Tourism in India and the impact of weather and climate

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ABSTRACT:

In the wake of the Covid-19 pandemic, India's tourism industry has the opportunity to further grow and expand through the development and implementation of sustainable policies. The diversity of India's geography is observed in its weather which is variable both spatially and temporally throughout the year. The number of foreign tourist arrivals into the country is influenced by the seasonal weather changes and significant reductions in visitors are observed during the monsoon season. In future decades, the changing climate has the potential to further shape tourism patterns. Warmer temperatures and an increased frequency of high intensity rainfall are the two most common predictions for the future climate of India. This will result in a shorter winter tourism season in the northern states where a cold climate currently enables winter sports activities such as skiing and snowboarding. Coastal tourism along India's vast coast may become less attractive to tourists due to damage and disruption to coral reefs and marine wildlife. Sea-level rise and coastal erosion may push beach tourists to more desirable and scenic destinations. India's transport infrastructure is key to enable the safe and efficient movement of tourists in urban areas and around the country. The current weather is already impacting the air, road and rail networks and further challenges are highly likely due to a changing climate. There is still opportunity for India's tourism industry to adapt through physical and policy developments which would make India a more competitive and sustainable tourism destination.

Tourism in India and the Impact of Weather and Climate

KEYWORDS:

(Please supply up to 6 keywords for your Chapter)

1. Weather and Climate
2. Climate Change
3. Tourism Trends
4. Indian Monsoon
5. Climate Risks and Adaptation

Tourism in India and the Impact of Weather and Climate

Main Body:

1.0 Introduction (Geography of India and its influence on weather and climate and tourism)

One of the many drivers of tourism is the local weather and climate of the destination. For example, leisure tourists may travel to warmer regions of the world such as the Mediterranean, the Caribbean or South Asia. Those in search of winter tourism may travel to ski resorts in North America and Europe. Not only does the local weather and climate help to drive tourism, it also plays a part in shaping the culture and history of the destination. In some cases, extreme or inclement weather may be a push factor for potential tourists. The weather is also dynamic and varies by season and this variation can cause peaks and troughs in tourism visits throughout the year.

In addition to the vast range of different cultures and landscapes, India is one of the very few countries in the world which displays a variety of different climates and weather phenomenon ranging from extreme heat and drought to extreme cold and flooding. For example, the Himalayan region to the north of the country is home to a cold, alpine climate. Southern India has a warm and wet tropical climate. Regions to the west and north-west have a dry, arid/semi-arid climate while a humid subtropical climate is evident to the north-east of the country. These differences in climate help to shape the diverse landscape of the country which includes mountains, deserts and tropical rainforests. India's climate is also dynamic throughout the year with four primary seasons.

The months of December, January and February are categorised as being part of the winter season. During this period the average temperature variation across the country is greatest with the most Southern part of the country experiencing a mean minimum temperature of 22^{o}C and the Punjab region in the North experiencing a temperature of 6^{o}C. The colder temperatures in the North of the country are driven by cold air masses from the Siberian region.

The months of March, April and May are referred to as the pre-monsoon season and the average daytime temperatures become warmer across the whole country. Of specific note are the very high temperatures in the West and North-West desert regions of Gujarat and Rajasthan where daytime temperatures may reach as high 45^{o}C at the end of May. During the night-time the temperature could be up to 20^{o}C lower in these regions.

The period from June to September is the monsoon season during which the country experiences 75% of the total annual rainfall. The duration of the monsoon season varies from just over 2 months in the north-west of the country to more than 4 months in the South-west region. The monsoon season begins in the South in early June and gradually over several weeks extends further north. In most years, the whole country is impacted by the monsoon rains by the end of July. Annual variations in the timing and intensity of the monsoon rains are due to global phenomena such as the El Nino-Southern Oscillation (ENSO) and regional factors such as sea-surface temperatures in the Indian Ocean.

The remaining months of the year in October and November are referred to as the post-monsoon season and decreases in temperature across the country are observed. Many areas in the South states of Tamil Nadu, Andhra Pradesh and Karnataka are also prone to storms, resulting in heavy rainfall, strong winds and inevitable damage to property.

The variation in weather throughout the year leads to variations in tourist and visitor numbers from outside of India. Between 2016 and 2018, the number of foreign-tourist arrivals in India increased from 8,804,411 to 10,557,976, an increase of 20% (Government of India Ministry of Tourism, 2019).

[FIGURE 1 HERE] Figure 1 shows the percentage share of these visitors, in 2018 by month, highlighting the seasonal variation. The lowest monthly percentage share of 5.74% occurs in exceptionally warm month of May. In 2018, nearly half of India's foreign tourist arrivals (42.78%) were from Europe and North America. In these regions the months of June, July and August coincide with school vacation periods and therefore would help to drive foreign tourist visits to India, particularly from the Non-Resident Indian (NRI) community. However, the wet monsoon season that covers all of India during this period results in the mean monthly percentage share of foreign tourist arrivals of only 7%. In 2018, the cooler months of December, January and February saw monthly percentage share of foreign visitors between 9.9% and 11.3%. Thus, the data suggests that visitors to India are sensitive to weather conditions, particularly when extreme weather conditions are likely to occur such as very high temperatures or extremely wet and hazardous conditions.

2.0 Changes to climate in the Indian Subcontinent and tourism trends

There is now sufficient scientific evidence globally that human-induced changes to the climate have been occurring over the past century and will continue for many decades to come. For example, the latest sixth assessment report of the United Nations, Intergovernmental Panel on Climate Change (IPCC, 2021) states that, 'human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years'. Different regions of the globe have experienced different types and levels of climate change driven by local geography and atmospheric circulation patterns. The question of how climate change is likely to impact India is pertinent given that the statistics presented earlier in this chapter suggest seasonal variations in tourist arrivals into India are partly related to the weather and climate and therefore could indicate how future tourism will be impacted. It is important to note that there are uncertainties in future climate prediction at the regional level. Nevertheless, there is broad consensus about historical observations and trends and the first-order impacts of climate change in the South Asia region.

2.1 Temperature changes and the impact on tourism

At a global level, average mean temperatures could be between 1.1^{o}C and 5.4^{o}C higher by 2100 compared to the year 2021. According to Aggarwal and Lal (2001), the average temperature change in India could be 1.33^{o}C higher by 2050 and 2.48^{o}C higher by 2080 compared to the 2020 value. Changes in temperature have multiple impacts on tourism in India. One of the major tourism impacts could be in towns and cities which attract tourists for a variety of reasons including special events and shopping. Observations indicate that temperature differences exist between urban areas and their surrounding regions referred to as the urban-heat island effect or the urban-cool island effect. In Delhi, the urban-heat island effect has been observed to be greatest in March with average night-time temperatures 2.5^{o}C higher in the city centre compared to the rural surroundings (Pandey et al. 2014). In the months of May and June, a cooling effect of up to 4.5^{o}C has been observed although temperatures tend to be significantly higher during these months. In Mumbai, greater urbanisation has resulted in the intensity of the urban heat island effect to increase by an average of 2.2^{o}C between 1991 and 2018 (Shahfahad et al. 2021). As Indian cities get warmer, tourists travel patterns and behaviours could change. There could be a shift in tourists visiting in the pre-monsoon season to the winter season, thereby deepening the seasonal variation in tourism. It is also possible that tourists could reduce the time spent in urban tourist centres or avoid visiting urban areas altogether, instead opting to visit higher latitude regions or mountainous areas where temperatures are cooler (Gasper et al. 2011). Elderly tourists and young children are most sensitive to warmer temperatures having a negative impact on health. Therefore, religious tourism conducted by senior travellers could be impacted to holy sites in urban areas.

One of the most notable changes to the landscape due to climate change is in mountainous regions where the presence and persistence of snow fall can help to develop a winter tourism industry. In India's northern states of Jammu and Kashmir, Himachal Pradesh, Sikkim and Arunachal Pradesh, winter tourism helps to drive the local economy between December and February. Unfortunately, mountainous regions are also more sensitive to climate change. An analysis of two winter tourist resorts in the Kashmir valley have shown that increasing temperatures and decreasing precipitation are leading to less snow and receding glaciers (Dar et al. 2014). At the Gulmarg tourist resort, the skiing season usually commences in mid-December and continues till mid-April. In recent years, the season has been restricted to mostly February and March due to little or no snowfall in December and January (Dar et al. 2014). This has an inevitable negative impact on the local economy which is already impacted by reduced visitors due to political instability in the region. In addition, the overall reduction in snow fall has threatened the freshwater resource later in the year to tourism locations downstream.

The West and North-west regions of India encompassing the states of Gujarat and Rajasthan have an arid climate which has resulted in a desert landscape. During the summer season from March to May, temperatures are at their highest level. Over a 40-year period from 1966 to 2006, temperatures in Gujarat were observed to increase by an average of 0.5^{o}C per decade, taking the average daily maximum temperature to over 36^{o}C. In the desert region of Kutch, Gujarat, by 2065, minimum winter temperatures may have increased by up to 4^{o}C and maximum summer temperatures by 1.7^{o}C (Sarkar et al., 2015). To adapt to these temperature changes, when the Tourism Corporation of Gujarat organised the first annual Rann Utsav festival in 2005 (a 100-day festival in the desert region of the Rann of Kutch) the event was scheduled in the winter season from November to February to avoid the otherwise harsh climate.

2.2 Monsoon rains and the impact on tourism

Earlier it was shown that reductions in tourist arrivals are observed during the Indian summer monsoon season between June and September. The characteristics of the Indian summer monsoon rainfall has widespread implications on Indian society. The agricultural industry of India represents 15% of the economy but employs more than 50% of the workforce, some 700 million people. The level of rainfall and the geographical extent determines the level of agricultural output, most notably food and crops. For example, in July 2002, the weak strength of the monsoon caused a 19% deficit in rainfall for the country causing a 3% drop in GDP (Challinor et al. 2006). Food and water shortages caused priced to increase impacting the poorest communities the most. In 2005, the high intensity of the monsoon rainfall caused flooding in Mumbai and lead to infrastructure damage and loss of life. Road, rail and air transport were all impacted making it challenging, and in some cases impossible, for residents and tourists to travel around the country. Despite numerous scientific studies into the mechanisms that drive the monsoon rains, the levels, geographical extent and timing of the monsoon rains is notoriously difficult to predict. Current climate models that are used for long-term forecasts have found it challenging to model the interactions of the ocean, the atmosphere, the landmass and the mountainous terrain. The latest IPCC assessment report (IPCC, 2021) has taken into account the outputs from several highly sophisticated climate models to predict with medium confidence that the annual and summer monsoon precipitation will increase during the remainder of this century by about 10%. The general consensus among climate models is that the intensity of rainfall events is likely to increase whilst the number of rainy days may decrease. Regional differences across India are likely and northern states are expected to see the most increase in rainfall. When trying to predict the monsoon on a short-term seasonal-basis, weather forecasting

tools have also performed poorly. The unpredictability and impact of the monsoon season has multiple impacts on tourism in India.

(i) Tourists are unable to plan with confidence the timing, duration and location of their visit to India and many visitors may simply play it safe and avoid visiting altogether. In fact, hotel occupancy during the rainy season has been observed to be 50% lower.
(ii) Fewer business meetings and corporate events are likely to be scheduled during the monsoon season leading to reduced business tourism.
(iii) Those tourists that do visit during the rainy season are likely to impacted by reduced infrastructure mostly related to transport.

In the past, the Confederation of Indian Industry (CII) has suggested that tourism bodies should promote the monsoon season as an attraction providing tourists with a 'unique experience' and a form of 'eco-tourism' (Mathew, 2005). However, any efforts to achieve this have not led to any increase in the levels of tourism activity.

2.3 Rising sea-levels and the impact on coastal tourism

The coastline of India ranks 18th in the world in terms of length at more than 7,500km. Being surrounded by the sea helps to boost beach tourism with notable coastal resorts in the states of Goa, Karnataka, Kerala and Andhra Pradesh, in addition to the Andaman and Nicobar Islands. However, with so much of the country exposed to the coast, the threat of Tsunami impact, sea-level rise and sea pollution is also greater. The 2004 Indian Ocean earthquake and tsunami provided a devastating reminder of the vulnerability of the country. In fact, India topped the rankings in a study which assessed the relative vulnerability of the beach tourism sector in 177 countries based on exposure, sensitivity and adaptive capacity (Perch-Nielsen, 2010). A widely known impact of climate change is sea-level rise which is caused by the melting of ice sheets and glaciers and the volumetric expansion of the ocean due to higher ocean temperatures. The cities of Mumbai, Kochi and Vishakhapatnam have seen net sea-level rises of 1.20, 1.75 and 1.09 mm/year in the past century (Unnikrishnan and Shankar 2007). The most notable impacts of sea-level rise are increased risks of flooding and coastal erosion. Coral reefs and other marine wildlife can also be negatively impacted which can reduce levels of tourism activity. In the same coastal location, sea-level rise is likely to have uniform impact but the impact of coastal erosion can vary. For example, in Goa, the talukas of Bardez and Salcete are the most sensitive to coastal erosion, recording erosion rates of more than 0.6m per year (Kunte et al. 2014). The coast of the taluka Mormugao has experienced lower erosion rates (<0.3 m/year) and is therefore considered a low-risk area. Arabadzhyan et al. (2020) reviewed the impact of climate change on coastal tourism around the world and concluded that:

- More than 80% of tourists would be unwilling to pay the same holiday price in the event of degradation in coral quality.
- 77% of tourists were unwilling to return if the beach area was reduced due to sea-level rise.
- A fifth of tourists would opt for alternative destinations under various beach erosion scenarios.

The coast of India is fragile and the improved sustainability initiatives are required to ensure that tourists continue to visit the country.

3.0 Weather and climate change impact on tourism infrastructure

Like any tourist destination, the need for high quality infrastructure is important to attract tourists and ensure safe and productive visits. The critical tourism infrastructure necessary to sustain tourism

growth is related to transport, hotel and accommodation and health and medical infrastructure. In the 2019, World Economic Forum Travel and Tourism Competitiveness Index, India ranked 33rd, 28th and 109th globally for air transport infrastructure, ground and port infrastructure and tourism service infrastructure respectively. This indicates significant room for improvement if India is to remain a competitive destination. What's more, for a country such as India where the weather exhibits spatial and temporal variability, the threat to infrastructure is not insignificant.

In 2018, nearly 80% of foreign tourists arrived and departed India by air. With 153 commercial airports, of which 29 are open for International traffic, India ranks highly in terms of aviation capacity. The liberalisation of the Indian aviation market has attracted more foreign direct investment and many new airlines, particularly low-cost carriers have commenced services. In addition, increased state funding to improve airport infrastructure in recent years has enabled more efficient operations and passenger processing capabilities. The overall number of aircraft accidents have decreased in India from an average of 3.6 per year in the 1960s to 0.5 per year in the 2010s. Nevertheless, aviation operations and safety are sensitive to meteorological conditions and the rare incidents that do occur usually have poor weather as a contributing factor. Recent examples include the Air India Express accident during heavy rain at Kozhikode-Calicut airport in August 2020 and the Spicejet aircraft runway excursion during heavy rain at Mumbai Airport in July 2019. If the intensity of the Indian summer monsoon rains increase as forecast by climate models, airports in India are likely to experience more frequent flooding of the runways and aprons leading to reduced operations and possible safety concerns. Note that the two incidents mentioned earlier both occurred during the monsoon season. Some of India's airports are also located to coastal areas and have low elevations. India's lowest commercial airport is at Agatti Airport on the tourist archipelago of Lakshadweep, just 12 feet above mean sea level. Other low elevation airports include Trivandrum Airport in Kerala and Kolkata Airport in West Bengal, both less than 17 feet above mean sea level. With rising sea levels and intense precipitation, these airports are at most risk of disruption to operations. Rising temperatures also impact aircraft take-off performance, particularly at airports with short runways or those located at high altitude. Several studies have showed possible payload reductions on commercial flights due to warmer temperatures (Coffel et al., 2017; Gratton et al., 2020; Zhou et al., 2018). Agatti Airport in Lakshadweep has a runway length of 1204m and average temperatures throughout the year are warm and relatively consistent between 26°C and 32°C. This restricts the airport to small regional turboprop aircraft such as the ATR-42. Warmer temperatures due to climate change will restrict aircraft operations further since the carriage of passengers, cargo and fuel may be restricted to reduce aircraft weight and enable safe take-off operations on a short runway. Although there are plans to expand the runway and airport, these are limited due to the impact on the local environment and marine life. The limitations of air access to the islands could limit the number of tourists at a destination where passenger arrivals were growing at more than 7% per annum prior to the Covid-19 pandemic. At the other end of the country, Leh Airport in Ladakh is situated at 10,682 feet above mean sea level (the highest airport in India) and experiences temperatures in July and August of more than 25°C. The high elevation and warm temperatures, together with strong mountain winds has already restricted aircraft operations to the morning period.

India's surface transport infrastructure consisting of road, rail and seaports is extensive. The road network is the second largest in the world after the USA with more than 6.2 million kilometres of road. However, just 5% of roads are state or national highways and 73% are rural roads which are often unsurfaced and poorly maintained. Major road infrastructure improvements are underway. For example, the Delhi-Mumbai expressway is under construction and is expected to reduce travel time from 24 hours to 12 hours. Many tourists experience India's road network in urban areas such

as Mumbai, Delhi and Chennai where congestion has led to average vehicle speeds amongst the lowest in the world. The lack of state and national highways coupled with congestion in urban areas has a significant negative impact on the efficiency of mobility for tourists. This situation is further compounded during the monsoon season when heavy rains can cause widespread disruption due to landslides and flooding especially in urban areas. Both Mumbai and Bangalore experienced severe flooding during the monsoon season in 2017. A study for the city of Bangalore, estimated that 24% of the city's road network would become immovable during a 1-in-10 year normal rainfall event. For a 1-in-100 year rainfall event, 45% of the road network would become immovable (Singh et al., 2018). The railway network in India is also extensive and forms a relatively cheap mode of transportation for both locals and tourists. Just like the road network, landslides and flooding is also a risk for the railway network during the monsoon season. In addition, very high temperatures would also increase the risk of buckling and therefore derailments. Speed restrictions are also often imposed during extreme heat which would lead to longer journey times. For many tourists, the best way to see the country is to travel by road or rail. Many foreign tourists are unaware of the potential impacts of weather and climate on tourism infrastructure in India but extreme events would certainly degrade the visitor experience. Repeat visitors may then opt to avoid extreme weather seasons generating further peaks and troughs in the already seasonal tourism pattern.

4.0 Adaptation and resilience in a changing climate

Despite global efforts to control temperatures and prevent drastic climatic changes, long-term observations from thousands of weather stations have proven that the Earth's climate is changing and will continue to do so in the future. Th richness and diversity of India's tourism industry will continue to grow and expand but is likely to see changes to tourism patterns. India still ranks relatively highly in terms of tourism competitiveness, but India is also highly sensitive and vulnerable to the regional weather in the Indian subcontinent. The government and specifically the Indian Ministry of Tourism is aware of these challenges as evident from its 2019 Tourism Statistics report. For India to sustain growth and development of its tourism industry it will need to adapt and develop infrastructure and policy so that it can maintain its attractiveness to both domestic and foreign visitors.

Urban tourism destinations will need to adapt by:

- Implementing road and traffic polices that provide resilience to extreme weather, reduces congestion and improve journey times.
- Investing in infrastructure projects that improve drainage and reduce the risk of flooding, particularly during the monsoon season.

The transport sector will need to adapt by:

- Conducting a weather and climate risk assessment of all commercial airports in the country.
- Assessing the commercial and operational risk due to extreme weather and incorporating resilience measures into airport masterplans.
- Consider the construction of runway extensions at field-length limited airports at high-altitude and/or very warm temperature locations.
- Consider the construction of sea-defence walls at low-lying airports to mitigate the risk of inundation from sea-level rise and heavy precipitation.

- Conducting a weather and climate risk assessment of urban and rural roads in terms of the threat of flooding, landslides and rail track buckling.
- Investing in major road and rail projects that improve connectivity between major urban hubs.

Mountain and winter tourism will need to adapt by:

- Assessing the economic risk of a reduced tourism season.
- Introducing weather resilient tourist attractions and events that can improve the demand and in-flow of tourists all-year round.
- Exploring the opportunities of artificial snow to maintain a longer winter tourism season.
- Identifying mountainous locations where temperature increases are less likely to occur due to a changing climate.

Beach and coastal tourism will need to adapt by:

- Assessing the future risks of sea-level rise, reductions in beach surface area and coastal erosion.
- Consider the construction of sea-defences that reduce coastal erosion and maintain beach quality.
- Assess the implications of rising sea temperatures on marine wildlife and coral reefs.

The Indian government has already introduced investment and projects related to tourism sustainability. These have included the development of educational institutes and courses to broaden knowledge, understanding and skills associated with delivering a tourism service and maintaining tourism infrastructure. The Swadesh Darshan and PRASHAD schemes introduced by the Ministry of Tourism are good examples of forward planning. Similar schemes to protect, sustain and develop resilience to climate change are required to ensure India does not lose its tourism assets. India cannot achieve their tourism goals alone and international cooperation with regional bodies, and United Nation organisations are already in place which will become even more vital in the post-pandemic period.

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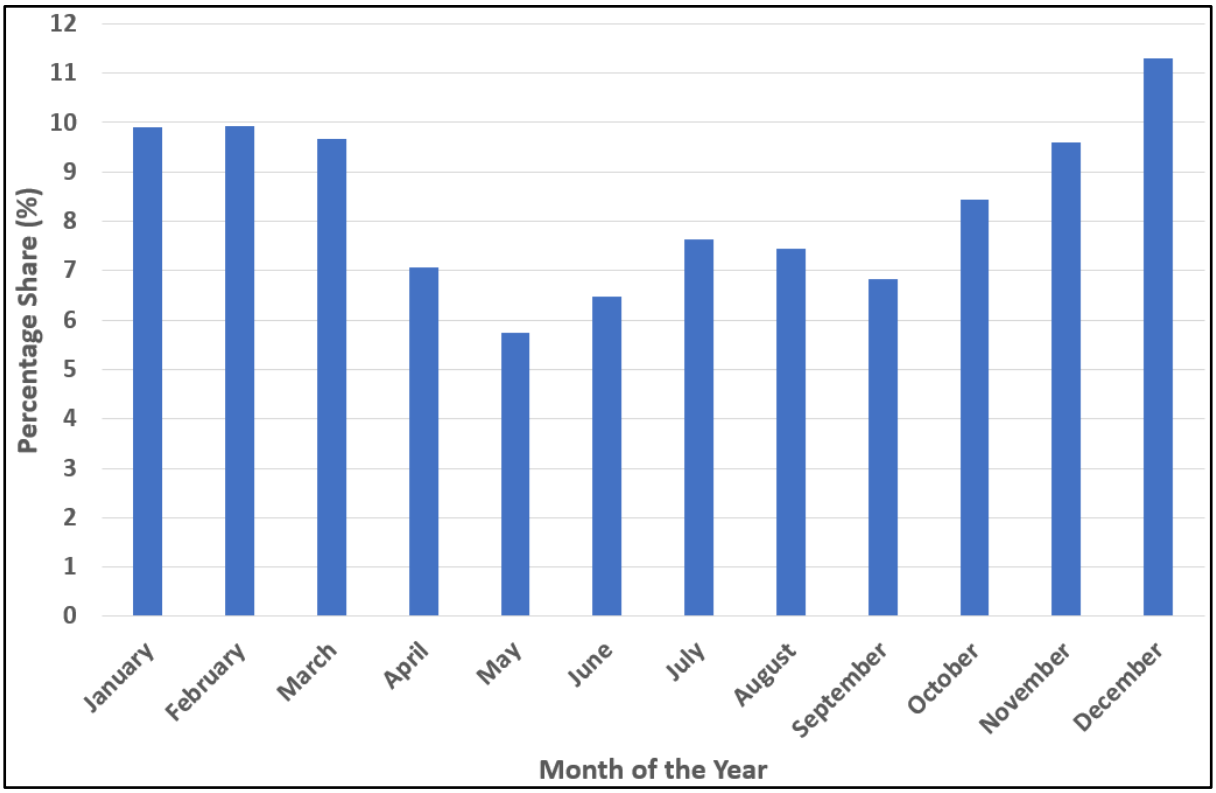

Figure 1 – Monthly percentage share of foreign tourist arrivals in India in 2018.

(Source: Government of India Ministry of Tourism (2019).