessibility, fragility, marginality, diversity and niche, to examine the impacts and vulnerability of climate change on tourism in the Himalayas, with the cases of the three most popular protected areas of Nepal – Mt Everest National Park, Annapurna Conservation Area and Chitwan National Park – located in three physiographic zones. Each physiographic zone differs greatly and hence presents potentially different impacts and vulnerability to climate change. Avalanches and glacial lake outburst floods are the major hazards in high mountains; landslides, debris flows and flash floods are common in the hills; and floods are rampant in lowland Terai. The effects of these climate-related hazards on tourism are further exacerbated by mountain characteristics.*

KEY WORDS: Himalayas, climate change, Nepal, nature-based tourism, vulnerability, impacts

Résumé: Vulnérabilité aux changements climatiques du tourisme de nature dans l'Himalaya népalaise

Ses attractions naturelles uniques, y compris la chaine de montagnes la plus haute au monde, ont fait de l'Himalaya népalaise le haut lieu des randonneurs et des grimpeurs. Le tourisme de nature dans l'Himalaya népalaise est, cependant, extrêmement vulnérable aux changements climatiques. Cet article propose un cadre conceptuel basé sur des spécificités des zones montagneuses décrites by Jodha (1991) telles que l'inaccessibilité, la fragilité, la marginalité, la diversité, et son état de marché de niche, pour examiner les conséquences des changements climatiques sur la vulnérabilité du tourisme en Himalaya. L'étude a suivi le cas des trois zones protégées les plus populaires du Népal: le parc national de l'Everest, la zone de conservation de l'Annapurna et le parc national de Chitwan, situées dans trois zones physiographiques différentes. Chacune des ces zones a des caractéristiques particulières, sujettes donc à des conséquences et à une vulnérabilité potentiellement différentes. Les

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principaux hasards en montagne sont les avalanches et les inondations dues au débordement de lacs glaciaires; dans les collines, il s'agit de glissements de terrain, de coulées de débris et d'inondations subites; les inondations sont courantes dans la zone de plaine Terai. La montagne amplifie les effets de ces hasards dus au climat sur le tourisme.

Mots-clés: Himalaya, changement climatique, Népal, tourisme de nature, vulnérabilité, impacts

Zusammenfassung: Klimawandel und Sensitivitaet des Naturtourismus in den nepalesischen Himalayas

Aufgrund seiner einzigartigen Naturattraktionen, einschliesslich der hoechsten Gebirgskette der Welt, sind die nepalesischen Himalayas schon seit langem ein Mekka fuer Bergwanderer und Bergsteiger. Der auf Natur basierende Tourismus in den nepalesischen Himalayas reagiert allerdings sehr empfindlich auf Schwankungen in den klimatischen Bedingungen. Diese Studie schlaegt ein konzeptionelles Rahmenwerk vor, das auf Jodha's (1991) gebirgsspezifischen Eigenheiten basiert, welche Unzugaenglichkeit, Empfindlichkeit, Marginalisierung, Diversitaet und Nische umfassen, um Auswirkungen des Klimawandels und die Sensitivitaet des Tourismus in den Himalayas anhand von Fallstudien der drei populaersten geschuetzten Gebiete in Nepal, dem Mt. Everest Nationalpark, dem Annapurna Naturschutzgebiet und dem Chitwan Nationalpark, welche in drei physisch-geographischen Zonen liegen, zu untersuchen. Diese natuerraeumlichen Zonen sind sehr verschieden und Auswirkungen sowie Empfindlichkeitsgrade gegenueber Klimaveraenderungen sind daher moeglicherweise sehr unterschiedlich. Lawinen und ploetzliche Ueberflutungen, verursacht durch das ueberlaufen von Gletscherseen, stellen die hauptsaechlichen Gefahren in Hochgebirgen dar; Erdrutsche, Schlammlawinen und Flutwellen kommen haeufig im Vorgebirge vor, und Hochwasserepisoden sind weitverbreitet in tiefergelegenen Gebieten. Die Auswirkungen dieser klimatisch bedingten Gefahren auf den Tourismus werden durch gebirgsspezifische Eigenschaften weiter verstaerkt.

Stichwörter: Himalayas, Kilmawandel, Nepal, Naturtourismus, Verletzlichkeit, Auswirkungen

Introduction

The Himalayas, the youngest and most fragile mountainous region on Earth, are located in Nepal and Bhutan, as well as parts of Pakistan, Tibet and India. Given its unique natural attractions, including the highest mountains in the world, this region has become a popular destination for trekkers and mountaineers. Nepal alone receives as many as 490,000 international air travellers annually; this number is much higher when overland tourists from India are counted. Tourism, one of the most important sectors of Nepal's economy, contributes 9.1 percent of total foreign currency and employs approximately 257,000 people (MCTCA 2004).

Nepal's tourism is primarily nature-based, attracting tourists for its spectacular landscapes, majestic mountains, glaciers, lakes, rivers and unique flora and fauna across its diverse ecological gradient, conserved by an extensive network of parks and protected areas. Mountaineering, trekking, whitewater rafting and safari tours into the jungles are the main forms of nature-based tourism activities in Nepal. Trekking is the most popular tourism activity in Nepal, as about 43 percent of all international

visitors participate in trekking through the natural and cultural landscapes of the Nepalese Himalayas (MCTCA 2004). Jungle safari, which offers unique opportunities for viewing charismatic mega fauna, such as one-horned rhinoceros, tigers and elephants, is very popular in the foothills of the Himalaya. Whitewater rafting on the rivers originating from the world's tallest mountains in the world is also emerging as a popular tourist activity in Nepal. The prospect of climate change as a result of global warming, however, has heightened concern over the ability of this region to maintain its natural beauty and, consequently, its tourism base (Alam and Regmi 2004).

This paper assesses the potential vulnerability of nature-based tourism in light of anticipated climate change in Nepal. Furthermore, based on the mountain-specific characteristics developed by Jodha (1991), this paper proposes a conceptual framework to assess the vulnerability of nature-based tourism using the cases of the three most popular protected areas in Nepal: Mt Everest National Park, Annapurna Conservation Area and Chitwan National Park. Despite differing social, political and economic conditions across these areas, this paper assumes that the existence of similarities of mountain-specific characteristics and physiographic regions makes the study applicable to the broader Himalayan region in general. The paper begins with a review of the literature that discusses how climate change in general impacts nature-based tourism, followed by a conceptual framework related to climate change, vulnerability of tourism and the mountain-specific characteristics of the Himalayas. The paper then discusses Nepal's climate and how it determines tourism seasonality. Finally, it examines the potential vulnerability to climate change of tourism in three protected areas as a result of interaction between climate change, physiographic regions and mountain specificities.

Nature-based Tourism and Climate Change

Nature-based tourism is an important and growing segment of tourism, which includes travelling to undeveloped areas for the purpose of enjoying nature (Goodwin 1996). It includes a range of activities, such as trekking, bird watching, jungle safari, camping, hunting and fishing, rock climbing and whitewater rafting (Blamey 2001b). It is a form of recreation that takes an individual away from the regular stress of modern life with the intent of getting in touch with natural landscapes, flora and fauna. It is one of the fastest-growing sectors of the tourism industry, comprising some 20 percent of all leisure activities (TIA 2002; Goeldner & Ritchie 2006). In countries, such as Kenya, New Zealand and Nepal, this sector accounts for as much as 40–60 percent of all international tourists (Nyaupane *et al*. 2004). The International Ecotourism Society (TIES 2003) estimated that, in the last decade, the annual growth rate for this sector ranged between 10 percent and 30 percent, as opposed to the 4.3 percent for other tourism sectors.

Climate is an integral part of nature-based tourism and can both attract or repel tourists (Gomez Martin 2005) and can directly affect the choice of recreation by limiting time and space for tourism activities (Scott *et al*. 2007). Climatic characteristics include temperature, precipitation, clouds, fog, wind and humidity. These characteristics affect nature-based tourism in various ways, including the quality of a recreation/tourism experience. Comfortable and barrier-free climatic conditions attract tourists (Beniston 2003) and changes in these factors can have a direct impact on the quality of their trips. Climate change can also alter the environment of the tourists' origins and change the demand (Richardson and Loomis 2004); however, the focus of this paper is on supply components of nature-based tourism.

Although climate is not the only factor that tourists weigh, it is one of the most important considerations for a range of activities designed to satisfy tourists. Climate change affects nature-based tourism by affecting the natural resources on which tourism is based (Scott *et al*. 2007). Any change in the characteristics of the climate in the Himalayas could reduce the tourism flow negatively by altering the perceived attractiveness of the Himalayas environment. Unlike tourism based on built attractions, such as theme parks and shopping malls, and cultural attractions, such as historical museums, archaeological remains, historical monuments, folklore and traditional festive celebrations, nature-based tourism is very sensitive to climatic variability and change (Smith 1993).

Studies examining the potential consequences of climate change on mountain environments in North America and Europe provide some insights into the implication of any change in climatic conditions for nature-based tourism. For example, Scott and Suffling (2000) demonstrated that parks in the mountains of Canada are expected to experience both a latitudinal and elevational shift in their ecotone, with potential for species reorganization and other impacts on biodiversity. The implication of such shifts in ecotones is the fragmentation of habitats. Similar impacts are expected in Yellowstone National Park (USA), where a modelling exercise projected a decrease in high-elevation tree species, with some tree species being regionally extirpated (Bartlein *et al*. 1997).

A study of mammal populations in the isolated mountain tops of the Great Basin in the western USA projected that a warming of regional temperature of 3°C would cause a loss of 9–62 percent of species inhabiting each mountain range and the extinction of 3–14 mammal species in the region (McDonald and Brown 1992). A study of the effect of global warming found that migratory birds wintering in the southern USA arrived on average 13 days earlier (Butler 2003). Likewise, drought conditions during the summer of 1988 contributed to widespread forest fires in Yellowstone National Park, which resulted in evacuations of campgrounds and seasonal visitor accommodations being closed four weeks earlier than normal (Franke 2000). Compared to the tourist flows of previous years, total annual visits to Yellowstone in 1988 were reduced 15 percent and park officials estimated a total loss of $US60 million due to

forest fires. Unlike the other studies, Jones and Scott (2006) indicated that tourism in Canada's national parks will experience an increase in visitors due to a lengthened tourism season and improved warm weather. Similarly, using a statistical model of monthly visitation and climate change, Scott *et al*. (2007) examined the direct impact of climate change on visitations and projected that annual visitation would increase by 6–10 percent in the 2020s. The direct impact of global warming and climate change on mountains in North America and Europe is focused on loss of snow cover and vulnerabilities of climate change on ski industries (Koenig and Abegg 1997; Scott and Suffling 2000; Blamey 2001a; Scott *et al*. 2006). For example, it is estimated that Austria would experience losses of 10 percent winter tourism revenue as changes in snow cover could put low elevation ski resort at risk (Scott *et al*. 2006). The number of snow-reliable ski resorts in the Alps will be reduced from 85 percent to between 44 percent and 63 percent (Elsasser and Burki 2002). More recent studies, however, reported that vulnerability to climate change of the ski industry can be reduced by snow-making technology (Scott *et al*. 2006). The vulnerabilities to climate change of the Nepalese Himalayas, however, are not comparable because of the differences in mountain characteristics and attractions.

The Himalayan region is a storehouse of biological diversity and cultural heterogeneity with distinctive ethnic groups, mountain peaks, sacred lakes and monasteries. Home to endangered species, such as the snow leopard, one-horned rhinoceros, Royal Bengal tiger, Asian elephant, red panda, and some 850 species of birds, the region offers abundant diversity in fauna and flora, which enhances the region's stature in nature-based tourism.

The annual influx of visitors in the Nepalese Himalayas increased from about 6,000 in 1962 to 491,504 in 1999 (MCTCA 2004). Nepal's diverse natural and cultural heritage determines the level of tourism activity and the types of programme found at specific localities. Valued geographical attributes include aesthetic landscape, remoteness and cultural traditions. Being away from modern amenities is also a part of the appeal for tourism in Nepal (Zurick 1992). Nature-based activities (discussed earlier) play a significant role in Nepal's tourism, as 45 percent of foreign visitors visit one or more of the country's protected areas (DNPWC 2004; MCTCA 2004). Climate change can adversely affect natural attractions of the Nepalese Himalayas through glacier retreat, avalanches, landslides and flooding, gradual extinction of many species of flora and fauna, and damage to forest ecosystems through fire and insect infestation. Any changes in the physical characteristics of climate can potentially have negative consequences for tourism industries.

In such cases, the quality and volume of tourism would likely be significantly diminished. This paper, therefore, proposes a conceptual framework (Figure 1) to examine the vulnerability of the nature-based tourism sector of Nepal to changing climatic conditions, such as global warming. The framework is based on five mountain-specific characteristics outlined by Jodha (1991), which are discussed in the next section.

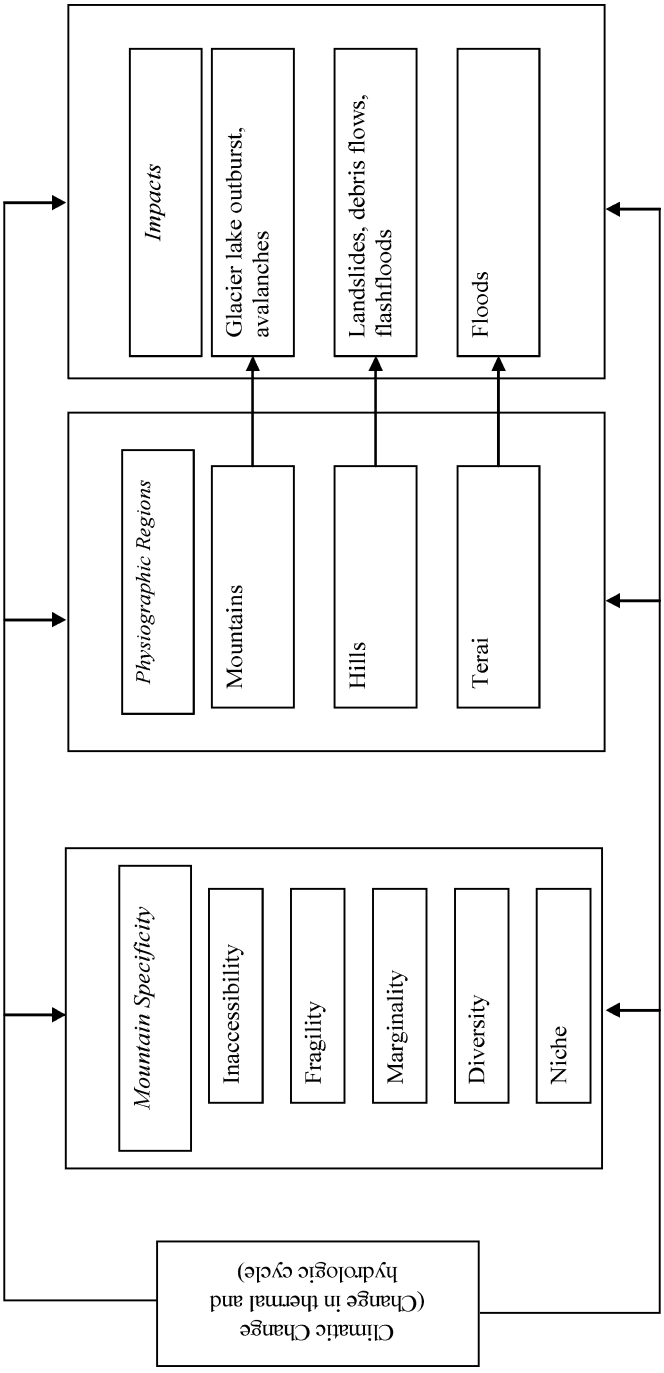

Figure 1. Framework of climate change impacts on mountain tourism.

Mountain Characteristics

Mountains are different to the plains because of the presence of certain characteristics, referred to as mountain specificities. Following Jodha (1991), they are (i) inaccessibility, (ii) fragility, (iii) marginality, (iv) diversity and (v) ecological niches. Since they are largely the products of specific attributes of the mountain system, these specificities act as both major attractions and constraints for nature-based tourism. For instance, if properly harnessed, diversity and niches can offer useful opportunities for making the best use of mountain characteristics in generating revenue through nature-based tourism. Likewise, inaccessibility can be valued as a geographical attribute, where tourists can experience the culture and tradition of communities remotely connected to the modern world. However, fragility and marginality, jointly or individually may limit the capacity of the tourism sector to make desired plans for adaptation, thereby making them more vulnerable to climate and other ongoing changes.

Mountain characteristics play an important role in framing both ecological and social systems, including resource use and social institutions. Jodha (1991) argued that mismatches between human activities and mountain specificities induce negative changes, including disruption of both ecosystems and social systems. Mountain specificities have been used widely to characterize the vulnerability of Nepal's economy for more than a decade (e.g. Jodha 1991, 2001). Jodha's (1991) discussion of mountain specificities in light of tourism development has been elaborated by Sharma (2000) and Nepal and Chipeniuk (2005). Despite this recognition, no studies have used mountain characteristics to analyse the vulnerability of tourism in the context of climate change. In the remainder of this section we discuss the mountain characteristics in the light of climate change and vulnerability to tourism development.

Inaccessibility

Owing to orographic conditions (high elevation, steepness and ice and snow) and frequent natural hazards (e.g. landslides, earthquakes and floods), inaccessibility is the best known of all mountain characteristics (Price 1995). It is manifested as isolation, limited mobility, distance, poor communications and educational facilities, and high transportation costs (Jodha 2001). It imposes a number of compulsory survival strategies on local communities, hence their relationship in protection and maintenance of local resource base. At the same time, inaccessibility of mountain communities to the larger world also calls for local resource-centred economic activities; if managed inappropriately, they can degrade the natural environment upon which a society is based. Because of its inaccessibility, the mountain region is still a distant fantasy land of 'Shangri La' (Ives and Messerli 1989). Unlike tourism activities packed with modern amenities, inaccessibility is a part of the appeal for some nature-based activities, such as trekking, mountaineering and other adventurous tourism activities to Nepal (Zurick 1992). Inaccessibility also helps to generate employment and other economic opportunities for locals in transportation, such as porters, requirement for

yaks and mules and accommodation, helping distributing economic activities along the trails (Sharma 2000). On the other hand, inaccessibility and remoteness makes the nature-based tourism industry more sensitive to climate and weather conditions. Additionally, since most of the region does not have roads and tourists must hike for several days to reach desired destinations, it makes the region less competitive for today's time-constrained tourists.

Fragility

Low carrying capacity and vulnerability to intense pressure from market and other demographic forces makes the Himalayas fragile. The conditions created by fragility include vulnerability to degradation of the natural resource base (Jodha 2001). Steepness, high elevation, continuous geological movements and extreme climatic conditions increase vulnerability to erosion, landslides, avalanches, floods, and loss of flora and fauna (Nepal and Chipeniuk 2005). Societal response to fragility has been the establishment of series of terraces with 35° slopes. In addition, farmers have adapted to this mountain characteristic through several strategies, among these the practice of agro-forestry activities in marginal areas. However, the continuous uplifting of the Himalayas, with an estimated rate of 1–9 mm per year (Jackson and Bilham 1994; Kumar *et al*. 2001) makes the dynamic and unstable Himalayan range prone to erosion, landslides and avalanches (Ives 2004). Due to their steepness, the high mountains and hills are more fragile than the lowland Terai. Fragility itself is a tourism asset; however, there is a limitation as certain activities can be undertaken only at a certain scale, which reduces the carrying capacity of the tourism industry in the region (Sharma 2000). Therefore, tourism in the Himalayas needs more emphasis on conservation and promotion of those activities that are less harmful to the environment of the region.

Marginality

The poor resource base – both human and natural – and a weak institutional base are the causes of marginality. Factors contributing to marginality are remoteness and physical isolation, fragile and low-productivity resources, and several human factors that prevent participation in mainstream development activities (Jodha 1991). In addition, mountain communities have been neglected and not included in mainstream development priorities, because they are located in peripheral regions (Nepal and Chipeniuk 2005). Often, mountain regions are also characterized by economic and political uncertainty and instability (Smethurst 2000).

For example, ongoing conflicts in Kashmir, India and Pakistan, political instability in Nepal, ethnic suppression in Bhutan and conflicts between Tibet and China further marginalize the mountain communities. These are some of the reasons why some of the least-developed countries, their provinces and communities are found in mountainous areas in Nepal, Bhutan, Afghanistan, Ethiopia, Burundi, Rwanda, Myanmar, Kazakhstan, northern Pakistan and Yunnan and Xizang in China, to name a few (Ives

1997). Since most of the nature-based tourism destinations are located in peripheral regions where communities are marginalized, outside investors tend to control the tourism industry and obtain most of the benefits (Nyaupane *et al*. 2006). Community-based tourism would be appropriate to empower marginalized communities and to plough back the revenues to the regions.

Diversity

Diversity is one of the most important mountain characteristics for tourism development. Nepal has established 16 protected areas (nine national parks, three conservation areas, three wildlife reserves and one hunting reserve) covering 18.15 percent of the total area of the country, wherein the protection of species is ensured. These protected areas present excellent examples of diverse species of plants and animals, ranging from sub-tropical to cold desert climatic species. It should be noted that the rich biodiversity and natural beauty are key factors attracting tourists to the country. The high levels of biodiversity, often with sharp transitions in vegetation types, is a function of interactions among various factors, such as altitude, elevation, geological and edaphic conditions, slopes, and rainfall patterns (Jodha 1991). As the climate changes rapidly with altitude, so do flora, fauna and hydrology in the mountains (Whiteman 2000). As a consequence, mountains demonstrate rapid changes from vegetation to snow and ice (Beniston 2003).

Collectively, this makes the Himalayan region a storehouse of biodiversity. Many endemic plant and animal species have been surviving in the Himalayas by adapting to various natural and human-induced changes. In particular, altitude, a typical characteristic of mountain regions, can facilitate both plant and animal species to migrate for adaptation. Physical and biological diversity have shaped diversity in cultural landscapes as well. Many cultures, languages, religions and rituals have thrived in the region for centuries. The ecological diversity of the Himalayas is an important asset for maintaining the gene pool and ethno-botany (Nepal and Chipeniuk 2005), and can also help in the innovation of specialized nature-based tourism, such as seeing alpine vegetation and flowers, or watching birds, insects and butterflies. However, it is also important to note that diversity has made the Himalayan region so complex that generalization must be a cautious endeavour (Ives and Messerli 1989).

Niche

The climatic features of mountains provide a niche for specific productions, activities and services that offer a comparative advantage over non-mountainous areas in these respects (Jodha 2001). Owing to their heterogeneity, humans have developed niches using mountain characteristics for several products, including off-season fruits, high-value ornamental gardens, high quality vegetable seed production, and valuable medicinal plants. The Himalayan region particularly is very potent for tourism based on its terrestrial uniqueness. Utilizing their unique natural and cultural resources,

mountain communities could potentially enhance their economic conditions and quality of life. While these niches remain dormant unless they are exploited for economic development, their unsustainable use could also result in complete deterioration (Jodha 1991). Therefore, wise-use policies to protect niches are necessary for the sustainability of nature-based tourism. Since niches are a part of the diversity that characterizes mountain habitats, their environmental risks are similar to those of diversity (Jodha 2001). Promotion of environmentally friendly small-scale high-value specialized tourism products is ideal to enhance the local economy of the region.

Mountain specificities and climate are intertwined because one affects the other. The following section describes the climatic conditions of Nepal.

Climate of Nepal

The climate of Nepal varies from arctic to tropical within the 200 km span from the northern to the southern border. Nepal is broadly divided into three physiographical zones: mountains, hills and Terai (Ives and Messerli 1981) (see Figure 4). The mountain region, which lies between 4,877 m and 8,848 m above sea level, comprises 35 percent of Nepal's 147,181 km^2 of land. The hills lie between the altitudes of 610 m and 4,876 m and account for 42 percent of the total land area. The Terai region, a northern extension of the Gangetic plain, lies below an elevation of 610 m and comprises 23 percent of the total area. The topographical variations also create a widely varying climate and offer rich biodiversity and natural beauty – one of the key factors attracting tourists. There are four seasons, as defined below: (a) spring (March–May), hot and dry weather associated with occasional rain showers; (b) summer monsoon (June–September), very hot and humid, characterized as the rainy season; (c) autumn (October–November), warm and humid; winter (December–February), when the climate begins turning cool and dry.

The annual mean precipitation is around 1800 mm in Nepal. Owing to great variations in topography, it ranges from more than 5,000 mm along the southern slopes of the Annapurna range in central Nepal to less than 250 mm in the north-central portion near the Tibetan plateau (Webster 1987; Shrestha 2001). The most outstanding feature of Nepal's climate is monsoon precipitation, characterized by two distinct phases: the 'wet' and the 'dry'. The wet phase (May–September) refers to the monsoon season and more than 75 percent of the annual precipitation occurs during this time. The monsoon, which is highly variable across space and time, is first experienced in the north-eastern part of the country and then gradually moves westward with diminishing intensity (Webster 1987; Shrestha 2001). The amount of summer monsoon precipitation and the number of days with rainfall decrease as the monsoon circulation progresses towards the western part of the country, creating variable climatic regimes (Barros and Lang 2003; Kansakar *et al*. 2004). Spatial distribution of rainfall is also of great concern regarding the occurrence of floods, landslides and other extreme events. Most floods occur during the monsoon season when heavy

precipitation coincides with snowmelt in the mountains. The variation in the pattern of rainfall from east to west is substantial and is further modified by the region's diverse terrain (Langnot and Barros 2002; Kansakar *et al*. 2004), creating many micro-regions with differing ecological conditions. In the dry phase (December–January), wind direction reverses to bring cool, dry air from the north-west (Webster 1987). While precipitation is comparatively lighter during this time, winter rain tends to be more concentrated in the western part of the country.

Several recent observational studies have established that there is a strong association between El Niño Southern Oscillation (ENSO) and monsoon rainfall in the Indian subcontinent (Shukla and Mooley 1987; Webster and Yang 1992; Parthasarathy *et al*. 1994; Lau and Yang 1996; Kripalani and Kulkarni 1997; Soman and Slingo 1997; Webster *et al*. 1998). In essence, drought years in the Indian subcontinent are frequently, but not exclusively, related to warm sea surface temperatures (SST) in the equatorial central and east Pacific (El Niño), and wet year(s) are related to abnormally low SST (La Niña). There are no definitive trends in aggregate precipitation, although there is some evidence of more intense precipitation events (Goswami *et al*. 2006). A somewhat clearer picture emerges in stream flow patterns in certain rivers, where there havsbeen an increasing number of flood days. Some rivers are also exhibiting a trend towards a reduction in dependable flows in the dry season, which has implications both for water supply and energy generation (Shakya 2003), factors that have implications for the tourism industries. Although tourists' activities are minimal during the monsoon season, the impacts of intensive monsoon rainfall on the tourism industry of Nepal should not be underestimated. Impending climate change may increase the intensities of monsoons (Kripalani and Kulkarni 1997), which can have direct implications for the flow of tourists during the tourist season, as some tourism infrastructure, such as roads, trails and bridges, are damaged by monsoon floods.

Tourism and Seasonality

While various climatic conditions, such as temperature, precipitation, humidity and the like, are important for tourism (Gomez Martin 2005), the most dominant one is the seasonal factor. This is especially true in nature-based tourism, which depends on climate. Being located in the monsoon belt, Nepalese Himalayas are affected by the presence of strong seasonality. This poses challenges for the tourist industry to maintain tourism demand throughout the year. For example, Nepal's tourist population is the lowest during the height of the monsoon season in June and July (Figure 2). The monsoon season brings considerable rain lasting from a few hours to a few days. The intense monsoon brings landslides, damages roads and tourists trails, making it impossible for tourists to enjoy outdoor activities, such as trekking, bird watching, elephant riding, sightseeing and others. The drop in the flow of tourists during

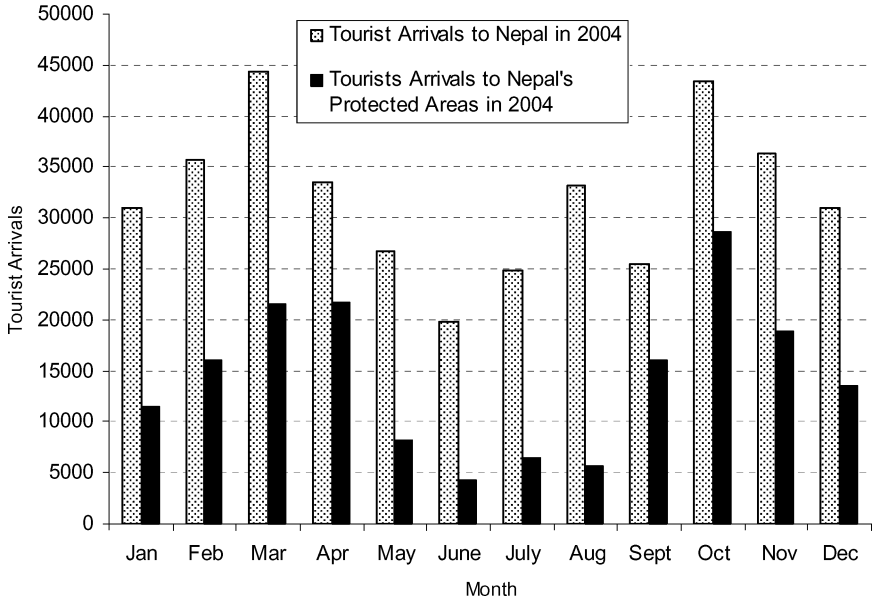

Figure 2. Seasonal distribution of tourist arrivals to Nepal and its protected areas in 2004. *Source*: MCTCA (2004) and DNPWC (2004).

monsoon season leaves many businesses with little demand for their services. On the other hand, periodic water shortage during the dry season could have significant impacts on water-based tourism activities. While the scientific community is unsure about the onset and recession of the monsoon cycle in the future, there is a general agreement across models that impending climate change will very likely result in greater precipitation variability. Changes in climatic conditions, therefore, would assuredly change the seasonality of tourism.

Seasonality can affect tourism in several ways. First, it creates physical conditions (e.g. the absence or presence of snow, rain and wind during travel) so that tourists prefer to travel to destinations where there is enough snow, rain and wind to support the activities, or have minimum disturbances. Winter tourism, particularly skiing, has received greater attention because it is potentially vulnerable to climate change (Wall 1992). For example, the ski season (number of days) in Canada is projected to reduce by 7–32 percent in the 2050s because of a reduction in snow cover (Scott *et al*. 2003). More discussion on the impacts of climate change on the ski industry has been provided in the previous section. Water-based activities, such as rafting, canoeing and boating, are also potentially vulnerable because they depend on the level of water in lakes and rivers. Secondly, changes in temperature

and humidity cause discomfort to individual tourists and affect their vacation plans (de Freitas 2003; Gomez Martin 2005). Thirdly, cloudy conditions can block the views of mountains and reduce the aesthetics of various destinations and attractions. Smith (1993) differentiated between climate-dependent and weather-sensitive tourism. Certain activities are climate-dependent because climate itself attracts visitor who expect to have favourable weather conditions in their holiday destinations. Indian tourists going to Kathmandu during the summer months is an example of climate-dependent tourism. In the case of weather-sensitive tourism activities, the climate is not a tourist attraction in its own right, but weather conditions play an important role when these activities are planned (Amelung *et al*. 2007). Most of the nature-based tourism activities in the Himalayas are weather-sensitive. For example, rain and foggy conditions significantly decrease the quality of the trekking experience in the Himalaya.

Like many tourism destinations, climatic conditions determine tourism seasons in the Himalayan region. They are typically associated with patterns of easterly monsoon rainfall in summer between May and August, and cold and westerly monsoon in winter. These climatic conditions, particularly summer monsoons, create seasonal variations in tourist flows. The flow of tourists to Nepal in the summer months is affected adversely by summer monsoons due to physical obstructions, discomfort and a lack of aesthetics. Most airstrips in Nepal are made of loose gravel and are prone to erosion during the monsoon season. Likewise, roads and trails in the mountain wash away with landslides and erosion. The monsoon season is also very uncomfortable for tourists because of the rain and high humidity. The constant formation of clouds in the ridges and valleys blocks views of the landscape. Winter monsoons are characterized by snowfall in the mountains, and rainfall and cold waves in the low lands. High snowfall in the high Himalayas causes avalanches and disrupts mountaineering activities. Winter monsoons, however, are brief and less intense and their effects in the low lands are much less than the summer monsoon.

Although trans-Himalayan regions, such as Mustang and Dolpo, do not receive much rainfall in the monsoon season, access to those areas is obstructed by the effects of monsoons in the lowlands. Figure 2 shows the seasonal flow of tourists to the country and its protected areas. The figure reveals that spring and autumn are peak seasons and summer and winter are shoulder seasons. The comparison shows that there is more seasonal variation in tourist visits to Nepal's protected areas than the overall tourists visiting the country. Although June is the least favourable month for tourists visiting Nepal, the number of tourists in this month is only 55 percent fewer than in the peak month of March. However, the number of tourists visiting the country's protected areas in the same month is 85 percent fewer than in October, the peak month of arrivals to protected areas. Similar patterns can be seen for July and August. This provides evidence that nature-based tourism is more impacted by seasonality than tourism in general.

Climate Change and its Impacts

Although the tourism sector is highly influenced by climate, our understanding about potential vulnerability to climate change in this sector remains limited (Gossling and Hall 2006; Scott *et al*. 2006). Until recently, climate change had not even garnered substantial attention from both the tourism industry and scholarly community. Uncertainties in projections of future climate change have not narrowed during the last 30 years; however, the recent report of the Intergovernmental Panel on Climate Change (IPCC) stated that the Himalayas could face an increase in frequency and intensity of rainfall (Solomon *et al*. 2007). This may impose the risk of flooding and landslides, causing disruption in the flow of tourists. Based on daily rainfall data for the monsoon season from 1951–2000, Goswami *et al*. (2006) showed an increase in the frequency and intensity of heavy rainfall events in central India, corroborating the prediction by most models. It will likely become drier during the dry season, with a significantly wetter monsoon season. This pattern of precipitation would cause droughts during the winter months and floods during the monsoon, thereby increasing the vulnerability of tourism industries in Nepal.

In the last three decades, the average air temperature measured at 49 stations across Nepal has risen by 1.8°F (1°C) (Shrestha *et al*. 1999). This is twice as fast as the average warming (1°F, 0.6°C) for the mid-latitudinal Northern Hemisphere (24° to 40°N) over the same time period. The temperature differences are most pronounced during the dry winter season and least noticeable when monsoon season peaks. For the purpose of examining the impacts of climate change on nature-based tourism, three protected areas – Mt Everest National Park, Chitwan National Park and Annapurna Conservation Area – will be discussed in more detail. These are the most popular protected areas of Nepal and more than 90 percent of the tourists visiting the country's protected areas (DNPWC 2004) come here. These areas also represent the three physiographical zones discussed earlier, and are located in three different regions, eastern, central and western Nepal.

Mt Everest (*Sagarmatha* in Nepali) National Park, home of the world's tallest mountain, is one of the major tourist attractions of Nepal and is also a national icon for tourism promotion. The park receives about 20,000 international trekkers and mountaineers per year, making the park the third most popular protected area in the country. However, the park is considered one of the world's six World Heritage Sites most vulnerable to climate change, and it was requested that it be added to the 'in danger' list at the most recent UNESCO's meeting held in Christchurch, New Zealand (World Bulletin 2007). The United Nations University Mountain Hazards Mapping Project predicted that flash floods from moraine-dammed and ice-dammed lakes were the major threat facing the Mt Everest region (Ives and Messerli 1981). Researchers from the United Nations Environment Program (UNEP) and the International Centre for Integrated Mountain Development (ICIMOD) identified 3,252 glaciers and 2,323 glacial lakes, of which 44 are filling rapidly, and that might burst in as little as five

years. UNEP/ICIMOD (2002) also identified 20 lakes formed from melting glaciers, which are potentially dangerous to the communities living along the streams, downstream cities, ecosystem and the tourism industry (see Figure 4). Sixteen of these lakes are in the Mt Everest region and in eastern Nepal.

Significant glacial retreat, as well as aerial expansion of glacial lakes in the high mountain region, have also been documented in recent decades, and there is a greater likelihood that such changes are related to rising temperatures (Agrawala *et al*. 2003). Considering the average vertical lapse rate of 6.5°C km^{-1}, the present glaciated area above 5,000 m is likely to be free of snow with an increase in temperature of 1°C in the next few years. Similarly, an increase in temperature of 3–4°C could result in the loss of 60–70 percent of snow cover from the Himalayas (Alam and Regmi 2004). Glacier retreat also contributes significantly to stream flow variability in the spring and summer, while glacial lake outbursts, which are becoming more likely with rising temperatures, are an additional source of flooding risk. Nepal's low level of development and complex topography leaves it quite vulnerable to climate change.

In the Himalayas, loss of ice evokes concerns of further expansion of glacial lakes, leading to an increased potential for glacial lake outburst flooding (GLOF) in the valleys downstream. Nine major glacial lake outburst floods took place between 1935 and 1985 in eastern Nepal. Of them, the most recent was Dig Tsho glacial lake outburst in the Mt Everest area that took place on 4 August 1985 (Vuichard and Zimmermann 1986). The flow of water was 2–4 times the magnitude of maximum monsoon flood levels. The flood killed five people, destroyed 30 houses, 14 bridges, trail networks and the Namche Small Hydel Project, which was at its completion phase to supply electricity to Namche Bazar, one of the major tourist attractions and the gateway of Mt Everest. The flood also destroyed many bridges and trekking trails to Mt Everest.

All of this damage not only impacted the lives of the local people, but also the regions' tourism industry. All 14 bridges between Langmoche Valley and Jubing were destroyed, including the high suspension bridges of Jorsalle, Phakding, Gyuphede and Jobing. Entire stretches of trails were destroyed or made impassable because of river bank erosion, sliding or massive debris deposition (Vuichard and Zimmermann 1986) and the region was isolated from the rest of Nepal for several days (Vuichard and Zimmermann 1987). The flood took place when tourism was not yet popular in the region and during the off-season. If a similar flood was to occur now, its consequences would be catastrophic. The impacts of such natural disasters interact with the mountain characteristics. As the accessibility, fragility and marginality increases, the intensity of impacts increases and the ability of the region to recover decreases. Isolated areas would be even more isolated, slowing rescue and recovery operations.

Annapurna Conservation Area (ACA) is the country's largest protected area (7,629 km^2) and the most popular trekking area, with more than 40,000 tourist visits annually. It is home to some of the world's highest peaks and the world's deepest valley – the Kali Gandaki River Valley. The conservation area was established in 1986. Because of the great variation in topography, rainfall ranges from more than 5,000 mm along

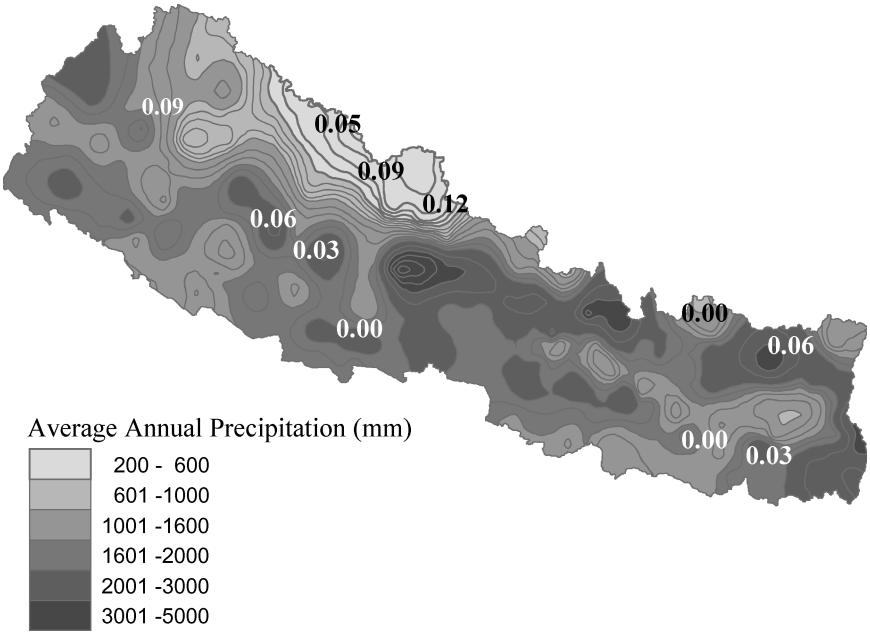

Figure 3. Observed pattern of temperature change in Nepal, 1971–1994, superimposed on average rainfall data. *Source*: Shrestha *et al*. (1999).

the southern slopes of the Annaurna range in central Nepal to less than 250 mm in the north central portion near the Tibetan plateau. The observed pattern of temperature change (Figure 3) shows that warming trends in this region are accelerating more rapidly than in other regions of the country. More importantly, the trans-Himalayan region, which receives lower average rainfall, exhibits a higher degree of warming compared to lower elevations that are comparatively wetter.

Theoretically, if this trend continues, drier regions will become even drier owing to the projected increase in temperatures further affecting the ecosystem sensitivity of the region. The northern arid part of ACA, particularly Mustang, is developed as low-volume high-yield tourism, which will be affected by further scarcity of water because of increasing evapotranspiration. Although the total annual precipitation will change only slightly, there will be greater seasonal anomalies (Shrestha *et al*. 1999). Meteorological data collected from Jomsom from 2002 to 2004 indicate a decrease in winter precipitation in the form of snow and an increase in rainfall after the winter months (Dahal 2007). This has already affected traditional flat-roofed houses made of mud and stone. Locals have experienced roof leakage and wall erosion problems in their homes, teashops and hotels.

The lower elevation, which already receives the highest average rainfall in the country, however, will see potential increases in monsoon precipitation (Shrestha *et al*. 1999). Although this region is less prone to glacier lake flooding than the Mt Everest region (Figure 4), there is evidence that the number of flood days has increased because of more intense precipitation events (Alam and Regmi 2004). The recent high intensity rainfall in Syangja district in western Nepal caused catastrophic floods, with depths reaching up to 6.2 m and scouring channels from 10 m to 120 m wide, killing 55 people and destroying 640 houses. The loss was estimated to be 336 million rupees ($US4.6 million).

The intensive monsoon rain, together with the mountain specificities of the Himalayas, make the hills of Nepal one of the most landslide-prone regions in the world. Communities and the authorities concerned with developing the Himalayan region must confront the constant challenge of dealing with natural disasters, as discussed earlier. Climatic change in the form of heavy precipitation and temperature variations will increase the frequencies of landslides; other adverse effects from monsoons will, in turn, create serious consequences for tourism, as the disasters often block roads and trails. Shifts in the timing and the intensity of the monsoons, the most important climatic phenomenon of the region, and the manner in which part of the Himalayas intercept monsoons, can have major impacts on landslides and floods.

Chitwan National Park, the first and most popular park in Nepal, is situated in central Nepal, covering 932 km^2 in the subtropical lowlands of the inner Terai. Two major rivers, Narayani and Rapti, pass through it, making the park very rich in both aquatic and terrestrial animals. The park is home to the second largest population of one-horned rhinoceros, and other endangered species, such as Royal Bengal tigers, Gangetic dolphins, 525 species of birds, 150 different butterflies, 125 different types of fish and 49 species of reptiles. Recognizing that these unique ecosystems possess international significance, UNESCO declared the park a World Heritage Site in 1984. Major tourism activities in the park include wildlife viewing, bird watching, canoeing and jungle driving.

As shown in Figure 3, the central hills are wetter than the other regions. The Organization for Economic Co-operation and Development (OECD) recently assessed the change in average temperature and precipitation in Nepal using more than a dozen general-circulation models (GCMs) (Agrawala *et al*. 2003). The findings suggest that there is a significant and consistent increase in temperatures projected for Nepal for 2030, 2050 and 2100 (see Table 1). The study also projects an overall increase in precipitation, mostly during the monsoon season. As indicated by the standard deviation, potential increases in monsoon precipitation in an area that is in the threshold can experience extreme climatic conditions in the future. High rainfall in the hills will flood the lowland. The potential impact of climate change in this park and surrounding area therefore would primarily be flooding.

A natural disaster in 1993 is a vivid reminder of the consequences of intensive monsoons. Torrential rainfall in central Nepal triggered disastrous landslides and caused

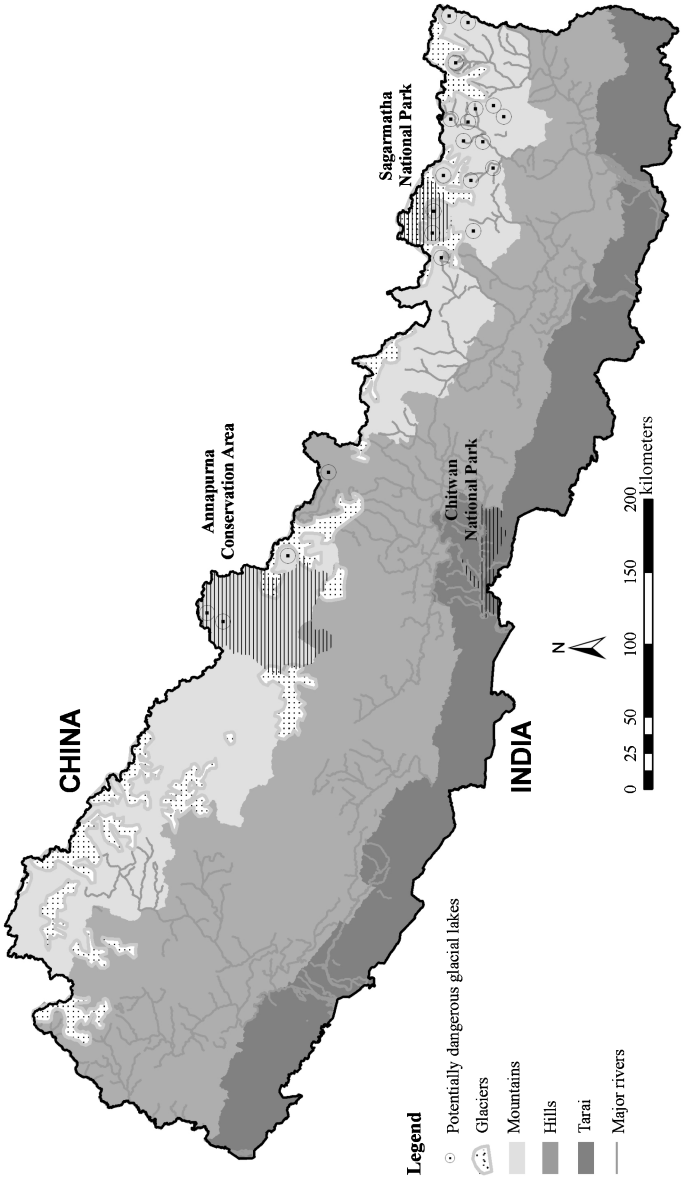

Figure 4. Glaciers and potentially dangerous glacial lakes in Nepal. *Source*: UNEP/ICIMOD (2002).

Table 1. General-circulation model estimated projection of temperature and precipitation change for Nepal

	Temperature change (°C) Mean (standard deviation)			Precipitation change (%) Mean (standard deviation)		
Year	Annual	Winter	Summer	Annual	Winter	Summer
2030	1.2 (0.27)	1.3 (0.40)	1.1 (0.20)	5.0 (3.85)	0.8(9.91)	9.1(7.15)
2050	1.7 (0.39)	1.8 (0.58)	1.8 (0.29)	7.3 (5.56)	1.2(14.39)	13.1(10.2)
2100	3.0 (0.67)	3.2 (1.00)	2.9 (0.51)	12.6(9.67)	2.1(25.02)	22.9(17.8)

Winter = December, January and February; Summer = June, July and August.
Source: Agrawala *et al*. (2003: 16).

immense debris flow and major flooding in main streams in the Terai plains. An estimated 28,000 people in the mountain areas and 42,000 people in the lowlands were affected. About 160 people in the highlands and more than 1,000 people in the lowlands were killed by the devastating floods and landslides in the Bagmati, Kulekhani and Narayani basins of central Nepal. Rising floodwaters submerged forests, villages and resorts for a number of days. This flood damaged the tourism infrastructure of Sauraha, a gateway to Chitwan National Park, and killed some endangered species of animals and destroyed their habitats. The rainfall on 19 July 1993 at Tistung was recorded at 540 mm, with a maximum intensity of 70 mm per hour and recurrence interval of less than 100 years.

On 20 July, 483 mm of rainfall was recorded at Hariharpuri Garhi. Some 500–800 km^2 of the central portion of the Bagmati watershed received very intense precipitation (Dhital *et al*. 1993). The same year, debris flow in Butwal, a town close to the birthplace of lord Buddha, Lumbini, destroyed 98 houses and arable land with a value of 58 million rupees ($US0.8 million) (Khanal 1999).

This disaster shows that the impact of climate change in the Himalayas depends on the physiographic regions and associated mountain characteristics. Avalanches and glacial lake outburst floods predominate in high elevations in eastern Nepal; landslides, debris flows and flash floods are common in the hills; and floods are frequent in lowland Terai. With limited opportunities for tourism infrastructure development in the Himalayas, such destruction can have a significant effect on the tourism industry (UNEP/ICIMOD 2002). These three regions are related to one another for both climate-related changes and tourism. GLOF events in the high Himalayas bring significant changes to discharges in rivers originating from the Himalayan glaciers and have severe implications on downstream areas. More melting is expected to increase the frequency of GLOF, which will have devastating consequences on infrastructure, such as roads, trails, dams, powerhouses and protected areas and communities living downstream. In addition, glaciers and snows on the higher elevation are the main source of rivers in the hills and Terai. IPCC predicted that if the warming continues,

glaciers will shrink from the present 500,000 km^2 to 100,000 km^2 by 2030 (Solomon *et al*. 2007). Over the long term, this will reduce the perennial water flow in the rivers, which will impact water-based tourism activities, such as rafting and canoeing. Similarly, tourism in the high mountains depends on the hills and Terai for access, food and human resources. Destruction of roads and bridges in the hills and Terai directly obstructs access to the mountains.

Despite some variations, there will be a threat to the ecosystem and biodiversity across the Himalayas. Although some species may proliferate, warming leads to extinction of most plant and animal species. This is particularly important in the Himalayan alpine ecosystem, where plants and animals must migrate to higher elevations to adapt to rising temperatures. Nepal's protected area system protects diverse species of plants and animals, ranging from sub-tropical to cold desert climatic species. Rich biodiversity and natural beauty are two key factors in attracting tourists. However, approximately 10 percent of known species of the Himalayas were listed as threatened (Lal *et al*. 2001) and, annually, 2.45 percent of species are on the verge of extinction because of climate change (Alam and Regmi 2004). Warmer and drier conditions from global warming have also caused a significant increase in the number of major wildfires (National Wildlife Federation 2006). IPCC reported that forest fires caused by unusually high temperatures in Nepal may threaten extinction of red pandas, leopards, monkeys, deer, bears and other endangered animals (Lal *et al*. 2001). In response to climate change, many birds are changing their nesting and migratory patterns (Butler 2003). This will have a direct impact on the increasing number of special interest nature-based tourists, such as wildlife-viewing and bird-watching tourists in the Himalayas. Nature-based tourism is linked closely to biodiversity and the attractions created by a rich and varied environment. The loss of biodiversity in the ecosystem, therefore, means a potential loss of tourism in the Himalayas.

Conclusion

Unique natural features, including the highest peak in the world, biodiversity and natural landscapes, have made the Himalayas a major tourist destination. Nature-based tourism plays an important role in improving economic conditions and, hence, is one of the principal sources of optimism for the country's economic development. However, the tourism industry is challenged by global climate change. The literature on impacts of climate change in mountain tourism focuses on reduced snow cover and its impact on the ski industry, which is not pertinent in the Himalayas.

The impact of climate change on tourism in the Himalayas is very complex. This paper argues that the region's vulnerability to climate change in nature-based tourism can be understood better by examining the five distinct characteristics (inaccessibility, fragility, marginality, diversity and niches) in the region. As the degree of mountain specificities varies by physiographic regions, so does its

impact on the tourism industry. Therefore, the impacts of climate change in the Himalayas should be evaluated carefully, taking into consideration the effects of climate change on each physiographic zone and how these effects interact with mountain characteristics.

Under changing climatic conditions, parks in the three physiographic regions face different consequences that can have deleterious effects on nature-based tourism. Parks in the mountains, particularly north-eastern Nepal, will experience more avalanches and glacial lake outburst floods, while the hills will face more landslides, debris flows and flash floods and the lowland Terai will see more flood-related hazards. These climate-related hazards destroy tourism infrastructure, including roads, bridges, dams, hydroelectric projects, trails and resorts – all pivotal for sustaining tourism in Nepal.

Further, fragility and inaccessibility increase the impacts and reduce the ability to recover from the impacts, and make the area more inaccessible. Tourism-industry leaders must plan their infrastructure carefully to avoid hazard-prone areas. Although a hazard mapping project was initiated in 1979 for the Mt Everest region and Kathmandu vicinity (Ives and Messerli 1981), these maps should be updated to take climate change into consideration and should be expanded to other areas with an application for the tourism industry.

Increasing GLOF activities, erratic monsoons and wildfires, caused by periodic droughts, will affect biodiversity adversely. Similarly, warming temperatures may lead to extinction of plant and animal species. This is particularly important in the Himalayan alpine ecosystem where plants and animals must migrate to higher elevations to adapt to rising temperatures.

Since tourism seasonality in the Himalayas is determined by the monsoon season, changes in the pattern of monsoons directly impact the flow of tourists and their activities. The seasonality effect of monsoons can be reduced by expanding arid transmountain regions as tourism destinations. More importantly, these areas should be developed as self-sustaining, or minimally dependent on external resources, so that they will not be as impacted by monsoons in the southern region.

While one can argue that most of the climate-related disasters take place during the monsoon season, when tourism activities are minimal, the impact of the aftermath of monsoon in early autumn and longer-term indirect impacts should not be underestimated. Unlike direct impacts, it takes longer to see how long-term indirect effects on biodiversity would impact nature-based tourism.

This is one of the first papers examining the impacts of climate change on nature-based tourism in Nepal. This study provides a regional perspective on assessing the impacts of climate change on tourism in protected areas of Nepal. Diversity makes the Himalayan region more complicated in terms of research and its policy implications. This study, therefore, suggests that there is a need for local data to assess the potential consequences at each nature-based tourism destination.

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