Environmental Assessment of Tourism in the Indian Himalayan Region

Original Application No.178/2022

Date of hearing: 09.03.2022

A

Report Submitted to

MoEFCC in compliance of order of Honorable National Green Tribunal (NGT) Principal Branch, New Delhi

25th November, 2022

By

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Acknowledgements

This report titled, 'Environmental Assessment of Tourism in the Indian Himalayan Region (IHR)' in compliance to Hon'ble National Green Tribunal (NGT) order dated 09.03.2022 (Tourism has brought economic prosperity in the Himalayan region, but the environmental cost has been catastrophic) has been prepared in a short duration of three months based on the inputs of the committee of scientists of GBPNIHE constituted by the Institute in March 2022. This time bound assignment was not an easy task to complete without the support and timely inputs/data/information provided by various departments within different states across the IHR and other published and unpublished sources.

At the outset, we are thankful to Prof. Sunil Nautiyal, Director, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand for providing full support and all the facilities in the Institute which could make the present study possible. At the same time, we acknowledge with thanks the Pollution Control Board, Tourism department, and the Transportation departments of the IHR states; Ladakh UT, Jammu & Kashmir UT, Himachal Pradesh, Uttarakhand, Sikkim, West Bengal Hills, Assam hills, Arunanchal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya for providing useful information and support for their respective states. Without their cooperation, this report would not have been completed.

We acknowledge in particular the support received from Chief Wildlife Wardens, Airport Authority, Municipal Committee, Rural Department, Tsangda Project of Ladakh UT, etc. Our heartfelt thanks are also due to Department of Economic and Statistical department, Central Ground Water Board, Department of State Forest Department, Department of Forest Survey of India, and Directorate of Urban Development for providing valuable information from their respective departments.

We would also like to thank Tourism & Civil Aviation Department, Govt. of Sikkim; Forest & Environment Department; Urban Development and Housing Department; Municipal Cooperation, Khangchendzonga Conservation Committee (KCC) Yuksam, West Sikkim. Our special thanks are also due to Ms. Uden T. Bhutia, Dr. P.G. Bhutia, Dr. B K Acharya, Dr. Sarla Khaling and many others for their valuable inputs which helped lot in improving the content of the report. We extend our thanks to Tourist bureau, foreigner's registration office, DIB, Darjeeling, and Gorkhaland Territorial Administration for providing relevant data and necessary support. The authors are thankful to all the academic institutions and other govt. departments of the different state governments for sharing their immense knowledge on the subject through secondary information. We acknowledge the support received from different government agencies/department of forest and data retrieved from reports available on websites and the web pages of different departments, research papers are greatly acknowledged. Support received from the members of a Centre for Biodiversity Conservation and Management are greatly acknowledged. Meanwhile, we also acknowledge different websites used for obtaining some secondary data in the report.

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Abbreviations

ADB	Asian Development Bank
ALTOA	All Ladakh Tour Operators Association
AMC	Aizawl Municipal Corporation
AMC	Agartala Municipal Corporation
AMDCZ	Areylungchok Musk Deer Conservation Zone
APTI	Air Pollution Tolerance Index
AQ	Air Quality
AQI	Air Quality Index
asl	above sea level
BCM	billion cubic meter
BOD	Biological oxygen demand
CAAQMS	Continuous Ambient Air Quality Monitoring Sensor
CAMP	Conservation Assessment & Management Prioritisation
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CBT	Community Based Tourism
CCA	Community Conserved Areas
CEC	Court-appointed central empowered committee
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CRED	Centre for research on environmental development
CYMA	Central Young Mizo Association
DD	Data Deficient
DMC	Dhansiri. Dimapur Municipal Council
DO	Dissolved Oxygen
E. coli	Escherichia coli
EC	Electrical Conductivity
EN	Endangered
EPA	Environmental Protection Agency
ESPAY	Ecotourism Service Providers Association of Yuksam
ESPP	Environmental & Social Policy & Procedures
ESZ/ESA	Eco-Sensitive Zones / Area
ETP	Effluent Treatment Pant
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product
GMC	Gangtok Municipal Corporation
GNP	Gross National Product

GRAP	Graded Response Action Plan
GRC	Garhwal Regional Center
GSDP	Gross State Domestic Product
GVA	Gross Value Added
GyMC	Gyalshing Municipal Council
HCFs	health care facilities
HPSPCB	H.P. State Pollution Control Board
HRC	Himachal Regional Center
ID	Indeterminate
IHM	Institute of Hospitality Management
IHR	Indian Himalayan region
IMC	Imphal municipal corporation
IMC	Itanagar Municipal Cooperation
ISWM	Integrated Solid Waste Management
IUCN	International Union for Conservation of Nature
JMC	Jorethang Municipal Council
KCC	Khangchendzonga Conservation Committee
KMC	Kohima Municipal Council
LAHDC	Ladakh Hill Development Council
LC	Least Concern
LiFE	Living for Environment
LRC	Ladakh Regional Center
MCL	Municipal Committee of *Leh*
MDF	Moderately Dense Forest
MINARS	Monitoring of Indian National Aquatic Resources
MLD	megalitres per day
MNP	Mangan Nagar Panchayat
MoEFCC	Ministry of Environment, Forests and Climate Change
MSPCB	Mizoram State Pollution Control Board
MSW	Municipal solid waste
MSWM	Municipal solid waste management
MTB	Mountain Biking Himalaya
N	Nitrate
NAAQ	National Ambient Air Quality
NAMP	National Air Monitoring Programme
NASA_RTI	National Aeronautics and Space Administration_Research Test and Integration
NCAER	National Council of Applied Economic Research
NEERI	National Environmental Engineering Research Institute
NERC	North East Regional Center
NGT	National Green Tribunal
NITI Aayog	National Institution for Transforming India Aayog

NMC	Namchi Municipal Council
NO_2	Nitrogen Dioxide
NPCB	Nagaland Pollution Control Board
NWMP	National Water Quality Monitoring Programme
OF	Open Forest
PAN	Protected Area Network
PAP	Protected Area Permit
PM_{10}	Particulate Matter with with a diameter of 10 microns or less
$PM_{2.5}$	Particulate Matter with with a diameter of 2.5 micrometers or less
PPP	Public-Private Partnerships
q	quintals
R	Rare
RDF	Refuse Derived Fuel
RDS	Respirable Dust Sampler
RET	Rare, Endangered and Threatened
RIMS	Regional Institute of Medical Sciences
RNP	Rangpo Nagar Panchayat
RRC	Resource Recovery Centers
RSPM	Respirable Suspended Particulate Matter
SEIAA	State Environment Impact Assessment Authority
SNP	Singtam Nagar Panchayat
SO_2	Sulphur dioxide
SPCB	State Pollution Control Board
SRC	Sikkim Regional Center
SSF	Seven security force
STDC	Sikkim Tourism Development Corporation
SWM	Solid Waste Management
T.D.S.	Total Dissolved Solids
TC	Total Coliform
TDP	Ton Per Day
TPD	Tonnes Per Day
TPSS	Tsomgo Pokhri Sanrakshan Samiti
ULBs	Urban local bodies
UTs	Union Territory
VDF	Very Dense Forest
VOC	Volatile Organic Compounds
VU	Vulnerable
WII, ENVIS	Wildlife Institute of India, Environmental Information System network
WUM	Workers' union Manipur

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Preface

In a recent decade of the United Nations sustainability (2030), tourism is considered to be one of the fastest growing industries in the world. It might have a significant impact on foreign exchange and employment. While being closely linked to the social, economic, and environmental well-being of the country, tourism has the potential to contribute, directly or indirectly, to all the sustainable development goals, in particular Goals 8, 12, and 14. The Himalayan region is known for its unique ecosystem, serene beauty and its tranquility have been attracting tourists for decades with a wide range of human interests. Due to infinite exploring options in the Himalaya throughout the years, tourism sector is going to be pushed to newer dimensions. It may cover everything from adventurous, recreational, health fitness, ecotourism, pilgrimage, or many more. Tourism in the Himalaya not only affects the ecology, but also affects the local people's quality of life, and their overall well-being. In recent years, sustainable tourism has emerged in response to lessening the impacts of mass tourism on the Himalayan environment and boosting its socio-economic success. In context to sustainable tourism development, a number of extremely fragile regions within the Himalayan complex have been designated as eco-sensitive zones in order to encourage eco-friendly activities. In view of delicacy of the Himalayan ecology and fragile topographic character, tourism development needs to be maintained for a long-term basis. In this regard, the Hon'ble National Green Tribunal has considered the matters relating to environmental safeguards in some of the Eco-Sensitive Zones/areas, including some of the areas in the Himalayan region. Hon'ble NGT has issued directions on 09.03.2022 in reference to Original Application no. 178/2022 to G.B. Pant National Institute of Himalayan Environment, Almora, to undertake a study and update studies relating to the ill-effects of tourism. These ill-effects, according to Hon'ble NGT, particularly are on environmental components like waste generation, air, and water quality deterioration, loss of greenery and biodiversity, land/soil contamination, and ground water in some of the Eco-Sensitive Zones/areas, including the Himalayan states of India. These states/UTs include: Ladakh, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, West Bengal Hills, Assam Hills, Arunachal Pradesh, Nagaland, Manipur Tripura, Mizoram, and Meghalaya in view of action plans to prohibit and regulate activities adversely affecting the environment. In the same framework, whole of the report is prepared in view of its geographical expansion starting from the north-western to the north-eastern Himalayan region. We hope that the report would be able to respond to the quarries made in the Hon'ble NGT order and fill up some of the gaps in existing knowledge of the Himalayan tourism. It would also be able to suggest a way forward for sustainable or responsible tourism in the Himalaya usually known by its inherent nature-topographically fragile and ecologically delicate.

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Lead Scientist

Executive summary

The Indian Himalayan Region (IHR) is well known for its snow-capped peaks, scenic beauty, sub-alpine and alpine pastures, beautiful landscapes, rich biodiversity, and cultural diversity and attracts domestic and international as well as domestic tourists, pilgrims, trekkers, and mountaineers from different parts of the world. The Himalayan ecosystem not only provides a variety of ecosystem services to the regional inhabitants and the people inhabiting the adjacent low-lands but also has a strategic location from a viewpoint of security of our nation. This region has full potential for tourism in terms of economic growth, local employment, livelihood, and income to the mountain residents, and has been a prominent source of revenue generation to different states/UTs. Accelerated growth of tourism in some of the pockets of the IHR in the past few years had a substantial impact on its economy, local community, and environment. At the same time, it is realised that due to mass tourism in certain pockets of the IHR, environmental degradation is also apparent in the form of reasonable increase in tourists inflow, waste generation, plying vehicles, air and water pollution, impact on forests and biodiversity, etc. These impacts altogether have increased waste disposal alongside valleys and sometimes along rivers in absence of adequate waste treatment and waste disposal systems. This has caused degradation of land, soil, water, air quality and other components of fragile mountain ecosystems over a period of time.

Tourism and hospitality contribute about $71.5 billion to Gross Domestic Product (GDP), which is expected to grow at an average annual rate of 7.9% from 2013 to 2023 (Niti Aayog, 2018). Theme-based development of tourist circuits was undertaken under Swadesh Darshan Scheme by the Govt. of India. Among 15 thematic circuits, few are within the IHR, such as, the North-East Circuit, Eco-circuit, Himalayan Circuit, and Spiritual Circuit. Kaziranga National Park in Assam has been identified as an iconic tourist site among 19 identified sites. Ministry of Tourism sanctioned 18 projects covering all the North Eastern States for Rs. 1,456 crores (US$ 211.35 million) to develop and promote tourism in the region under Swadesh Darshan and PRASHAD schemes.

The findings of this study can be summarized as follows:

1. The annual average growth of tourism (based on a decade 2011-2020) reveals that the number of tourists visiting Uttarakhand were 2,70,41,965 ± 90,65,417 tourists/year (yr) which is the highest in view of tourist influx. This is followed by Himachal Pradesh (1,60,35,126±42,17,317 tourists/yr), Jammu & Kashmir (65,24,418±35,84,903 tourists/yr), Assam hills (51,75,956 tourists/yr), Sikkim (8,93,221±4,22,771 tourists/yr), Meghalaya (6,24,127±3,46,095 tourists/yr), Tripura (3,72,081±1,24,626 tourists/yr), Ladakh (1,95,209±90,979 tourists/yr), Arunachal Pradesh (1,64,388±76,925 tourists/yr), Manipur (1,45,780±36,797 tourists/yr), West Bengal (90,000 tourists/yr), Mizoram (74,032± 34,550 tourists/yr), and Nagaland (62,042 ± 3,601 tourists/yr).

2. While the vehicular influx including domestic was recorded highest in Uttarakhand (2,55,11,089 vehicles/yr) followed by Jammu & Kashmir (1,07,774 vehicles/yr), Tripura (3,15,529 vehicles/yr), Manipur (3,04,000 vehicles/yr), Arunchal Pradesh (2,83,655 vehicles/yr), Meghalaya (2,79,208 vehicles/yr), Mizoram (1,81,091 vehicles/yr), Himachal Pradesh (68,983 vehicles/yr), Nagaland (14,704 vehicles/yr), Assam Hills (10,397 vehicles/yr), Sikkim (5,949 vehicles/yr) and Ladakh (2,219 vehicles/yr).
3. Air quality trend over a decade (2011-2020) for some of the selected states/UTs like Ladakh, Uttarakhand, Sikkim, Arunachal Pradesh, etc. reveal that air quality parameters such as $PM_{2.5}$ is on rise. However, there is a need to monitor air quality across the important tourist destinations in the region, particularly in the states such as Uttarakhand, Himachal Pradesh, Sikkim, etc. We have analyzed the relationship between tourists arrival and $PM_{2.5}$ for some representative sites of the Indian Himalayan region (IHR) during the period 2011-2019. $PM_{2.5}$ data set was extracted from Average Total Surface Mass Concentration- $PM_{2.5}$ monthly 0.5 x 0.625 deg [MERRA-2 Model M2TMNXAER v5.12.4]. The analysis shows that in the North western Himalaya, the rate of $PM_{2.5}$ increases with the increase in tourists for the last one decade in Ladakh region. While for the Central Himalaya, we found a positive correlation between number of tourists and $PM_{2.5}$ for the sites such as Kedarnath (0.50), Badrinath (0.38), Gangotri (0.32) and Yamunotri (0.43). Similarly, in the Eastern Himalayan region, we observed increase in $PM_{2.5}$ values with the increase in tourist's arrival for Arunanchal Pradesh and Sikkim states.
4. The most challenging aspect is to decipher a relationship between tourist influx and water quality. However, specifically looking the impact of tourists on water quality there is a lack of data in the present context. Also, there are multiple factors that determine the water quality of a place in the mountain watersheds such as Pangong Tso in Ladakh, Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar in Jammu and Kashmir, Nainital and Bhimtal in Uttarakhand, Tsomgo Lake and Lake Gurudongmar in Sikkim, Nakhapani, Jorepokhari, and Mirik in West Bengal Hills, Loktak in Manipur, Dumboor in Tripura, Umiam in Meghalaya, etc.
5. Remedial measures for air pollution control are limited, i.e. electric vehicles, rope ways, etc. However, the ecological remedial measures along with regulation also need to be introduced at least in the important tourist destinations during peak tourist period.

Determining a relationship between tourist influx, loss of forests, and biodiversity requires long-term monitoring of a few indicator species that are susceptible to air quality and warming due to vehicular pollution and tourist's activities.

Considering the revenue receipts in the western Himalayan States, Ladakh received more than Rs 90 million a year. While in Himachal Pradesh, tourism contributes 7% to SGDP (2020-2021). In case Uttarakhand, tourism contributed 50% of the total GSDP from 2006-07 to 2016-17. While in terms of revenue generation from tourism in the north-eastern states (NER) like

Assam, it stood first amongst all the NER states. It was followed by Sikkim as the second highest contribution about 7.68% to GSDP. On the other hand, Nagaland state recorded the lowest income from tourist industry. Among all the IHR states, Sikkim accounts for the highest investment in the tourism sector, i.e., 1.9% of the total state expenditure. While all other the IHR states invest less than 1% of the total expenditure.

Due to COVID-19 pandemic, the tourism industry has been hit tremendously. For example, Assam had a loss of around Rs.1000 crore in the month of December and January (The times of India, 31st December 2019) among the NER states. Similarly, the tourism sector in Sikkim suffered a loss of about Rs. 600 crores in the year 2020. Managing tourism within available civic amenities and infrastructural carrying capacity within the threshold limit has been a challenging task.

According to the Ministry of New and Renewable Energy, Government of India (2018), urban areas of eleven states of the IHR generate a total of 6346 MT solid waste per day which converts to 23.16 Lakh MT of solid waste per annum. In other words, this is 4.35% of the national average of solid waste of 531.53 Lakh MT. Jammu and Kashmir (1792 MT/day) generates the highest amount of solid waste followed by Uttarakhand 1528 MT/Day, Assam 1134 MT/D, and Himachal Pradesh 370 MT/D waste. Sikkim is one of the least producers of urban solid waste, which amounts to 89 MT/D. As such there could not be available a specific report regarding segregating the household waste at source. This is one of the major challenges where the concerned authority needs to take appropriate measures for segregation of waste at source. Upon recycling and reusing waste, Ladakh has generated revenue worth Rs. 14,60,617 after sale to Jammu and Kashmir.

It is difficult to ascertain the impact of tourism on water quality as the water quality data available for the IHR states is limited to certain locations. Similarly, monitoring of air quality parameters is limited to a few stations in the IHR. PM_{10} observations are available (2018 and 2019) for Srinagar, Baramulla and Ganderbal in Kashmir and relating air quality with tourists flow can make only a generalization until the domestic influx of tourists and vehicles is not separated.

Similarly, with the increasing mass-tourism, it is generally observed that forest cover is decreasing in the IHR. However, it is difficult to relate these two things. According to FSI, 2021 report, major loss in forest cover was noticed in the North Eastern states of Arunachal Pradesh (257 km^2), followed by Manipur (249 km^2), Nagaland (235 km^2), Mizoram (186 km^2) and Meghalaya (73 km^2). Although this deforestation may largely be attributed to shifting cultivation, felling trees, anthropogenic pressure, natural calamities and developmental activities. Yet, responsible tourism anyway has to take care of this aspect.

During the course of this study, some of the gap areas were also identified, which include issues such as data deficiency on tourist and vehicular (type wise) influx, long-term trends of air and water quality, weak infrastructure for solid waste management, purification measures for air and water, non-availability of adequate supply of water (tourist demand and supply), non-availability of continuous data pertaining to air and water quality of the tourists places and eco-sensitive zones, inadequate assessment of forest cover and biodiversity losses around the ESZ/ESA and socio-economic issues including contribution of tourist revenue to state economy, tourist carrying capacity, etc. There is also a need to bring environmental awareness among the tourists and local people engaged with tourism on responsible and nature-based tourism and enhance the capacity of officials engaged in the tourism and other related departments. Enforcement of National Acts/Guidelines/Regulations relating to each aspect of environmental conservation and sustainable resource utilization needs to be implemented in toto.

State specific recommendation such as prior online registration of visiting tourists at a spot, assessment of carrying capacity of tourist destinations and eco-sensitive zones, quantification and segregation of waste, developing bio-composting units for reuse of biodegradable waste, community based waste recycling from non-biodegradable waste need to be implemented in order to attract responsible tourism and its sustenance. Regulated tourism throughout the year in the locations of mass and seasonal tourism would help recovery the ecosystem. Regular air and water quality monitoring in urban as well as rural areas need to be practiced for assessing the impact of tourism. In view of bringing under control ambient air quality, introducing electric vehicles in the Himalayan spots need to be paid attention. Inventory of different water resources, including their seasonal discharge rates and quality measurements need to be recorded. Study on tourism activity on biodiversity and socio-cultural system is required to be conducted in view of both positive and negative aspects. Strengthening community-based tourism needs to be encouraged for practising sustainable tourism in the IHR.

Chapter 1: Introduction

The Indian Himalayan Region (IHR) is spread across 2 Union Territories and 11 Indian States, namely, Ladakh Union Territory (UT), Jammu and Kashmir (UT), Uttarakhand, Himachal Pradesh, Sikkim, West Bengal Hills, Assam Hills, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya from north-west to north-east (Fig.1). It spreads over a length of about 2500 km and a width of 220-330 km. Nearly 50 million people reside in this region, which is characterized by a diverse demographic, environmental and socio-economic system. The entire IHR is a paradise for tourists and has experienced a continued tourism growth over the last few decades to become one of the fastest-growing economic sectors of India. The Himalayan region provides a diverse range of prospects for modern tourists, ranging from distinct cultural attractions, trekking, skiing, kayaking, rock climbing, mountain biking, bungee jumping, paragliding, and other modern sports in recent years. At the same time, specific negative impacts in some of the towns/tourist destinations are linked to the current form of tourism in the IHR. These include problems of solid waste, air and water pollution, degradation of watersheds, and the loss of natural resources, biodiversity, ecosystem services, etc.

The above ill-effects of unplanned tourism growth were published in The Hindu Newspaper dated 27.02.2022 titled, "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic". In view of this, Hon'ble NGT passed an order dated 9.3.2022 and directed the G.B. Pant National Institute of Himalayan Environment, Almora to undertake study and to update any study already conducted in light of the inputs available in the above media report. Such study / updation exercise may be completed within three months. A report in this regard be provided to the Chief Secretaries of 12 States in the Himalayan region as well as to the Secretary, Environment and Secretary, Tourism, Government of India for further action. The Tribunal has considered the matters relating to environmental safeguards in some of the Eco-Sensitive Zones/area, including some of the areas in the Himalayan region, and issued directions in the light of studies, for action plans to prohibit and regulate activities adversely affecting the environment. Prohibitions include constructions beyond capacity of such areas, waste treatment facilities, regulated and limiting traffic, etc. as shown by the said orders. The said orders and study reports need to be considered in the course of this study. The Hon'ble NGT further directed the Secretary, Environment, Government of India to conduct an online meeting with the Chief Secretaries of 12 States within one month of the receipt of the report of the G.B. Pant Institute as well as other inputs which may be compiled by the MoEF&CC from its own sources to steer preparation of appropriate action plans in all the 12 States, dealing with the mitigation measures to offset the adverse impact of tourism activities on the environment.

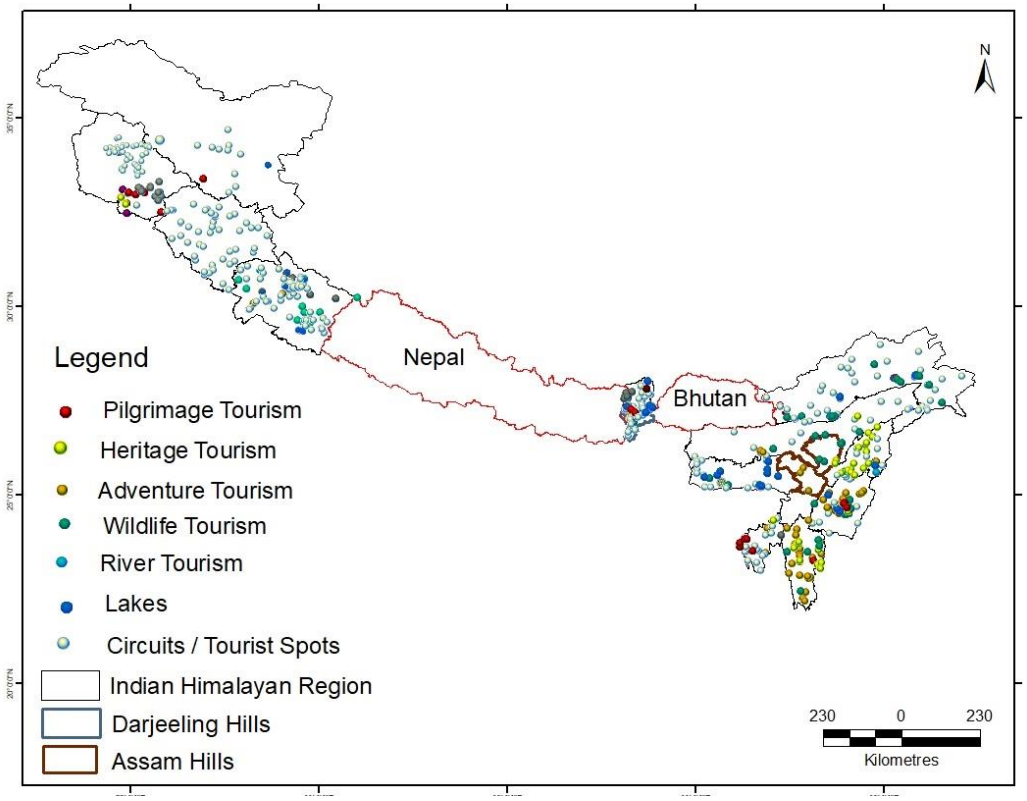


Fig. 1: Tourism in the Indian Himalayan Region

Objectives of the Study

The overall objective of this study was to determine "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been enormous" (NGT Order No. 178/2022 Dt. 9.3.2022). As a follow-up of the above NGT order, the GBPNIHE spread across the entire IHR conducted a quick appraisal to prepare a draft reply and submitted it to MoEF&CC in Ist week of June 2022. The objective of the study was to collect data/information from secondary sources for each IHR state on the following:

(i) Collect data on tourism growth (number of tourists/vehicles and revenue generation); (ii) Assessment of waste generation (biodegradable and non-biodegradable); (iii) Segregation of waste (recycled, reused and unutilized); Waste disposal/treatment facilities (dumping sites, waste burning and biocomposting); (iv) Impact of tourism on air and water quality and measures taken by State Govt. for mitigation; and (v) Impact of tourism on forest and biodiversity and compliance of rules and regulations ESZ/ESA to avoid the negative impacts to the environment. To prepare a report, based on this study, was the overall goal of this time bound assignment.

Methodology

Given the short period of the assignment, the GBPNIHE constituted a team of experts of its faculty and held a few rounds of consultations among them to develop methodology to accomplish this time bound important task. For each of the study aspects, 10 questionnaires were developed to collect secondary information/data on a long-term basis (2011-2020) from concerned State Govt. Line Deptts. (viz., Tourism Deptt., Transport Deptt., Central Pollution Control Board, State Ground Water Board, Forest Dept., etc.) and a request letter to the Chief Secretary of each of the IHR state/UTs was sent along with the questionnaire for further forwarding to the concerned Deptts. through the CS office. Data/information was sought on the number of tourists visiting the state/tourist destinations annually, annual income from tourism, number of tourist vehicles entering into the state, category wise quantity of waste (biodegradable and non-biodegradable) generated such as plastic, glass, metal, rubber, etc., waste segregated (recycled, reused and leftover), waste disposal treatment facilities available in the state such as dumping sites and their capacity, waste burned and bio-composting of waste, air quality of important tourist destinations (e.g., PM_{10}, $PM_{2.5}$, SO_2, NO_2, etc.), facilities for air purification, water quality (physio-chemical parameters) of the tourist towns and water purification measures taken by State Govt., loss of biodiversity due to tourism activities, encroachment and tourist regulations in ESZ/ESA, etc. The team of Institute faculty was given responsibility of the IHR states to study the data/information available in the public domain and also to approach the concerned state Deptts. to get the desired data. The data/information thus collected was compiled, synthesized and report was written and sent to GBPNIHE HQs by the team of faculty for further checking by lead scientists. The detailed data/information on various aspects of this report for each of the 10 States and 2 UTs are given as a separate chapter in this report. The relevant Acts/Rules & Regulations of State/Central Govt. were cited wherever required in the report. During the process of this assignment web meetings were held from Institute HQs with the team of scientists involved in this study. A template of the report was developed that was followed by all the team members to write the report. The draft report was submitted to MoEF&CC in Ist week of June 2022 and subsequently to NGT in mid-June 2022. Expert comments received from the MoEF&CC on the Draft Report in July 2022 were attended by the team members and the final version of the report was submitted to MoEF&CC in July end 2022.

Results and Findings

(i) Tourist influx

Among all states, the highest number of tourists are reported from West Bengal (39,260,173) followed by Uttarakhand (24,951,541), Himachal Pradesh (16,042,225), Jammu & Kashmir (11,616,180), Assam (4,790,361), Meghalaya (708,048), Sikkim (624,925), Tripura (378,524), Arunachal Pradesh (279,123), Manipur (136,130), Mizoram (65,705), and Nagaland (46,658) annually (NITI Aayog, 2018). With these upward trends in tourist numbers in the IHR, it is assumed that environmental and social systems would be subjected to change. Apparently, these developmental impacts in the IHR have direct or indirect impacts that have an effect on

the Himalayan ecosystem such as sprawling urbanization, traffic congestion, pollution, exploitation of natural resources, loss of indigenous culture, and so on.

In the IHR, there are 15 national parks and 59 sanctuaries covering 9.6% of the geographical area within the Protected Areas (PA) network of India (Rawal and Dhar, 2001). Eco Sensitive Zones (ESZ's) also known as Ecologically Fragile Areas (EFA's) are the areas notified by the MoEF & CC around Protected Areas, National Parks and Wildlife Sanctuaries. All the identified areas around Protected Areas and wildlife corridors are to be declared as ecologically fragile under the Environment (Protection) Act, 1986 (National Wildlife Action Plan, 2002-2016).

Alongside, the entire area is characterized by numerous places having the potential of eco-tourism, geo-tourism, sports tourism as well as pilgrimage tourism. According to the 11th Five-Year Plan of India's Planning Commission states, "*Tourism is the largest service industry in the country. Its importance lies in being an instrument for economic development and employment generation, particularly in remote and backward areas (e.g., in IHR)*" (NITI Aayog, 2018).

State-wise profile of the 13 IHR states/UTs are described illustrating general scenario of tourism, tourism growth vis-a-vis economic growth, transport and tourism, ill-effects of tourism particularly on environmental components, waste generation, waste segregation, utilization of waste, tourism impact on air, water and biodiversity, eco-sensitive zones and specific gaps and state-specific recommendation for developing sustainable tourism in the Himalayan Region.

1.1. Introduction

Ladakh became a union territory on 31 October 2019 after the reconstitution of the erstwhile Jammu and Kashmir state as separate entities (two UTs). The high-altitude region of Ladakh UT is predominantly described as arid, ecologically fragile, and culturally rich. Ladakh landscape is characterised by rugged mountains interspersed with lakes, wetlands and river basins, resulting in a wide variety of habitats with unique and diverse species of plants and animals. Ladakh, which attracts both domestic and foreign tourists, is being emerged as an important global tourist destination comprising various tourist spots, viz., *Pangong Tso lake, Nubra and Siachen Valley, Kargil, Drass*, the world's highest motorable road (*Umlingla Pass*; 19,024 feet), along with some of the most popular monasteries, such as, *Hemis, Alchi, Lamayuru, Shey, and Thiksay* (Fig.1.1).

In addition, Ladakh UT also harbours a unique and diverse assemblage of wild flora and fauna. A recent checklist on birds of Ladakh (Sharma *et al.* 2021) reported 378 species of birds out of which 27 were reported for the first time from Ladakh. Being located on Asian Flyway, Ladakh hosts a variety of migratory birds and their breeding grounds, thus making Ladakh and its

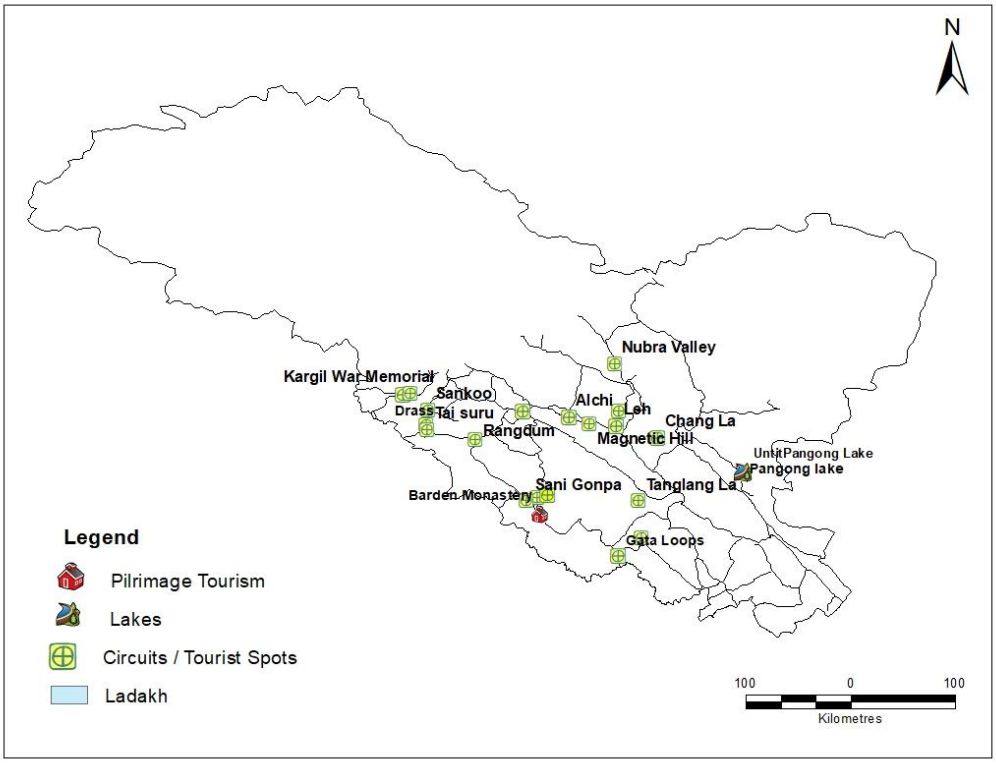


Fig. 1.1: Major tourist spots and circuits in Ladakh

Wetlands an important area to maintain global bird diversity, e.g., the only known breeding site in India for Black-necked crane (*Grus nigricollis*) and Bar-headed goose (*Anser indicus*) exists in Ladakh. Similarly, a total of 43 species of mammals have been reported from Ladakh. Vegetation is predominantly dry alpine steppe consisting of widely spaced shrubs or sub-shrubs, Juniper (*Juniperus spp.*) are culturally important for local communities in Ladakh and thus has traditionally been exploited very heavily resulting in a severe decline in the wild. Ladakh is also rich in its medicinal plant wealth. A total of 397 medicinal plant species have been recorded for their use in pharmaceutical and nutraceutical industries as well as in traditional medicinal uses in the indigenous Sowa Rigpa medicine system. Other taxonomic groups like reptiles, amphibians, fishes, insects etc. are represented by a few species in the region, and many of these are highly threatened with restricted to very limited habitats and their wild populations are under threat (Sharma, 2017). Global Biodiversity Information Facility (GBIF) has reported 2470 species from Ladakh among which 69 species have been placed under various threatened categories as per the assessments of the IUCN.

In Ladakh prime tourist attractions are physical (landscape, wildlife, lakes, adventure, winter sports, etc.) and socio-cultural environments (monasteries, heritage sites, etc.). In 1974, when the area was opened for tourists, only 527 visitors travelled to the Ladakh region and most of them were foreign travellers (500 in number). This trend continued till 2008 when the number of domestic tourists surpassed the number of international visitors. Since 2010, Ladakh has witnessed a several-fold increase in the number of tourists and reached above 3,00,000 in 2021. In 2011, total tourist inflow increased by 2.3 times and domestic tourists increased by 2.5 times as compared to the tourist inflow in 2009 & 2010 which continued increasing up to 2021 (Fig. 1.2). The large quantum of tourist inflow accelerated infrastructure growth in the private sector, as reflected by the number of hotels, guesthouses, and home stays (Fig. 1.3). Out of the total 1169 establishments, the maximum are guest houses (59%), followed by hotels (25%), and home stays (16%).

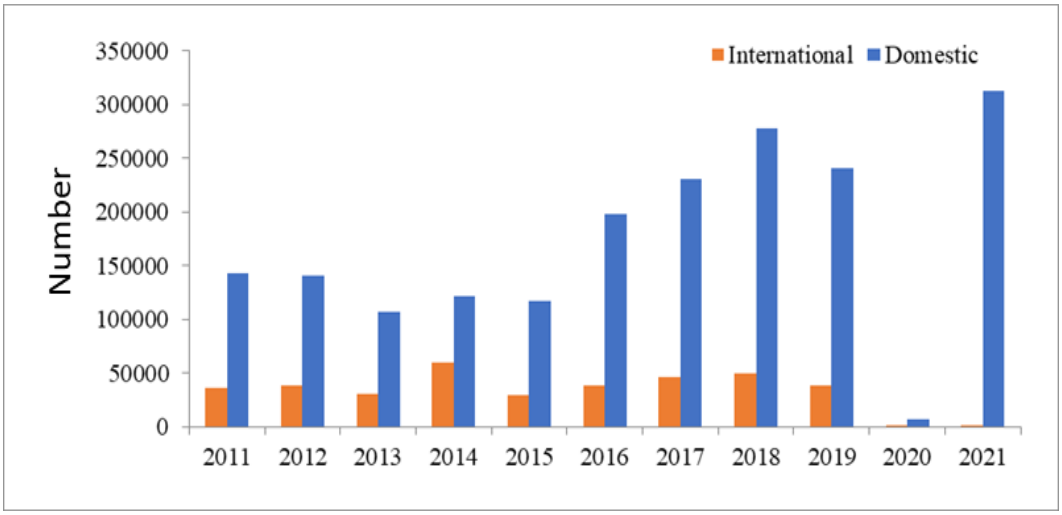


Fig. 1.2: Growth of tourism in Ladakh UT (*Source: Directorate of Tourism, Ladakh UT*)

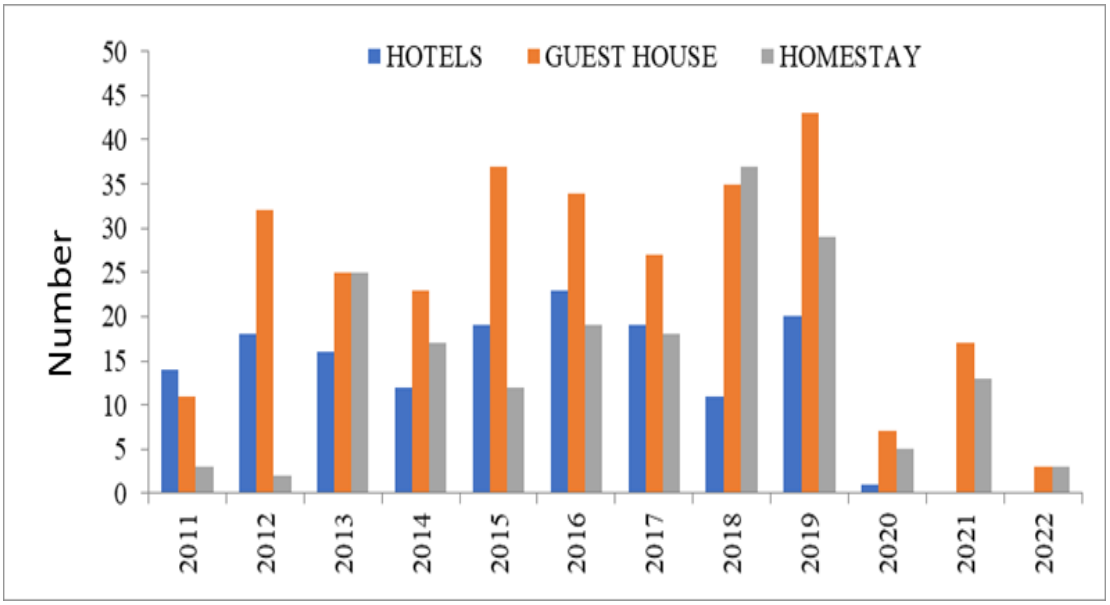


Fig. 1.3: Growth of tourism-related infrastructure in Ladakh UT (*Source: Directorate of Tourism, Ladakh UT*)

Largely, summer tourism is prompted by heat waves in the plains of India and vacations in the educational system, and winters are the inhospitable environment in Ladakh. Despite many limitations in winters (sub-zero temperature, a limited number of operational hotels/guesthouses, land-locked period, etc.) adventurous tourists visit Ladakh for popular activities like *Chadder* trek and wildlife tourism to see snow leopard or other big animals. Before the COVID-19, pandemic, cultural tourism during winters (festivals in monasteries) was also a popular attraction for the people interested to understand environmental and cultural aspects of Ladakh.

The government is also receiving direct revenue (as entry fee which includes Environment Fee, Red Cross Donation, and Wildlife Protection Fee) from the visitors for Inner Line Permit/Protected Area Permit (Fig.1.4) which has reached above Rs 90 million in the year 2021. Majority of this revenue comes from domestic visitors (Table 1.1.). Ladakh landscape also attracts movie makers (wildlife or other), hence is also a source of revenue (entry/filming fee) for the Department of Wildlife Protection (Ladakh UT). Visitors to *Hemis National Park* and Wildlife Sanctuaries in the Leh district contribute more than Rs 1 Crore in the years of mass tourist inflow to Ladakh UT (Table 1.2). Number of people who visited *Changthang Cold Desert Wildlife Sanctuary* ranged from 2,543 to 22,879 between 2014 and 2016 while for *Karakoram Sanctuary* it ranged from 11,066 to 13,088 in the same years.

Table 1.1: Share of revenue generated by domestic and foreign tourists

Year	Share of the direct fee (%) from visitors	
	Foreign	Domestic
2017	3.7	96.4
2018	27.4	78.5
2019	26.2	79.2
2020	6.6	93.8
2021	0.4	99.6

Table 1.2: Revenue (in Rs) generated from visitors to Wildlife Protected Areas of Leh district

YEAR	Revenue Collected (Rs)
2018-19	1,41,99,717
2019-20	1,12,06,847
2020-21	2,11,409

(*Source: Department of Wildlife Protection, Leh*)

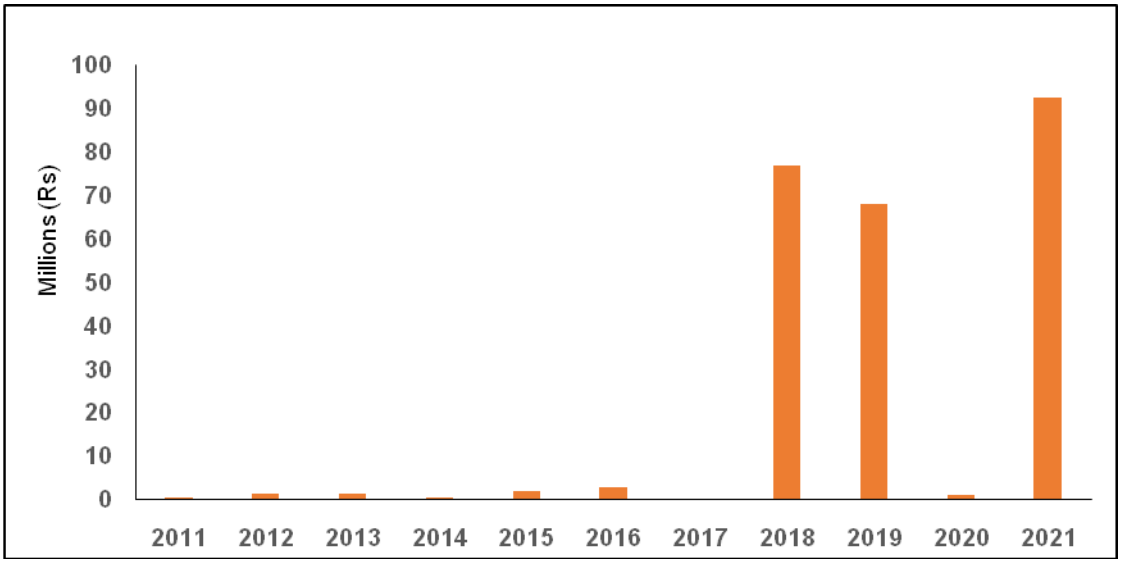


Fig. 1.4: Revenue generated by the government as a direct fee from visitors (Inner Line Permit Mechanism - Red Cross, Wildlife, and Environment) in Leh District (*Source: Office of Deputy Commissionaire, Leh, and Department of Wildlife Protection, Leh*)

1.2. Ill-effect of tourism particularly on environmental components

1.2.1. Assessment of waste generation

Due to rapid anthropogenic pressure on account of increasing in urban populations, enormous seasonal tourist inflows, ever-increasing hospitality industry operations and an influx of a huge migratory labour force during the summer season, these generates huge amounts of waste. To

address the issues of solid waste management, the Municipal Committees of Leh & Kargil town and Project *Tsangda* in the rural areas of Leh & Kargil districts are involved in collection and management in Ladakh UT. Project *Tsangda*, launched in Dec 2017, is an initiative by the district administration to manage the solid waste in rural areas. Presently, 7 Solid Resource Management Centres (viz., Nubra, Nimoo, Khaltse, Durbuk, Choglamsar, Chushot and Kharu) are established to collect and segregate the solid waste in Leh district under the project.

In the urban area of Leh town, a total of 20918 quintal (q) waste (biodegradable and non-biodegradable) was generated in the 11 months of 2021-22 (June 2021 to April 2022). However, only 1387 q waste (plastic bottles, multi-layer plastics, cardboards, tin, etc.) was sold for reuse, 19531 quintal waste was deposited at the MCL processing site (Table 1.3). From rural areas of district Leh, a total of 1054.07 of non-biodegradable waste was generated from 7 Solid Resource Management Centres in 11 months (Apr-21 to Feb 22). Moreover, 752.18 q of non-biodegradable waste was sold (treated) for reusing and a total of 301.89 q was still left.

Table 1.3: Solid waste generated and treated in urban and rural area of Leh, Ladakh UT

Local bodies	**Time period**	**Waste Generated (q)**	**Waste treated (q)**	**Untreated (q)**
Urban (MCL, Leh)	June 21- Apr 22	20917.73	1387.02	19530.71
Rural (Project Tsangda Trash Leh)	Apr-21 to Feb 22	1054.07*	752.18	301.89

**Only non-bio-degradable waste*

Maximum waste was generated in three months of tourist season (July 2021 to Sep 2021) which ranges from 3016 to 3883 q, while minimum waste was generated during three months of lean tourism period (Jan 22 to March 22; 739-888 q; Table 1.4). A strong relationship (r^2 =0.92; p <0.01) was observed between waste generation (collected month wise) and number of tourists (monthly arrival in a year, June -December 2021) at Leh town (Fig. 1.5).

Table 1.4: Urban biodegradable or non-bio-degradable waste generated and treated (in Quintals) month wise in Leh Municipal Committee (MCL), Leh, Ladakh.

Month	Total Waste generated (q)	Waste treated (q)	Untreated (q)
Jun-21	1740.06	34.6556	1705.4044
Jul-21	3016.3	352.6611	2663.6389
Aug-21	3741.68	77.1000	3664.5800
Sep-21	3882.96	153.5000	3729.4600
Oct-21	1427.05	159.7000	1267.3500
Nov-21	639.05	235.2000	403.8500
Dec-21	958.44	0.0000	958.4400
Jan-22	754.96	0.0000	754.96

Feb-22	738.63	0.0000	738.63
Mar-22	887.55	0.0000	887.55
Apr-22	3131.05	374.2000	2756.8500
Total	**20917.73**	**1387.02**	**19530.71**

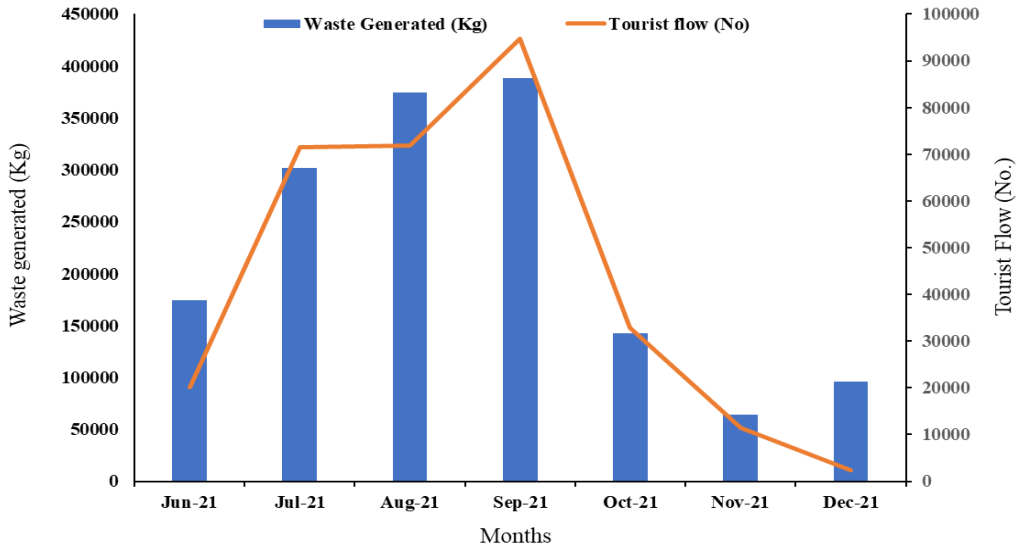


Fig. 1.5: The waste generation and tourist flow during July 2021-December 2021 at Leh Urban town, Ladakh (UT).

Solid waste segregation in the rural areas of Leh district (Project *Tsangda*) indicates that total solid wastes generated (Apr-Dec, 2021) ranged from 57 q to 142.00 q and maximum was generated in the month of July (Table 1.5), which again co-inside with number of tourists. Following a similar trend of urban waste, minimum waste in rural areas was generated in peak winter months of December 2021 (57.00 q) and January 2022 (63.57 q). Composition analysis indicates that paper waste (35.63%) and plastic waste (33.54%) are the major contributors to the total solid waste, followed by metal (7.42%) and rubber (4.89%).

Table 1.5: Rural non-biodegradable waste generated and segregated (in Quintals) in the Leh district (07 sites) of Ladakh UT

Month	Paper Waste	Plastic waste	Metal	Glasses	Rubber	Others	Total Waste
Apr-21	21.09	25.82	8.35	1.18	3.72	30.79	90.95
May-21	49.81	25.01	6.47	0.41	3.65	19.02	104.37
Jun-21	29.13	33.03	8.66	1.21	7.87	25.54	105.44
Jul-21	48.94	57.57	11.01	1.2	3.19	20.09	142.00
Aug-21	43.35	36.5	8.44	0.9	6.46	20.77	116.42
Sep-21	39.01	50.54	6.45	0.49	7.7	9.67	113.86

Oct-21	35.82	32.14	3.45	0.35	4.31	7.31	83.38
Nov-21	39.09	28.89	7.1	0.44	3.89	10.41	89.82
Dec-21	37.06	26.23	6.55	0.33	5.22	11.87	87.26
Jan-22	13.62	17.24	5.73	0.21	3.54	16.66	57.00
Feb-22	18.6	20.54	5.99	0.39	1.98	16.07	63.57
Total	**375.52**	**353.51**	**78.2**	**7.11**	**51.53**	**188.2**	**1054.07**

(*Source: Project Tsangda Leh, 2022*)

1.2.2.1. Case Study: Clean up drive along the *Markha Trek* in Leh, Ladakh

Markha trek is one of the most popular trekking routes in Ladakh, with nearly 6000 people trekking the route annually (~3000 tourists and an equal number of local guides and porters). In the pandemic year of 2020 when most of the restrictions were in place, All Ladakh Tour Operators Association (ALTOA) launched a clean-up drive along the *Markha* trek from 21-28 July 2020 in association with Department of Tourism, G.B. Pant National Institute of Himalayan Environment, Ladakh Regional Centre, and Women's Travel Association.

Waste from different camping sites along the *Markha* trek was collected, segregated and brought back to the Leh town where it was handed over to the Solid Resource Management Centre of Project *Tsangda*. A total of 837.39 kg of waste was collected during 8 days from the *Markha* trek which comprised 44% tin, 26% glass and 30% miscellaneous waste (Fig. 1.6 A and 1.6 B). In addition, during the clean-up drive, it was observed that camping sites along the mountain trek had maximum waste accumulation than village surroundings. So, it can be concluded that waste collected along the trek is exclusively contributed by the trekkers and their associates.

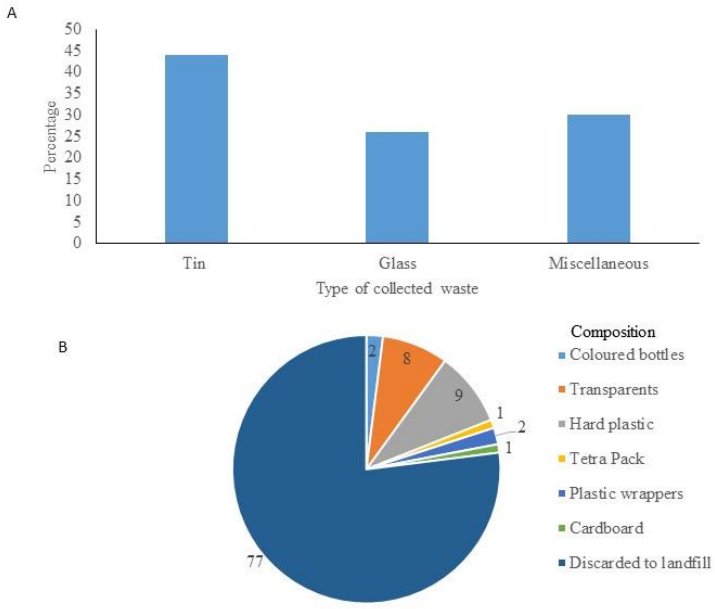


Fig. 1.6: Composition of solid waste collected during the cleanup drive (A) Percentage of waste collected along the *Markha* trek; (B) Composition of the miscellaneous waste.

1.2.2. Segregation / Utilization of waste

In Ladakh UT, a functional waste processing unit is not available. Segregated wastes from urban and rural Leh are being transported to other states or UTs for reuse and recycling. For example, a total of 1387 q solid waste from urban Leh was transported for sale (for recycling and reusing) to Jammu and Kashmir (UT) from June 2021 to April 2022 (Table 1.6), and a worth of Rs. 14,60,617 revenues were generated. The composition of solid waste included paper (801 q), plastic waste (417 q), metal (63 q) and others (106 q). Similarly, a total of 752 q solid waste from rural Leh was transported to Jammu & Kashmir during April 21 to Feb 2022 for recycle and reuse (Table 1.7), and a worth of Rs. 3,35,436 revenue was generated by Project *Tsangda*. The transported waste included paper (403 q), plastic waste (289 q), metal (53 q), rubber (0.9 q) and others (7 q). Till Feb 2022, a total of 8027 q waste was unutilized (dumped) and ready for sale purposes at Project *Tsangda*, Leh Centre.

Table 1.6: Urban waste utilization (in Quintals) in Leh district from June 2021 to April 2022

Details	Non-biodegradable							
	Paper	Plastic	Glass	Metal	Rubber	Ceramic	Others	Total
Reused & recycled (q)	801.37	417.10	-	63.00	-	-	105.55	1387.02

Table 1.7: Rural waste utilization (in Quintals) in Leh district from April 2021 to Feb 2022

Details	Non-biodegradable							
	Paper	Plastic	Glass	Metal	Rubber	Ceramic	Others	Total
Reused & recycled (q)	402.63	288.95	-	52.94	0.90	-	6.76	752.18
Unutilized* (till Feb 2022)	2362.14	4221.57	482.91	256.85	114.57	-	588.63	8026.67

*Total unutilized waste from since 2017

1.2.3. Waste disposal / treatment facilities

Safe and reliable disposal of solid wastes is a major problem for city planners and administrators. However, due to paucity of resources, the common method of waste disposal is open dumping. In Leh town before 2021, the solid wastes were dumped in open site at Bomb Guard near proximity of Leh town. The people of nearby places were facing issues due to unscientific dumping of urban waste. Addressing the issue, Ladakh Hill Development Council (LAHDC)-Leh has allocated land to the Municipal Committee Leh (MCL) to build landfills and incinerators at Skampari, Leh.Since June 2021, the waste from the urban area is being deposited and processed at the new site. In addition, the MCL installed a 30 tons/day capacity Solar Power-based Solid Waste Management Plant (Fig.1.7. a) with the aim of achieving 100% source segregation and 90% material recovery to generate revenue from recyclables and

organic compost. Presently, the non-biodegradable solid waste is segregated and compacted for sale under the Solid Waste Management Plant, however, biodegradable waste (food, etc.) is being standardized for making bio-compost. Moreover, construction of landfill area near Solid Waste Management Plant is under progress (Fig.1.7 b).

Fig. 1.7: (a) Establishment of solar power-based solid waste management plant: A new initiative by Ladakh (UT), (b) Landfill area under construction near Solid Waste Management Plant Skampari, Leh

1.2.4. Impact on Air quality

A vogue for travel to far destinations is supported by the transportation sector which is apparent from the number of vehicles (tourism-related activities) registered. Till 2017-2018, induction of new taxis was growing in Leh district but a self-restriction was imposed to avoid cut-throat competition, hence no growth of taxis is visible in Leh district (Fig. 1.8 A), however, this was not the case in Kargil district (Fig. 1.8 B). A new trend of motor-biking in high altitudes has surfaced as solo or group riding in two-wheelers. Group tourism has also contributed to the growth of mini-buses in Ladakh. Despite a self-imposed restriction on the induction of new taxis, inter-/ intra-regional conflicts have been arising within the Ladakh UT or neighbouring states (see web reference, 1-3). Other than motorable destinations of Ladakh, trekking routes also attract visitors including global tourists but visitors are concentrated on a few popular trails. Associated problems with trekking include dumping waste along the trails, and near campsites for overnight stops. Chadar trek (on frozen Zanskar river), Markha Trek, Stok Kangri expedition, were few popular routes. The highest mountain in the Stok range in Ladakh is Stok Kangri (6,154 m asl), and is located within the Hemis National Park. Expedition to the peak has been banned due to the negative impact of trekking groups on natural resources, particularly water (web references,4-6). Growing human population coupled with a high tourist influx and tourism-related infrastructure has attributed to several management issues, e.g., generation of waste, conversion of productive land, parking area, water availability and pollution, energy needs, threats to wildlife and habitats, etc. The tourism industry is susceptible to many factors such as CORONA 19 Pandemic, unstable environment of the region, etc.

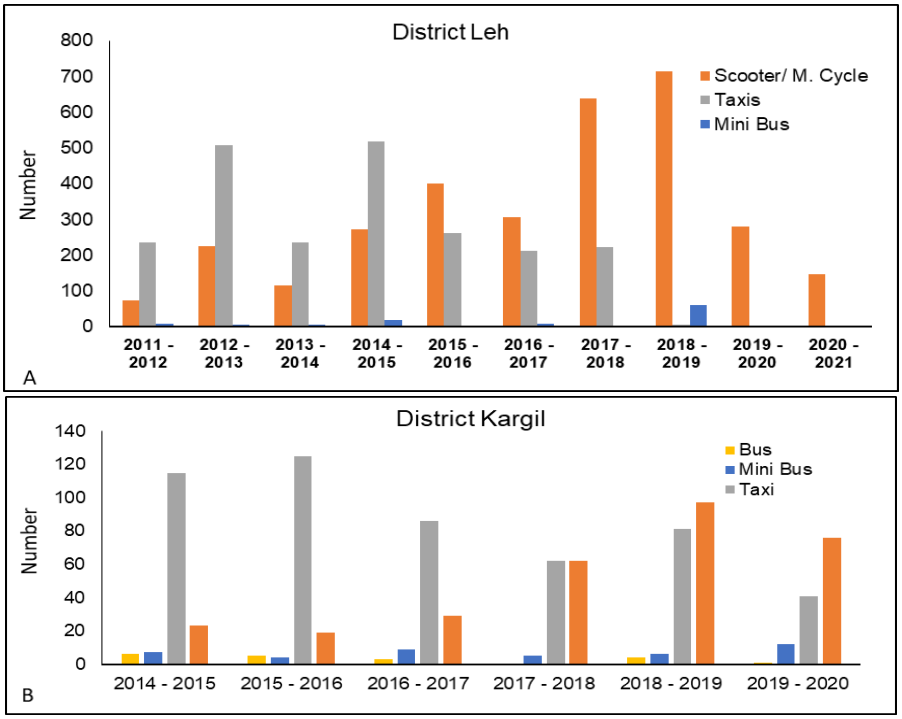


Fig. 1.8: Number of vehicles used in the tourism sector in Ladakh (A) Leh District, and (B) Kargil District (*Source: Department of Transport*)

Vital parameters of air quality in Ladakh region have not been monitored rigorously and continuously. Therefore, no long-term records are available to assess district-wise air quality or even in regional/UT scale. Only PM_{10} monitoring has been initiated in Leh district in September 2019 which provides a monthly record for summers. PM_{10} monitoring in Ladakh during September-November 2019 and June-October 2020 reveals the values ranging from 31 to 68 $\mu g/m^3$. Notably, PM_{10} values remained well within the NAAQ standard in all months except for October 2021 (Table 1.8).

Table 1.8: Air quality monitoring at Leh District during 2019 & 2020

Year	**2019**	
Month	**District**	**PM_{10} ($\mu g/m^3$)**
September	Leh	36.46
October	Leh	31.08
November	Leh	33.77
	2020	
Month	**District**	**PM_{10} ($\mu g/m^3$)**
June	Leh	54.28
July	Leh	48.96
August	Leh	45.23
September	Leh	50.71
October	Leh	68.24

As per the information obtained from an Air Quality Monitoring Station maintained by NASA_RTI at Leh (https://aqicn.org/station/india/leh/nasa_aqcs_119), PM_{10} values range between 7 ug/m^3 and 112 ug/m^3 during the period from March 2021 to May 2022. Similarly, values for $PM_{1.0}$ ranges between 3 ug/m^3 and 57 ug/m^3 , whereas values for $PM_{2.5}$ ranges between 5 ug/m^3 and 93 ug/m^3 during the same period. Air quality for most of the months was within permissible limits as per the standards of Central Pollution Control Board (CPCB) except for the month of March, April, August and December 2021 which showed satisfactory levels (Table 1.9). Considering the available data, it is currently not possible to deduce a relationship between the air quality and tourism. Thus, there is a need to strengthen the pollution monitoring network in Ladakh UT particularly at popular tourist destinations. Recently, as a measure for reduction in air pollution and to achieve carbon neutrality, the administration of Ladakh UT launched ten electric buses in Leh and Kargil town for public transport in August 2021.

Table 1.9: Air quality parameters for Leh town based on the NASA_RTI monitoring station

Month	$PM_{1.0}$ (ug/m^3)	$PM_{2.5}$ (ug/m^3)	PM_{10} (ug/m^3)
Mar, 2021	57.27	93.58	112.83
Apr, 2021	32.53	55.90	69.93
Aug, 2021	36.77	53.58	65.59
Sept, 2021	5.31	8.22	10.60
Oct, 2021	6.30	10.33	13.69
Nov, 2021	18.41	32.55	45.85
Dec, 2021	29.47	52.00	73.76
Mar, 2022	6.09	11.30	16.77
Apr, 2022	5.16	8.94	12.26
May, 2022	2.87	5.02	7.04

(*Source: https://aqicn.org/station/india/leh/nasa_aqcs_119*)

1.2.5. Ill impact on water quality/groundwater

Ladakh (UT) has two districts: Kargil and Leh, and considering Nubra as a geographically distinct region in the Leh district, a separate assessment for Kargil, Leh and Nubra is given. Since 2018, water quality in Ladakh has been monitored for hand-pumps and springs during warmer months (March to November). As per Indian Standard (IS: 10500: 2012), the acceptable quality of T.D.S. in drinking water is 500 mg/L in ideal cases and 2000 mg/L in the absence of alternate sources. The monthly average values show that the T.D.S. ranges from 0 to 348 mg/L, and no observation in any district/region and in any month has ever exceeded the prescribed limit. The acceptable limit of Chloride in drinking water is 250 mg/L in normal cases and 2000 mg/L in the absence of alternate sources. All the observed values of chloride were within 250 mg/L except for two individual incidences when slightly high values of 500 mg/L were observed in Leh during July 2019. The maximum permissible limit of iron in drinking water

is 0.3 mg/L and no relaxation is granted even if an alternate source is not available. Most of the recorded values for iron were within the acceptable limit. Only one individual observation in Leh (April, 2018; 0.5 mg/L) exceeded the prescribed criteria. Moreover, Coliform Bacteria was found to be entirely absent from the water in all the years and in all the districts/regions of Ladakh (UT). Considering the good water quality even during peak tourist season in Ladakh (i.s. summer months), it can be concluded that there is no direct impact of tourism on water quality.

As per the report on water in Liveable Leh (Gohel *et al.* 2019) per person average water demand in Leh is 135 litres per day (L/day) with a total demand of 5.0 megalitres per day (MLD) in summers and 1.55 MLD in winters. However, the required demand as per Central Public Health and Environmental Engineering Organisation (CPHEEO) is 12.66 MLD in summers and 4.17 MLD in winters as per the population level in Leh town. Among the different users, a tourist in Leh uses approximately 100L water per day whereas local residents use 75L/day and migrant workers use 30L/day. Water in Leh (Gohel *et al.* 2019) is supplied through borewells owned by the Public Health Engineering Department (63%), natural springs (8%) and private borewells (29%). As per the information on National Jal Jeevan Mission dashboard (https://ejalshakti.gov.in/jjmreport/JJMState.aspx), 13,843 households (32%) of the total population have been connected with tap water until May 2022 including 7854 households in Leh and 5989 households in Kargil district. The increasing tourist inflow might result in even high water demand during summer season, which can potentially presimpact on natural springs and private borewells. However, Jal Jeevan Mission which is under progress in Ladakh UT is expected to help in effective management of water needs in the region.

In terms of water quality assessment, long-term information is not available for UT. As part of the information on State Pollution Control Board of Jammu & Kashmir (http://jkspcb.nic.in/Content/MonitoringatPollutedRiverStretchesinJandK.aspx?id=454) water quality monitoring has been initiated at 8 locations along stretches of the river Indus, however, data/information is still not available. Thus, the only information available from Ladakh UT is from the Jal Jeevan Mission program. Further, Leh has entered into India's first Public Private Partnership for a Faecal Sludge Management System with a sewerage which will cover nearly 40% of the town. As per the information obtained from the treatment plant, a total of 6.7 million litres of sludge has been treated by the plant during the year 2018-2021 which includes 0.6 million litres of sludge from sewage pipes and 6.1 million litres of toilet and bathroom sludge.

Groundwater resources in the district Leh has also been examined by the Hon'ble High Court of Jammu & Kashmir, observations and directives are given below (High Court of Jammu & Kashmir, OWP no.1513/2018, date of order, 16.08.2018)-

- **Para 7**- "*……It also comes to fore that establishment of restaurants/hotels/guest houses/home stays/ camps/resorts is on spree in District Leh, depleting ground water level because innumerable borewells and hand pumps are at galore."*

- **Para 11**- "*Ladakh Region, it is germane to mention here, does not have rain water harvesting system and as a sequel whereof, groundwater level in Ladakh Region is depleting day by day. Consequently, it is bounden duty and responsibility of District Administration, Leh, that groundwater resources (aquifers) are protected from such activities that impact the equity of access and sustainability of the resource. All the precautionary measures and steps shall be taken by the District Administration, Leh, at all levels to protect groundwater from depletion, deterioration, biological and chemical pollution as well as to prevent and/or reduce adverse impacts on the environment. Effective schemes and measures are to be formulated and implemented to conserve, replenish, recharge and manage groundwater in an equitable and sustainable manner. Any use of groundwater, surface water or land and forest resources or activity in relation to these resources, which are likely to have significant negative impacts on natural sources as also to local sources of groundwater shall be sternly prevented and all protective, preventive and precautionary measures in this regard shall be set in motion by District Administration of Leh. This apart, Public Health Engineering, Leh, shall ensure that potable water is provided to the colonies/habitations, in discharge of their public obligation and while doing so it shall inhibit illegal extraction of groundwater*."

1.2.6. Ill impact on forest and biodiversity

The forest cover in Leh and Kargil districts of Ladakh UT was 129 km^2 in 2011 which increased to 138 km^2 in 2017 accounting for 6.5% increase in the forest cover during seven years. This includes 15 km^2 of moderate forest and 123 km^2 of open forest. However, information on forest types is not available for Leh and Kargil districts of Ladakh UT. Major reasons for the increase in the forest cover include afforestation activities carried out by the State Forest Department, conservation efforts by the concerned agencies and improvements in the methodology of FSI.

Wildlife attracts many tourists in Ladakh, and popularly organized tours represent the snow leopard or brown bear, however, enthusiastic bird watchers can be seen anywhere. Protected Area Network (PAN) in Ladakh consists of one National Park and two Wildlife Sanctuaries. PAN occupies an area of 12,350 km^2. Some of the important wildlife and birding hotspots which are popular for ecotourism in Ladakh include Rumbak valley in Hemis National Park, Suru valley in Kargil, Rangdum marshes in Zanskar, Ulley village and Ridzong Monastery, Phey Spituk Shey, Thiksey Marshes, Nubra Valley, Tsokar lake basin, Tsomoriri lake, Puga-Sumdo valley, Yaya Tso lake, Nyoma Loma Marshes, Hanle Basin, etc. Wetlands in Ladakh, e.g., Pangong, Tso Kar, Tso Morari are popular tourist destinations which are also important habitats for a large number of waterfowl species. Close encounters of tourists in these wetlands lead to disruption in the life cycle of migratory and other birds. In Changthang area, off-road driving poses a threat to the unique assemblage of flora and fauna species hosted by the wetland. Changthang wetlands are also particularly affected by campsites, because they have been recently opened to tourism, and therefore have few hotels and tourism infrastructures. A total of 665 wetlands have been documented in Ladakh region which constitutes a vast habitat for the migratory waterfowl and other birds (Nasim & Keng, 2012).

Pristine wildlife habitats in Ladakh are frequently visited by wildlife enthusiasts and thus are potentially under threat from human impacts like disposal of solid waste and impact on natural habitats. However, no such studies have been conducted so far on the impact of tourism on the natural habitat of the wild plants and animals in Ladakh but on physical degradation of environment of famous tourist destination, i.e., *Pangong Tso* (located within Changthang Cold Desert Wildlife Sanctuary). Judicial System has also made observations on increasing pressure in Pangong, and have given directives for the improvement of the environment, parts of the judgment are reproduced below (High Court of Jammu & Kashmir, OWP no.1513/2018, date of order, 16.08.2018) –

- "*Many of our rivers arise from the lakes at higher altitudes in the Himalayan ranges. Qua Pangong Lake, also known as Pangong Tso, is a beautiful endorheic lake situated in the Himalayas, which falls within Changthang Cold Desert Wildlife Sanctuary. Pangong Lake is one of the biggest tourist attractions of the country. The beauty and allure of this lake attracts people from all over the country and beyond. Having said that, Pangong Lake requires preservation and conservation from being contaminated and polluted under the guise of developmental works, construction and erection of structures around the lake*."

- *"Perusal of report, produced by learned counsel for respondents, reveals that a slew of camps/restaurants/ structures has been set up illegally and are being operated along bank of Pangong Lake without any permission, generating constantly all type effluences and contaminants and as a consequence whereof posing serious threat to the very existence of the Pangong Lake, besides snuffing out ecologically fragile region as also wildlife*."

- *In view of above discourse, District Administration of Leh is directed to take well planned, sustainable and scientific efforts and steps to prevent degradation, or say ultimate death, of Pangong Lake. And for this purpose, District Administration will remove all structures around the Pangong Lake, including take up the matter with the authorities of Army to shift the structure(s) erected by Army, around the lake to any other place/area where it is found appropriate having regard to security scenario and given preservation of Lake as well. Not only this, a scheme / policy is also important to be formulated by the State Government, if not already formulated, for preservation and conservation of Pangong Lake. District Administration of Leh shall also endeavour to save, protect and preserve the flora and fauna in and around Lake. So far as borewells and handpumps are concerned, District Administration shall seal all borewells and handpumps, which are operating illegally, unauthorizedly and without permission from the authority".*

1.3. Gaps and Plan of Action

Sr. No.	Gaps	Plan for Action
1.	There is a need to conduct impact assessment studies focussed on tourism processes and their impact on natural resources (water, land, pollution, etc.) including wildlife and their habitats	Famous tourist places in Ladakh require carrying capacity study for developing a planned infrastructure and amenities in consultation with diverse user groups.
2.	The number of visitors & vehicles in a Wildlife Protected Areas are not regulated	Require vigilance and regular patrolling to reduce unwanted wildlife-tourist interaction, habitat destruction due to off-road driving, and encroachment.
3.	Associated problems with trekking include dumping waste along the trails, and near campsites for overnight stops.	With high influx of tourists in Chadar trek (on frozen River Zanskar), Markha Trek, Stok Kangri expedition, there is a need of proper monitoring regarding issues like throwing of waste and its generation, conversion of productive land, parking area, water availability and pollution, energy needs, threats to wildlife and habitats
4.	There is a need to work on creation of alternate sources of drinking water in view of water demand of the tourists and availability of local capacity to supply safe water.	As an alternative to packaged water building a network of Water ATMs (urban centres) and promoting Clean Water Springs for drinking water purposes on the routes

1.4. Summary

Several segments of Ladakh tourism are structured, regulated and well-advertised (e.g., defined tourist circuits, taxi fare and operation, home stays, accounting of tourist numbers and hotels, etc.) but some sectors require more attention. The air and water quality monitoring data, though limited to summer months and to recent two years, suggests that both air and water quality, in general, is good in the Ladakh region and there is no direct influence of tourism. A mechanism exists to address issues of waste collection, segregation, and disposal from rural and urban areas but still miles to go, particularly on reducing the single use plastic and wider adoption of alternatives. Apparently, the only sector that exhibits a direct relationship with tourism activities is the solid waste sector. Analysis revealed almost three times higher waste generation during the tourist season. Although authorities have taken necessary action regarding efficient management of solid waste, the same needs to be expedited. Few of the most visited tourist spots (e.g., Hanley, Tso Morari, etc.) fall in the Sanctuary/National Park areas where new facilities to cater the needs of the tourism sector are appearing but no

mechanism exists for waste management and water treatment. Such places require immediate attention for planning and management, and the role of the Wildlife Department becomes important in regulating affairs within the sanctuary area.

Some of the suggestive measures on sector of Solid Waste Management are:

i. as an alternative to packaged water building a network of Water ATMs (urban centres) and promoting Clean Water Springs for drinking water purposes on the routes,
ii. waste recycling units for the segregated wastes instead of transporting kilometres away to other states, this can be achieved in PPP mode, and
iii. applying appropriate technologies for direct use, like use of shredded plastic chips in road constructions.

However, Ladakh has been well explored by researchers but more on social (anthropology and culture), geology and glaciers, and climate change processes, there is a need to conduct impact assessment studies focussed on tourism processes and their impact on natural resources (water, land, pollution, etc.) including wildlife and their habitats. There is an urgent need to understand ***"tourism carrying capacity"*** in relation to (i) the development of urban centres and dependent natural resources, particularly water and land, for developing a master plan of urban growth to support tourism-related infrastructure and amenities without developing conflict with diverse user groups, (ii) developing a mechanism for ***"responsible tourism"*** to minimize the impacts of solid waste management and adoption of appropriate technologies to convert waste into wealth, and (iii) pace of tourism in wildlife protected areas - to develop understanding in formulating strategies/plans to ***regulate the number of visitors & vehicles*** in a Wildlife Protected Area (as practised in other parts of the country) for maintaining tourism carrying capacity of a protected area; Vigilance and regular patrolling in the Protected Areas to reduce unwanted wildlife-tourist interaction, habitat destruction due to off-road driving, and encroachment, if any. Hon'ble High Court of Jammu & Kashmir has also put directives to protect the flora and fauna of "*Pangong Tso*" (a most visited tourist destination in Changthang Cold Desert Wildlife Sanctuary) and needs of Scientific Efforts (High Court of Jammu & Kashmir, OWP no.1513/2018, date of order, 16.08.2018)-

Para 9 – "*In view of above discourse, District Administration of Leh is directed to take **well planned, sustainable and scientific efforts** and steps to prevent degradation, or say ultimate death, of Pangong Lake. And for this purpose, District Administration will remove all structures around the Pangong Lake, including take up the matter with the authorities of Army to shift the structures erected by Army, around the lake to any other place/area where it is found appropriate having regard to security scenario and given preservation of Lake as well. Not only this, a scheme / policy is also important to be formulated by the State Government, if not already formulated, for preservation and conservation of Pangong Lake. District Administration of Leh shall also **endeavour to save, protect and preserve the flora and fauna in and around Lake**. Insofar as borewells and handpumps are concerned, District*

Administration shall seal all borewells and handpumps, which are operating illegally, unauthorizedly and without permission from the authority."

Given the fragility, sensitivity and complexity of the landscape and patterns of anthropogenic land use, biodiversity conservation in the region cannot be achieved by solely relying on the protected area model. Instead, it requires a landscape-level model that allows the coexistence of humans and biodiversity. Thus, while promoting the wildlife-based ecotourism, it is pertinent to conduct the periodic assessment of such activities on the natural habitat of the wild flora and fauna in Ladakh. This will ensure the growth of the tourism-based economy as well as the conservation of the biodiversity heritage of Ladakh. A network of monitoring stations for air and water quality is also required for consistent monitoring in town and most occupied routes of tourist vehicles in Ladakh UT.

2.1. Introduction

The present Jammu and Kashmir UT became a union territory on 31 October 2019 after the reconstitution of the erstwhile Jammu and Kashmir State (J&K) as two separate entities (J&K UT and Ladakh UT). The region has remained a popular destination for pilgrims to famous shrines like Shri Amarnath Ji holy cave and Mata Vaishnav Devi. Apart from the cultural tourism, the region also attracts tourists due to its picturesque landscape, dense temperate forests, wetlands and unique biodiversity (Fig.2.1). Global Biodiversity Information Facility (GBIF) has reported 4748 species from Jammu & Kashmir UT which includes 145 species of mammals, 773 species of birds, 62 species of other vertebrates, 583 species of invertebrates, 2847 species of seed plants and 338 species of other lower taxa. Among these, 429 plant species have been listed as threatened including 24 critically endangered, 88 endangered, 75 vulnerable, 3 near threatened, and 32 least concern species as per IUCN assessment (Hamid *et al.* 2020). Similarly, among the animals, 71 threatened and near-threatened species have been reported (33 species of birds, 26 species of mammals, 5 species each of reptiles and fishes and 2 species of amphibians; Bhat *et al.* 2020). The UT is covered with a forest cover of 39.15% which has witnessed an increase of 9% in Jammu division and 21% in Kashmir division during the last decade (ISFR 2011 & 2021).

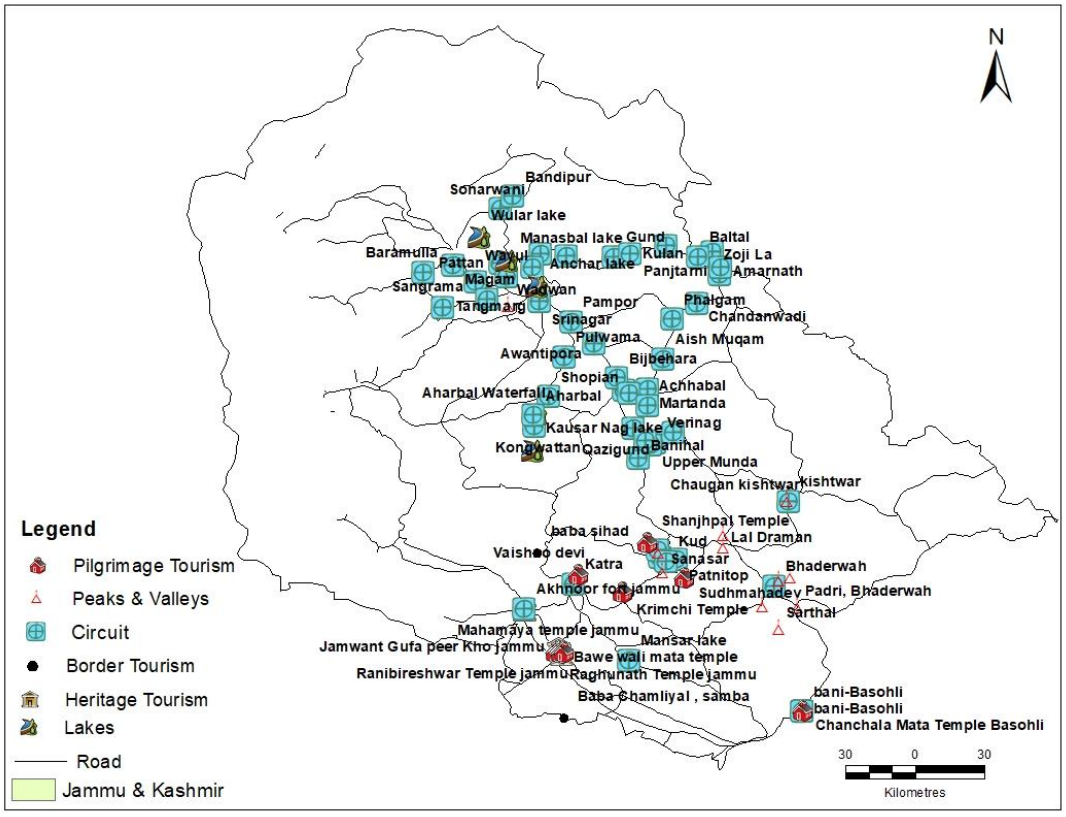


Fig.2.1: Major tourist spots and circuits in Jammu & Kashmir

Tourism constitutes one of the major economic activities in the UT and has witnessed a continuous increase during the past few decades. From 1951 to 1985, the number of total tourists visiting the Kashmir Valley had increased from 10,000 to 5,03,620 persons. However, later due to political turmoil and terrorism crisis, the Kashmir valley witnessed a substantial reduction in the number of visitors till 1997 after which growth was again observed. Phase after year 2002 shows a tremendous tourist growth in the Kashmir Valley till the rise of the Pandemic Situation (2020-21). Five years in the last decade (2011-2020) witnessed more than 11 lakh visitors in a year. Overall, the number of foreign tourists visiting the Kashmir valley in a year ranged from 1,250 (1951) to 59,320 (1978), whereas continuous substantial growth was observed only after the year 2003 but their proportion to the total number of tourists remained below 5% due to the surge of domestic tourists (Fig. 2.2). Interestingly, during the turbulent years (1995-1997), the number of foreign visitors was several-fold higher than the number of domestic tourists (320 *vs.* 8200 in 1995; 370 *vs.*9590 in 1996; 7020 *vs.* 9110 in 1997).

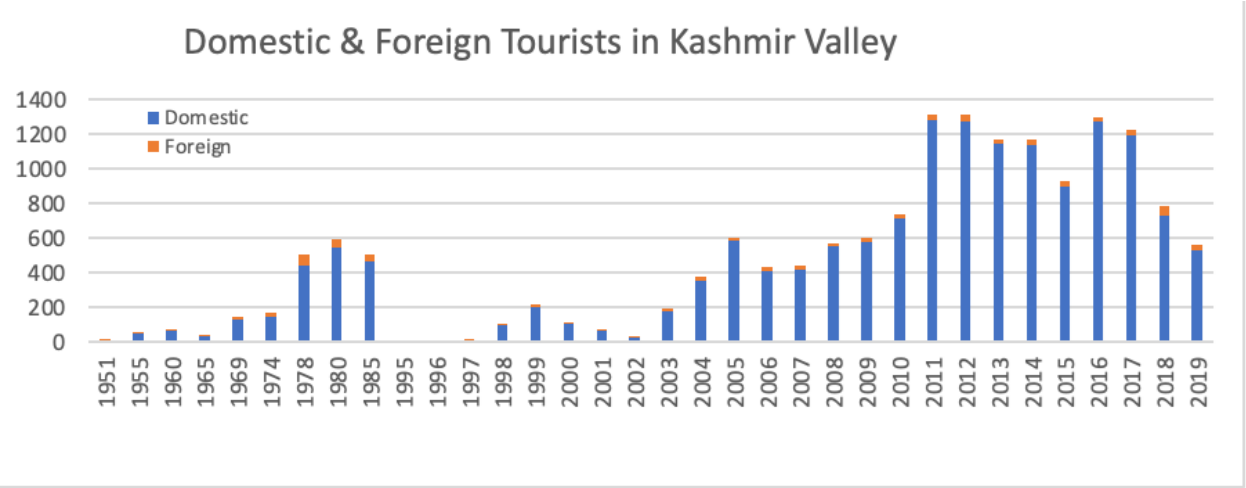


Fig. 2.2: Contribution of domestic visitors and foreign nationals to the total tourists visiting Kashmir valley of Jammu & Kashmir UT (*Source: Directorate of Tourism, J&K UT*).

Besides, the tourism in the Kashmir Valley, every year pilgrims visit the major shrines (Shri Amarnath Ji Holy Cave and Mata Vaishnav Devi) of J&K UT. Pilgrim tourism is much higher than the traditional tourism in Jammu & Kashmir ranging between 2.2. lakh to 111.16 lakh per annum (Fig.2.3). Number of pilgrims in a typical year range between 2 to 29 times higher than the total tourists visiting the Kashmir valley. The number has increased many folds from 1965 (2370 pilgrims) to 2012 (1,11,160 pilgrims), and a majority of these pilgrims visit Mata Vaishnov Devi Shrine (93 to 98% of the total pilgrims in a year) (Fig. 2.4). Despite the turbulence in the Kashmir valley (1999-2002), pilgrim tourism was least affected (40.7 to 52.8 lakh pilgrims in a year) which can be attributed to the locational advantage of the shrine.

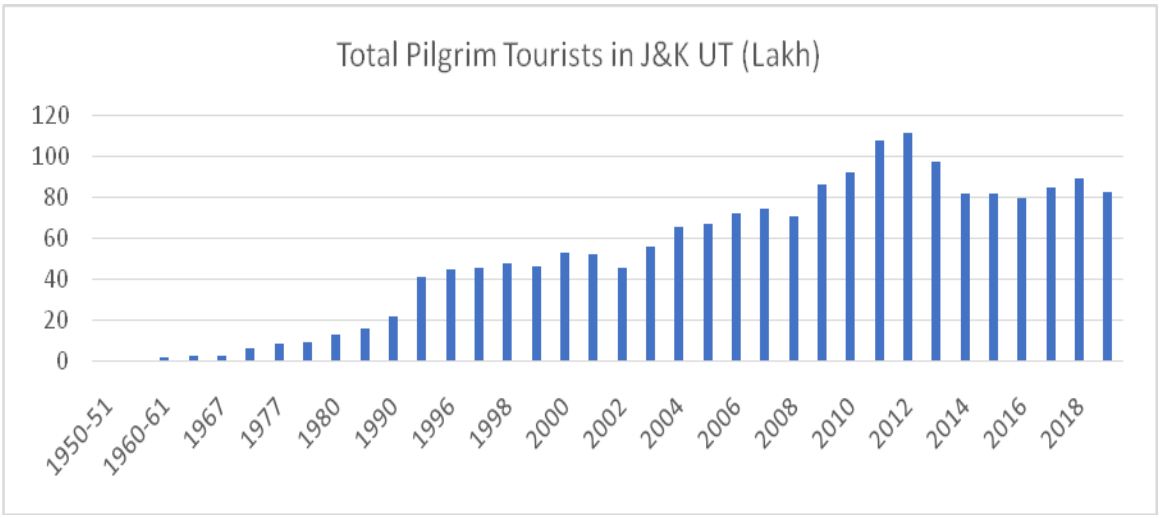


Fig. 2.3: Pilgrim Tourists in Jammu & Kashmir UT (*Source: Directorate of Tourism, J&K UT*)

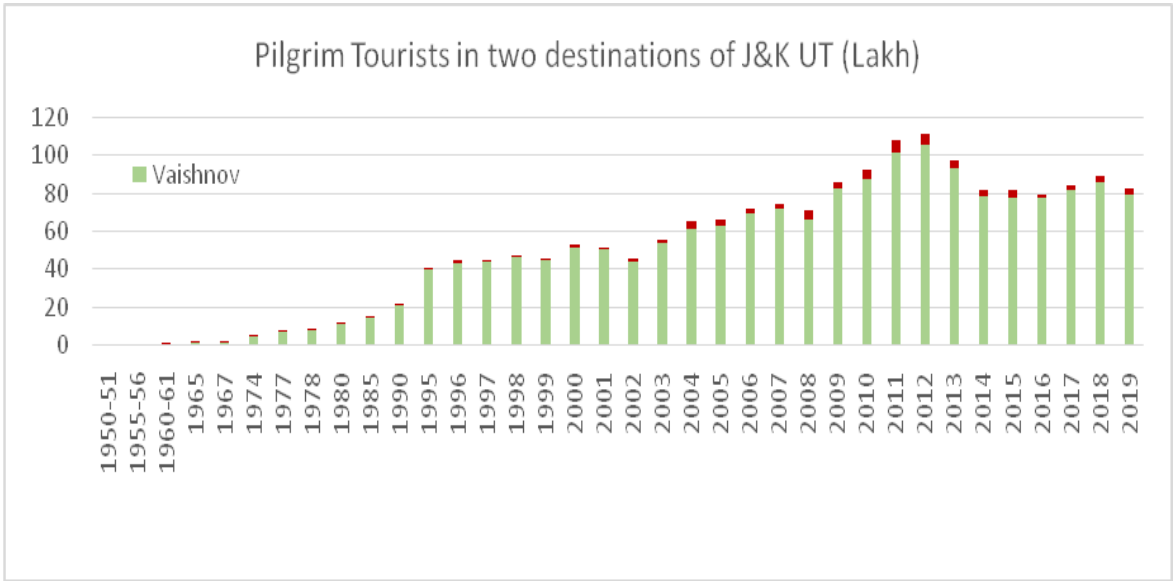


Fig. 2.4: Pilgrim Tourism in two major destinations in J&K UT - (a) Shri Amarnath Holy Cave, and (b) Mata Vaishnav Devi (*Source: Directorate of Tourism, J&K UT*)

Tourism related infrastructure owned by government (Tourist Huts and Bungalows) and private owners (Hotels) are continuously growing in the union territory (Fig. 2.5). Number of government owned tourist huts and bungalows is less than 250 in the UT. However, due to increasing influx of tourists, the number of hotels in the UT had increased to 1674 and the number of restaurants to 326 in 2018-19 (Fig. 2.6).

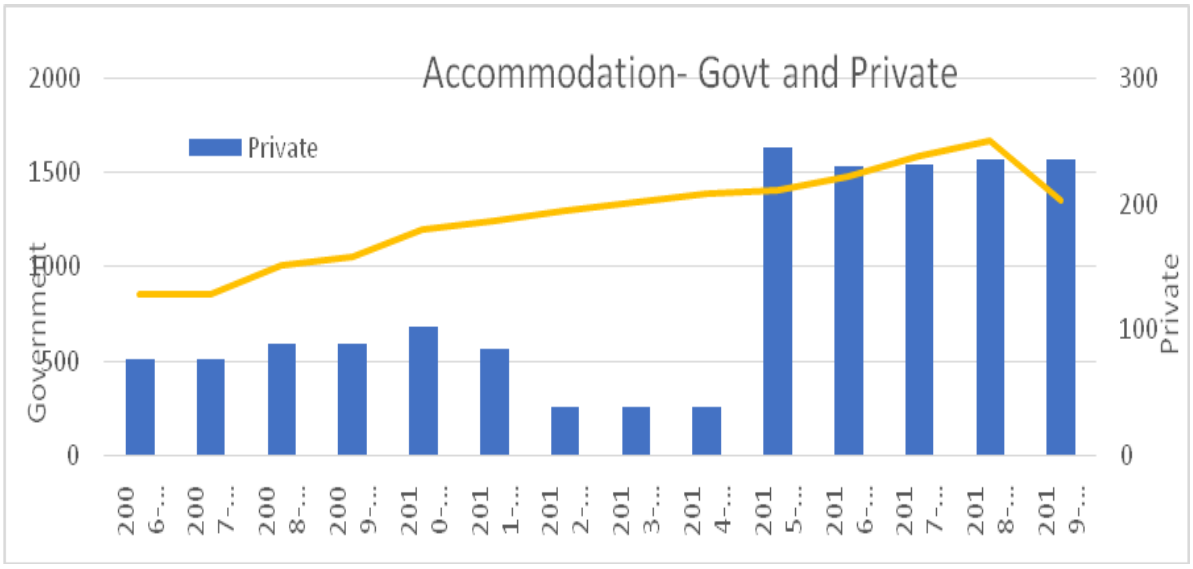


Fig. 2.5: Growth of government and private accommodations in the tourism sector of J&K UT (*Source: Directorate of Tourism, J&K UT)*

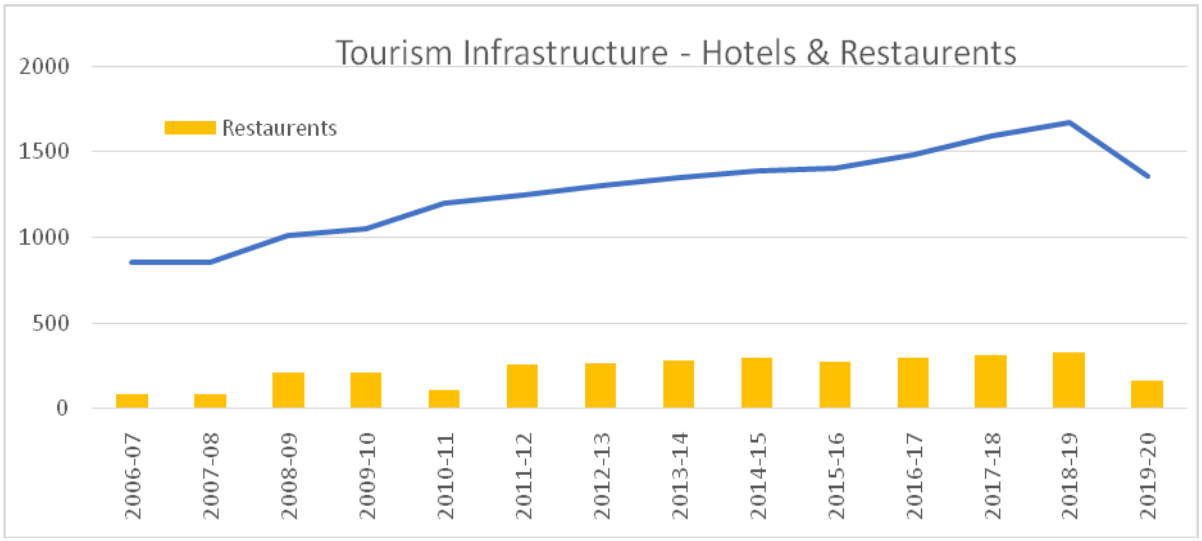


Fig. 2.6: Growth of hotels and restaurants in J&K UT (*Source: Directorate of Tourism, J&K UT*)

2.2. Ill-effect of tourism particularly on environmental components

2.2.1. Assessment of waste generation in Jammu & Kashmir (UT)

In the era of increasing urbanization and industrialization, Solid Waste Management (SWM) is becoming a significant challenge. In Jammu and Kashmir (UT), 80 civic local bodies (2 Municipal cooperation, viz., Jammu Municipal Corporation and Srinagar Municipal Corporation; 6 Municipal Councils; 70 Municipal Committees; and 2 Cantonment Boards) are responsible for the management of solid waste. In the year 2019-2020, the total solid waste generation in all the Corporation / Local bodies of J&K UT was 15133.94 q/d, out of which 14593.8 q/d was collected, and 5382.46 q/d was treated (Table 2.1). Year wise data obtained from Jammu

Municipal Corporation, Jammu and Kashmir showed an increasing trend of total solid waste generation from 2017 (10,03,75.0 t/yr) to 2021 (12,48,30.0 t/yr) (Table 2.2). Waste processing and recycling was started from 2019 and 2020, respectively, and waste processed ranged between 2.5% (2019) to 11.70% (2021). In Srinagar Municipal Corporation, an increasing trend of solid waste generation was recorded from the months of March to November during the years 2017-2022 (Table 2.3).

Table 2.1: Municipal Solid Waste generated, collected and treated in Jammu & Kashmir (UT)

Name of Province	Generation (q/d*)	Collection (q/d*)	Treated (q/d*)	Untreated (q/d*)
Jammu	6896.69	6709.77	789.05	6107.64
Kashmir	8237.25	7884.03	4593.41	3644.34
Grand Total	15133.94	14593.8	5382.46	9751.98

*q/d- Quintal per day

Table 2.2: Year wise Municipal Solid Waste generated, processed and recycled in Jammu Municipal Corporation, J&K from 2017-2022

Year	Waste Generation		Waste Processed			Waste Recycled	
	q /day	q/Year	q /day	q/Year	%	q/day	q/ Year
2017	2750	1003750	0	0	0	0	0
2018	2900	1058500	0	0	0	0	0
2019	3200	1168000	80	29200	2.5	0	0
2020	3380	1233700	400	146000	11.83	80	29200
2021	3420	1248300	400	146000	11.70	80	29200
2022*	3640	436800	500	60000	13.74	80	9600

(*Source: Jammu Municipal Corporation, Jammu and Kashmir; *Till April 2022*)

Table 2.3: Month wise and Year wise Municipal Solid Waste generated from 2019-2022 in Srinagar Municipal Corporation, J&K

Months	Total Solid Waste Generated (q)			
	2019	2020	2021	2022
Jan	73950	90050	92910	96280
Feb	73460	101760	97630	97660
Mar	93090	113430	143900	146220
Apr	113790	100110	173280	151330
May	125860	105690	139400	-
Jun	127150	118890	136760	-
Jul	127150	NA	140810	-
Aug	94150	NA	138020	-
Sep	91430	NA	138240	-
Oct	113440	NA	141030	-

Nov	109410	NA	125700	-
Dec	97900	NA	116140	-
Total	**1240780**	**629930**	**1583820**	**491490**

(*Source: Srinagar Municipal Corporation, J&K; NA-Not available*)

Case study 1: *Hotel and restaurants generate a high quantity of Municipal solid waste (MSW) at Pahalgam during Amar Nath Yatra season (June-August 2015)*

A study on Municipal solid waste (MSW) generation during the *Yatra* Season (June to August 2015) at Pahalgam (a tourist destination during Amarnath Yatra Season) describes that the maximum amount of waste was generated from hotels and restaurants (74%), followed by local households (18%), and markets (5%) (Fig. 2.7; Bashir and Goswami, 2016).

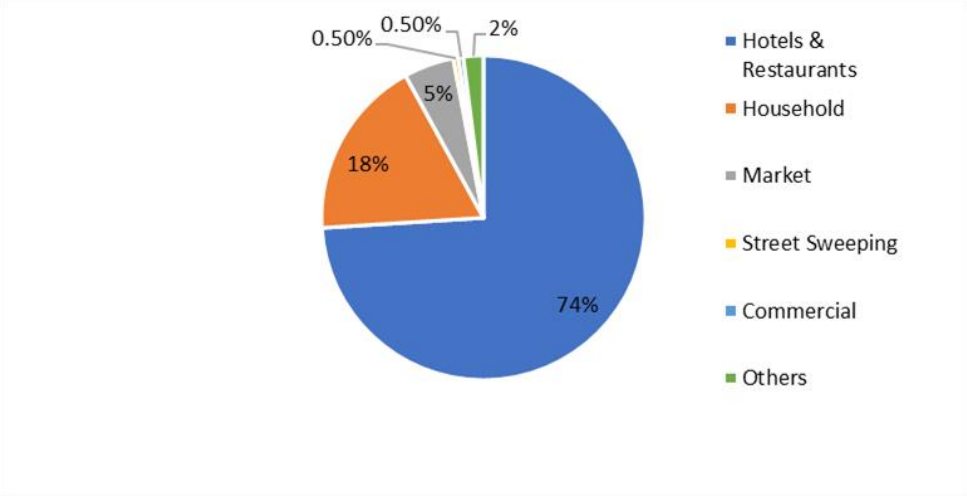


Fig. 2.7: Total contribution of categorized Municipal Solid Waste generated at different sites at Pahalgam (*Source: Municipal Committee Pahalgam, 2015*)

Segregation / Utilization of waste

In the Jammu division, an NGO namely "*Faith and Samiti*" conducts door to door collection of solid waste from nearly 1500 HHs. Although the 13 local bodies in the division claim a 100% collection of solid waste from their respective areas, but no segregation is being done except partial segregation by two local bodies, i.e., segregation of bio-waste at Katra and Jammu Municipal Corporation. Secondary waste segregation was started at Katra town, as a pilot project, with segregation of approx. 14.95 q/d of waste and channelization for further recycling (JK-PCB 2019-2020).

In the Kashmir division, door to door collection of municipal solid waste is conducted by Srinagar Municipal Corporation (80% households). Door-to-door collection is being conducted in Urban local bodies, expect 12 Municipal Committees (Yaripora, Frisal, Kulgam in district Kulgam, Shopian Municipal Committee Khansahiv, Baramulla, Sopor, Pattan, Hajin in Bandipoura,

Kupwara, Handwara, Langate in Kupwara district). Construction and demolition waste is separately collected and disposed of, while other wastes (garbage, dry leaves) are occasionally burnt (JK-PCB 2019-2020).

Case Study 2: *Municipal solid waste (MSW) generation during Amar Nath Yatra season (July-August 2011)*

A study on municipal solid waste (MSW) generated during Amar Nath Yatra season (July-August 2011) in Pahalgam was conducted at three sites, viz., Aru, Chandanwari, and Nunwan *Yatra* Base Camp to assess the composition and generation of Municipal Solid Waste (MSW) during the *Yatra* season. At these sites, pilgrims spend more time on food consumption before leaving for Holy Cave. These sites have hotels, shops, nomadic tents of Gujjars, pony sheds, and *Yatries Bhandaras* (restaurant), etc. The total net weight of solid wastes generated was highest in July at all the sites (38.55 - 429.98 kg/day), and was lowest in August (12.19 - 21.56 kg/day, Table 2.4. Bhat *et al.* 2012). Among the solid waste generated, food wastes (382.07 kg/day) contributed highest to the total net weight, followed by cardboard (67.93 kg/day), glass (51.82 kg/day), paper (37.18 kg/day), and plastic (25.53 kg/day).

Table 2.4: Estimation (kg/day) of Municipal solid waste (MSW) generation at representative sites of Pahalgam during 2011 Yatra Season

Composition	**Site 1**		**Site 2**		**Site 3**		**Site 1+2+3**		**Total solid Waste**
	July	August	July	August	July	August	July	August	
Food Wastes	15.16	7.11	50.82	10.11	296.1	2.77	362.08	19.99	382.07
Plastic	1.72	0.68	4.33	0.11	18.43	0.26	24.48	1.05	25.53
Paper	1.79	0.99	10.5	0.99	22.79	0.12	35.08	2.1	37.18
Rubber & Leather	0.15	0	0.09	0.21	1.28	0	1.52	0.21	1.73
Glass	2.72	2.72	20.73	3.12	15.75	6.78	39.2	12.62	51.82
Cloth Rags	0.8	0.067	5.84	0.33	8.21	0.25	14.85	0.647	15.497
Cardboard	7.4	2.34	19.64	2.11	35.21	1.23	62.25	5.68	67.93
Metals	1.33	0.13	3.57	0.89	9.11	0.22	14.01	1.24	15.25
Bones	4.97	1.21	0	0	0	0	4.97	1.21	6.18
Wooden Chips	1.6	1.22	14.5	3.15	16.9	0.54	33	4.91	37.91
Inert Materials	0.91	0.91	3.53	0.54	6.2	0.02	10.64	1.47	12.11
Total	38.55	17.38	133.55	21.56	429.98	12.19	602.08	51.13	653.21

Waste disposal / treatment facilities

Solid waste disposal / treatment facilities are very limited in Jammu and Kashmir UT. JK-PCB report 2019-20 indicates only 4 composting sites, 1 vermi-composting and 02 biogas units, and 62 dumping sites in both provinces (Table 2.5). In the Kashmir region, one landfill site has been established at Saidapora Achan (Srinagar) where different types of waste are disposed of by the Srinagar Municipal Committee.

Table 2.5: Municipal waste disposal / treatment facilities in the State

Provinces	**Composting**	**Vermicomposting**	**Biogas**	**Dumping site**
Jammu Division	1 No (Jammu Cantonment Board)	3 No. [MC, Bhaderwah (Since 2010); MC, Doda (Since 2010) & MC, Sunderbani (Since 2010)]	3 No. [MC, Sunderbani plant at base camp (Since 2012); Shri Mata Vaishno Devi Shrine Board (Since 2012); Biogas plant at cattle pond, Dogra Hall (Since 2019)]	29 No.
Kashmir Division	3 No. (Srinagar Municipal Corporation; MC Pahalgam; MC Tangmarg / Gulmarg)	-	-	33 No.
Total	4	3	3	62

2.2.2. Impact on Air quality

During 1990 to March 2021, the number of buses have increased by 4 times, the number of taxis has increased by 10 times and number of Auto rickshaw/Tempos has increased by 15 times in Jammu and Kashmir (Fig. 2.8). In J&K UT, a water transport system is active in limited parts of the Kashmir region and is confined to the boats only (house boats, passenger boats, luggage boats, fishing boats, passenger doongas, shikara taxis and residential boats) which are associated with the tourism sector and allied activities. Taxi shikaras are a big attraction for tourists in Kashmir, hence a tremendous growth was observed in this category with the growing number of tourists (Table 2.6).

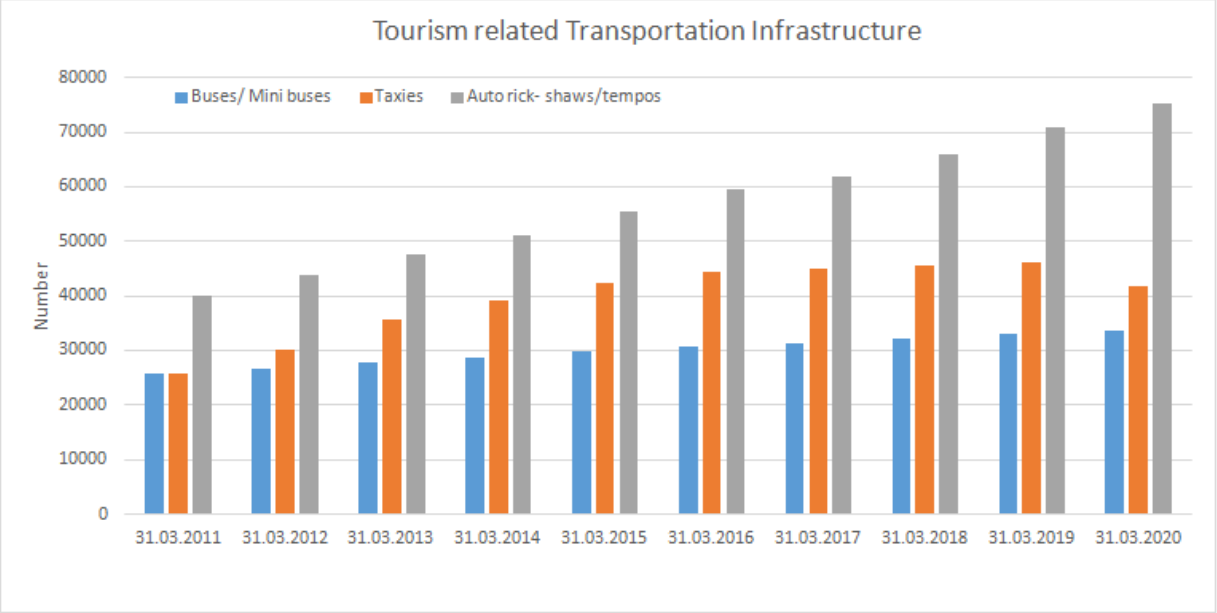


Fig. 2.8: Growth of tourism-related transportation infrastructure in J&K UT (Source: Transport Commissioner, J&K).

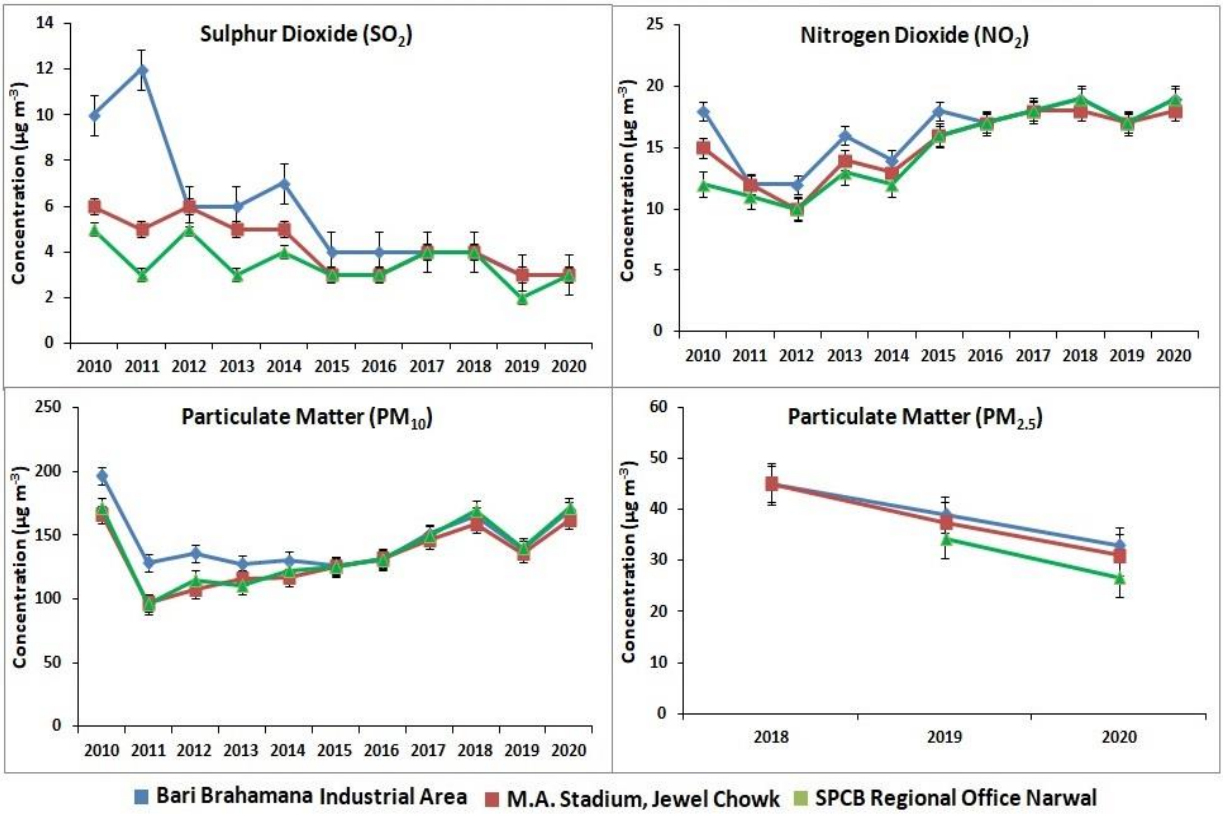


Fig. 2.9: Air quality moitoring (24 hrs) at different stations in district Jammu (***Source:*** *ENVIS Resource Partner on Control of Pollution Water, Air and Noise*, www.cpcbenvis.nic.in).

Table 2.6: Air quality monitoring (24 hr) at Pulwama and Srinagar districts

	Pulwama (24 hr)						Srinagar (24 hr)		
	Particulate Matter (PM_{10})			**Particulate Matter ($PM_{2.5}$)**			**Particulate Matter (PM_{10})**		
Row	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
2018	49.0	170.0	104.0	12.0	63.0	35.0	51.3	395.7	153.0
2019	43.0	269.0	120.0	12.0	49.0	35.0	61.3	485.7	132.3
2020	67.0	228.0	128.0	16.0	64.0	34.0	47.3	319.3	134.3

(***Source:*** *ENVIS Resource Partner on Control of Pollution Water, Air and Noise,www.cpcbenvis.nic.in*).

In Jammu and Kashmir UT, monitoring of air quality parameters (i.e. SO_2, NO_2, PM_{10}, $PM_{2.5}$) is limited to a few stations. SO_2 observation from three stations in the Jammu region indicate that the average SO_2 value varies between 2 and 12 µg/m^3 between 2010 and 2020 with an average value of 4.5 µg/m^3. The average minimum (24 hrs) and maximum (24 hrs) SO_2 values, during 2010-2020, were ~2 µg/m^3 and 10.5 µg/m^3, respectively. The highest SO_2 value of 23 µg/m^3 was recorded in M.A. Stadium, Jewel Chowk station in 2014. SO_2 observations at all the stations in all the years were well within the National Ambient Air Quality Standard (NAAQS i.e. 50 µg/m^3). NO_2 observations at three stations in the Jammu region indicate that the average annual NO_2 value was 4.5 µg/m^3 between 2010 and 2020. The minimum (24 hrs) NO_2 value varies between 2 µg/m^3 and 25 µg/m^3 with an average of 8.9 µg/m^3. On the other hand, the maximum NO_2 value (24 hrs), ranged between 17 to 35 µg/m^3 with an average being 24.8 µg/m^3. NO_2 values at any station or any time period have not ever exceeded the NAAQ standard (i.e. 40 µg/m^3).

Annual average observation of PM_{10} during 2010-2020 ranges from 72 to 258 µg/m^3 with an average of 137 µg/m^3 indicating violation of the NAAQ standard (i.e. 60 µg/m^3). The minimum (24 hrs) values range between 18 to 112 µg/m^3 with an average of 66.8 µg/m^3. The maximum (24 hrs) PM_{10} values vary from 133 µg/m^3 to 858 µg/m^3 with an average of 254 µg/m^3. These values again show maximum PM_{10} values above NAAQS standard in the Jammu region.

Since 2018, $PM_{2.5}$ is being monitored at three sites (M.A. Stadium and Bari Brahamana Industrial Area of Jammu, and Khrew of Pulwama), and in 2020 one more station (Regional Office, Jammu) has been operational for monitoring. Minimum $PM_{2.5}$ (24 hrs) values ranged from 12 to 18 µg/m^3 with an average of 14 µg/m^3 during 2018-2020. Maximum $PM_{2.5}$ (24 hrs) values ranged from 49 to 79 µg/m^3 with an average of 64 µg/m^3 indicating that all the values exceed NAAQ standard. Annual average $PM_{2.5}$ values cover a range of 31 to 45 µg/m^3 and averaging 37 µg/m^3. Average $PM_{2.5}$ values exceeded NAAQS only in the two stations in 2018 of the Jammu region. The remaining values were within the specified standard.

Monthly air quality data at three locations of Jammu region during 2019-2021 suggest that RSPM has exceeded the standard limit for 24-hours average (i.e., 100 µg/m^3) as well as annual average (i.e. 60 µg/m^3) for all the months during 2019-2021 at all the three locations. Only in April-May months of 2020 at SPCB Building Complex and May and September months of 2021 at M.A.M Stadium, the RSPM values were within the standard limit. Also, RSPM values tend to be high during winters (mainly in December) and tend to be low during summers (mainly in May). The 24-hours average and annual average $PM_{2.5}$ values also remained well within the standard limit for all the months during 2019-2021. $PM_{2.5}$ exceeded the permissible limit only once in the month of October, 2021 at SPCB Building Complex, Jammu. The standard limit for SO_2 is 80 µg/m^3 for 24-hours average and 50 µg/m^3 for annual average. Interestingly, observations reveal much lower SO_2 values in all the three monitored locations of Jammu region for all the months during 2019-2021. The annual average of SO_2 values range only between 2.8 µg/m^3 and 3.46 µg/m^3. NO_2 was also found to be within the standard limit for 24-hours average (80 µg/m^3) and annual average (40 µg/m^3). It has never exceeded the prescribed limit during 2019-2021. The annual average of NO_2 ranges between 16.35 µg/m^3 and 20.6 µg/m^3.

In view of important tourist spots of Jammu region (namely, Patnitop, Sanasar, Mansar, Surinsar and Purthu-Basohli), only PM_{10} monitoring is done (Table 2.7). Nevertheless, observed values reveal that PM_{10} exceeded the permissible limit at Surinsar during September-October, 2021 and at Purthu Basohli during October 2021. During 2022, PM_{10} values exceeded at Mansar in January-February and at Surinsar in February.

In the Kashmir division, monthly air quality data is available only for district Baramulla and Ganderbal for the years 2017 and 2018. The data are not continuous and limited to the parameters $PM_{2.5}$ and PM_{10}. In general, the observed values have not exceeded the standard limits prescribed for 24-hours average ($PM_{2.5}$- 60 µg/m^3; PM_{10}- 100 µg/m^3) and annual average ($PM_{2.5}$- 40 µg/m^3; PM_{10}- 60 µg/m^3). Only one incidence in October 2018 was observed when PM_{10} values exceeded the standard limit for 24-hours average and reached 87.32 µg/m^3. Currently, all air quality monitoring stations in Jammu and Kashmir UT are limited in number and situated in the urban cities of Jammu and Kashmir. Thus, it is not possible to deduce a relationship between the tourism and air quality in the region. A larger network of air quality monitoring stations is thus required particularly at the popular tourist destinations across the UT.

Table 2.7: PM_{10} (µg/m^3) monitoring at important tourist locations (Year 2021 and 2022**)**

Month of the year	Patnitop	Sanasar	Mansar	Surinsar	Purthu Basohli
September 2021	46	38	98	117	-
October 2021	-	**-**	-	106	111
December 2021	-	**-**	92	78	43
January 2022	-	**-**	107	94	78
February 2022	-	**-**	117	105	-

(*Source: Jammu & Kashmir Pollution Control Committee , http://jkspcb.nic.in*)

In summary, the long-term annual air quality monitoring for 2010-2020 period in Jammu for SO_2 and NO_2 reveal fairly good air quality. Commencement of $PM_{2.5}$ and PM_{10} monitoring in Jammu, Srinagar and Pulwama since 2018 also confirms good quality of $PM_{2.5}$. The only peculiar feature is that PM_{10} remains consistently high in all the monitoring stations during 2018-2020. Monthly data, though limited and non-continuous, also affirm good quality of air in terms of SO_2, NO_2 and $PM_{2.5}$ but consistently high PM_{10} in Jammu region between 2017 and 2020. Notably, the PM_{10} remains high round the year in Jammu including peak as well as lean tourist months, hence, cannot be attributed directly to tourism activities. Nevertheless, the PM_{10} is frequently observed high in the selected tourist destinations but the scattered nature of monitoring hampers establishing its direct relationship with tourism.

Based on a revised action plan for Control of Air Pollution in 'Non-Attainment Cities' of Jammu and Srinagar, in response to the Hon'ble NGT Order; dated 8th October 2018, various government departments including Transport and Traffic, Municipal Corporations, Consumer Affairs and Public Distribution, State Pollution Control Board, Social and Urban Forestry, etc. have been mandated for taking timely action to control pollution in the two cities (http://jkspcb.nic.in). Different activities to reduce and mitigate air pollution include phasing out 15-year-old commercial vehicles, introduction of cleaner fuel; regular checking of vehicular emissions, regulation and management of traffic, promotion of e-vehicles, construction of peripheral roads, plantation, and greening of roads, etc. are some of the measures. Most of the air qualities monitoring stations are clustered around Jammu and Srinagar city, and these stations are still lacking in other cities, towns, and rural areas of other districts. Thus, more air quality monitoring stations in all districts would present a better picture of the air quality standards in the Jammu & Kashmir UT.

2.2.3. Impact on water quality/groundwater

The Union Territory of Jammu & Kashmir is mainly drained by three rivers, i.e., Jhelum, Chenab and Ravi along with their tributaries. In addition, the region is also home to more than 1200 water bodies including prominent lakes like Dal, Wular, Manasbaal, Nigeen, ANchar, Hokersar, Mansar, Surinsar, Sanasar, Gharana, etc. Further, the region is interspersed with a large number of groundwater springs. Studies on the water quality assessment in the Kashmir region shows that the quality of surface water bodies has reduced significantly during the past few decades. For example, wetlands around Srinagar, i.e., Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar, etc. have witnessed a significant reduction in the surface area and the water quality has deteriorated since 1970's to the present (Dar *et al.* 2020; Kumar *et al.* 2022). On the contrary, freshwater springs in the Kashmir region have excellent water quality index, except few springs near highly urbanized areas which have a poor to very poor quality (Bhat *et al.* 2022). Similarly, water quality assessment at five sites in one of the largest wetlands in Asia, i.e., Wular was also found good in terms of its water quality index (Bhat and Pandit, 2014).

In Jammu region, studies in the River Tawi which flows across the Jammu city, shows that the physico-chemical water quality of the river falls under the permissible limits. Due to increasing anthropogenic pressure, water quality is worsening which was validated during COVID-19 lockdown when the water quality improved significantly due to reduced human activities (Gandotra *et al.* 2008; Kour *et al.* 2021). Another study in River Neeru in Bhadarwah region shows that the water quality was better in tributaries away from the town, but river stretches below the town show a moderate to heavy level of water pollution (Kumar *et al.* 2019). Research shows that although water bodies particularly around the urban areas have witnessed deterioration during the last few decades, yet water springs particularly in rural areas are good in terms of water quality index.

Under the National Water Quality Monitoring Program of MoEF&CC, Pollution Control Board of Jammu and Kashmir conducts regular monitoring of water at 74 locations across the state (http://jkspcb.nic.in/Content/MonitoringatPollutedRiverStretchesinJandK.aspx?id=454). These stations cover different types of water bodies including river stretches, lakes, ponds, groundwater, dug wells, etc. In Jammu region, a total of 27 monitoring stations have been established with the highest number of 7 stations on River Tawi followed by 5 stations in River Chenab, 4 stations in Mansar Surinsar lake complex and 2 stations on River Basantar. Similarly, in Kashmir a total of 47 water quality monitoring stations are currently active. Among these, 13 stations are located at Dal lake, 8 at groundwater sources, 7 in River Jhelum, 5 at Wular lake and 5 each in Rivers Sindh and Lidder.

Physical parameters

River water quality monitoring is available for 14 districts of J&K since 2013. pH observations reveal that it falls within the permissible limit (i.e., 6.5-8.5) for all the districts during all the observed years. The dissolved oxygen (D.O.) is also found within the permissible limit (i.e., 6 mg/l) for most of the districts except for Rajouri (year 2015), Srinagar (2012 and 2013) and Udhampur (2012, 2013 and 2015). The electrical conductivity (E.C.), though within the permissible limit for irrigation and industrial uses (i.e., <2250 µmhos/cm), exceeds in some districts for drinking purposes (i.e., <400 µmhos/cm; as per WHO, 2011) such as in Kathua (2020), Rajouri (2018), Reasi (2018), Samba (2018, 2020) and Srinagar (2013). The EC for Udhampur remained above 400 µmhos/cm for all the observed years (2012-2020). The permissible limit of BOD is 2 mg/l and 3 mg/l for different categories. Biochemical oxygen demand (BOD) values come under "ii" and "iii" categories in most of the districts except for Anantnag, Ganderbal and Kathua (excluding 2020). The BOD remained exceptionally high in Udhampur. The TDS observations were only available for Kathua (2020), Samba (2020) and Udhampur (2020) which exhibit the values ranging between 264 mg/L and 320 mg/L and hence can be considered acceptable. Thus, physical water quality is mainly degraded in Udhampur which is likely because of industrial activities and impact of tourism seem to be minimal (Table 2.8).

Table 2.8: General statistics of the physical parameters for various lakes and rivers of Jammu & Kashmir

Place name	BOD range (mg/L)	TDS Range (mg/L)	COD range (mg/L)
Banganga	6-25	100-500	24–68
Gharana	2-90	12-1320	16-245
Mansar lake	1-12.4	2.5-200	71-173
Dal lake	3.4-32	12-200	75-386
Wular lake	1.3-3.3	15-40	77-205
Nigeen	1-9	5.1-90	84-317
Anchar	2.3-5.8	3.7-49	100-382
Jhelum	3.4-32	19-29	66-199
Liddar river	0.6-3.1	8-217	51-135
Sindh river	0.7-1.5	9.5-20	81-216
Chantkul	0.7-1.5	9.5-20	81-216

Based on the quarterly data, as provided by Jammu & Kashmir Pollution Control Committee for important pilgrims, showed values of dissolved oxygen (DO) ranging between 5 to 9 mg/L. There were no sign of seasonal or temporal decreasing trend of the values destinations at Banganga, and Katra. This is a heavily impacted tourist region due to the Mata Vaishnu Devi shrine. The water quality of selected tourist spots, viz., Dal Lake, Wular Lake, Mansar Lake, Surinsar Lake and Katra region is presented in table 2.8. The assessment for physical parameters suggests that pH is within the permissible limit for all the selected spots. The DO is also within i-category except for Mansar Lake (2011) and Surinsar Lake (2011, 2019 and 2020) which falls within permissible limits. Data on EC is not available for Wular Lake but for other spots, EC exceeds for drinking purposes in Dal (2011) and Surinsar Lake (2018) and remained within the permissible limit for other spots. The TDS observations were not available for these spots. Noticeably, BOD was found to be within the permissible limit for Katra but was exceeded for all other selected spots. In 2019, due to concerns on shrinking of Dal Lake, the J&K government set up a committee to declare its surrounding areas as an Eco-Sensitive Zone (ESZ), and prepare a draft notification. Therefore, the physical water quality in tourist lakes is degraded which can somewhat be attributed to the tourism activities.

Chemical parameters

Chemical characteristics were rarely assessed to determine the quality of river, groundwater and tourist spots in J&K UT. Only Nitrate (i.e. Nitrate- N+ Nitrite-N (mg/l) records are available for rivers of the UT, which indicate that Nitrate values were well Fwithin the permissible limit (i.e., 1.2 mg/l or less) in most of the districts but exceeded the limit in Rajouri (2017, 2018), Reasi (2017, 2018), Srinagar (2013) and Udhampur (2015, 2017, 2018, 2019). For groundwater, Nitrate was within the permissible limit for Anantnag and Ganderbal. In Jammu, Nitrate often exceeded the limit. For other districts, values exceeded slightly. Srinagar shows an exceeding trend in Nitrate. Notably, very high Nitrate values were observed in Kulgam and Udhampur in 2018.

In selected tourist spots, Nitrate values were found to be within the permissible limit. Only in Srinagar, the values were exceeded in 2018. Chemical Oxygen demand (COD) in Banganga ranged between 5 to 32 mg/L except again for the months from April to June during 2011 to 2016 which ranged between 24 to 68 mg/L. Values for Chloride ranged between 16 and 38 mg/L; whereas values for Phosphate were >2 mg/L except for the quarter of January to March 2013 when the values touched 6.7 mg/L in Banganga.

Biological parameters

Biological parameters are not available for rivers. For groundwater, Fecal Coliform observations are available for Jammu (2018, 2019), Kathua (2018), Rajouri (2019), Reasi (2018, 2019), Samba (2018, 2019) and Udhampur (2018, 2020) which show values to be within the permissible limit (i.e., MPN/100 ml 50 or less). Thus, the chemical water quality varies on spatiotemporal scale and continuous data are needed to assess the impact of tourism.

Among the 350 polluted stretches of rivers across the country, five are present in Jammu and four are present in Kashmir region. The polluted river stretches in Jammu includes Banganga, holy spring, Katra, River Bansntar in Samba, River Deval in Udhampur and River Chenab at Akhnoor, all of which are monitored for the water quality parameters on a monthly basis by SPCB J&K. Similarly, all polluted river stretches in Kashmir region, i.e., Chantkol, Chatabal weir, Gowkadal and Dodherhama are also monitored for the water quality parameter every month. However, all these water quality monitoring stations are clustered around the urban regions of Jammu and Srinagar. There are very few water quality monitoring stations present in districts like Doda, Kishtwar, Ramban, Poonch, Shopian, Budgam, Kupwara, etc. Thus, the establishment of more water quality monitoring stations will help in better understanding the water quality in the UT and in assessing the impact of tourism on the biological water quality.

The Dal Lake in Srinagar City is one of the most important tourist attractions in the Kashmir region. The Dal Lake with nearly 50,000 inhabitants in the houseboats in addition to a large population of locals and tourists in the surroundings has witnessed extreme loss of water quality during last four decades (Kumar *et al.* 2022). The lake has been infested with 12 dominant macrophytes with an average values of biological oxygen demand (27.5 ± 1.49 mg/l), chemical oxygen demand (61.75 ± 0.85 mg/l), nitrate nitrogen (636.5 ± 1.04 µg/l), ammoniacal nitrogen (137 ± 1.31µg/l) and orthophosphate (44.6 ± 0.18 µg/l) (Parray et. al., 2021).

2.2.4. Impact on Forest and Biodiversity

In terms of the protected area network, a total of 4161 km^2 is currently covered under 4 National Parks and 14 Wildlife Sanctuaries. In addition, 37 conservation reserves and 4 Ramsar sites have also been designated in different regions for conservation of the local flora and fauna. Currently, limited information is available on the impacts of the tourism activities on the wildlife and biodiversity of the region. For example, a study on the economic valuation of biodiversity values in Dachigam National Park in Kashmir reported that consumer surplus per visitor per visit was Rs. 12,470 which translates into an annual monetary recreational value of

about Rs. 247,614,828; but do not consider the negative impacts of tourism on the biodiversity in the Park (Bhat & Bhatt, 2019). Another study shows that increasing demographic pressure with the growing energy demands for domestic and tourism sectors have resulted in heavy pressure on the available forest stock thus posing a serious threat to the ecological sustainability of the catchment (Malik *et al.* 2011). A recent article in newspaper *Daily Excelsior* highlights that a large number of tourists are attracted towards the wilderness areas like National Parks and Sanctuaries in Jammu & Kashmir. However, many of them consider it as a picnic which needs to be strictly controlled to preserve our biodiversity heritage (https://www.dailyexcelsior.com/tourism-and-environment-2/). Another article by *The WIRE* highlights that commercial tourist enterprises in the state have over-ridden the ecological concerns needing formulation of stringent regulations and their enforcement for environmental sustainability (https://thewire.in/environment/jammu-and-kashmir-environment-conservation-tourism). Thus, environmental impact assessment studies for popular tourist circuits and destinations in Jammu and Kashmir UT is required for implementing the appropriate regulatory measures to develop a mechanism for sustainable tourism with long-lasting economic gains.

2.3. Eco-sensitive zones/Areas

Seven eco-sensitive zones have been notified in the J&K UT around the boundaries of National Parks (Kazinag National Park, Kishtwar High Altitude National Park) and Wildlife Sanctuaries (Limber Wildlife Sanctuary, Lachipora Wildlife Sanctuary, Hirpora Wildlife Sanctuary, Jasrota Wildlife Sanctuary, Rajparian Wildlife Sanctuary, Ramnagar Wildlife Sanctuary, and Surinsar-Mansar Wildlife Sanctuary). Limits of eco-sensitive zones may extend from the boundary of a National Park/Sanctuary to a distance of 10km. Recently, the Ministry of Environment, Forest and Climate Change, Govt of India has declared 62.2 km^2 around Gulmarg Wildlife Sanctuary as eco-sensitive zone.

The Jammu & Kashmir government has accorded sanction to the constitution of the district level committees for the preparation of the zonal Master Plans for notified five eco-sensitive zones (wildlife sanctuaries, national parks) in the Union Territory. These include Jasrota Wildlife Sanctuary in Kathua; Rajparian Wildlife Sanctuary in Anantnag, Hirpora Wildlife Sanctuary in Shopian; and Ramnagar Wildlife Sanctuary in Jammu and Kishtwar High Altitude National Park. The committees will prepare zonal master plans in the manner as specified in the notifications and the guidelines issued by the central government.

2.4. Gaps and Plan of Action

Sr. No.	Gaps	Plan for Action
1.	Currently, limited information is available on the impacts of tourism activities on the natural resources and environment of the region.	Along with the monitoring of tourist carrying capacity in terms of tourist inflow of vehicles, air quality and solid waste management studies largely need to be done in the Kashmir region or pilgrims visiting Shri Amarnath Ji holy cave and Mata Vaishnav Devi in Jammu in view of ensuring quality tourism in the state.
2.	Concerns have often been raised at various forums on deteriorating health of water bodies and environment of the region, e.g., Dal Lake, water and air pollution in Jammu and Srinagar regions but limited efforts have been made to address such challenges.	Conservation and effective management of these lakes through third party need to monitor in view of proper management in future.
3.	Specific impacts of the tourism activities on the local environment in terms of impacting air quality is currently not so clear.	Regular air quality monitoring at tourist spots of Jammu region (namely, Patnitop, Sanasar, Mansar, Surinsar, Purthu-Basohliand pilgrims' sites, etc.) and in Kashmir Valley is required.

2.5. Summary

Due to improving and affordable connectivity, particularly air travel, the tourism sector is booming in India resulting in growth of related infrastructure. Landscape of J&K UT caters different types of tourism needs (viz., nature and religion) of the domestic population and other nationalities. In the Kashmir valley, scenic and famous water bodies are the main attractions, while religious tourism dominates in Jammu division. Pilgrims of the famous shrines, Holy Amarnath Cave, use space and resources of both the Jammu and Kashmir regions. Srinagar is a famous tourist destination to anchor for J&K tourism and Dal Lake is the main attraction along with historical places in the city.

In addition to various economic activities like horticulture, agriculture, forestry, industry, etc., tourism and allied sectors provide major employment and revenue in the Jammu and Kashmir UT. In general, tourism is scattered in Jammu and Kashmir with a major inflow of tourists in destinations like Mata Vaishno Devi, Holy Amarnath cave, Gulmarg, Phalgam, Baltal, etc. Most of the tourists also visit urban areas of the UT like cities of Jammu, Srinagar making it difficult to quantify the impact of tourism on the environment. Currently, limited information is available

on the impacts of tourism activities on the natural resources and environment of the region. Concerns have often been raised at various forums on the deteriorating health of water bodies and environment of the region, e.g., Dal Lake, water and air pollution in Jammu and Srinagar regions but limited efforts have been made to address such challenges. However, specific impacts of the tourism activities on the local environment in terms of impacting quality of air, water and biodiversity are currently unclear. For example, researchers have largely attributed the eutrophication process for deteriorating the health of Dal Lake which is also a popular destination for tourists in Kashmir.

Under the current scenarios of ever-increasing tourist inflow in the mountain regions, assessment of tourism carrying capacity shall be central part of the tourism management planning. A clearly visible impact of tourism in any natural landscape is dumping of solid waste in the form of leftovers like plastic, food and other wastes. Cleanliness is often seen as a behavioural attitude which is often lacking among the majority of tourists especially in the absence of waste disposal and collection mechanisms. Thus, all the tourist destinations in the UT shall have a well-established waste disposal, segregation and collection mechanism with sufficient hoarding and signages to promote use of such facilities. Further, local tourist guides and porters are particularly needed to be sensitised towards the impacts of solid waste and skills for management of the solid waste.

Water bodies particularly in the Kashmir region are major attractions for tourists, thus are vulnerable to the impact of tourism in terms of solid waste generation, water and air quality deterioration and impact on the local flora and fauna. Many lakes in the Kashmir region like Dal, Wular, Manasbaal, Nigeen, Anchar, Hokersar, Mansar, Surinsar, Sanasar, Gharana, etc. are scenic attractions for the tourists. Most of the tourist destinations in the UT are situated in different watersheds which are often interspersed with a large number of groundwater springs. Thus, for the sustainable tourism management, it is very important to ensure the conservation and effective management of all natural water sources including rivers, streams, lakes, springs etc. in the region. Regular monitoring and studies on water quality assessment can provide useful insights for understanding the impact of tourism and management of natural water sources for their future sustenance.

In addition, deterioration of air quality is also a major impact of tourism due to heavy inflow of vehicles. Most of the tourist destinations in the UT had witnessed manifolds increase in the number of vehicles during the past few decades. However, air quality monitoring stations are currently not available, thus such monitoring stations need to be established at important tourist destinations to understand the impact of tourism on air quality in the mountains. Similarly, research and survey efforts shall be made for understanding the differences between the biological diversity of the popular tourist destinations and pristine natural ecosystems to quantify the impact of tourism on the biodiversity.

3.1. Introduction

Himachal Pradesh spreads over an area of 55,673 sq. km. with a population of more than 60 Lakh people. It extends from 75°47'55" East to 79°04'20" East Longitudes and 32°22'40" North to 33°12'40" North latitudes. Here, tourism has grown fast with a considerable rise in the number of tourists visiting in the state. Tourism industry occupies an important place in the economy of Himachal Pradesh. The state has a diverse natural resources, including 30 wildlife sanctuaries, 5 natural parks, and 3 game reserves. The state has the world's highest cricket ground at Chail and also the World's most beautiful cycling trek. The MTB HIMALAYA & Himalayan Adventure Sports & Tourism Promotion Association has given a new face to the biking in India and has further added to the tourist attractions of the state. Availability of natural resources has made the state an attractive destination for investments in tourism, agricultural, hydroelectric power and cement. The average Gross State Domestic Product (GSDP) growth rate between 2004-05 and 2009-10 was about 11.4%. Himachal Pradesh is a leading producer of apples, producing 2.8 lakh metric tons of apple in 2009-10 (IBEF Report on Himachal Pradesh, November 2011).

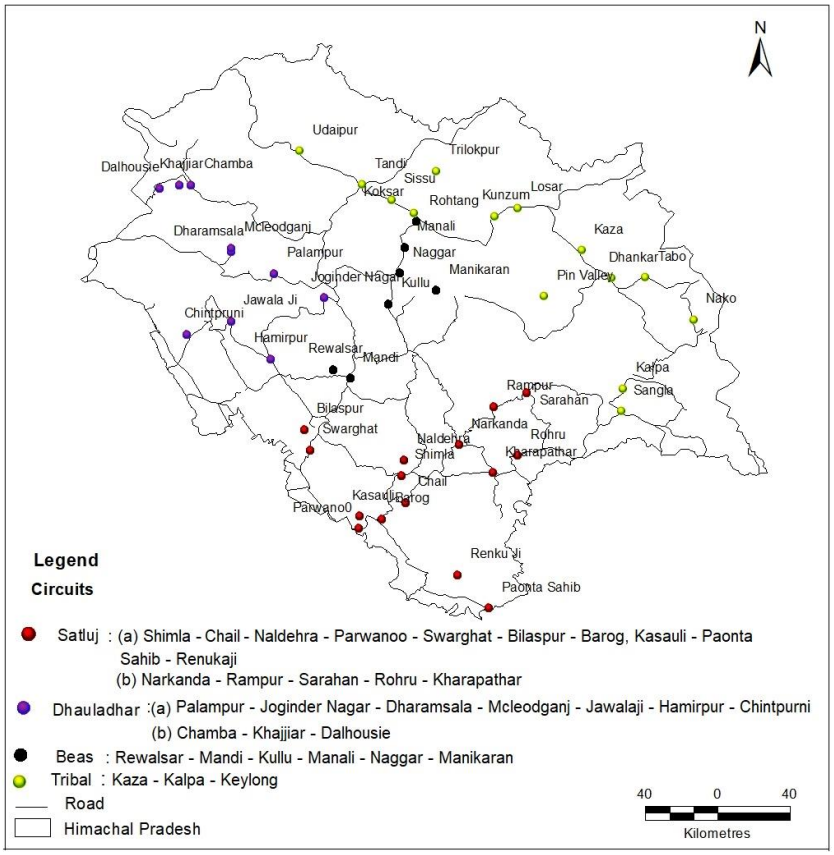
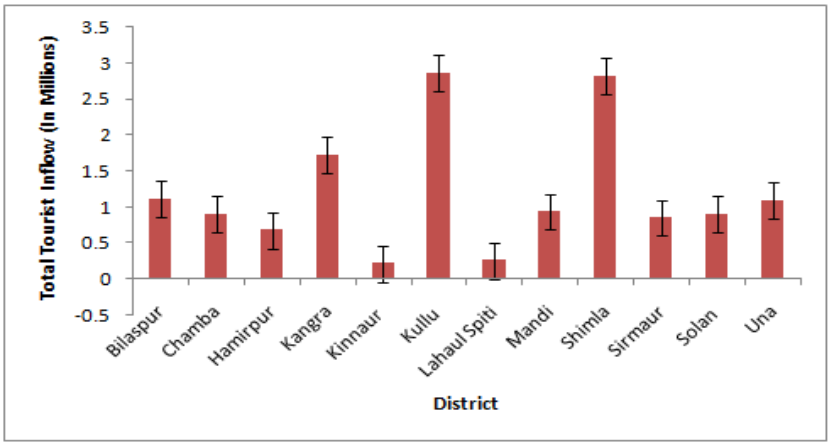


Fig.3.1: Major tourist spots and circuits in Himachal Pradesh

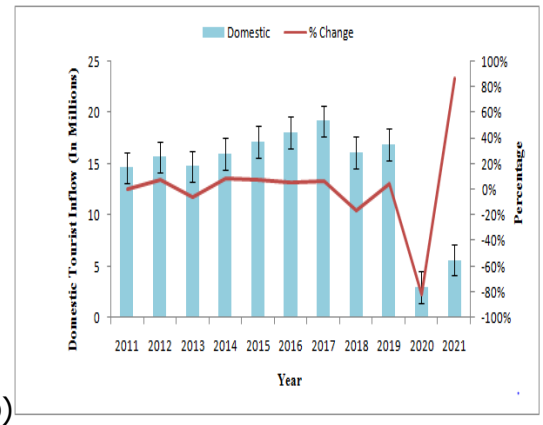
3.1.1. Tourism growth (number of annual tourist visiting) vis-a-vis economic growth (annual income from tourism)

There has been significant increase in the number of tourists in Himachal Pradesh from past few years. The total inflow of tourists has increased significantly from 149,90,444 in 2011 to 172,12,107 in 2019 which decreased to 30,56,879 in the year 2020 due to lockdown during COVID-19 (Fig.3.2 a). There was an average increase of 14.29% in total inflow of tourists from 2019 when compared to 2011, while an average decrease of -81% inflow of tourists in the year 2020 when compared to 2019. The maximum tourist inflow was recorded in Kullu and Shimla districts. The rate of change in domestic tourists showed a continuous increase from 2014 to 2017 as 5% to 8% respectively, while a decrease of -82% in 2020 was noticed due to COVID-19 as compared to 2019. Further, after the pandemic there was an increase of 87% in domestic tourists in 2021, the rate of change in foreign tourist showed an increase from 2015 to 2017. While there was a decrease of -89% in 2020 which continued to -89% in 2021 as international travel was banned till 2021. Fig. 3.2 (b) shows rate of change in domestic tourists and Fig. 3.2(c) shows the rate of change in foreign tourists in Himachal Pradesh from 2011 to 2021.

(a)



(b)



(c)

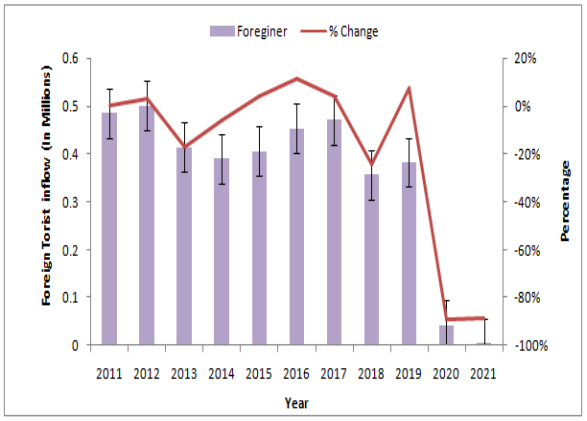


Fig.3.2: (a) District wise tourist inflow in Himachal Pradesh (2011-2021), (b) Rate of change in domestic tourists in H.P. from 2011 to 2021, and (c) Rate of change in Foreign tourists in H.P. from 2011 to 2021 (*Source: Himachal Tourism Website, https://himachaltourisum.gov.in/counter/,* 2022)

3.1.2. Tourism and Economic Growth

Himachal Pradesh is a major tourist destination and tourism is contributing greatly to the growth, development and economy of the State. The tourism sector acts as an engine for economic growth and a major source of revenue and employment in the state. This is the reason that Government of Himachal Pradesh has developed infrastructure i.e. roads, airports, helipads, communication network, public utility services, transportation facilities, water and sanitation facilities and other amenities for growth and development of tourism sector. The contribution of the tourism sector to the State Gross Domestic Product (GDP) is about 7% which is quite significant (Himachal Pradesh Economic Survey 2020-2021). The tourism sector has provided about 14.42% jobs in Himachal Pradesh. Currently, there are 3350 hotels, 1656 home stays 1314 guides, 2912 Travel agency, 222 adventurers and 898 photographers registered with Himachal Pradesh State Tourism Department which indicates the importance of tourism in economic growth of state (https://himachaltourism.gov.in/counter). A taxi business for tourists is another source of income. Activities like horse riding, yak photography, rabbit photography is also proving income to the people in and around of the state. Table 3.1 shows district wise number of hotels, home stays, guides, travel agency, adventurers and photographers in Himachal Pradesh which was maximum in Kullu district. The State is endowed with all the basic resources necessary for thriving tourism activity like geographical and cultural diversity, clean and peaceful environment and beautiful streams, sacred shrines, historic monuments and the friendly and hospitable people. Tourism plays an important role in economy of the state. The importance of tourism is evident from the fact that tourism and hospitality sector in Himachal Pradesh has recorded a loss of 46% in turnover during Covid pandemic. (Growth rate of GSDP at constant price varied from 6.4% (2011-2012) to 6.5% (2018-2019) and was 4.9% in 2019-20 (Fig. 3.3a&b). Fig. 3.3 (c&d) shows the year wise tourist influx from 2011-2020 and growth rate in the state GSDP with current and constant price (Himachal Pradesh Economic survey; Department of Economics & Statistics HP, 2020-21). Thus, tourism plays an important role in economic growth of the state. Some major impact of tourism in economy is foreign exchange earnings/balance of payments, income generation, employment generation, entrepreneurial activities, etc.

Table 3.1: District wise registered hotels, home stays, guides, travel Agency, adventurers and photographer registered with Himachal Pradesh Tourism Department

District	Hotel	Homestay	Guides	Travel Agency	Adventure	Photographer
Kinnaur	73	66	12	19	0	0
Lahaul & Spiti	88	258	1	15	0	0
Kullu	**953**	**327**	**386**	**1374**	73	**783**
Chamba	225	106	106	51	5	17
Kangra	672	267	128	231	97	3
Shimla	493	335	451	978	6	91
Mandi	198	100	75	115	38	4

Bilaspur	84	14	29	28	2	1
Hamirpur	60	7	2	6	0	0
Sirmaur	111	42	55	7	0	0
Solan	286	125	69	81	0	0
Una	106	9	0	7	0	0

(*Source: H.P Tourism department website https://himachaltourism.gov.in/counter/*, 2022)

Fig.3.3: (a) Growth rate in GSDP with current prices in H.P., (b) Growth rate in GSDP in constant price in H.P., (c) Tourist influx and growth rate with current price, and (d) Tourist influx and growth rate in GSDP at constant price from 2011-2020 in H.P. (Source: Himachal Pradesh Economic Survey, Department of Economics & Statistics HP, 2020-21)

3.2. Ill effect of tourism particularly on environmental components (waste generation, air and water quality deterioration, loss of greenery and biodiversity) land/soil and ground water

Increased tourism is slowly degrading the environment of Himachal Pradesh from past few years. Tourist destinations like Shimla and Kullu-Manali are in danger due to huge quantities of garbage, which are left behind by tourists. Cole and Sinclair (2002) measured ecological footprint of tourism in Manali and found that unplanned nature of development with rapid speed has led to many environmental concerns. Problems of water scarcity, quality degradation and open sewage disposal in the River Beas are the most striking effects of tourism. Tourism,

besides being a boon to the economy of Himachal Pradesh, it causes the adverse impacts on ecology and environment of the State. The Hon'ble NGT order states, "The State Government has neither formulated, nor issued any specific guidelines – statutory or otherwise – on prevention and control of environmental degradation and damage in relation to the glacier of Rohtang Pass valley". It needs to be mentioned that Himachal Pradesh is considered to be one of the leading mountain states and yet it is not able to halt environmental damage due to increasing tourism and despite its updated policies and development master plans (NITI Aayog, 2018).

3.2.1. Ill effect of tourism on waste generation

The waste generated from hill spots and trekking/expedition is a challenging task on the way of Solid Waste Management in the state. The average waste generation was 200 gm – 300 gm/person/day in hill spots and 200 gm – 288 gm during trekking/expeditions during 2003 (Kuniyal *et al.* 2003a). This waste comprised 65.2% - 83.1% of bio-degradable waste of the total waste which mainly contained vegetable waste, fruits, and other food material. In case of non- biodegradable waste, its components were largely glassware, polythene, plastic bottles, and wrappers. Among non-biodegradable waste, it was recommended that 60.68% of waste was able to be recycled if collected and transported properly. In the Kullu and Manali region, the bio-degradable waste generated from the tourists was found to be 47.6% - 65.5% of the total waste generated respectively (Kuniyal *et al.* 2003b). Himachal Pradesh generates the maximum amount of garbage in May and June when floating population visit from plain to the mountain. However, the garbage generation in the state's hill station has gone down to an unusual amount during the lockdown season.

3.2.2. Ill effect of tourism on water quality

Indiscriminate throwing of municipal solid waste into rivers is the common practice in the tourist spots, as a result river water is continuously being polluted (Kuniyal *et al.* 2003b). The adverse impacts of urbanization and tourism include an increased demand for clean drinking water, although tourists' demand is more than urbanization, which surpasses the capacities of the supply system and leads to water shortages, and increased downstream water pollution. A major source of water pollution is garbage generated in tourist destinations. A study at Manali suggests that garbage dump is a major source of water pollution in that area. Low Dissolved Oxygen (DO) values due to increased water pollution were recorded in month of June when tourist season remains on peak (Kirch, 2002). Further, recent reports suggest that urbanization and population growth have been tremendous, which are impacting the land use/cover changes and also endangering the water resources both in quality and quantity in the Himalayan regions (Sharma *et al.* 2021; Thakur *et al.* 2018).

3.2.3. Ill effect of tourism on air quality

Previously, air pollution studies over a four-year (1996-99) period shows that suspended particulate matter (SPM) during summers had gone up to 112 µg/m³ at Manali. Trace gas concentrations, such as SO_2 and NO_2 during 1996-97 were between 12-29 µg/m³ and 16-28

µg/m³ at Kullu, and 12-40 µg/m³ and 12-34 µg/m³ at Manali respectively. SO_2 and NO_2 concentrations were in excess under specified 24-hour standard duration for sensitive areas (15-30 µg/m³) during summer season in Manali (Kuniyal *et al.* 2003b). Similar results were reported by NEERI after 12 years in its study carried out in 2011-2012 both in summers and winters at different stations on the way to Rohtang, Marhi, Solang and Kothi, where there were found an increase in concentration of carcinogenic elements. As (chemical element arsenic) and Ni (Nickel) were recorded exceeding the CPCB limits except Pb (lead) which was found within stipulated standards. Besides, these several other factors, such as, inadequate and poorly maintained roads as well as inadequate practices of inspection and maintenance of vehicles, unplanned traffic flow, and non-availability of effective emission control technology, etc., also contributes to air pollution from vehicular sources. Air quality over the period of time has largely affected the tourist destinations like Kullu-Manali, Shimla, Dharamshala, etc.

3.2.4. Ill effect on loss of greenery/biodiversity

Conversion of land to tourism uses results in loss of biodiversity; otherwise it supports and may also affect biodiversity in surrounding areas (World Tourism Organization). Demand for tourism has exaggerated the pressure on hill stations and is becoming a major concern for change in land use and land cover. According to a study conducted by Vijay *et al.* (2015) in Manali, built-up area has increased from 4.7% to 15.7% during 1989 to 2012 indicating fast growing development in the area. At the same time, exponential increase in the number of tourists from 1.4 to 28 lakhs during 1980 to 2011, respectively confirms excessive pressure on tourism in the region. Even, numbers of hotels have also increased over the years indicating a loss of greenery and biodiversity in the region. Therefore, there is a need to minimise the disastrous effects of unregulated tourism and learn lessons from the over-exploited tourist destinations of the state. So devising mechanism to help achieve tourism growth in the landscape in a sustainable manner is a need of the hour. These steps would have minimal impacts on biodiversity, while providing sustainable livelihood options for the local community would also go hand in hand together.

3.2.5. Ill effect on land/soil contamination and groundwater

Tourists using the same trail over and over again, trample the vegetation and soil, eventually causing damage that can lead to loss of biodiversity and other impacts. Such damage can be even more extensive when visitors frequently stray off established trails (Sunlu, 2003). Waste generated in excess can lead to leaking of contaminants which may percolate into the groundwater, where they can potentially migrate into streams (Kirch, 2002).

3.3. Assessment of waste generation

Himachal Pradesh has 12 districts, each of which is sub-categorised into tehsils and blocks. Different villages and urban areas are controlled by urban local bodies and village Panchayats in these blocks. Nagar Panchayats, Municipal Councils, and Municipal Corporations are the three types of urban local bodies based on population. In Himachal Pradesh, there are four municipal corporations (Shimla, Solan, Palampur, and Dharamshala), as well as, 56 municipal councils and

Nagar Panchayats. These urban local bodies are authorized to deal with problems related to solid waste. According to a guidebook on Solid Waste Management for ULB's, "State Strategy on Solid Waste Management-Himachal Pradesh" released by Department of Urban Development Himachal Pradesh in 2019. It was estimated that total waste generated per day by the ULBs was 370 TDP (approx.) which consisted of 190 TDP of biodegradable/wet waste and 150 TDP of non-biodegradable/dry waste. The highest waste generation recorded in the area under municipal cooperation in Shimla. In addition, solid waste generated due to local communities, ever increasing tourism in the form of recreation, trekking and religious place visits have also contributed to the higher production of solid waste in the state. In Table 3.2, a summary of waste generation for various ULBs located in popular tourist destinations in Himachal Pradesh is shown. Shimla has the highest municipal waste generation pattern for the years 2017–2021. The municipal solid waste largely consists of domestic waste collected from houses. This waste is composed of biodegradable waste or wet waste consisting of Kitchen waste and paper. Small proportion of this is made up of non-biodegradable waste or dry waste. So far very few scientific studies have been conducted in Himachal Pradesh on the composition of Solid waste in one such study conducted by NEERI on solid waste characteristics, it was found that 52% of solid waste generated was biodegradable, 24% consisted of paper, 10% plastic, 4% textile, 1% glass,1% rubber,1% metal and 7% inert material composed the waste (State Strategy on Solid Waste Management-Himachal Pradesh 2019). Sharma *et al.* 2018 conducted a similar study on waste composition for Solan, Mandi, Sundernagar, and Baddi, and obtained the same results as NEERI's previous study. The majority of municipal solid waste is made up of easily biodegradable kitchen garbage which can be easily converted into manure through compositing, which readily reduces the chances of diseases and environmental hazards caused by biodegradable waste. Non-biodegradable waste can be recycled and reused, decreasing the amount of waste going to landfill.

Table 3.2 Municipal waste generated (in tonnes per day TDP) in important tourist destinations

Sr. No.	District	Important tourist destinations ULB's	Total Waste produced (TPD)	Total Waste produced in 2020-2021	Total Waste produced in 2019-2020	Total Waste produced in 2018-2019	Total Waste produced in 2017-2018
1.	Shimla	Shimla	90	82	82	85	85
2.	Sirmaur	Paonta	9	8.65	8.65	8.65	8.65
3.	Bilaspur	Naina Devi	1	0.5	1	1	1
4.	Kullu	Kullu	10	6-7	7-8	8-9	8-9
		Manali	12	10	35	35	35
		Banjar	0.50	0.5	0.5	0.6	0.52
5.	Mandi	Rewalsar	0.60	1	1	1	1
		Karsog	1	1	-	-	-
		Mandi	23	16.50	16.50	24	30
6.	Kangra	Kangra	6	4.5	4.5	4.5	4.5

		Baijnath	7.80	4	3	3.45	3.45
		Dharamshala	18	15	20	25	25
		Jawalamukhi	2.10	0.33	0.33	3	3
		Palampur	1.50	6	1.4	1.5	1.5
7.	**Chamba**	Chamba	8.50	6	5	5	8
		Dalhousie	2.50	3.6	25-30	25.30	25.30

(***Source:*** *Action Plan for Municipal Solid Waste Management Himachal Pradesh, February, 2017, Government of Himachal Pradesh Directorate of Urban Development and Annual Report under SWM rules 2016 for the year 2020-2021,2019-2020,2018-2019,2017-2018*)

3.4. Segregation /utilization of waste

According to different reports for 2020-2021, 2019-2020 and 2018-2019 on the Action Plan for Municipal Solid Waste Management Himachal Pradesh, the data have been provided for the total waste generation, its collection, and treatment and dumping. The percentage of households segregating waste at source is given in these reports but no separate data were provided for the amount of waste segregated. For the year 2020-2021 80% premises were found segregated waste at source in Municipal Corporation Shimla. The majority of Himachal Pradesh's urban-rural bodies are dustbin-free, collecting garbage from homes and commercial areas on an individual basis. These ULBs encouraged people for source segregation and some of them are even successful in their efforts. Apart from segregation, garbage storage is a serious concern, as some homes throw trash in streets, seasonal streams (*nallahs*), and open areas, resulting in poor solid waste management.

Resource utilization of garbage can be determined based on the type of waste collected. As indicated earlier, properly segregated waste can be managed in a scientific manner. According to the action plan 2020-2021, majority of biodegradable or wet waste is transported to composting pits in the concerned ULB. Apart from that, ULBs such as Municipal Corporation Shimla utilizes biodegradable waste for biomethanation, with the end result being biogas. The other type of waste, which has a high calorific value, is processed into Refuse Derived Fuel (RDF), which is then transferred to nearby cement or other factories for use. In Himachal Pradesh, there are just two waste-to-energy plants, one each in Shimla and Manali. The remaining garbage is either recycled or dumped at a dumping site.

3.5. Waste Disposal/treatment facilities

In Himachal Pradesh, the same garbage disposal pattern as in the rest of India is followed, specifically, depositing it in landfill sites. However, in recent years, the lack of a dumping site owing to the closure of an existing dumping site has caused a dilemma for ULBs in terms of storing and managing the trash. Because the state's hilly terrain prevents the establishment of

big landfill sites, unlike plain regions, the majority of the trash collected is decomposed into compost and processed into RDF, which is then supplied to cement plants as a fuel for burning. Only Manali and Shimla ULBs have waste-to-energy power plants. However, this facility at Manali is not completely operational due to unforeseen circumstances (table 3.3).There have not been much information about the dumping site except for the space for waste processing is mentioned in the Annual Report under SWM standards 2016 for the different years 2020-2021. Sharma *et al.* (2018) conducted a study for the four dumping sites in Himachal Pradesh. The data on municipal solid waste management have been provided for the different ULB's from the year 2017 onwards after the municipal solid waste management rules of 2016 came into effect.

As per the Hon'ble Tribunal vide latest order dated 20.11.2017, 09.10.2018, 10.10.2019 and 08.06.2021, a status report was filed on 25.10.2021 by the Additional Chief Secretary. The Hon'ble Tribunal vide latest order dated 08.06.2021 has directed as under:
"We have considered the report. It is seen that the ropeway project has not been completed for want of requisite EC. Steps are in progress for setting up of STP at Marhi and upgradation of STP at Manali, for parking facilities, Solid Waste Management facility, Nature Park, and Electric Buses. The said steps need to be expedited. We find it difficult to understand the delay in grant of electric connection to the STP at Marhi. With regard to the upgradation of STP at Manali, though it is stated that the work was likely to be completed by June, 2021, the latest status is not known. Steps for the Solid Waste Management facility at Manali and other pending jobs need to be expedited."

The department wise steps taken / compliance status with respect to implementation of the orders of the Hon'ble National Green Tribunal was submitted. Under the development of solid waste management facility at Manali following steps have been taken:
The Deputy Commissioner, Kullu has informed that as per the report of the Executive Officer, Municipal Council Manali, the Waste to Energy Project for the Management of the Solid Waste is being established at the existing site at Rangri, Manali. First section of the Solid Waste Management facility for the production of the Refuse Derived Fuel (RDF) is operational. RDF is being sent to ACC Barmana Cement Plant. The Municipal Council, Manali has signed Memorandum of Understanding (MoU) with M/s Nextgen Chemicals Pvt. Ltd. on 05.08.2917 to setup Waste to Energy Plant (second section) of the capacity to treat 35 Tonnes of Waste / garbage per day to generate 1MW electricity. Efforts are being made to set up the second section.

Table 3.3: Details of waste processing for waste disposal/treatment facilities for important tourist destinations (2017-2021)

Sr. No.	District	Important tourist destinations	Dumping site availability	Area Available for waste processing	Waste Processed (TDP)	Waste processed for Compost	Compost produced	RDF	Landfilled waste
2020-2021									
1.	Shimla	Shimla	Land available 9.923 ha	2.45 ha	60-80	0.5 tpd	50 kg	35	5-8
2.	Kullu	Manali	No sanitary landfill sites available	1.5 bigha	7	-	-	-	-
3.	Kangra	Dharamshala	No sanitary landfill sites available	2.96 ha	4	30 tonne	20 tonne	-	-
4.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891 ha	3.6	100 kg	50 kg	-	-
2019-2020									
5.	Shimla	Shimla	Land available 9.923 ha	2.45 ha	60-80	0.5 tpd	50 kg	25	5-8
6.	Kullu	Manali	No sanitary landfill sites available	1.5 bigha	35	-	-	-	-
7.	Kangra	Dharamshala	No sanitary landfill sites available	2.96 ha	4	600 kg	200 kg	-	16
8.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891 ha	-	-	-	-	25-30 quintal
2018-2019									
9.	Shimla	Shimla	A new waste to energy plant having 100 tonnes / day	2.45 ha	60-80	0.5 tpd	50 kg	40	5-8

			capacity is set up on Tara Devi bypass road. RDF section has been made functional						
10.	Kullu	Manali	No waste processing facility is setup	1.5 bigha	35	-	-	-	35 (tourist season) 12 (off season)
11.	Kangra	Dharam shala	No sanitary landfill sites available	1.5 ha	-	4 MT	-	-	20
12.	Chamb a	Dalhou sie	No sanitary landfill sites available	0.089 1	-	-	-	-	25-30 quintal
2017-2018									
13.	Shimla	Shimla	A new waste to energy plant having 100 tdp capacity is set up on Tara Devi bypass road. RDF section has been made functional	2.45 ha	60-80	0.5 tpd	50 kg	40	5-8
14.	Kullu	Manali	No waste processing facility is setup	0.75	22	-	-	-	17
15.	Kangra	Dharam shala	No sanitary landfill sites available	1.5 ha		2	-	-	-
16.	Chamb a	Dalhou sie	No sanitary landfill sites available	0.089 1 ha	-	-	-	-	25-30 quintal

3.6. Correlation of tourist inflow with waste generation

In view of exploring the relationship between the number of visitors visiting the state and the waste produced, year wise data on the number of tourists visiting the state was compared with the amount of waste produced (TPD) in the districts. The data were compiled for 3 districts having the main tourist sites in Himachal Pradesh, namely, Shimla, Kullu and Kangra. Since there was no consistent yearly data available on tourists, while yearly data on waste output was available. Therefore, normalization of data was done by considering the data for waste generation on yearly basis, i.e., data for waste generated in the years 2017-2018 considered as data for the year 2017, hence making both the variables comparable. According to data analysis, the highest waste production occurred during the years when the most tourists visited in Kullu and Shimla districts. The amount of waste produced was 46.62, 45.19, and 94.6 TPD for Kullu, Kangra, and Shimla districts, respectively, in 2017. This was the year when the number of tourists visiting these districts reached its peak. The numbers of visitors for the year 2017 visiting these districts were 3,865,101 in Kullu, 2,823,289 in Kangra, and 3,480,997 in Shimla (Fig. 3.4 & 3.5). Waste production was the lowest in 2020 in Kullu (19.18 TPD) and Shimla (78.21 TPD) districts when the number of tourists visited was the lowest from 2017-2020. However, the trend for Kangra district was different. Here, in spite of the high tourist inflow, the waste generation was the lowest (40.47 TPD) in 2019 (Fig 3.6). Overall, there is a positive correlation between the number of tourists and the amount of waste produced, suggesting that as the number of tourists rises, so does the amount of waste generated.

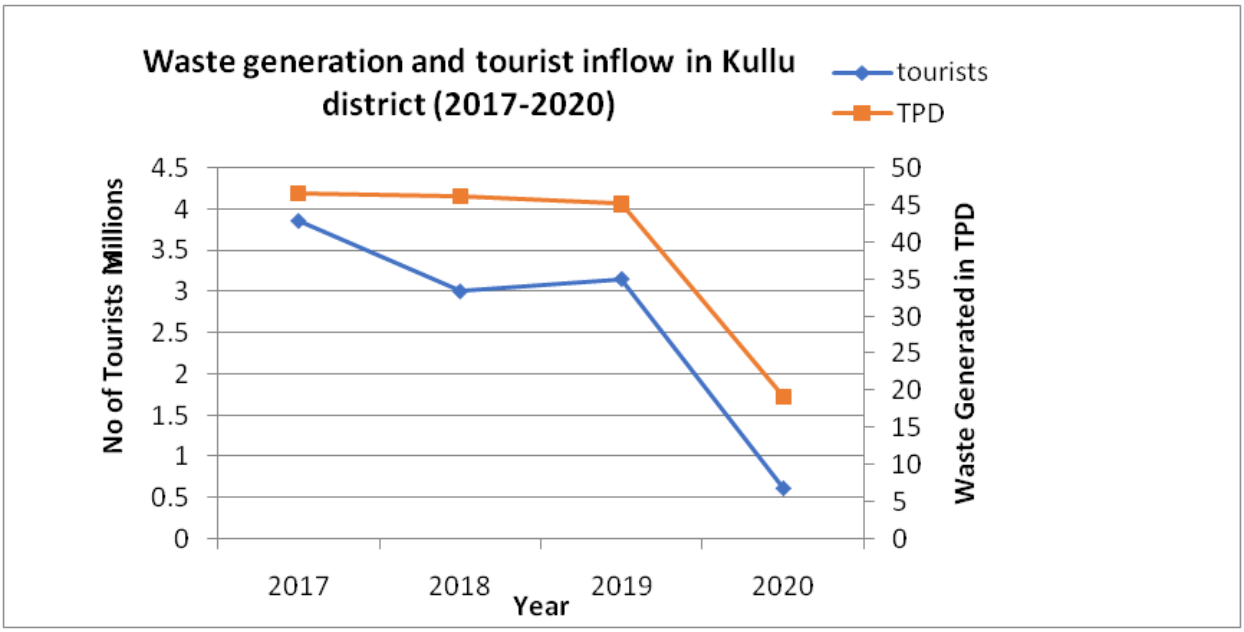


Fig. 3.4 : Correlation of waste generation with tourist inflow in Kullu district
(*Source: HPTDC and Annual Report under SWM rules 2016 for the year 2020-2021, 2019-2020,2018-2019,2017-2018)*

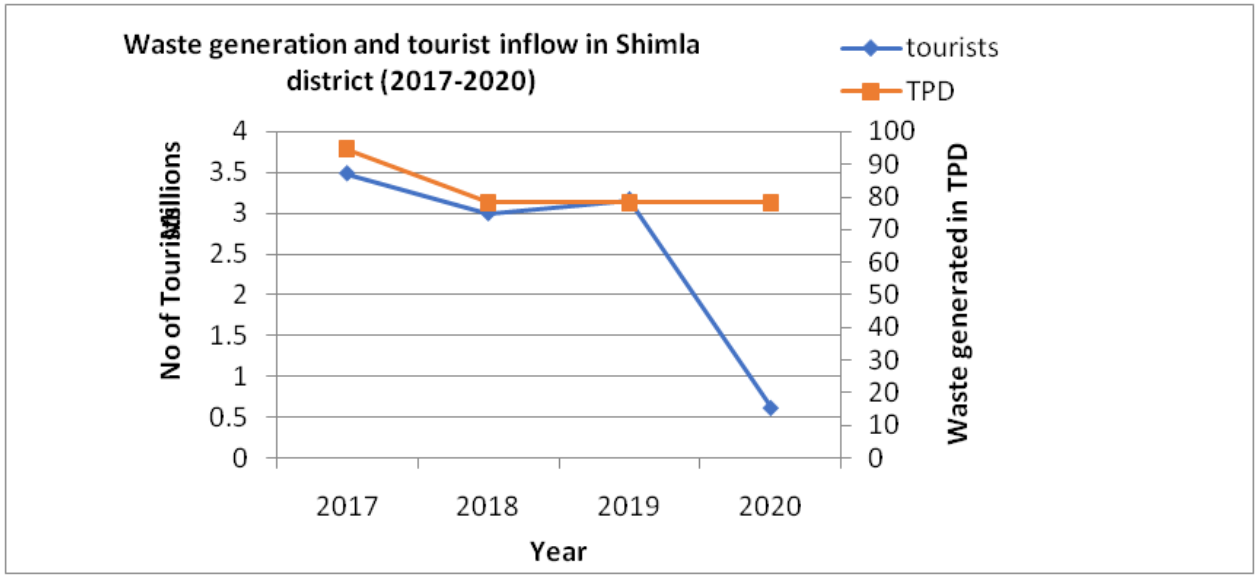


Fig. 3.5: Correlation of waste generation with tourist inflow in Shimla District
(*Source: HPTDC and Annual Report under SWM rules 2016 for the year 2020-2021, 2019-2020,2018-2019,2017-2018)*

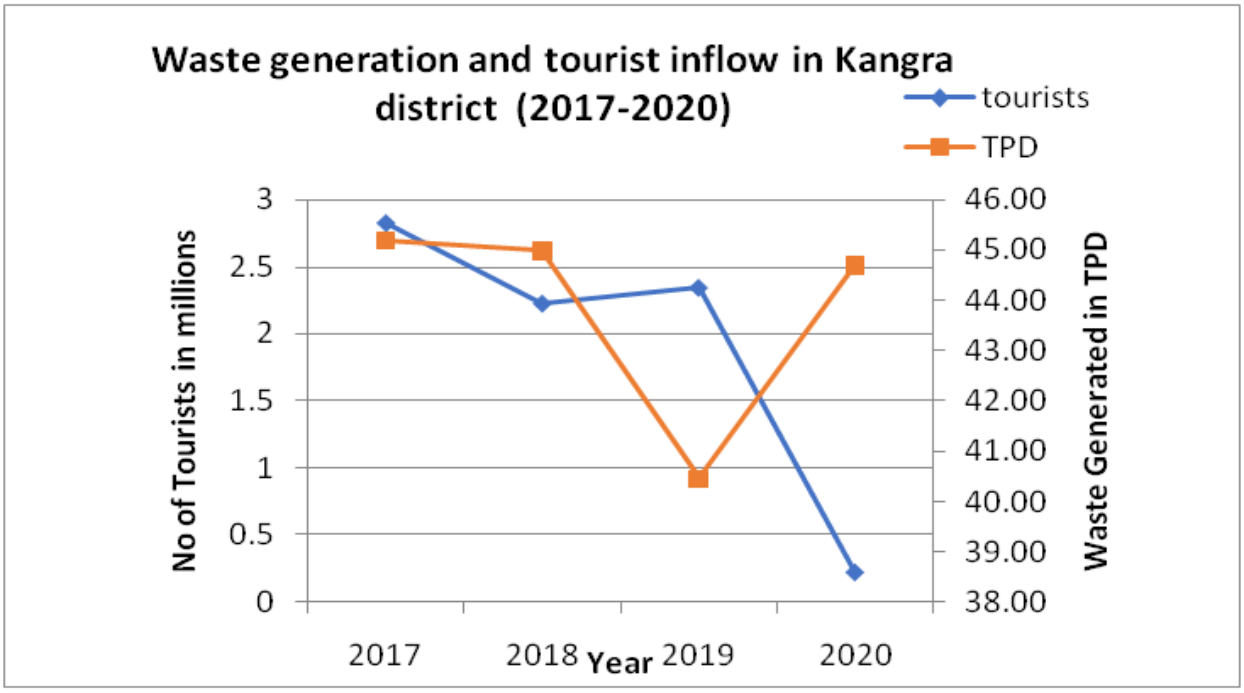


Fig. 3.6 : Correlation of waste generation with tourist inflow in Kangra district
(*Source: HPTDC and Annual Report under SWM rules 2016 for the year 2020-2021, 2019-2020,2018-2019,2017-2018)*

3.7. Challenges

The state faces a variety of challenges in managing properly municipal solid waste. The amount of solid waste that is landfilled is constrained by the state's steep topography, which makes it challenging to build major waste management facilities like sanitary landfills. On the other hand, this is fact that the state is a major tourist destination which makes the problem even worse. Increase in tourists also result in an increase in garbage production, which makes waste management for urban local authorities more difficult. There have been numerous attempts made throughout the state to manage municipal solid waste properly, including door-to-door waste collection, the removal of public waste bins from public places, etc. But these programmes still need to address a number of gaps. The report on social, general and economic sectors (non-public undertaking) for the year ended on 31 March 2019 by the Comptroller and Auditor General of India. It was states that the state's efforts in ULBs to manage solid waste were unable to keep urban areas clean or control waste disposal in a precise manner. Some ULBs were found to have inadequate data about the frequency and amount of solid waste collection, segregation, and disposal, while a few other ULBs had no data at all. Additionally, the regular fixation, revision, and collection of user fees were not consistently followed by the ULBs in order to finance the regular solid waste management activities. Funds available for capital expenditure were not fully utilized, negatively affecting the development of necessary infrastructure. The CAG report highlighted that, as evident by the difference between the achievement reported by the ULBs and the position observed during the audit, differences in the various stages of the solid waste management process were not being acknowledged by the ULBs. Because of the serious shortcomings in solid waste collection, segregation, storage, processing, and disposal identified in this report, unsegregated and unprocessed solid waste was being thrown into the air and carelessly dumped in open "dump sites," an unsustainable practice that put the environment and public health at risk.

3.8. Ill effect on Air Quality

3.8.3. Number of Registerd Vehicles plying in Himachal Pradesh

In the past few years, there has been a significant increase in the number of vehicles in Himachal Pradesh with every upcoming New Year. In the year 2007, there were 0.3 million registered vehicles in Himachal Pradesh which almost doubled as 0.6 million in 2011. Further, this increased to 1.3 million in 2018 and over 1.6 million registered vehicles across the Indian state of Himachal Pradesh at the end of fiscal year 2019. There has been an approximate increase of 1.3 million vehicles in Himachal Pradesh from 2007 to 2019. As per the data of Economics & Statistics Department of Himachal Pradesh (2021), the maximum numbers of registered vehicles were 0.14 million in district Solan while least were 3729 in Lahaul & Spiti from 2011 to 2020. Data of district Kangra and Hamirpur were not available (Fig.3.7 a). The rate of change of number of vehicles showed a continuous increase from 9% to 11% from 2015 to 2018 while it showed a decrease of -21% in 2020 when compared to 2019 (Fig. 3.7 b).

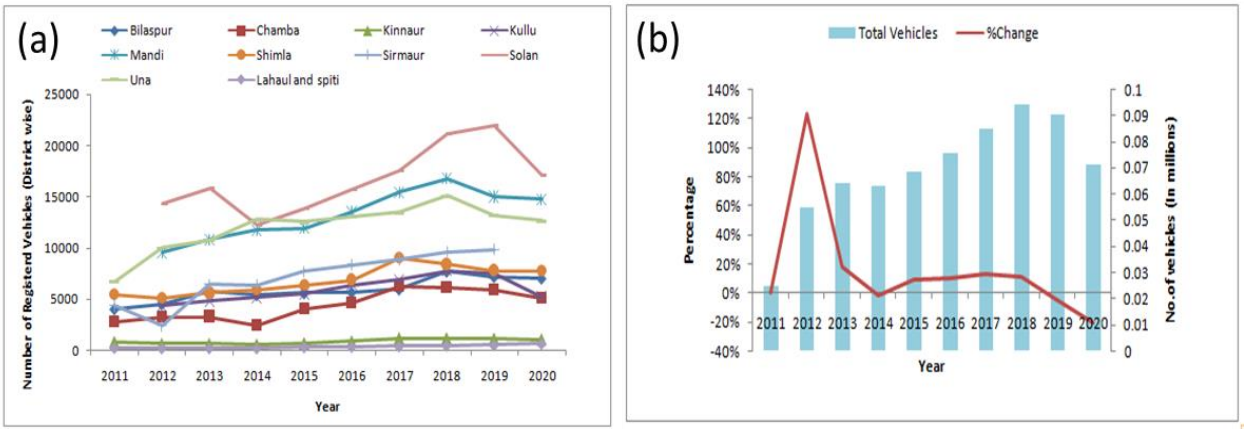


Fig.3.7: (a) Number of registered vehicles in H.P. (District wise 2011-2020), and (b) Rate of change in number of vehicles in H.P. (2011-2020) (Source: Economics & Statistics Department of Himachal Pradesh 2021)

3.8.4. Number of vehicles plying for tourism related activities

Out of the total registered vehicles in Himachal Pradesh, the exact data of the number of taxis and Volvo buses plying was not available but as per HRTC the currently total Volvo and Scania fleet stands at 100+ buses with daily buses running from Delhi to Shimla, Manali, Dharamshala, Joginder Nagar, Baijnath, Hamirpur, Nalagarh, Chintpurni, Jawala ji, Pathankot, Chamba, Palampur, Rewalsar and Sarkaghat. There were about 2517 registerd taxis in Kullu district in the year 2017 as per Himachal Pradesh government when was asked by Hon'ble NGT to Himachal Pradseh Government.

3.8.5. Types of registered vehicle (based on fuel)

In view of preventing and reducing the impact of air pollution in Himachal Pradesh, 75 electric buses have been sanctioned and deployed to Himachal Pradesh. After the successful completion of the pilot, the state government deployed electric buses in Kullu as well and further deployment of 50 buses in Shimla district across the state in 2018. Also, the state government started another electric vehicle project in 2018 in which it deployed 50 electric cabs across the state. The data type of vehicle based on type of fuel is on table 3.4 and table 3.5 (Source: *E. Vahan Portal*). The number of CNG and electric vehicles have increased in 2021 as compared to previous years, although this increase is very less to know how much the air quality has improved due to increase of electric vehicle.

Table 3.4: Category wise total vehicles in Himachal Pradesh till date (2022) (Source: E Vahan Portal, https://vahan.parivahan.gov.in/vahan4dashboard/)

Type of Vehicle	No. of Vehicles
Petrol	16,36,141
Diesel	4,10,792
CNG	208
Electric	1288

Table 3.5: Year wise fuel type vehicles in Himachal Pradesh till date (2022) (Source: E. Vahan Portal, https://vahan.parivahan.gov.in/vahan4dashboard/)

Type of Vehicle	Year 2018	Year 2019	Year 2020	Year 2021
Petrol	1,21,161	1,12,044	1,13,697	98,690
Diesel	22,250	24,656	18,587	14,723
CNG	1	3	4	70
Electric	62	54	181	327

3.8.6. Air quality monitoring at himachal pradesh

At present, Himachal Pradesh has established air quality monitoring stations at different cities. The monitoring stations are established in industrial areas, residential areas and ecological sensitive areas under the national ambient air quality program of CPCB.

3.8.6.1. Parameter wise Air Quality

3.8.6.1.1. **Respirable suspended particulate matter (RSPM)-**The yearly average concentration of RSPM showed 150.80µg/m^3 in 2012 as the highest concentration at Poanta Sahib in district Sirmaur in Himachal Pradesh, followed by 129.44 µg/m^3 in 2010 and 129.30 µg/m^3 in 2011.A possible reason behind high level of RSPM in Poanta Sahib is that it is an industrial area. The second highest concentration of RSPM was observed as 93.4 µg/m^3 in Una (2013), followed by 91.63 µg/m^3 in Kullu in 2011.The lowest concentration was observed as 30.56 µg/m^3 in Kangra in 2010. Fig. 3.8(a) shows the monthly average concentration of particulate matter in Solan, Kangra, Una, Sirmaur and in major tourist destination Kullu-Manali and Shimla from 2010 to 2020, although levels of RSPM showed a decrease in all districts after 2016. The rate of change in RSPM ranged from -19% to 3% in a decade. Further during COVID 19 lockdown, a decrease of -0.34% was observed in 2020 as compared to 2019. Fig. 3.8(b) shows yearly average concentration of RSPM and rate of change of RSPM in Himachal Pradesh from 2010 to 2020.The rising pollution is a matter of serious concern, especially high level of particulate matter exceeding National ambient air quality standards, 2009. CPCB issued direction for industries under Section 5 of the Environment (Protection) Act, 1986 as Further in compliance of Hon'ble NGT order dated 28.03.2019 and 04.07.2019 in O.A No. 67/2019 and O.A. No. 138/2019, CPCB issued directions under Section 5 of the Environment (Protection) Act, 1986 to the Chief Secretaries/Administrators of States Governments / Union Territory Administrations vide letter dated 23.08.2019 directing as below.

1. *The state government shall formulate and enforce fuel policy regarding use of pet coke and FO in the state/UT in light of various orders passed by Supreme Court regarding use of pet coke and FO in Writ Petition(C) 13029/1985.*
2. *State Government / Union Territory Administration through respective SPCB/PCC shall take strict action against any industry if found violating, the fuel policy on use of pet coke and FO that will be enforced as above, using the power conferred under environmental laws*.

These orders were passed specifically for industrial areas. Further, annual mean value of RSPM was within annual permissible standards in all districts (monitoring stations) as per HPSPCB.

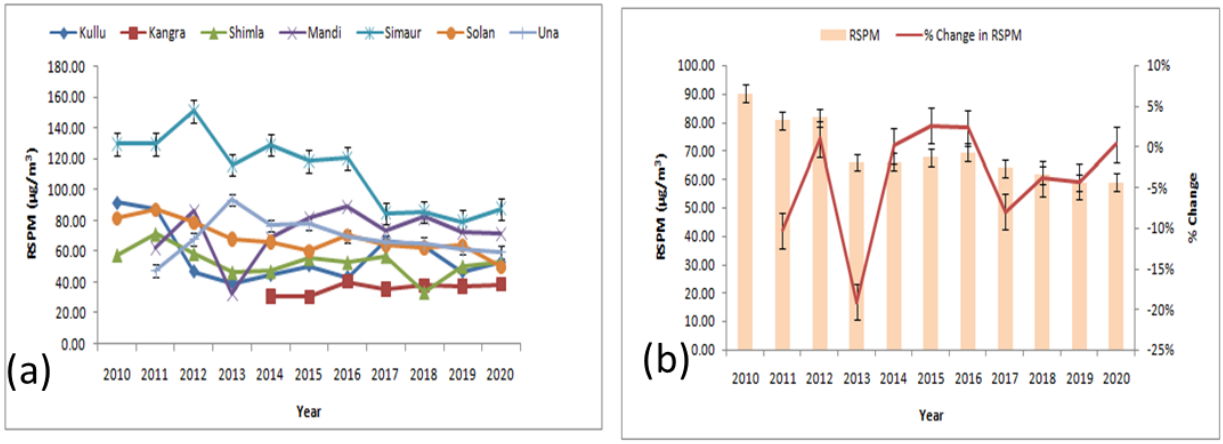


Fig.3.8: (a) Concentration of RSPM in different districts of Himachal Pradesh from 2010 to 2020, and (b) Yearly Average concentration of RSPM and rate of change of RSPM in Himachal Pradesh 2010 to 2020 (*Source: https://hppcb.nic.in/airquality.pdf*).

3.8.6.1.2. **Particulate Matter 2.5** ($PM_{2.5}$) **-** $PM_{2.5}$ data were available from 2018 to 2020.The results revealed that average concentration of $PM_{2.5}$ from 2018 to 2020 was highest in district Sirmaur 48.2 µg/m^3 (2018) followed by 42.32 µg/m^{3}in Mandi (2018), Una 34.7 µg/m^3 (2019), Shimla (34.2. µg/m^3) in 2018, and the lowest in Kangra (14.19 µg/m^3) (Fig.3.9a). The rate of change of $PM_{2.5}$ showed a decrease of -26% in 2020 as compared to 2019. Fig. 3.9 (b) shows yearly average concentration of $PM_{2.5}$ and rate of change of $PM_{2.5}$ in Himachal Pradesh from 2018-2020. Annual mean value of $PM_{2.5}$ was within annual permissible standards in all districts (monitoring stations) as per HPSPCB.

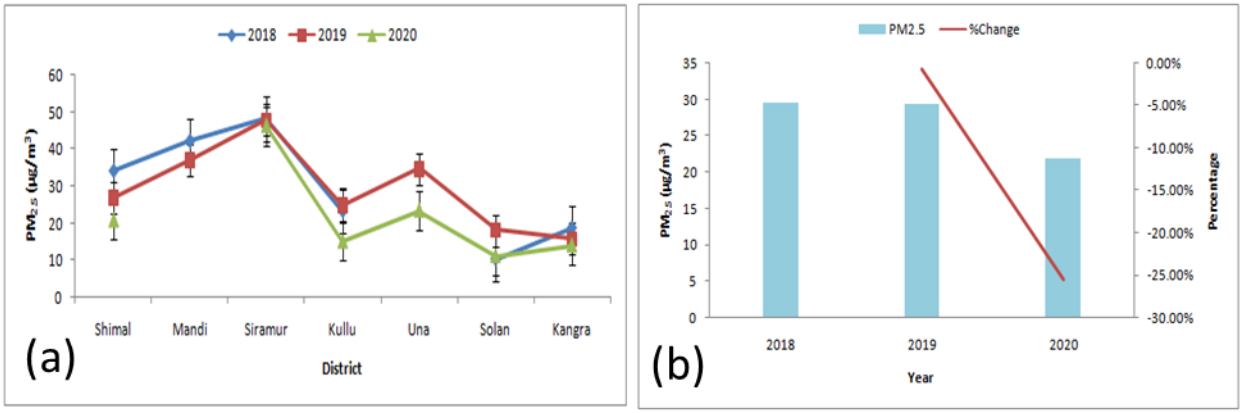


Fig. 3.9: (a) Concentration of $PM_{2.5}$ in different districts of Himachal Pradesh from 2018 to 2020, and (b) Yearly Average concentration of $PM_{2.5}$ and Rate of Change of $PM_{2.5}$ in Himachal Pradesh from 2018-2020 (*Source: https://hppcb.nic.in/airquality.pdf*))

3.8.6.1.3. **Nitrogen Dioxide (NO_2)** - NO_2 is a major pollutant released by vehicular emission. It is a primary pollutant and is a precursor of secondary harmful pollutant such as surface ozone. NO_2 was within permissible standards of NAAQS as per HPSPCB data. The yearly average concentration of NO_2 showed highest average concentration of 26.5 ug/m^3 in 2018 in district Shimla followed by 25.45 ug/min 2019 in Shimla (Fig.3.10 a). The concentration of NO_2 was within permissible standards of NAAQS in all districts from year 2010-2020.The rate of change of NO_2 ranged from -16% to 6%. While in 2020, NO_2 decreased to -17% as compared to 2019 due to the Covid restrictions in year 2020. Fig. 3.10 (b) shows yearly average concentration of NO_2 and rate of change of NO_2 in Himachal Pradesh from 2010-2020.

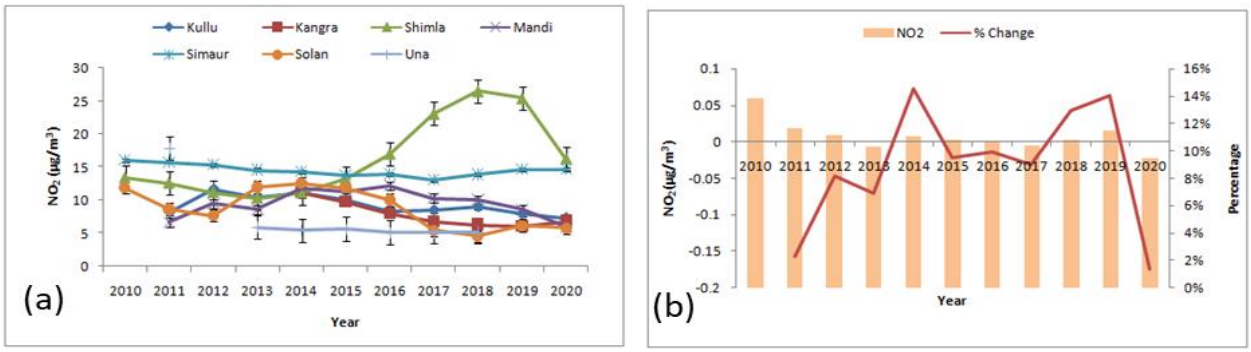


Fig.3.10: (a) Concentration of NO_2 in different districts of Himachal Pradesh from 2010 to 2020and (b) Yearly Average concentration of NO_2 and rate of Change of NO_2in Himachal Pradesh from 2010-2020 (*Source: https://hppcb.nic.in/airquality.pdf*)

3.8.6.1.4. **Sulphur Dioxide (SO_2) -** Sulphur dioxide is mainly released by burning of fossil fuel and other waste product. It was found well within the permissible standards of NAAQS in all the monitoring stations of Himachal Pradesh as per HPSPCB data.SO_2 showed highest average concentration 6.08 ug/m^3 in 2011 in Una followed by 3.3 ug/m^3 in 2019 in Sirmaur followed by 2.5 ug/m^3 in Shimla in 2018. Fig. 3.11 (a) shows yearly average concentration of SO_2 in different districts of Himachal Pradesh. The rate of change of SO_2 ranged from -24% to 6% in a decade while in 2020 it showed a decrease of -3% when compared to 2019 (Fig. 3.11 b).

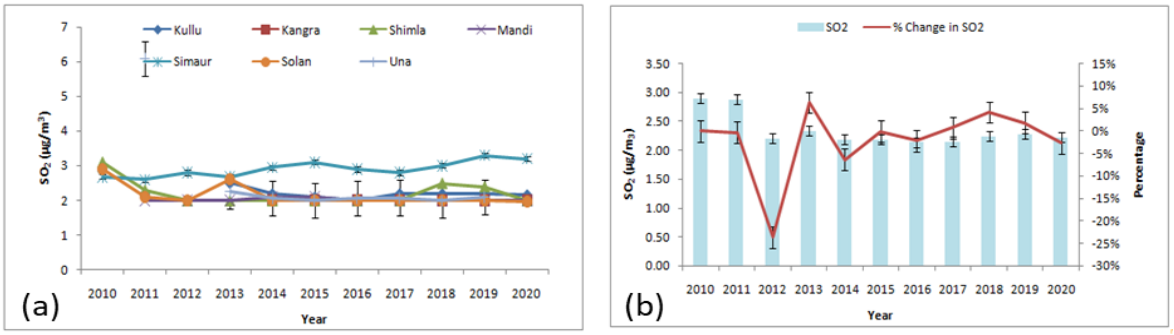


Fig.3.11: (a) Concentration of SO_2 in different districts of Himachal Pradesh from 2010 to 2020, and (b) Yearly Average concentration and Rate of change of SO_2 in Himachal Pradesh from 2010-2020 (*Source: https://hppcb.nic.in/airquality.pdf*)

3.8.6.1.5. **Surface Ozone (O_3) -** Surface Ozone is a secondary pollutant. It is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight. Currently, the data of surface ozone was available only for four districts and the average concentration of Surface Ozone was highest in district Una as 22.4 ug/m^3 (2020) and 3.8 µg/m^3 (2019) in Mandi followed by 3.02 µg/m^3 (2018) in district Kangra. Surface ozone concentration was within the permissible limit of NAAQS in all monitoring stations (Fig. 3.12 a). The rate of change of surface ozone showed a decrease of -6% in 2020 when compared to 2019 (Fig. 3.12 b).

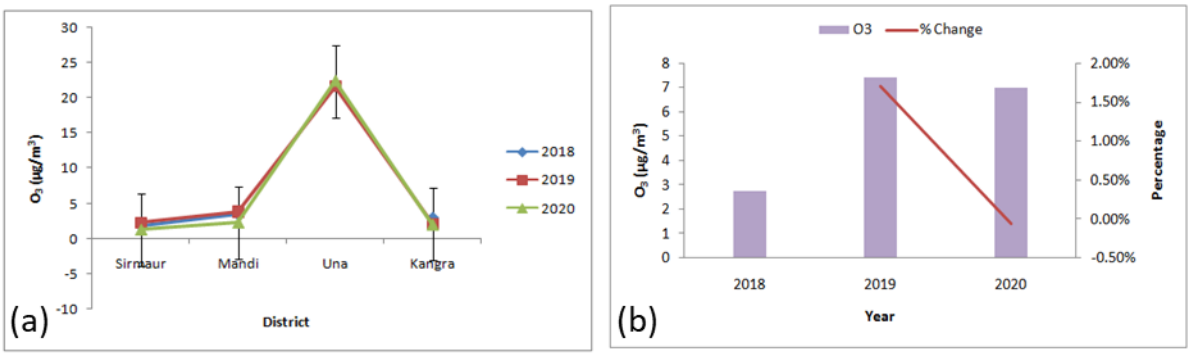


Fig. 3.12: (a) Concentration of O_3 in different districts of Himachal Pradesh from 2018 to 2020, and (b) Yearly Average concentration and rate of Change of O_3 in Himachal Pradesh from 2018-2020 *(Source: https://hppcb.nic.in/airquality.pdf*)

Surface ozone data of Kullu district was not available with HPSPCB, but G.B. Pant National Institute of Himalayan Environment, Himachal Regional Centre has also been monitoring Surface Ozone from 2010 to 2015 (at Mohal) 2016 to 2018 at Kothi and again at Mohal from 2019 onwards under ISRO funded long-term project. Figs. 3.13 (a&b) show concentration of surface ozone at Mohal and Kothi (2010-2020). The average concentration of surface ozone showed the highest concentration of 49.7 ppb at Kothi in 2018 and lowest as 15.98 ppb in 2015 at Mohal-Kullu. The rate of change for surface ozone varied from -32% to -20% from 2011 to 2015 at Mohal-Kullu.

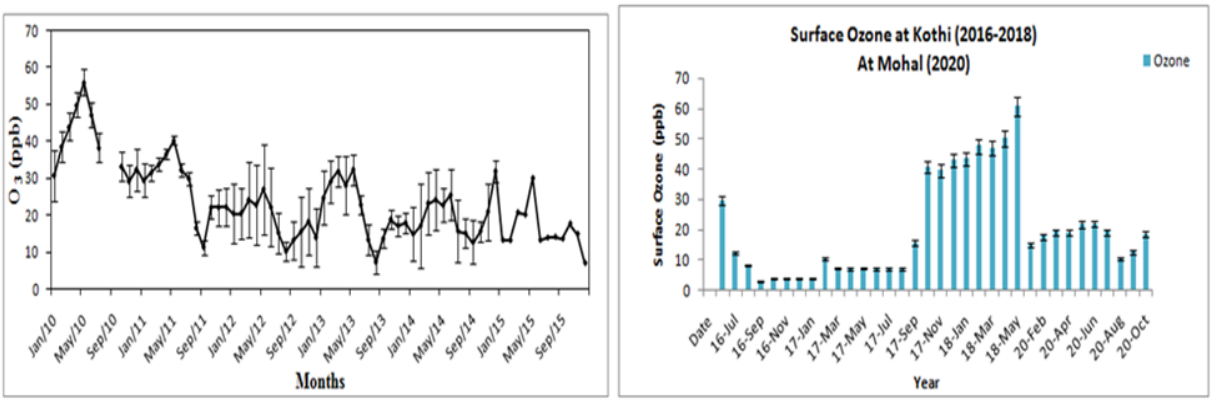


Fig. 3.13: (a) Concentration of O_3 at Mohal- Kullu in Himachal Pradesh from 2010 to 2015, and (b) Concentration of O_3 at Kothi, Manali in Himachal Pradesh from 2016 to 2018 and at Mohal in 2020

3.8.6.1.6. **Black Carbon (BC) -**Black Carbon data was not available for any district with HPSPCB. G.B. Pant National Institute of Himalayan Environment, Himachal Regional Centre is continuously monitoring Black Carbon in Mohal - Kullu under ISRO funded long-term project. Black carbon showed bimodal peak in this region. The highest average concentration was 4394.9 ngm-^{3} in 2009 followed by 4154.7 ngm-^{3} in 2010 and lowest as 1226.2 ngm-^{3} in 2016 (Fig.3.14 a). The decadal rate of change of Black Carbon ranged from -5% to 43% and showed a decrease of -27% in 2021 as compared to year 2020 at Mohal- Kullu (Fig.3.14 b). In view of preventing air pollution in ecological sensitive areas, Hon'ble NGT has directed an order to run electric buses in Rohtang. Black carbon concentration was within permissible limit as per WHO (World Health Organization) Standards.

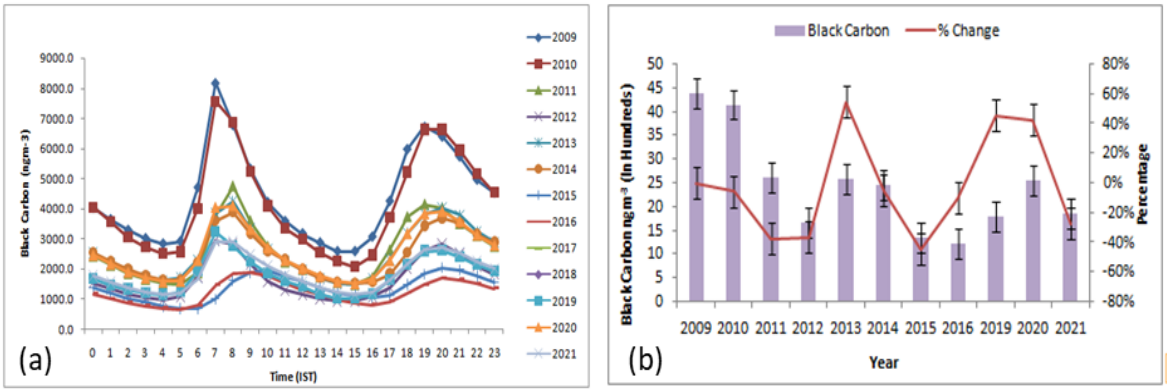


Fig.3.14: (a) Concentration of Black Carbon in Mohal-Kullu from 2009 to 2021, and (b) Yearly average concentration and rate of change of BC in Mohal- Kullu from 2009-2021

3.8.7. **Correlation between Tourist Vehicles and air quality**

Although the annual mean of all the air pollutants were within permissible limit of annual standards, still increasing tourism and heavy inflow of vehicles especially during peak tourist

season may affect air quality in Manali which is a famous tourist destination in Himachal Pradesh. It has witnessed increased number of both private and commercial (taxis) vehicles over the period of time. The number of private vehicles has grown from 312 in 2005 to 4615 in 2013 recording a Compound Annual Growth Rate (CAGR) of 35% whereas number of taxis has increased from 165 in 2005 to 2725 in 2013, registering a CAGR of 10.46%, in total the local vehicles in Manali recorded a CAGR of 37%, speaking of its negative effect on valley's air (Singh, 2015). The unregulated traffic flow leads to massive traffic jams and high emission by these stranded vehicles. Table 3.6 shows year wise data of number registered private vehicles and taxis in Manali.

Table 3.6: Year wise data of number of registered private vehicles and taxi in Manali (2005-2014) (Source: Singh, 2015)

Year	No. of Private Vehicles	No.of Taxis	Total
2005-2006	312	165	477
2006-2007	310	214	524
2007-2008	433	227	660
2008-2009	409	269	678
2009-2010	557	276	833
2010-2011	738	310	1048
2011-2012	706	519	1225
2012-2013	722	506	1228
2013-2014	740	404	1144
Total	4976	2890	7857

Besides, taxis and private vehicles, recreational vehicles like ATVs and Snow Scooters are an additional source of both air and noise pollution in the valley and their numbers have grown over the years with increasing demand in adventurous sports. A total of 140 ATVs and 74 snow scooters are registered in the valley after the direction of NGT. Both these vehicles run on diesel polluting snow with spillage and creating air and noise pollution (Singh, 2015). The impact of increased tourist vehicles on air quality degradation can also be seen as in June 2017 around 4,000 vehicles entered into Shimla on weekends apart from locally-registered vehicles. The level of RSPM was increased by 40% during that period. The state environment and pollution control board had gathered the ambient air quality data through two monitoring locations - one at the bus stand and other at the ridge. The RSPM level at the main bus stand on the circular road was recorded at 97.74 ug/m^3 almost double the permissible limit.

This level multiplied during the weekends. Similarly, the air-quality level has also decreased in Manali that attracts hordes of tourists. The RSPM level in Manali increases on the weekends (Hindustan Times, Shimla, by Gaurav Bisht 29 June, 2017). Although, average annual value of most of the pollutants remained under prescribed limits of NAAQS, the values increased in peak tourist season.

3.8.7.1. Tourist season and air quality

The major tourist destinations in Himachal Pradesh are Kullu-Manali, Shimla and Dharamshala. One of recent study conducted in famous tourist destination Shimla indicates that air pollutants were monitored at Station 1- Ridge and Station 2- at the state bus terminal by HPSPCB. It was observed that higher concentration of RSPM was in spring season as spring to summer season remains a peak tourist season.The increased RSPM levels attribute to substantial increase in tourists due to which traffic increases manifold in Shimla with its busiest road network (Ganguly & Thapa, 2016). Correlation between tourist inflow and corresponding air quality in the region was analysed. The tourist inflow data show that it was highest in months of May and June followed by April. High average concentration of RSPM and NO_2 were observed in June, May in 2012 and 2013 in Kullu and Shimla, respectively. While from year 2014 to 2019 both the pollutants were well within the permissible limits except for June 2018 in Kullu and Shimla (Table 3.7, 3.8 & 3.9). RSPM and NO_2 were within prescribed limits in Dharamshala. In all the tourist destinations, average mean of all the pollutants were within permissible limit although a peak is sometimes observed during increased tourist inflow. This is also fact that the increase cannot be only linked to tourism as high peak values were also observed when number of tourists were comparatively low. Therefore, increase in air pollutants is sometimes due to heavy rush by tourists as well as due to other local anthropogenic activities. However, in spite of increased vehicles and tourism activities, all the pollutants are found to be within limits in all the tourist areas.

Table 3.7: Status of tourist inflow and air pollutants in Kullu Himachal Pradesh (Source: HPTDC and HPSPCB)

Year	**Month with highest number of tourists**	**Number of Tourists**	**RSPM (µg/m^3)**	**No$_2$ (µg/m^3)**
2012	June	441767	109 (Highest in the year)	15.1 (Highest in the year)
2013	May	357770	73.9 (Highest in the year)	12.7 (Highest in the year)
2014	August	469938	21.8	8.0
2015	June	453753	34.8	6.4
2016	June	452538	42	4.8
2017	June	512397	48.3	6.1
2018	June	457168	64.7 (Exceeding prescribed limits)	9.2 (Highest in the year)
2019	June	425419	52.32	4.62
2020	Dec	210776	--	

Table 3.8: Status of tourist inflow and air pollutants in Shimla, Himachal Pradesh (Source: HPTDC and HPSPCB)

Year	Month	Number of Tourist	NO_2 (µg/m3)	RSPM (µg/m^3)
2012	June	477202	8.8	122.2 (highest in the year)
2013	May	456247	15.1 (highest in the year)	88.5 (highest in the year)
2014	May	464799	13.7	88
2015	May	476733	16.1	77.2
2016	June	492727	18.8	64.9
2017	June	496974	24.9	68.9
2018	June	403038	28.5(Highest in the year)	125.4 (highest in the year)
2019	June	428088	7.9	82 (Highest in the year)
2020	Jan	272933	-	-

Table 3.9: Status of tourist inflow and air pollutants in Dharamshala, Himachal Pradesh (Source: HPTDC and HPSPCB)

Year	Month	Number of Tourists	NO_2(µg/m^3)	RSPM (µg/m^3)
2015	April	308001	11.1	32.5
2016	April	328120	7.9	32.2
2017	June	347297	7.3	48.0
2018	April	281922	5.9	33
2019	Oct	274074	7.3	31
2020	Jan	138126	-	-

3.8.8. Measures/mitigation for air purification (dust setters, etc. /scrubbers, other ecological measures, etc.)

The Hon"ble NGT, New Delhi in OA No. 681 of 2018 issued an order dated October 08, 2018, wherein, all the States and Union Territories with non-attainment cities must prepare appropriate action plans within two months aimed at bringing the standards of air quality within the prescribed norms within six months from date of finalization of the action plans and approved by state level six member Air Quality Monitoring Committee (AQMC) and final approval by Chairman, CPCB on the recommendations of three member Committee comprising of Dr. Prashant Gargava, Member Secretary, CPCB, Prof. Mukesh Khare, Professor, IIT Delhi, and Prof. Mukesh Sharma, Professor, IIT Kanpur.

In compliance with this order, H.P Government proposed an action plan for contolling air pollution in non-attaintment cities in H.P. which are Baddi, Nalagarh, Parwanoo,Poanta Shahib,Kala Amb, Damtal and Sundernagar.

Table 3.10 Action Plan of Himachal Government in compliance with NGT order for air pollution

Sr. No.	Source group	Action Point	Target date from date of approval
1.	**Vehicles**	Restriction on plying and phasing out 15 year old commercial diesel driven vehicles	The matter would be taken with MoRTH, GOI
		Regular checking of Vehicular emission and issue of pollution under control certificate (PUC)	January 2019 & continue as regular activity
		Good traffic management including redirection of traffic movement	January 2019
		Ban on registration of Diesel driven auto rickshaw/Tempo	April 2019
		Promotion and operationalization of E-Rickshaws	April 2019
		Monitoring on Vehicle fitness	January 2019 & continue as regular activity
		Launch extensive drive against polluting vehicles for ensuring strict compliance	January 2019 & continue as regular activity
2.	**Road Dust**	Regular cleaning of road dust	January 2019 & continue as regular activity
		Water spraying on new/kacha road through tankers	January 2019 & continue as regular activity
		Construction of pucca pavement along the roads	June 2019
		Tree plantation along the roads	June 2019
		Development of green belts in open areas, gardens, parks, community, places schools and housing societies	June 2019
3.	**Construction activities**	Covering of construction site	April 2019
		Transportation of construction materials like sand, soil, stone, chips etc. in converted system	April 2019 & continue as regular activity
		Restriction on storage of construction materials along the road	January 2019
		Enforcement of Construction and waste demolition waste rules	April 2019
4.	**Biomass**	Restriction on open burning of municipal solid	January 2019

	and garbage burning	waste, biomass, plastic, agriculture and horticulture, etc.	
		Immediate lifting of solid wastes generated and cleaning of municipal drains for its disposal	January 2019
		Action Plan to minimize the forest fire	April 2019 & continue as regular activity
5.	I**ndustries**	Identification of air polluting industries and their regular monitoring including use of designated fuel and closure of unauthorized units	April 2019
		Ensuring installation and operation of air pollution control devices in industries	January 2019
		Ensuring emission standards in industries	January 2019
		Restriction on using un-authorised fuel in boilers	April 2019
		Conversion of brick klin to forced/induced draft	April 2019
		Action against non-complying industrial units	January 2019
		Disposal of Boiler ash & other non-hazardous wastes into the designated dumping sites	January 2019
		Fugative emission control	January 2019
6.	**Traffic and Transport ation**	Restriction on movement of goods vehicles in certain areas during day time and peak hour	January 2019
		Action to check visibly polluting vehicles through routine checking	January 2019 & continue as regular activity
		Action to check overloaded vehicles	January 2019 & continue as regular activity
		Ensuring commercial vehicles carrying husk, sand, construction debris etc are properly covered	January 2019
7.	**Strengthe ning of AAAQM monitorin g**	Installation of more continuous ambient air quality monitoring stations (CAAQMS) at different stations	August 2019
		Upgradation of existing National Air Quality Monitoring Programme (NAMP) stations for monitoring of 12 parameters	June 2019

3.8 Impact on water quality/ ground water

Water, especially fresh water, is one of the most critical natural resources. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This has resulted in water shortages and degradation of water supplies, as well as generating a greater volume of waste water. The water quality data for the year 2011-2020 was collected from the yearly reports of Central Ground Water Board (CGWB) and Central Pollution Control Board (CPCB).

3.8.1. Physical Parameters

The mean value of electrical conductivity of River Beas was 143.33±68.90 µS/cm (Sharma & Walia, 2016), while the average conductivity for River Satluj water varies from 206.75 to 913.75 mho/cm (Sharma & Walia 2017). The highest conductivity was observed in Khab, Kinnaur and lowest in Kol dam, Bilaspur. Further as per Central ground water board, the lowest value of electrical conductivity has been detected in district Lahaul-Spiti whereas the highest values were detected in districts of Bilaspur, Una and Sirmaur from year 2011-2020. EC values were well within the permissible limit prescribed by BIS (2012) and WHO (2011).

Dissolved oxygen is an important parameter in assessing water quality because of its influence on the living organisms within a body of water. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification, etc. (Vikal, 2009). Data Analysis of HPSPCB was done which showed that DO was highest (14.97mg/L) in district Shimla in 2012 followed by Mandi (11.93 mg/L) in 2020 and 10.24 mg/L in Kullu. The decadal rate of change in dissolved oxygen varied from -8% to 7%. In 2020, DO levels increased by 4% when compared to 2019 (Fig. 3.15).

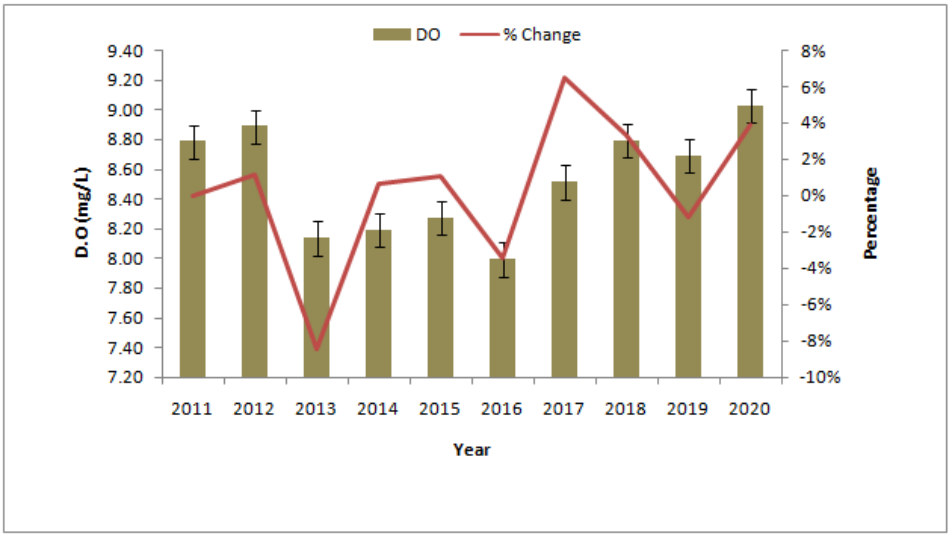


Fig. 3.15: Yearly average Concentration of Dissolved oxygen and rate of change in DO in different districts of H.P. from 2011-2020 (*Source: https://hppcb.nic.in/waterquality.pdf)*

BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites). As per CGWB, the values of BOD in the groundwater in all the districts range from not detectable to 0.9 (in district Sirmaur, 2014). Further, monthly data was analyzed from HPSPCB which was highest (15.13mg/L in 2012) at Solan followed by 7.34 in 2011 again at Solan, indicating high pollution level at Solan while it was lowest (0.10 in 2016) in district Kinnaur. The decadal rate of change in BOD levels varied from -68% to 58% while there was a decrease of -53% in BOD levels in 2020 as compared to 2019 (Fig. 3.16).

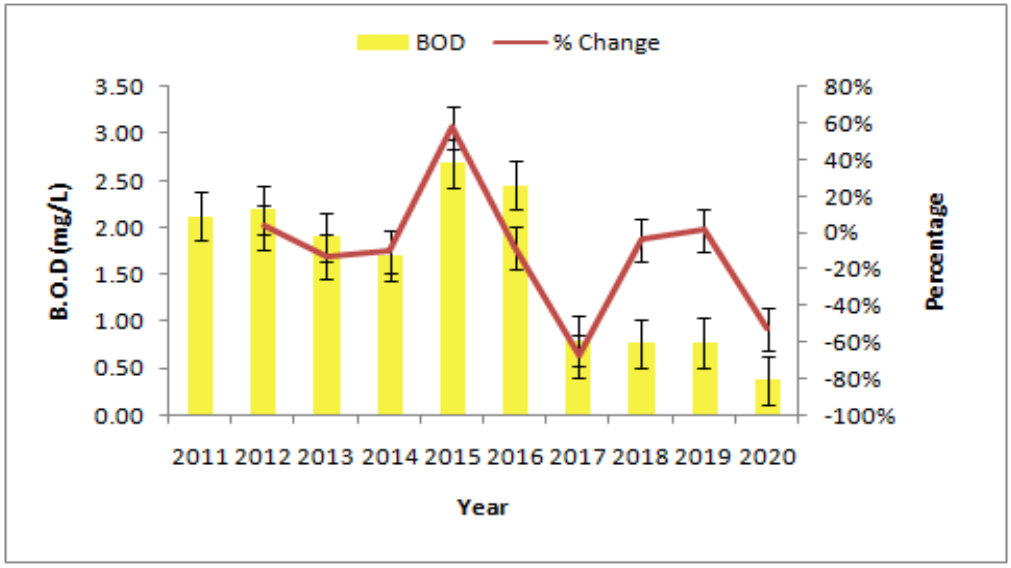


Fig. 3.16: Yearly Average Concentration of BOD and rate of change in BOD in different districts of H.P. from 2011-2020 *(Source: https://hppcb.nic.in/waterquality.pdf)*

TDS in water may originate from natural sources, sewage, urban runoff or industrial waste discharges. For drinking water, WHO (2011) has prescribed a maximum permissible limit of 1500 mg/l. BIS (2012) has prescribed a maximum permissible limit of 2000 mg/l. The mean value of TDS of River Beas for Beas Kund was 95.33±45.77mg/L, which was within the acceptable limit of 500 mg/L prescribed by BIS, 2012 (Sharma & Walia, 2016).

3.8.2. Chemical Parameters

Both BOD and COD are key indicators of the environmental health of a surface water supply. COD is the amount of chemical oxidant for oxidation of organic water that is present in water. The mean value of COD in water of River Beas was 1.92±0.94 mg/L (Sharma & Walia, 2016), while at River Satluj basin the COD varied from 34.25 to 121.75 mg/l. Further, an increasing trend of COD was seen at Khab Kinnaur and Rampur indicating increased population activities, garbage dump and sewage mixing (Sharma & Walia 2017). This trend of increase in COD indicates an increasing level of pollution in the region. Chlorides are formed when chlorine combines with other elements. The mean value of chloride in water of River Beas was 15.45±7.9 mg/L, while the chloride levels varied from 8.750 to 150 mg /L. in River Satluj basin,

which was within the prescribed limit of 250 mg/L prescribed by BIS 2012. Further as per the CGWB report from 2011-2020, the lowest value of chloride ranges from 19.5 mg/l in district Hamirpur (2011) to 93.2 mg/l in district Mandi (2014). According to the CGWB yearly report from 2011-2020, the values of phosphate maintained a consistent trend throughout the past ten years in almost all the districts and the value calculated was <0.1 to below detectable limit. Iron (Fe) usually occurs in groundwater in solution as ferrous (Fe^{2+}) ions. When this ion is exposed to air, they form the insoluble ferric (Fe^{3+}) forms making the water turbid and unacceptable to most people. According to the CGWB yearly report from 2011-2020, the values of iron remained well below detectable limits in Himachal Pradesh.

3.8.3. Biological parameters

3.8.3.1. Escherichia coli and Total Coliform

According to WHO (2011) and BIS (2012), drinking water should be free from Coliform and *E. coli* (Sharma & Walia, 2016). Total Coliforms (TC) are the bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste. The monthly data was taken from HPSPCB for 2011 to 2020 which showed that TC was highest as 692 CF in 2016 in district Mandi. It is followed by 625.25 in 2015 again in Mandi followed by 540 CF in 2012 at district Bilaspur. While, lowest Coliform was 12.58 in 2011 in district Kinnaur. The decadal rate of change in total Coliform value ranged from -2% to 55% for 2011 to 2019 while it decreased to -31% in the year 2021 (Fig. 3.17).

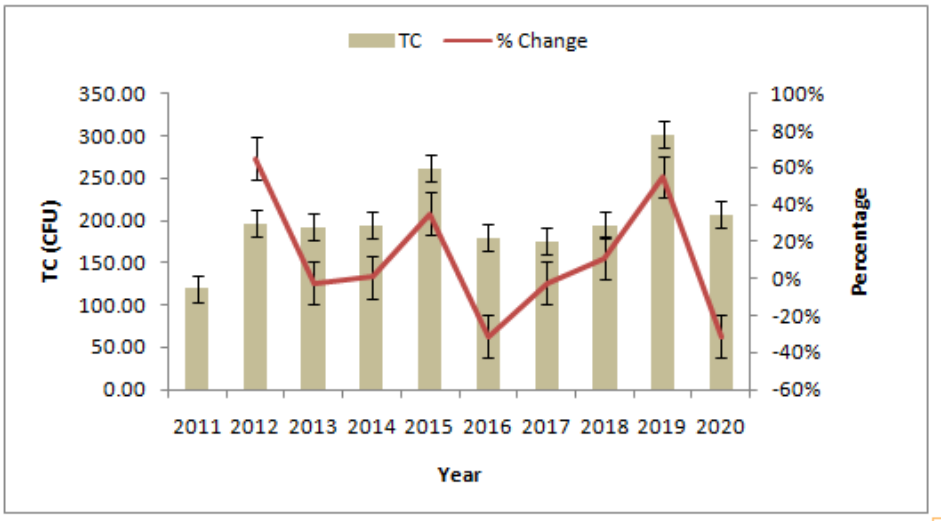


Fig. 3.17: Yearly average total Coliform and rate of change in Coliform from 2011 to 2020 (*Source: https://hppcb.nic.in/waterquality.pdf)*

3.9. Correlation with tourism activities and Water Quality degradation in Himachal Pradesh

A study was conducted in 2002 by Kirch to assess the water quality degradation in Manali which is one of the famous tourist destinations. As per the study, twenty of the surveyed hotels had septic tanks and the other 22 were connected to the separate sewer system in the core area. In three of the hotels, the septic tank was emptied into the creek behind the hotel "twice a year

during the rainy season" (Kirch, 2002). It is worthwhile mentioning that the hotels are located upstream of Manali's core area through which the creek flows. Another hotel patron made use of the sludge as fertilizer, while one replied that the remains were taken to the garbage dump. A major source of water pollution is Manali's garbage dump. It is located on the right bank of the River Beas some 3 km downstream from Manali where it is frequently washed away.More than 3000 kg/day of solid waste generated at Manali is biodegradable apart from plastic food wrappers and plastic bags (Cole, 2000). Overall, urbanization in Manali resulted in an increased amount of garbage production and a shift to non-biodegradable materials. Tourism increases the pollution created by the garbage dump not only through larger numbers of producers, but also because tourists exhibit different consumption behaviour than the permanent population. Garbage produced by tourists consists largely of packaging materials, food wrappers, paper, plastic bags, plastic water bottles, etc., materials that are non-biodegradable (Cole, 2000). Also, water samples in the year 2015 were collected from River Beas water, springs, ground water, water supply and *nallah* (rivulets) showed no significant water pollution in terms of chemical constituents but quality of water found deteriorated from upstream to downstream where large population is concentrated (Kushwaha *et al.* 2012).Though the pollution is not alarming, yet contamination has begun with the release of untreated sewage from mushrooming hotels and domestic waste asking for mitigation measures (Singh and Dey, 2015).

3.9.1. Water pollution and Tourist Seasons

Water quality data was not available for all the tourist destinations.For reference, we have taken water quality data of Kullu and Shimla districts from HPSPCB. The tourist inflow was highest in May and June particularly during summer. During this period, DO, BOD and Total Coliform were well within the prescribed standards by BIS, 2012 and WHO, 2011. Tables 3.11 & 3.12 show that the most of the visited months by tourists and corresponding concentrations of DO, BOD and Total Coliform during that period in Kullu and Shimla districts. The water pollution is controlled in this area. A large number of tourists can lead to excessive water consumption and waste generation which could pollute the water bodies in upcoming time.

Table 3.11: Status of tourist inflow and water pollutants in Kullu, Himachal Pradesh (Source: HPTDC and HPSPCB)

Year	Month with highest number of tourists	Number of Tourist	B.O.D (mg/L)	Total Coliform (CFU)
2013	May	357770	1.1	250.57
2014	August	469938	0.11	225
2015	June	453753	0.15	235.44
2017	June	512397	0.1	237
2018	June	457168	0.17	229
2019	June	425419	0.2	339

Table 3.12: Status of tourist inflow and water pollutants in Shimla, Himachal Pradesh (Source: HPTDC and HPSPCB)

Year	Month with highest number of tourists	Number of Tourist	B.O.D (mg/L)	Total Coliform (CFU)
2013	May	456247	1.49	136.25
2014	May	464799	0.84	21.8
2015	May	476733	0.16	16
2017	June	496974	3.3	200.7
2018	June	403038	-	84.14
2019	June	428088	1.9	159

Measures/mitigation facilities: Water (Prevention & Control of Pollution) Act, 1974 provides for prevention & control of water pollution and maintaining or restoring wholesomeness of water. Thus, it requires provision of pollution control measures i.e. sewerage schemes and sewage treatment plants so as to check the entry of raw sewage into recipient water bodies.

- As per Section 25/26 of the aforesaid Act, it is mandatory to obtain prior consent of the Board to discharge sewage/trade effluent. Provision of sewage management system is the fundamental responsibility of the Urban Development Department and I & PH department.
- The State Board has only regulatory functions with regard to monitoring the performance of operational STPs as well as sewage management systems. The concerned departments are required to obtain consent to establish/operate and renewal prior to establishing/operating STPs/ sewage management systems.
- The State Board processed all the cases received for Consent to establish/ consent to operate/renewal of Sewage Treatment Plants owned by I& PH Department and granted consents to STPs. Besides, the State Board is regularly issuing directions to the Department of I&PH to comply with the provisions of these rules.
- Water Purification Invigorative Scheme (WaPIS) was launched by the Hon'ble Chief Minister of Himachal Pradesh on June 5, 2019. The State Board has initiated a novel concept to mitigate the water pollution of rivers and *nalla(s*) in the State especially with main focus on Sukhna *Nalla* (Parwanoo), River Markanda (Kala Amb) and River Sirsa (Baddi) in the first phase. The State Board has initiated the phytoremediation technique to reduce the water pollution level of above-mentioned rivers out of seven identified Polluted River Stretches (other four are Pabbar, Giri, Ashwani and Beas).

3.10. Impact on Forest and Biodiversity

3.10.1. State wise RET categories species wise / forest cover

According to the India State of Forest Report 2021 published by the Forest Survey of India, forest cover of the state is 27.73% of the total geographical area, i.e., 15,443 sq.km. Under the various categories of forest cover, very dense forest covers 3,163 sq. km. of the total geographic area, moderate dense forest covers 7,100 sq. km. of geographical area, while open

forest covers 5,180 sq. km. of geographic area. In comparison to the year 2019 reports, forest cover has increased by 9 sq. km.

Himachal Pradesh due to its unique geographical location and climatic conditions is rich in floral and faunal species. This region's distinctive flora is valued for its ethno-medical characteristics, making it economically important. Many plants, particularly medicinal plants, and rare native animals are facing extinction in recent years as a result of habitat loss, overexploitation, climate change, and other factors, posing a severe threat to the state's floral and faunal diversity. As a result, the Himachal State Compensatory Afforestation Fund Management and Planning Authority (CAMPA) and committee for threatened animals are working to list these vulnerable plants and animals to priority conservation efforts in order to manage and conserve these Himalayan plants and animal biodiversity. Based on the Shimla conservation assessment management prioritization (December 2010 Report), and committee for threatened animals (February 2017 report), Himachal Pradesh state biodiversity board), the Red-list status of candidate species, there are 57 plant species of plants and 16 species of animals that are classified as threatened.

3.10.2. Loss of biodiversity due to waste disposal

The biodiversity of the state is badly harmed by contamination of the air, water, and soil caused by garbage dumping. Landfills emit carbon dioxide and water vapour, as well as, trace amounts of oxygen, nitrogen, hydrogen, and non-methane organic molecules, in addition to methane (Crawford & Smith 1985). These gases may contribute to climate change, which is one of the leading causes of species extinction (Foden & Young 2016). Air pollution has a greater impact on lower life forms than it does on higher life forms. On land, plants are often more harmful than animals, but this is not the case in freshwater. Most of the species are declining as a result of pollution, with the exception of a few that is increasing. Landfills generally result in the destruction of natural ecosystems for flora and fauna. The soil at and around the dumping site deteriorates, making it less suitable for maintaining natural habitats for native plants and animals. Leachate, a liquid produced by landfills, contaminates surrounding water sources, causing significant ecological damage. When ammonia release from leachate enters ecosystems, it gets nitrified, resulting in nitrate. This nitrate can subsequently induce eutrophication, or a shortage of oxygen in adjacent water sources, due to increased plant growth. Due to a shortage of oxygen, eutrophication causes "dead zones" where organisms cannot survive.

3.10.3. Growing vegetation nearby dumping sites with altitude

A total 175 plant species belonging to 137 genera and 48 families were recorded during the study carried out by G. B. Pant National Institute of Himalayan Environment, Himachal Regional Centre, Mohal- Kullu in and around dumping sites of Manali, Kullu, Mandi, Bilaspur, Hamirpur, Kangra and Chamba (Fig. 3.18). The largest number of species was noted from the family Asteraceae (26 spp.), followed by Poaceae (18 spp.), Malvaceae (11 spp.), Fabaceae &

Solanaceae (08 spp. each), Amaranthaceae (07 spp.), Euphorbiaceae & Rubiaceae (06 spp. each), and Plantaginaceae (05 spp. each). The genus *Solanum* exhibited the highest diversity with 5 species followed by *Amaranthus, Erigeron, Euphorbia* and *Ipomea* (04 species each). Most of the species growing in these areas were herbaceous (113 spp.), followed by trees (42 spp.) and shrubs (20 spp.). It can be pointed out that due to more garbage disposal the alien and inferior plants will preponder and encroach into the habitats of native vegetation.

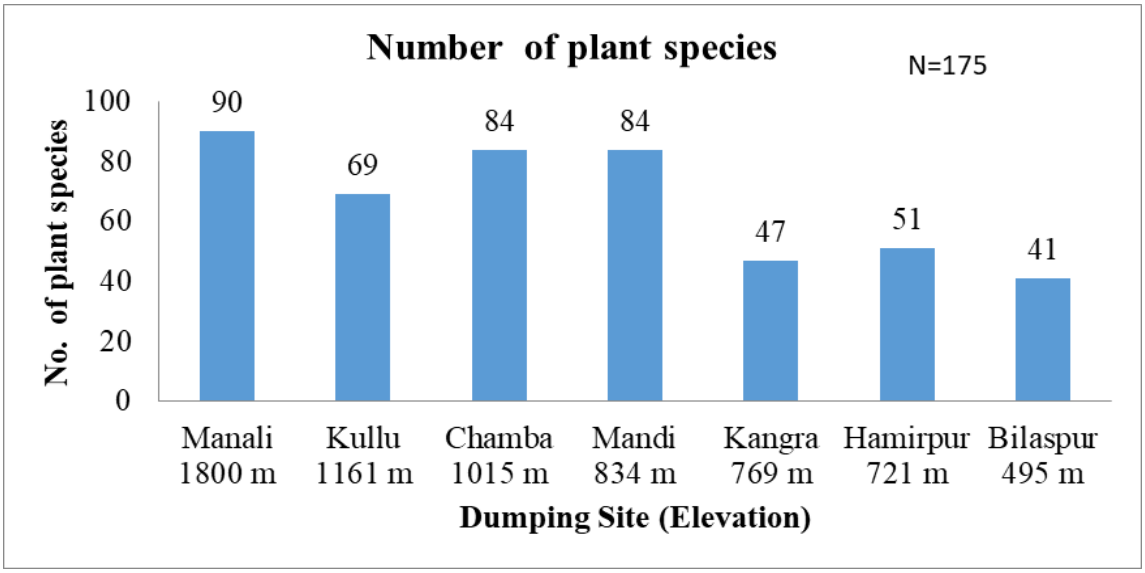


Fig. 3.18: Number of species recorded from different dumping sites

3.11.Eco sensitive zone/area

In Himachal Pradesh, the guidelines dated February 2011 for declaring eco-sensitive zones around national parks and wildlife centuries were published in the year 2017. Inder Killa National Park, Sechu Tuan Nala WLS, Tarla WLS, Majathal WLS, Shimla Water Catchment WLS, Daranghati WLS, and Rakcham Chitkul WLS are among the seven sites designated as eco sensitive zones in Himachal Pradesh. Ten places are under scrutiny and field verification, and 13 are still pending with the Indian government. The activities in these eco sensitive zones are divided into three major categories for regulation under the notification, which comprises: prohibited activities, regulated activities, and permitted activities.

1. **Prohibited activities:** Commercial mining, setting of saw mills, industries causing pollution (air, water, soil, noise, etc.), establishment of major hydroelectric projects, and commercial use of firewood, use or production of any hazardous substances, undertaking activities related to tourism like over flying national park area by an aircraft, hot-air balloons, discharge of effluents or any solid waste into natural water bodies or terrestrial area.
2. **Regulated activities:** Felling of trees, establishment of hotels and resorts, drastic change of agricultural system, commercial use of natural water resources including ground water harvesting, erection of electrical cables, fencing of premises of hotels and lodges, use of polythene bags by shopkeepers, widening of roads, movement of vehicular traffic at night,

introduction of exotic species, protection of hill slopes and river banks, air and vehicular pollution, sign boards and hoardings.

3. **Permitted activities:** Ongoing agricultural or horticultural practices by local communities, rainwater harvesting, organic farming, use of renewable energy sources, and adoption of green technology for all activities.

3.12. Gaps & Plan of Action

Other than these restrictions, authorities in the Great Himalayan National Park have published instructions for tourists and trackers, making it mandatory for travellers to carry back non-biodegradable waste and dispose of it away from the GHNP and the eco-zone.

Sr. No.	Gaps	Plan for Action
1.	Lack of awareness among tourists and the local community about the impact of tourism on the environment.	As tourism has shown a drastic increase in the last few years, sustainable tourist activities should be practiced by both local communities as well as by the tourists. Theme based tourism should be implemented for sustainable tourism.
2.	Data on revenue generation from tourism is not available for the entire state.	Data should be made available on total income generation from tourism so that the importance of economic growth from tourism can be assessed.
3.	Data on category wise waste generation, such as, biodegradable and non-biodegradable, at district level is only available for very few ULBs.	Research should be conducted to obtain a basic understanding of the types of waste generated in the ULB's area so that a proper action plan can be developed for scientifically disposing of waste generated according to its type.
4.	There is a huge data gap for the waste segregation recycled, reused, and which is left unutilized.	There are massive data gaps for segregated, recycled, reused, and unutilized waste which should be filled for all the districts of the state to get a clear picture of waste management practices followed by the ULBs.
5.	Details of dumping sites, waste burning or bicomposting is available in a scattered manner and is available only for a few ULB dumping sites.	There is a dilemma with information about dumping sites because most of the ULBs do not have landfills, but waste is nevertheless disposed off at dumping sites, according to reports. The reporting on waste dumping needs to be made

		clear.
6.	Air quality data available only for limited stations.	More monitoring stations should be established so that the accurate air quality of each district can be estimated.
7.	Lack of air quality data in rural areas.	Although air pollution is relatively low in rural areas; still, monitoring stations should be established in rural areas to assess the impact.
8.	Lack of monitoring of all parameters of air quality.	All parameters such as surface ozone and black carbon should also be monitored in all monitoring stations.
9.	Lack of data on all the basic water quality parameters. Data were available only for 2-3 parameters.	Data should be provided in a proper portal. All the basic parameters (physical, chemical and biological) should be monitored regularly so that the impact of tourism on water quality can be assessed.
10.	There has been no report or research done so far on the direct effect of waste on biodiversity loss in Himachal Pradesh. The qualitative assessment of plant diversity around dumping sites has been done only for six dumping sites.	A detailed scientific study is needed to be carried out for the assessment of floral and faunal diversity around dumping sites, with long-term monitoring of the impact of waste on biodiversity. Other than this, the study of plant diversity can later help in recommending suitable native plants for phytoremediation of dumping sites.
11.	Other than general recommendations for activities permitted or prohibited in eco sensitive zones provided by the Government of India, there is no comprehensive action plan for the management of eco sensitive zones in Himachal Pradesh.	A well-thought-out area-specific action plan is required for the management of eco-sensitive zones in Himachal Pradesh especially regarding proper solid waste management. The preparation of an action plan, particularly for tourism-related activities, should be developed in consultation with local people. For public awareness, the developed action plan should be posted on the websites of the forest department or eco sensitive zones.

3.13. Summary

Accelerated growth of tourism in Himachal Pradesh in the past few years had a substantial impact on its economy, local community and environment. The tourism industry has served an important industry in economic development of people in the state, but as a coin has two sides; similarly tourism has two sides. With increase in tourism, there is increased waste generation, increased vehicles, increased waste disposal into rivers which together have led to degradation of the soil, water and air quality over the period of time. Waste disposition has become a huge problem which needs immediate attention. The total waste generated per day by the ULBs was about 370 TPD which consisted of 190 TDP of biodegradable/wet waste and 150 TPD of non-biodegradable / dry waste. Maintaining and recording the exact data for waste generation is quite difficult while the management of solid waste by the urban local bodies (ULB) of the state is not effective in controlling disposal of waste in a scientific manner. At present, ULBs such as Municipal Corporation Shimla utilizes biodegradable waste for biomethanation, with the end result being biogas. The other type of waste, which has a high calorific value, is processed into Refuse Derived Fuel (RDF). Currently, only ULBs in Manali and Shimla have waste-to-energy power plants. The facility at Manali is still not completely operational due to unforeseen circumstances. Decentralization of waste management, introduction of latest technologies such as automatic bio-composters, plastic brick making machines, etc. can help in robust waste management especially on the hilly cities with limited area for dumping of waste.

The annual mean of all the air pollutants were within permissible limit of annual standards. However, mass tourism may adversely affect air quality in tourist destinations in Himachal Pradesh. It has witnessed an increased number of both private and commercial (taxis) vehicles over a period of time. Some mitigating measures to combat degrading air quality, such as, (i) nature based solutions can be used as a sustainable way to combat air pollution. Some of the sensitive species such as lichens, algae, and trees have been used as bio-indicators of air quality, (ii) improving the vegetation cover/greenery will also help in reducing air pollution, and (iii) some of the plant species have the potential to reduce air pollution through different mechanisms such as bioaccumulation and deposition.The plant species with high Air Pollution Tolerance Index (APTI) value can be used to mitigate air pollution and the species with low APTI value can be used as bio-monitors due to their high sensitivity which can be used to help combat degrading air quality. Regular monitoring of water quality, especially monitoring of natural water resources, capacity building and awareness among the local community and tourists about water quality degradation will help improve the water quality in the region. Further, proper management of sewage waste is required so that it does not mix with other natural water resources which will also help to prevent pollution of water, degradation of land and deterioration of air quality. Several efforts are being made by the government of Himachal Pradesh to protect eco-sensitive zones. Recently, the central government has published a draft notification declaring a 50 square kilometre area around the Nargu Wildlife Sanctuary as an eco sensitive zone. The area declared as eco-sensitive zone which includes 17 revenue villages in Joginder Nagar and Mandi forest division of H.P. (The Indian Express, 19 November 2020). Eco

sensitive zones act as a buffer zone between protected areas and residential areas which make implementation of different laws and policies thus proper tourist management in eco sensitive zones is needed in Himachal Pradesh.

Himachal Pradesh is hosting a huge number of tourists every year. Although, the data of a number of tourists was available, yet due to lack of data availability in revenue generation from tourists there was a gap in assessing the relationship between economic growth and tourism in Himachal Pradesh. Further, there is a lack in regular data of air quality as well as water quality.Data of Eco sensitive zones was also not available, thus it was difficult to assess the impact of tourism on eco sensitive zones.

Thematic based tourism such as ecotourism, and awareness and capacity building programs should be organized to sensitize the Government Officials which sould be field based pertaining to local as well as tourist community and should be aware about the ill-effects of tourism in the environment. Installation of more equipment with the latest technologies is required at all districts both in urban as well as rural areas to monitor air quality which will be helpful to assess the exact impact of tourism on air pollution. Further, industrial areas should use dust setters and scrubbers to minimize pollution. Biofuel can be used as an alternative to minimize the pollutants. Further, plantation of green belts in urban areas will minimize the effect of air pollution in the region. Water quality monitoring parameters and its frequency (seasonal) need to be expanded. Monitoring of heavy metals is also suggested. Waste disposal in a proper way should be done by municipal corporations so the generated waste could not be disposed of in rivers. Further, more water purification systems should be installed in the region. In many regions, waste generated in urban areas is generally collected in a segregated manner. However, garbage collection need to be more efficient and frequent. Also, the appropriate places for constructing scientific landfills to dispose of waste need to be managed by practicing vermicomposting and RDF production. Also, decentralization of trash management should be encouraged to improve waste collection and management efficiency.

Uttarakhand

4.1. Introduction

Tourism sector is important for Uttarakhand in view of its immense contribution to both employment and income generation. Uttarakhand ranks 12th in tourism in India, and presents a vast scope to improve the ranking. The state is situated in the foothills of Himalayas. The presence of several hill stations, wildlife parks, pilgrimage places & trekking routes make Uttarakhand an attractive tourist destination. Mussoorie, Corbett, Almora, Ranikhet, Bhimtal, Kausani, Dhanaulti, Chakrata, Lansdwon, Mukteshwar, Chamba, Auli, Binsar, Pauri, Valley of flowers, Chopta and Nainital are some of the most frequent tourist destinations in Uttarakhand. Some of the holiest Hindu shrines are also situated in the region such as Badrinath, Kedarnath, Gangotri and Yamunotri where pilgrims visit in the hope of salvation and self-purification (Fig.4,1). With very heavy religious and spiritual tourism in Uttarakhand, tourism contributes a major portion of GSDP. Under the Swadesh Darshan scheme launched by the Govt. of India during 2014-15, National Mission on Pilgrimage Rejuvenation and Spiritual, Heritage Augmentation Drive (PRASHAD) was launched through which Badrinath, Kedarnath and Gangotri- Yamunotri were identified for development in Uttarakhand. For the integrated Development of Heritage Circuit in Kumaon Region of Uttarakhand, Katarmal–Jageshwar-Baijnath-Devidhura are also taken under Swadesh Darshan scheme (Annual Report 2019-2020, Ministry of Tourism, Govt. of India). Eco-circuit is being developed at Tehri- Chamba- Sarain around Tehri Lake in Uttarakhand (Annual Report 2020-2021, Ministry of Tourism, Govt. of India). In January 2018, to boost tourism the Central Govt. launched the regional connectivity scheme as 'Udan' which will help the low-income group people to fly easily on affordable air fares.

As per Environmental Performance Index 2012, Uttarakhand ranks 16 among all the Indian states. This index, used at the national level, is guiding as it combines categories such as air pollution, water, forest, waste management and climate change as defining criteria of Indian states (Maximum Ranking Score: 1) to assess their environmental performance index. Uttarakhand ranked 25 for air pollution, 28 for water pollution, 26 for waste management, and the best performance was in terms of forests, where the state ranked 5th position. Continuous increase in tourist inflow may further damage the environment if not managed in a sustainable way.

Sundriyal et al., (2018) studied impact of tourism development on environment in Mussoorie by analyzing traffic management; ambient air quality; Municipal Solid Waste (MSW) generation; water demand and supply; infrastructure availability and development during 2014-15. Heavy traffic congestion was observed during peak tourist season. Fine particulate matter was found higher during summer, which might be associated with the higher inflow of vehicles while in winters, coarse particulate matter was high. No significant difference in average Black Carbon concentration was observed during winter and summer, although the contributing factors were found varying in both the seasons. In winters 23% contribution was from biomass burning while it was only 8% during summer.

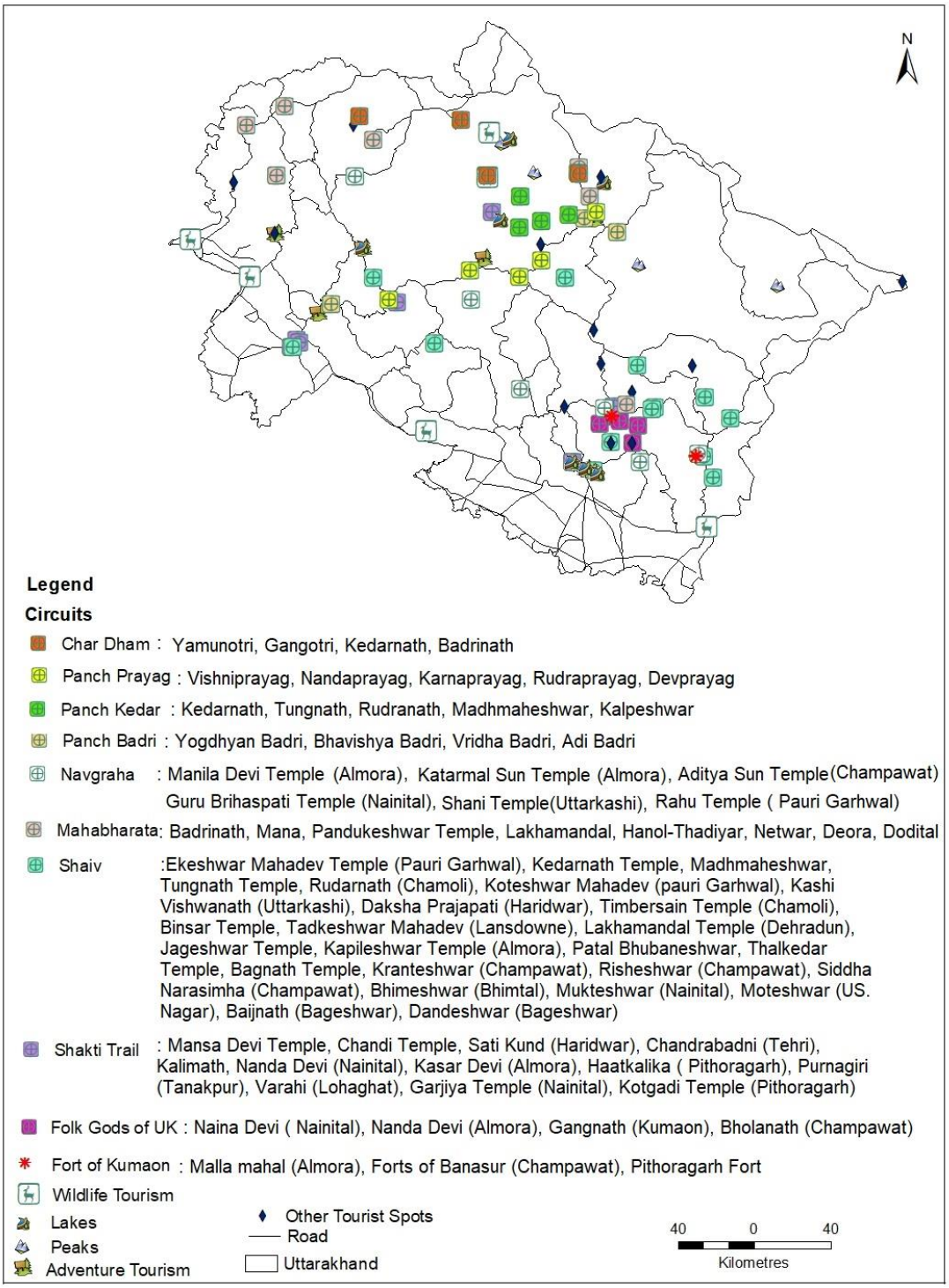


Fig. 4.1: Major tourist spots & circuits in Uttarakhand

So, vehicles might be the main contributors of BC during summer. Littering by tourists all over the places was also observed along with unattended waste bins. Municipal solid waste (MSW) production was found correlated with the tourist inflow. The MSW composition was also studied which consisted of 66% wet waste and 34% dry waste. Plastic waste was the major contributor

in dry waste. Another problem was of water shortage during peak tourist season (Sundriyal et al., 2018).

Construction of hotels, restaurants and commercial centres is also increasing rapidly to cater tourists in different parts of the state, which is adding up to the problem of water shortage and liquid and solid waste generation. So, all these areas along with other issues need to be worked on. The tourist's inflow is on the one hand economically beneficial, while on the other hand it can be harmful for the environment if not managed in a sustainable way. As the tourist attracts towards the natural environment of Uttarakhand, so they may unknowingly harm the plant diversity present in the natural habitats. So, the status of plants, mainly the threatened plants as per the IUCN list, should be known for making favourable policies for their protection. Figure 4.2 depicts that out of IUCN categories threatened plants 84.68% plant diversity is of least concern, 3.23% is critically endangered, 4.84% is endangered, 2.42% is vulnerable, and 4.03% is data deficient.

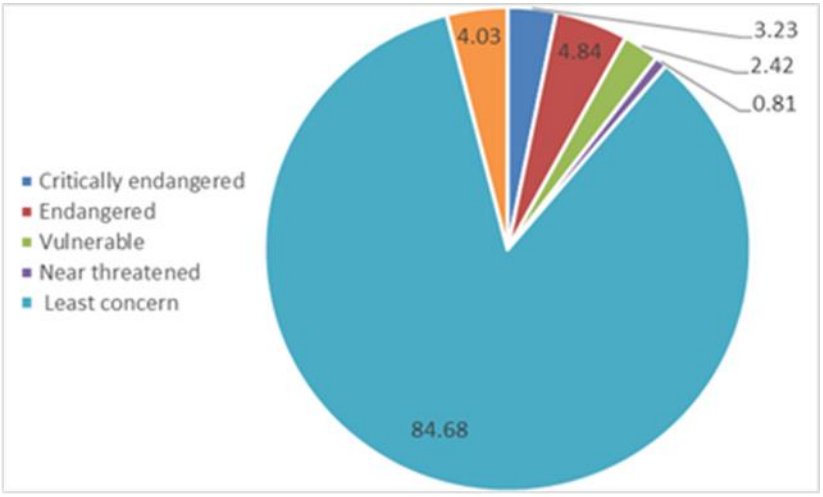


Fig. 4.2 Percent distribution of plant found in Uttarakhand classified under IUCN threat categories

Tourism growth (number of annual tourists visiting) vis-à-vis economic growth (annual income from tourism). As per Niti Aayog (2018) during 2012-2016, Uttarakhand ranked 2nd in terms of tourist inflow with the total tourists of 24,951,540. Highest tourists' inflow was observed during 2014-15 between 2011 and 2020. In 2019, domestic tourist inflow in the state were 35.60 million and foreign tourist visits had crossed over 0.15 million (India Brand Equity Foundation). It is observed that tourist arrivals can be strongly affected by disasters, which is visible from Uttarakhand data of tourist influx of 20 million in 2013 when tourist numbers dropped. Highest drop (appx. 80%) was recorded in 2020 due to lockdown during COVID-19 pandemic (Department of Planning, 2018) (Fig.4.3). As per the data of Directorate of Economics and Statistics, Uttarakhand, tourism contributed 50% to the total GSDP during 2006-07 to 2016-17 along with the increasing livelihood options for the people residing here (Uttarakhand Toursim Policy, 2018). Hindustan Times (dated 22 May 2022) mentioned that 'According to the State TSA, tourism is estimated to contribute 2.96 per cent directly to the State's Gross Value Added

(GVA) and 11.8 per cent to the State employment. With the inclusion of indirect share pertaining to linkages of tourism with other sectors of the economy, these shares work out to 6.59 per cent in GVA and 26.8 per cent in employment'. It also indicates that there is the likelihood to create well-planned and managed tourism, in which environmental factors and socio-cultural aspects can be well integrated.

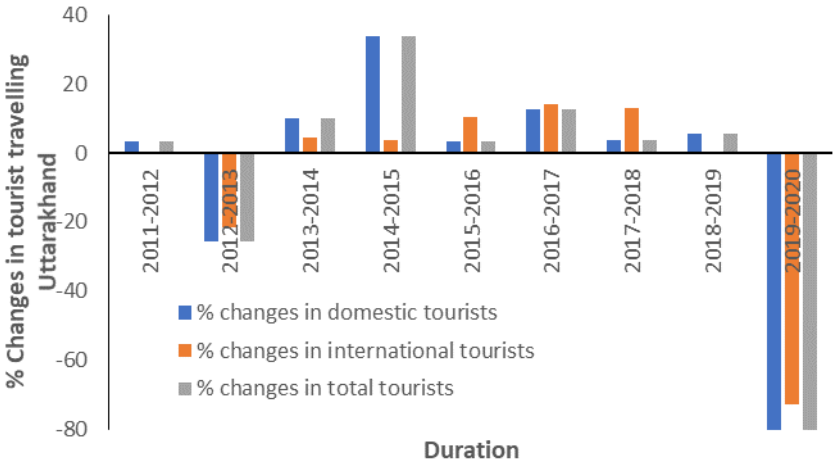


Fig.4.3: Percentage change in tourist during 2011-2020
(*Source : Ministry of Tourism, Govt. of India. (ON1788) and Past Issues*)

With upward trends in tourist numbers in the IHR, it is likely that environmental and social trends and standards will be subjected to change. Apparently, these developmental trends and activities in the IHR have direct or indirect causes and effects such as pollution, overexploitation of natural resources, food insecurity, ill-planned urbanization, traffic congestion, loss of indigenous culture, natural disasters, and so on.

4.2 Assessment of waste generation in Uttarakhand

Worldwide, average waste generated per person per day is about 0.74 kilogram but ranges widely from 0.11 to 4.54 kg per person per day. So, the solid waste management has become a major environmental issue in the IHR. In the name of mountain ecotourism or adventure tourism, the number of tourists, trekkers and mountaineers is increasing rapidly. Consequently, the load of human-induced pollution, solid waste, being deposited in these ecologically sensitive and topographically fragile areas of the mountains is also increasing. In the absence of any formal waste management bodies, and the absence of infrastructural services, the practice of 'leaving behind' self-generated wastes is the major factor increasing the load of garbage in the trekking and expedition locations (Kuniyal, 2005). Rivers, lakes and other water bodies are also being polluted with uncontrolled disposal of solid wastes. As per the available data (2009-2012) IHR states are accumulating 22,372 metric tonnes (MT) of municipal solid waste per day. Figure 4.4 is showing comparative status of total waste generated in different districts of Uttarakhand during 2007-2020, and it is showing continuous increase in total waste generated (TPD).

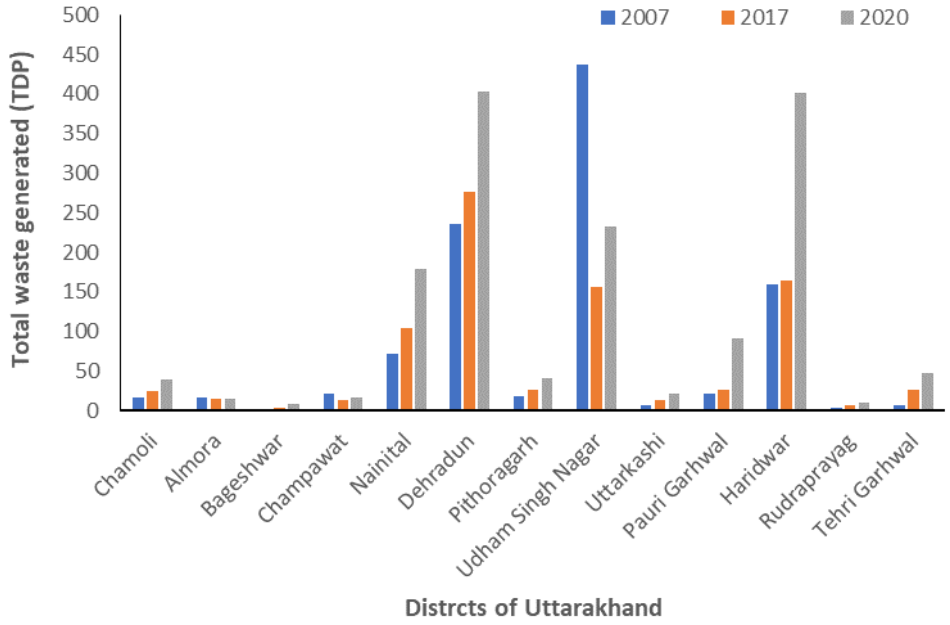


Fig.4.4: District wise status of waste generation in different years in Uttarakhand (*Source: Directorate of Urban Development Uttarakhand, Dehradun on the basis of Swachch Sarvekshan Based on Urban MSW Action Plan, 2017*).

By analysing the status of wet and dry waste generation in different districts of Uttarakhand, over all status of municipal waste generation can be understood (Fig. 4.5). As per 2018-19 Annual Report of Central Pollution Control Board (CPCB), a total of 1527.46 TPD (tonnes per day) solid waste was generated, 94% of which was collected and appx. 524 TPD was treated (CPCB, 2019).

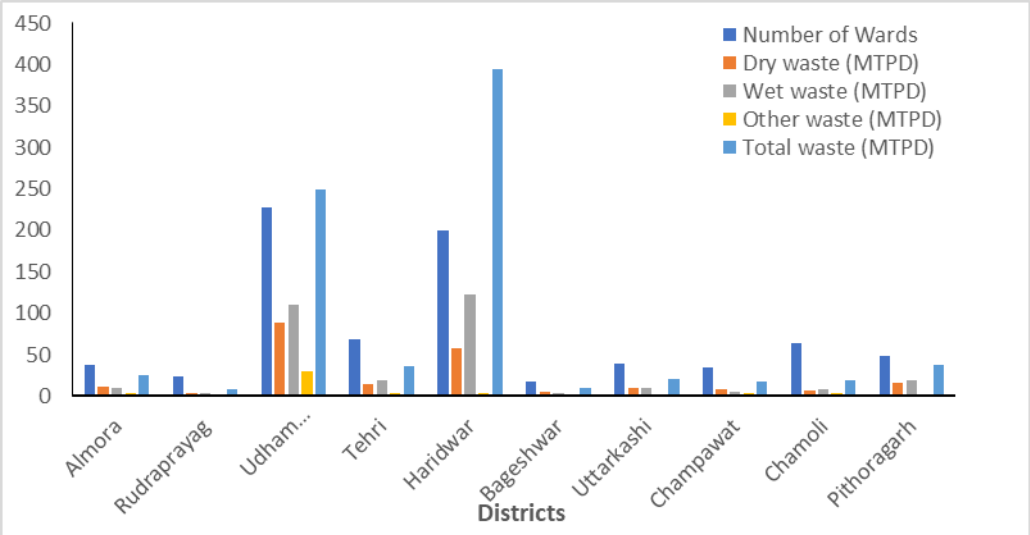


Fig.4.5: Solid waste management bodies and segregation of wet and dry waste in some of the districts of Uttarakhand (District Administration, 2021) Waste disposal/ treatment facilities

The importance of waste management along with good water quality has received much attention in the context of sustainable development. Various schemes such as the Swachh Bharat Abhiyan (2014), National River Conservation Plan (1995), Swajal Dhara (2002), Namami Gange Programme (2014) for Solid Waste Management, Urban Sewage Treatment Plants, Rural Water and Sewerage Scheme and Jalagam/Watershed Management Plans have been brought in by the government at the central and state levels. Uttarakhand, placed in an extremely fragile ecological zone, is currently reeling under enormous quantity of waste being generated by its towns and cities, which are also urbanizing at a rapid pace added with extra pressure from floating population due to tourism, one of the most critical sectors of the State economy. Most of the districts in the state are hilly and are highly neglected in terms of solid waste management as most of the facilities are available in the plain cities like Dehradun, Haridwar and Haldwani. The hilly terrains make waste management significantly difficult however, such reasons should not hinder development of waste infrastructures in the hilly areas as these are home to a large floating population generating waste in enormous quantities which should be addressed on an urgent basis

As per the survey conducted by UKHDR, the behaviour/ choice for disposing garbage/ solid waste found varied among the districts (Fig.4.6). The most preferable choices were either disposal of garbage at open spaces or at fixed places near the premises where they are residing. As per Hindustan Times report (Dt. 10 March 2018), there are 912 wards in the state, of which only 3% (29 wards) have the facility of 100% segregation of waste at source. Furthermore, there are 21% wards (715) that still do not have 100% door-to-door collection of solid waste. Currently here are 91 Urban Local Bodies targeting the population of 3440814, generating 1551.76 MTPD solid waste (Uttarakhand Pollution Control Board Order No. UKPCB/HO/GPI (TPI)-GCM/476 (II/7130-1415) Dt. 22 Feb, 2021).

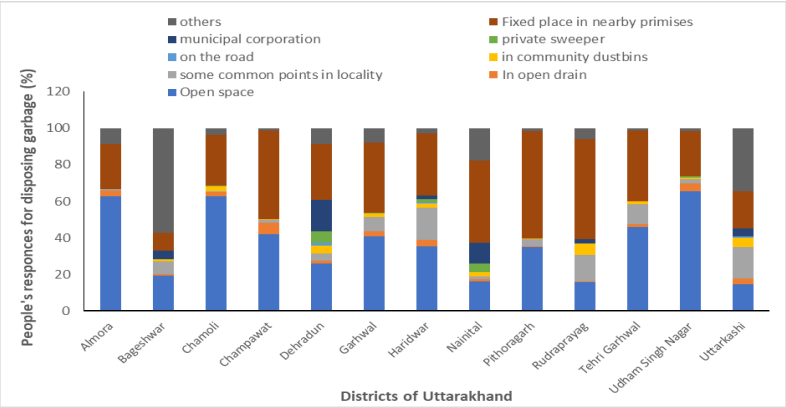


Fig.4.6: People's choices for disposing garbage in the districts of Uttarakhand (2017)
(Source: Uttarakhand Human Development Report)

In the year 2016, the Government of India enacted "Solid Waste Management Rules, which is the upgraded form of Municipal Solid Wastes (Management and Handling) Rules, 2000 (SWM, 2016). There are a total of 90 ULBs and 09 Cantonment Boards responsible for implementation of the SWM Rules (2016), in the State, but most of the ULBs in Uttarakhand do not comply with the prescribed guidelines. Although it is said that door-to-door collection of solid waste is practiced in all the wards but the segregation of waste at source is not carried out in all wards. Appropriate technology is often not adopted for disposal and processing of wastes owing to limited number of treatment plants. As per the office order of Ministry of Housing and Urban Affairs (No.1/18/2015-SBM) Dt. 2 December 2020, Uttarakhand Government is working on SWM in different areas. 11 SWM projects are completed; 11 SWM projects are in first phase targeting the cities such as Dehradun, Haridwar, Almora, Jaspur, Karnprayag, Joshimath, Gaucher, Uttarkashi, Muni-ki-Reti, Purola, Pokhri; 4 SWM projects are in first phase in Pithoragarh, Sitarganj, Badrinath, and Tehri-Garhwal; 2 SWM projects are completed in Srinagar and Naogaon; 3 SWM projects are in first phase in Ramnagar, Nanakmatta, Piran Kaliyar; 6 SWM projects are in second phase in Chamoli, Gopeshwar, Agastmuni, Joshimath, Gauchar, Kapkot and Almora; and 17 SWM projects are in first phase in Nand Prayag, Ranikhet, Chiliyanaula, Gangolighat, Badahaat, Uttarakhshi, Gangotri, Gadarpur, Gairsain, Ukhimath, Bhikyasen, Chapawat, Didihat, Satpuli, Dharcula, Gaja, Lambgan, Tanakpur, Banbasa, Chinyalisaur and Khatima. There are 71 STPs installed in different areas of Uttarakhand with the total capacity of 448.18 MLD and the operational capacity of 345 MLD while the total sewage generation is around 627 MLD. The District of Uttarkashi has a great religious significance as it is referred to as the Kashi of North. Two out of the four major Dhams, namely Gangotri and Yamunotri are also in this district, thus becoming the birthplace of two most important rivers of India, Ganga and Yamuna, respectively. This place invites a number of tourists in the Char Dham Yatra season and the number is ever increasing. As per the District Administration, Uttarakashi (2021), the quantity of sewage generated from the households is 0.010 MLD during the Yatra Season and 0.005 MLD in the non-Yatra Season. The STP installed at Gangotri is of 1 MLD capacity. Good practices are implemented in the towns of Dehradun and Hardwar. Door-to-door waste collection is initiated in 1106 wards out of total 1170 wards. Source segregation of waste is being carried out in 366 wards. There are two compositing facilities setups in the State. 13 landfill sites are identified in the State, 2 landfill sites have been constructed (Nagar Nigam Dehradun and Nagar Nigam Haridwar) while 2 landfill sites are in operation. Total number of existing dumpsites in the State are 42 (CPCB, 2019).

4.3 Ill effect of tourism on Air quality

Due to high inflow of vehicles during tourist season and open burning of waste and biomass during different seasons, quality of air is also getting deteriorated due to the production of harmful gases such as sulphur dioxide, nitrogen oxides, carbon dioxide, carbon monoxide, ozone and particulate matters (PM10 and PM2.5). Figure 4.7 is showing the actual and projected concentration of different types of air pollutants reported in Uttarakhand during 2014,

2016 and 2021 (Kumari et al., 2019). Black carbon is also generated due to open burning of biomass and through fuel combustion.

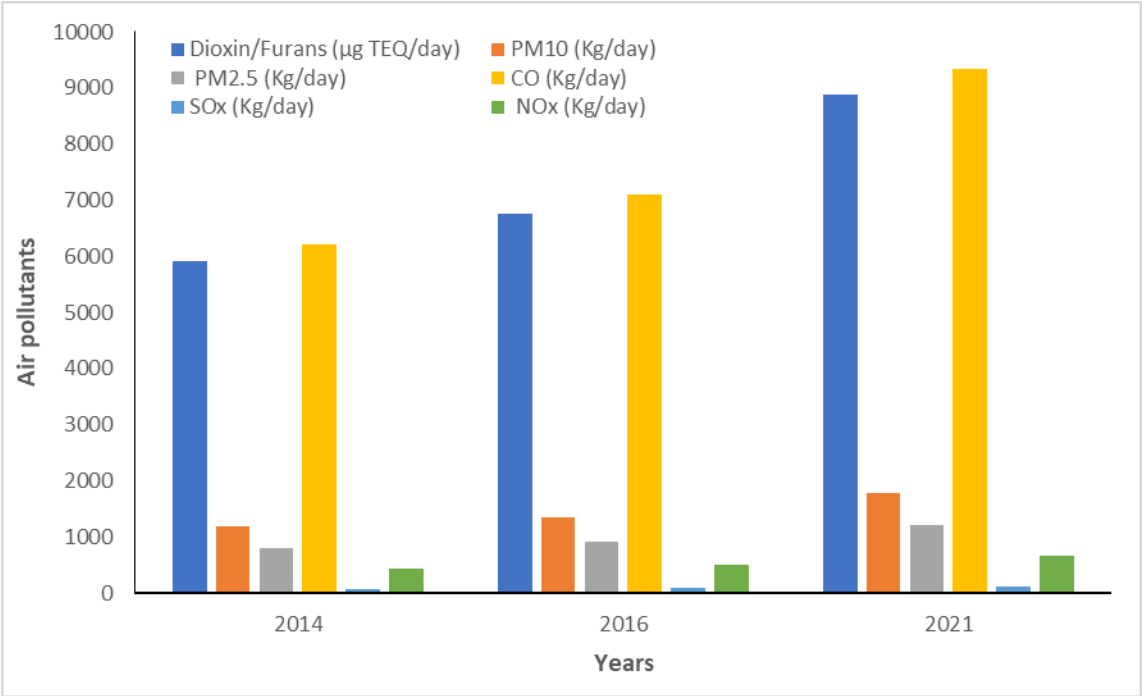


Fig.4.7: Air pollutants distribution in Uttarakhand in different years (*Kumari et al., 2019*)

To tackle the problem of air pollution in the cities, Government of India has taken many steps, one of them being National Clean Air Program (NCAP, 2019. Goal of National Clean Air Program (NCAP) is to meet the prescribed annual average ambient air quality standards at all locations in the country in a stipulated time frame. Under this programme, 122 cities in the country are identified as non-attainment cities which include three cities from the Uttarakhand (Dehradun, Rishikesh and Kashipur). These are the cities that have fallen short of the National Ambient Air Quality Standards (NAAQS) for over five years. For continuous monitoring of air quality, air monitoring stations are being installed at different locations (Fig.4.8). SOx and NOx gas level was found satisfactory while particulate matter content was observed at higher side, which need to be taken care by the concerned department.

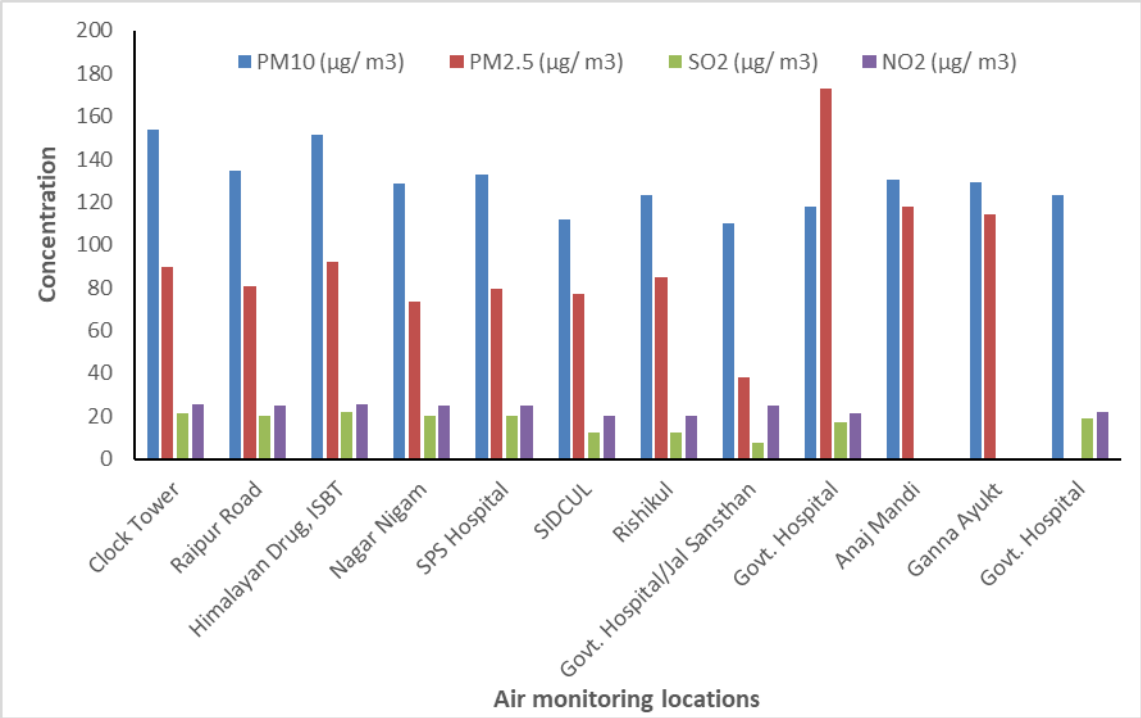


Fig.4.8: Air quality monitoring parameters in some of the cities of Uttarakhand (Source: Central Pollution Control Board)

*Average data based on 2019-2021 datasets, Time weighted annual average for PM10 is 60 µg/m3, SO_2 is 50 µg/m3 and NO_2 40 µg/m3 as per National ambient air quality standards in India.

The air scrubbing facility is not installed as per the current knowledge but as a preventive measure for dealing with the air pollution in eco-friendly way, first urban forest known as Anand Van is developed in Jhajra Forest Range of Dehradun. It is spread in 50-hectare area ***(euttaranchal.com)***. In August 2020, development of 6 city forests was also announced with the target of increasing green cover in urban spaces of the state. In this regard, 10-hectare land has been identified in Udham Singh Nagar and Haldwani (Nainital) and the selection of land is under process in hilly areas of Kumaun region. The plant/ tree species, found in Uttarakhand, which are having capacity to reduce the harmful effect of gaseous pollutants is enlisted in Table 4.1.

Table 4.1: Plans/ tree having the potential to reduce gaseous and particulate matter contamination from the environment (**https://ueppcb.uk.gov.in/pages/display/218-draft-district-environment-plan-state-environment-plan**

Sr. No.	Scientific Name	Vernacular Name
1	*Butea monosperma*	Purasu
2	*Cassia fistula*	Sarakkonnai
3	*Cassia siamea*	Kassod Tree
4	*Casurina equisetifolia*	Casurina
5	*Cedrella toona*	Tun
6	*Dalbergia sissoo*	Sisam
7	*Ziziphus mauritiana*	Beri
8	*Acacia nilotica*	Kikar/Babul
9	*Melia azedrach*	Neem
10	*Prosopis spicegera*	Jand
11	*Ficus bengalensis*	Bohar
12	*Ficus religiosa*	Pipa
13	*Salvadora oleoides*	Van
14	*Albizia lebbeck*	Siris
15	*Acacia leucocephala*	Reru
16	*Dillenia indica*	Naithekku
17	*Erythrina suberosa*	Mulmurungai
18	*Ficus religiosa*	Pipal (Arasu)
19	*Hardwickia binnata*	Aachaan
20	*Madhuca indica*	IIpai
21	*Millingtonia hortensis*	Maramalle

4.4 Ill effect of tourism on water quality / ground water

The state of Uttarakhand is filled with natural sites which play an important social and religious role. This leads to a heavy influx of unsustainable tourism and in return a heavy toll on the environment. Kumaon region of Uttarakhand is blessed with scenic beauty and a variety of natural lakes such as Nainital, Bhimtal, Naukuchiatal, Khurpatal, Sattal, Garurtal and Shyamalatal. The lakes of this region are susceptible to degradation as most of them have developed into famous tourist spots. As per UKPCB, water quality monitoring has been conducted for the Nainital and Bhimtal lake. It can be seen that over the years, DO and BOD has remained more or less the same in both the lakes, however, Total Coliform (MPN/100) was more in Nainital lake. The concentration of Coliforms in water bodies indirectly signals towards contamination with human or animal excreta. On the contrary the amount of Dissolved Oxygen and the Biochemical Oxygen Demand signifies that the water quality of the lake comes under Category A. While analysing the dataset available for important glacial fed rivers of

Uttarakhand, it is observed that the general water quality parameters such as pH, conductivity, DO etc. are found within the prescribed limit while the bacterial contamination is very high in most of the cases (Table 4.2 & 4.3). This might be due to fecal contamination of water resources due to tourist influx in larger number along with the increased settlement in the area.

Table 4.2: Faecal coliform (max count in MPN/100 mL) status in some of the glacier fed rivers of Uttarakhand (**https://cpcb.nic.in/annual-report.php**)

Year	**2012**	**2013**	**2016**	**2017**	**2018**	**2019**
Bhagirathi at Gangotri	Na	Na	Na	2	7	7
Alkananda B/C Mandakini at Rudra Prayag	Na	Na	Na	240	2300	2
Mandakini B/C Alkalnada at Rudraprayag	Na	Na	Na	170	450	2
Alkananda A/C Mandakini at Rudraprayag	Na	Na	Na	Na	780	2
Alkananda B/C To Bhagirathi at Devprayag	Na	Na	Na	Na	780	2
Bhagirathi B/C With Alaknanda at Devprayag	Na	Na	Na	Na	36	2
Alkananda A/C With Bhagirathi at Devprayag	Na	Na	Na	Na	490	2
Ganga At Rishikesh U/S	Na	Na	Na	22	26	40
Ganga After Confl. Of River Song Near Satyanarayan Temple D/S Raiwala	Na	Na	Na	90	110	110
Ganga at Haridwar D/S	Na	Na	Na	Na	Na	230
Upper Ganga River D/S Roorkee	Na	Na	Na	Na	Na	90

Table 4.3: Total coliform (max count in MPN/100 mL) status in some of the glacier fed rivers of Uttarakhand

Year	2012	2013	2016	2017	2018	2019
Bhagirathi at Gangotri	Na	Na	Na	11	179	9
Alkananda B/C Mandakini at Rudra Prayag	Na	Na	Na	9500	7000	2
Mandakini B/C Alkalnada at Rudraprayag	Na	Na	Na	16000	4900	2
Alkananda A/C Mandakini at Rudraprayag	Na	Na	Na	Na	24000	2
Alkananda B/C To Bhagirathi at Devprayag	Na	Na	Na	Na	24000	2
Bhagirathi B/C With Alaknanda at Devprayag	Na	Na	Na	920000	630	2
Alkananda A/C With Bhagirathi at	Na	Na	Na	Na	2400	2

Devprayag						
Ganga At Rishikesh U/S	Na	Na	Na	80	70	401
Ganga After Confl. Of River Song Near Satyanarayan Temple D/S Raiwala	Na	Na	Na	280	350	280
Ganga At Haridwar D/S	Na	Na	Na	1600	350	350
Upper Ganga River D/S Roorkee	Na	Na	Na	1600	220	170

There are many springs fed perennial rivers flowing in the state such as Kosi, Ramganga etc, the water quality of which may be affected by the contamination of both the surface water as well as groundwater. Table 4.4 represent some of the water quality parameters in polluted stretches of different rivers, where major cause of concern is total and faecal coliform, which shows either open defecation or release on untreated sludge water in the river stretches.

Table 4.4: Status of some of the water quality parameters in stretches of polluted rivers of UK (https://cpcb.nic.in/annual-report.php)

Name of Polluted River stretches		pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	EC (µS/cm)	TDS (mg/L)	TSS (g/L)	Total coliform (MPN/100 mL)	Faecal coliform (MPN/100 mL)
Dhella	US	7.9	4.8	4	10	410	244	90	430	220
	DS	7.3	1	48	160	910	684	164	1600	540
Bhella	US	7.9	3	6.9	30	540	348	50	240	130
	DS	7	1	30	150	730	486	142	1600	920
Kichha	US	8.2	6	3.8	16	660	405	70	350	170
	DS	8.1	2.8	7.1	36	920	750	68.7	≥1600	920
Suswa	US	7.6	2.8	28	106	916	620		≥1600	≥1600
	DS	7.8	7.8	2	6	805	530		84	48
Kalyani	US	8.1	3.4	6.5	30	590	377	85	220	140
	DS	7.3	0.8	28	90	710	420	81.2	1600	540
Kosi	US	8	4	6.2	20	750	495	98	920	430
	DS	8.1	1.8	10	40	780	497	76	≥1600	920
Pilakhar	US	8.3	5.2	4.8	20	800	521	20	350	110
	DS	8.2	6	4.2	24	770	503	25	540	280
Nandhour	US	Stream dried								
	DS	8.4	8	3.4	12	420	288	92	920	540
Ganga	US	7.5	8.2	1.2	6	242	155		110	70
	DS	7.7	8.8	1.6	8	229	148		130	70

*US: Upstream; DS: downstream

Many sewerage treatment facilities are constructed in the recent times near the urban settlements situated along the banks of the river. A total installed capacity of 4.45 MLD at Gopeshwar, 1.08 MLD at Joshimath, 0.35 MLD at Karanprayag, 1.01 MLD at Badrinath and 0.15 MLD at Nandprayag have been constructed to treat the sewage. Treatment plants are constructed under 'Namami Gange' mission to prevent the possible contamination of the holy river. These mitigative measures have led to betterment of the water quality in the year 2019. Similarly, in the Tehri Garhwal district, the major river systems are Bhagirathi, Alaknanda, Ganga, Yamuna and Bhilganga. Sewage treatment infrastructure has been developed in the district under National Mission for Clean Ganga (NMCG). Total 9 STPs are currently operational in Ganga priority towns as envisaged under Namami Gange project. The treatment of wastewater before releasing into the river system saves it from the repercussions of the unsustainable tourism.

4.5 Impact of tourism on Forest and Biodiversity

The Uttarakhand state is popular for its biodiversity which is protected through various National parks such as Valley of Flowers (National Park), Nanda Devi National Park, Rajaji National Park, Corbett National Park and wildlife sanctuaries such as Askot Sanctuary, Kedarnath Sanctuary, Govind Wildlife Sanctuary etc. The state government is committed towards increasing forest cover and for protecting floral and faunal diversity. India's first Snow Leopard Conservation Centre is going to be developed in Bhaironghati area of Uttarkashi district with the collaborative efforts of forest department of Uttarakhand and United Nations Development Programme (UNDP). Total forest cover including very dense, medium dense and open forest cover is shown as Figure 8. While analysing the forest cover changes during 2011-2021, appx. 10% decrease in medium dense forests were observed (Fig.4.9). Data on loss of biodiversity due to waste disposal is not properly studied, but the unprecedented wastes are significantly changing the wildlife scenario in the Himalayas as extensive littering has altered the hunting abilities of many critically endangered species and other wildlife (Puri et al., 2020; Thakur et al., 2021).

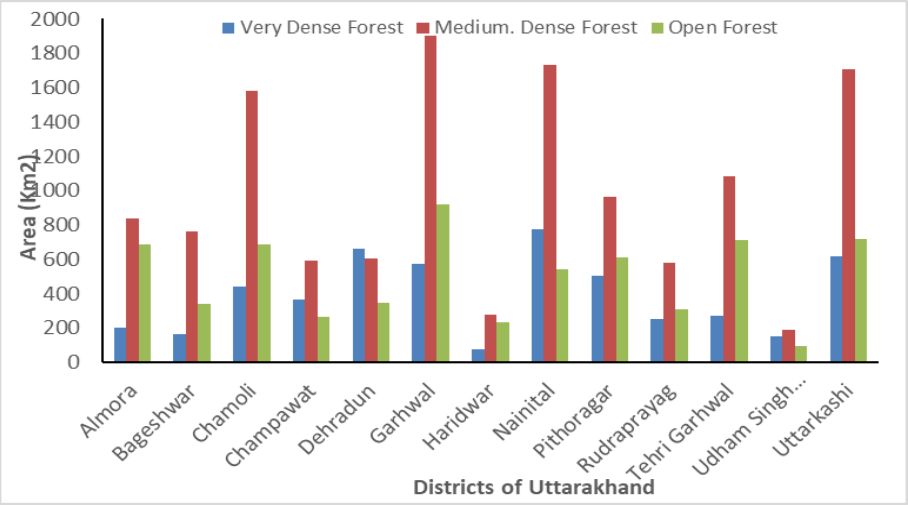


Fig.4.9: Forest cover of Uttarakhand in 2021

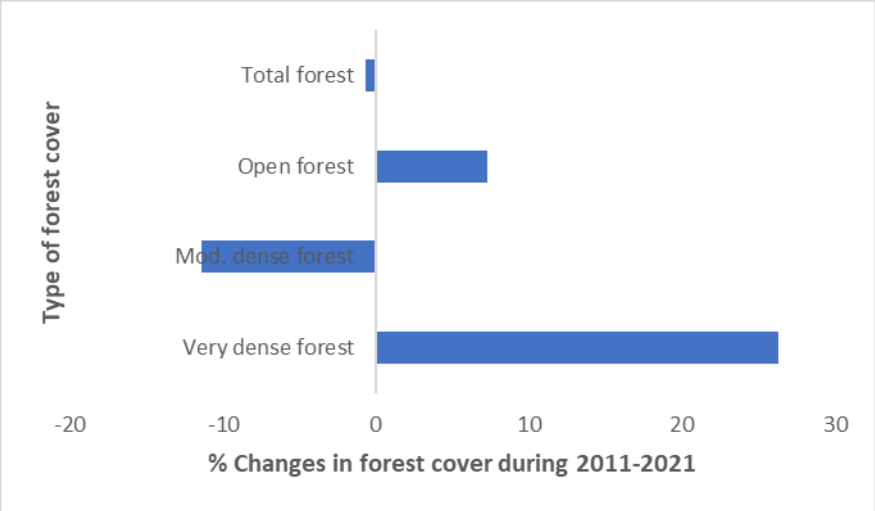


Fig.4.10: Changes in different type of forest cover during 2011-2021
(*Source: Forest Survey of India, Dehradun. India State of Forest Report 2021*)

4.6 Eco-sensitive zones/ Areas

Eco sensitive zones (ESZ's) also known as Ecologically Fragile Areas (EFA's) are areas notified by the MoEF&CC around Protected Areas, National Parks and Wildlife Sanctuaries. These ESZ's act as transition zones between highly protected areas and low protection areas. The purpose of declaring ESZ's is to create some kind of a protection to the PAs and sensitive corridors by regulating and managing the activities around such areas and ecologically important patches. Therefore, all identified areas around PAs and wildlife corridors are to be declared as ecologically fragile under the Environment (Protection) Act, 1986 (National Wildlife Action Plan, 2002-2016). An ESZ can go up to 10 km around the PA as per the above plan. The basic purpose is to regulate certain activities around National Parks and Wildlife Sanctuaries so as to minimize the negative impacts of anthropogenic activities on the fragile ecosystem encompassing the protected zone. According to ESZ guidelines, activities such as commercial mining and the establishment of sawmills and industries causing pollution are prohibited in such areas. It also prohibits tourism activities like flying over protected areas in an aircraft or in a hot air balloon and discharge of effluents and solid waste in natural water bodies or terrestrial areas. Felling of trees, drastic change in agriculture systems and commercial use of natural water resources, including groundwater harvesting and setting up of hotels and resorts, are also regulated in these areas. Some of the important ESZ in Uttarakhand are briefly mentioned below:

Uttarakhand has Nandhaur Wildlife Sanctuary ESZ, Bhagirathi ESZ, Nanda Devi National Park ESZ, Askot Wildlife Sanctuary, Binsar ESZ and many others are in the line of declaration as ESZ for protection of environment and biodiversity. Nandhaur tiger reserve was declared a sanctuary

in 2012 and opened for visitors in 2015. Nandhaur Wildlife Sanctuary is located in two districts namely, Nainital and Champawat districts of Uttarakhand and spread over an area of 270 sq km, is the home to tiger, wild elephant, leopard, jungle cat, nilgai, small Indian civet, jackal, wild boar, flying foxes and sloth bears, as well as over 200 species of birds. The Bhagirathi ESZ notification from Gaumukh to Uttarakashi covering an area of 4179.59 sq. km was issued by the MoEF&CC on 18th December 2012 keeping in view the requirements of the local people without affecting their rights and privileges and also ensuring eco-friendly development for their livelihood. The MoEF&CC had declared 454.65 square km around the boundary of The Askot Wildlife Sanctuary in the Pithoragarh district of Uttarakhand with as the ESZ. The notified area extends from 0 to 22 km around the Askot Wildlife Sanctuary. The Askot Wildlife Sanctuary was established to protect the endangered flagship species Musk Deer and its habitat and also known as Musk Deer Park. In 2012, the MoEF&CC declared an area between Gaumukh to Uttarkashi, spread over 4,179.56 square km, including 88 villages, as Bhagirathi ESZ. Binsar Wildlife Sanctuary (47.07 Sq. Km.) about 22 km from Almora city is an important and well-known sanctuary for rich flora & fauna diversity. The extent of ESZ varies from 300 meter to 3 kilometers around the Binsar Wildlife Sanctuary with an area of 81.63 square km. The state government is also contemplating to declare ESZs in all the buffer areas of the remaining national parks and wildlife sanctuaries.

As per the action plan for management of eco sensitive zones, there should be proper facilities of waste treatment, prohibition in construction activities, should have proper traffic regulations and ESZ authorities have to manage other gap areas. But there is no secondary data available as per the web records, so such data sets including tourist visit details, vehicles entering with the ESZ, along with other prescribed guidelines should be available on the web portal.

Table 4.5: Regulations mentioned in the ESZ Gazette Notification for important PAs of Uttarakhand

Name of the ESZ	Area	Operational/ active action plans (Prohibition of construction/ Traffic regulation etc.)
Nandhaur Wildlife Sanctuary ESZ	540.267 sq. km.	As per Gazette of India CG-DL-E-26052020-219552 for Nandhaur Wildlife Sanctuary ESZ, new construction of hotels and resorts shall not be allowed within one kilometre from the boundary of the protected area or up to the extent of the ESZ, whichever is nearer. The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions as per the zonal master plan.
Bhagirathi ESZ	4179.59 sq. km.	The construction of various buildings, hotels, resorts in the ESZ shall strictly follow the traditional concepts and

		architecture of the area. The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions as per the zonal master plan.
Nanda Devi National Park ESZ	270 sq. km.	As per Gazette of India for Nanda Devi National Park ESZ , no new construction of hotels and resorts shall be allowed within 1 km from the boundary of the Wildlife Sanctuary or upto the extent of the ESZ whichever is nearer. The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions as per the zonal master plan
Askot Wildlife Sanctuary ESZ	454.65 sq. km.	As per Gazette of India for Askot Wildlife Sanctuary ESZ, new construction of hotels and resorts shall not be allowed within 1 km from the boundary of the Wildlife Sanctuary or up to the extent of the Eco-sensitive Zone whichever is nearer. The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions as per the zonal master plan
Binsar ESZ	81.63 sq. km.	As per Gazette of India CG-DL-E-25092021-229953 for Nandhaur Wildlife Sanctuary ESZ, no new construction of hotels and resorts shall be allowed within 1 km from the boundary of the Wildlife Sanctuary or up to the extent of the ESZ whichever is nearer. The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions as per the zonal master plan

4.7 Gaps & Plan of Action

Sr. No.	Gap areas in relation with tourism and environment	Recommendations
1.	Lack of proper documentation of tourist inflow in hill stations except few places	Online registration of all the tourists (domestic/foreigners) coming to major sensitive and fragile tourist areas/ tourism types may be incorporated in the guidelines along with the details of private or commercial vehicles registered for tourism purposes.
2.	Documentation of vehicles used by the tourists is completely missing	In the online tourist registration form, details of personal vehicles used for travel should be made essential. All the commercial vehicles used for tourism may have a barcode system. This step may be

		used for automatic scanning at major locations/entry points. Here, vehicles entering into the hill stations may be checked under the pollution norms. Nainital is following such option, but has a scope of further modification.
3.	The initiatives on waste collection data, segregation of such waste and further usages is being taken care by different district administration of the state, but proper management as per SWM guidelines are yet to be complied. Along with this, the waste management works are mainly concentrated in specific areas, while the exact tourist locations are missing as most of the resorts or hotels are being developed at outskirts of the main stations, especially for the tourists who want to enjoy the natural beauty of the area.	All the resorts / hotels and similar type of setups should be directed to develop waste management sites, mainly for dry waste and treatment of dry waste should be taken care by the local administration. The pictorial banners should also be installed at various places on the route to hill stations, for making the tourists aware about not throwing waste on the road here and there.
4.	Air quality monitoring is localized in definite locations only and its remediation measures missing, although ecological measure are taken care in some of the big cities of Uttarakhand	Air quality monitoring stations (solar energy based) should be installed at all the major hill stations. This would help for getting the actual picture of particulate matter ($PM_{2.5}$,PM_{10}), SO_x and NO_x gases, black carbon and other gaseous pollutants. Data retrieval system should be in place for user agencies.
5.	River water quality data along with polluted stretches is available for some locations but water availability data is missing in most of the hill stations and tourist locations.	Water crisis during tourist season is very common in hill stations of Uttarakhand. These are mainly located in higher altitudes. So inventorization of such water resources, their seasonal discharge rates, and quality measurements is essential. Tourist inflow needs to be regularized in the overcrowded locations. The major resorts or hotels need to be directed to set up purification units for grey water, so that

		it can be used for other uses to avoid the wastage of fresh water.
6.	IUCN list of some of the threatened plants are available for most of the important National Parks and Sanctuaries, but the exact information of impact of tourism on plant diversity is not available	The areas where tourists come in contact with the plant diversity, should have the information of such important plants, so that they can become aware of such plants and will harm them. The PAs staff should be trained to record such impacts by tourism on biodiversity.
7	Information of tourist inflow, vehicle details, biodiversity, solid waste, water, air quality management practices is not available in the form of any report, although in most of the sites, manual entries are being done by the forest staff at the entry gate.	Online entry system should be developed for managing the tourist/ vehicle inflow in such sensitive zones. Renewable energy-based vehicles should be encouraging, wherever possible. Air and water quality monitoring should be done on continuous basis and waste management practices should also be followed as per the action plan of the ESZ.

Summary

In Uttarakhand, tourism sector contributes immensely towards both the revenue generation as well as for the employment generation. Due to the presence of many Holi shrines, Government is putting lot of efforts for enhancing different types of tourism activities and upgrading the facilities for tourists. Under this process, protection of environment should also be considered as an important factor. State database on various sectors were found rich, except the tourism sector. The dataset highlighting the impact of tourist based activities on the Himalayan environment (particularly on the impact of tourism on environmental components such as air, water quality, biodiversity, etc.) is scarcely available or not available in most of the cases, so to establish the relationship between tourism activities and environmental factors is very difficult. Such a study is urgently required for understanding the situation and to make proper guidelines for implementation. In these guidelines, the concept of carryiong capacity of natural resources should be one of the guiding principles for making tourism a sustainable activity over long run.

Sikkim

5.1. Introduction

5.1.1. General scenario of tourism in Sikkim

Sikkim is the least populous state (total population 610,577 as per Census, 2011) in India and the smallest state (geographical area of 7,096 km^2) in Indian Himalayan region (IHR). Climate of Sikkim ranges from subtropical to high alpine. Kanchenjunga, the world's third-highest peak, is located on Sikkim's border with Nepal. Development and promotion of tourism in Sikkim is relatively recent. Until 1990, there were virtually marginal tourism activities primarily because of stringent and the cumbersome Inner Line Permit system which did not help much in promoting tourism. However, with the sustained effort of the state government, Inner Line Permit was relaxed in the year 1990, which led to unprecedented flow of tourists in the successive years. The tourism centres and circuits began slowly developing from Gangtok (East district) and gradually extended to Namchi and Ravongla (South district), Pelling and Yuksum (West district), and Lachen and Lachung (North district) (Fig. 5.1). Further, adventure tourism (e.g. trekking along the Yuksam- Dzongri- Goechala trail) also began to pick up. From 1988 onwards, tourists were also allowed to visit Tsongmo Lake and Nathula Pass. Similarly, relaxation permits for Zuluk in East Sikkim and Gurudongmar Lake, Yumthang Valley and Yumesamdong in North Sikkim, witnessed a surge of tourist flow to these areas. These major milestones in Sikkim's tourism history led to an increase in tourist influx in the state. The tourism in the state further got boost from Government of India's decision to allow leave travel concession (LTC) by Air to the Northeast region (NER) in 2010 for central government employees and the recent "Go East Policy" of the Government that greatly helped socio-economic development of NER including Sikkim. As an impact, the tourism sector received an escalating boost during the period 2010-2019 (except for 2020 & 2021 due to COVID-19 pandemic) with total tourist arrival numbers equalling and surpassing (in some years more than double) the state population. The government upgraded inhouse facilities in departmentally run hotels and lodges and encouraged the private sector to cope up with the tourist accommodation facilities. As a result, today there has been a boom in the hotel business. The natural strength of Sikkim has been aptly supported by the government policies. Sikkim is the first state to have a policy on ecotourism that is strictly implemented. Sikkim has popular home stays where tourists can have first hand experience of rural Sikkim to adventure sports; from ancient monasteries and flamboyant festivals to all the amenities of the modern world. The key features of tourism in Sikkim include Eco-Tourism and Wildlife Tourism, Village Tourism, Adventure Tourism, Wellness, Religious, Culture, Heritage and Pilgrimage Tourism and Community Based Tourism (CBT).

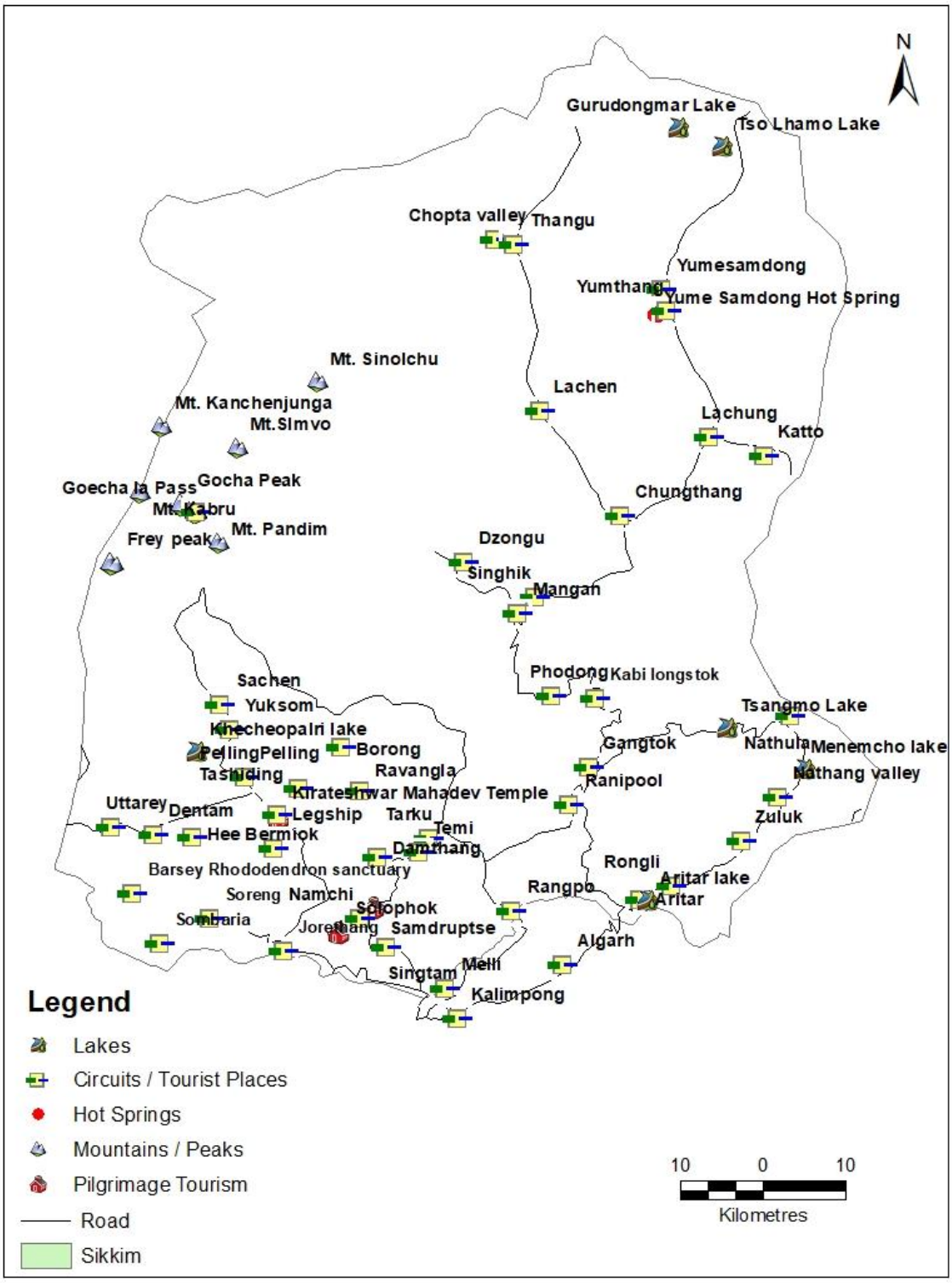


Fig. 5.1: Major tourist spots and circuits in Sikkim

Tourism is emerging as the most Important Civil industry in Sikkim and having realized 'tourism' as a major engine of economic growth, employment generator and poverty alleviation, the Government of Sikkim has endorsed Tourism as "thrust sector" and the year 2010 was observed as Year of Tourism. The Sikkim policy 2010 seeks to make the tourism sector a main civil industry of the state, to enhance employment potential as well as to foster economic integration through developing linkages with other sectors. Sikkim is now the only organic state of the Country that will give it an edge in the future apart from conserving its ecosystem. Some of the pro-tourism initiatives in the state are as follows:

- Educate people by organizing capacity building programmes for the youth and other
- Stakeholders engaged in tourism.
- Single window clearance system has been adopted to license and register travel agents, hotels, lodges and other sectors relevant to it.
- The people are encouraged to preserve the old monuments and heritage sites.
- The Green Mission programme has been launched under which every individual, agency and the department contributes towards the planting of trees all over the state.
- Village tourism is encouraged to preserve culture, heritage and handicrafts and to create better economic and employment opportunities in the rural area.
- Floriculture is being promoted and all the hotels and restaurants have been requested to use natural flowers instead of artificial flowers.

Plastic is banned in the state and the tourists are educated to respect local culture and tradition. Sikkim is a tourist friendly state and during crises such as natural calamities, mishaps and even during roadblocks people and agencies have played a major role in helping the tourists to overcome these problems by coordinating with various other agencies for the safety of the tourists. In order to foster a culture of conservation and to establish an appropriate source of employment for the local residents, the government of Sikkim has structured an ecotourism policy that largely hinges on two primary objectives which are: alleviating poverty and conserving nature. As a matter of fact, Sikkim has emerged as the first state in India that has structured an effective policy for ecotourism with due support and assistance of experts from Japan and America. The outcome of the ecotourism policy that was formulated and implemented by the government of Sikkim led to the state being accorded the status of the cleanest state on the basis of their conservation initiatives. As per the State Ranking Survey (2013), Sikkim was ranked 1st in Luxury Tax on Hotels and State expenditure on tourism during 2011 and 2013. The state ranked 3 in Gross State Domestic Product (GSDP) and ranked 4, especially in intangible aspects which include law and order conditions and safety and security for residents, availability of qualified human resources for travel and tourism and the political stability of the state. The literacy rate is also very high and ranked 8th among other states of India. These factors play an important role to promote tourism in Sikkim.

5.1.2. Tourism growth *vis-à-vis* economic growth

As per the records of Tourism and Civil Aviation Department, Government of Sikkim and India Tourism Statistics, Government of India, trends of tourist influx in the state is monotonically increasing from 2010-11. Tourist arrivals in Sikkim, both domestic and foreign, have witnessed a substantial increase in the last one decade barring the two year's COVID-19 pandemic period (2020-21). This is because of enhanced promotional schemes and campaigns done by the tourism department from time to time. From 55,2453 in 2011, the domestic tourist arrivals have gone up to 14,21,823 in 2019 registering an average growth rate of over 11.3 % per annum (p.a.) during the same period. Similarly, the international tourist arrivals also increased from 23,602 in 2011 to 1,33,388 in 2019 with an average growth rate of over 27.4 % p.a. during 2011-21.

The maximum number of tourists (15,55,216; including 14,21,823 domestic and 1,33,388 international) visited Sikkim in the year 2019 (Fig.5.2 a & 5.2 b). The highest growth for domestic tourists from the base period (2010-11) was recorded (51%) in 2018 and for the international tourists (87.4%) in 2019. However, the number of tourists declined drastically in the year 2020 due to the spread of COVID-19 pandemic and subsequent lockdown across the country. During 2021, the tourists inflow again witnessed a rise in the total number of tourists visiting the state (5,22,997) and registered approximately 55% growth from previous year.

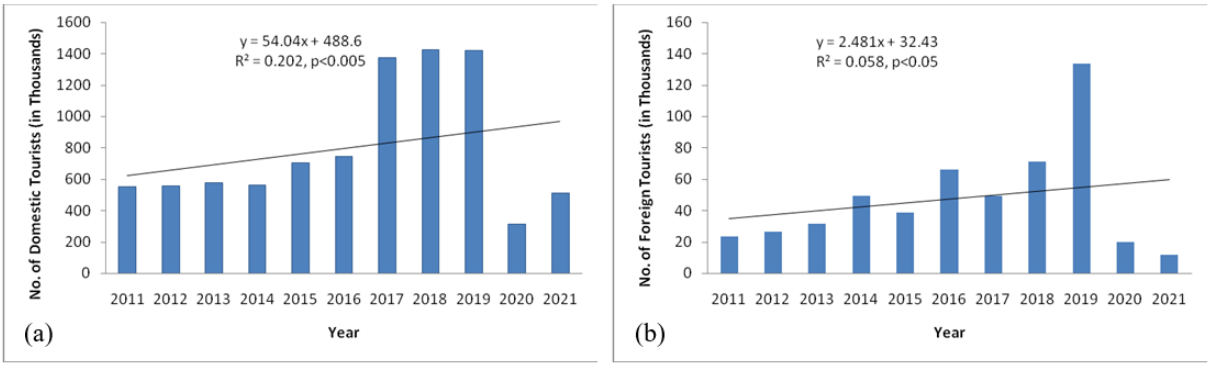


Fig. 5.2: Trends of tourists [(a) Domestic and (b) Foreign] flow in Sikkim (Source: Tourism Statistics, Govt. of India and Tourism & Civil Aviation Department, Government of Sikkim)

However, it has been noticed that there have been year-to-year fluctuations in tourist volume. The data portrays that although there is a growth in arrivals, the state of Sikkim has not been able to maintain consistency in its inbound tourism traffic. However, amongst all the states of IHR, Sikkim was ranked 7th in terms of tourist arrival based on a five year average for the duration 2012-2016. One of the major factors for the North Eastern Region (NER) states lagging behind in ranking is accessibility in comparison to the western IHR states.

Seasonal trend analysis of tourist volume showed that 43% tourists influx was received in Sikkim in summer months (April–June) and approximately 24% influx during winter months (December-February) and 14% during post monsoon months (October–December). The

remaining months (i.e. July–September) have an inflow of approximately 7% of the annual inflow of tourists per month. Similar trends were also observed in earlier studies (Joshi & Dhyani 2009).

Financial aspects of investments made by Sikkim in the tourism sector – with an ever-increasing number of tourist arrivals – become a very significant parameter in assessing whether increasing demand is being met by the supply side. As per the NITI Aayog (2018), revenue receipts in Sikkim are second highest amongst NER states after Assam and accounts worth approximately Rs. 45,000 (thousands) annually against the annual expenditure of Rs. 1,180,622 (thousands) on tourism sector and total expenditure of the state of Rs. 62,218,255 (thousands). Among all the IHR states, Sikkim accounts for the highest investment in the sector i.e. 1.9% of the total state expenditure. All other IHR states invest less than 1%. Tourism sector in Sikkim has been contributing 2-3% to the GDP in the state and barring Sikkim, all mountain states show a slightly decreasing contribution of tourism to the GDP of the respective state (NITI Aayog, 2018). As per the information from Sikkim Tourism Development Corporation (STDC), the tourism sector suffered losses to the tune of Rs. 600 crore in the year 2020 due to the COVID-19 pandemic (Table 5.1).

Table 5.1: Details of the non-tax revenue raised during the period 2013-14 to 2017-18 from Tourism sector (Rs. in crore)

Year	Budget estimate	Actual tax revenue raised
2013-14	5.60	2.65
2014-15	2.80	2.64
2015-16	3.14	3.96
2016-17	3.80	5.42
2017-18	4.50	5.14
2018-19	18.42	5.17

(Source: CAG Report, 2018)

There is a proportionate relationship between the infrastructural development and the number of tourist influx. Based on the Figures of tourist accommodation available and the number of service providers, at present direct employment generated by this sector can be roughly estimated to be around 12,000 to 15,000 jobs. At the same time, the human development index also notes that the industry has 61 percent direct workers employed from outside the state. Similarly, even a significant proportion of the transport sector also engages employees. The local youth are reluctant to take up jobs offered by these service providers. In the last decade, the tourism sector in Sikkim has seen a growth rate of 10-12 percent. The Gross State Domestic product of the tourism sector in 2016-2017 has been Rs. 1,44,735 lakhs with a total contribution of the tourism sector to GSDP being 7.68 percent (DESME, State Income Unit). In terms of existing capacity and strength and as per figures available, there are currently 1,021 hotels (with over 16,945 rooms and 34,133 beds capacity), 1,119 travel agents, 69 restaurants,

66 tourist guides and 371 homestays registered with the department. In addition, there are 47 hotels registered at the project level (under construction) stage (Carrying Capacity Survey, 2017. Dept. of Tourism, GoS). There were 646 taxis registered under the luxury Taxi category and 6,445 under local (non-Luxury) taxis as on 31st March 2015 (Regional Transport Authority, MV Dept. GoS). The indirect employment generated by the industry is, however, much larger and encompasses a broad section of the population ranging from construction to supplies and various services. It is vivid that tourism has emerged very strongly as one of the key drivers of the state economy with potential for generating long-term employment.

5.1.3. Ill-effects of tourism particularly on environmental components

Tourism in Sikkim is booming, which is likely to get further spurt under the influence of climate change, improved mobility, growth of infrastructure, active government participation and enhanced levels of incomes. Though this would multiply the positive gains of tourism, it may also have negative implications for the ecology, agriculture, high altitude biota and socio-cultural environment of the state. As tourism in Sikkim mainly thrives on high altitude landscape, alpine lakes, and biodiversity associated with high altitude geologically fragile area and sensitive habitats, the increased inflow and associated human activities in the form of increased vehicular traffic, vibrations, and related pollution may damage the environment and the sanctity of these areas, adversely affecting the touristic experience and sustainability in the long run. Negligible benefits to the local communities residing in the vicinity of these nature tourism areas and resources may also hamper their participation in resource conservation in absence of sufficient incentives.

5.2. Assessment of waste generation in Sikkim

The problem of solid waste in context of the IHR is quite acute and alarming. According to the Ministry of New and Renewable Energy, Government of India, urban areas of eleven states in the IHR generate a total of 6346 MT of solid waste per day, which leads to 23.16 Lakh MT of solid waste per annum (MNRE, 2018). It accounts for 4.35% of the national average 531.53 Lakh MT/day. Sikkim is one of the least producers of urban solid waste, which is 89 MT/ day (Table 5.2). It clearly depicts that the management and minimization of solid waste in the IHR will be a great challenge.

Table 5.2: State-wise solid waste generation in urban areas of the IHR

Sr. No.	States	Total waste generation (MT/day)	Total waste generation (in Lakh MT/Annum)
1	Arunachal Pradesh	181	0.66
2	Assam	1134	4.14
3	Himachal Pradesh	342	1.25
4	Jammu and Kashmir	1792	6.54
5	Manipur	176	0.64
6	Meghalaya	268	0.98
7	Mizoram	201	0.73

8	Nagaland	342	1.25
9	Sikkim	89	0.32
10	Tripura	421	1.54
11	Uttarakhand	1400	5.11
12	West Bengal (Darjeeling Municipality) gm/capita/day	465	

(*Source: Ministry of New and Renewable Energy, Government of India, 2018 and Darjeeling Municipality, 2007*)

Sikkim has witnessed a rapid growth of urban population with 33.06% rise between 2001 and 2011 as against 21.14% for India (Census 2011). Thus, an increase in tourist influx has led to a proportionate increase in the quantity of garbage and solid waste in the town. In the capital town of Gangtok about 26 MT solid waste is produced daily. Namchi town, the headquarters of South District, generates around 10 MT of solid waste daily and similar figures are reported for other major townships.

As per the recorded data from 2016 to 2021 by the State Pollution Control Board (SPCB), Government of Sikkim, on average; municipal solid waste is generated 271253.40± 3048.07 Q/yr annually in the state. In Sikkim, seven municipal corporations / urban local bodies (ULBs); namely, Gangtok Municipal Corporation (GMC); Gyalshing Municipal Council (GyMC); Mangan Nagar Panchayat (MNP); Namchi Municipal Council (NMC); Rangpo Nagar Panchayat (RNP); Singtam Nagar Panchayat (SNP); and Jorethang Municipal Council (JMC) are collecting and managing the solid waste from the urban and rural areas on daily basis. As per the record of SPCB for 2020-2021, highest waste was generated by GMC 182500 Q/yr (69%) and followed by RNP 21900 Q/yr (8%), JMC 18250 Q/yr (7%), NMC 14600 Q /yr (6%), GyMC 12775 Q/yr (5%), SNP 9855 Q/yr (4%), and MNP 2555 Q/yr (1%). Due to the improvement in infrastructure, 100% generated solid waste was collected from each 07 ULBs during the year 2020-2021 which earlier used to be collected approx. 86% (229950 Q/yr) of the total generated waste (267691 Q/yr) in the year 2017-2018. The Government of Sikkim has also passed several gazette notifications regarding management of municipal waste in the State.

Regarding the bio-medical waste, approximately 4.8 Q/day waste was generated daily during in the year 2020-21 in Sikkim with the highest contribution from East district (3.4 Q/day) followed by from South district (0.78 Q/day), West district (0.41 Q/day), and North district (0.22 Q/day). The generated bio-medical waste is disposed/treated by 185 health care facilities (HCFs) having captive treatment and disposal facilities (reported by SPCB, GoS) mainly because of the fact that the common bio-medical waste treatment facility is not available in Sikkim. In the year 2016, approximately 3.88 Q/day bio-medical waste was generated and out of it only 1.7 Q/day waste was treated/disposed off. This indicates that the bio-medical waste disposal facilities have been improved in recent times.

Regarding the plastic waste, Sikkim Government has imposed a ban on plastic carry bags in the year 1998 and on the sale and use of plastic having less than 50 microns thickness in the year 2019 in the state. As per the record of SPCB (GoS), total 1027 Q/yr of plastic waste was generated and collected in the year 2021 in the state which increased to 827.5 tonnes/yr in the year 2016. The hazardous waste was mostly generated by the industries setup in the state. As per records of SPCB (GoS), total 19151.9 Q incinerable hazardous waste (East district-15436.7 Q and South district- 5815.2 Q) was generated in Sikkim 2020-2021 which was recorded as 5218.15 Q in the year 2015-2016. E-waste like, computers, printers, telephones, scanners, CRT monitors, keyboards, mouses, adaptors, CFL tube lights, SMPS chargers, monitors, printer cartridges, cellular phones, LED displays, xerox machines, UPS, etc. are the major components of the E-waste generated in the Sikkim. In the year 2020-2021, a total of 6646 E-waste (items as mentioned above) were recorded excluding 1315 LED lights.

Based on the records from SPCB and GoS, almost all generated waste is being collected. During 2020-2021, generated municipal waste was 262435 Q/yr and collected waste was 262435 Q/yr. This shows that the process of solid waste collection is scrupulously followed in the Sikkim state. The state government has developed a mechanism for waste collection in the state. The waste is collected from the households located in accessible areas (connected to road head within the municipal areas) through the designated waste collection vehicles of municipal cooperation. Whereas, in case of the inaccessible areas, the designated staff of municipal cooperation/individuals manually collect the waste and take it up to the road head where the same is handed over to the waste collection vehicles. The designated pickup collection vehicle has a capacity of transporting approximately 500 to 600 kg of waste. All the collected waste is delivered at the waste transfer station located in a convenient location. Further, tipping trucks of about 10 MT capacity transports the waste from the transfer station to the waste management plant (dumping/ landfill area) located at Martam, East Sikkim and Sipsu, West Sikkim including Chandey, North Sikkim.

5.3. Segregation / Utilization of waste

In Sikkim, the state government has devised certain regulations for proper management of solid waste such as the Sikkim Non-Biodegradable Garbage (Control) Act, 1997 and the Sikkim Non-Biodegradable Garbage (Control) Rules, 2001. Under these regulations, individuals violating the law are liable to be punished with imprisonment for six months or with fine up to Rs. 5,000 or by both. From the year 2000, the Sanitation Rules for Towns of Sikkim have been extended to entire Sikkim vide notification No. 104 (181)/ UD and HD/ 1986- 2000, date 17 June, 2000.

The practice of community bins/secondary waste storage facilities has been stopped in the state; instead, bins have been placed for local public and tourists in the main market area. Also, all the wards coming under urban local body (ULB) are covered with segregation bins for wet and dry waste. The state government provided separate bins for bio-degradable and non-bio-degradable waste to the majority of households. The practice of community waste receptacle for recyclable items cardboard, plastics, newspaper, metals, glass, etc., is performed at

community level. Based on information available with the State, total 1027 Q/yr plastic waste was collected during 2021, which was reused for the construction of roads and highways by the National Highways and Infrastructure Development Corporation (NHIDCL).

5.4. Waste disposal / treatment facilities

Based on the analysis of solid waste for 2016-2021 in Sikkim, 20% of the collected waste (47750.03±8572.46 Q/yr) was treated and the remaining 80% (195449.47±8384.81 Q/yr) was disposed off in dumping/landfill areas. As per the record of SPCB, GoS in the year 2016-2017 treated only 17.82% of the generated waste and the remaining 82.18% waste was disposed of in landfilling or dumping. Whereas, during 2020-2021, total 28% (74277.50 Q/yr) waste was treated and remaining 72% (188157.50 Q/yr) was landfilled and dumped. Hence, in Sikkim, the treatment of the waste has improved in 2020-2021 as compared to 2016-2017. State Pollution Control Board suggested setting up of a Refuse Derived Fuel Plant at Martam and Sipsu to reduce the solid waste load and increase the life of these two sites. For the management of solid waste in the state, 01 landfilled area (42600 m^2) is operational at Martam in East Sikkim district and 02 landfilled areas (total area132460.3 m^2) are under construction, one at Sipsu, West Sikkim (112460.3 m^2) and another at Rindang in North Sikkim district (20000 m^2). Recently, one compost plant has been made operational at Martam, East Sikkim district with 50 tonne/day capacity and with a capacity of 500 kg/day. One organic waste converter is functional at Vegetable market, Mangan, North Sikkim district. In addition, one bio-digester plant with a capacity of 7000 litre was installed at Tikjuk, Gyalshing, West Sikkim. Based on the analysis of the tourist influx and municipal waste generated data (2016-2021), the results indicate no significant correlation ($p>0.05$), but the positive correlation between year and collected waste ($r = 0.892$) significantly ($p<0.04$) reveals that the waste collection mechanism in the state is improving.

5.5. Transport & tourism: Number of vehicles

In the tourism sector, transportation plays an important 'flow' function in the tourism value chain. In Sikkim, transportation is dominated by the road transport and connects tourists from various parts of the world. Over the years, road network, flight connectivity, and means of transport have improved. As a result, the tourist inflow to Sikkim is on rise since the last decade. With the increasing inflow of tourists and the expected growth in tourist inflow, the number of vehicles, especially public transport and other tourist vehicles have been increased so as to meet the growing demand of the tourism sector. As per information from the Sikkim Nationalized Transport Department (2021), total 95,251 vehicles (private- two and four wheelers, government vehicles, tourist taxis, bus, luxury taxis, good carriages, etc.) were registered in the state with the high growth rate of 268.85% recorded for the year 2020-2021 from the base year 2011, until then only 25,824 vehicles were registered. Total 69,427 new vehicles (all types)from 2011 to 2021, were registered in the state; out of which 13,639 vehicles are engaged in tourism services. However, during the Covid-19 pandemic period (2020-2021), few number of tourist/taxi vehicles (505) were registered in comparison to the private vehicles (7015). The growth of vehicles during last decade has offered employment to the nearly 11%

of families/households in the state as more than 13639 persons got employment through transport services in the tourism industry. The careful analysis of the registered vehicles during 2011-2021 in the state showed that the private vehicles are increasing at higher rate (1903.16% per decade) than that of tourist/taxi vehicles (819.07%), which would be increasing the carbon emission in the environment with alarming rates. Further, owing to the increasing demand for services in the tourism sector, the rapid development of transportation facilities has been stimulated in the state.

During 2006 to 2010, it was found that an average annual growth percentage rate of tourist inflow in Sikkim state was 12.76 %, whereas the numbers of registered taxis increased by 4.67% (Rizal and Ashokan, 2013). In the study, a statistically significant positive correlation between the tourists' inflow and total numbers of registered taxis in Sikkim was found at 5 percent level ($p < 0.05$). In Sikkim, road transport has a big role to play in the tourism industry. The increasing inflow of tourists also increases the demand for tourism transport. It is observed that both tourists' inflow and the total numbers of registered taxis in Sikkim are increasing every year.

5.6. Ill effect on air quality

The State Pollution Control Board (SPCB) Sikkim established eight Air Quality (AQ) monitoring stations at Rangpo, Singhtam, Deorali Pelling, Ravangla, Namchi, Chungthang and Mangan to monitor the Air Quality of the state. These stations have been monitoring the AQ since October 2017. The AQ values are higher in Rangpo stations which are progressively decreasing toward north (Fig. 5.3). The similar values are also observed at the Singtam. The Rangpo station is the entry point of Sikkim whereas Singtam is the commercial hub of Sikkim. The regions where the tourist influx is more, the AQ values are high. In the north region of the state, the tourist influx is limited. Therefore, the AQ values are less throughout the year and air quality is good. The AQ values are maximum from November to April months whereas minimum in the months of May, June, July, August, September and October. The less valued months are coinciding with the monsoonal months. In all the stations, the recorded values (Oct 2017-Dec 2021) are less than 100. The data of all the stations show that the air quality of Sikkim falls under good and satisfactory condition.

5.7. Ill effect on water quality / groundwater

Under Monitoring of Indian National Aquatic Resources (MINARS), the SPCB Sikkim collects water samples from River Teesta and its tributaries from 14 identified sites. The pH values of the water bodies (mainly river) ranging from 6.5 to 7.5. There are no significant changes in the pH values. The conductivity values of the water samples are almost similar in all the stations. The values of the water conductivity vary from 150 µmhos/cm to 310 µmhos/cm. There is no significant change in conductivity values from north to south in all the stations. However, in October 2018, the Ranipool station showed an exceptional higher value of 1300 µmhos/cm.

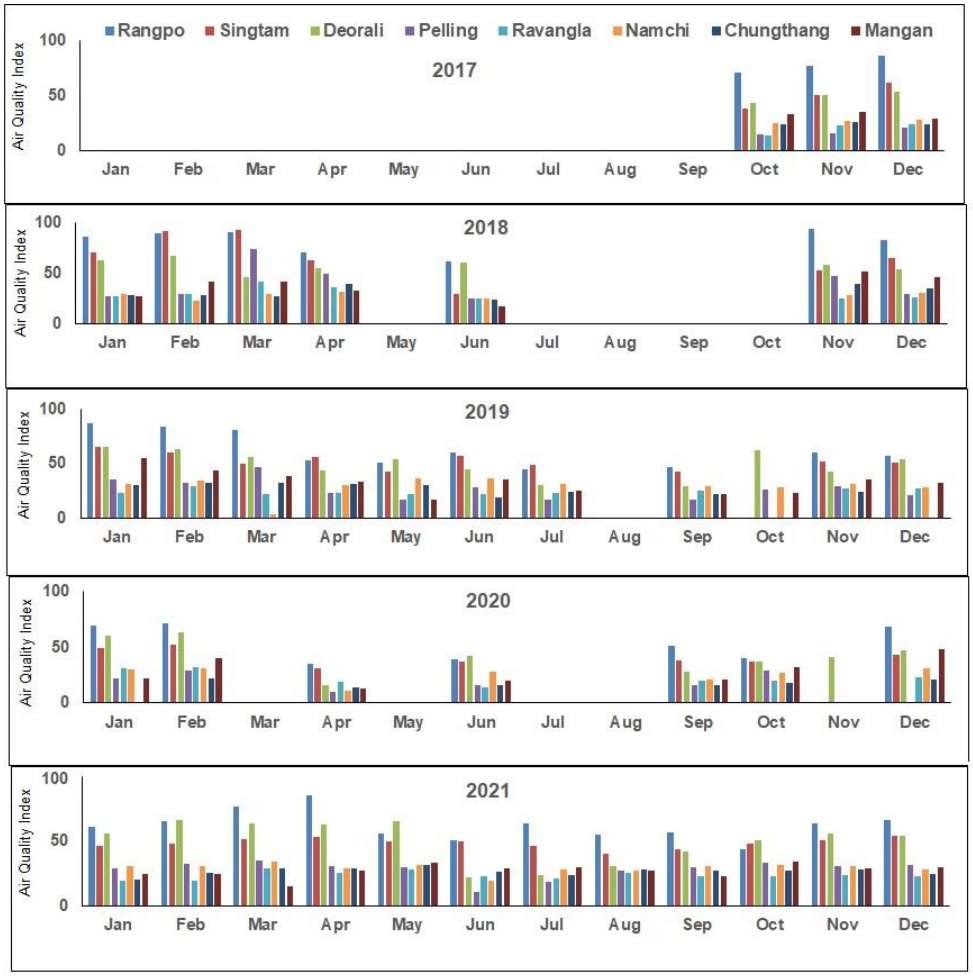


Fig. 5.3: Trends of air quality at selected sites in Sikkim

5.8. Ill effect on Forest and Biodiversity

Sikkim is notable for its biodiversity, including alpine and subtropical climates, as well as being a host to *Khangchendzonga*, the highest peak in India and third highest on Earth. The State is endowed with rich floral and faunal diversity. Species wise, the State harbors over 5,068 flowering plants in 1491 genera belonging to 209 families, 542 orchids, 38 rhododendrons, 16 conifers, 28 bamboos, 362 ferns and its allies, 9 tree ferns, 30 primulas, 11 oaks, 1681medicinal plants, above 144 mammals, 568 birds, 48 fishes, and over 689 butterflies and 7000 species of moths (Arrawatia and Tambe, 2011; Gogoi *et al* 2021).

Apart from the rich diversity of the state, it is facing several threats which mainly cause the loss of natural resources. The main threats being development activities, unplanned trekking tourism, hunting and trapping of wild animals, smuggling of medicinal and aromatic plants and lack of awareness amongst the forest security forces (Tambe and Rawat, 2006). The impacts of unmanaged tourism are accelerating the rate of destruction in areas, which were once regarded

as inaccessible. The negative impacts of unplanned tourism like deforestation due to use of firewood, unhygienic conditions, garbage accumulation, smuggling of plants and animals have to be regulated and at the same time, the benefits arising from this enterprise are equitably shared. Unplanned tourism also threatens sensitive and biologically important high-altitude wetlands (Annual Administration Report 2018-2019, F&E Dept. Govt. of Sikkim). Furthermore, it is threatening the natural habitats of several climate sensitive wildlife species such as globally endangered Musk Deer (*Moschus chrysogaster*) in Areylungchok Musk Deer Conservation Zone (AMDCZ) falls within the Khangchendzonga National Park, which is protected under schedule I of Wildlife Protection Act-1972 (Tambe and Rawat, 2006). In addition, seasonally migrating livestock herds, as well as, livestock imported into the region for the tourism enterprise pose a serious risk through spreading exotic diseases to wildlife. Furthermore, unplanned tourism threatens sensitive and biologically important high-altitude wetlands.

5.8.1 RET categories species wise

Among 5,068 plant species, the state covers 52 plant species in RET categories, which include 20 species under rare, 11 vulnerable, 14 endangered, 4 intermediate, and 2 species in possibly extinct categories (Nayar & Sastry 1990). A recent study identified 75 species of the state under the different threat categories of IUCN (9 critically endangered, 33 endangered and 33 vulnerable) (Gogoi *et al.* 2021). In faunal diversity, the state comprises 68 species under different RET categories. As per IUCN conservation status of faunal diversity of the state 6 species were found endangered, 11 vulnerable, 12 near threatened, 30 least concern, 1 data deficient and 8 species are not under evaluated categories.

5.8.2 Changes in Forest cover

The total forest cover in the state is 3341.03 km^2 which is 47.08% of the state's geographical area. In terms of canopy density classes, the state has 1102 km^2 (15.52%) under very dense forests, 1551 km^2 (21.86%) under moderately dense forests and 688 km^2 (9.70%) under open forests, 296 km^2 under scrub (4.17%) and 3459 km^2 under non-forest (48.75%). In the last one decade (2011 to 2021), the total forest cover declined by 0.25% of the total geographical area of the state. The main reason behind declining in forest cover is due to diversion of forest land for non-forestry purposes like establishment of hydropower projects, construction of border roads for national security purpose, rural connectivity roads for economic upliftment of rural masses, and development of ecotourism centres (Annual Administration Report 2018-2019, F&E Dept. Govt. of Sikkim).

Tourism in Sikkim Himalaya has shown its impact on forests in terms of extraction pressures for firewood, fodder and timber, changes in species composition, and poor regeneration status of firewood along the trekking corridors of Yuksam–Dzongri area (Chettri *at al.* 2002, 2006). Impacts of tourism in Sikkim in terms of pressure on resources and degradation of forests and lands, deterioration of pastures and changes in pastoralist traditions, problem of litter and garbage, waste management, and huge tourist influx have also been reported by earlier researchers. In such studies apprehensions have also been raised that tourism growth could

also lead to habitat destruction, resource depletion and changes in subsistence agricultural economy of the state. The decreasing trends of livestock population and food crops, and increase in the area and production of cash crops was reported as a consequence of monetization of village economy owing to promotion of home stays and ecotourism / tourism in pristine village ecosystems. In some of the rural areas, diversion of agricultural land for tourism purposes is common (Joshi and Dhyani 2009).

5.9. Eco-sensitive zones/ Areas

Sikkim has currently 8 eco-sensitive zones, including one national Park (Khangchendzonga National Park) and seven wildlife Sanctuaries. All were declared as eco-sensitive zones in 2014 (ENVIS Hub: Sikkim 2021). Their salient features are as under:

Eco-sensitive Zones in Sikkim:

Khangchendzonga National Park

Notification# S. O. 2166, dated 27th August 2014, notifies an area up to 200 meters around the boundary of the Khangchendzonga National Park as the Eco-sensitive Zone. The draft of the Notification was published on 3rd February 2014.

Kitam Bird Sanctuary

Notification# S. O. 2167, dated 27th August 2014, notifies an area up to 25 meters around the boundary of the Kitam Bird Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 25th February 2014.

Kyongnosla Alpine Sanctuary

Notification# S. O. 2168 dated 27th August 2014, notifies an area up to 200 meters around the boundary of the Kyongnosla Alpine Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 4th February 2014.

Shingba Rhododendron Sanctuary

Notification# S. O. 2169 dated 27th August 2014, notifies an area up to 50 meters around the boundary of the Shingba Rhododendron Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 6th February 2014.

Maenam Wildlife Sanctuary

Notification# S. O. 2170 dated 27th August 2014, notifies an area up to 50 meters around the boundary of the Maenam Wildlife Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 25th February 2014.

Fambonglho Wildlife Sanctuary

Notification# S. O. 2171 dated 27th August 2014, notifies an area up to 25 meters around the boundary of the Fambonglho Wildlife Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 4th February 2014.

Barsey Rhododendron Sanctuary
Notification# S. O. 2172 dated 27th August 2014, notifies an area up to 50 meters around the boundary of the Barsey Rhododendron Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 25th February 2014.

Pangolakha Wildlife Sanctuary
Notification# S. O. 2173 dated 27th August 2014, notifies an area up to 50 meters around the boundary of the Pangolakha Wildlife Sanctuary as the Eco-sensitive Zone. The draft of the Notification was published on 6th February 2014.

Among these, Khanchendzonga National Park (KNP) is the main tourist destination and attracts thousands of mountaineers, hikers, trekkers and nature lovers visiting the KNP and the surrounding region. Number of tourists increased continuously from 2012 to 2019 (Fig. 5.3). However, their numbers decreased during 2020-2021 due to covid-19 pandemic. Tourism might create the issue of disposal of waste (plastic especially) and use of firewood as fuel leading to deforestation. Thus, Eco-Development Committees have been constituted in all the buffer villages (20 nos.) with a view of participatory mode of protection and conservation of bioresources of the region, as per the recent guidelines of MoEF (Management Plan of Khangchendzonga National Park, 2008-2018). Department of Forest and Environment, Sikkim jointly with Khanchendzonga Conservation Committee (KCC), a Non-Governmental Organization in West Sikkim, created a system by which trekkers have to declare all the non-biodegradable waste products before the entry in the National Park and after exit these items are checked to ensure that all the wastes are brought back. Tourists not abiding the system are fined with a sum of Rs. 5000, if they fail to account for waste that was not brought back. Yuksam (West Sikkim) was the first village in Sikkim to ban the use of plastic (both bags and bottles) in 1996. Ecotourism Service Providers Association of Yuksam (ESPAY) initiated in 2004, provides capacity building to trekking guides, yak owners, porters and other ecotourism-related professionals. As of 2017, more than 100 cooks, around 250 naturalists, guides, around 1000 porters and pack animal operators have been trained. Currently, all trekking groups are required to carry kerosene stoves to minimize the use of firewood for cooking (Anonymous 2017).

Tsomgo lake, located in the fringes of Kyongnosla Alpine Sanctuary, is a popular tourist destination visited by four lakh persons in 2012 (Tambe and Arrawatia, 2012) that rose to over five lakh in 2018-19. In and around the lake, approximately180 shops have been set up by locals for tourists which are an additional source of pollution in the region. The Tsomgo Pokhri Sanrakshan Samiti (TPSS) is a part of the Forest Department's initiatives to promote nature conservation and ecotourism in the state and serves the purpose of protection and conservation of the lakes in the state in partnership with the concerned Gram Panchyat Unit (Department's Notification No. 355/f-Sikkim Gazette No. 244, Monday 11 August 2006).Tsogmo Pokhri Sanrakshan Samiti (TPSS) was formed in 2008 with the support of the Department of Forest, Government of Sikkim, and WWF-India and removed around 20 trucks of waste in a week in 2009.

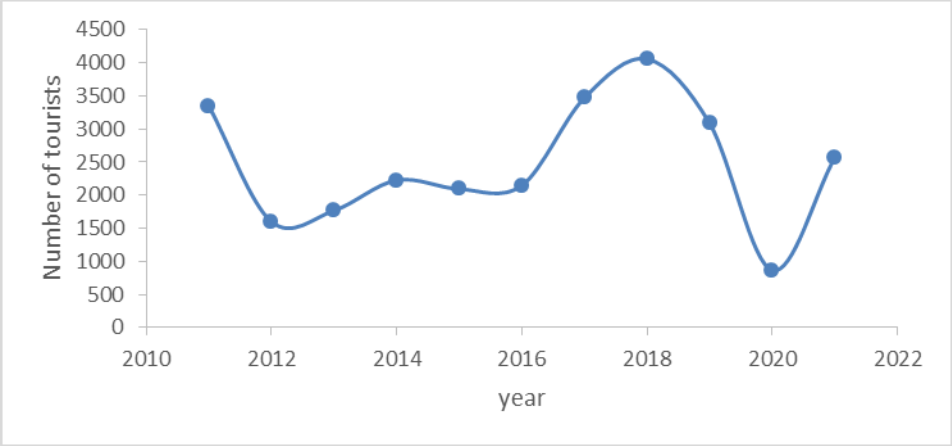


Fig. 5.4: Flow of tourists in Khangchendzonga National Park (2011- 2021) (*Source: KNP/KBR Division, Forest and Environment Department, Govt. of Sikkim*)

There are around 180 households in the three villages (Thegu, Changu, and Chipsu) in the vicinity of Tsogmo lake. Two members of each of the three villages around the lake serve on the TPSS, as well as, other stakeholders such as representatives of the police and shopkeepers' associations. As per the guidelines, Rs. 10 is collected from every visiting tourist as Pokhri Sanrakshan Shulk or Lake Conservation fees. The fees collected are credited with the revolving fund account of TPSS on a monthly basis. About 50% of it is transferred to the Forest & Environment Department of State and the rest of it is used by TPSS for the conservation of Tsomgo lake (Tambe and Arrawatia, 2012).

Kyongnosla WLS is a home to red panda, blood pheasant, Himalayan takin, snow leopard, Tibetan fox, Himalayan black bear, serow, musk deer, Himalayan goral and many migratory birds like tufted pochard, common pochard and seagulls along with resident birds like blue whistling thrush, redstart and forktail. Wildlife (especially, serow and red panda) of the area is facing a threat from free-ranging feral dogs, that feed on the garbage around Tsogmo and also from the kitchen in the military bases in the area (Kyongnosla Alpine Sanctuary, 2022).

Fambonglho Wildlife Sanctuary located in vicinity of the capital town Gangtok which was declared as protected area in 1984 and tourist flow in 2 decades between 1995 to 2014 indicated its initial decrease up to 2004.A steady increase was recorded and maximum visitors (253 numbers) were recorded in 2014 (Lepcha *et al.* 2015).

- **Status in compliance of waste treatment facility:** In KNP, segregation of waste is carried out at the exit point of the national park. Most of the plastic waste is placed into dumping sites outside the national park. Cleanliness drives are carried out regularly (once in a year) with the involvement of local stakeholders. Around 800 kg of waste is collected per year from the trekking route of Yuksum Dzongri in KNP since 2017 (Anonymous 2017).

- **Measures taken for waste management:** A garbage monitoring form is issued at entry check-post where the details of all dry items taken inside the park are entered and on exit through the check-post.It is assured that all the plastic waste are brought back. Thereafter the segregation bins are kept. In case of non-compliance, a penalty fee of Rs. 5000is levied on tourists. Garbage bag on a security deposit of Rs. 300is issued to collect and bring back the plastic waste to be checked to the post. It is mandatory for every tourist visiting the park. Cleaning drives inside the park with involvement of local stakeholders is a regular feature.

- **Prohibition of Construction:** As per the government notifications, construction is completely banned in all the Eco-sensitive zones in Sikkim, except road construction in strategic locations near Indo-China borders and a few approach roads developed by the Forest & Environment Department.

- **Traffic regulation:** Traffic regulation is strictly followed in all the Eco-sensitive zones except in the Kyongnosla WLS. In KNP, vehicle movement is not possible due to non-availability of road inside the National Park. However, in Kyongnosla WLS, 3000 vehicles per day are permitted for tourists and other visitors to Tsomgo lake and Nathula Pass by the Tourism department, Government of Sikkim and entry is checked at different check-points.

5.10. Gap area and Plan of Action

Sr. No.	Gaps	Plan for Action
1.	A holistic assessment and periodic monitoring on impacts of tourism activities on the environment and ecology of eco-sensitive zones and key destinations is imperative.	A systematic and comprehensive database of tourist's inflow, particularly in eco-sensitive zones and major tourist destinations and circuits and income generated from tourism related activities from hotels, transport agencies, eco-sensitive zones, and major tourist destinations need to be developed.
2.	The uncontrolled growth of the number of tourists can lead to damage in natural resources and increase conservation costs	Carrying capacity assessment of eco-sensitive zones and major tourist destinations and circuits need to be carried out. Further, enforcing guidelines for a regulated tourism and prescription for the suitable management options for natural resources are, therefore, needed.
3.	The waste treatment and management facilities at tourist destinations and eco-sensitive zones are lacking. Further, so far, only about 20% of the waste is treated and the rest is disposed off /landfilled	Waste treatment and reuse facilities should be increased. Furthermore, there is an urgent need for proper disposal and management of waste at such potential tourist sites.

4.	Strengthening environmental awareness and consciousness of people will help in identifying the potential ecotourism sites based on the environmental management.	All stakeholders of tourism need to be sensitized about sustainable forms of tourism and impacts of tourism through frequent seminars, conferences, and workshops at the local, national and international level.

5.11. Summary

The high frequency of the tourists in Sikkim offers employment to marginal people and contributes in generating state revenue. Natural, cultural, sacred values and heritage sites of the state have potential to draw enormous benefits from ecotourism enterprises. Hence, development in tourism sector invariably leads to economic growth of the area, which is manifested in terms of increase in income and employment opportunities, infrastructural growth, and improvement in the standard of living of the community. With regard to tourism infrastructure development,

Sikkim has excelled in leveraging central funds for the construction and development of different attractive tourist wayside amenities, destination and circuit development, and unique tourist attractions such as ropeways, skywalks, and landmark religious monuments. Religious tourism has been augmented with the construction of several unique and gigantic religious monuments. This tourism includes: statues of Guru Padmasambhava in Samdruptse, the Chardham at Solophok, Namchi and Lord Buddha"s Statue at Tathagata Tsal in Rabong. Ropeways have been built in Namchi and Tsomgo Lake. A skywalk, the first of its kind, in Pelling town has been attracting a number of tourists while a Greenfield airport started in 2018 in Pakyong has been helping increase in tourist inflow in the state.

Owing to its diversity of communities, Sikkim has a number of traditional religious festivals that attract tourists, notable amongst which are the Pang Lhabsol, Drukpa Tseshe, Tendong Lho Rum Faat, Dasain and Tyohar, Losoong, Bhumchu, Saga Dawa and Sakewa. There are also a number of tourism focused festivals held every year in different locations around the state. In view of further enhancing employment opportunities and tourism in the state, the government of Sikkim has initiated hosting "Global Film Festival " since the last few years. The State government in the past years has given top priority and importance to the development of sufficient and required infrastructure and services for the development of the tourism sector in the state. The tourism in the state has been exponentially increasing during last decade (barring COVID-19 pandemic period) particularly owing to pro-active policy of the state government to promote tourism / eco-tourism and promotional schemes by central Government such as "Go East Policy" leading to socio-economic development and economic prosperity in the state. Further, Ministry of Tourism, Government of India has provided funds under centrally sponsored schemes for the implementation of various programme/projects like angling, computerization, wayside amenities, and refurbishment of monasteries, tourist's lodges, lake and waterfall development, trekking routes/trails, basic amenities, development of destinations and circuits, parking, landscaping and gardens, and restoration of monuments.

Sikkim is a model state for promoting ecotourism, solid waste management and capacity building on ecotourism, but is largely challenged by emerging threats of mass tourism, such as, unregulated tourism, waste generation, increase in number of vehicles, frequent traffic jam, vehicular emissions, leading to air and water pollution. Though the region offers tremendous opportunities for promotion of tourism, such huge tourists influx may create pressure on natural resources and key tourist destinations and circuits such as Gangtok city, Namchi city, Tsogmo Lake, Lachung, Lachen, Gurudongmar Lake, Yumthang Valley Lake, etc. The rapidly increasing tourist influx in Sikkim also poses concerns regarding carrying capacity of these tourist destinations and circuits. In other words, even if the state is making progress as one of the potential tourist destinations in the IHR, emerging challenges can have upsetting impacts on environment and ecology, particularly of the eco-sensitive zones, in future.

6.1. Introduction

6.1.1 General scenario of tourism in Darjeeling

The Darjeeling Himalayan region (including hilly parts of Darjeeling and Kalimpong districts) is located in the north-western section of West Bengal and the north-eastern part of India. The geographical location of the Darjeeling Himalayas, which is situated at the pedestal of Mt. Kanchenjunga and the eastern Himalaya, is one of the main reasons for its current appeal as a tourist destination. It is a noteworthy example of India's booming homestay tourism market and is also known as the 'Queen of the Hills' for its picturesque beauty, charming 'European' hill station ambiance, and world-renowned tea industry (Roy *et al.* 2021). The district comprises four subdivisions: Darjeeling Sadar, Mirik, Kurseong and Siliguri. Darjeeling is the district headquarter. There are 06 community development blocks, 4 municipalities, 1 municipal corporation and 134 gram panchayats in this district (District Environment Plan Darjeeling, 2021).

Darjeeling Himalaya region has been one of the most popular tourist destinations in the country since its inception in the 1830s, and tourism generates a significant amount of revenue in almost all of Darjeeling's key locations. Darjeeling district became popularized as a tourist destination soon after the East India Trading Company acquired it from the kingdom of Sikkim in 1835, and since then it is serving as a mountain retreat especially during the summers. After the end of British colonial rule in 1947 and Darjeeling's merging with the state of West Bengal, the area started to experience rapid population growth, mostly in the form of migrants from Tibet, Bhutan, and Nepal. The government of West Bengal viewed this influx as an opportunity to capitalize on expanding its tourist industry to generate revenue for the state, and started to expand on pre-existing infrastructure from the British colonial era.

During 1960's-70's, new hotels were built, roads were widened, nature parks were constructed and shops and restaurants were established to support Darjeeling's growing population, and also to encourage domestic and international tourism. Various modes of industry that had formed during British colonialism such as tea cultivation and handicraft production were encouraged and promoted to incentivise the growing population through tourist visiting the region. Due to these initiatives, development of tourism sector has become synchronous with the Darjeeling district's population growth (Scrase et al. 2015). Between the years of 2001 and 2011, Darjeeling's total population increased by 14.77%, from just over 1,609,172 to approximately 1,846,832 (Census, 2011). At the same time frame, the percentage of tourists visiting Darjeeling has also increased significantly, from approximately 50,000 total domestic and international tourists in 2000 to over 240,000 in 2011 (West Bengal State Tourism Department, 2014).

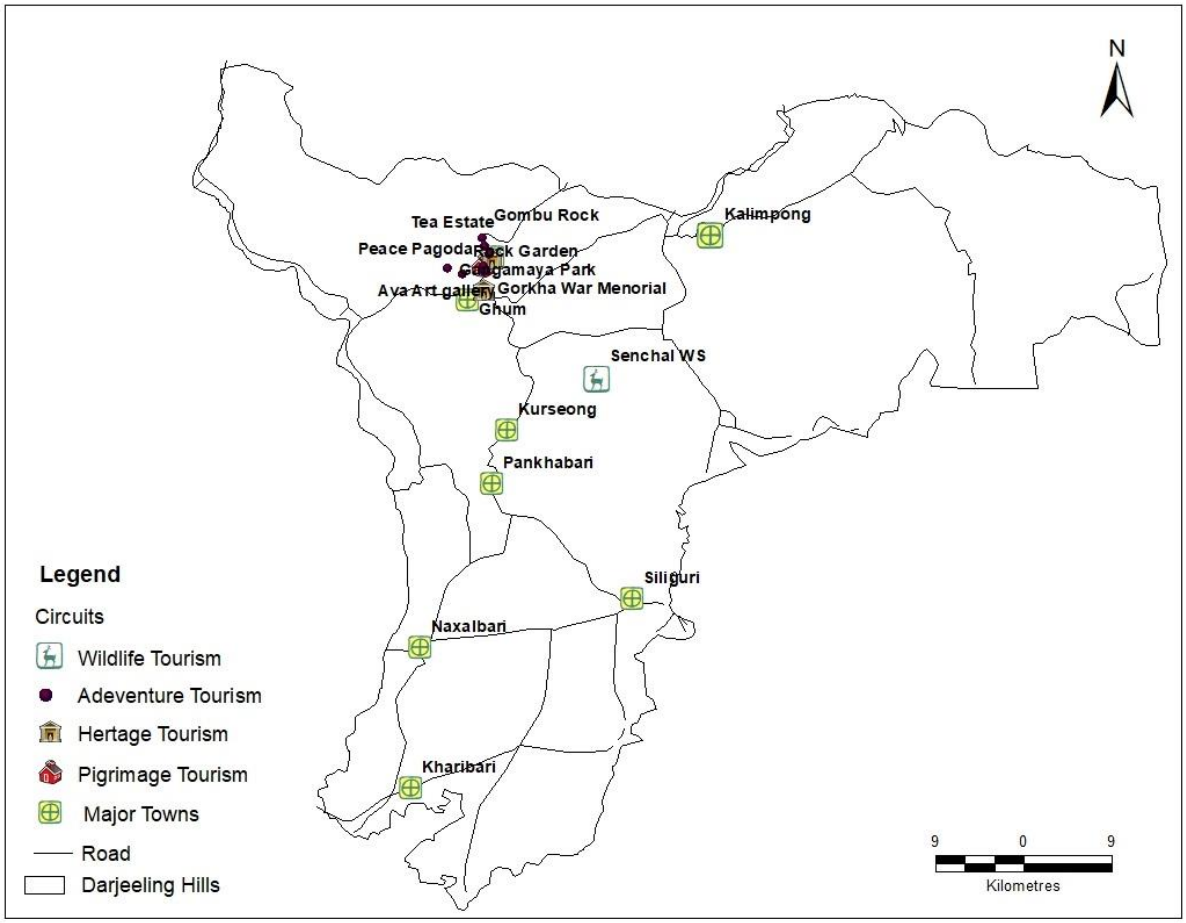


Fig. 6.1: Major tourist spots and circuits in Darjeeling

According to the West Bengal Tourism Department, 42% of Darjeeling's tourists in 2012 reported visiting for rural and adventure tourism, "looking to experience the rural and raw beauty of Northeast India". Because of the rising demand for tourists, Darjeeling has seen the emergence of two types of tourism viz. rural and urban. Urban tourism mainly focused on multiple tourist activities in which Darjeeling town is leading destination and place of interest, while rural tourism is a relatively recent phenomenon that has grown in popularity over the past few decades as a means of linking visitors with rural communities around Darjeeling Himalayan region and also strengthening those areas socially, culturally, and economically (Kannegieser, 2015). Therefore, homestay tourism has been flourishing in Darjeeling's rural tourism sector. Over the last decade, Homestay in Darjeeling's rural areas has recognized the potential as an effective instrument for individual and community empowerment (Rawat, 2020).

Apart from traditional tourist attractions, tourism activity in the form of "homestay" has expanded in popularity in recent years (DCHB report, 2011). According to the West Bengal Interim Report, Darjeeling district (excluding Siliguri sub-division), as a part of the Darjeeling Himalayan region, is "the most highly frequented tourist destination in all of West Bengal" with

more than 500,000 domestic and 50,000 international visitors annually (Kannegieser, 2015). While the state of West Bengal is ranked as the 6th most visited state in India, nearly 87% of those visitor's flock to the district of Darjeeling (World Travel and Tourism Council, 2010).

6.1.2. Tourism growth *vis-à-vis* economic growth

As per the record of the Tourism Department, Darjeeling, Government of West Bengal;, trends of tourist influx in Darjeeling shows increasing number of tourists during 2010-19, both Domestic as well as Foreign. Though it is increasing, the tourist arrival in Darjeeling, both domestic and foreign, during 2010-19 does not show any significant trends. The maximum number of tourists (6,32,637; including 5,53,862 domestic and 44,057 international) visited Darjeeling in the year 2018 (Fig.6.2 & 6.3). The average annual growth for all kind of the tourists was recorded nearly 17% during the period 2010-2019. From 3,15,462 in 2010, the domestic tourist arrival has gone up to 55,38,62 in 2019 registering an average growth rate of over nearly 16.5 % p.a. during the said period. Similarly, the international tourist arrival also increased from 31,562 in 2010 to 44057 in 2019 with an average growth rate of over approximately 70% p.a. during 2010-19.

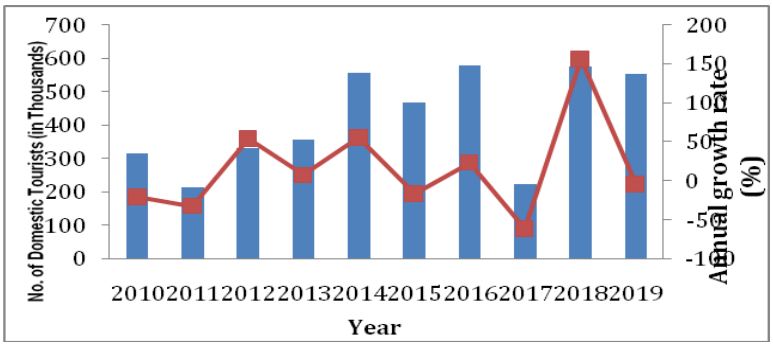


Fig. 6.2: Trends of Domestic tourists inflow in Darjeeling town during 2010-2019 *(Source: Tourism Department, Darjeeling, Government of West Bengal)*

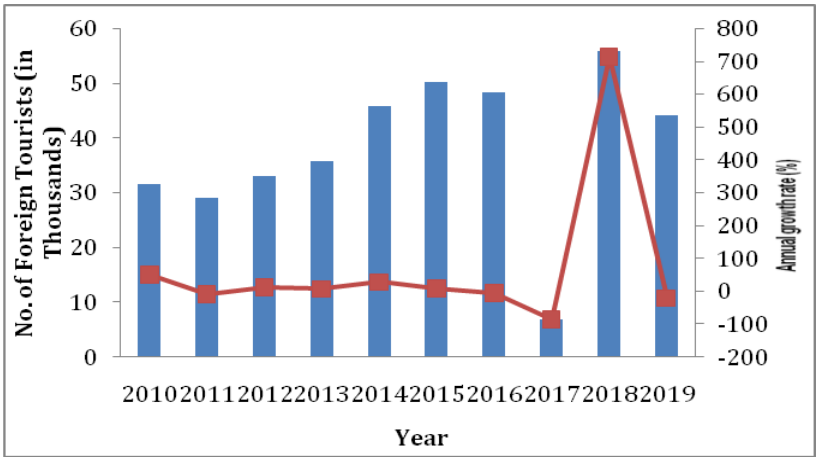


Fig. 6.3: Trends of Foreign tourists inflow in Darjeeling town during 2010-2019 *(Source: Tourism Department, Darjeeling, Government of West Bengal)*

Due to non-availability of long-term monthly tourist data, the seasonal patterns of domestic tourist volume to Darjeeling was analysed for the period 2012-2014 only. Seasonal trend analysis of domestic tourist volume for 2012-14 showed that 43.2% tourist influx was received in Darjeeling in summer months (April–June), approximately 27% influx is received during winter months (December-March) and 18 % during post monsoon months (October–November). The remaining months (i.e. July–September) have an inflow of approximately 12% of the annual inflow of tourists per month (Fig. 6.4).

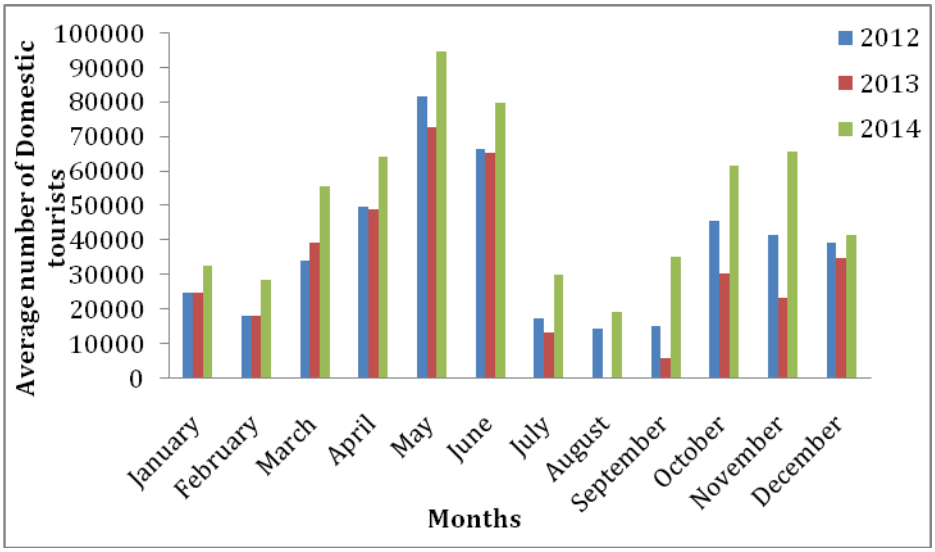


Fig. 6.4: Monthly trend of domestic tourist arrivals in Darjeeling hills in 2012 to 2014 *(Source:* Gorkhaland territorial administration, department of tourism*, Government of West Bengal)*

Data obtained from the Tourism Department, Gorkhaland Territorial Administration, Darjeeling shows that there had been 4.7 lakhs tourists in the year 2012- 13 while in 2013-14 the Figure has shot up to 3.9 lakhs including both foreign and domestic tourists. The domestic tourist visit is maximum in the month of May-June and the foreign tourist visit especially in the month of October- November. These data further imply that during the time of tourist season especially in summer and winter, the growth in number of both domestic and foreign tourists sharply increases.

Similarly, seasonal trend analysis of foreign tourist volume for 2005-10 showed that maximum (33%) tourist influx is received in Darjeeling in summer season (March-May), followed by post monsoon season and during onset of winters (30%). The influx during monsoon season (June–September) is approximately 17% of the annual inflow of tourists per month (Fig. 6.5).

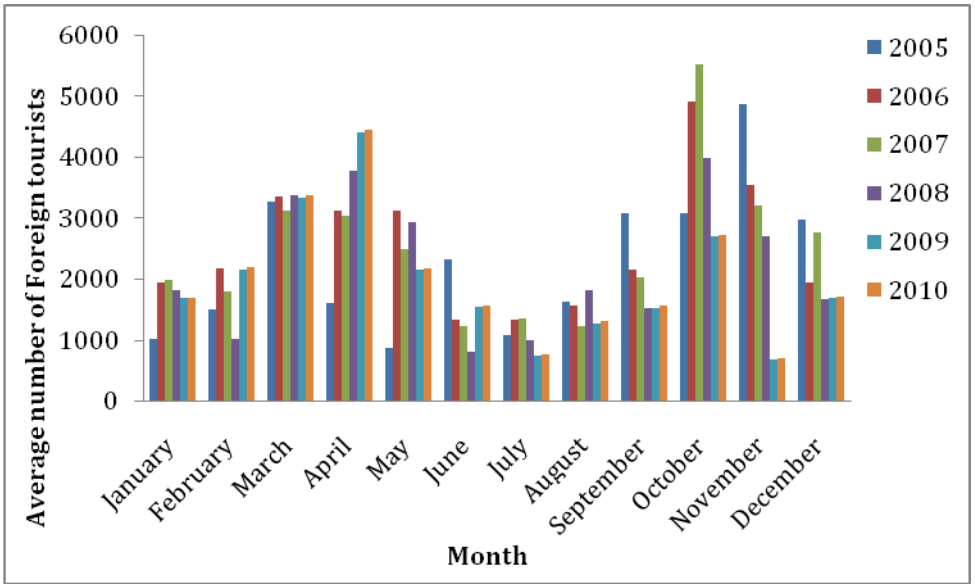


Fig. 6.5: Monthly trend of foreign tourist arrivals in Darjeeling hills in 2005 to 2010 *(Source:* Source: Foreigners registration office, DIB, Darjeeling*, Government of West Bengal)*

It may, however, be noted that there have been year-to-year fluctuations in tourist volume. Darjeeling, being the tourists hotspot and a famous hill station, contributes a large amount of revenue to state GDP. Though the data on revenue generated from tourism for West Bengal hills was available, a case study of Tiger hill (tourist spot in Darjeeling) is depicted below (Fig. 6.6). The data reveals that during the reporting period over 10 lakh tourists visited Tiger hill, which lead to a collection of Rs. 2,29,65,000.0 as revenue from tourism in Tiger hill (Darjeeling).

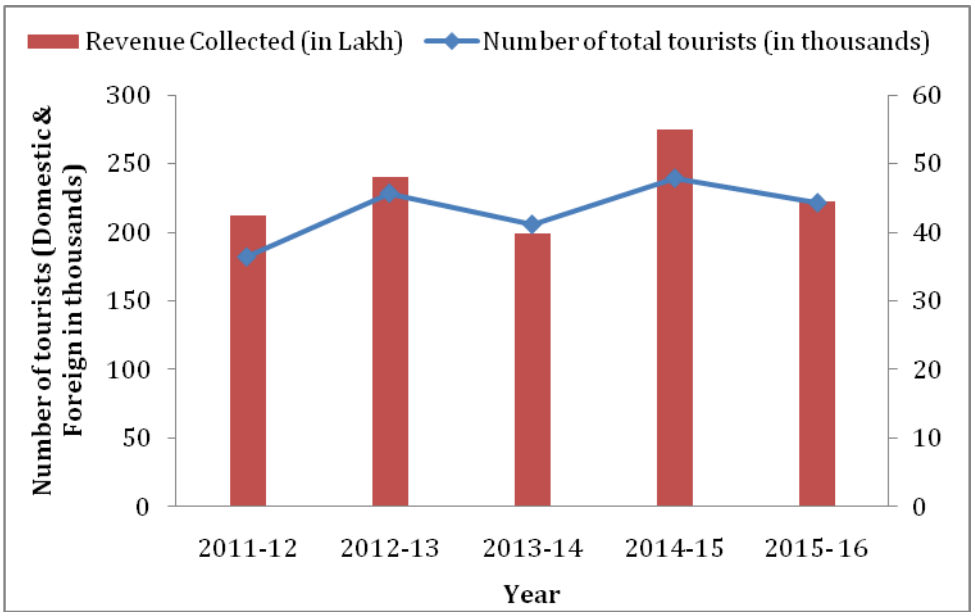


Fig. 6.6: Trend of tourists inflow and revenue generated at Tiger hill, Darjeeling (*Source: Tourism Department, Darjeeling, Government of West Bengal*)

6.1.4. Ill-effects of tourism particularly on environmental components

The major tourism products of Darjeeling and adjoining areas are Nature based tourism, Tea tourism, Bird-watching, Toy Train- a World Heritage product, trekking, water Rafting, Butterflies Tours, Forest Safaris, and Wellness Tourism. Moreover, in recent years, tourist arrival in the area has increased to about 4.5 lakh tourists every year (Das and Roy 2016), and thus accommodating these inflows have been a serious issue lately. Although the tourism industry is the major source of livelihood for the local population, the rapid growth of the tourism industry has been putting continuous and tremendous pressure on the resources of this fragile hill station (Rai, 2020).

The activities of the tourism industry include the continued loss of vegetation due to construction of the multi-storeyed building, roads for communication etc. Tourist growth continues in an uncontrolled and unregulated manner. Hotels and roads are rapidly increasing with the increasing number of tourists. According to the district Gazetteer of Darjeeling District (1980) the road length in the district are- national highway 100 km, state highway 80 km, major district road 37 km and ordinary district road 516 km. Today, the town is covered with concrete jungle, where large numbers of multi-storied buildings have been built (Sharma, 2012; Biswas and Pal 2016). Due to ever increasing and over exploitation of natural resources, the environment of Darjeeling Himalaya gets degraded (Sharma, 2012). Also, there has been vast change in forest cover and rhododendron species, which are the main attraction for tourists in the past and present are on the verge of extinction (Sharma, 2012).

Water is the most important natural resource. Tourism industry uses water much more for hotels and personal use by tourists resulting in a water crisis. Many hill stations in the Himalayan region face water scarcity during tourist season; Darjeeling is one of them. Darjeeling district suffers from water shortage; this problem becomes more severe when tourist flux increases. The total demand for water in the Darjeeling town is 75 lakh liters per day while total supply is 24 lakh liters per day with a deficit of 50 lakh litres per day (Tamang and Jana, 2017). The demand for water increases with the tourist influx. During the tourist season, on an average, each hotel is forced to buy around 2-3 tankers of water every day (Bhutia, 2017).

6.2. Assessment of waste generation in Sikkim

The problem of generating solid waste in Darjeeling hills is quite alarming. In mountain areas of Darjeeling, trekking tourists generate a great deal of waste. The main source of solid waste is coming from hotel and tourist activity. About 50 tons of solid waste is generated daily, out of which only 62% is disposed-off daily (Limbu, 2014). The major types of solid waste are Vegetable waste (20-65%), Paper and carton (15-40%), Fines (sand, ash, broken glass) (15-40%), and plastic waste contributing to 2-13% (Limbu, 2014). Further, As per the District Environment Plan (2021), 350-400 MT/Day solid waste is generated from Siliguri Municipal Corporation, 66.38 MT/Day solid waste is generated from Darjeeling Municipality, 11 MT/Day

solid waste is generated from Kurseong Municipality, and 3.6-4 MT/Day solid waste is generated from Mirik Municipality.

6.3. Segregation / Utilization of waste

Though 100% generated solid waste is collected; segregation and management of waste is still a gap area in the solid waste management aspect in Darjeeling. Sweeping is done manually, however 100% coverage of manual sweeping is not done due to lack of workforce. Wet-waste management is done on-site and the composting is done by bulk waste generators which are limited in 30. Action Plan has been prepared for wet-waste management only for Darjeeling Municipality; it is yet to be done for the rest of sub-divisions. Facilities for central Biomethanation/ Composting of wet waste do not exist. Disposal of inert and non-recyclable wastes is done at sanitary landfills (District Environment Plan, Darjeeling- 2021).

6.4. Waste disposal / treatment facilities

There are limited Waste Deposition centres (for domestic waste) in Darjeeling, which is insufficient for deposition of waste generated in bulk due to increase in urban population and tourist's inflow. Hence, as per the District Environment Plan of Darjeeling- 2021, there is need to setup 379 additional Waste Deposition centres in all four subdivisions (162 in Darjeeling Sadar, 72 in Mirik, 120 in Kurseong and 250 in Siliguri (District Environment Plan, Darjeeling- 2021).

6.5. Impact on Air quality

There exists only one Automatic Air Quality monitoring station in the district located at Siliguri, Tinbati and operated by State Pollution Control Board (SPCB) and two manual monitoring stations operated by SPCB are located at Siliguri Municipality Building, Siliguri and Bose Institute, Darjeeling. The prominent industries with major emission potential are Tea Industries, Food and Agro Industries, and Saw Mills (District Environment Plan, Darjeeling- 2021). Urban Local Bodies (ULB) wise annual average values for air quality parameters for Darjeeling district depicts that PM_{10} value for Darjeeling (57.6 µg/m^3) is almost equal to the National Ambient Air Quality (NAAQ) value (60 µg/m^3) whereas it is much higher for Siliguri (90 µg/m^3). The annual mean NO_2 values for Darjeeling and Siliguri are found to be 35.20 µg/m^3 and 37.54 µg/m^3 respectively. Although these values are less than the NAAQ value of NO_2 of 40 µg/m^3, they are on the higher side of the NO_2 concentration level in terms of air quality.

Another study by Sarkar *et al.* (2015) on continuous monitoring of black carbon (BC) aerosols in Darjeeling during January 2010–December 2011, showed that the concentration of BC was maximum during pre-monsoon (5.0 ± 1.1 µg/m3) followed by winter (3.9 ± 2.2 µg/m3), post monsoon (2.9 ± 1.0 µg/m^3) and minimum during monsoon (1.7 ± 0.7 µg/m^3). It is observed that the contributions of local emissions, long-range transport and mountain wind transport are approximately 56%, 27% and 17%, respectively, towards the total BC loading over Darjeeling during pre-monsoon. The high concentration values observed in pre-monsoon season and winter season reflect the direct influence of tourist activities on air quality as the highest inflow of tourists in Darjeeling is observed during these two seasons.

6.6. Impact on water quality / groundwater

Number of wetlands and lakes are scattered in the subdivisions of Darjeeling. Researchers have studied water quality of some of the key lakes and wetlands (e.g. Mirik, Nakhapani and Jorepokhari). These lakes are not only the center of attraction of tourists but are also the suitable habitats for some important faunal species such as the rare Himalayan Salamander. The study conducted by Rai (2017) for two years 2011-2013 on water quality of Mirik, Nakhapani and Jorepokhari lakes of Darjeeling hills showed that Dissolved Oxygen in Mirik Lake ranged from 1.2 mgL^{-1} to 9.6 mgL^{-1}, 3.96 mgL^{-1} to 6.01 mgL^{-1} in Nakhapani and from 3.2 mgL^{-1} to 8 mgL^{-1} in Jorepokhari lake. In Mirik Lake, DO values usually ascend from March to reach the highest in the month of September, and the lowest in the month of November. In Nakhapani Lake, it slowly increases from July and reaches the peak in the month of January. In Jorepokhari Lake DO, values gradually ascend from March to the maximum in May and reach to the lowest value in January. Mirik Lake had the highest DO concentration during monsoon which could be attributed to untreated sewage disposal from hotels and residential areas. A DO level that is too high or too low can harm aquatic life and affect water quality. The pH ranged from 6.15 to 9.3 in Mirik Lake, 5.98 to 7.6 for Nakhapani Lake and 6.3 to 8.04 for Jorepokhari Lake. The pH was observed to be minimum in the month of March and the maximum in September in all the three lakes (Rai, 2017). pH in lake water is influenced by a number of parameters such as temperature, dissolved CO_2, ions and buffering capacity of water, untreated sewage discharge and subsequent microbial decomposition of organic matter in the water body. Higher pH values in Mirik Lake could also be attributed to these factors. Total Bacterial Count, Total Coliform, Faecal Coliform and Faecal Streptococci showed seasonal variation with highest population during the warmer period (April-September) and lowest in winter period (November-February). Among the three lakes, Mirik Lake was observed to have relatively high Total Bacterial Count values (5.2 X 10^5 CFU mL^{-1} - 6.2 X 10^5 CFU mL^{-1}) clearly reflecting a greater anthropogenic pressure on the lake and its catchment as the influx of tourists is more in Mirik Lake than in Nakhapani and Jorepokhari lakes (Rai, 2017). The presence of total bacterial count in lake water can be attributed to a number of factors such as agricultural runoff, effluent from septic system or domestic sewage discharge and infiltration of grazing animal excreta, faecal matter deposited as a result of open air defecation, human activities like recreation and farming; untreated sewage and industrial effluents, natural soil or plant bacteria, and other unhygienic practices. In all the lakes the highest value of TC (MPN mL-100) was observed in July and lowest TC values in the month of January (Rai, 2017). In Mirik Lake, the highest value of TC (2400 MPN mL-100) was observed in July-September and lowest in November - January months. MPN of TC in Nakhapani and Jorepokhari Lakes showed an almost similar trend that of Mirik Lake. Moreover, increase in TC load during the warmer summer months (April - October) and decline with decrease in water temperature during cold months (November-January) could be attributed to higher tourist influx during the warmer months and low influx during cold months which affects recreational activities like boating, horse riding, picnics and others, in and around the lake adding to the TC load (Sharma *et al.* 2010, Saleem *et al.* 2011).

6.7. Impact on Forest and Biodiversity

The Darjeeling Himalaya is the part of Singalila range of the Eastern Himalaya located in the eastern region of India covering an area of 3,149 km^2 geographical area. The major forest types are northern tropical wet evergreen forests (plains up to 150 m), northern subtropical semi-evergreen forests, North India moist deciduous forests, northern subtropical broad-leaved wet hill forests (300- 1650 m), northern montane wet temperate forests (1650-3000 m), East Himalayan moist temperate forests (1500-1800 m) and sub-alpine forests (3000 - 3700 m) (Ghosh and Mallick 2014). Due to great variation in elevation in this region, wide arrays of climatic zones are available, which favored the high floral and faunal diversity. Das (2011) estimated 3,362 species of vascular plant whereas Ghosh and Mallick (2014) has estimated over 2900 species in Darjeeling Himalaya. In terms of faunal diversity this regions adobe 130 mammals, 550 birds, 125 freshwater fish, 51 reptiles, 25 amphibians, 43 months and 24 butterflies (Anonymous 2018a & b).

6.7.1 RET Categories species wise

Among the 3,362 plant species, the Darjeeling Himalayan region encompasses 129 plant species in RET categories, which includes 103 species in rare, 4 vulnerable, 7 endangered, 3 critically endangered, 3 near threatened and 9 species in threatened categories (Anonymous 2018a & b). As per IUCN conservation status of mammalian diversity of the region includes, 3 species in endangered, 5 vulnerable, 5 near threatened, 8 least concern and 1 species in lower risk categories (Anonymous 2018 b).

6.7.2 Changes in Forest cover

The total forest cover of Darjeeling Himalayan region is 2367.80 km^2 which is 75.19% of total geographical area of the district (ISFR, 2019). Forests often suffer negative impacts of tourism in the form of deforestation caused by fuel wood collection and land clearing for construction (Banu 2019). Deforestation is the most significant environmental component adversely affected by tourism. Percentage of forest has changed drastically in Darjeeling during 1901-2001 (Basu 2006). The changing patterns of land use and land cover is in a precarious condition due to the rapid increase in cultivated land, expansion of settlement, and construction of roads since the last 150 years (Basu 2006). However, in the last one decade (2011-2019) the total forest cover has increased by 2.50% of the total geographical area of the state (IFSR 2011-19). There has been vast change in forest cover and population of rhododendron trees, which are the main attraction for tourists in the past and present are on the verge of extinction (Sharma, 2012). Construction of resort accommodation and facilities frequently requires clearing forestland.

6.8. Eco-sensitive zones/ Areas

There are three designated Eco-Sensitive Zones/ Areas in West Bengal hills.

1. Neora Valley National Park: Declared on 14/09/2017. Order no. 179.S.O. 2994 (E) [12.09.2017] Final Notification declaring Eco Sensitive Zone around zero (Nepal Border on Western Side and Sikkim on Northern Side) to two kilo-meters from the boundary of Neora Valley National Park, West Bengal.

2. Singalila National Park: Declared on 20/11/2017. Order no. 180.S.O. 3613(E) [17.11.2017] Final Notification declaring Eco Sensitive Zone around zero (Northern side-Pangolakha Wildlife Sanctuary in the State of Sikkim) to two kilometres from the boundary of Neora Valley National Park, West Bengal.
3. Senchal Wildlife Sanctuary: Declared on 18/01/2019. Order no. 183.S.O. 319(E) [15.01.2019] Final Notification declaring around one kilometer from the boundary of the Senchal Wildlife Sanctuary, West Bengal.

Singalila National Park, which is home to the Red Pandas, attracts nearly 26000 tourists annually and a sharp increase in tourist inflow has been observed in the last few years. The effective carrying capacity is estimated as 5,601 (excluding Nepal infrastructure), exceeding which results in biodiversity degradation (Sherpa and Mondal, 2021). The inflow of vehicles and tourists into the national park stood around 13,000 till the year 2017 whereas the number increased to maximum 33,000 with an average of 30,000 from 2018 onwards (Fig. 6.7). If this trend continues, the effective carrying capacity will be decreased further from 5601. Further, pollution caused by increasing the number of visitors and vehicles into the park results in environmental degradation (Sherpa and Mondal, 2021). It is a serious matter of concern for the sustainability of the ecosystem of the national park and red panda habitat. To protect the biodiversity of the national park, the entry of tourists and vehicles should be restricted to check the pollution and maintain a balanced effective carrying capacity.

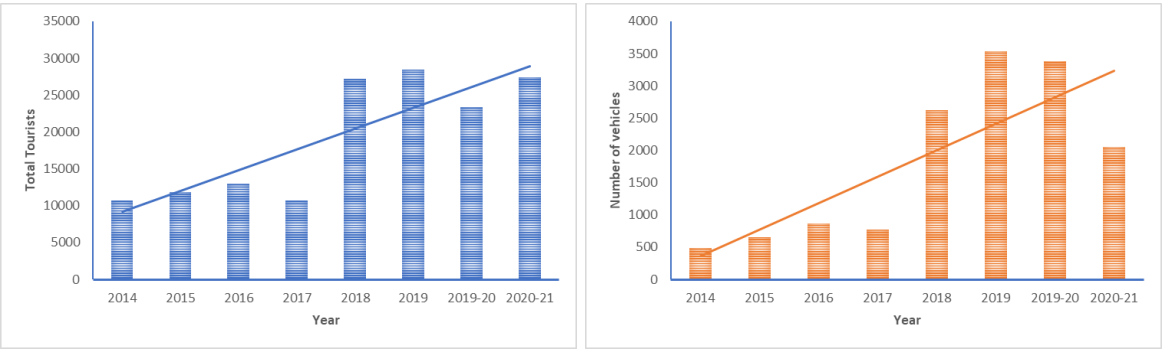


Fig. 6.7: Increasing flow of tourists in Singalila National Park in the last 8 years (*Source: Sherpa and Mondal, 2021*).

In Singalila National Park, Chettri *et al.* (2019) conducted a study to understand the composition and volume of waste. The study showed that the tourist inflow was positively correlated with the waste generation. A sharp increase in the volume and composition of the solid waste was observed during the peak tourist seasons. The direct influence of the mismanaged waste was observed on the feeding habits of endangered species such as Red Panda (*Ailurus fulgens*) and Kaleej Pheasant (*Lophura leucomelanos*). In Singalila National Park the adventure tourism has improved infrastructural development, increase of income and employment opportunities, and revival of local culture; however, it has adversely impacted forest and wildlife ecology (Chakrabarty and Sadhukhan, 2019).

- **Status in compliance of waste treatment facility**

In this aspect, there is a deficiency of data/information. However, a study indicated that at Icchey Gaon in Neora valley National Park, solid wastes are collected in bins for disposal. Every family burns all the solid waste once a week, or bury the waste under the ground. There is no waste management system developed for segregating, transporting and processing of the waste materials. Sometimes plastic and glass bottles are recycled by selling in the local markets after use (Bhattacharya *et al.* 2019).

- **Prohibition of Construction**

As per guidelines of Eco-sensitive zones, construction is prohibited in these areas. In Singalila National Park, a total of 36 hotels in Indian part and 30 hotels in Nepal part are existing in fringe areas (Chakrabarty and Sadhukhan 2019).

- **Traffic regulation**

Permission of the forest department of the State is required before entry in every Eco-sensitive zone. In Singalila National Park, the number is increasing and needs a check as it has crossed the carrying capacity (Sherpa and Mondal, 2021). Land rovers available to take the tourists are 75 in numbers and it has been estimated that 75% vehicle and outsider are not permitted inside the park. However, in Neora Valley National Park, road is not available inside the national park and only trekking is the option for exploration. For Senchal Wildlife sanctuary the data is not available.

6.9. Gap area & Plan of Action

Sr. No.	Gaps	Plan for Action
1.	Darjeeling is in need of a proper urban planning. Overcrowding, broken roads and illegal constructions are common features of Darjeeling. The Darjeeling Himalayan Railway, renowned as the UNESCO heritage, suffers from lack of maintenance and continues to deteriorate. In addition, waste is dumped on the tracks. The World Heritage committee also took a note on the deteriorating condition.	Construction and development needs to be done by adhering to proper urban planning, developing building codes, and adopting efficient sources of energy to make it resilient to climate changes.

2.	One of the main problems in Darjeeling is the broken roads and ill managed traffic which lead to hours of traffic jam and it becomes crowded during tourist season which also leads to generation of immense pollution in the form of waste, air and water.	It is necessary to control the number of tourists visiting these locations so that it does not lead to over tourism.
3.	Waste management is a big challenge in all the eco-sensitive zones. There is a lack of facilities for segregation of waste at source.	Waste management is a big challenge in all the eco-sensitive zones. Proper management including, listing and declaring all the non-biodegradable plastic and waste products before the entry, and rechecking all the non-biodegradable plastic and waste products brought back to ensure the waste not lifted in these zones is required.
4.	Considering the sprawl of the district and tourist influx, an additional number of air quality monitoring stations are required for identification of hotspots or areas of concern pertaining to air pollution in association with SPCB.	There is a need to mitigate data gaps on air and water quality and storage, and prepare an inventory of water bodies. There is also a need to install continuous Real Time air and Water Quality Monitoring stations at key tourist destinations including water bodies/ lakes. Additionally, there is a need is to create an air and water quality monitoring cell in the district.

6.10. Summary

Tourism is an important economic activity in the hill areas of Darjeeling district generating incomes and employment for the local population. Darjeeling receives around 3.5 lakhs domestic tourists and 50,000 foreign tourists per year that generate nearly 30% of the total tourism business of the region worth around Rs. 350 crore per annum. Apart from an increase in the income and the demand for local products, tourism also results in a multiplier effect. The facilities and services deteriorate sharply during the peak season as the amenities available cannot cope up with the huge rush. There are shortages of drinking water, electricity cut, deterioration of municipal services, congestion in public transport and lack of accommodation which lead to a chaotic condition. Mushroom growth of hotels, shops, restaurants; have defaced much of the pristine glories of the hill station. Uncontrolled urban growth, high-rise building construction, overlooking government regulation, dumping of dirt and filth has robbed the scenic beauty. Uncontrolled and widespread falling of trees for the urban expansion has not only defaced the scenic beauty and grandeur but has caused the imbalance in the ecological set up. In spite of so many adverse effects of tourism in the Darjeeling hill areas, there is no denying fact that the economy of Darjeeling relies on the three 'T's, Tourism, Tea and Timber,

among which Tourism plays a vital role. Darjeeling is located in the lap of nature with diverse culture of different ethnic communities; rich heritage, harbouring a myriad of wildlife and forests against the background of snow-clad hills. Regulation of tourism is necessary which is evident by the tourism increase in hill stations during the pandemic. Though eco-tourism and rural tourism are emerging in the past few years with tremendous success, the pillars of sustainable tourism are still ignored. Sustainable building codes are nowhere to be seen, roads are underdeveloped, and projects undertaken are done so without assessing the damage to the environment by removing huge forest covers. Even at the State level the government agencies are largely ignorant of the linkage of climate change and tourism. Water pollution, air pollution, noise pollution, solid waste and littering, and sewage are major of concern. In Darjeeling, air and noise pollution increases due to more use of tourist transportation, especially from CO_2 emissions related to plying vehicles that lead to severe local air pollution. Construction of hotels, recreation, and other facilities often leads to increased waste generation and sewage pollution. Wastewater has polluted the area surrounding tourist attractions, damaging the flora and fauna. Also, sewage pollution can threaten the health of humans and animals.

Darjeeling excels in tourism but much of its vast potential still awaits exploitation. The area is, however, ecologically fragile and under severe pressure due to the demands made on environmental resources by growing tourist traffic and rapid urbanization. Tourism, here is a purely seasonal activity, shows an economic weakness because the people are out of employment during the slack season. The whole region, therefore, needs a proper policy and planning for efficient exploitation of the existing tourist industry. The development of Tourism in the hill areas of Darjeeling is necessary but it should not expand at the cost of the ecological balance.

7.1. Introduction

7.1.1. General scenario of tourism in the Himalayan states

North-Eastern state, Assam took a step to recognize tourism as a sector of the income as back as 1958. When the British acknowledged Kaziranga as a game reserve in 1916 and a wildlife sanctuary in 1950, Assam was anticipated as an attractive destination for tourists, mostly those who are interested in nature and wildlife observation. Apart from it, Shillong, the administrative headquarter of the Assam province during the British period witnessed an environment of outdoor recreation initiated by the colonial ruler. At least some people from inside and outside the state started visiting Kaziranga, and also the Kamakhya temple (Guwahati) in the later part of 1930s which may be considered to be the opening of the tourism sector in the region (Fig.7.1). Since then, significant changes have taken place in the region's tourism sector because of the efforts made by the central and the respective state government in this direction. However, the tourism sector has recently originated in Northeast India and in spite of it has a history of both international and domestic tourists, witnessing merely 0.57% and 0.62% of the domestic and foreign tourist arrivals, respectively of the country. The domestic Tourist inflow in Assam in 2017 was the maximum among the other northeast region at 6.05 million domestic tourist visits, followed by Sikkim, Meghalaya and Tripura. The most important tourist season prevails from October to May. With the overall development in the basic infrastructures along with roads and other facilities, the number of tourist places has accelerated rapidly in North-East India (Devi, 2012). Only two districts, namely Dima Hasao (earlier called North Cachar Hills) and Karbi Anglong, form the hill tourist destinations of the Assam. Almost 75-80% of the tourists visit the region for soothing weather and local festivals (Duarah and Milli, 2013). Following two hills regions of the Assam emerged as a new tourist destination in a short time.

Hills Districts

i) Dima Hasao

Dima Hasao is one of the hill district of Assam with the Borail Range and Shillong Plateau being prominent features of the topography. This renders the district a rugged and hilly terrain which may present logistical challenges but more than recompensates for that with beautiful mountains, a pleasant climate unlike the humid plains, a multitude of scenic waterfalls, pretty valleys, lakes and tribal cultures that define its cultural landscape which makes it ideal for tourism, and adventure.

ii) Karbi Anglong

Karbi Anglong or the land of the Karbis may well be called the heartbeat of Assam. This beautiful, large sprawling district lies in the centre of Assam. This hill district with its diversity of rare flora and fauna has remained untouched and undiscovered. The peculiarity in the topography of the district lies in the fact that there are two parts in this district. The western part is bifurcated from the Eastern side by a part of the Nogaon district. Thus, we have the

Hamren Sub-division in the Western part with its rolling hills, dense forests, waterfalls, rivers and streams. The East part has a combination of flat paddy lands, and green hills interspersed with blue meandering rivers. While, summer in Karbi Anglong can be hot and humid and lasts from June to August. The remaining parts of the year are pleasant. The Peak season for tourists to visit the district is October to March.

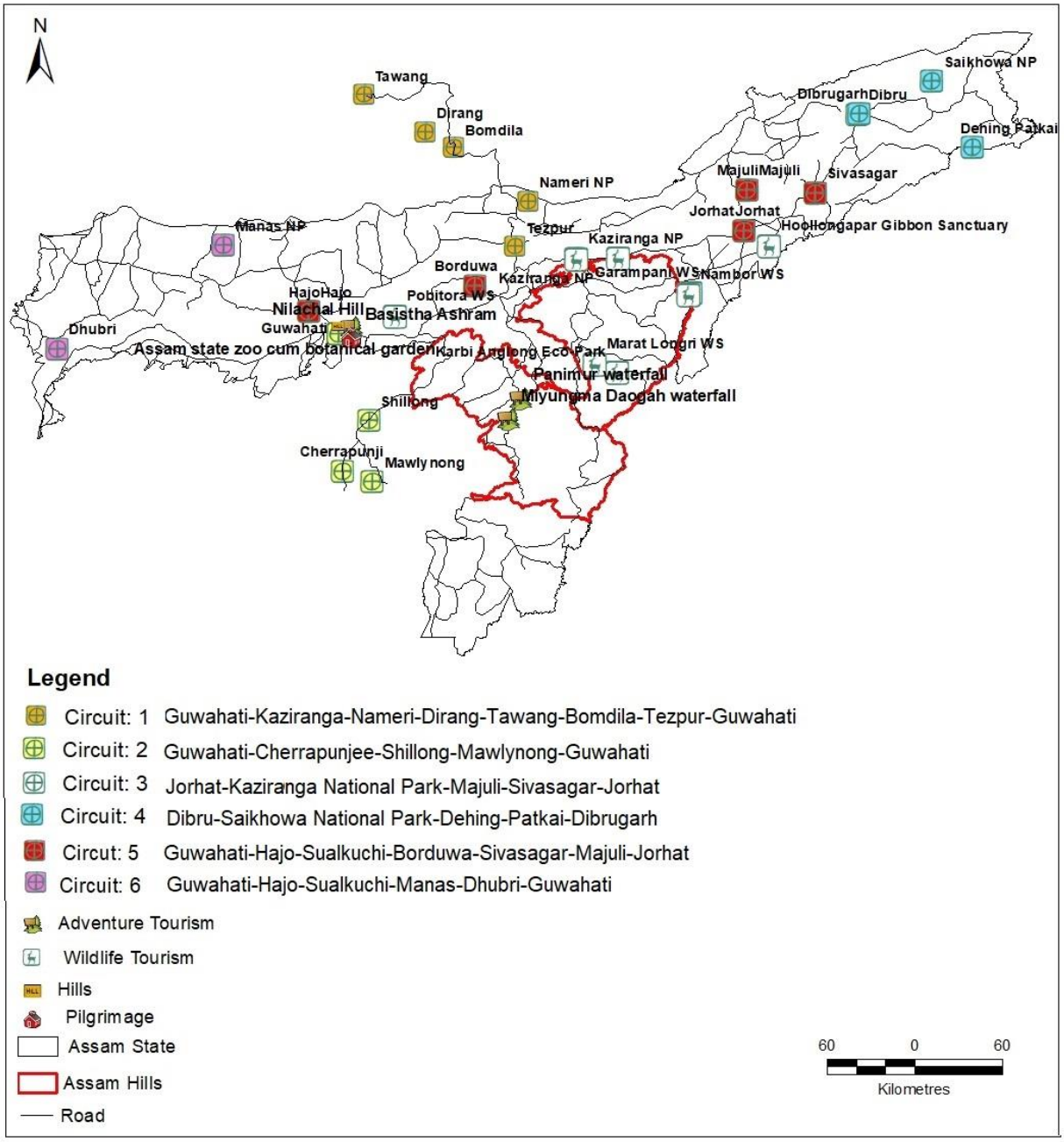


Fig. 7.1: Major tourist spots and circuits in Assam

7.1.2. Tourism growth (number of annual tourists visiting) vis-a-vis economic growth (annual income from tourism)

Along with the economy, tourism has a great significance in the socio-cultural and traditional integration and exchange among different people of different regions. Assam, being a region comprised of immense scenic beauty attracts a large number of tourists from both inside and outside the country. Every year the state of Assam experiences an influx of about more than 4 million tourists (Assam Tourism Development Corporation Limited, 2019) from across the country and the world. The entire trend of tourists' influx to Assam has witnessed continuous growth from about 2.2 million in 2004 to about 5.9 million in 2018. As reflected in Table 7.1 data, the influx of tourists showed an increasing trend since 2004 from 2.2 million to almost around 6 million in 2018.

Table 7.1: Total tourists arrival in Assam in different years

Year	Tourist Flow
2004	22,93,915
2006	32,79,808
2008	36,31,732
2010	40,66,081
2012	45,28,949
2014	47,02,165
2016	55,16,180
2018	59,56,530

(Source: Assam Tourism Development Corporation Limited, 2019)

But this trend was disrupted when the influx of tourists started showing a decreasing trend in 2019. The reason for this was the political unrest that was prevailing in Assam in late November 2019 till Jan 2020. This being the peak time for the tourists visiting the region, the tourism sector had to bear a significant loss of around Rs. 1000 crore in the month of December and January alone (The times of India, 31st December 2019). Apart from tourism itself, many other sectors that are directly or indirectly related to this sector were equally affected. The already deteriorating situation of the tourism industry of the region was further worsened with the onset of the covid 19 pandemic in 2020-21. In the region, when it was trying to overcome the effects of the political unrest that was held from December 2019- January 2020, covid19 spread throughout the country around February and in Assam around late March 2020. Apart from the loss, that the state had to bear, due to the Anti-CAA movement, the tourism sector has borne an additional loss of around Rs. 200 crores approx. by the next three to six months since February 2020.

Tourism has been playing an important role as a means of livelihood for many people in the region. The share of tourism employment is more than 2.5 per cent of the total employment of the state (Gogoi, 2017). The overall infrastructural development and the initiatives taken by the Government to promote tourism in Assam extensively have led to the integrated development

of this sector encouraging more and more people to get attached to it. Consequently, many people have started to get associated with it, leading to a continuous hike in revenue generation from this sector (Table 7.2).

Table 7.2: Total Revenue earned across five tourist areas from tourists only

Tourist spots	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Kaziranga	1436750	1554390	900601	1021570	983650
Sivasagar	700310	735175	762694	802957	1027444
Bhalukpung	156000	177000	85600	51600	144200
Chandubi	91500	107400	214800	178040	524800
Barpeta Road	140300	163100	262400	376100	350800
Total	2524860	2737065	2226095	2430267	3030894

Source: Statistical handbook of Assam 2018, 2019

Apart from the commercial hotels and lodges, the tourism industry was facilitated as a means of earnings to innumerable people living in the fringe areas of the tourist spots of the state who generate their livelihoods by running small scale business of homestay where they provide a traditional picture of the lives of the local inhabitants to the tourists. This attracts a great number of tourists, as the visitors are able to live the local lifestyles, they are introduced to the local customs and traditions, along with that, they also taste the local cuisines of the region, thus, experiencing a more lively encounter with the region as a whole. Such provisions have attracted a great number of international tourists from across the world which has in turn resulted in more local people getting inclined to the tourism sector (Table 7.3).

Table 7.3: Total number of Homestays and visitors to these Homestays across Assam (2012-2020)

Years	2012 (in thousands)	2018 (in thousands)	2019-20 (in thousands)
Total Visitors to the Homestays	7.2	14.3	9.7
National and Local Visitors to the homestays	5.3	11.2	6.3
International Visitors to the Homestays	1.9	3.1	3.3
Total Number of Homestays	3.2	6.4	6.1

Source: Statistical handbook of Assam (2018, 2019)

Although the hill tourist regions of Assam have been progressing in tourism very fast, but it is not on the top ten list of India in respect of domestic and foreign tourists (Devi, 2012). It is not even having a 2.5% share, which was the lowest, earned by other states like Gujarat in respect of domestic tourists and Goa, in respect of foreign tourists. Assam had only 0.6% of India's

total domestic tourists and 0.1% of the foreign tourists in 2009 (Ministry of Tourism, Govt. of India). Assam state stood at the 18th position among the states of India, in respect of tourist inflow and income. Again, in a 2011 survey, Assam ranked 27 among 28 states in the country in the tourism survey based on various parameters. (The Telegraph, Calcutta, 28 September 2011).

7.2 Ill-effect of tourism particularly on environmental components

7.3 Assessment of waste generation in Assam

During 2009-2012, Assam state on average generates about 1146 Metric Tonnes of waste per day. The quantities of waste are growing at the rate of 3% annually with the increasing per capita generation and change in the living standards, especially in the bigger cities. It is endorsed that waste management is a huge challenge in hills tourist spot and become much more threatening as the number of tourists grows. Assam has 0.03 gm per capita solid waste generation by tourism and its allied sectors but it reflects waste generation and disposal as a key focus area for sustainable tourism (Niti Aayog, 2018).

7.4 Segregation / Utilization of waste

The government of Assam has been working in order to improve the solid waste management scenario of the state. Despite the efforts, the success has been limited to only a few cities of the state but a great deal is still to be achieved to comply with the SWM Rules, 2016 totality, especially in relation to the treatment and disposal of waste. Most of the municipalities of Assam state are dumping its waste on a wetland site. So far, no concrete system of segregation has been put on place.

7.5 Waste disposal/ treatment facilities

At present, there is one centralized waste compost plant of 60 tonne/day (TPD) each and 03 Nos of decentralized waste to compost plant in the state. The state is focusing on various other options for waste processing including waste to energy. Except Guwahati city, all other local bodies are utilizing low lying areas for disposal of MSW.

7.5. Number of Vehicles (State/District Wise)

Transportation is one of the important components of tourism activities. The relationship between transport and tourism development is very important because it contributes significantly to the development of tourism. It overcomes the physical, social and economic development of human beings. It is observed that registered vehicles in Halflong hill station of Dima Hasao district vary year to year over the period 2011-21. In 2016, 9208 vehicles were registered in Halflong which has shown a high number after 2021 (Fig. 7.2). The rate of change in the number of vehicles showed a fluctuating trend from 0.06% to 0.09% during 2011 to 2021, while it showed a decreasing trend of –0.52 and -0.51% in 2015 and 2017, respectively.

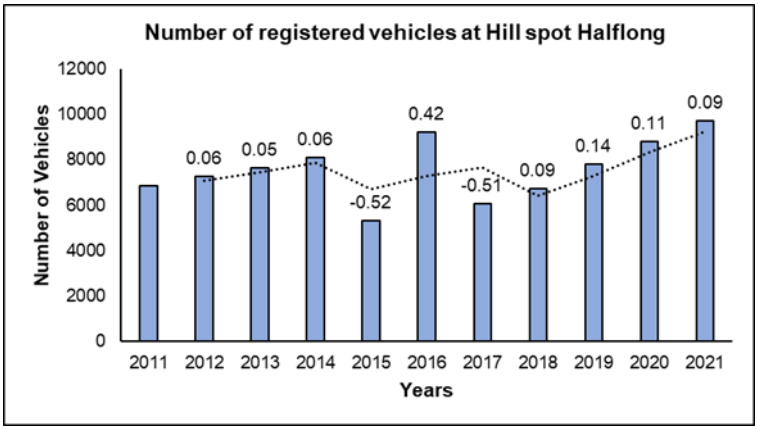


Fig. 7.2: Number of registered vehicles in Halflong (2011-2020)

In Dima Hasao district (Halflong) after the monsoon, October month reported an increasing registration with the tourist flow in the area In Karbi Anlong district, registration of vehicles has increased in the month of March. Numbers of diesel and patrol-operated vehicles have been increased 42% and 27% in 2018 and 2021 respectively at Dima Hasao district and similar trend is also found at Karbi Anglong with 9% and 11%, respectively. Table 7.4 shows numbers of vehicles registered as follows.

Table 7.4: Number of diesel and petrol operated vehicles in Assam Hills

	Dima Hasao		Karbi Anglong	
Year	Diesel	Petrol	Diesel	Petrol
2021	155	1089	540	6241
2020	106	594	531	5209
2019	189	1008	938	6168
2018	106	854	999	7084

Source: Vahan.nic.in

Ill effects from tourism arise when the visitors harnessed more than the capacity of the environment and its ability to handle this change. Unrestrained tourism accelerates possible threats to many natural areas around the Assam Hills like Halflong in the eastern Indian Himalaya. It can put massive pressure on an area and lead to impacts such as soil pollution, waste pollution, permanent habitat loss, increased pressure on endangered species and increasing forest fires. It often creates stress on water resources, and it pushes local populations to use critical resources. Dima Hasao district has two Hazardous Waste (HW) generating industries, of which 1.275 (Mt) of hazardous waste is recyclable. Karbi Anglong district has one authorised industry of HW generation and 13 (Mt) HW is recyclable waste (CPCB, 2019).

7.6. Ill-effect on Air quality

Air quality data were generated by M/s Eco Laboratories & Consultants Pvt. Ltd. for the ambient air of selected sites of Dima Hasao district from December 2017 to Feb 2018. This site is close to the tourist destination Halflong. Fig. 7.3 shows the variation in air pollution during selected days in 2017 and 2018. All the analysed pollutants were well within the permissible limit prescribed by NAAQS. The major contribution of air pollution is by opencast mining, such as excavation, loading and transportation, etc. which leads to a momentary rise in the suspended particulate matter (PM_{10}). The dust liberated in mining and other related operations is injurious to health if inhaled in sufficient quantity. As such there is no noticeable impact on air quality. As such, there is no noticeable impact on air quality. Tourist flow and vehicle influx have no drastic impact on air quality of both the districts of Assam Hills.

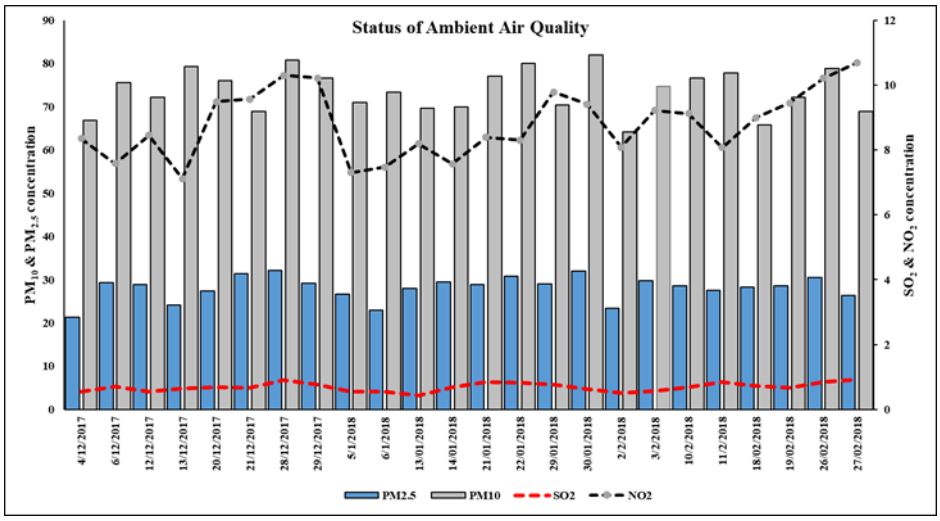


Fig.7.3: Status of Ambient Air Quality in near Halflong area Dima Hasao district (*Source: M/s Eco Laboratories & Consultants Pvt. Ltd.*)

7.7. Impact on water quality / groundwater

Water is of vital importance for human and animal life, maintaining ecological balance, and promoting developmental activities. Considering its vital importance and ever-increasing demand for water, in the face of population growth, urbanization & industrialization and considerations of climatic change, making water, an increasingly a scarce resource, available for multiple uses, planning and management of this vital resource, utilization of water economically, optimally and equitably assumes greater importance. Dima Hasao district has the different facilities of surface irrigation and groundwater availability. Majority of surface irrigation facilities are tanks, lift irrigation, rainwater harvesting, sewage treatment plant and perineal source of water. While in groundwater facilities open well, deep tube well, medium tube well and shallow tube well are available in Dima Hasao district of Assam.

The samples of water quality were collected from 2011to 2019 (Statistical Handbook of Assam 2011-19). The groundwater table is in this region between 20 and 25 mts from the ground level to evaluate the physicochemical characteristics of the water resources existing in the study area. pH, DO, BOD, EC, N and Total Coliform range were measured 6.1-8.2, 6.0-7.2, 0.5-5.8, 33-668, 0.10-0.70 and 0-360, respectively. There would not be any adverse impact on the groundwater quality. The mineral formation does not contain any harmful elements, which could percolate into the ground and pollute the groundwater. Hence, no control measures are required.

7.8. Ill-effect on Forest and Biodiversity

In 2010, Dima Hasao had 31 millihectares of natural forest, extending over 11% of its land area. In 2021, it lost 127 kilohectares of natural forest, equivalent to 64.6 Mt of CO_2 emissions. From 2002 to 2021, Dima Hasao lost 12.0 kilohectares of humid primary forest, making up 18% of its total tree cover loss in the same time period. The total area of humid primary forest in Dima Hasao decreased by 8.4% in this time period (Fig. 7.4 a&b). From 2001 to 2021, Dima Hasao lost 69.0 kilohectares of tree cover equivalent to a 16% decrease in tree cover since 2000 and 28.5 Mt of CO_2e emissions. From 2002 to 2021, Karbi Anglong lost 27.9kha of humid primary forest, making up 17% of its total cover loss in the same time period. The total area of humid primary forest in Karbi Anglong decreased by 9.8% during this period (Fig. 7.5 a&b). From 2011 to 2021, Karbi Anglong lost 105kha of tree cover, equivalent to a 13% decrease in tree cover since 2000, and 47.3 Mt of CO_2 emissions.

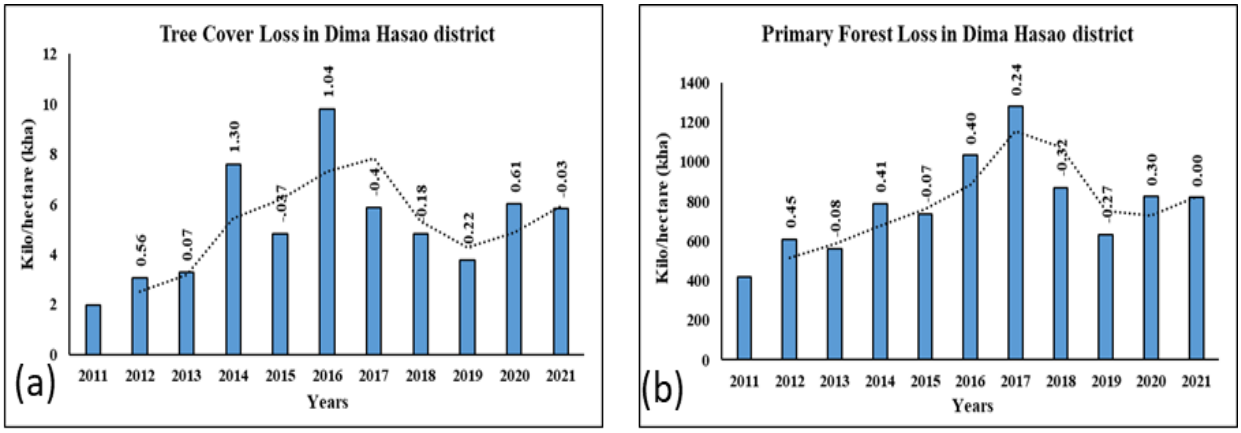


Fig. 7.4: (a&b) Primary forest loss and tree cover loss of Dima Hasao district

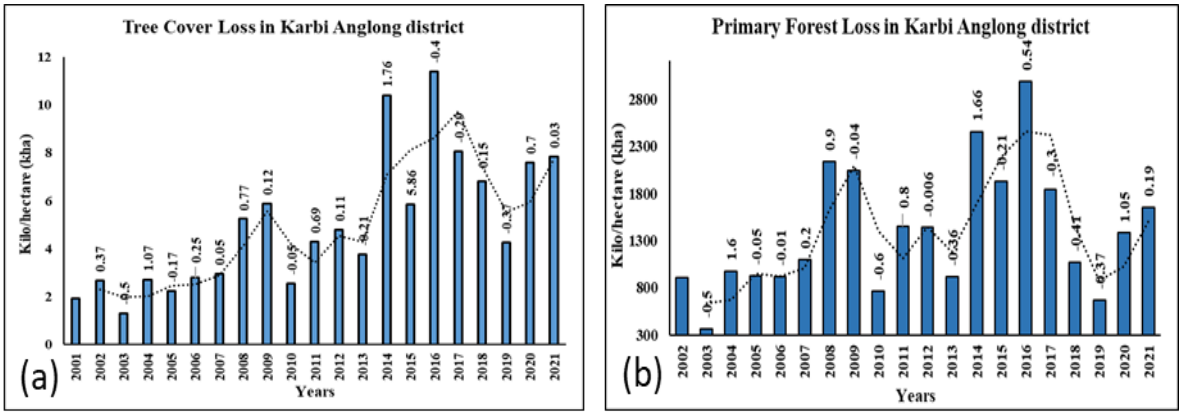


Fig. 7.5: (a&b) Primary forest loss and tree cover loss of Karbi Anglong district

In Dima Hasao district, no protection around the forest area of Halflong and various disturbances and their effects on the normal growth of natural flora were found. Invasive species like *Chromolaena odorata* and *Mikania micrantha* are available in the area. Conservation of habitat and ecosystem by means of protected area network, ecological restoration and sustainable resource management is very important for biodiversity conservation (Angermeir, 2001). It has been observed that the Sacred Groves of Halflong are examples of conservation carried out by the community but it has also been observed that more importance is given to the actual deities and religious beliefs than the forest. This has changed ideas over time, which has led to the degradation of the forests. Assam control of Tree Felling Rules, 2002 implemented by the government, to control felling of trees, these rules provide for the registration of the tree plantation raised on non-forest land with the Divisional Forest Officer except for trees including *Aam, Jamun, Kathal, Eucalyptus, Poplar*, a species of homegrown *Bamboo, Leteku, Paniol, Madhuriam* which do not require felling permission. It has been documented that the usage of at least 15 animals listed under the Endangered, Vulnerable and Near Threatened category of the IUCN Red List in the hills of Dima Hasao. While several are listed under Least Concern in the IUCN Red List, there has been a drastic change in the abundance of the species even within the last ten years. Species like *Gekko gecko, Gallus gallus, Canis aureus, Macaca assamensis, Nycticebus coucang* are less abundant now as compared to the last ten years. At present, at least 24 are hunted for their meat as much as it is hunted for its medicinal value. Smoked meat of *Sus scrofa, Trachypithecus pileatus, Hoolock hoolock etc.* are in high demand (Lalduhawma and Betlu, 2013). All the above degradations in forest and biodiversity in Assam hills are not due to tourist activities. All are primarily attributed due to the occupancy of household land, roads and networking, etc.

7.9. Eco-sensitive zones / Areas (data not available with the concerned department Attached letter)

The Assam government decision came after the Supreme Court-appointed central empowered committee (CEC) pulled up the government earlier this month (17 May 2022) over slackness in protecting the animal corridors. The government declared seven protected areas; Kaziranga

National Park and Tiger Reserve, Burachapori Wildlife Sanctuary, Laokhowa Wildlife Sanctuary, Garampani Wildlife Sanctuary, Nambar-Doigrong Wildlife Sanctuary, East Karbi Anglong Wildlife Sanctuary, and North Karbi Anglong Wildlife Sanctuary. No construction could be done in these eco-sensitive areas. Assam Government cleared, "The eco-sensitive zone will categorize activities inside it as prohibited, regulated and promoted. The zone is intended to protect flora and fauna, besides ensuring ecological and environmental security around the national park.

Development of tourism in rural hill areas provide an opportunity for a wide range of benefits, both direct and indirect, to the local community. So the local management committees should encourage management of tourism in the hill regions. It has been observed that municipalities do maintain regular data on waste generation and its composition. At present, no systematic and authentic data on MSW generation is available. There is a need for the digitalization or web portal of waste collection and disposal data. Issues of water highlight the need for a database on water availability, water quality as well as access to data sources for different uses and applications of the hilly region. Launching public awareness campaign for air pollution control, vehicle maintenance, minimizing the use of personal vehicles, lane discipline, etc. for controlling the air pollution in this particular area would be a prime need of the hour. The environment and wildlife resources have been the major attractions to bring tourists into the North East region. Environmental and wildlife protection is therefore perceived as an essential component for the long-term success of tourism in this region. The tourism development activities should also include increasing awareness towards the conservation of natural and cultural assets both among the locals and tourists. It is expected that through the cooperation and productive interaction of the tourism industry, environmental protectors and the local community, it will ensure regulated tourism that will benefit all and achieve environmental sustainability in the region.

7.10. Gap areas & Plan of Action

Gaps	Plan of Action
Not available in-situ conservation of all wild flora and fauna/research-based plan	Complete inventory and documentation require in terms of wild flora and fauna/extensive need based on field-based research and consultation with local stakeholders for documentation.
Little community-based tourism	With Community-Based Tourism (CBT), local people would enhance their involvement and participation in tourism planning and development in their areas, having a positive impact on the social, economic, and environmental conditions of the tribal communities of Assam.

Needs proper collection and segregation of waste	Assam Hills manage or make arrangements for the house to house waste collection and identify the generation points to minimise the negative impacts. Data on waste generation, collection and its treatment need to be generated, and documented properly further.
Needs consistency in monitoring of ambient air quality	Data deficit in air pollution is noticed. Local authorities should develop a database based on regular monitoring for obtaining changes in coming future.
Lack of institutional capacity for climate change planning	Expansion in the institutional capacity of local government for climate change planning is urgently needed. This will require adaptation practices to evolve in view of NDC and SDGs.

7.11. Summary

Due to improving and affordable connectivity, particularly air travel, tourism sector is booming in India and related growth in infrastructure. Landscape of the IHR caters different types of tourism needs (viz., nature and religious) of the domestic population and other nationalities. Accelerated growth of Tourism in the IHR in the past few years had substantial impact on its economy, local community and environment. The tourism industry has served an important industry in economic development of people in the IHR. But as a coin it has also two sides, with increase in tourism, there is an increased waste generation, vehicles, waste disposal into rivers. These all has led to degradation of the soil, water and air quality over the period of time. Decentralization of waste management, introduction of latest technologies can help in robust waste management especially in the hilly cities with limited area for dumping of waste. Lack of scientific disposal of solid waste in downstream during the peak tourist season is the biggest challenge in the hills.

Further, with increased number of vehicles in the tourist places, some areas is facing its impact on air quality which can be only measured by regular monitoring of pollutants and understanding their diurnal and seasonal variability in the region. Some of the mitigating measures to combat degrading air quality, such as, (i) nature based solution can be used as a sustainable way to combat air pollution. Some of the sensitive species such as lichens, algae, and trees have been used as bio-indicators of air quality, (ii) improving the vegetation cover/greenery will also help in reducing air pollution, (iii) some of the plant species have the potential to reduce air pollution through mechanisms such as bioaccumulation and deposition. Tolerance and sensitivity of the plant species vary depending on the type of stress due to pollutant and plant physiology. Regular monitoring of water quality especially monitoring of natural water resources, capacity building and awareness among the local community and tourists about water quality degradation will help improve the water quality in the region. Further, proper management of sewage waste is required so that it does not mix with other natural water resources and will also help prevent degradation of air quality. It is important to

note that several leading mountain states such as Himachal Pradesh, Sikkim, Jammu & Kashmir and Uttarakhand have specific best practises. Many governmental and commercial initiatives have the potential to be upscale and out-scaled in the future. However, things on ground are of tremendous concerns. The Hon'ble NGT's orders to mountain states, e.g., Himachal Pradesh on Rohtang Pass, Jammu & Kashmir on Vaishnav Devi make the steps taken there are vivid. Travelers to the IHR are being reported for drug usage among minors, labour exploitation, and illegal property transactions despite the fact that states have put strict standards for outsiders in place. Mass tourism/pilgrimage is causing serious harm to the Indian Himalayan States. Our country is selling the natural and cultural splendour of the Himalaya at a very low premium and allowing development in the IHR like we do in the plains of India. The recommendations, if incorporated into action, have the potential to help preserve the IHR landscapes while also enhancing the well-being of local residents.

Arunachal Pradesh

8.1. Introduction

Arunachal Pradesh is one of the 13 states/union territories of the Indian Himalayan Region, and is an ideal destination for tourists (Fig.8.1). It's located at the top of North-Eastern India; this is the first Indian land to greet the morning sun. It's also called the 'Land of the Dawn-lit Mountains'. It lies between 26°28' N, and 29°30' N Latitudes and 91°30'E and 97°30' E Longitudes. It spreads over an area of 83,743 sq.km touching the international boundaries with Bhutan (160 Km) in the west, China (1080 Km) in the north, Myanmar (440 Km) in the south-east and the plains of Assam to the south. It borders the states of Assam in the south and Nagaland to the east and southeast. It is the largest of the Seven Sister States of northeast India by area. The state extends from the snow-covered Himalayas to the Brahmaputra plains.

Arunachal Pradesh is the home of 26 major tribes and acknowledged to be one of the most splendid, variegated and multilingual tribal areas of the world. In 2022, Arunachal Pradesh has 26 districts with a population of 17,11,947 of which 883,358 males and 828,589 females according to unique identification aadhar India and a literacy rate of 65.38%. Agriculture is the mainstay of the economy of Arunachal Pradesh. It is largely dependent on 'jhum' cultivation. Topography and climate of Arunachal Pradesh is conducive for cultivation of rice, millets, wheat, maize, pulses, sugarcane and potatoes. The state is the largest producer of kiwis in India and the second largest producer of large cardamom. The traditional agriculture practices also add tourism value to the beauty of the state along with cultural diversity.

8.1.1. General scenario of tourism in the Arunachal Pradesh

The major part of the Eastern Himalayan ranges in Arunachal Pradesh is the most picturesque tourist destination of India. With its numerous turbulent streams, roaring rivers, deep gorges, lofty mountains, snow-clad peaks, thousands of species of flora and fauna, and an endless variation of scenic beauty, there is tremendous potential for the development of tourism in Arunachal Pradesh; especially, adventure and eco-tourism. The state has vast potential for offering various attractions to the tourists like paragliding, river rafting, angling, hiking, trekking, mountaineering, land gliding, snow skiing etc. For the wildlife enthusiasts and nature lovers, Arunachal has a number of wildlife sanctuaries, national parks, and biosphere reserves, its lush-green tropical forests teeming with wildlife. Arunachal Pradesh is also famous for the Buddhist Circuit. But, the tourism potential of the state for generating much-needed income & employment remains underutilized. Though the state has high tourism potential, owing to a lack of infrastructure facilities such as transport, communication facilities, accommodation, and other tourism-support facilities, most of it remains out-of-bound to the tourist.

Places of tourist attraction in the state can be broadly classified as follows:

i) Places of Religious Importance and Archeological/Historical Sites
ii) Wildlife Sanctuaries and National Park
iii) Adventure Tourism
iv) Arts and Craft

v) Culture Tourism (Fairs & Festivals, Dances)

Places of tourist interest include Bomdila, Tawang and the nearby Buddhist monastery, which happens to be the largest in India. Itanagar is famous for its excavated ruins of the historical Ita fort and the attractive Gyaker Siri or Ganga Lake and the famous Gompa Temple. Malinithan and Bhismaknagar are the two important archaeological sites in the state and Parashumkund is a prominent pilgrimage site.There are twelve tourist circuits in the state shown in Fig.8.1. They are as follows:

- Tezpur – Bhalukpong – Bomdila - Tawang
- Itanagar – Ziro – Daporijo – Aalo – Pasighat
- Pasighat – Jengging – Yingkiong – Tuting
- Tinsukia – Tezu – Hayuliang
- Margherita – Miao – Namdhapha – Vijoynagar
- Roing – Mayudia – Anini
- Tezpur – Seijosa – Bhalukpong
- Ziro – Palin – Nyapin – Sangram – Koloriang
- Doimukh – Sagalee – PakeKessang – Seppa
- Aalo – Mechuka
- Daporijo – Taliha – Siyum – Nacho
- Jairampur - Manmao- Nampong – Pangsau Pass

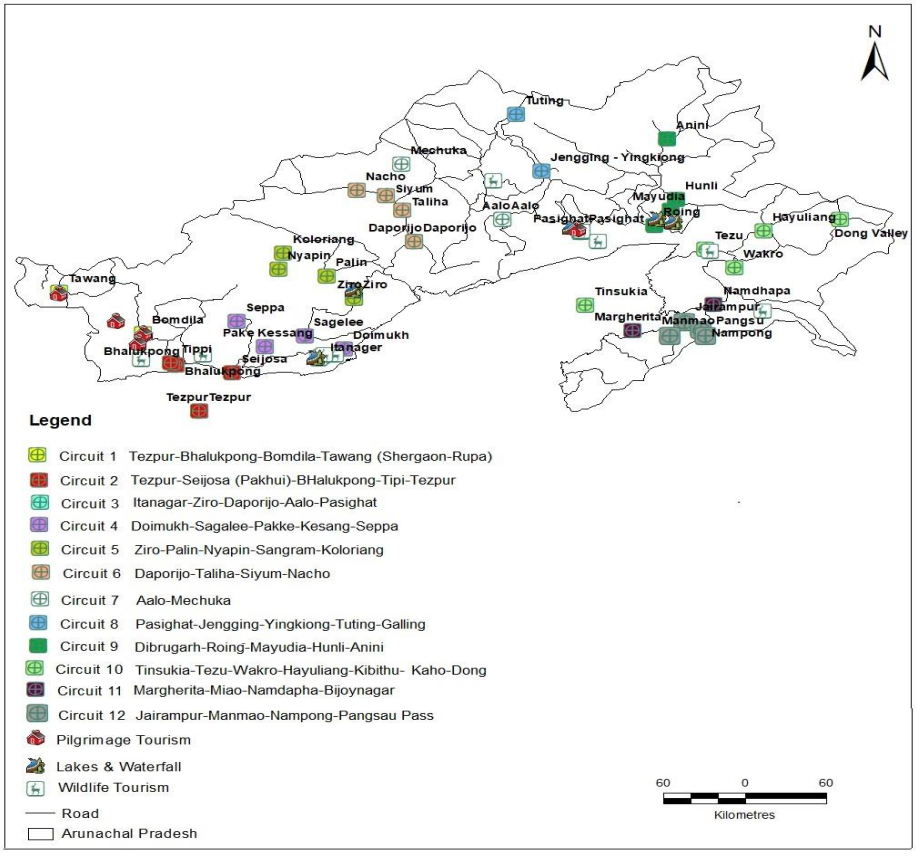


Fig. 8.1: Major tourist spots and circuits in Arunachal Pradesh

8.1.2. Tourist growth

Many domestic and international tourists visit in Arunachal Pradesh. Figures 8.2 & 8.3 show the detailed information of domestic & international tourists visited Arunachal Pradesh in all the months during the period of year 2011 – 2021.

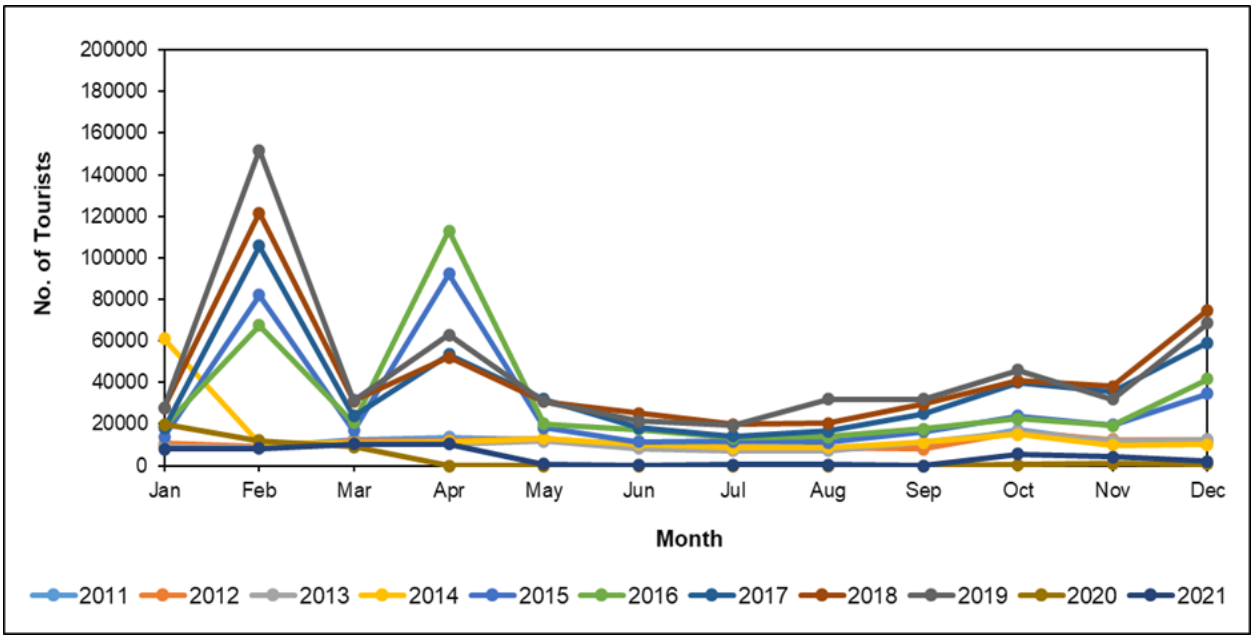


Fig. 8.2: Domestic Tourists visited in Arunachal Pradesh (Jan-Dec) during the period 2011-21

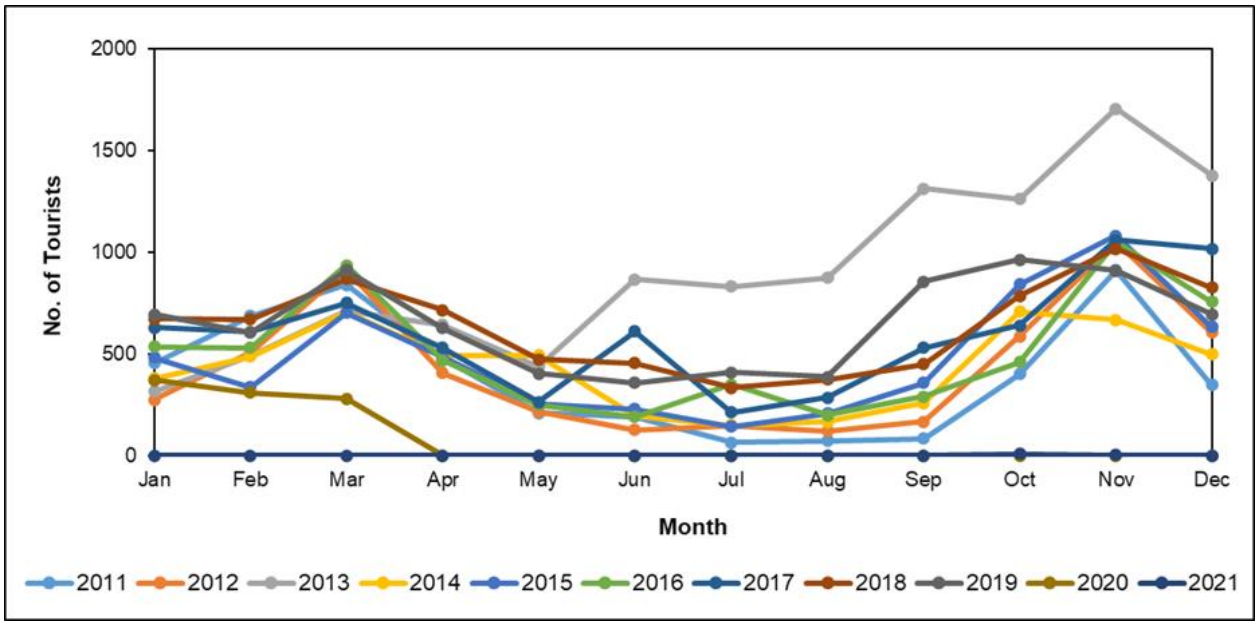


Fig. 8.3: International Tourists visited in Arunachal Pradesh during the Year 2011-21

The data from the year 2011 to 2021 show that the average number of tourists per year is roughly around 2,70,000 in Arunachal Pradesh. During the mentioned period, maximum tourists

visited the state in the Year 2019 (total 5,63,464), and 98.6% were domestic tourists. If we talk about only international tourists, then the maximum number of international tourists visited the state in Year 2013 (10,846). The overall data as presented in Fig.8.3 show that the highest numbers of visitors are seen during the months of January, February and March. On the contrary, the months July, August and September can be considered as the lean period for tourism in Arunachal Pradesh. The main cause of this seasonal difference is the climate and monsoon. The month of February receives a higher number of tourists because of the cold weather, snow-clad mountains and beautiful snowfalls. The year 2020 and 2021 reported the lowest number of tourists due to the COVID-19 pandemic. But during the other years many domestic as well as international tourists have visited the state of Arunachal Pradesh.

The Department of Tourism collects revenue sent by districts in which a total revenue received is compiled each month which is inclusive of PAP (Protected Area Permit), Leased assets ILPs (Inner Line Permits) etc. The revenue for the financial Period of 2015-16 is Rs.1,02,48,797; 2016-17 is Rs.1,23,05,748; 2017-18 is Rs.1,16,83,137; 2018-19 is Rs.78,44,936; 2019-20 is Rs.78,72,484 and 2020-21 is Rs.29,99,642. Thus, during the period of 2015-16 to 2020-21, the total revenue collected by the state tourism department is Rs. 5.28 crores.

District-wise distribution of tourists in Arunachal Pradesh from 2011–2021; which shows that the tourist inflow is highest in Lohit District (2,61,134) followed by Tawang District (2,60,308) and West Kameng (2,46,373). While Upper Subansiri District received the lowest tourist inflow (160) followed by Kurung Kamey (4,350). The reason behind the maximum inflow of tourists in Lohit district is due to the Hindu Pilgrimage site, Parsuram-kund. Tawang and West Kameng also experience a high inflow of tourists during the winter where tourists come to experience the snowfall and scenic beauty.

Dirang, Bomdila are the main tourist attractions in West Kameng district where most of the tourists visit every year. On the other hand, because of the poor connectivity and bad road condition Upper Subansiri and Kurung Kamey districts experience a low inflow of tourists. There was a gradual increase of tourists both domestic and international till 2019, after that steep decline of tourism due to COVID-19 pandemic. Maximum tourists visited the West Kameng district in Years 2011, 2015 & 2016; Lohit district in 2012 & 2014; East Siang district in 2013, Tawang in 2017, 2018, 2019 & 2021; and West Siang in 2020.

8.1.3. Ill-effects of tourism particularly on environment components

Tourism development at both the national and international levels can make a positive contribution to the life of a nation provided it is well planned, doesn't affect the local cultural heritage, natural and social environments. In other words, it should not go beyond the carrying capacity of a particular state or region. Tourism need to be directly correlated to the resources that are available and also the system in place to manage the resources. Thus, in achieving the goals of sustainable tourism in any particular state, the carrying capacity, management of resources, conservation of cultural and environmental assets are the major factors.

As per the data collected from various departments on solid waste generation, its door-to-door collection and dumping, the government of Arunachal Pradesh is moving in the right direction so far by improving the basic facilities in its major towns (nearly 30 towns). However, as far as management of dumping sites or treatment of waste at source or dumping site is concerned, the government authorities have a lot to do in the immediate future. Detailed information on waste generation and collection is given in Section 2 of this report. The central government and state government agencies are taking up adequate positive steps to promote nature sensitive community based ecotourism in the state of Arunachal Pradesh. That involves promotion of community-based approaches like homestays, nature-based tourism, adventure tourism, declaration of Community Conserved Areas (CCAs) for tourism purposes, etc. This approach is a good strategy to move further for developing a sustainable tourism model in the state.

8.2. Assessment of waste generation in Arunachal Pradesh

Solid waste generation is directly linked to the tourism sector as it increases with the increasing number of tourists. Presently Arunachal Pradesh has 33 notified urban areas or towns namely Aalo, Anini, Basar, Boleng, Bomdila, Changlang, Daporijo, Deomali, Dirang, Doimukh, Dumporijo, Hawai, IMC, Jairampur, Khonsa, Kimin, Koloriang, Longding, Mariyang, Miao, Namsai, Palin, Pangin, PMC, Raga, Roing, Sagalee, Seppa, Tawang, Tezu, Yingkiong, Yupia, and Ziro.

In recent years, Arunachal Pradesh has witnessed the construction of a large number of roads and buildings along with an increasing population and tourists. One of the direct impacts of urbanization and population increase is the generation of domestic, medical and other types of solid waste.

Although, it is again to be mentioned that till now, Arunachal Pradesh is among the few Himalayan states which is not facing mass tourism, moreover the population density of the state is among the lowest, so the tourism in the state can be considered within the carrying capacity of the state.

As per the data collected from the concerned state department, there has been a gradual increase in the quantity of waste generation (domestic only) from the period of 2011 to 2019, and always the waste collected has been lesser than the waste generation. It has been seen that Itanagar Municipal Corporation (IMC) has the highest amount of waste generation (more than 829 MT/day) as compared to other towns of the state, certainly due to the large population size, lifestyle of the people living here, market and hotels etc. The town of Aalo also produces a huge amount of waste (nearly 397 MT/day) in comparison to the other towns. It is to be noted that in other towns the waste generation was very low initially, but in recent years it's gradually increasing. Till now, a total 30 dumping yards are present in Arunachal Pradesh, which covers an area 2,22,896.50 m^2, which is really a very small area. However, on the other hand, it is also an important fact to mention that most of the dumping sites are located on river bank sides or inside the forest areas. Therefore, it is causing negative impacts as discussed

above. So far, in Arunachal Pradesh, there is no proper system in place for proper treatment of the collected waste or for management of the dumping sites. In future, if the scenario remains the same, this is going to affect the local environment very seriously.

8.3. Number of Vehicles

As per records from the year 2011 to 2021, Arunachal Pradesh has registered 3,84,480 vehicles which includes transport and non-transport vehicles both. Out of this, 3,52,990 are non-transport vehicles and 3,14,90 are transport vehicles. The capital complex has the highest number of vehicles i.e. 2,64,553 vehicles and Kamle with the lowest i.e. 31 vehicles. The number of transport and non-transport vehicles of Arunachal Pradesh are shown in Fig.8.4a, whereas total numbers of vehicles based on fuel type are presented in Fig. 8.4b.

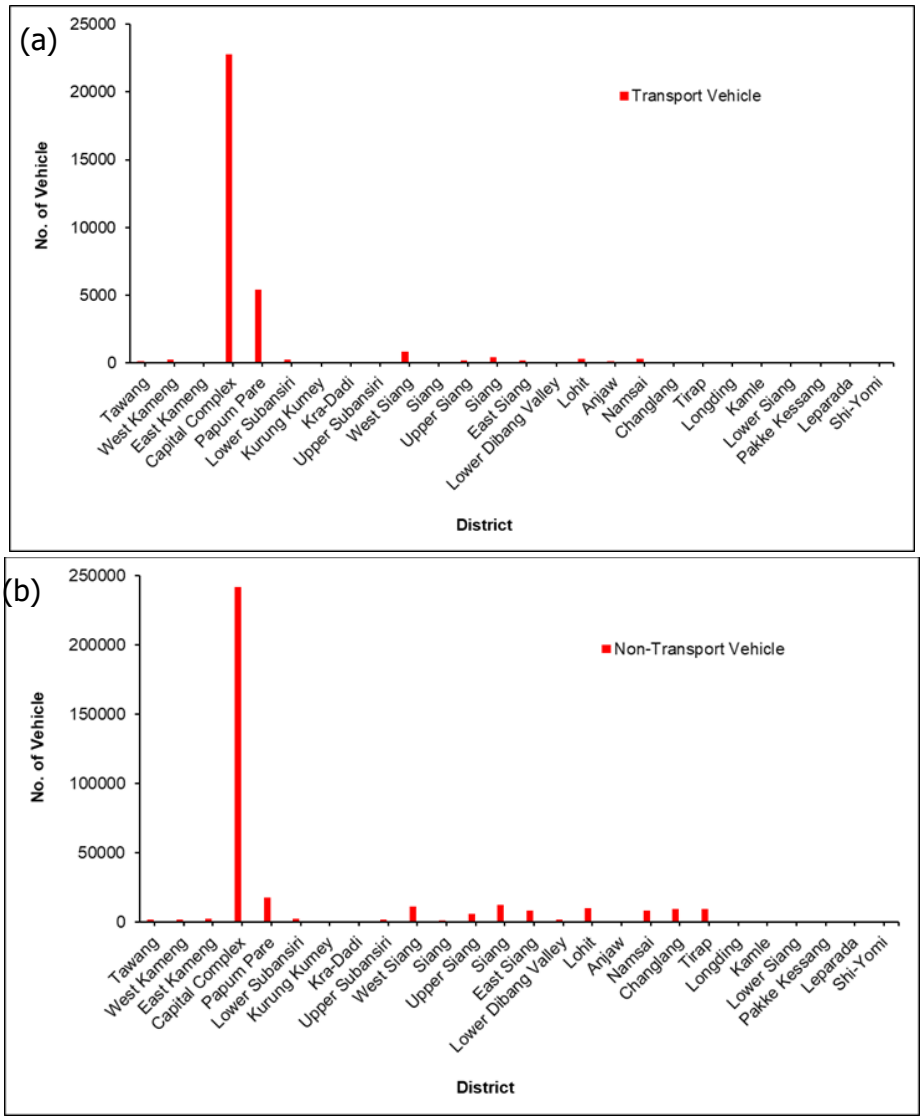


Fig. 8.4 a&b: Total number of (a) Transport, and (b) Non-Transport vehicle operating in Arunachal Pradesh (2011-21)

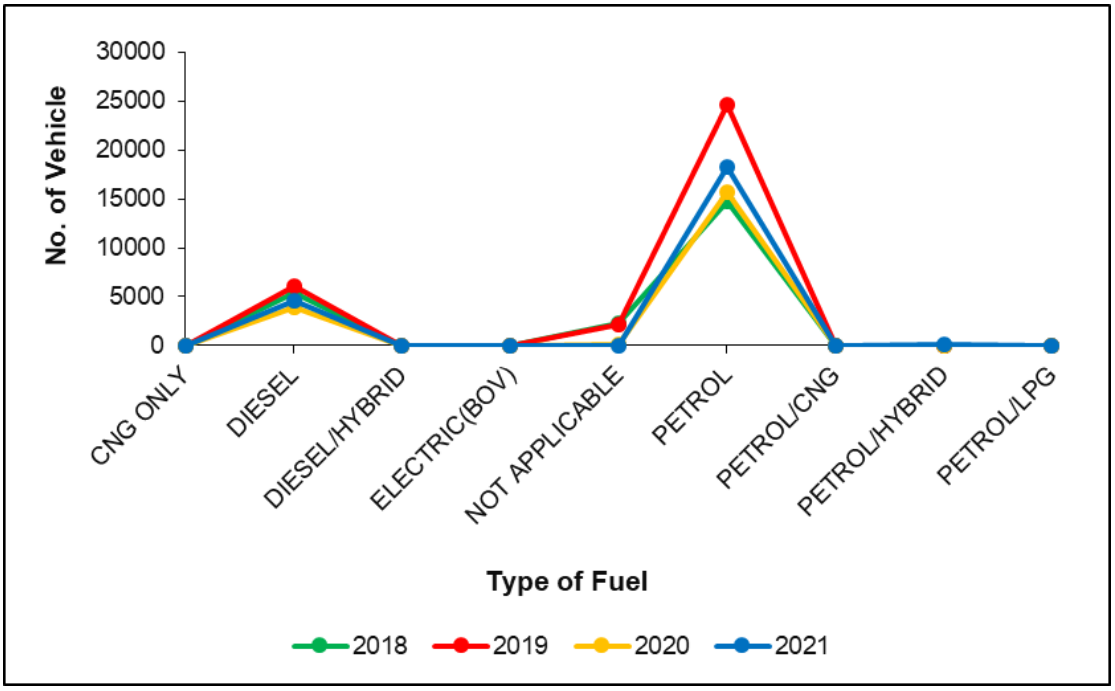


Fig. 8.5 : Total number of vehicles categorized by fuel type

As per the data from the year 2018 to 2021, Arunachal Pradesh has registered 73,458 petrol vehicles & 20,053 diesel vehicles (Fig. 8.5).

8.4. Ill-effect on Air Quality

Tourism has been impacting air quality directly or indirectly for decades. Air pollution resulting from excessive use of internal combustion vehicles (cars, taxis, buses, motorcycles, etc.) in tourism areas is a major problem. The details of air quality parameters monitored at Itanagar and Naharlagun have been incorporated. The variation of various air quality parameters (PM_{10}, SO_2, NO_2) monitored at Itanagar and Naharlagun for the time period 2016 –2021 are shown in Fig. 8.6 to 8.11.

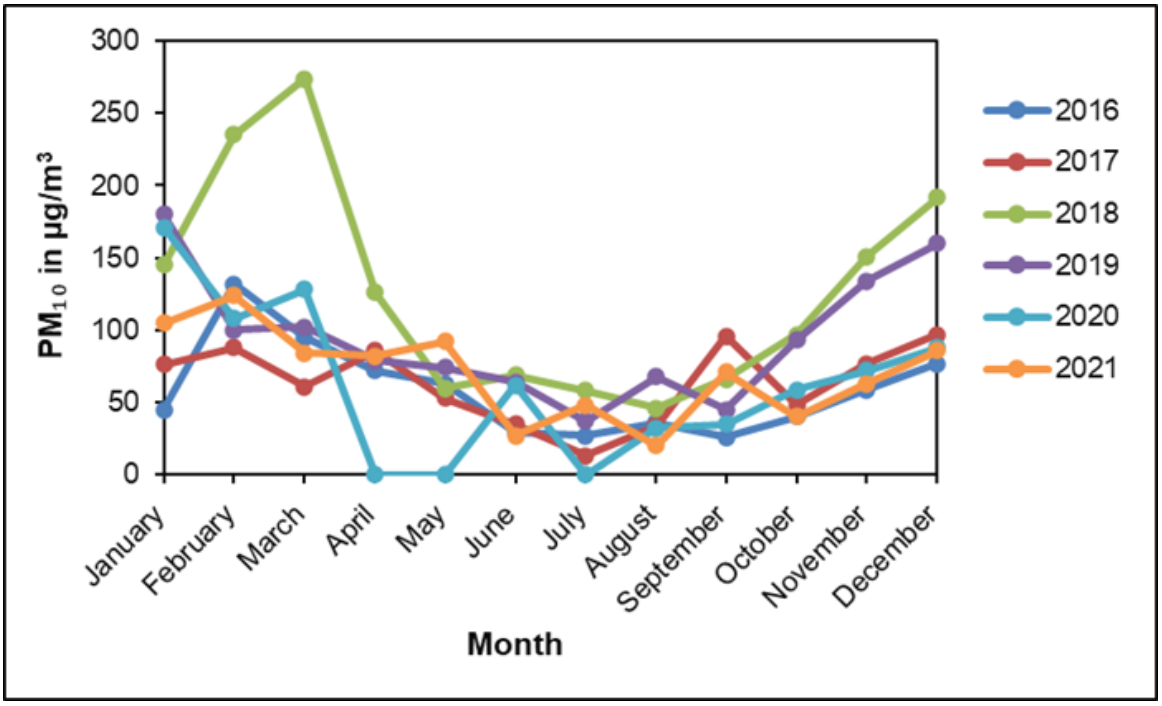


Fig.8.6: PM_{10} in Itanagar (Jan-Dec) during the period (2016-21)

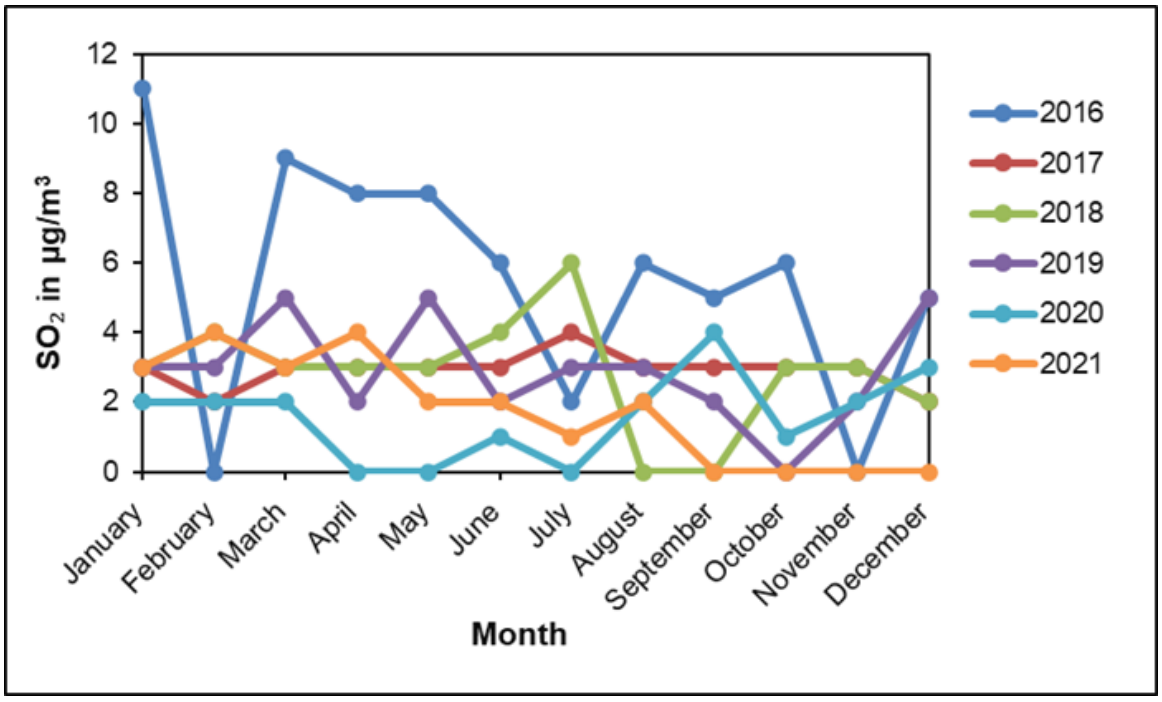


Fig.8.7: SO_2 in Itanagar (Jan-Dec) during the period (2016-21)

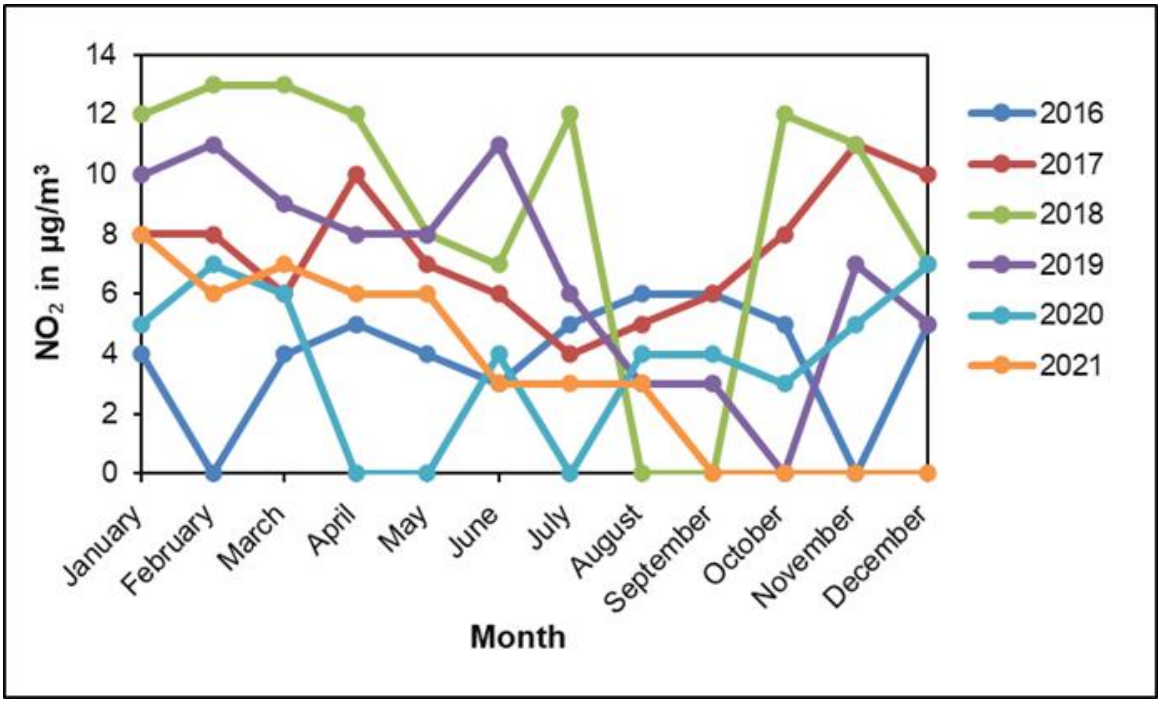


Fig.8.8: NO_2 in Itanagar (Jan-Dec) during the period (2016-21)

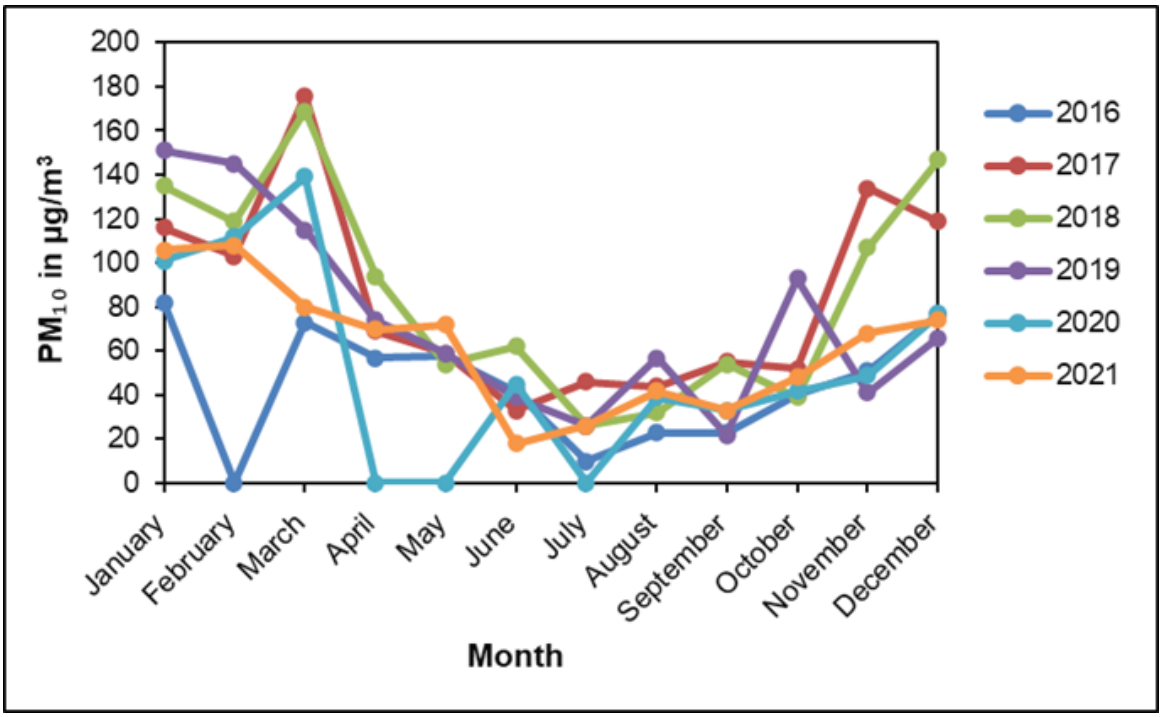


Fig.8.9: PM_{10} in Naharlagun (Jan-Dec) during the period (2016-21)

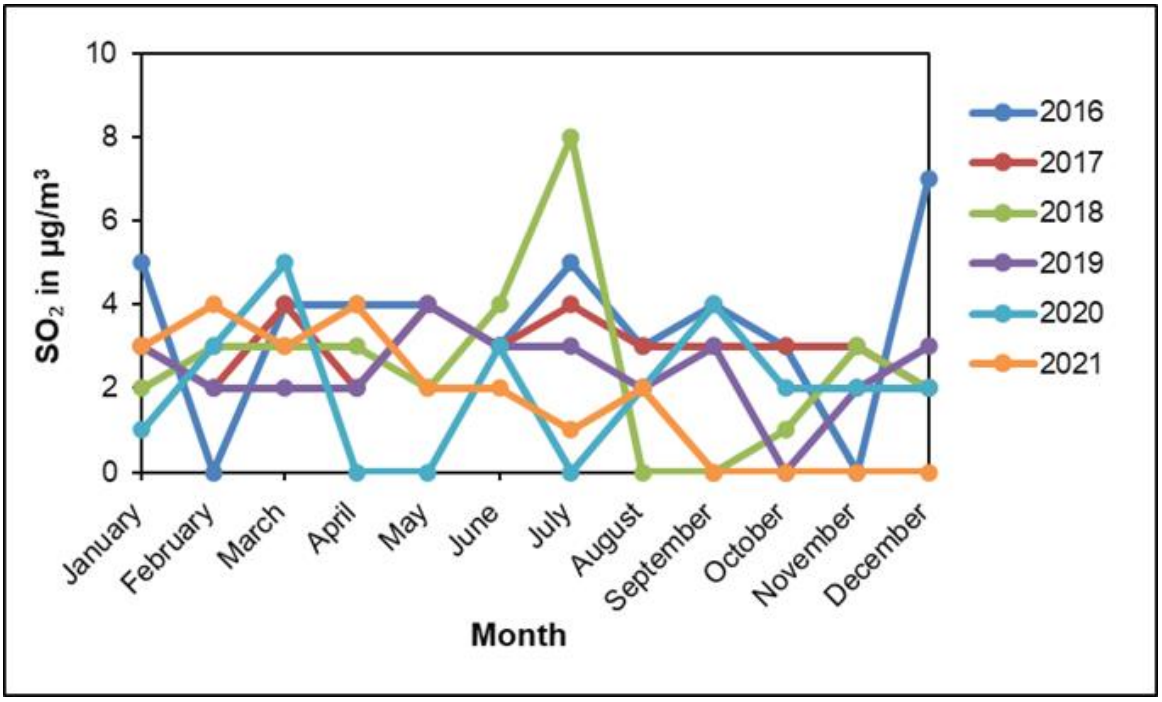


Fig.8.10: SO_2 in Naharlagun (Jan-Dec) during the period (2016-21)

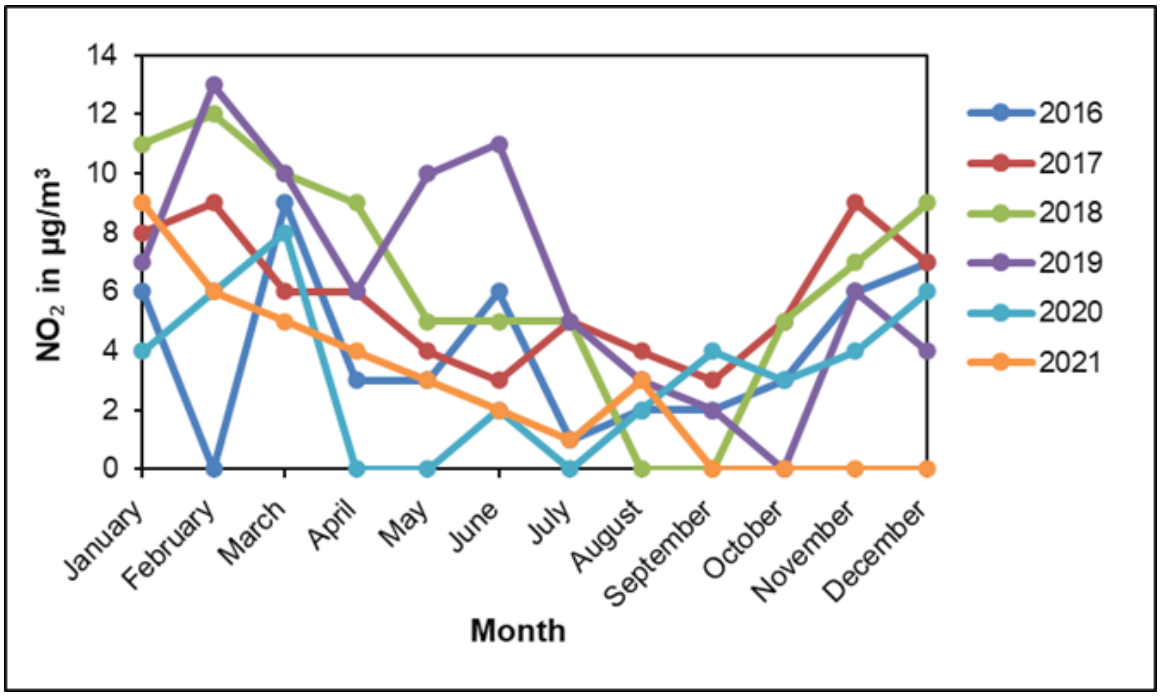


Fig. 8.11: NO_2 in Naharlagun (Jan-Dec) during the period (2016-21)

As per the available data (*Data Source: State Pollution Control Board, A.P.*) for Itanagar and Naharlagun townships of Capital Complex (from 2016 – 2021), the values of most of the air quality parameters ($PM_{2.5}$, SO_2, NO_2) is within the safe permissible limits (refer Box-1) for human health except the values of PM_{10} particulate matter for both the stations. At both the

stations, PM_{10} values during the months of January, February and March are exceeding the standard value (i.e. 100 μg/m^3). Since both the monitoring stations are located in close proximity of roads, so these higher values of PM_{10} may be due to movement of vehicles and availability of fine soil near the sites. In general, if we talk about the air quality of the Itanagar Capital Complex and also the entire state, it can be said that the air quality of the state is of good quality. However, in future the rapid urbanization and rapidly increasing number of vehicles may lead to poor air quality particularly in the capital complex and other urban/sub-urban areas of the state.

As per the data received from the Directorate of Transport, Govt. of Arunachal Pradesh for the period of 2011-2021, the state has reported 3,84,480 vehicles (including transport and non-transport vehicles) and the number is increasing very rapidly. Interestingly, the state's Capital Complex has almost 68% of total vehicles reported for the mentioned period. Therefore, following the similar trends of increasing vehicles in the capital complex there is a possible threat of air pollution in this area. There is another fact that the state of Arunachal Pradesh still has lower vehicular density as compared to other Himalayan states. Arunachal Pradesh ranks 21st among the Indian States on the basis of vehicular density in our country (as on 2016).

8.5. Ill-effect on water quality/groundwater

Brahmaputra is one of the major rivers of Asia and 41.88 % of its basin is shared by Arunachal Pradesh. The state has the highest average run-off of 350 BCM. About 80% of the mean annual flow of River Brahmaputra is contributed by more than 3,000 small and big river tributaries. Within Arunachal Pradesh, there are 19 major river catchments consisting of 46 major and medium type rivers. The 10 major River basins are: Tawang, Kameng, Dikrong, Subansiri, Siang, Sisiri, Dibang, Lohit, Tirap-Dehing and Tista. Numerous rivers originating from these basins ultimately drain to Brahmaputra River. Such a massive water resource is certainly a boon for the State for development of agriculture, power and industry sectors but at the same time, these rivers also have the destructive potential unless proper measures are taken up. Rivers of Arunachal Pradesh could be broadly classified into three types' namely (i) Hilly reach (incised rivers), (ii) Foothill sub-montane reach (Boulder Rivers) and (iii) Floodplain (alluvial rivers).

Arunachal Pradesh has 2.56 BCM annual replenishable ground water resources and net annual groundwater availability of 2.30 BCM. Water, and especially fresh water, is one of the most critical natural resources. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of wastewater.

The State Pollution Control Board has been monitoring water quality of nearly 14 selected streams/rivers (at selected locations) on a regular basis in the state and the same data was

collected from them. A brief description of the different parameters monitored on regular basis by the State Pollution Control Boards is given below:

8.5.1. Turbidity

Based on the available data of turbidity in different locations, it shows that the turbidity in the different water bodies of Arunachal Pradesh varies greatly. According to WHO, the permissible limit of turbidity in normal drinking water should be less than 5 NTU and preferably less than 0.1 NTU. Here, the water samples are shown turbidity between 1.75 NTU to 308 NTU (Fig.8.12 a&b).

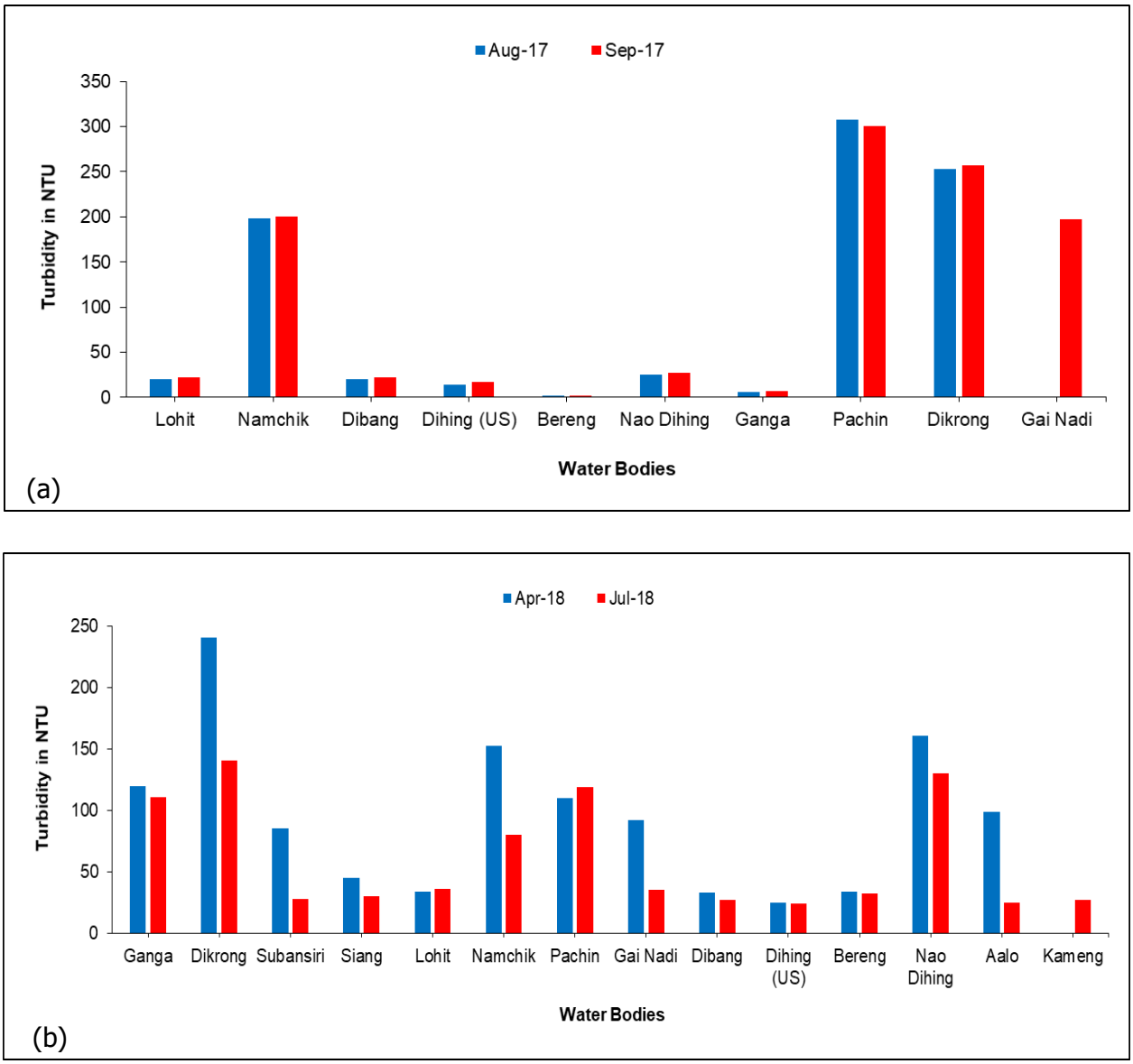


Fig. 8.12: Turbidity of water samples collected from different water bodies in Arunachal Pradesh: (a) Aug-17 & Sep-17, (b) Apr-18 & Jul-18

8.5.2. Total Dissolved Solid (TDS):

Based on the available data of TDS in different locations, these show that the TDS in the water is within the permissible limit as suggested by BIS i.e., below 500 mg/L (Fig.8.13; 8.14 a&b).

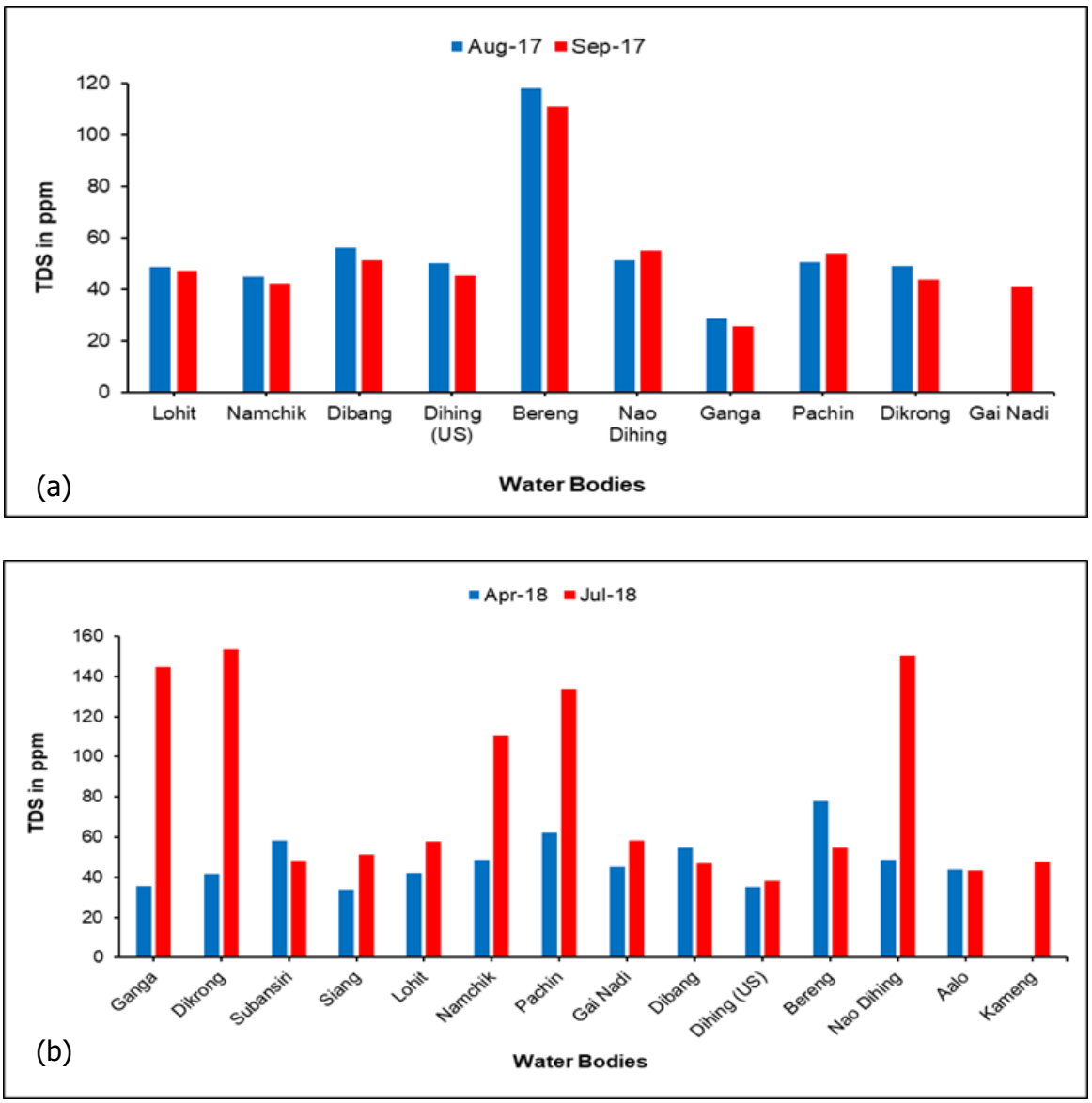
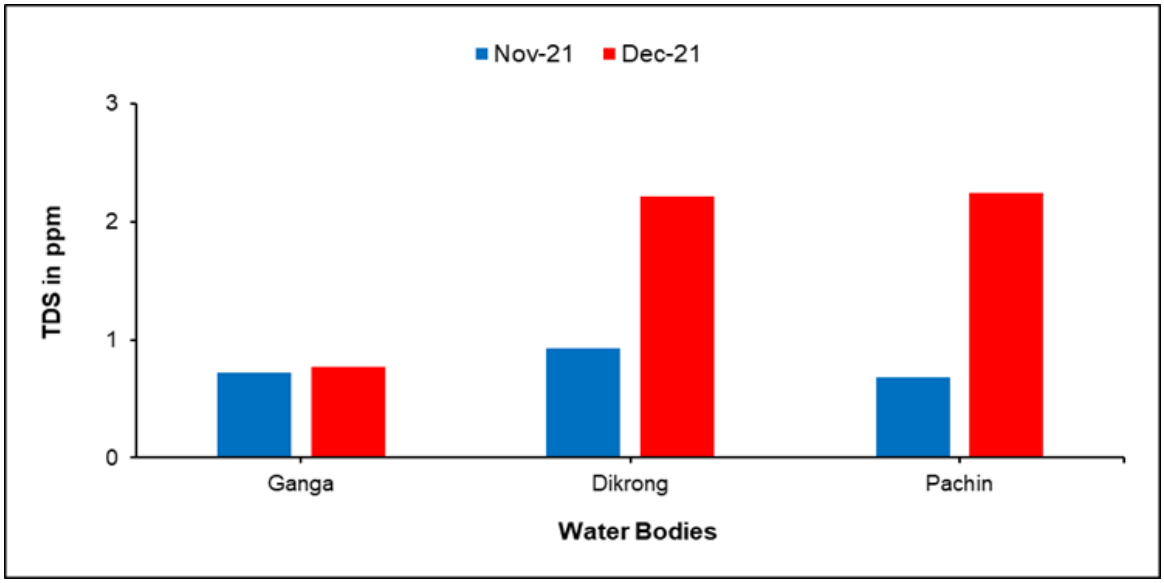
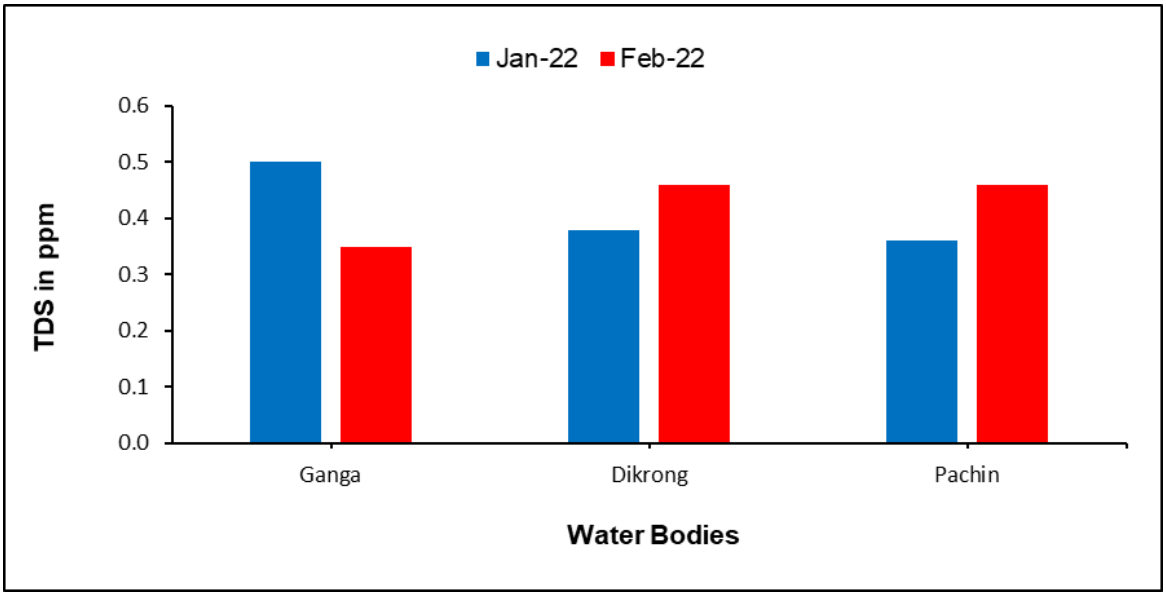


Fig. 8.13: TDS of water samples collected in different water bodies in Arunachal Pradesh: (a) Aug-17 & Sep-17, (b) Apr-18 & Jul-18



(a)



(b)

Fig. 8.14: TDS of water samples collected in different water bodies in Arunachal Pradesh: (a) Nov-21 & Dec-21, (b) Jan-22 & Feb-22

8.5.2. Dissolved Oxygen (DO)

The DO of the available datasets of Arunachal Pradesh shows some abnormality (Fig.8.16). The DO value of the water samples collected in the month of November 2021 from Ganga, Dikrong and Pachin is less than 6.5 which is the minimum requirement of healthy water. It is observed

that the DO concentration during the year 2022 is showing increased value but still it's not up to the minimum required level.

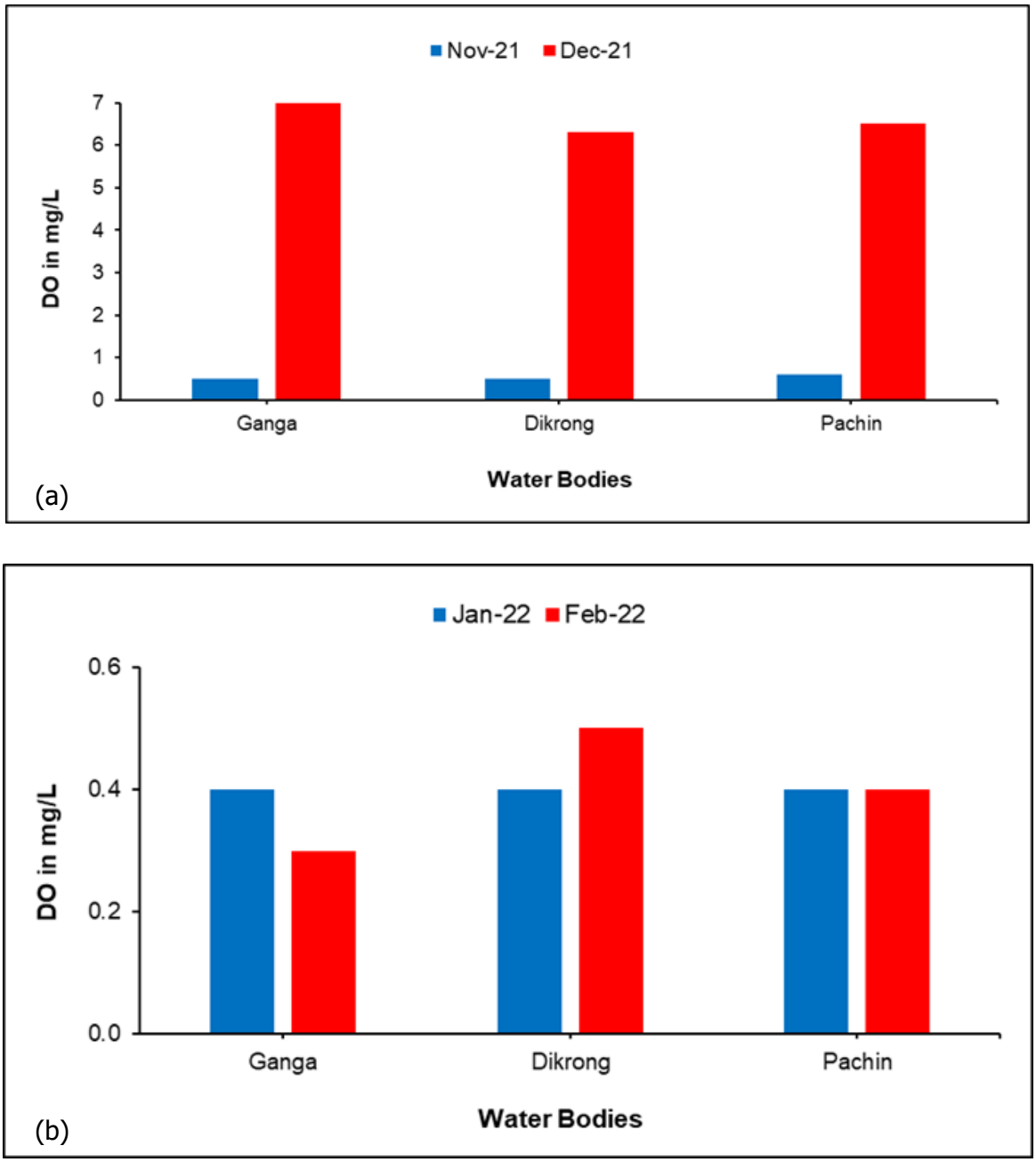


Fig. 8.15: DO of water samples collected in different water bodies in Arunachal Pradesh: (a) Nov-21 & Dec-21 (b) Jan-22 & Feb-22

Thus, overall, the data on different water quality parameters indicates that so far the major surface water sources (particularly rivers) are having moderately good quality water. Although

this data doesn't include any information on micro pollutants (biological organisms such as *E. coli*), heavy metals, etc., which are very important parameters for drinking purpose.

In addition to the data collected from state agencies, the North East Regional Centre, GBPNIHE has also conducted water quality assessment of 19 natural springs located in Capital Complex and the study informed that the water quality of all the springs is good, except high pH in few samples.

Pollution of water sources (surface as well as ground water) is directly related to their use, management practices, conservation efforts and surrounding environment. Therefore, if there is an over exploitation of these water resources without adopting a sustainable strategy may affect the quality and quantity of these most precious resources. It is a well-known fact that natural springs in the entire IHR are facing a serious threat of drying so all the states have to work out appropriate strategies for conservation of these resources. Dumping of solid waste and release of harmful effluents in rivers is a very harmful practice which is common in Arunachal Pradesh, it is certainly deteriorating the water quality.

8.6. Ill-effect on Forest and Biodiversity

Arunachal Pradesh is considered one of the forest-rich states in the eastern Himalayas. As per ISFR 2021, the total forest cover (within and outside the recorded forest area) is 66,430.67 sq.km (79.33% of geographical area; GA). Of that, very dense forest is 21,058.37 sq.km (25.15% of GA), moderate dense forest is 30,175.56 sq.km (36.03% of GA), open forest is 15,196.74 sq.km (18.15% of GA). Scrub, not counted in total, is spread over 796.98 sq.km (0.95 % of GA). The total forest cover of Arunachal Pradesh in 2019 was 66,687.78 sq. km which means the state has lost 257.11 sq. km of its forest cover as per the ISFR, 2021. Although occupying only 2.5% of India's geographical area, the state occupies a significant place in terms of floral and faunal biodiversity, being considered as one of the top 18 global biodiversity hotspots and home to 216 species of Mammals, 119 species of Reptiles, 53 species of Amphibian, 218 species of Pisces, and 770 species of Birds along with many other unreported species. The state has about 20% species of the country's fauna, about 4,500 species of flowering plants, 400 species of pteridophytes, 23 species of conifers, 35 species of bamboos, 20 species of cane, 52 species of Rhododendron and more than 500 species of orchids. It has been recognized by the International World Conservation Union in 1995 as one of the major centres of plant diversity. 2 National Parks, 1 biosphere reserve and 10 Wildlife Sanctuaries constitute the protected area network of the state covering 11.68% of its geographical area.

8.7. Eco-sensitive zones/Areas

There are ten Wildlife Sanctuaries, one Biosphere Reserve and two National Parks in the state of Arunachal Pradesh. Most of the protected areas are away from any villages and the people of the state are in a habit of living in such areas without interfering with the conservation projects. Almost all the protected areas are in rugged terrain and inaccessible, which has added more protection to all these Protected areas. The protected areas like Pakke Wildlife Sanctuary,

Namdapha National Park, Kamlang Wildlife Sanctuary and Itanagar Wildlife Sanctuary have a fringe human population where activities have been initiated by involving the local communities in conservation of wildlife and its habitat. There are two tiger project areas namely Namdapha Tiger Reserve and Pakke Tiger Reserve. One of the Elephant Reserves has been notified as Kameng Elephant Reserve, covering the district of Papum-pare, East Kameng and West Kameng. Management of Elephant reserves is the landscape management, which covers more territorial jurisdiction of Elephant habitat and corridors and provides scope to address more areas irrespective of legal status of the land to bring under the conservation program.

Conservation initiatives taken by the state are as under:

- Protected Area network (PAN): 9582.68 sq. km.,
- Declared Sanctuaries and National Parks: 13,
- Research Institute: 1,
- Proposed Institute: National Institute of Biodiversity at Itanagar,
- Biosphere Reserve: 1,
- Implementation of JFM,
- Various afforestation and beneficiary schemes for sustainable development,
- Bamboo & Cane development policy,
- Medicinal plant development board,
- Ban on unplanned timber harvesting,
- Ban on cane harvesting,
- Emphasis on NTFPs for sustainable development,
- Catchment area development.
- Watershed development program
- Establishment of state wildlife board.

8.8. Gaps and plan of action:

Based on the data analysis and understanding of the issues, a few gap areas have been identified and suitable actions are suggested for the state of Arunachal Pradesh. The proposed action plan can help in balancing tourism development and environmental conservation for the benefit of both.

Sr. No.	Gaps	Plan for Action
1.	Inadequate management of solid waste in the state	Treatment of waste at dumping sites is required to avoid pollution on priority basis.
2.	Need to increase regular monitoring of various environmental parameters particularly air quality, water quality, etc.	Increased number of air and water monitoring stations particularly at popular tourist destinations would be viable to install. Restriction and phasing out of 15 years old vehicles.
3.	The Tezpur- Bhalukponk-Bomdila-Tawang (TBBT) circuit receives more tourists as compared to few other circuits in the state.	Monitoring of tourists on regular basis at major tourist places in TBBT circuit required. Decentralization of tourists in other circuits is equally import.
	Tourism sector in Arunachal Pradesh has still to be popularised as an 'eco-tourism destination'	Promotion of eco-tourism is needed as an alternative livelihood option linking with conservation.

8.9. Summary

The aim of this particular task was to identify impacts of tourism on different tourism sectors with special reference to the Himalayan states. However, particularly talking about the state of Arunachal Pradesh, although a lot of baseline data was collected on all related aspects, it is difficult to establish a direct relationship with tourism and its impacts on all the studied sectors. The possible reason is relatively very less inflow of tourists in the state and also non-availability of database on direct income and direct impacts of tourism in the state. In general, it can be stated that as such the state of Arunachal Pradesh is not facing any serious challenge specifically due to tourism development. However, there are many associated sectors which certainly require immediate and effective actions (particularly solid waste management, water resources management, rural livelihoods, etc.) on the ground.

Arunachal Pradesh is already having its 'State Eco-tourism Policy' in place; however, the tourism sector in Arunachal Pradesh could not develop its reputation as 'eco-tourism destination'. Efforts should be made to make Arunachal Pradesh as a hub for community driven eco-tourism. The people and government agencies can work together to make it happen. In 2021, the "Pakke Tiger Reserve 2047 Declaration on Climate Change Resilient and Responsive Arunachal Pradesh" was adopted by the state government and aims to promote development that is climate-resilient in the state. This declaration also focuses on multi-sectoral approaches for climate-resilient development and low emission which are based on five themes which are health and well-being for all; environment, forest, and climate change; livelihoods, and opportunities; sustainable and adaptive living; and evidence generation, and collaborative

action. This recent development is a positive move by the state in the direction of sustainable development of all sectors including tourism in the state.

There are other sectors/areas on which the state departments and also the central agencies working in the state/region are taking up action-based work in the state.These in brief are as under:

- Promotion of eco-tourism as an alternative livelihood linking with conservation
- Enhancing afforestation and plantation activities to conserve natural beauty
- Promoting non-timber forest product utilization for the conservation of forests
- Containing encroachment and illegal felling
- Expansion of the protected area network
- Augmenting wildlife protection
- Survey and documentation of traditional ecological knowledge
- Promoting alternative energy sources
- Involving different stakeholders on biodiversity conservation

It is recommended to establish a system in the state which can help the government to gather categorical information on cost-benefit (environmental and economic both) due to the tourism sector only. At present, there is no such system in place, that's why it's very difficult to assess direct impacts of tourism. Generation of reliable knowledge including scientific data is always essential to understand the magnitude of issues. So all the concerned departments should have a well-established mechanism to regularly collect data and keep it updating regularly so that this can be used in proper planning and studies.

Nagaland

9.1 Introduction

The State of Nagaland was inaugurated as the 16th State of India on the 1st December, 1963 with its capital at Kohima. Nagaland, known as 'The Land of Festivals', is blessed with rich biodiversity, diverse topography, scenic beauty and unique cultural heritage. The State is bounded by Assam in the west, Myanmar on the east, Arunachal Pradesh and parts of Assam in the north and Manipur in the south.

9.1.1 General scenario of tourism in Nagaland

The State has great potential for developing the tourism sector for economic development, especially in eco-tourism, adventure tourism, village tourism, community-based tourism, agro-tourism, and culture-tourism etc. However, due to its rough topography, poor transport and communication infrastructure, limited availability of good tourist amenities, travel restrictions for foreign (RAP/PAP) and domestic tourists (ILP) and other constraints, the tourism industry has not been able to progress to its full potential. Under the Industrial Policy of Nagaland (2000), the State Government has identified the tourism industry as one of the 'thrust areas' for industrial development to harness the tourism potential of the State. The Tourism Policy of Nagaland was launched on 27th September 2000 to develop the sector as a significant employment generator in the State. The policy emphasized eco-tourism development and community participation through village councils and village development boards. The policy also envisions setting up tourism development committees at state and district levels for coordination among different departments, infrastructure development, regulation of tourism activities, human resource development, and private sector participation in the tourism sector.

The following tourist circuits have been identified and proposed to be developed phase-wise and in order of priority. They are: 1. Dimapur - Kohima – Dimapur; 2. Dimapur - Kohima - Wokha - Mokokchung – Dimapur; 3. Mokokchung - Mon – Tuensang; and 4. Kohima - Phek - Zunheboto (Fig. 9.1).

There are 33 major and 38 minor tourist spots identified in the State of Nagaland, covering districts of Kohima, Mokokchung, Phek, Zunheboto, Peren, Wokha, Kiphire, Mon, and Dimapur. The major tourist spots cover eight government operated tourist sites; thirteen festivals and fairs locations; five historical sites; fifteen natural sites; two natural wetlands; five protected areas; five govt. registered resorts; and nineteen tribal cultural villages. A survey conducted by the Ministry of Tourism (2017) reported that Kohima has the highest average of overnight visits by leisure tourists both domestic and foreign. For same day destination visits, Kohima topped the list for domestic tourists, while for foreign tourists, the number was equal for Phek, Dimapur and Mokokchung districts.

Two projects under the *Swadesh Darshan* Scheme of the Ministry of Tourism, Government of India, have been sanctioned in the State of Nagaland since 2018. The project on "Development

of Tribal Circuit: Peren-Kohima-Wokha" for Rs. 97.36 crores, was the first project implemented in the State under the Scheme. Inaugurated in 2018, different tourist facilities have been developed like tribal tourist village, eco log huts, open air theatre, tribal rejuvenation centre, cafeteria, helipad, tourist interpretation centre, wayside amenities, last mile connectivity, public conveniences, multipurpose hall, nature trails, and trekking routes, etc. The other project "Development of Tribal circuit: Mokokchung–Tuensang-Mon" of Rs. 99.67 crore, is under progress (https://pib.gov.in/PressReleasePage.aspx?PRID=1554645).

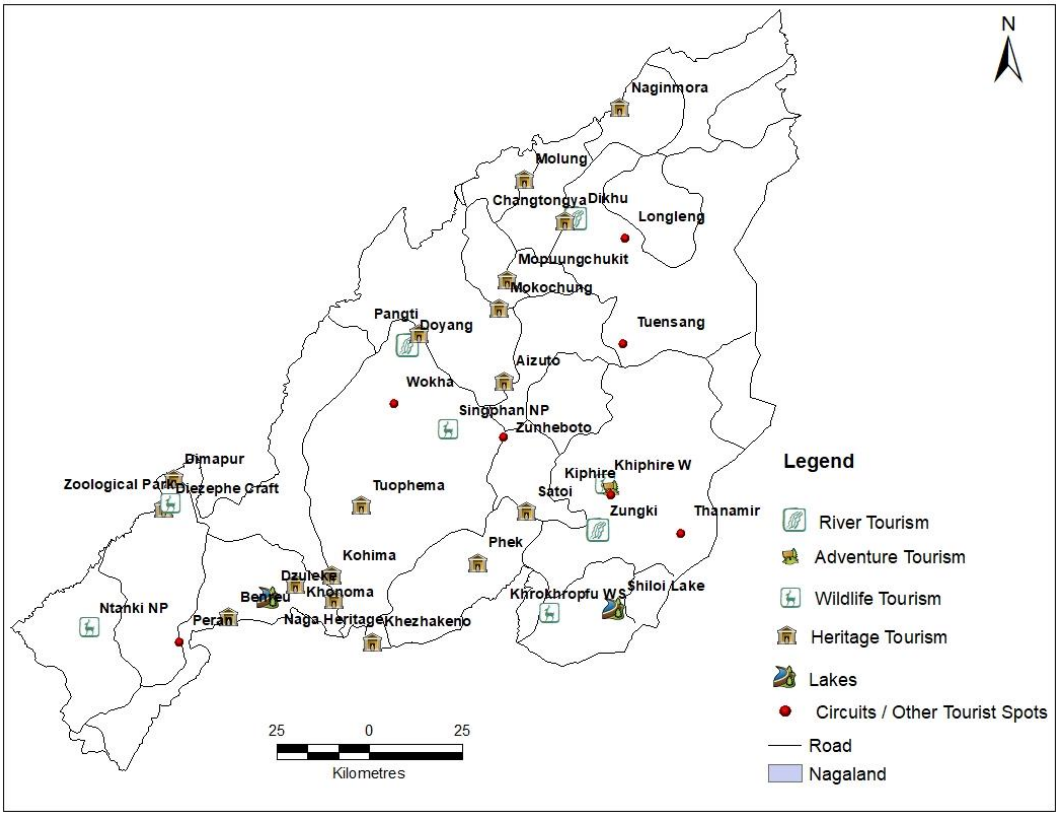


Fig. 9.1: Tourist spots and circuit map of Nagaland with several important tourist spots includes festivals and fairs, govt. operated tourist sites, historical sites, natural sites, natural wetland areas, protected areas, popular resorts, and popular village tourism sites.

9.1.2 Tourism growth vis-a-vis economic growth

The inflow of tourists, both International and Domestic, to the State of Nagaland showed an increasing trend from the period 2010 to 2021 (Fig. 9.2). The mean of tourist number/month between years are significantly different (Kruskal-Wallis chi-squared = 80.983, df = 11, $p \leq 0.05$). The drastic decline in the tourist inflow during 2021-21 was due to the occurrence of the COVID-19 global pandemic, restricted the movement of people into the State as well as within the State which is also evident from the Dunn's Kruskal-Wallis multiple comparison test. The

annual tourist inflow was higher for domestic tourists estimating ~ 90% of the total number of tourists visiting the State. The monthly trend showed the peak tourist inflow during the month of December (Fig. 9.3). There is a significant difference among mean monthly tourist (total) inflow across specific months of several years (Kruskal-Wallis chi-squared = 31.038, df = 11, $p \leq 0.05$). Specifically, tourist inflow in all December months is different from all other months which is also evident from the Dunn's Kruskal-Wallis multiple comparison test. Whereas, it is interpreted high in comparison to other months. This month also coincides with the popular Hornbill festival, which attracts a number of domestic and foreign tourists.

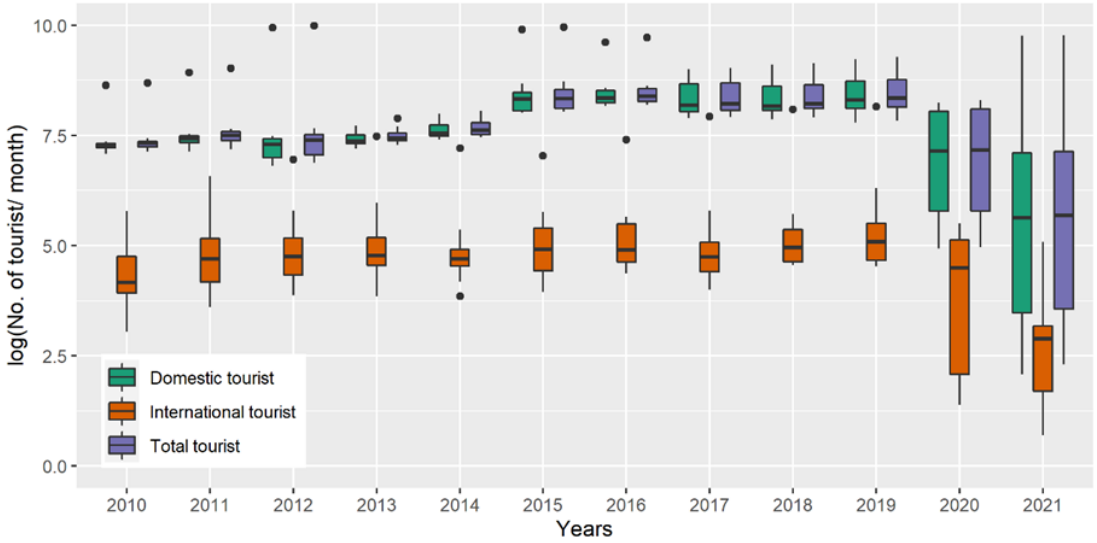


Fig. 9.2: Annual trends of tourist inflow in Nagaland during 2010-2021 (Data Source: Department of Tourism, Nagaland).

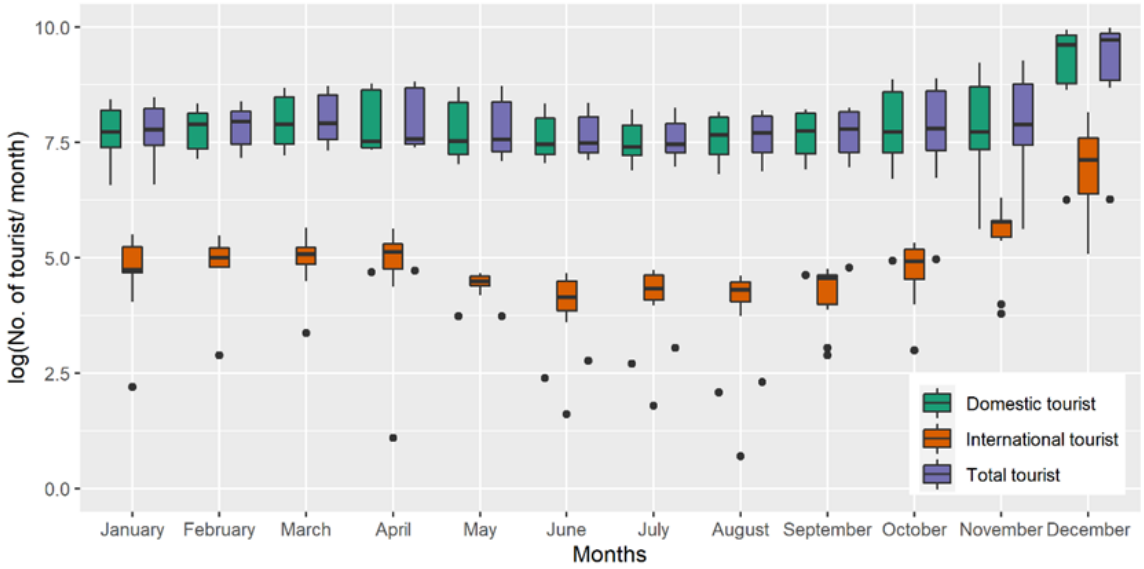


Fig. 9.3: Monthly trends of tourist inflow in Nagaland during 2010-2021 (Data source: Department of Tourism, Nagaland)

The Hornbill Festival of Nagaland is a Naga cultural festival to showcase the State's diverse cultural traditions and rich heritage. It is being organised by the State Government annually during the 1st to 10th of December at Naga Heritage Village, Kisama, Kohima. The festival has become one of the major tourist attractions for the State, by both international and domestic visitors. Tourist inflow into the State during the Hornbill festival showed a steady rise from 2010 to 2019. The absence of data during 2020-21 was due to the outbreak of the COVID-19 pandemic, and the festival was celebrated virtually. Thus, no physical visits of tourists took place during the pandemic period .

The contribution of the tourism sector to the State's economy can be determined by its share in the Gross Value Added (GVA) of the State. A study conducted by the National Council of Applied Economic Research estimated that the total share of tourism (both direct and indirect) to total GVA for the State of Nagaland amounted to 5.91%, and its share in employment was 8.34 %. These values were lower than the national average of 9.24 % and 12.38%, respectively (NCAER 2019).

9.2. Assessment of waste generation in Nagaland

9.2.1 Segregation / Utilization of waste

Under Nagaland Municipal Act, 2001, three Municipal Councils were created. They are: Kohima Municipal Council, Dimapur Municipal Council and Mokokchung Municipal Council. As per Nagaland Municipal Act, 2001, 16 town councils were formed, followed by four town committees upgraded to full-fledged Town Councils in 2016. However, solid waste management has been routinely managed by three Municipal Councils.

(i) Kohima Municipal Council

Kohima City comprises 19 wards, which generate about 60-70 metric tons of solid waste/ day. The primary sources of municipal wastes are generated from domestic, commercial, hotels and restaurants and markets, street sweeping, hospitals and nursing homes, drain cleanings, construction and debris waste, etc. In 2000, Nagaland Pollution Control Board (NPCB) carried out a survey on solid waste in Kohima, where it was found that domestic waste generates most of the solid waste, accounting for 31.49%, followed by commercial and institutional waste by 27.41%, and 23.37% respectively. It has also been observed that the difference in quantity and quality of waste was due to a number of factors, and one such factor is economic growth. Therefore, "as economic prosperity increases, the amount of waste increases in weight and volume", with a more significant part consisting of luxury waste such as paper, plastic, metal, glasses, etc. Thus, it may be noted that the higher group generates more waste, as they have a variety of items to consume compared to a relatively poorer section of the society.

The solid waste generated in the Kohima Municipal Council (KMC) area is very heterogeneous, as a result its composition varies from place and time. As per study carried out by NPCB, the composition and characteristics of solid waste in Kohima City are found to be 42% of

combustible materials and 58% non-combustible. The KMC carries out the primary solid waste collection through daily street sweeping and storage bins. During the last few years, only 50-60 % of the waste has been collected daily from the sources and dumped at a site 8 km away from the city on NH-39. Based on a scientific study in 2010, the amount of waste generated from Kohima city is ~ 54 MT/day. Out of this, about 35-40% of wastes are collected from the entire city as per the data available. The daily generation of wastes (54 MT) is collected mainly from the primary sources, such as, residential (57%), commercial (19%), institutional (15.50%), industrial (3%), biomedical wastes (0.50%) and construction and demolition (5%) (Chatterjee, 2010). To date, the current disposal system is not in compliance with the Municipal Solid Waste (Management and Handling) Rules 2000 since KMC does not have a proper and scientific method of Solid Waste Management.

(ii) Dimapur Municipal Council

The Dimapur Municipal Council's jurisdiction falls within the municipal area measuring 18.13 km^2, divided into 23 wards comprising about 96 colonies. With the assistance of Dimapur Municipal Council conducted a waste assessment study for 24 days starting from 12th February to 13th March 2019. In the study, it has been estimated that the Dimapur Municipal area generates 111.12 tons/day (TPD). This estimate does not include the data from two colonies/areas as there was an issue with the non-payment of RST. The estimate above is more than the previous year's estimate (June 2018 estimate). Projection of the waste generation could not be ascertained. However, it can be assumed that in a year's time, the waste generation will increase by at least 15 TPD.

(iii) Mokokchung Municipal Council

Mokokchung jurisdiction falls within the municipal area of 7 km^2 which is divided into 18 wards. At present, out of 18 wards under MMC, door to door collection of waste has been introduced in six wards, namely, Alempang, Artang, Majakong, Kumlong, Kichutip, and Mongsenbai wards. Apart from this, concrete/open dustbins have been provided in 18 wards for areas like residential, markets, main roads, institutions, offices, etc. Daily collection is made from such bins. The collection of waste in the 12 wards follows this type of collection. Segregation of waste has not been implemented in Mokokchung Town. However, MMC is setting up to sensitize the waste generators on segregation of waste, specifically on bio-degradable, plastics and e-waste.

Segregation of domestic/ household waste is being implemented and enforced on a trial basis by the ward sanction committee of 6 wards where the door-to-door collection of waste has been introduced. At present, solid waste disposal is done by collecting the waste and dumping it at the dumping site situated at Salangkaba Menjen, located 10 km away from the Mokokchung Town.

9.3. Waste disposal / treatment facilities

In recent years, Nagaland has witnessed an inflow of tourists and an increase in population, due to which there has been the construction of a large number of roads and buildings. One such environmental challenge, a direct consequence of increasing urbanization, is waste accumulation.

At present, Nagaland has 32 Urban Local Bodies (ULBs) where a solid waste management policy has been implemented. In 2010-11, there was no waste processing and disposal facility in the State; only the Kohima municipal council applied for authorization and was granted. Then until 2016-17, only nine ULBs started implementing the solid waste management policy. After that 32 ULBs started implementing the solid waste management policy. The status of garbage generated and collected during the period 2010-11 to 2019-20 showed a gradual increase up to 2017-18, followed by a slight decline till 2019-20 (Fig. 9.4). This may be due to Covid-19 pandemic outbreak. The garbage treatment and landfill facility were only available from 2016 to 2017 onwards. The year 2015-16 has no data on solid waste from the Central Pollution Control Board report. In case of solid waste processing facilities, only composting and vermi-composting facilities were available in Kohima from the year 2012-13.

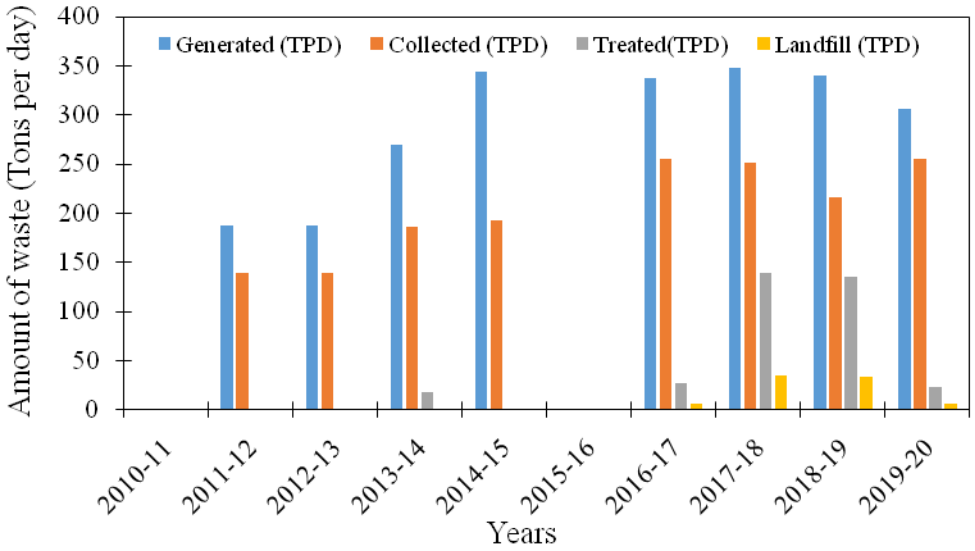


Fig. 9.4: Financial year-wise waste generation, collection and management of solid waste in Nagaland (2010-11 to 2019-20)

9.4. Ill-effect on Air quality

Nagaland Pollution Control Board under the National Air Monitoring Programme (NAMP) is monitoring the air quality on a regular basis at Dimapur and Kohima towns in Nagaland. Dimapur is the commercial hub and the largest town amongst all the other districts of Nagaland. It is bounded by Kohima district on the south and east, Karbi Anglong district of Assam on the west, and stretch of Golaghat district of Assam in the north. According to 2011 census, it is the most populous district of Nagaland.

9.4.1 Number of vehicles registered in the state of Nagaland

Data for number of vehicles registered in the State of Nagaland have been obtained from the *Parivahan Seva* website of the Ministry of Road Transport & Highways (MoRTH), Govt. of India (https://parivahan.gov.in/parivahan/;https://vahan.parivahan.gov.in/vahan4dashboard/).

Registered vehicles have been divided into different categories based on fuel type used. The time period of data available is from year 2018 onwards. There were 9 categories of vehicles classified according to fuel type viz., Diesel, Petrol, Petrol/Hybrid, Electric (BOV), Diesel/Hybrid, CNG Only, Dual Diesel/CNG, Petrol/CNG and Others Category. There was a steady increase in the number of vehicles registered from 2018 to 2021 (Fig. 9.5). Till December 2021, the total number of vehicles in Nagaland was 1,01,092. Out of this, the number of vehicles registered in Dimapur and Kohima comprises about 91% of the total with Kohima having the highest (51 %) and lowest at Phek, Tuensang and Zunheboto DTOs (0.6-0.75 %). According to fuel type, Petrol and Diesel-run vehicles comprise the highest number in the whole State (99.5 % of the total), with Diesel-run vehicles being highest in number. District-wise, the number of Diesel vehicles was highest in Kohima (n = 42,433) while Dimapur has the highest number of Petrol vehicles (n = 32,719). Electric vehicles were registered in Dimapur and only 2 in Kohima. CNG and Dual Diesel/CNG vehicles were reported only in Kohima RTO.

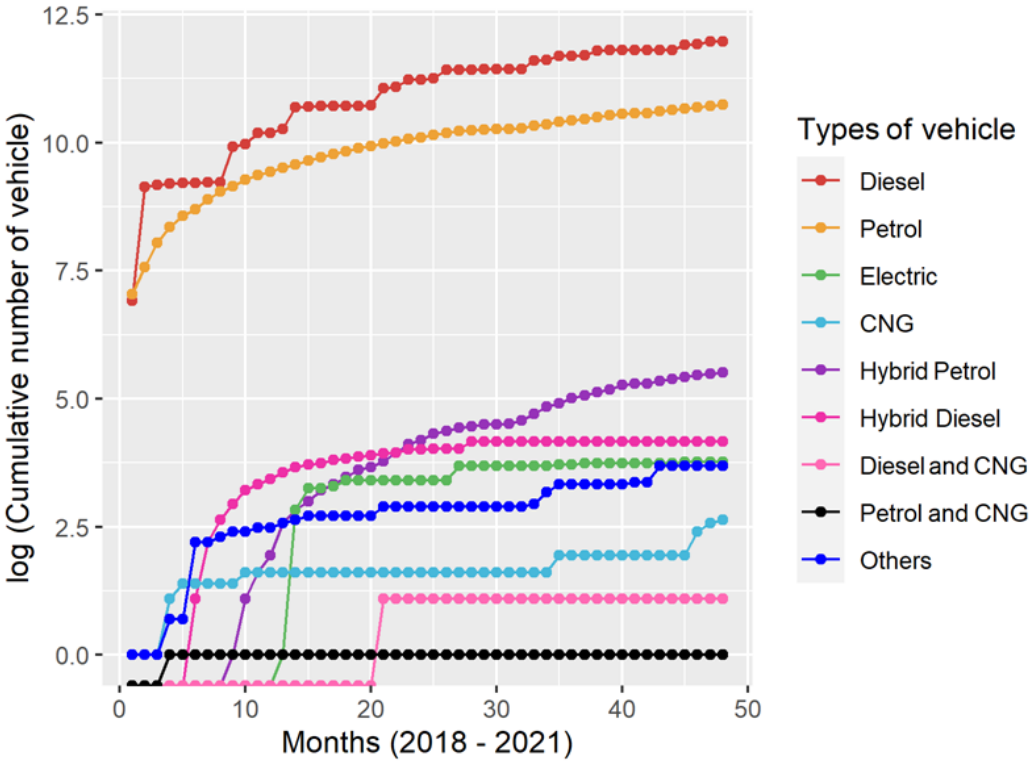


Fig. 9.5: Trend of increase in number of vehicles (by fuel type) registered in the state of Nagaland during 2018-2021 (Data source: https://vahan.parivahan.gov.in/vahan4dashboard/)

9.4.2. Parameter wise air quality

Under NAMP, two air quality monitoring stations, i.e., in Opposite NST Office (609) and Opposite War Cemetery (610) were set up in Kohima. However, the station Opposite War Cemetery (610) has been shifted to a new location in PWD junction. In Dimapur, two monitoring stations have been set up, i.e., in Bank colony (317) and Dhobinala (448). Three air pollutants are monitored and analyzed, viz., Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), and Respirable Suspended Particulate Matter (RSPM). The monitoring of pollutants is carried out for 24 hours (4 hourly sampling for gaseous pollutants (NO_2 & SO_2) and 8 hourly sampling for particulate matter (RSPM) twice in a week (CPCB, https://cpcb.nic.in/namp-data/; NPCB, https://npcb.nagaland.gov.in/?p=763).

The average concentration of PM_{10} and NO_2 were found to be higher at Dimapur than at Kohima. In Dimapur, an increasing concentration in PM_{10} was observed from the year 2012 to 2018 after which its concentration declined during 2019-20 (Fig. 9.6). In Kohima, the PM_{10} concentration increased till year 2018 after which it started declining till year 2020. The annual permissible limit for PM_{10} is 60 $\mu g/m^3$ but the data show that it is higher in all the years from 2011 to 2020. NO_2 concentration increased from year 2014 to 2018 and declined till 2020 in Dimapur town, while in Kohima there was no change in the values during all the observance years. SO_2 concentration remained constant throughout the monitoring period, i.e, 2013 to 2020 in both Dimapur and Kohima cities. Nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) in both the towns are well within the national air quality standards in both the monitoring stations (CPCB, 2009).

The Respirable Suspended Particulate Matter (RSPM) values of every month of Dimapur and Kohima is shown in Fig. 9.7 and 9.8 respectively RSPM value for every year shows a similar trend, i.e., it is high in the dry seasons of the starting years and gradually decreases during the monsoon season. After the monsoon ends it increases again. The data shows that RSPM is mostly higher than the permissible limit in every month of each year in both the cities.

The major sources of air pollution in Dimapur and Kohima towns were identified (NPCB, https://npcb.nagaland.gov.in) as follows:

i. Dust raised from vehicular movement on the dusty roads.
ii. Vehicular emissions
iii. Burning of wastes such as municipal waste bin, garden/leave waste, etc.
iv. Construction activity, and
v. Burning of fossil fuel for domestic purpose.

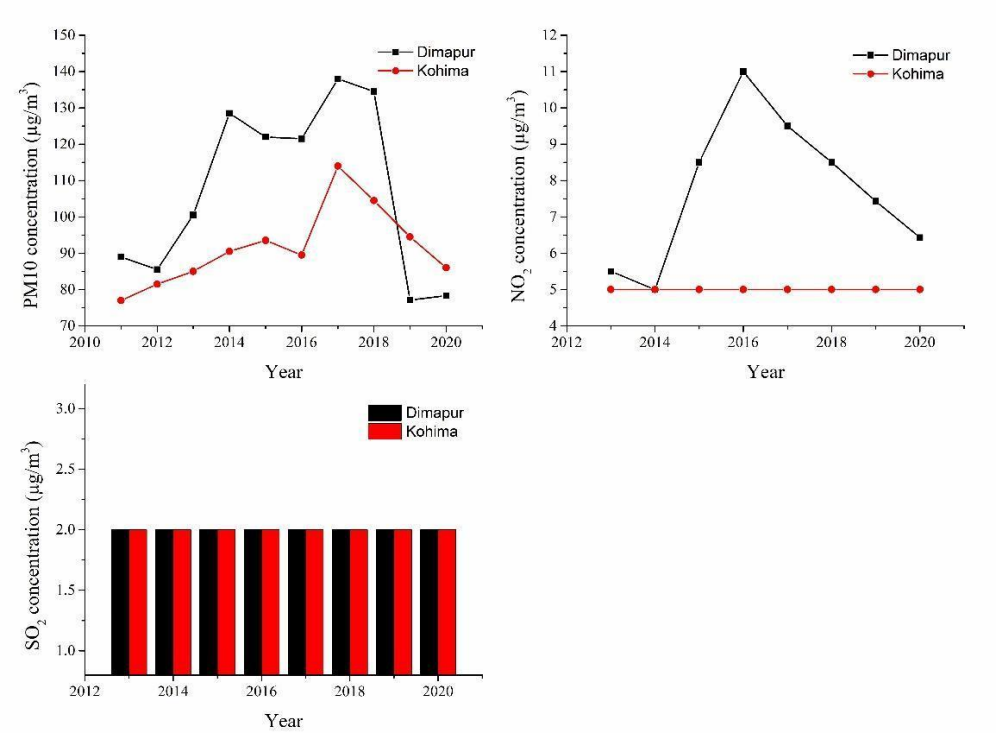


Fig. 9.6: Annual data of air quality in Dimapur and Kohima towns of Nagaland

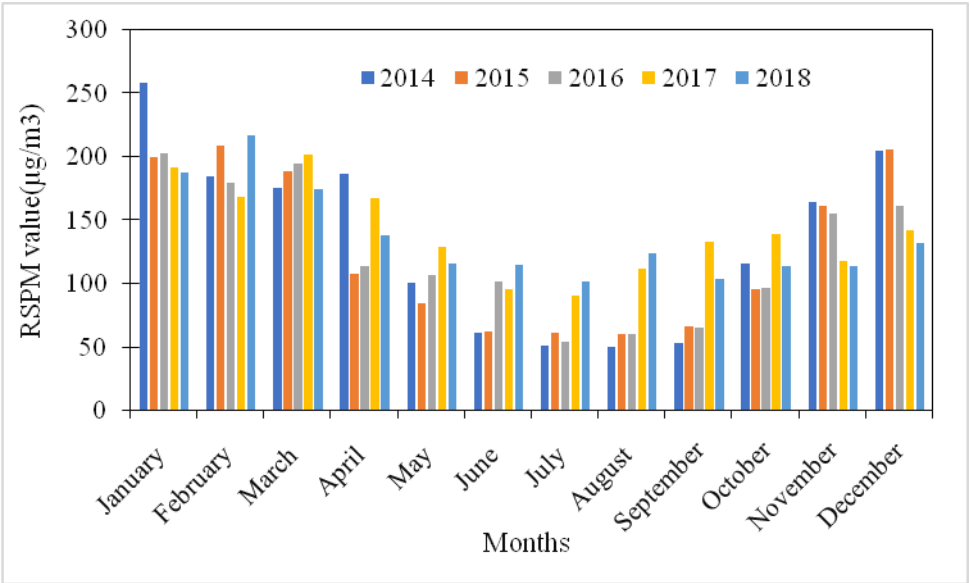


Fig. 9.7: Monthly data of RSPM (PM_{10}) value in Dimapur, Nagaland

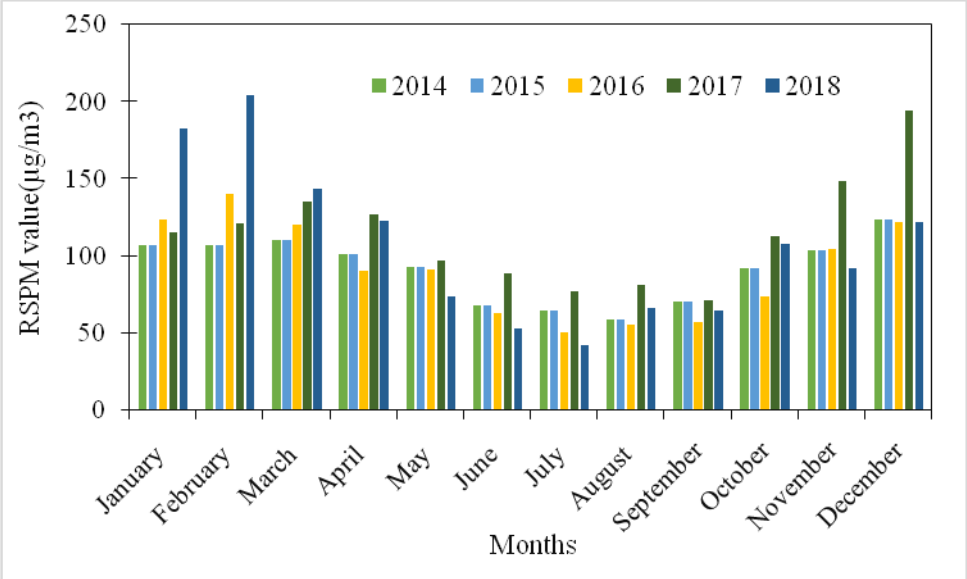


Fig. 9.8: Monthly data of RSPM (PM_{10}) value in Kohima, Nagaland

9.5 Measures/mitigation measures for air quality

Dimapur and Kohima towns have been placed under non-attainment cities because it was found that for a period of 5 years (2011-2015), the air quality in case of PM_{10} was consistently above the National Ambient Air Quality Standards. The government through the Air Quality Monitoring Committee, Nagaland has formulated two action plans for the cities of Dimapur and Nagaland to monitor air pollution. Measures on Graded response Action Plan (GRAP) have also been incorporated to monitor and improve air quality as follows:

1. Regular cleaning of road dust and sprinkling of water on unpaved roads.
2. Strict vigilance and no tolerance for visible emissions, impounding or imposing heavy fine on plying of visible polluting vehicles.
3. Strict enforcement of pollution under control (PUC) emission norms.
4. Deployment of traffic police for smooth traffic flow at identified vulnerable traffic cross section areas.
5. Strict enforcement of Hon'ble Supreme Court directions, dt. 23.10.2018 on use of fire crackers.
6. Intensify public transport system with cleaner fuel.
7. Strict enforcement of ban on open burning of garbage, etc. covered movement of vehicles carrying solid waste, construction materials, etc.
8. Shut down and shifting of small polluting industries.

Apart from the Nagaland Pollution Control Board, other different agencies such as Municipal Board, Transport Department, PWD, District Administration and Traffic Police have also been

given responsibility for implementation of these mitigation measures according to the relevant fields of operation.

9.6. Impact on water quality / groundwater

9.6.1. Monitoring of Water quality/groundwater

The Nagaland Pollution Control Board in collaboration with the Central Pollution Control Board under the National Water Quality Monitoring Programme (NWMP) is monitoring the water quality in the state. Four major rivers, namely, *Dhansiri* and *Chathe* at Dimapur, *Dzu* at Kohima, and *Milak* at Mokokchung are monitored. Ground water sources from 10 stations are monitored on a half yearly basis (NPCB, https://npcb.nagaland.gov.in).

9.6.2. Physico-chemical parameters of river water

Dhansiri and *Chathe* (*Diphu*) are the main rivers of Dimapur district of Nagaland. River *Dhansiri* originates from *Laisang* peak of Nagaland. It flows through a distance of 352 km from south to north before joining the Brahmaputra on its south bank. Its total catchment area is 1,220 km^2 (NPCB, https://npcb.nagaland.gov.in).

In compliance to the Hon'ble National Green Tribunal order dated 20.09.2018, 19.12.2018 and 08.04.2019, Action Plans were prepared by Govt. of Nagaland for restoration of pollution river stretch of River *Dhansiri* from Full *Nagarjan* (station code:1796) as it enters into Dimapur town and then to Kushiabill, Nagaland-Assam Border (station code: 1928) as it exits Dimapur city area. The data on dissolved oxygen (DO), electrical conductivity (EC), biochemical oxygen demand (BOD), Nitrate content of River Dhansiri is available from 2012 to 2020 (Source: NWMP, CPCB). The other parameters, viz., total dissolved solid (TDS), chemical oxygen demand (COD), chloride, and phosphate were available only for the year 2016, 2017, and 2018 based on data collected from the report on *'Action plan for rejuvenation of River Dhansiri, Dimapur, Nagaland'*. This was approved by *Nagaland River Rejuvenation Committee* (constituted in compliance of order of the Hon'ble National Green Tribunal) and submitted to Central Pollution Control Board (CPCB), Delhi in September 2019. Under Dimapur district, there were 6 NWMP locations for monitoring the quality of River *Dhansiri*.

The results of the physico-chemical characteristics of River *Dhansiri* were analysed. The values of physico-chemical parameters from different stations were averaged for each year. The results revealed that the average minimum DO in all the years was below the designated best use DO level (>4 mg/l) except in 2014 and 2015. However, the maximum DO level was well above the designated level in all the years except 2013. The BOD is one of the most important indicators of pollution and BOD<3 mg/l is designated as most suitable for best use. However, the BOD level in the early years (2012 to 2015) were found higher. Thereafter, it shows a decrease in the BOD values near to designated to its best use. The higher BOD may be attributed to the discharge of domestic wastewater mostly in untreated form and the municipal waste is thrown into the water bodies without treatment. There are three major drains, namely, *Hospital Nullah* (HN) near *Purana Bazaar* Bridge; *Lengri Nullah* (LN), below bridge near

slaughter house; and *Sugarmill Nullah* (SGN), near *Darogajan gate* are the major Nullah contributing to the River *Dhansiri*. The high levels of BOD can also be because of decaying of the organic matter, as well as, due to increased runoff from urban and agricultural fields. The major towns located on the catchment of River Dhansiri are Dimapur town and East Dimapur. However, the main polluted load comprises after crossing Dimapur town which has a total population of 1,22,834 (Census, 2011) consisting of 23 administrative wards with 35,000 households, whereas East Dimapur comprises a total population of 27,000. The TDS and chloride content in all the three-monitoring years (2016, 2017 & 2018) was found well below the acceptable limit of BIS standard. Under the present circumstances, it appears that River *Dhansiri* may serve the purpose of bathing and irrigation and for this objective, municipal sewage generated should be treated properly (Action plan for rejuvenation of River Dhansiri in Nagaland, 2019).

The River *Chathe* originates from areas near *Medziphema* or *Chumukedima* areas of Dimapur. The river traverses its entire journey through the hills of Nagaland and outflows into the *Dhansiri*, 9.6 km downstream of Dimapur. The length of the river is 48 km. The River *Chathe* is monitored at two points at mid-stream below *Medziphema* and below *referral hospital*. The maximum DO value for most of the years were >4 mg/l except for 2012 and 2013. Similarly, the minimum BOD level for all the years were <3 mg/l except 2013 and 2014. The water analysis report shows that it falls under priority IV. The main reason for pollution is due to inflow of domestic sewage from *Medziphema* and *Chumukedima* areas (Action Plan for Rejuvenation of Polluted River Stretches Priority III/IV/V in Nagaland, 2019).

The physicochemical characteristics of the *Dzu* shows that the maximum value of DO for all the years was well above designated DO level for best use except for the year 2012 and 2013. Similarly, the minimum BOD level was below the designated best use (<3.0 mg/l) except in 2013 and 2014. There are no major industries that discharge effluents in large quantities to cause such serious contamination. Therefore, the main source of pollution is due to domestic waste and municipal solid waste which is being dumped into the nullahs and river (NPCB, https://npcb.nagaland.gov.in/; Action Plan for Rejuvenation of Polluted River Stretches Priority III/IV/V in Nagaland, 2019). The identified polluted stretches for all the three rivers (viz., *Dzuna*, *Dzucha* and *Dzu*) were below the Kohima Municipal Council Dumping site. While for *Sano Ru*, the identified polluted stretch was below Kohima town.

The River *Milak* flows through Mokokchung district in Nagaland. The main tributary of River *Milak* is *Tsurong*. The physicochemical characteristics of the River *Milak* shows that the maximum DO values are well above the designated use. However, the minimum values are below the best use (>4 mg/l) (Fig.9.9). The BOD values are also within the designated use at different stations except for both the years except at *Paper Nagar*, *Tuli* in *Mokokchung* in 2018. Further, there is no data on other parameters, viz. TDS, COD, chloride, phosphate and thus need to be studied.

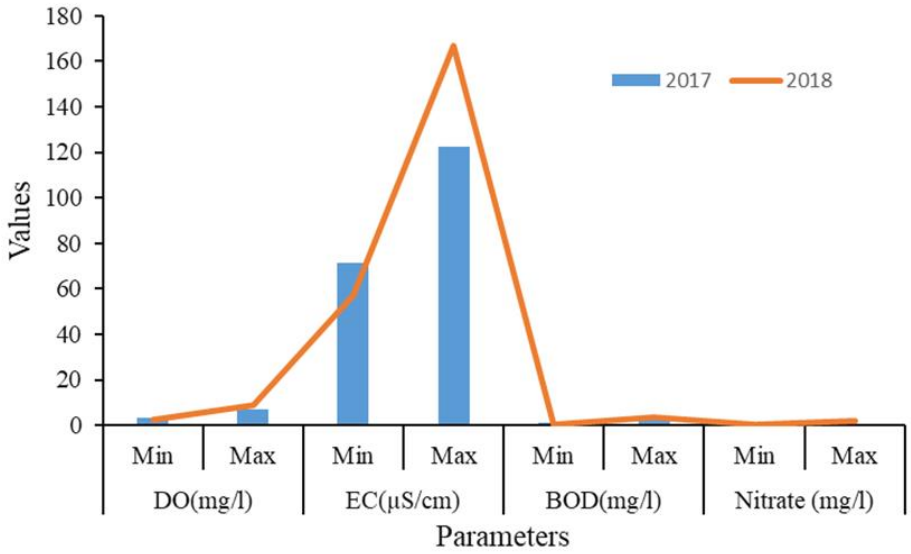


Fig. 9.9: Physicochemical characteristics of River Milak in Mokokchung, Nagaland

9.6.3. Physico-chemical parameters of groundwater

The 10 stations (from 2896 to 2905) include: 5 borewells and 5 open wells from Kohima and Nagaland. EC and nitrate content is available. However, no data were available for TDS, COD, chloride, nitrate, phosphate and iron. Thus, a detailed study would be required to analyse the health of these borewells and open wells located in Nagaland state.

9.6.4. Measures/mitigation facilities

The major towns attributing to River *Dhansiri* are Dimapur town and East Dimapur which are the main contributors of pollution load. Dimapur town has a total population of about 1,22,834 (Census 2011) and the population is expected to grow 2,71,350 by 2035. East Dimapur has a population of 27,000 which is expected to grow by 59,644. Main source of water supply for these two towns are groundwater supply, i.e., ring wells and borewells. Considering, water supply is consumed at 135 LPCD, the sewage flow is considered as 80% of the net water supplied to the consumer which accounts to waste water generation of 16.19 MLD. At present, there are no sewage treatment plants (STP) in Dimapur city. The total sewage generation of both Dimapur town and East Dimapur is about 16.19 MLD. However, the present STP which is under construction has a total capacity of 25.43 MLD. Therefore, it has a gap analysis of -9.24 MLD. Septic tanks have been made by individual households for disposal of sewage and supernatant is directly or indirectly disposed off in nearby drains which joins into the 3 major drains and these finally merges into River Dhansiri. Dimapur Municipal Council (DMC) under the AMRUT SAAP-I had constructed a Septage Management Plant of 30 Kilo liter per day (KLD) capacity at Burma camp, Dimapur. The septage management plant is in operation. There are 615 numbers of industries in Dimapur city comprising 6 in red category, 296 in orange category, 294 in green category and 19 in white category largely consisting of stone crushers, brick kilns, steel fabrication, tyre retreading, mechanised furniture unit, etc. The total amount of water consumption by different categories of industries is about 157 KLD and the amount of

industrial effluent generated is 44.3 KLD. There are four (4 nos.) hospitals with ETPs with a total capacity of 259 KLD and generating waste water of about 156 KLD. All the 615 industries have been issued consent under the Air (Prevention & Control of Pollution) Act, 1981 and Water (Prevention & Control of Pollution) Act, 1974. The legacy waste in the Dimapur Municipal Council (DMC) dumping site is in the bioremediation process. Bioremediation process will be continued till the Solid Waste Management Project under Swachh Bharat Mission by the Ministry of Urban Development is completed. The Dimapur Municipal Council (DMC) has started the process of bio-mining in the existing dumpsite after the wastes are treated and bioremediated. There is no common bio-medical waste treatment facility in the state of Nagaland. Most of the HCFs are disposing of their biomedical waste through deep burial and the municipal waste generated is being collected by Dimapur Municipal Council and East Dimapur Town Council for final disposal in the dumping year. However, considering the environmental pollution control point of view, there is a need for development of at least 1 (one) small scale Common Biomedical Waste Treatment Facility (CBWTF) facility in the catchment of River Dhansiri (Action plan for rejuvenation of River Dhansiri, 2019).

As per the revised action plan for rejuvenation of polluted river stretches for priority III/IV/V rivers, the committee has given the short term and long-term action plans and time limits to the implementing agencies responsible for execution of the action plans. Some of the action's particulars about the industrial pollution control, solid waste management, sewage treatment and disposal plan (NPCB, https://npcb.nagaland.gov.in) are as follows:

- Comprehensive inventorisation of industries in the catchment of water bodies has been completed by Nagaland Pollution Control Board (NPCB).
- NPCB has notified in local dailies not to dispose/discharge spent oil/waste into the drains.
- No industry should discharge effluent directly into drains without treatment. They have to set up effluent treatment plant (ETP) for operation of units. Kohima Municipal Council (KMC), Dept. of Industries & Commerce, and NPCB have been given responsibility to jointly inspect and direct such units for compliance.
- A solid waste management facility was developed by Kohima Municipal Council at Lerie Kohima. This waste management facility was funded by Asian Development Bank (ADB) and commissioned in February 2016 for quantification, characterization and processing of solid waste as per municipal solid wastes rules, 2016.
- Awareness and social action/public participation for cleaning work in 19 wards in Kohima-by-Kohima Municipal Council.
- For construction of community toilets, and construction of septage management at Kohima, KMC was the responsible agency. A total of 44 community toilets/public toilets had been sanctioned under Swachh Bharat Mission. The septage management facility with 90,000 litres/day funded by ADB was in the final stage and supposed to be commissioned in December 2019.

9.7. Ill-effect on Forest and Biodiversity

9.7.1. State wise RET category species and forest cover

Unique geographical location, including diverse terrain, varying altitudes and climatic conditions, provides the Nagaland state with rich floral and faunal diversity that attracts many tourists to the State. Another significant reason for Nagaland's contribution to biological diversity is that it is located between the Indian, Indo-Malayan and Indo-Chinese regions. This unique location of the State also makes it a bio-geographical gateway for plant migration. The overall effect of the above factors has resulted in diversified and luxurious vegetation across the State.

As per the record of the Botanical Survey of India, there are three plant species which are extinct or possibly extinct in Nagaland. Total 13 endemics, 4 rare, 3 vulnerable and 4 endangered plant species are found in the State. As per the IUCN red list documentation, the State currently holds 1 critically endangered, six endangered, and 17 vulnerable mammal species. Three vulnerable categories of amphibians are found here. 4 critically endangered, 7 endangered, and 6 varieties of vulnerable reptiles inhabit the region. Among birds, 6 are critically endangered, 3 endangered, 23 near threatened and 15 are vulnerable. Based on the 2021 FSI report, the Forest Cover in the Nagaland state is 12251.14 km^2 which occupies 73.89 % of the State's geographical area. In terms of forest canopy density classes, the State has currently 1272.04 km^2 under Very Dense Forest (VDF), 4449.04 km^2 under Moderately Dense Forest (MDF) and 6530.03 km^2 under Open Forest (OF). However, the entire forest cover in 2019 was 12486 km^2 which means the State has lost 235 km^2 of its forest cover within the last two years (Indian State of Forest Report 2021, Fig. 9.10).

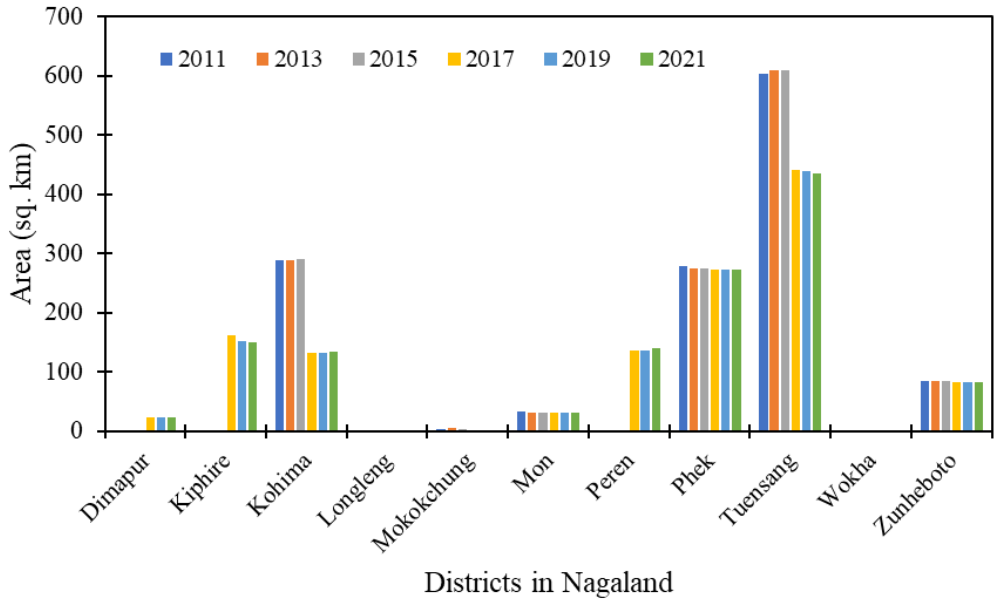


Fig. 9.10: Change in Very Dense Forests across different districts of Nagaland during 2011-2021

9.7.2. Loss of biodiversity due to waste disposal

The major cause of biodiversity loss in the Nagaland state is due to shifting cultivation, rapid urbanization, logging, and un-balanced forest economics (ENVIS Nagaland Newsletter, October - December 2017). Shifting cultivation, commonly known as slash and burn agriculture, is an age-old traditional agriculture practised in Nagaland and has caused massive loss of old-growth forests. The effect of urban development is seen in all the major towns but is most prominent in the capital town of Kohima and the commercial hub of the State, Dimapur. Firewood has been used as a source of energy for cooking and heating purposes, and a large area of forests has been cut._Finally, forest economics has been an essential economic subsistence source of humans throughout the ages in Nagaland. One of the best examples of this is the use of timber. Its best example is to harvest wood and create commercial items. However, no studies are available to date to show the impact of waste disposal on the state's forest ecosystem and overall biodiversity.

9.7.3. Eco-sensitive zones/ Areas

Fringe villages around Intanki National Park (INP) have agreed to declare the park as 'Eco-sensitive zone' and to abide by the rules and regulations. The declaration to this effect was taken during a meeting organised by the Intanki National Park officials with the fringe villages on July 25, 2017 at Forest Rest House in *Jalukie* town. This was attended by 16 out of the total 20 villages (Eastern Mirror, Jul 26, 2017). However, till date, no eco-sensitive zones are in action and implemented neither in Intanki National Park nor in the entire State.

9.8. Ill-effects of tourism, particularly on environmental components (waste generation, air & water quality deterioration, loss of greenery & biodiversity), land/soil contamination and groundwater

A couple of studies have highlighted the status of tourism development in the State of Nagaland and its prospects, especially for eco-tourism, rural/village tourism, cultural tourism and many more (Shiteo 2017; Ezung 2011). However, no studies have been found to directly link the growth of tourism in the State with environmental problems such as waste generation, environmental pollution, and loss of forest and biodiversity. Aienla and Sarma (2014) published a review paper on waste management in tourist destinations of Nagaland. They reported that there is a lack of proper waste management in the majority of the tourist destinations except for a few, such as *Khonoma Green village* and *Touphema Heritage Village*, where community-based tourism management has been practiced. In another popular tourist spot, the *Dzukou valley*, a news item published in *The Morung Express* (dated 29thAugust, 2021) reported that the increase in tourist footfall is creating the problem of waste management and pollution due to lack of proper waste management infrastructure. Further, this may pose a threat to the pristine ecology of Dzükou (https://morungexpress.com/waste-management-a-problem-in-dzkou-valley).

RSPM could be a surrogate for hazardous pollutants that are released from vehicles used by tourists and local residents. Monthly RSPM data were measured in µg/m^3 only in Dimapur and Kohima city of Nagaland from 2014 to 2018. Data from both the cities were averaged, which is

a sampling representation of monthly RSPM for Nagaland. We correlated the mean RSPM with the number of total tourists visiting per month in Nagaland during the same time period. We performed linear regression to find out relation between monthly tourist visit and monthly measure of RSPM within Nagaland. Solid waste generation due to mass tourism in the region is an emerging problem in major touristic states of Himalaya. We received the details of garbage generated and collected during 2010 – 2020 in Nagaland from the review report on municipal solid wastes, Central pollution control board (Ministry of Environment, Forest & Climate Change). In this report, we compiled solid waste generated (TPD), collected (TPD), and treated (TPD) for each financial year between 2010 – 2020. The mean monthly total tourist inflow during this financial year was also calculated. We also performed linear regression to find out relation between yearly tourist visit and yearly mean of solid waste generated (TPD) within Nagaland. In both cases, the statistical relationship is very weak (Fig. 9.11). We also tried to build a relationship between monthly tourist inflow and increasing cumulative number of various types of vehicles during 2018 -2021. However, for none of the cases we find any significant impact of tourism on vehicle growth in the state of Nagaland.

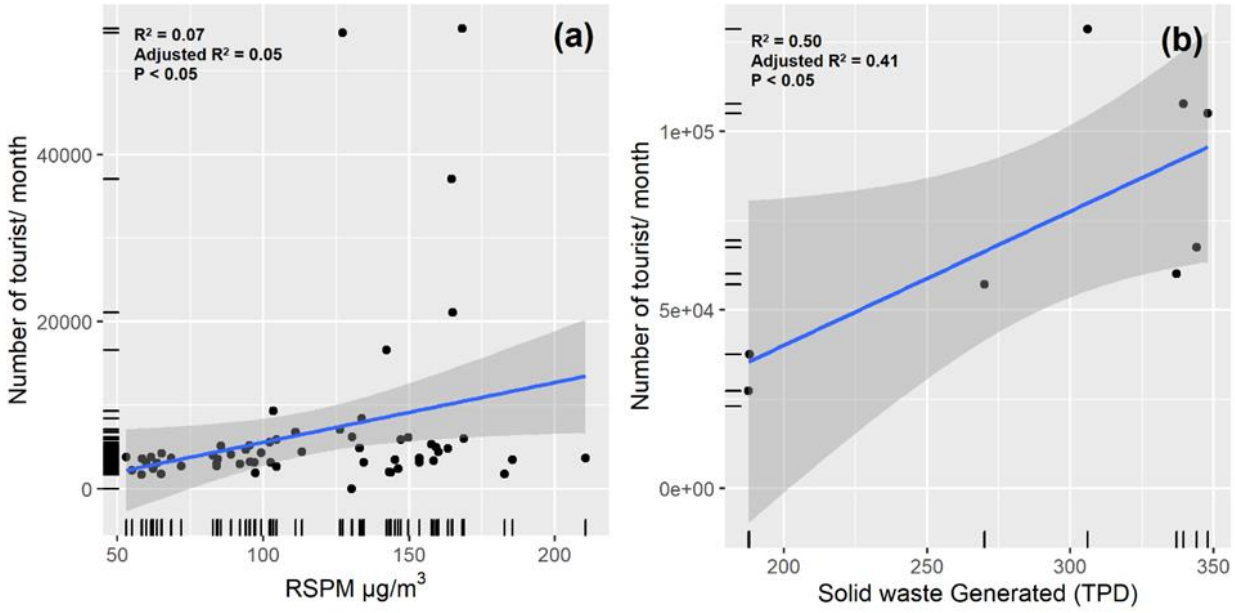


Fig. 9.11 a&b (a) Relationship between RSPM µg/m^3 and number of tourist/ month (b) Relationship between solid waste generated in tonnes/ day and number of tourist/ month

In Nagaland, the available data obtained for tourist inflow was for state level and not specific to the tourist inflow at particular tourist destinations/tourist circuits. This information would be helpful to ascertain the impact of growth of tourism and allied sectors on the economy and environment of the area. In view of the available data, vehicular influx could not directly be linked to tourism since the data only represent the vehicles registered within the state. Data on entry/exit of tourist vehicles from outside the state to particular tourist destinations/routes would also be needed in order to determine how the growth of tourism can affect the air quality and to design regulating measures to minimize the impacts.

In Nagaland, the identified main reason for air pollution has been dust raised from vehicular movement, vehicular emissions, burning of waste, construction activity and burning of fossil fuel for domestic purposes. Dimapur, the most populous city and gateway to Nagaland, have higher vehicular movement. Kohima being the capital of Nagaland also has industrial units categorized in red, orange, and green. The particulate matter has been a major concern for both the cities, and due to GRAP initiatives, there has been decline in the particulate matter, and NO_2 concentration. However, the direct impact of tourist inflow on air quality has not been studied so far.

The major reason for water pollution in Dimapur city was discharge of domestic wastewater, domestic sewage, domestic waste, and municipal waste into the water bodies without treatment. The three major drains in the Dimapur are the major contributors for pollution in River Dhansiri. The Kohima municipal council dumping site has been a major contributor to the water bodies in Kohima. Population has always been a key to generation of waste and wastewater in any city. But there is no such study in case of Nagaland where tourism activities have impacted/polluted the water bodies.

There is also a data gap on the waste management and biodiversity loss at important tourist destinations/routes. Therefore, these pin-pointed studies on these aspects are urgently needed.In this regard, possible actions in brief could be mentioned in a following suggested action plan.

9.9. Suggested Action plan

Sr. No.	Gaps	Plan for Action
1.	Data on the number of visitors in the state are lacking and can be generated from ILP/PAP applications. Registration of in-bound and out-bound tourist vehicles at State's entry/exit points and at entry to tourist destinations/circuits.	Assessment of tourist carrying capacity of all tourist destinations/circuits need to be conducted.
2.	No establishment of proper waste management facilities at tourist places and less strict implementation.	Establishment of more number of waste recycling/composting units, air and water quality monitoring stations (at least to cover every district and major tourist circuits/destinations) are required.

3.	Little community-based tourism management practiced in Khonoma Green village and Touphema Heritage Village.	Strengthening community-based tourism and developing Eco-Tourism models in several touristic cities in Nagaland with participation of local people and government departments. Need to promote skill development of local youths and promoting NGO activities and their involvements.
4.	Human activities and developmental projects which adversely affect forests cover steep slopes, catchment areas of rivers, lakes and reservoirs, geologically unstable terrain and such other ecologically sensitive areas should be restricted.	Environmental Impact Analysis (EIA) and Strategic Environmental Assessment (SEA) studies need to be practiced simultaneously for all tourism industries and development activities in the state.

9.10. Summary

The tourism sector is an emergent industry having great potential for economic development of the state of Nagaland. The natural landscape and rich floral and faunal diversity provide good prospects for different types of tourism activities especially ecotourism, village tourism, adventure tourism, etc. In spite of the limitations due to scarce infrastructural and communication facilities, the tourist inflow to the state, both from domestic and international, has been increasing over the last 10 years. However, on the basis of the Nagaland case study, the direct impact of tourism on the environment could not be ascertained to justify the statement, "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic". In view of Nagaland State, there is a need to conduct more focussed studies for assessment of the impact between tourist inflow and tourist activities in different destinations on environmental problems like waste generation, loss of forest and biodiversity, pollution of air and water bodies.

10.1. Introduction

Manipur, the northeastern state of India, is bordered by the Indian states of Nagaland to the north, Assam to the west, and Mizoram to the southwest and by the country Myanmar to the south and east. Total geographical area of the state is 22,327 square km with population density of 2,855,794 individuals as per the 2011 census statistics. Manipur meaning "land of gems" is blessed with the diverse tourist attractions such as majestic Loktak Lake, the strategic Moreh town, the unique floating Keibul-Lamjao National Park, and the endemic Sangai Deer, the beautiful Dzukou Lilies, along with the naturally formed limestone caves, pristine green hills and valleys, meandering rivers, cascading rapids, exotic flora and fauna complimented by a rich arts and culture, folklore, myths and legends, indigenous games and artistic handloom and handicrafts. These features come together to make Manipur a miniature heaven on Earth and an intriguing tourist destination. The state has been identified as a 'Key Area' for its 'unrealized potential as an eco-tourism product'. The healthcare practices of Manipur are already well known and potential to have an area for medical tourism. The State has a high percentage of qualified health specialists who can cater to different ailments both in terms of allopathic and ayurvedic medicines.

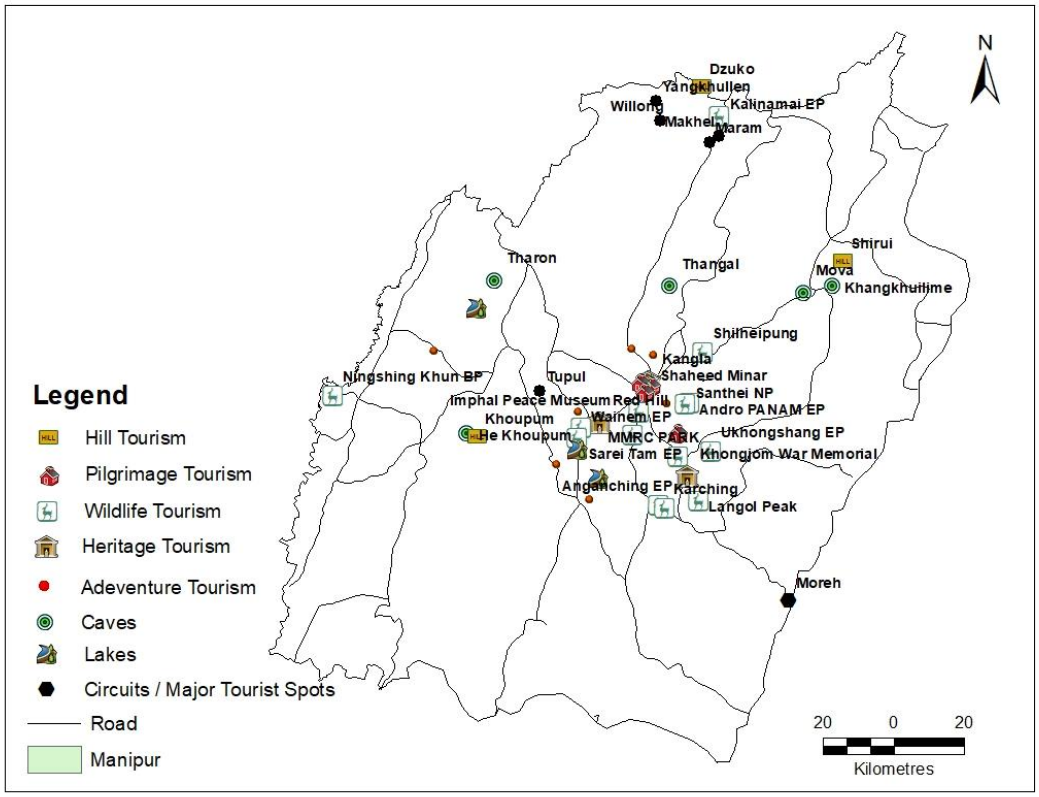


Fig.10.1: Major tourist spots and circuits in Manipur

Status of RET species in the state

Based on secondary published literature (Mehta *et al.*, 2020), a total of 133 plants belong to 86 genera and 36 families included under different threat categories; among which 132 species are angiosperms and 1 species (*Pteris vittata* L.*)* is pteridophyte. The most dominant family is Fabaceae, representing 47 species from 29 genera, followed by Poaceae and Scrophulariaceae. Among these, 12 species are recorded in Red Data Book (Rare 04; endangered 04; Vulnerable 02; In determinant 01; presumed extinct 01) of Indian Plants (Nayar and Sastry, 1987; 1988; 1990) and 121 (1 pteridophyte, 120 angiosperm) recorded in IUCN (Endangered 02; Vulnerable 03; Data Deficient 08; Least Concern 108.

A total of 86 plants (angiosperm) recorded endemic to India found in Manipur, belonging to 56 genera and 28 families (Herb 45; Shrub 14 each; Climber 08; under shrub 2; Tree 09; Bamboo 5 (Singh *et al.* 2015).

10.1.1. General scenario of tourism in Manipur

Despite the enormous potential of tourism in Manipur, the development of the region with regards to tourism did not take place due to various reasons. These include, Protected Area Permit (PAP) regime for entry of foreigner's; the remote geographical location of the state; poor availability of resources; lack of proper infrastructures, facilities and amenities to cater to various types of tourists; unavailability of trained guides, etc. are the major hindrances for harnessing state's tourism potential. The problem is further exacerbated by frequent bands, road blockades, strikes, protests, etc. resulting in social unrest.

Manipur has been afflicted by insurgency which often deters tourists. However, the situation in Manipur has been substantially improved over the years. This could be seen that there are increase in number of air flights reaching to Imphal, introduction of night landing facilities of aeroplane, on-going extension of railways line to Imphal from Jiribam, exclusion of Manipur from the Protected Area Regime since January, 2011, improved law and order situation, establishment of 3-star and 4-star category hotels, Institute of Hospitality Management (IHM) and other tourism projects, etc. have all resulted in steady rise in number of tourist arrivals and has helped in propagating Manipur tourism in the country and all across the world.

In recent years, the state government has given high emphasis on the construction of suitable tourism infrastructure and services to help the tourism industry development of the state. Some of the important steps taken by the state government are: (i) destination development (ii) development of tourist circuits, (iii) adventure tourism development, (iv) identification and celebration of fairs and festivals, (v) marketing, publicity and promotion activities, (vi) culture, arts and crafts, handloom promotion, (vii) human resource development, (viii) participation in national and international events, and (ix) tourism master plan development.

10.1.2. Tourism growth (number of annual tourists visiting) vis-a-vis economic growth

According to published data, the number of tourists visiting the state has increased from 1,35,083 in 2011 (consisting of 578 foreign visitors and 1,34,505 domestic visitors) to 1,82,500 (consisting of 6,391 foreign and 1,76,109 domestic tourist) in 2018. Although the number of foreign tourist visitors recorded a maximum (13,608) in the year 2019, the overall tourist influx declined significantly after 2019 (Fig.10.2). The yearly proportion of domestic and foreign tourists visiting Manipur from 2011 to 2021 is shown in Figure 10.2. Furthermore, it is evident that the rate of change in visitors influx decreased drastically (-70.85%) in the year 2020 due COVID-19 pandemic and the positive rate of change was observed maximum (26.35%) in the year 2015 respectively (Fig.10.3).

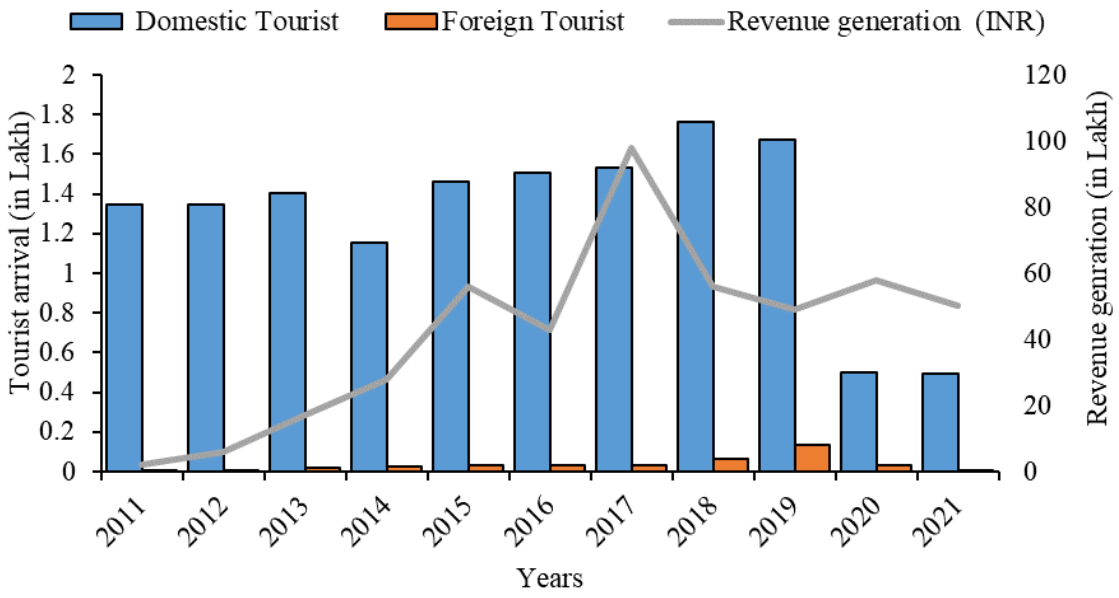


Fig. 10.2: Tourist influx and revenue generation in Manipur state (Source: Directorate of Tourism, Government of Manipur)

10.1.3. Economic growth (annual income from tourism)

As per revenue receipts, the economic services tourism from 1991 to 2022, the revenue of the state has significantly increased between the year 2011 to 2021. The income from the tourism sector was INR 2 lakh in the year 2011 which was recorded maximum (98 lakh) in the year 2017 and it was INR 50 lakh in the year 2021. The year wise economic growth trend. Furthermore, the rate of change of revenue generation in the state has shown an irregular trend and it ranged between 18.37% to 200%. The rate of change was the maximum for the year 2012 and minimum during 2020. However, during the year 2018 it has declined drastically to -42.85%. Similarly, the COVID-19 pandemic also influenced a significant decrease (-13.79%)

in the year 2021 (Fig. 10.3). Based on the statistics, it can be concluded that the tourism industry is not only flourishing, but also providing ample opportunities for sustainable, environmentally friendly and responsible tourism in the state, which was shattered by the COVID-19 pandemic.

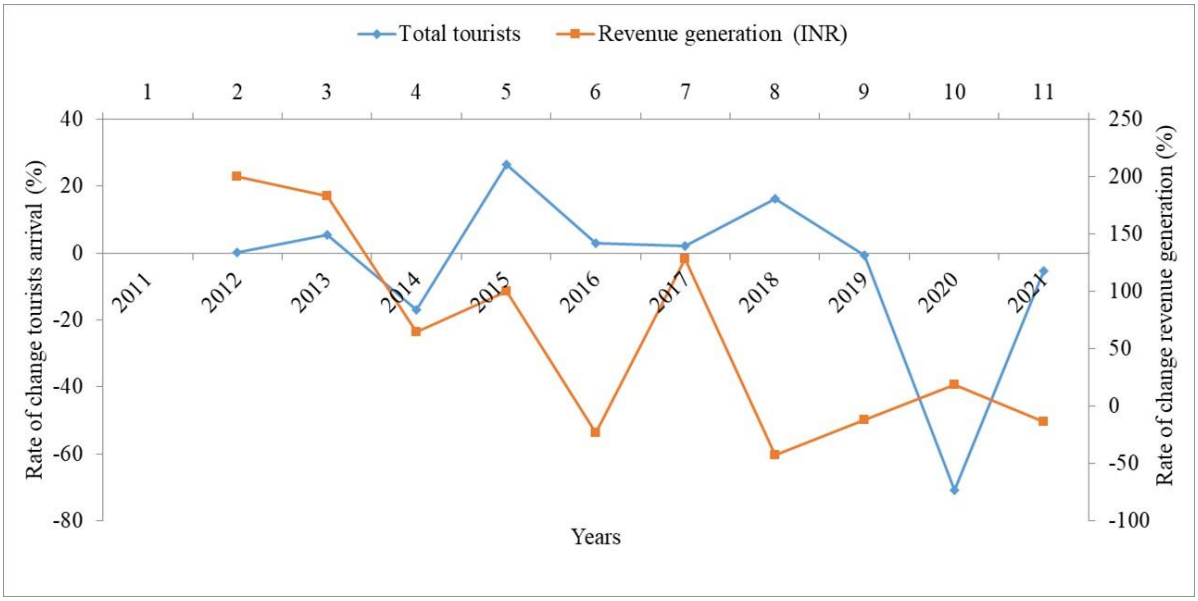


Fig. 10.3: Rate of change in tourist arrival and revenue generation in Manipur (Source: Revenue Receipts Government of Manipur (https://www.ceicdata.com)

10.1.4 Assessment of waste generation

a. Solid waste and its management

Studies in Imphal town also indicated that the solid waste management (SWM) is not appropriate and highly unsatisfactory based on Solid Waste Management and Handling Rules, (2000). There are many shortcomings in the existing system of municipal solid waste management (MSWM). According to the report Swasth Bharat Sampann Bharat assessed on May 2022, Manipur generates a total of 178 TPD (tonnes per day) solid wastes, of which 120 TPD come from the city of Imphal alone and out of the total waste generated by the state, only 70% is collected by the civil authorities while 30% waste remains uncollected. In the absence of sanitary landfills, solid wastes get dumped in the open places, creating nuisance and unhygienic conditions. This may have resulted in a high risk of contamination to different environmental compartments including soils, groundwater/surface water, and air, leading towards human health hazards (Yadav and Devi, 2016). At temporal scale, a concurrent increase in waste generation can be seen in the Imphal city (Fig. 10.4). According to the study on urban solid waste management in Imphal, the Imphal municipality generated 48 TPD of MSW in 2001 and which increased to 72 TPD in 2011 and at present it reached to 100-120 TPD and is projected to rise about 170 tonnes/ day by 2035 (Mahongnao, 2017). Furthermore, the per capita generation of MSW also increased from 0.190 kg/day in 2001 to 0.217 kg/day in

2011 (Annepu, 2012). The city observed a decadal rate of change in MSW on an average of 50% in the year 2011 which further increased to 60.67% in 2021-2022.

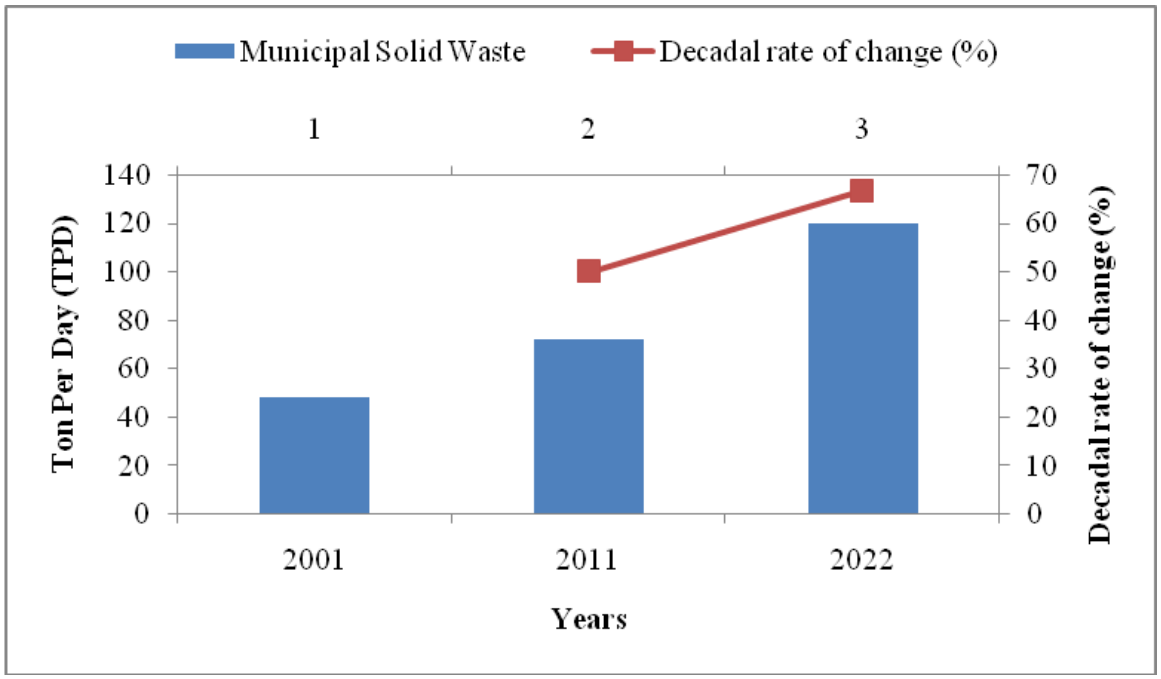


Fig. 10.4: Decadal rate of change in municipal solid waste management in Imphal City (Source: Mahongnao 2017)

The municipal solid waste (MSW) management in Imphal is still infused with challenges owing to the predominant reliance on the conventional method of waste collection, transportation and disposal. Segregation of waste is not done at source even though the municipal laws stress the importance of it. The situation at present is alarming and requires improvement in the area of infrastructural up gradation, public-private partnership (PPP), public participation, awareness campaign and implementation of existing laws. The reliance on modern methods of waste recovery and recycling in the present context of waste management is negligent (Mahongnao, 2017). Furthermore, there is also no requisite expertise for municipal solid waste management in the MAHUD (Department of Municipal Administration, Housing & Urban Development) directorate which controls 28 local urban bodies at present. There is no permanent dumping site/treatment plant for MSW. Plastic/polythene bags also seriously pollute the environment and burning of waste products including plastic is the common norm in Manipur (Sophia and Devi, 2020).

b. Category wise Biodegradable (wet) and Non-biodegradable (dry), e.g., plastic, glass, metal, rubber, ceramic, etc.)

The physical composition of MSW in Imphal has a maximum content of organic waste (60.59%) followed by plastic (11.06%) and paper (7.16%). The physical composition suggests that the adoption of technologies such as compost and recycling plants is imperative in the management

of MSW in Imphal municipality (Fig.10.5). The existing laws do not promote the "3R" policy which is a key tool for effective management of MSW in the contemporary world. "3R" policy means "reduce, reuse and recycle". Huge volumes of waste can be reduced, reused and recycled to reduce the pressure on production of virgin materials (Mahongnao, 2017).

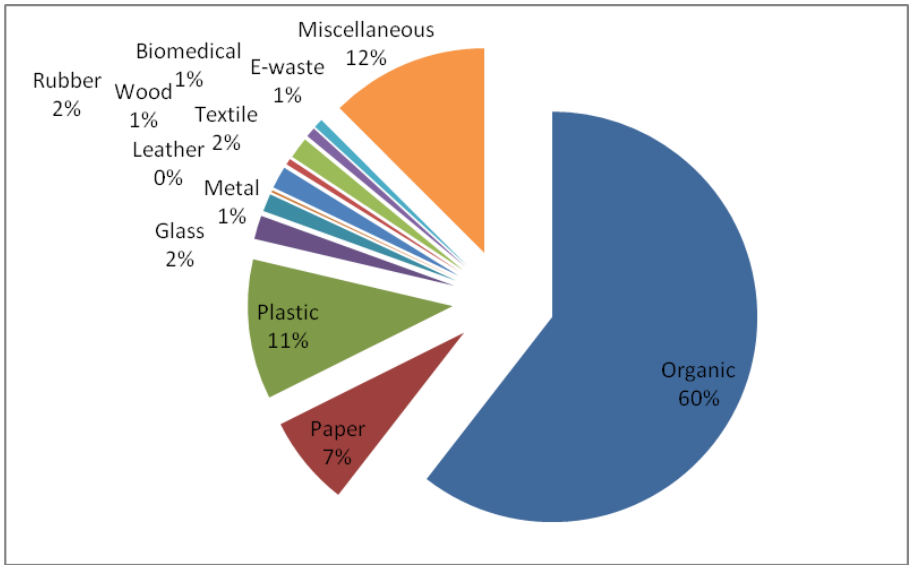


Fig.10.5: Physical composition of Municipal Solid Waste in Imphal city (Source: Singh and Dey, 2015)

10.2. Segregation / Utilization of waste:

The data on the segregation and utilization of waste of the state are not available.

10.2.1 Recycled/Reused/Unutilized / left over

a. Waste disposal/ treatment facilities

In Imphal municipality, two garbage collection systems are found. First, residents collect rubbish in a plastic bag, carton box, or jute bag outside the house's corridor. Second, NGOs or municipal trucks collect the assembled waste and dispose of it in landfill sites. The Imphal municipal corporation (IMC) collaborates with 6 NGOs namely, centre for research on environmental development (CRED), workers' union Manipur (WUM), seven security force (SSF), TACDEF solid waste management of Manipur, Khaba waste management system (KWAMS), and social upliftment and welfare organization (SUWO) to carry out the management of municipal solid waste in Imphal municipality. The transportation of MSW is done by a varied number of vehicles (Mahongnao, 2017). At present, the MSW is dumped in Porompat and Langol landfill sites. Landfill in Lamdeng is closed due to complaints by nearby villages about the emanation of foul smell.

In an endeavor to protect and preserve the green cover of northeastern state of Manipur, a solid waste treatment plant has been set up at Lamdeng in Imphal West. The plant, set up under a state government initiative, is helping the state manage solid and industrial waste. The operations of the plant, which will treat, process, recycle and dispose of solid waste of Imphal, has been handed to a private agency Eco Care Private Limited. The plant has been functioning under the Public-Private Partnerships (PPP) model. Imphal produces 120 tonnes of waste per day and a number of processes are involved in effectively managing this waste. It includes monitoring, collection, transport, processing, recycling and disposal. Moreover, the end product that is recovered from the waste in the treatment plant is quality oriented bio composes which can be used as manure by farmers. The treatment plant is spread across an area of 12 acres. The entire process of waste management includes usage of machinery like the JCB's, tractors and processing and refining machines. This venture has also helped generate employment opportunities for many in the city. Currently, the plant employs 19 people. The treatment plant was constructed at a cost of Rs. 4,175 crore and in near future the plant is coming up with a power plant with a target of 1 Megawatt of power by using gas fire (https://www.cleanfuture.co.in/2018/01/10/manipur-gets-waste-management-plant/). In recent years, incineration plants are installed in most of the hospitals, research institutes and clinics in Imphal with a purpose of burning bio-medical waste. Although the concept of producing energy through incineration technology is absent in Imphal. Till date there is no report of segregating the household waste at source in Imphal. This is one of the major challenges where the concerned authority should take appropriate measures for segregation of waste at source (Khelchandra, 2019). Although some good initiatives were also observed from the state in recent years viz., Kaibi village's initiative of buying solid waste from its residents to spread awareness on waste management and the efforts have paid off, as the village has been at its cleanest in the past one month.

10.2. Ill-effect of tourism on Air quality

Growing tourism offers opportunity to the resident populations but also causes ill effects to the environment and to biodiversity. In the urban centres of Manipur like Imphal, various polluting factors can be seen such as i) vehicle emission, ii) domestic solid waste, iii) excessive dust fall and, iv) unwarranted noise generation by vehicular traffic.

a. Air quality and pollutants

The main source of air pollution in Manipur has been identified as auto exhaust emissions of the fast growing number of automobiles, dust-fall due to bad road management and other miscellaneous commercial earthmoving activities. The slash and burn activities in forest during February-March every year for preparation of the field for agricultural crop under Jhum practices adds huge amounts of fumes and particulates into the atmosphere. The increasing trends in vehicle number in Manipur increase the problem of air and noise pollution. Two wheelers are by far the dominant type in Manipur. Most of the vehicular population is found in urban areas. The number of two- wheelers registered as on 31-3-2013 was 67.88 % of the total population and personalised vehicles as on 31.3.2013 was 84.26% of the total population. It is

estimated that about 8000 – 9000 vehicles per year are increasing and therefore by 2030, the vehicular population of the state would be around 4-5 lakhs (ENVIS, 2015). The level of growth in private modes of transport in comparison with public transport is a significant contributory factor for urban air pollution. Although two wheelers are generally more fuel efficient than passenger cars they typically emit more pollutants per kilometre thereby contributing more to the particulate carbon monoxide, Sulphur dioxides and nitrogen oxide emissions. The use of a large number of second-hand vehicles as transport is another cause of concern. In addition to this, the ambient air is further polluted by the dust from the poorly maintained road and smoke emitted from the burning solid-waste. The air quality in all the valley districts of Manipur is within the permissible limits. There are no major highly polluting Industries in the area. The use of boilers and the existing brick kilns of seasonal operation produce emission of local influence only. The air quality in the valley is not considered bad. However, there is an urgent need for putting a check on the rising and indiscriminate establishment of small industrial units within thickly populated areas and also a check on the rising trend of use of second-hand vehicles in the state (ENVIS, 2015). The total vehicle population of Manipur as on December 2017 has increased to 367,035. Another problem is the continuous increase in construction activities. Dust from such construction clogs the air and makes breathing difficult especially for people with asthma related ailments. The routine burning of waste products as a form of disposal, including plastic and polythene bags, has adverse consequences for health in the urban area of the state (Sophia and Devi, 2020).

b. Number of vehicles (state / district wise)

According to the Ministry of Road Transport and Highways (India), a significant increase in the vehicle numbers can be seen since the financial year 2007 to 2019. However, considering the decadal change, based on the available datasets (2011-2019), the number of vehicle registration was maximum (3,95,000) in the year 2014 and thereafter almost static trend was seen (Figure 10.6). The rate of change in vehicle registration has shown an irregular trend over the years and it ranged between 3.9 % (2012) to 37.7% (2013). However, between two successive years 2015-2016 followed by 2018 a negative rate of change was observed (Fig.10.6).

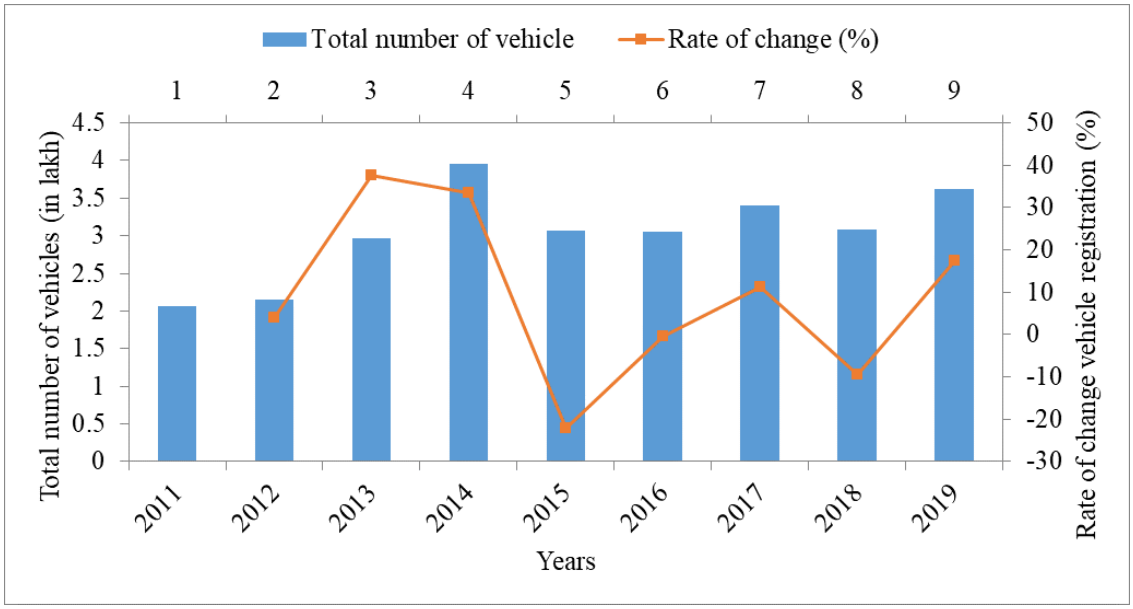


Fig.10.6: Total number of registered motor vehicles across Manipur from the financial year 2011 to 2019 (Source: Ministry of Road Transport and Highways (India) © Statista 2021)

a. Parameter wise air quality

The data related to air quality was retrieved from the online portal of Indiastat. It was observed that the data on the ambient air quality is too scanty in the state with only few air quality monitoring stations. The available dataset related to air quality parameters are listed in table 1. The PM_{10} value between 2016 to 2018 indicates good air quality <40 µg/m^3 which has shown poor quality (80-120 µg/m^3) 2019 onwards. Similarly, the $PM_{2.5}$ data is available from the 2019 onwards and indicates slightly poor air quality with the values between 50-100 µg/m^3. However, the SO_2 and NO_2 concentrations were observed under good condition Table 1.

Besides, the assessment of the particulate pollution ($PM_{2.5}$ and PM_{10}) in the indoor air of Manipur University campus was attempted. The results revealed variation in the spatial and temporal concentrations of air particulates within the campus. The $PM_{2.5}$ concentrations ranged between 8.33 µg/m^3 and 129.16 µg/m^3 whereas, the PM_{10} concentrations ranged between 16.54 µg/m^3 to 269.88 µg/m^3 (Khoiyangbam et al. 2021). The lowest concentrations of both $PM_{2.5}$ (8.33 µg/m^3) and PM_{10} (16.54 µg/m^3) were recorded in the classroom. The highest concentration of particulates was recorded in the University canteen for $PM_{2.5}$ and in Indoor stadium for PM_{10}. In general, particulate concentrations were recorded higher in spots adjoining the National highway (No.102) and showed a declining trend with distance. Out of the 12 spots under study, the $PM_{2.}5$ concentration was found above the permissible levels (25 µg/m^3; WHO, 2013) in 10 spots, whereas the concentrations of PM_{10} was exceeded in 8 spots. The values of AQM in the Imphal city of Manipur during the year 2019 is depicted in Table 10.1.

Table 10.1: Ambient air quality in Imphal city of Manipur, India

Year	SO_2 (µg/m^3)	NO_2 (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
2016	-	-	29	-
2017	-	-	-	-
2018	-	-	29	-
2019	9	21	109	56
2020	5	22	137	69

Source: https://www.indiastat.com/data/environment-and-pollution

10.3. Correlation analysis with total tourist influx and vehicles

Based on the available data on tourist influx and number of vehicles registered in the state of Manipur (2011-2019) a correlation analysis was performed and no significant ($p<0.05$) relationship was observed between these variables (Fig. 10.7).

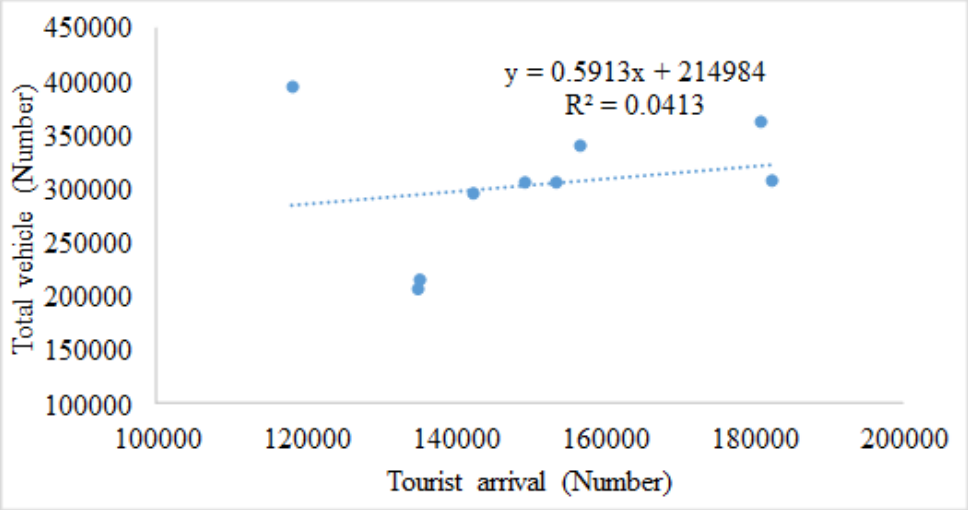


Fig.10.7: Correlation analysis with total tourist influx and vehicles between 2011 to 2019

10.4. Ill-effect of tourism on water quality / groundwater

Among the listed tourist attractions in the Manipur state, the iconic Loktak Lake, located at Moirang town is the largest natural freshwater lake in the North-eastern region of India and plays an important role in the ecological and economic security of the region (Tuboi *et al*,

2012). This Lake is broadly divided into three zones, *viz.,* northern, central and southern zone, on the basis of vegetation type, *Phumdi* thickness, drainage network, open water area location and human activity. *Phumdi is a Manipuri word meaning floating mats of soil and vegetation*. The lake is rich in biodiversity and has been designated as a wetland of international importance under RAMSAR convention in 1990. It has a catchment area covering 1046 sq.km has 293sq km of watershed area and 114 sq km is covered by *Phumdis*.

According to the Assessment report of noise pollution in the state by the Manipur Pollution Control Board, the ambient noise level is high at Keisampat junction, Kangla Park, Singjamei bazar and Kakching bazar especially during 9.30 to 10.0 am and 4.30 to 5.0 p.m. (Manipur Pollution Control Board). The noise level also tends to be higher in Regional Institute of Medical Sciences (RIMS). The noise level is comparatively low on non-working days in most parts of the Imphal city. At present, there is no problem of noise pollution in the institutional areas of Manipur University and Central Agriculture University. The results also indicate a comparatively low Ambient Noise Level at Nambol Bazar, Thoubal Bazar, Bishnupur Bazar and Moirang Bazar.

a. Water quality and pollutants

Water pollution is caused mainly by unplanned expansion of urban areas, inadequate drainage system and lack of adequate sanitation, untreated sewage running directly into water bodies, run-offs lashed with a variety of agro-chemicals from agricultural fields are harmful to aquatic plants and animals and ultimately to human beings. For example, at Loktak Lake, the increasing number of *Phum* dwellers has defiled the waters with faecal matter and domestic waste (Sophia and Devi, 2020). Similarly, the total plate count study of lake water indicated the presence of very high bacteria content. The highest being at The Keibul Lamjao National Park (220000/ 100ml) and the highest coliform count is recorded from Sendra area which is attributed to disposal of human and cattle wastages and seepage of waste matters from the surrounding area.

b. Impact on water quality / groundwater

The Nambul river, which flows from the heart of the capital city Imphal and among the main perennial sources of water for the Loktak Lake. The River Nambul is also one of the primary inland waterways that connect the villages of the southern and eastern part of the valleys and hills of Manipur. This river was under observation of the Manipur pollution control board from 2016-2018 in order to document water quality parameters (Laishram and Alam 2019). Based on the study, the range of water quality parameters, viz. water temperature was recorded in between 26-32 ºC in the year 2016; 21.4- 24 ºC in 2017 and 13.3-30 in 2018. Similarly the dissolved oxygen was ranged between 0-8.9 in the year 2016; 2.1-7.1 in 2017 and 0.3-13.6 in 2018; pH value ranged from 6.2-7.7 in the year 2016 ; 6.1-9 in 2017 and 6.5-8.3 in 2018, and total coliform ranged from 0-665 in the year 2016; 2.5-9500 in 2017 and 95-1305 in 2018, respectively. Furthermore, it was observed that the activities like cloth washing, bathing, fishing are contaminating the river beds up to some extent (Manipur Pollution Control Board, https://manipcb.nic.in/).

10.5. Ill-effect of tourism on forest and biodiversity

North eastern states are endowed with rich biodiversity and Manipur is among them. According to the Forest Survey of India 2018 report, the forest cover in the state of Manipur is 16,846.90 km^2 which is 75.46 % of the total geographical area of the state. Manipur state shares the eastern Himalayan endemic bird area and the Indo-Burma Biodiversity Hotspot with its rich flora and fauna and diverse ecosystem which includes 4,000 species of angiosperms, 430 medicinal plants, 34 edible fungi species, 500 orchid species, 55 bamboo species. Besides, the state hosts 40 endemic rice cultivars, 160 fish species and 21 migratory aquatic birds (https://cramanipur.wordpress.com/2020/07). However, there are still unexplored fauna and flora species in the state and the state is facing biodiversity degeneration due to various reasons, including lack of awareness in the society, faulty practices and limitations in the scientific community.

The threat to the biodiversity of the state has been reported; however, data on the impact of tourism on the biodiversity is lacking. Among others, the most unique Manipur's fauna is the Sangai, brow antlered deer. The floating mass of vegetation on Loktak Lake, the *Phumdi* sustains small herds of this endemic deer. The sanctuary of the deer is now the only floating national park in the world, named KeibulLamjao. The number of Sangai had decreased due to the continuous inundation and flooding by high waters of the artificial reservoir of the National Hydroelectric Power Corporation, Loktak, as well as by ecological change of the Loktak Lake (Singh, 2017). There were also threats on its life from poachers. A major source of pollution of the Loktak Lake on which the Phumdi floats is the man-made sometimes hazardous wastes and debris brought down by rivers which drain into the lake (Sophia and Devi, 2020). Besides, some threats to biodiversity are forest fire, fuel wood collection, hunting bushmeat, indiscriminate agro chemical uses, and lack of awareness.

10.6. Eco-sensitive zones/ Areas

Eco-sensitive zones are areas/zones with identified environmental resources having incomparable values which require special attention for their conservation. In order to protect the environment and the biological integrity of the area outside the protected areas and other such areas where an ecosystem has been adversely affected due to anthropogenic and climatic factors, the Ministry of Environment, Forest and Climate Change has been declaring such areas as Eco-sensitive zones/ areas (https://moef.gov.in/en). The purpose of these areas is to (i) protect environment and avoid its degradation due to anthropogenic activities, (ii) create some kind of barrier/ shock absorber for the specialized ecosystem (PAs), and (iii) act as transition zone from areas of higher protection to areas involving lesser protection. The following six **Eco-sensitive zones are proposed in Manipur and a**s per the information available in the Ministry of Environment, Forest and Climate Change (MoEFCC), GoI (accessed on 23.04.2022). The proposed proposals for an Eco-sensitive zone have been finalized. These include (i) Zeiled wildlife sanctuary, (ii) Bunning Wildlife Sanctuary, (iii) Yangoupokpi Lokchao Wildlife sanctuary, (iv) Kailam Wildlife sanctuary, (v) KeibulLamjao National Park, and (vi) Jiri-Makru Wildlife

Sanctuary. A total of 1654 km^2 area is covered under the Eco-sensitive zone, which provides effective conservation of wildlife habitat (**Table.10.2**).

Table 10.2: Details of Eco-Sensitive Zones of Manipur

The details of eco-sensitive zones of Manipur include prohibited activities, regulated activities and promoted activities are as follows:

Name of the ESZ	**Prohibited activities**	**Regulated activities**	**Promoted activities**
Zeiled wildlife sanctuary ESZ (235 km^2)	Setting up of saw mills, setting up of industries causing pollution, commercial establishment of hotels and resorts, commercial use of firewood, establishment of new hydroelectric projects, use of plastic carry bags, discharge of untreated effluents and solid waste in water bodies, construction activities, etc.	Felling of trees, Commercial establishment of hotels and resorts, Undertaking activities related to tourism like rope ways, over-flying the sanctuary area by hot-air balloons, etc., Construction activities, Commercial water resources including ground water harvesting, Drastic change of agriculture system, Erection of electrical cables and telecommunication towers, Fencing of existing premises of hotels and lodges, Widening and strengthening of existing roads and construction of new roads, rail tract, Movement of vehicular traffic at night, Introduction of exotic species, Protection of hill slopes and river banks, Commercial Sign boards and hoardings, Air (including noise) and vehicular pollution, Discharge of treated effluents in natural water bodies or land area, Small scale industries not causing pollution, Collection of Forest produce or Nontimber Forest Produce (NTFP), Security Forces Camp, New wood based industry, Eco-friendly cottages for temporary occupation of tourists, such as, tents, wooden houses, etc. for eco-friendly tourism activities, Eco-tourism, Solid Waste Management, etc.	Rainwater harvesting, organic farming, vegetative fencing, and adoption of green technology for all activities, cottage industries, agriculture, and horticulture practices, etc.
Bunning Wildlife Sanctuary ESZ (233.5 km^2)			
YangoupokpiLokchao Wildlife sanctuary ESZ (253 km^2)			
Kailam Wildlife sanctuary ESZ (734 km^2)			
KeibulLamjao National Park ESZ (176 km^2)			
Jiri-Makru Wildlife Sanctuary ESZ (256 km^2)			

Source: Ministry of Environment, Forest and Climate Change, GoI (accessed on 23.04.2022

10.7. Gaps and priority actions

Sr. No.	Gaps	Priority Actions
1.	Effective management of solid waste is lacking which may hamper the state tourism in near future.	• Proper solid waste management through capacity building, infrastructure development, waste recycling to attract tourism in the state. • Involvement of local Non-governmental organization for sensitization program. • Synergize the solid waste management campaigns with the notation cleanliness campaign,
2.	Sate seems to be far behind in terms of research especially in the documentation part.	• Research institutions need to be strengthened and supported by the central agencies. Outer state centralized agencies may help the state to document biodiversity, culture custom and physical parameters of the state in a campaign mode before they disappear or lost.
3.	There are threats to biodiversity such as forest fire, fuel wood collection, hunting bushmeat, indiscriminate agro chemical uses, and lack of awareness.	• Awareness regarding these issues needs to be initiated. State policies can be influenced to make strong rules and regulations to minimize such incidences.

10.8. Summary

Tourism offers opportunity to the resident populations but also causes ill effects to the environment and to biodiversity. In the urban centres of Manipur like Imphal, various polluting factors can be seen such as: i) vehicle emission, ii) domestic solid waste, iii) excessive dust fall, and iv) unwarranted noise generation by vehicular traffic. There is also a total absence of any systematic drainage system in Imphal city. Although Imphal has a potential to become one of the most beautiful urban centres in the country, the city presently has a very shabby and poor appearance. The urban living environment is generally dirty. The total apathy of all concerned has forced the people to accept such poor conditions as normal urban environments. The major environment illness caused by or envisages to be caused by development of tourism sector in the state are: i) enhanced vehicular emission due to increased number of vehicles, ii) enhanced problems of garbage disposal generated by tourists specifically plastic bottles, disposal cups, wrappers of food items, bottles, cans, etc., and iii) disturbance of the natural settings and habitat of many indigenous, rare or endangered species of flora and fauna. It is therefore necessary to take care of all the above aspects at the time of planning for the development of tourism sector in the state.

Mizoram

11.1. Introduction

Mizoram state is located between 21°56'N to 24°31'N latitude and 92°16'E to 93°26'E longitude with a geographical area of 21,081 km^2. It shares national boundaries with Tripura in the west, Assam and Manipur in the north and international border with Myanmar on the east and Bangladesh in the south and west respectively. The state is covered with verdant forests that teem with bamboo groves, vibrant wildlife, sheer cliffs and breathtaking waterfalls. Mizoram has many unique landmarks such as old folklores and villages with houses built on stilts. In the morning, the hills and peaks are covered under a dramatic sea of mist. In Mizoram, highlanders, also called Mizos, live. They are a carefree and friendly group of people. The state has diverse festivals and dances, handicrafts, flora and animals, spectacular natural beauty, and mild climate, pristine rivers and mountains make it a colorful sight. The local people's delight and kind attitude are the primary drivers behind establishing some of the most alluring tourist attractions in the state (Annual Final Report of Tourism Survey for the State of Mizoram, 2014-2015).

11.1. Status of RET species in Mizoram

Based on secondary published literature (Mehta *et al.*, 2020), a total of 117 plants belong to 78 genera and 23 families included under different threat categories; among which 116 species are angiosperms and 1 species (Pteris vittata L.) is pteridophyte. The most dominant family is Fabaceae, representing 60 species from 36 genera, followed by Cyperaceae and Orchidaceae. Among these 117 species, 04 are recorded in Red Data Book of Indian Plants (Rare 01; Vulnerable 02; Indeterminate 01) (Nayar and Sastry, 1987; 1988; 1990) and 113 (1 pteridophyte, 112 angiosperm) recorded in IUCN (Endangered 02; Vulnerable 07; Data Deficient 06; Least Concern 98 (Mehta *et al.*, 2020) (Annexure 1). In addition, a total of 51 angiosperm plants species recorded endemic to India found in Mizoram, which belong to 37 genera and 28 families (Singh *et al.*, 2015) (Annexure 2).

General scenario of tourism in Mizoram

On 18th March 1993, Mizoram declared Tourism as an 'Industry with a view to increase state revenue and boost the service providers in the sector with benefits through promotional activities on tourism (The Mizoram Responsible Tourism Policy, 2020). The State's stunning environment, biodiversity, and numerous community and government efforts to preserve its pristine condition have resulted in more market opportunities than ever before. The state government is trying to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private sector to develop tourism related infrastructure in the state without harming the existing ecology and environment in a responsible way. Special emphasis is being given particularly on the development of activity-based tourism and opening up of new destinations in the countryside and lesser-known areas. Appropriate infrastructure will be developed using

available resources. According to the latest data compiled by the respective associations of the tourist service providers as on 31st March 2020, there are 68 hotels in Mizoram–with a total of 505 rooms, 41 travel agencies, and 8 tour operators. There are a number of factors limiting tourism in Mizoram–including unstable flight schedules, inadequate connectivity and lack of infrastructure, poor management of heritage and adventure sites and inadequate community involvement. Development and establishment of hotels aim to service the low-end travelers that have cluttered the market and degraded Mizoram's pristine image. Further, absence of qualified tour guides and lack of awareness on tourism among the public in general and transport service providers in particular are the immediate areas where the Government should intervene.

Resolving these issues is therefore crucial and its resolution will require political will and a coordinated industry. Therefore, the Mizoram Responsible Tourism Policy outlines the way forward and urges all citizens and travelers to work together in one voice to implement the needed solutions (The Mizoram Responsible Tourism Policy, 2020). Tourism department, Government of Mizoram (GoM) has listed 164 tourist attractions/destination across 11 districts, viz., Aizawl: 38; Champhai: 18; Hnahthial: 02; Khawzawl: 09; Kolasib: 11; Lawngtlai: 05; Lunglei: 17; Mamit: 26; Saitual: 11; Serchhip: 23 and Siaha: 04, respectively (Fig.11.1). The potential areas for tourism in Mizoram include: Adventure and Adventure Sports Tourism, Wildlife and Eco-Tourism, Cultural Tourism, Rural Tourism-Home Stay, Nature-based Tourism, Wellness, Health & Herbal Tourism, Music Tourism, Fashion Tourism, etc.

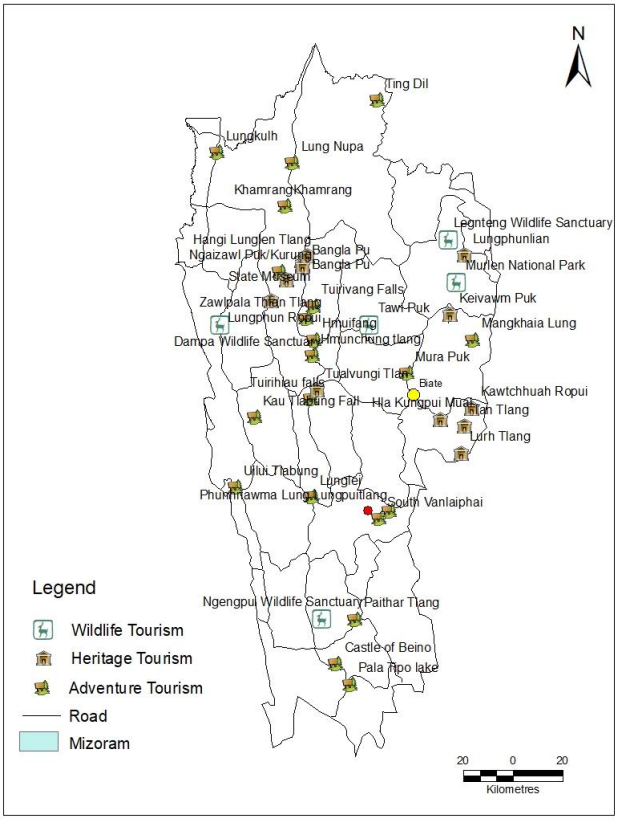


Fig. 11.1: Major tourist spots and circuits in Mizoram

11.1.2. Tourism growth (number of annual tourists visiting) vis-a-vis economic growth

11.1.2.1. Tourist influx

According to tourism department (GoM), a contentment increase in tourist influx in the state was observed upto the year 2020. During the year 2019-2020, the total number of tourist arrivals in the state was 161,677 with domestic tourist arrivals standing at 159,534 and foreign tourist arrivals 2143. Thereafter, a significant decrease in the tourist number was observed in the year 2021 and 2022 (Fig.11.2). This sudden decrease in the tourist number can be connected to the global COVID-19 pandemic outbreak. The annual growth rate of 81.04 % for domestic tourists, and 30.35 % growth rate of foreign tourist arrivals were recorded for the same period. The proportion of domestic and foreign tourists visited Mizoram from 2009 to the current year. Based on the collected literature, it is evident that the rate of change in tourist influx increased from 0.22% to 80.11% during 2009-2010 to 2019-2020. However, during the period of complete lockdown due to COVID-19 pandemic in 2020-2021, the rate of change of tourist arrival declined concurrently to -87.28%. In the successive years, i.e., 2021-2022 an increasing rate of change was observed.

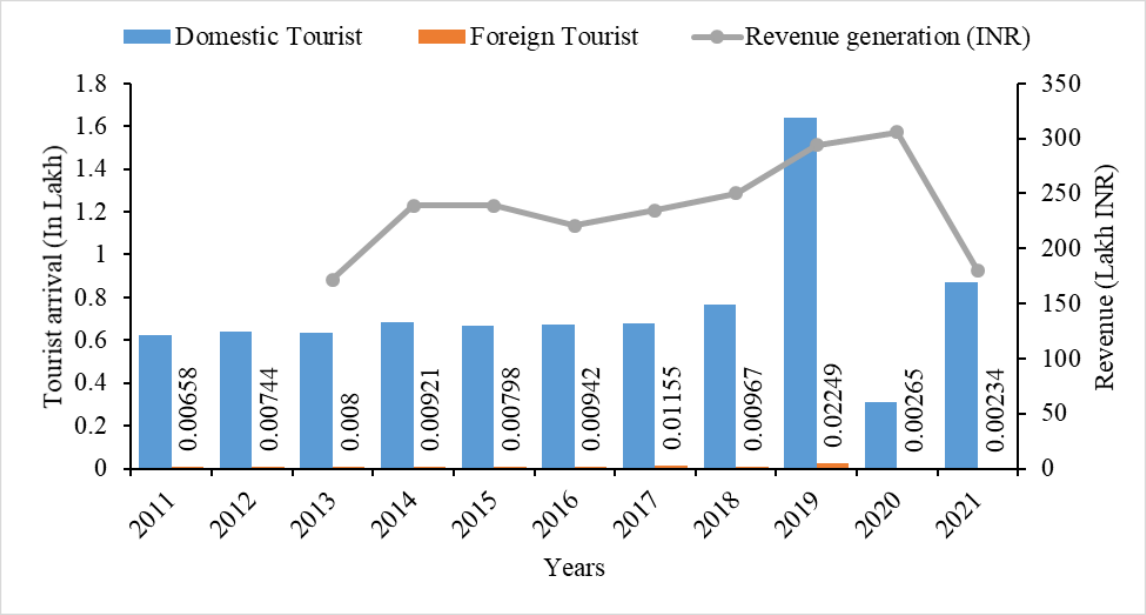


Fig. 11.2: Tourist influx and revenue generation in Mizoram state *(Source: Tourism department, Government of Mizoram. https://tourism.mizoram.gov.in)*

11.1.1.2. Economic growth

The state government is attempting to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private sector to develop tourism related infrastructure in the state without

breaching the existing ecology and environment in a responsible way. Records indicate that the state has generated more than targeted revenue from tourism upto the year 2020. Thereafter, the revenue was below the expected/targeted revenue that indicates the state has faced challenges in the tourism sector during the global pandemic of COVID-19. Furthermore, the rate of change of revenue generation in the state ranged from 3.89% to 39.28%. The rate of change was maximum (39.28%) during 2013-2014 and minimum (3.89%) during 2019-2020. However, during the COVID-19 pandemic in the year 2020-2021, it has declined drastically to -41.11% (Fig.11.3).

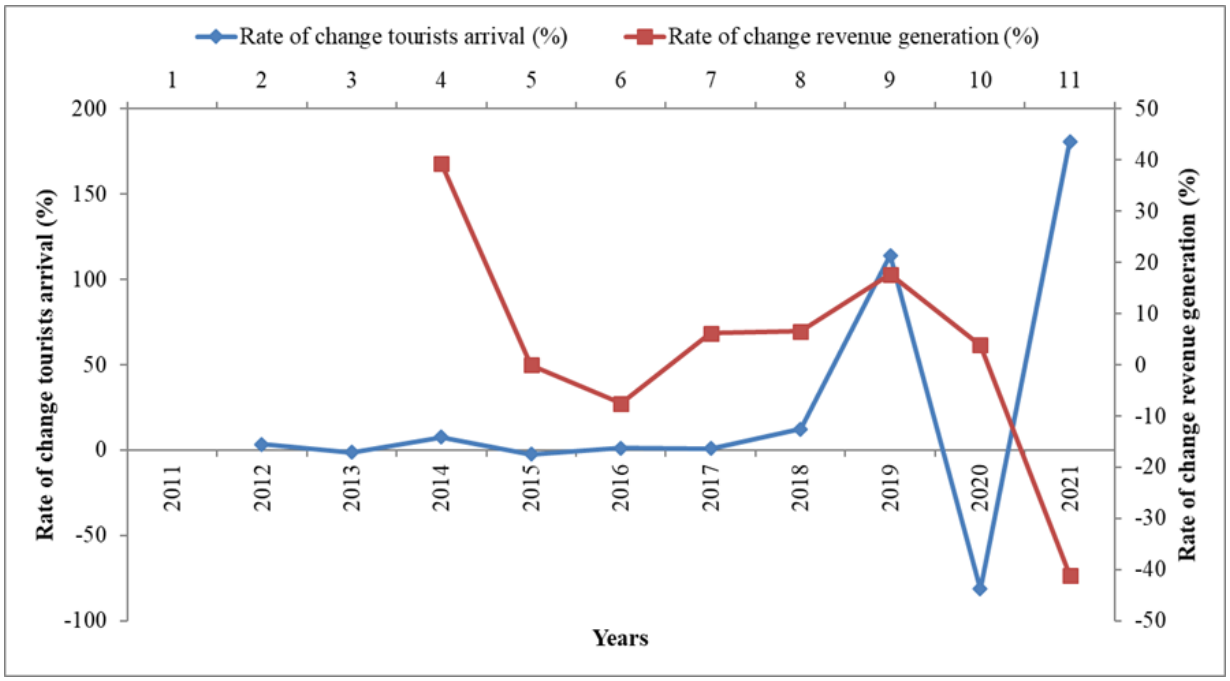


Fig. 11.3: Rate of change in tourist arrival and revenue generation in Mizoram *(Source: Tourism department, Government of Mizoram. https://tourism.mizoram.gov.in)*

11.1.3. 1. Assessment of waste generation

Mizoram's tourism industry has been showing no signs of significant progress for many years due to absence of proper infrastructure and facilities for tourists. However, Mizoram has been recognized for offering a plethora of tourism activities despite its limited resources from conventional tourism to adventure tourism apart from its breathtaking natural beauty. The Mizoram Responsible Tourism Policy, 2020 advocates quality tourism products by enhancing a variety of resources in tourism development. These tourism products could be developed with effective use and management of historical and cultural sites, nature attractions, as well as cultural events like festivals and traditional showcases.

11.1.4. Solid waste and its management

Solid waste management is among the biggest problems faced by the urban area. Compared with other urban management issues, solid waste management is given little attention (Lalneihzovi and Lalchhuanawma, 2017). In Aizawl, waste management is now looked after by the Sanitation Wing of Aizawl Municipal Corporation (AMC). Based on a survey (n=36,039 households), it is believed that 38 % of waste produced by Aizawl city is biodegradable while 39 % recyclable and remaining 23% is inert ash and debris. Out of total collected waste, 8 % goes directly to the landfill, similarly 10% of wet waste which was rejected from the composting goes to the landfill and 20% of dry waste rejected from the resource centres goes to the landfill (Lalneihzovi and Lalchhuanawma, 2017). Over the years, the amount of waste going to landfill has also been increased from 27.03 MT/day in the year 2011 to 36.94 MT/day in the year 2020. Furthermore, the decadal trend of per capita waste generation is also increasing from 470 gms/day/person in the year 2011 to 525 gms/day/person in the year 2020 (Table 11.1). With active participation and collaboration of the local councils in arranging solid waste management systems in the municipal area, the majority of the households regularly dump waste in the vehicle collection points at designated places. For families who could not participate in the solid waste management system through public-private partnership (PPP) mode, the place of dumping solid waste were waste pits owned by households, stream nearby, drainage, cliff nearby the locality, and it is also occasionally burned causing air pollution.

Table 11.1: Waste generated in Aizawl city of Mizoram

Waste Composition	Percentage Waste based on survey (%)	Quantity (MT/day) in 2011	Quantity (MT/day) in 2015	Quantity (MT/day) in 2020
Bio-degradable / Wet Waste	38	52.4	60.75	71.65
Recyclable / Dry Waste	39	53.78	62.35	73.53
Inert Ash & debris	23	31.72	36.77	43.36
Total Waste	100	137.91	159.88	188.54

Source: *Lalneihzovi and Lalchhuanawma, 2017*

11.1.2. Assessment of waste generation in each IHR states/UTs

In Mizoram, the Aizawl Municipal Corporation (AMC) takes care of waste management in Aizawl district, while the Urban Development and Poverty Alleviation Department manages wastes in rest of the census towns within the district. According to the census 2011, the population of Mizoram state was 2,93,416 and this has increased 9% (3,19,837) compared to the base year

2015 and further this increased to 10.5 % (353590) in the projected year 2020. However, the rate of increase of waste in different categories is much higher (Fig.11.4).

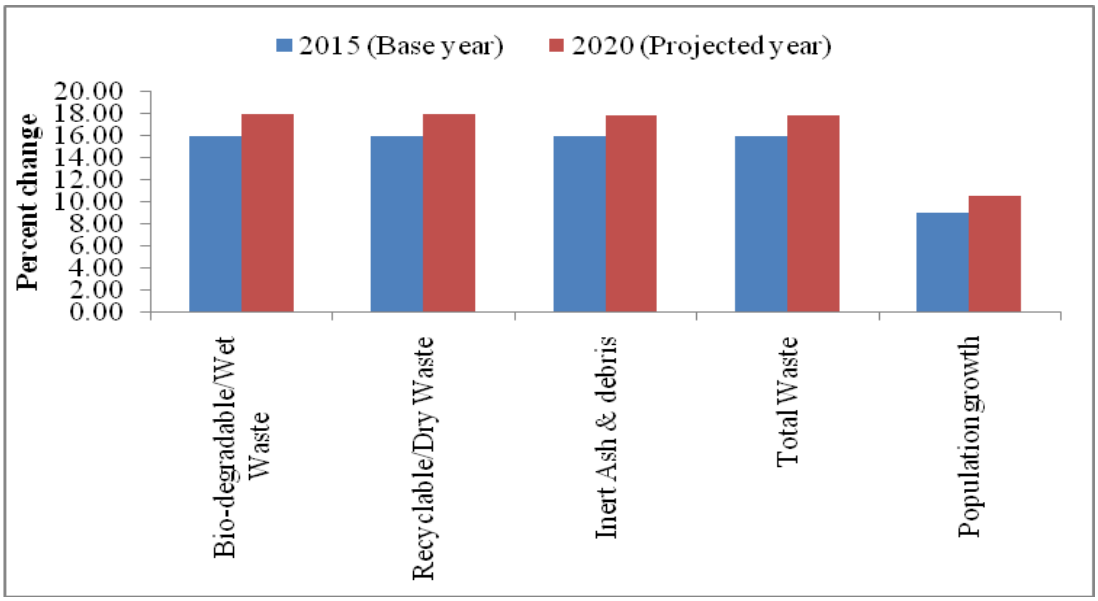


Fig. 11.4: Status of waste growth under different categories over the years w.r.t. to population growth (*Source: State Investment Project Management and Implementation Unit, Aizawl)*

The waste generated in Aizawl city of Mizoram shows an increasing trend over the years. The total waste generated was 137.91 MT/day (biodegradable: 52.4; recyclable: 53.78 and others: 31.72) in the year 2011. This was increased to 159.88 MT/day (biodegradable: 60.75; recyclable: 62.35 and others: 36.77) in the year 2015. In the year 2020, it reached 188.54 MT/day (biodegradable: 71.65; recyclable: 73.53 and others: 43.36) (Table 1). The available monthly solid waste data of the year 2020-2021 indicates that there is a significant hike in solid waste quantity during November to January. The sudden hike of waste can be related to the tourist influx in the city/state (Table 11.2).

Table 11.2: Quantity of waste received at Aizawl solid waste management centre (July 2020 - January, 2021)

Month	Waste Received in a day (in tonnes)			Waste Received in a week (in tonnes)			Waste Received in a Month (in tonnes)		
	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
Jul-2020	10.36	6.56	16.92	72.54	118.42	190.96	321.23	203.22	524.45

Aug-2020	4.13	4.21	8.34	28.91	29.44	58.35	128.01	130.39	258.40
Sep-2020	4.89	3.72	8.61	34.25	26.01	60.26	151.69	115.19	266.88
Oct-2020	3.44	2.46	5.89	24.05	17.21	41.26	106.52	76.21	182.73
Nov-2020	35.26	31.04	66.29	246.80	217.25	464.05	1,057.71	931.06	1,988.77
Dec-2020	42.57	24.18	66.74	297.98	169.23	467.21	1,319.64	749.45	2,069.09
Jan-2021	42.21	24.48	66.69	295.46	171.35	466.82	1,308.49	758.85	2,067.33

Source: https://smartcities.data.gov.in/

11.2.3. Category wise waste generated

Lalengzama1and Zorameni (2018) surveyed Lunglei District of Mizoram and categorized waste in 12 categories based on the use frequency, i.e., regular, some times and never (Table 11.3). In total, 85 households were targeted. It was observed that paper (95%), bones (93%), sanitary pads (93%), polythene (92%), etc. were among the regular disposed materials. Clothes (76%), glass (51%), etc. were common sometime disposed items and toilet waste (100%) and aluminum (96%) are among not or rarely disposed materials. This indicates that the Lunglei district has proper defecation management and is an open defecation free zone.

However, based on the monthly progress report for the state of Mizoram for November 2020, total bio-medical waste generation was 936.37 kg/day, total hazardous waste generation was estimated to be 20.374 MTA (Metric Tonnes per Annum) (based on revision of Annual Inventory report 2019-2020) and total plastic waste generation was 7905.5 TPA (Tonnes per Annum) (Municipal Corporation) and 3.1 TPA (Tonnes per Annum) (Urban and Rural areas).

Table 11.3. Types of waste disposed in Lunglei District of Mizoram state

		Respondents (n=85)		
Sr.No.	Particulars	Regular	Sometimes	Never
1	Aluminum	00 (00)	03 (04)	82 (96)
2	Glass	18 (21)	43 (51)	34 (40)
3	Plastic	29 (34)	38 (45)	18 (21)

4	Paper	81 (95)	04 (05)	00 (00)
5	Food waste	10 (12)	35 (41)	40 (47)
6	Toilet waste	00 (00)	00 (00)	85(100)
7	Clothes	02 (02)	65 (76)	18 (21)
8	Parcel	45 (53)	36 (42)	04 (05)
9	Polythene	78 (92)	04 (05)	03 (04)
10	Sanitary pads	79 (93)	06 (07)	00 (00)
11	Wood/leaf	41 (48)	35 (41)	09 (11)
12	Bones	79 (93)	06 (07)	00 (00)

Values in parentheses are in percentages; Source: Lalengzama & Zorameni (2018)

11.2. Segregation / Utilization of waste

In urban local body (ULB) Aizawl, there are 83 local councils, of which 17 census towns have implemented door-to-door waste collection, 15 census towns have implemented waste segregation and 10 census towns have implemented transportation of segregated waste (https://greentribunal.gov.in/) facilities. A solid wastes management centre comprising Engineered Landfill, Composting (vermi and mechanical compost) and Resource Recovery Centers (RRC) is in operation in Aizawl. Three more sites have also been identified within the Aizawl city. The dumpsites at Tuirial have been closed since December 2020 and remediation of the site is in progress. Other district sites are identified in all urban/census towns. Vermi compost centres and waste resource management centres or material recovery facilities have been constructed in all towns. While an engineered landfill area is proposed for two towns, viz, Lunglei and Kolasib towns, these are the most populous towns after Aizawl. Environmental clearance is being sought from State Environment Impact Assessment Authority (SEIAA), Mizoram. Under the initiatives taken by the state's UD and PA department and the AMC, a cleanliness competition is conducted every year during the month of October. The competition is made at district level, and town level and the government offices/institutions under separate categories. A group of experts were constituted by the departments of UD and PA. These experts from the UD and PA department, comprising the Information and Public Relations Department, Mizoram Pollution Control Board and Central Young Mizo Association (CYMA, the largest NGO of the State) (https://greentribunal.gov.in/).

11.3. Waste disposal/ treatment facilities

The Aizawl Municipal Corporation (AMC) takes care of waste management in Aizawl while the UD and PA Department manage wastes in the rest of the census towns within the district. A solid waste management centre comprising Engineered Landfill, Composting (Vermi & mechanical Compost) and Resource Recovery Center is in operation at Aizawl. However, in other districts sites are identified in all census towns for expansion of area dedicated for waste management in some of the towns in view of future expansion. Vermi-compost centers and Waste Resource Management Centre or Material Recovery Facilities have been constructed in all the towns, while Engineered Landfill is proposed for two towns, viz, Lunglei and Kolasib towns are the most populous town after Aizawl, the State's Capital. Environmental Clearance for the two is being sought from SEIAA, Mizoram.

a. Waste Processing

The ULB Aizawl, Mizoram has 4 census towns: Kolasib, Bairabi, Vairengte, Kawnpui and has 74 tonne per day (TDP) waste material recovery facility (https://greentribunal.gov.in/)

b. Recycling

Action plan for 100% sewage treatment including recycle and reuse of treated wastewater has been submitted to the State Govt. and according to the compliance status report for 3th quarter (October - December), 2020-21, the specific solid waste recycling information is not available.

c. Composting

The ULB Aizawl has a mechanical compost plant having the capacity of 50 TPD, and vermi-composting plant of 22 TDP capacities (Source: https://greentribunal.gov.in/).

11.1.5. Air quality and pollutants

Mizoram is one of the few states in the country where the problem of air pollution is very less. If it exists, it is only in small pockets of urban areas where population density is high and those people who have adopted a modern lifestyle. The growth and expansion of industries, automobiles and high per capita resource consumption have made the problems of pollution visible which extend to environmental domains including air, water and soil. Air quality of the state in particular is observed to be deteriorating at a fast rate due to vehicular emissions. The other major sources of air pollution in the state include forest fires during dry winter months due to burning of slashed vegetation for Jhum cultivation. Besides, few industrial activities also pose problems of air pollution in certain areas. Air quality monitoring is conducted by Mizoram State Pollution Control Board (MSPCB) and reports regarding the annual average concentrations of SO_2, NO_x and PM_{10} are available in the website of MSPCB, GoM from 2014 to 2017. The Air Quality Index (AQI) values recorded ranged between 17-87 for the year 2014-2017 in Mizoram

and in most cases, values are falling under good category. This shows that air quality in Mizoram is mostly good or satisfactory and the people have minimal impact of air pollution in the state.

The Aizawal capital city of Mizoram has the largest population among all the towns/cities in the state which is 293,416 as per 2011 census. It has four manual air monitoring stations which have been in operation since 2005 to till date. There is one Continuous Ambient Air Quality Monitoring Sensor (CAAQMS) at Sikulpuikawn. Besides, Champhai (02), Kolasib (02) and Lunglei (02) also have air quality monitoring systems in different locations. The air quality–data has been displayed to the public using LED display boards since February 2020 in Aizawal. The air quality parameters in four cities of Mizoram during 2019 are listed in table 7. Based on the year-round observations, the 24-hour average SO_2 concentration in all the AQMS was 2 µg/m^3. Similarly, the average NO_2 concentration ranged between 5-8 µg/m^3 and PM_{10} average value ranged from 8-48 µg/m^3, respectively (Table 11.4).

Table 11.4. Ambient air quality in different cities of different districts in Mizoram, India

District	No. AAQM stations	**SO_2** (µg/m^3)			**NO_2** (µg/m^3)			**PM_{10}** (µg/m^3)		
		Concentration			Concentration			Concentration		
		Minimum (24-h avg)	Maximum (24-h avg)	Annual Avg	Minimum (24-h avg)	Maximum (24- h avg)	Annual Average	Minimum (24-h avg)	Maximum (24-h avg)	Annual avg
Aizawl	5	2	2	2	5	21	8	10	211	48
Champhai	2	2	2	2	5	5	5	13	37	25
Kolasib	2	2	2	2	5	5	5	3	141	23
Lunglei	2	2	2	2	5	5	5	3	21	8

Source: NAAQST, CPCB, MoEF&CC 2020 https://cpcb.nic.in/upload/NAAQS_2019.pdf

Number of vehicles (state / district wise)

The number of registered motor vehicles across Mizoram has been increased concurrently from financial year 2011 to 2021. The registered vehicles in Mizoram were ninety-three thousand approximately in the year 2011, which was increased upto three lakh nineteen thousand in the year 2021. The annual trend of registered vehicles in Mizoram is depicted in figure 3. The rate of change in vehicle registration has increased over the years and it differed 6.06% in 2009 to 18.62% in 2013 (Fig.11.5). In total 3,19,214 vehicles were registered as on March 2022 and

among the nine districts of Mizoram state, maximum number (2,22,845) of vehicles were registered to Aizawl urban followed by Lunglei (27614) and minimum (5998) in Mamit district respectively (Fig.11.6). Interestingly, it was observed that the number of tourists visiting the state dropped dramatically during the COVID-19 worldwide pandemic 2020-2021, although the number of vehicles has shown a consistent upward trend. This illustrates that the rise in the number of vehicles in the state is not solely due to tourism but also due to changes in the socio-economic conditions of the state. Although published evidences on plethora of vehicles (tourist vehicles) degrading the environmental health of the state are not available but this plethora of vehicles is projected to have negative impact on the states air quality in populated

cities.

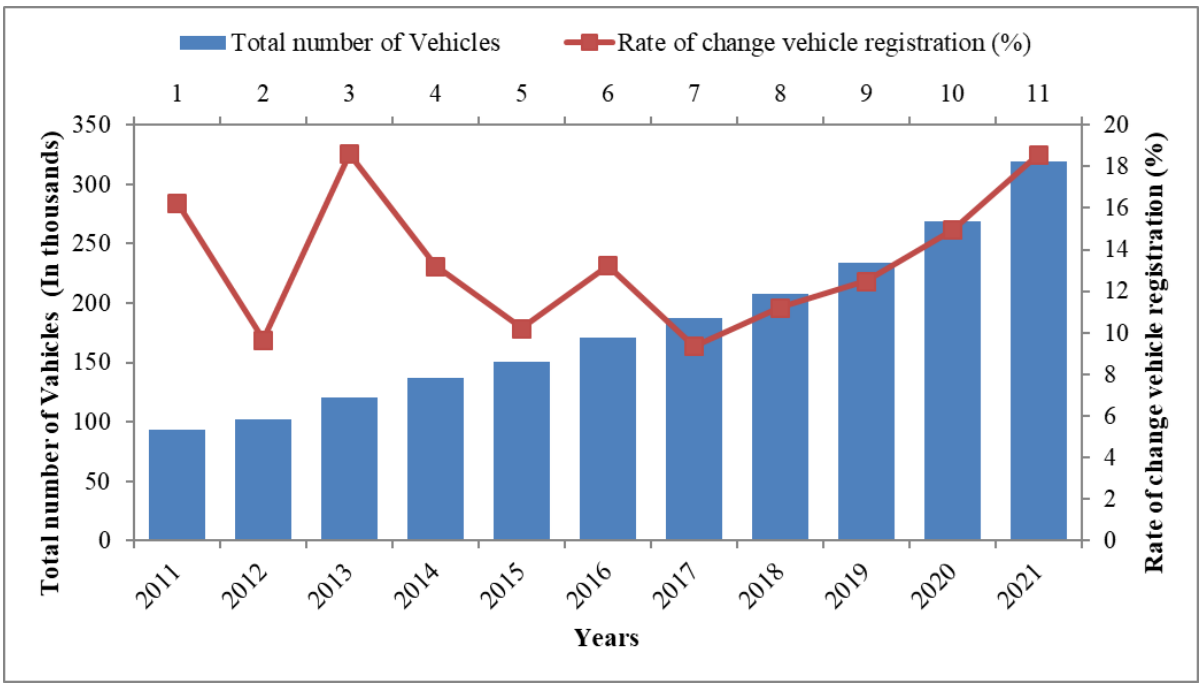


Fig.11.5: Total number of registered motor vehicles across Mizoram state from financial year 2007 to 2021 *(Source: Department of Transport, Government of Mizoram and https://www.statista.com/statistics/1116913/number-of-vehicles-in-mizoram-india)*

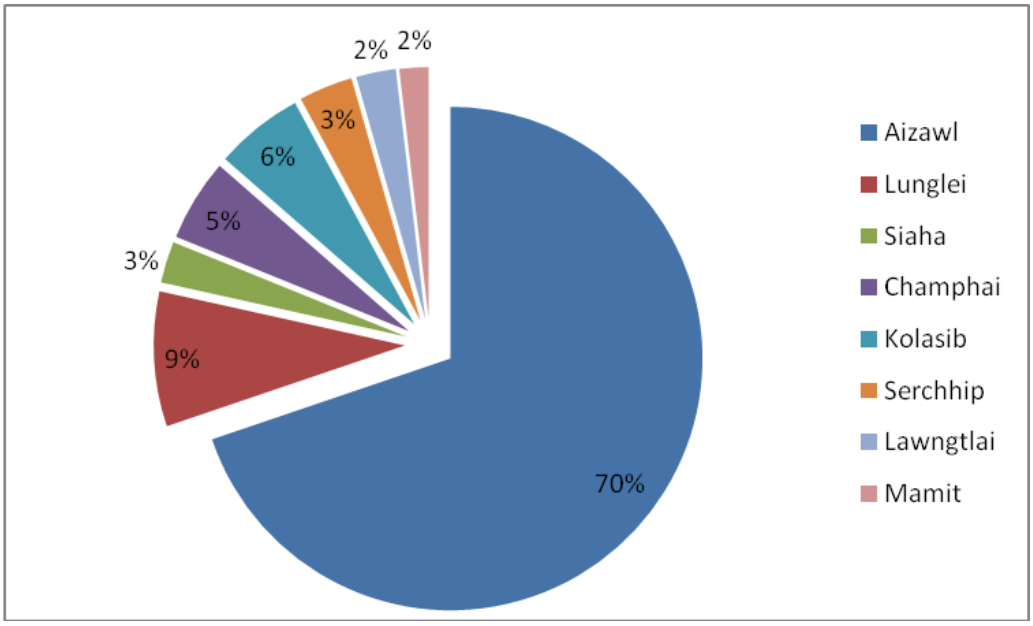


Fig.11.6: District wise registered vehicles in Mizoram as on 31 March 2022.*(Source: Department of Transport, Government of Mizoram)*

5.2. Parameter wise air quality (PM_{10}, SO_2, NO_2, etc.)

The decadal trend (2011-2021) of average air quality parameters of the state indicate that the PM_{10} concentration ranged between 24.2 µg/m^3 in the year 2020 to 53.82 µg/m^3 in the year 2012 which was good (<40 µg/m^3) to fair (40-80 µg/m^3) air quality range. A sharp decrease in the PM_{10} concentration was observed during the lockdown period. Similarly, the NO_2 concentrations ranged between 4.5 µg/m^3 in the year 2014 & 2015 to 9.3 µg/m^3 in the year 2011. However, the SO_2 concentration remained constant (2 µg/m^3) over the years, which were in good air quality range (Fig.11.7).

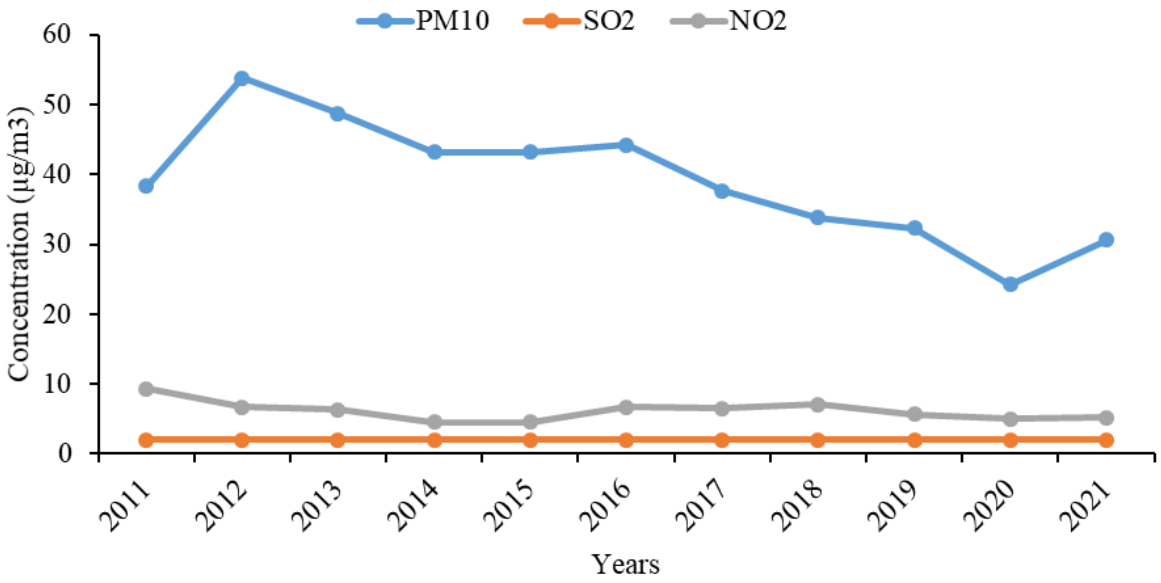


Fig.11.7: Parameter wise air quality trend in the state of Mizoram

5.3. Correlation analysis with available tourist data and vehicles data

Correlation analysis was performed on the decadal (2011-2021) data sets on tourist influx and total number of registered vehicles of Mizoram state and there was no significant relationship ($p<0.05$; $r^2=0.060$) between these variables was observed Figure 11.8.

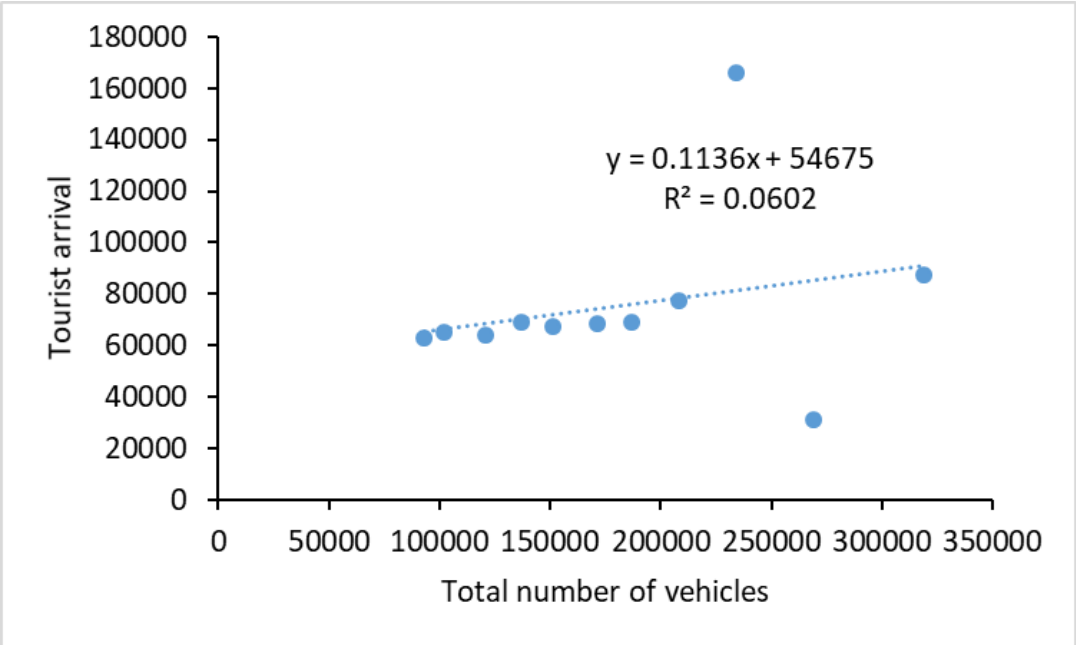


Fig.11.8: Correlation analysis of tourist arrival and total number of vehicles (2011 to 2021)

11.1. Water quality and pollutants

Human activities degrade water quality which ultimately adversely affects human beings in many ways. Population growth, unplanned urbanization and industrialization, modern agricultural practices, etc. put tremendous pressure on water resources both in terms of its quality and quantity. As per a report of Mizoram State Pollution Control Board (MSPCB) and Central Pollution Control Board (CPCB), the water quality (surface water) analyzed from 36 observation points showed that all parameters, viz., dissolve oxygen (DO), pH, conductivity, BOD, FC and TC were in conformity with the desired levels required for riverine environment. According to MSPCB data records, BOD, TO, FC and TC for the years 2016-2019 of River Tlawng (Daleshwari) and River Tuirial in Mizoram also indicate a satisfactory water quality status (https://mpcb.mizoram. gov.in/ page/water-quality-ind). However, water quality of ground water analysis from 18 observation points, revealed that only 33% samples were not found in compliance with the desired levels with respect to pH value, whereas Conductivity, BOD, nitrate, FC and TC were reported within the desired levels. Data analysis reveals that values of most of the water quality parameters in all districts of Mizoram are within the permissible range. Thus, it can be concluded that water quality in the state is more or less good except with respect to some parameters which exceed the permissible limit in some seasons (State of Environment Report of Mizoram, 2016).

11.2. Ill-effect of tourism on Forest and Biodiversity

Mizoram state is endowed with bountiful biodiversity and according to economic survey, 2019-2020, forests and forestry based products contribute significantly to the Mizoram state GDP i.e. 14.48% of the Gross State Value Added (GSVA). However, net decrease in forest cover, forest fragmentation and degradation, increased forest fire incidences and outbreaks of pests, are reported in recent years from the Mizoram state (Sahoo *et al.* 2018). Habitat loss and fragmented forests result in biodiversity loss (Wilson *et al.* 2016). In addition, global trends indicate that climate change either impacting directly and/or through synergies with other drivers could become a prominent, if not leading, cause of biodiversity loss over the coming century (Mantyka-pringle *et al.* 2012). It is suggested that the further developmental activities in the state need to be taken into consideration in order to minimize the biodiversity loss and its sustenance.

The recorded forest area in the state Mizoram is 5,641 km^2, of which 4,483 km^2 is reserved forest and 1,158 km^2 is unclassed forests. However, the forest cover in the state is 18,005.51 km^2 which is 85.41% of the state's geographical area. Being located in the North Eastern part of India, Mizoram is a biodiversity hotspot. It consists of 2,358 species of plants, of which 2,141 belong to Angiosperms, only six species of Gymnosperms, 200 species of mushrooms and 211 species of Pteridophytes (Singh, 1997). Similarly, orchids are very common in the state and about 251 species of orchids and 35 species of bamboos are reported from the state (Singh *et al.* 2002, Bisht *et al.* 2010). Besides, the state possesses a rich diversity of medicinal plants. About 500 species of the state have medicinal and ethno-botanical uses (Singh *et al.* 2002). Eight species of primates, e.g. hoolock gibbon, pig-tailed macaque, stump-tailed macaque,

phayre's leaf monkey, capped langur, slow loris etc. are also documented from the state (http://mizenvis.nic.in/Database/Biodiversity_1444.aspx).

Eco-sensitive zones/ Areas

Eco-sensitive zones are areas with identified environmental resources having incomparable values which require special attention for their conservation. In order to protect the environment and the biological integrity of the area, outside the protected areas and other such areas where an ecosystem has been adversely affected due to anthropogenic and climatic factors, the Ministry of Environment, Forest and Climate Change (MoEFCC) has been declaring such areas as eco-sensitive zones/ areas. The aims of these areas are:

- Protection of the environment and avoidance of its degradation due to anthropogenic activities.
- Creation of some kind of barrier/ shock absorber for the specialized ecosystem (PAs).
- Acting as a transition zone from areas of higher protection to areas involving lesser protection.

According to the information available in the MoEFCC, GoI (accessed on 25.04.2022), a total of 8 eco-sensitive zones (two National Parks & eight Wildlife Sanctuaries) proposals were finalized. These include, (i) Khawnglung Wildlife Sanctuary, (ii) Tawi Wildlife Sanctuary, (iii) Pualreng Wildlife Sanctuary, (iv) Murlen National Park, (v) Thorangtlang Wildlife Sanctuary, (vi) Lengteng Wildlife Sanctuary, (vii) Dampa Tiger Reserve, and (viii) Tokalo Wildlife Sanctuary.In total, 717.225 km^2 area (5.89% of total geographical area of the state) covered under the Eco-sensitive zone and provided effective conservation of wildlife habitat.

In order to implement the Biodiversity Act 2002 (No 18 of 2003), Mizoram State Biodiversity Board (MSBB) was constituted on 17th January 2006. It was reconstituted on 26th February 2009 with 5 ex-officio members and 5 expert members. The current State Biodiversity Board Mizoram was again reconstituted with Gazette Notification No.B.11015/19/ 2007-FST, dated 9th May 2016. The major objectives of the MSBB are to: (i) advice the State Government, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of all benefits arising out of the utilization of biological resources; (ii) regulate by granting of approvals on otherwise requests for commercial utilizations on bio-survey and bio-utilization of any biological resources of the state; (iii) perform such other functions as may be necessary to carry out the provisions of this Act or as may be prescribed by the state Government, and (iv) prepare in such a form and in such time in each financial year as may be prescribed, its annual report, giving full account of its activities during the previous year and submit a copy thereof to the State Government.

Details of Eco-Sensitive Zones of Mizoram

The important eco-sensitive zones in Mizoram are mentioned along with their prohibited activities, regulated activities and promoted activities as follows:

Name of the ESZ	Prohibited activities	Regulated activities	Promoted activities
Khawnglung Wildlife Sanctuary ESZ (16.19 km^2)	Commercial mining, setting of industries including new oil and gas exploration causing pollution, establishment of major hydroelectric and major thermal project, use or production of any hazardous substance, discharge of untreated effluents in natural water bodies, setting of new sawmills, setting of brick kilns, commercial use of firewood, etc.	Commercial establishment of hotels and resorts, Establishment of large-scale commercial livestock and poultry farms by firms, corporate, companies, Construction activities, Small scale non-polluting industries, Felling of Trees, Collection of Forest produce or Non-Timber Forest Produce (NTFP), Erection of electrical and communication towers and laying of cables and other infrastructures, Infrastructure including civic amenities, Widening and strengthening of existing roads and construction of new roads, Undertaking other activities related to tourism like over flying the Eco-Sensitive Zone area by hot air balloon, helicopter, drones, etc., Protection of hill Slopes and river banks, Movement of vehicular	Rainwater harvesting, organic farming, adoption of green technology for all activities, cottage industries including village artisans, use of renewable energy and fuels, agro-forestry, use of eco-friendly transport, skill development, restoration of habitat / degraded land, environmental awareness, etc.
Tawi Wildlife Sancturay ESZ (16.5 km^2)			
Pualreng Wildlife Sanctuary ESZ (46.58 km^2)			
Murlen National Park ESZ (19.5 km^2)			
Thorangtlang Wildlife Sanctuary ESZ (53.07 km^2)			
Lengteng Wildlife Sanctuary ESZ (21 km^2)			
Dampa Tiger Reserve ESZ (488 km^2)			

Tokalo Wildlife Sanctuary ESZ (56.38 km^2)		traffic at night, Ongoing agriculture and horticulture practices by local communities along with dairies, dairy farming, aquaculture and fisheries, Discharge of treated wastewater/effluents in natural water bodies or land area, Commercial extraction of surface and ground water, Open well, borewell, etc. for agriculture or other usage, Use of plastic bags, Introduction of exotic species, Eco-tourism, Commercial sign boards and hoardings, etc.	

Source: Ministry of Environment, Forest and Climate Change, GoI (accessed on 23.04.2022)

11.3. Gaps and Plan of Action

Sr. No.	Gaps	Plan of Action
1	Most of the monitoring and management initiatives such as AQMs, SWMS, etc. are focused on capital city and/or selected locations only.	Considering Mizoram as a famous tourist destination of the North Eastern India, monitoring and management activities need to be replicated in other tourist influx areas/districts for effective monitoring of tourism impacts in the state.
2	The state is responsive towards effective management of solid waste in urban areas but still in some parts of it throws waste to the nearby streams or practices open burning.	Awareness needs to be created and disseminated on SWM, sanitation, cleanliness through involving non-governmental organizations of the state, such as, Young Mizo Association (YMA) in a mode of house-to-house campaign, awareness campaign at schools, offices and villages.
3	Data on water quality is available for only two rivers, viz., River Tlawng (Daleshwari) and River Tuirial, 2016-2019.	In view of effective monitoring of water quality of riverine systems of the state, all the major rivers need to be monitored at least at district level.

4	Unavailability of separate data sets on tourist influx in protected areas (PAs) of the state, especially through online portals of the state.	These data sets are essential to assess the impact of tourism in PAs and to estimate carrying capacity of the PAs. Therefore, a joint mechanism needs to be developed by state tourism and forest departments to monitor tourist influx in PAs.
5	Over the years, the amount of waste going to landfill has increased from 27.03 MT/day in 2011 to 36.94 MT/day 2020. Furthermore, the decadal trend of per capita waste generation is also increased from 470 gm/day/person in the year 2011 to 525 gm/day/person in the year 2020.	The solid waste management centre comprising Engineered Landfill, Composting (vermi- and mechanical compost) and Resource Recovery Centres (RRC) is in operation at Aizawl. But, their further reasonable extension is required to manage this ever increasing load of waste.

11.4. Summary

There are a number of factors limiting tourism in Mizoram including indefinite flight schedules, inadequate connectivity and lack of infrastructure, poor management of heritage and adventure sites and inadequate community involvement. Development and establishment of hotels aim to service the low-end travellers that have cluttered the market and degraded Mizoram's pristine image. Further, absence of qualified tour guides and lack of awareness on tourism among the public in general and transport service providers in particular are the immediate areas where the Government should intervene. Resolving these issues is therefore crucial and its resolution will require political will and a coordinated industry. Therefore, the Mizoram Responsible Tourism Policy (2020) outlines the way forward and urges all citizens and travellers to work together in one voice to implement the needed solutions. The potential areas for tourism in Mizoram include: Adventure and Adventure Sports Tourism, Wildlife and Ecotourism, Cultural Tourism, Rural Tourism-Home Stay, Nature-based Tourism, Wellness, Health & Herbal Tourism, Music Tourism, Fashion Tourism, etc. The state government is trying to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private sector to develop tourism related infrastructure in the state without breaching the existing ecology and environment in a responsible way.

Tripura

12.1. Introduction

Tripura is the second smallest state of North-East India covering an area of 10491.69 km^2. Being isolated from the mainland, it suffers from overall proper economic development. The state has about 76% of the total geographical area under forest cover, out of which about 6% is under protected areas in the form of four wildlife sanctuaries, namely, Sipahijala, Trishna, Gumti and Rewa. Five parallel hill ranges (Jampui, Sakhantlang, Langtarai, Atharamura and Baramura-Deotamura) clothed with forests of varying density, and ten major rivers (Langai, Juri, Deo, Manu, Dhalai, Khowai, Haora, Gumti, Muhuri and Fenny) occupying the valleys between two adjacent hill ranges, dotted with tribal hamlets, provide a perfect landscape for tourists with different preferences for recreation, enjoyment and tastes (Fig.12.1). A number of treks exist through the forests and traditionally and culturally rich hamlets, which have potential to provide a deep insight into the cultural and ecological diversity of the state. Realizing the enormous economic, ecological, recreational and conservation potential and growing interests in tourism sector, it is important to develop and promote the activity in the state (Lal and Das, 2012).

In Tripura, the process of tourism development was accelerated since 1987, when tourism was given the status of industry and various incentives were offered. It is considered as an industry because, for its growth a separate infrastructure is required which include hotels, resorts and many other facilities which have integral relation with industry. Apart from poor infrastructure and communication facilities, insurgency was a major deterrent in the state still last decade. The tourist traffic increased substantially after the removal of the entry permit system in the state, in May 1995. In 2009-10, the State Government has established Tripura Tourism Development Corporation Ltd. in June 2009 having its corporate office located at Swetmahal, Agartala for effective management of the tourism industry in the State. The official records show a remarkable increase in the arrival of domestic and foreign tourists after withdrawal of the restrictions imposed on the visit of the foreigners in Tripura. Bus service between Agartala and Dacca has played an important role in this regard.

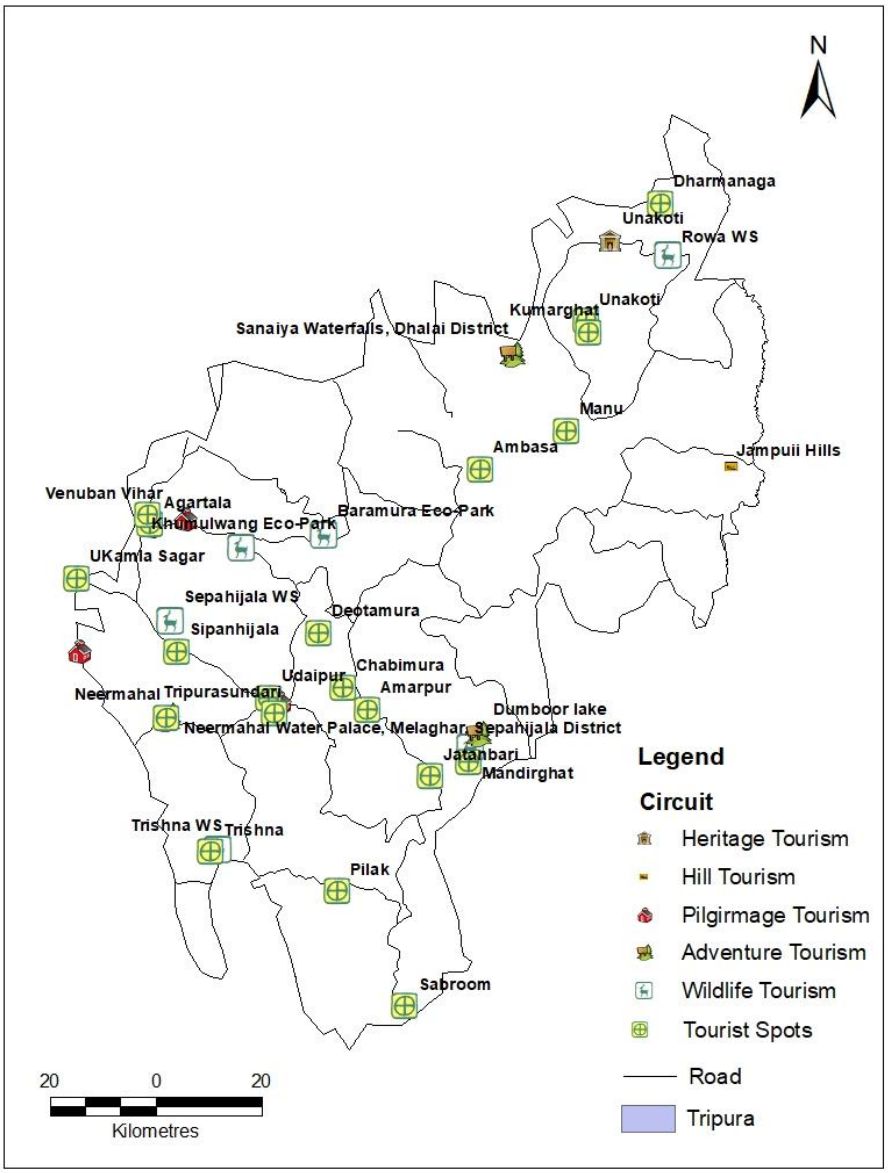


Fig.12.1: Major tourist spots and circuits in Tripura

Evidences collected from the literature indicated that there is a gradual increase in number of tourists arrival in Tripura state from 2008 to 2019. In a decade between 2008 to 2019, the domestic tourist influx increased about 50% in the state whereas, the foreigner tourist inflow increased 34 times during this period (Fig. 12.2). This trend of increasing the number of tourists in the state offers huge opportunity for tourism industry and offers considerable revenue generation and creating employment for the local people. The rate of change in tourists influx continuously increased in the state which ranged between 2.24% to 30.71% in a decade. However, the tourists influx during the period of 2020-2021 was almost negligible due to Covid-19 and further complete lockdown in the country therefore, the rate of change in tourist influx in the state during this period went down drastically at -87% (Fig. 12.2). The income

generated from the tourism activity in the state during the period of 2008-09 was Rs. 64.66 lakhs which increased about five-fold within a decade between 2008-2019 that was Rs. 345.76 lakhs (Fig. 12.3). The total vehicle registered in the state during the period of 2012-2013 was 244106 and gradually increased upto 2018-2019. The rate of change in vehicle registration increased continuously in the state which ranged between 10.08% to 16.96% (Fig.12.4). The increasing numbers of vehicle suggested that there is a increasing need of transportation of the tourists and other necessary items required in the sector of tourism and development. However, the increasing numbers of vehicle may cause the concern of environmental pollution and climate change impacts in the region (see Fig. 12.4). Considering the increasing numbers of vehicle to meet the demand of the public transport, the state started to encourage vechicle driven by clean fluel like CNG and Petrol and CNG mix to reduce the air pollution in the state (see Fig. 12.5).

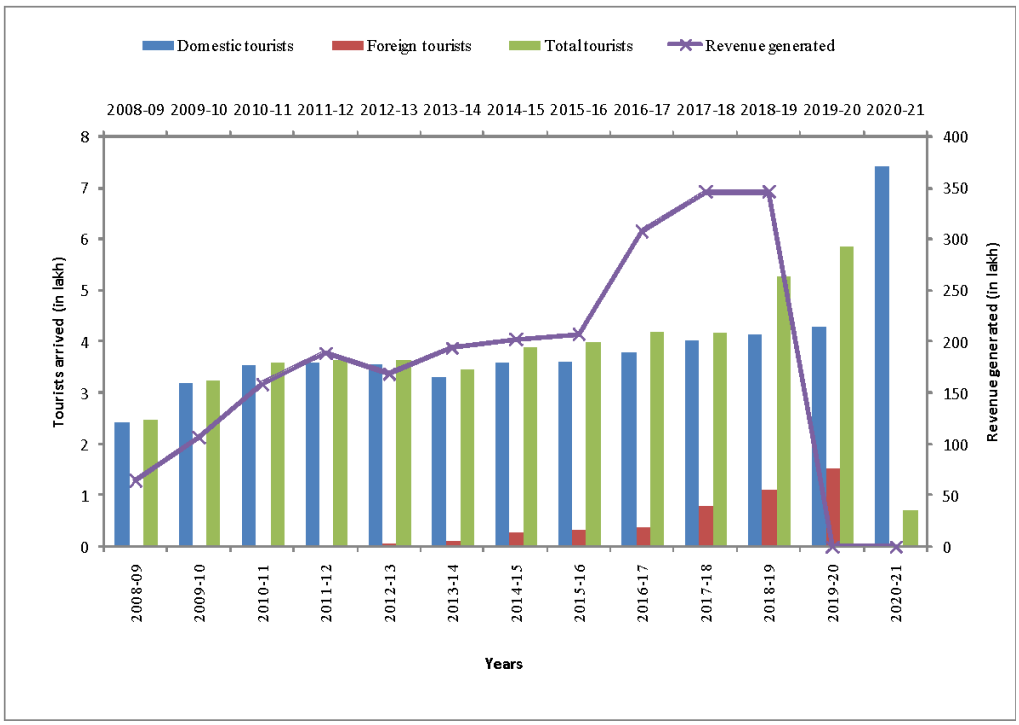


Fig. 12.2: Tourist Influx and revenue generation in Tripura state (*Source: Directorate of Economics & Statistics Planning –Statistics, Department Government of Tripura, Agartala. www.destripura.nic.in*)

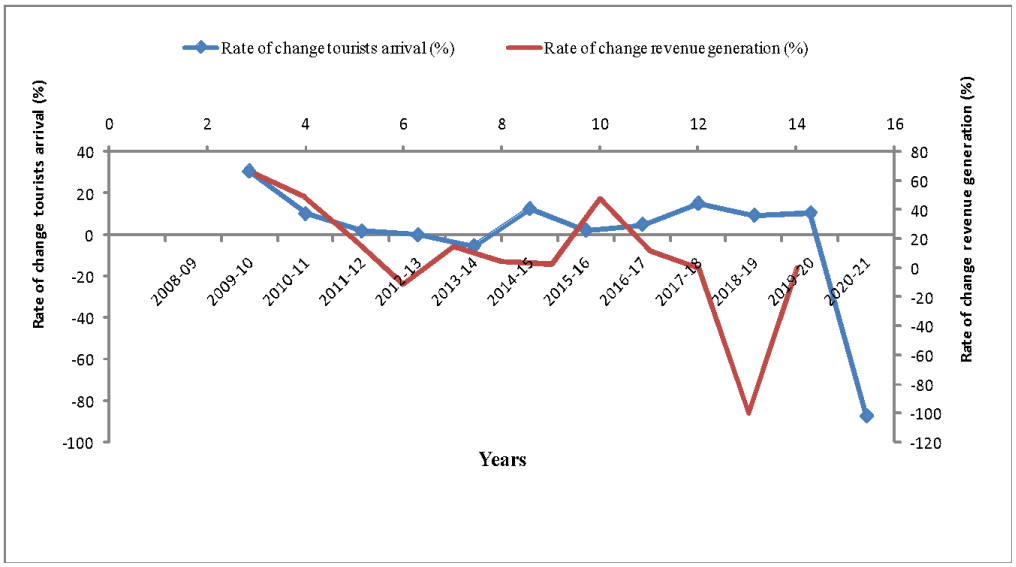


Fig. 12.3: Rate of change in tourist influx and revenue generation in Tripura (*Source: Directorate of Economics & Statistics Planning –Statistics, Department Government of Tripura, Agartala. www.destripura.nic.in*)

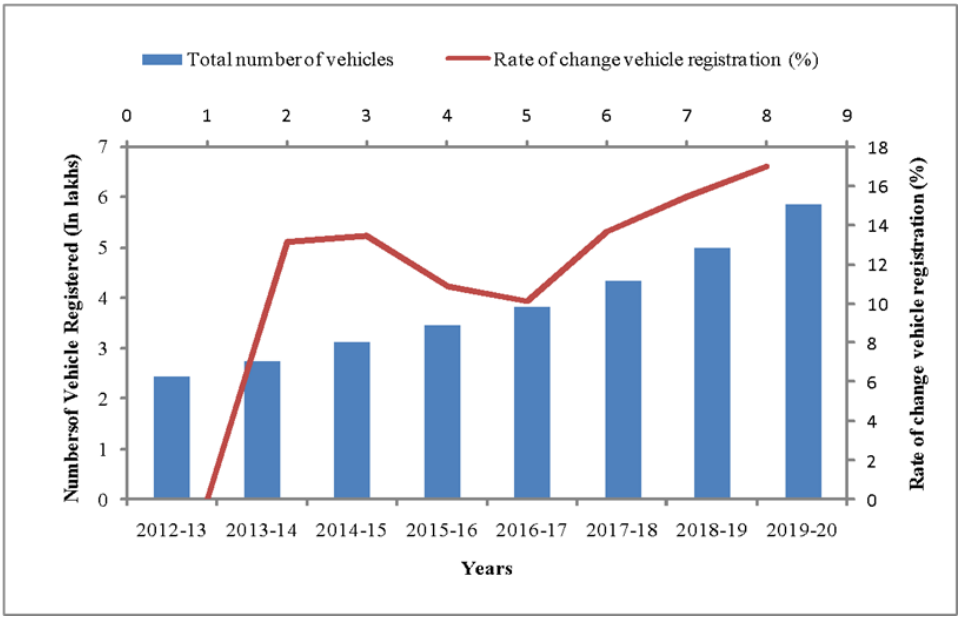


Fig. 12.4: Total vehicle registered in a decade in Tripura state (*Source: Directorate of Economics & Statistics Planning –Statistics, Department Government of Tripura, Agartala. www.destripura.nic.in*)

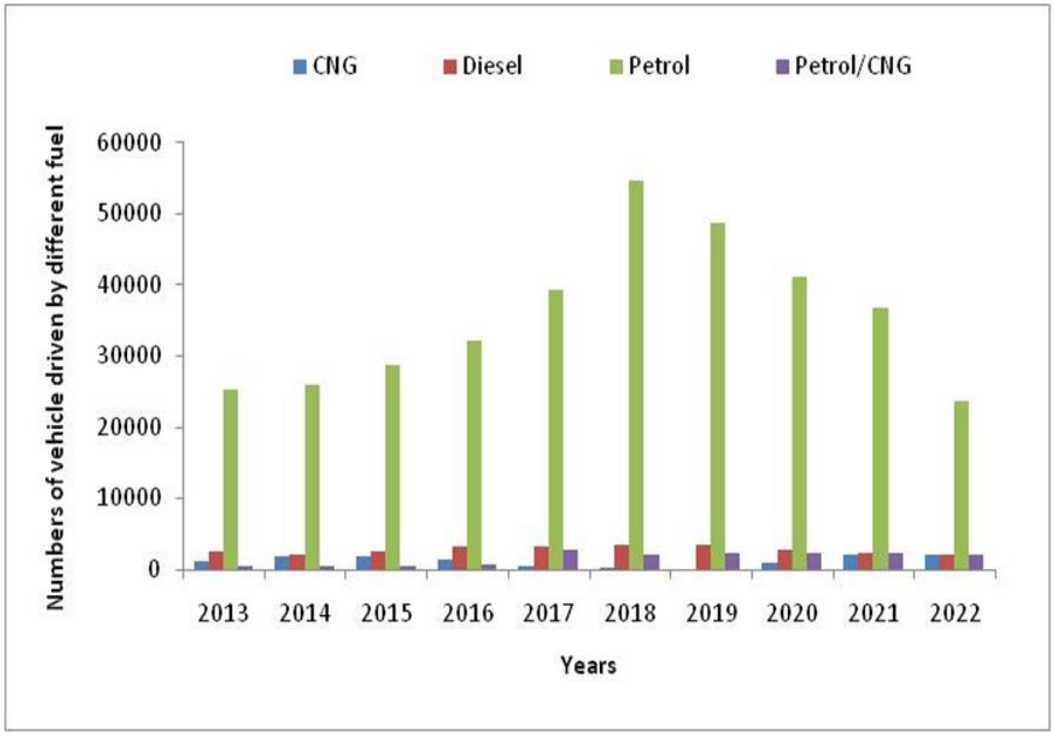


Fig. 12.5. Numbers of vehicle registered under different fuel category in Tripura state (Source - https://vahan.parivahan.gov.in)

12.2. Assessment of waste generation/segregation/disposal and treatment

Based on the literature survey, it has been observed that the huge quantity of solid waste is generated, collected, treated and land filled in the state. Data indicated that the quantity of solid waste generation is steadily increasing over the years with the maximum quantity of solid waste generated (445.72 ton/day) and collected (389.46 ton/day). The waste treatment started from the year 2014 and in during 2014-2015 the total solid waste treated was 250 ton/day. Tripura state also started to dispose-off solid waste through landfill in 2015, and maximum waste was disposed through this system was 239 ton/day during the period 2018-2019. In order to dispose solid waste efficiently the Hon'ble National Green Tribunal passed an Order dated 15.07.2019 in the matter of Bio Medical Waste Management Rules, 2016 vide OA No. 710-13 of 2017 in Tripura state. In this regard, the Director, Science, Technology & Environment, Govt. of Tripura requested all the District Magistrates and Collectors for preparation of District Environment Plan as per the direction of the Hon'ble NGT, which may in turn be compiled for preparation of State Environment Plan. In compliance to solid waste management, Agartala Municipal Corporation has formulated Solid Waste Management Regulation- 2017, which lays down duties of waste generators, duties of manufacturers of some products, duties of industrial units, setting up of solid waste processing & treatment facilities, duties of corporation, penalties etc. In Tripura, apart from the Agartala Municipal Corporation (AMC), there are 19 Urban Local Bodies (ULBs). The generation of Municipal Solid Waste in the

AMC area is about 250 metric ton per day (MTPD) and from the other 19 ULBs about 161.32 MTPD.

The Agartala Municipal Corporation has set up a Solid Waste Management (SWM) Plant with Sanitary Land Fill at Debendra Chandra Nagar with a capacity of 250 MT per day. As the total Municipal Solid Waste generated under all the above said 4 (four) Urban Local Bodies is about 250 MT per day, it has been decided that all the above said four Urban Local Bodies shall bring their Municipal Solid Waste to the Solid Waste Management Plant at D.C. Nagar, near Agartala by using Modern Garbage Compactors. All the 4 (four) Urban Bodies in West Tripura District have been provided with Modern Garbage Compactors with 8 MT capacity to transport Municipal Solid Waste to the SWM Plant at DC Nagar. Moreover, the solid waste generated from the Bishalgarh MC is being disposed in the DC Nagar SWM Plant due to proximity of the SWM Plant at D.C. Nagar. The SWM Plant at DC Nagar is presently operational and generating compost out of Municipal Solid Waste. There is a sanitary land fill attached to this SWM Plant for safe disposal of remaining municipal solid waste which is non bio-degradable. Also there is a Plastic Plant and Eco-brick plant attached to this SWM Plant at DC Nagar in which all types of plastic collected and transported to this plant is converted to fine granules which are sold in the market. In West Tripura district, Municipal Solid Waste is being collected, transported and processed as per the MSW Rules, 2016. It is noted that the quantity of waste generation and its collection has not increased exponentially during the period 2013-14 to 2019-20. However, waste treatment / land filling has fluctuated during this period (Fig. 12.6). Report suggested that the increasing number of tourist inflow may lead to waste dumping, air pollution, sound pollution and water quality in the state (http://trpenvis.nic.in/test/tourism.html).

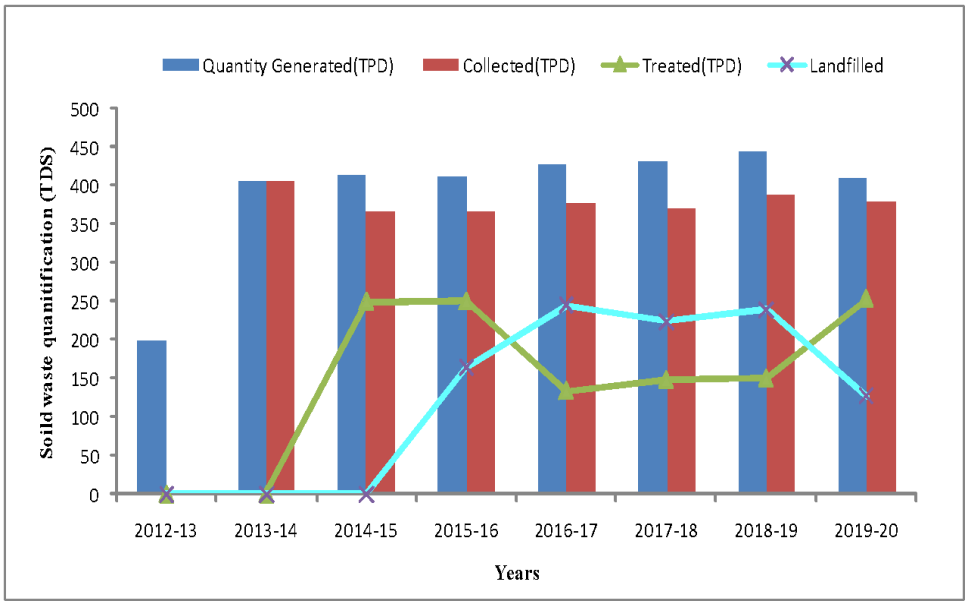


Fig. 12.6: Solid waste generation/collection/treatment and land filled in Tripura (*Source: Central Pollution Control Board*) * TPD= Ton per day

12.3 Ill-effect on Air quality

Data were collected for the period of 2017-2020 on air quality for the state of Tripura particularly from Agartala location since the only study on air quality was reported from this location. The particulate matter PM_{10} was maximum (67µg/m^3) in the year of 2020 and minimum (47µg/m^3) in the year of 2017 and 2018. Similar trend was also found for $PM_{2.5}$ that was maximum (49µg/m^3) in the year of 2020 and minimum (24 µg/m^3) in the year of 2018 and 2019. The maximum (21µg/m^3) quantity of SO_2 was found in the year 2017 whereas, minimum quantity (4µg/m^3) was calculated in the year of 2019. Data related to NO_2 were collected from the literature which indicated that the maximum (16 µg/m^3) NO_2 in the air was recorded in the year 2018 whereas, minimum (8 µg/m^3) NO_2 was quantified in the year of 2020. It is interesting to note that the quantity of NO_2 and SO_2 decreased drastically in the year of 2020 that due to Covid-19, the state did not receive tourists and vehicle movement in this year was negligible thereby the air was free from the pollutants (Fig. 12.7). Although the range of all the air quality parameters is under permissible limit, however, proper monitoring and management plan is required to maintain the air quality of the state. However, it is reported by the Centre for Science and Environment that in the capital Agartala, the pollution level is increasing due to congesion of the vehicle (https://www.cseindia.org/agartala-1754).

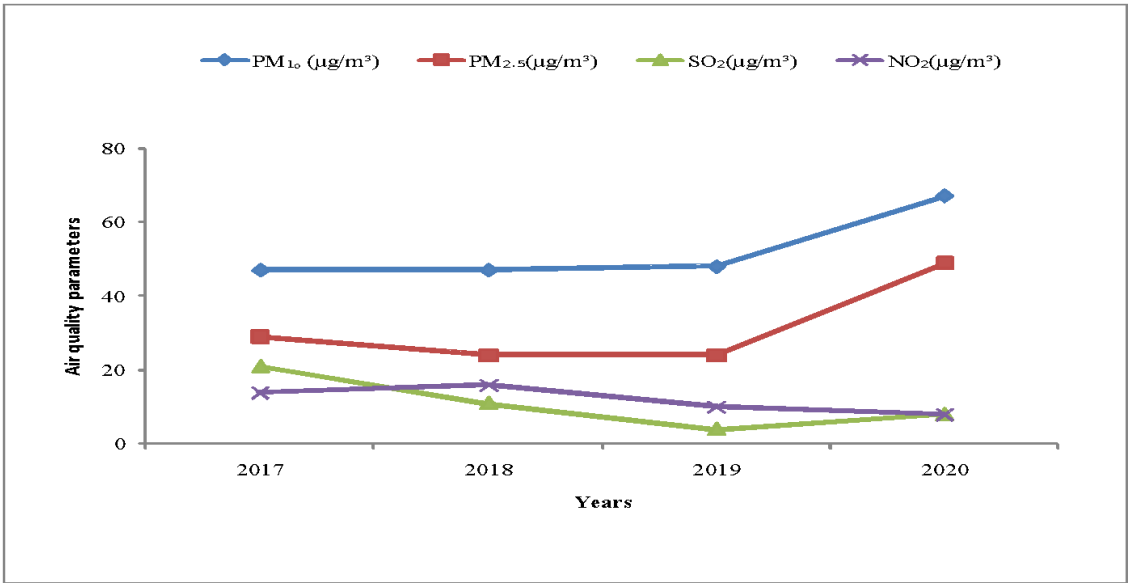


Fig. 12.7: Impact on air quality of Tripura state (*Source: Central Pollution Control Board*)

12.4. Impact on water quality / ground water

Data available from secondary sources for the State of Tripura in different seasons revealed that the water quality is not so poor particularly in respect to pH, BOD, Nitrate and Fecal coliforms (Fig. 12.8). The value of pH ranged from 5.6 to 7.7 between 2012 to 2020 which is under permissible limit. There is a slight decreasing trend of pH value from 2012 onwards.

Similarly, ground water pH is 6.5-8.5, which is under permissible limit. The BOD available were found maximum 0.8 (mg/l) in 2012 and minimum 0.7 (mg/l) in 2015. The range of Nitrate/Nitrite N(mg/1) ranged between 0.23 (mg/l) to 1(mg/l) during the period of 2012 to 2020. Total Fecal coliform (MPN/100ml) in ground water was recorded 2 for the entire period between 2017-2019. The increasing numbers of tourist inflow has impacts on water resources depletion (http://trpenvis.nic.in/test/tourism.html).

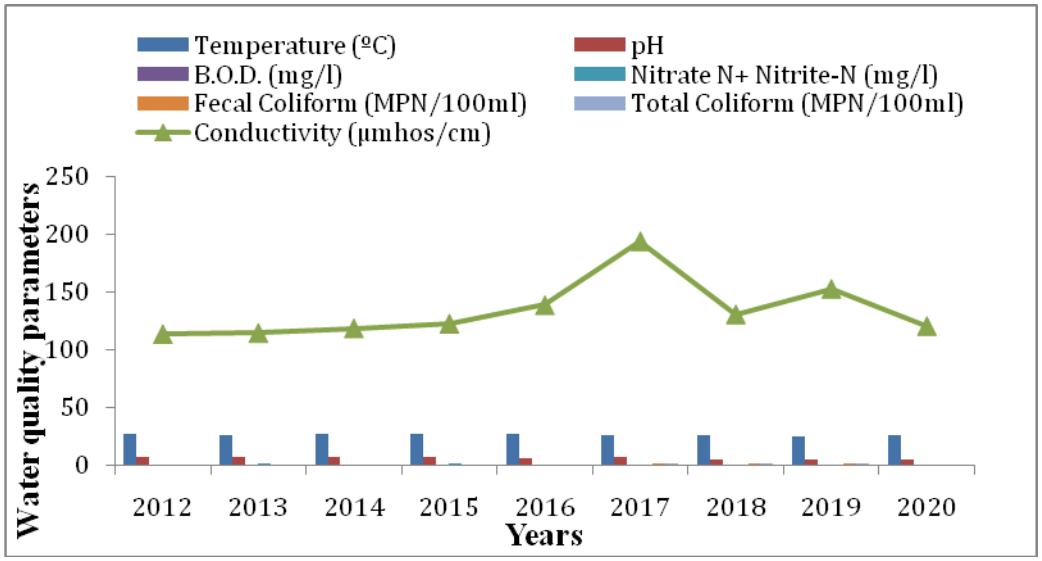


Fig. 12.8: Impact on ground water quality in Tripura state (*Source: Central Pollution Control Board*)

12.5. Ill-effect on Forest and Biodiversity

As per the ISFR (2017), based on the interpretation of IRS Resourcesat-2 LISS III satellite data for the period October 2017 to December 2017, the Forest Cover in the State is 7,725.59 sq km, which is 73.68% of the State's geographical area. In terms of forest canopy density classes, the State has 653.51 sq km under Very Dense Forest (VDF), 5,236.19 sq km under Moderately Dense Forest (MDF) and 1,835.89 sq km under Open Forest (OF). Forest Cover in the State has decreased by 0.41 sq km as compared to the previous assessment report in ISFR 2017. The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 76.06 million tonnes (278.89 million tonnes of CO_2 equivalent) which is 1.07% of total forest carbon of the country (Table 12.1). The floral diversity for a small state like Tripura appears significant from the fact the nearly 1463 of the 17,000 species or 8.6% Angiosperms (Flowering plants) known from India is recorded in Tripura (0.3% land of India). A total of 1546 species other than Bacteria, Fungi, Mosses, etc.) belonging to 862 genera and 192 families of Flora have been recorded of which 86% are widely distributed in India and adjoining countries. The Indian Wildlife (Protection) Act, 1972 amended till date include only six plant species while the Red Data Book on Indian Plants published by Botanical Survey of India contains data of more than 650 species considered rare and endangered. At least 15 of such species recorded from Tripura are known to be Rare or endengered (3). Similarly, the faunal

diversity of the State is quite rich. In the aquatic system, at least 129 species of fishes are recorded belonging to 32 families, and 11 orders. The fishes of the State include 11 vulnerable species three endangered species and three rare species and 9 species endemic to India are recorded from Tripura. The state is also facing degradation and extinction of the its biodiversity due to some anthropogenic and natural drivers, as a results some of the species are at the verge of threatened category and finally extinction. However, report indicated that the increasing numbers of tourist inflow may lead deforestation, rare and endangered flora and fauna and land use change in the state (http://trpenvis.nic.in/test/tourism.html).

Table 12.1: Forest area of the Tripura

S. No.	Parameters	Total area
1.	Forest Area (km^{-2})	6292.68
2.	Forest area to geographical area (%)	59.98
3.	Reserve Forest (km^{-2})	3588.18
4.	Total carbon stock (million tonnes)	76.06

(*Source: Tripura State Pollution Control Board*)

12.6. Eco-sensitive zones/ Areas

The state has two National Parks and four Wildlife Sanctuaries those constitute the Protected Area network of the State covering 5.76 % of its geographical area. These areas include: (1) Sipahijala Wild Life Sanctuary, (2) Tepania Eco-Park, (3) Trishna Wild Life Sanctuary, (4) Baramura Eco-Park, (5) Kalapania Nature Park, (6) Jampui Hills, and (7) Dumboor Lake. The Sepahijala Wildlife Sanctuary is located in the western part of Tripura, under Bishalgarh Subdivision of West Tripura District and about 28 km away from the capital town of Agartala. Here, the main attractions for visitors are Nature Interpretation Centre, Eco village with Tree House accommodation, high rise Watch Tower, Eco park and children joy ride, Exotic zoo animals, and Picnic spot. The Tepania Eco Park is located in Udaipur Sub-Division, 47 km from Agartala and 5 km from Udaipur. It is set amidst a charming ambience of natural beauty. This park is equipped with a rare orchid house, unique tree houses, tented accommodations, watch tower, hanging bridge, picnic block etc. The Trishna Wildlife Sanctuary is located at Joychandpur in Belonia Sub-Division, 95 km from Agartala and 15 km from Belonia. Among the four major sanctuaries in this State, Trishna is one of the attractive destinations for nature lovers. The great attraction of this sanctuary is a sizeable population of Indian Bison, commonly known as "GABA" and home to highly endangered only ape species of Indian sub-continent. The Baramura Eco Park is located in Teliamura Sub-division, 37 km from Agartala and 5 km from Teliamura. Here the tourists can avail picnic facilities, boating facilities, jungle tracking. The Kalapania Nature Park is located in Sabroom Sub-Division, 120 km from Agartala and 20 km from Sabroom.The main attraction of this park is a Nature Interpretation centre located in the middle part. The Jampui Hills is located in Kanchanpur Sub-Division of North Tripura District, 220 km from Agartala and 100 km from Dharmanagar. The luxuriant forest of jampui Hills is the premier one among the six principal hill ranges of this State. The Gumti Wildlife

Sanctuary is located in Amarpur Subdivision covering an area of 389.54 km2. The sanctuary boasts of a rich flora and fauna. The Dumboor Lake is the largest water body in the State, located in Gondacherra and Amarpur Subdivisions. These PAs are visited by tourists every year but there is no such information available on the impact of tourism on the forests and biodiversity of them.

12.7. Gaps and Plan of Action

Sr. No.	Gaps	Plan of Action
1.	Documentation on tourist influx in the protected areas including national parks and sanctuaries is lacking in the entire state.	An appropriate framework and action plan need to be developed by a state tourism department in collaboration with the forest department. In each district, collection of the information requires on number of tourists arriving in protected areas.
2.	Data related to carrying capacity of the tourist destination especially protected areas / eco-sensitive zones are mostly lacking in the state.	A detail inventory needs to be made with regard to the carrying capacity of the tourist destinations and protected areas. Identifying the potential areas and possible biotic pressure on locally available resources need to be assessed.
3.	Impact of tourism on biodiversity and socio-cultural system still needs to be studied in detail.	Study of tourism activity on biodiversity and socio-cultural system, positive and negative, is required. An appropriate code of conduct needs to be developed by state tourism department in consultation with the subject experts and local stakeholders.
4.	Initiatives on protected areas management is still lacking.	A sound full proof protected areas management plan needs to be developed. Execution in maintaining the integrity and sustainability of the areas is required.
5.	Data on quantification of solid waste (degradable and non-degradable) are lacking at district level.	Quantification of different type of solid waste at household level needs to be quantified at district level. Segregation unit of solid waste is required to be opened at district level in order to proper disposal of the waste.
6.	Data on converting degradable solid waste into compost is also lacking at district level.	A composting unit needs to be made functional at district level so that the collected bio-degradable waste may be converted and recycled into bio-compost.

7.	Data on quantification of solid waste from tourist destination especially protected areas is completely lacking.	A detailed inventory is required to be made in the protected area to quantify the solid waste generated. Besides, solid waste generated by the visitors needs to be collected, dumped and treated at a proper designated place. The designated site needs to be made available by the State Government.
8.	Data on water quality parameters at district level are lacking in the entire state.	Few of the studies related to ground water quality parameters are carried out in metropolitan cities. This needs to be extended to places of tourist destinations to determine the impact on water quality.
9.	Initiatives on water purification especially in rural areas are lacking.	There is a need to install water purification unit and pumping system in rural areas to make available potable water in this sector.
10.	Air quality monitoring lack at district level.	Air quality parameters are available only for the capital of the state. Sampling on air quality is required to conduct at district level. Major towns/metropolitans at a ceratin interval need to assess the changing pattern of air quality and developing strategies to maintain its quality.

Summary

Data related to tourist visits to protected areas is yet to be documented through close monitoring. Study on impact of tourists' influx on biodiversity is almost lacking in the state. All the garbage collected from the city is disposed off openly in two dump yards by way of landfill without proper processing. There is some facility for processing garbage at Debendra Chandra Nagar Dump yard, but it is not adequate and scientific. Hence, most of the garbage is dumped without processing. Installation of functional water system equipped with advanced instrumentation for water purification and distribution to households is almost at the back foot in the entire state including in rural areas. A sound management plan for conservation and management of these protected areas is highly needed. This is an important element for understanding future implications of tourism and developing action plan accordingly.

13.1 Introduction

Meghalya, one of the smallest states of the North-Eastern India, encompasses an area of 22,429 square kilometers with 76% of the state being covered by forests (including reserved forests and sacred groves). Rich biodiversity, lush green flora and fauna, dynamic rivers and waterfalls, national parks and wildlife sanctuaries, make the tourism of the state a very high potential sector for economic prosperity and environmental sustainability. More than hundreds of tourist spots exist in the entire state and majority of them lies in the most populated districts of East Khasi Hills in the state of Meghalaya (Fig.13.1). The state is also having two National Parks, three Wildlife Sanctuaries and as well as 500 natural limestone and sandstone caves including longest and deepest caves in the subcontinent (Nayak and Mishra, 2013).

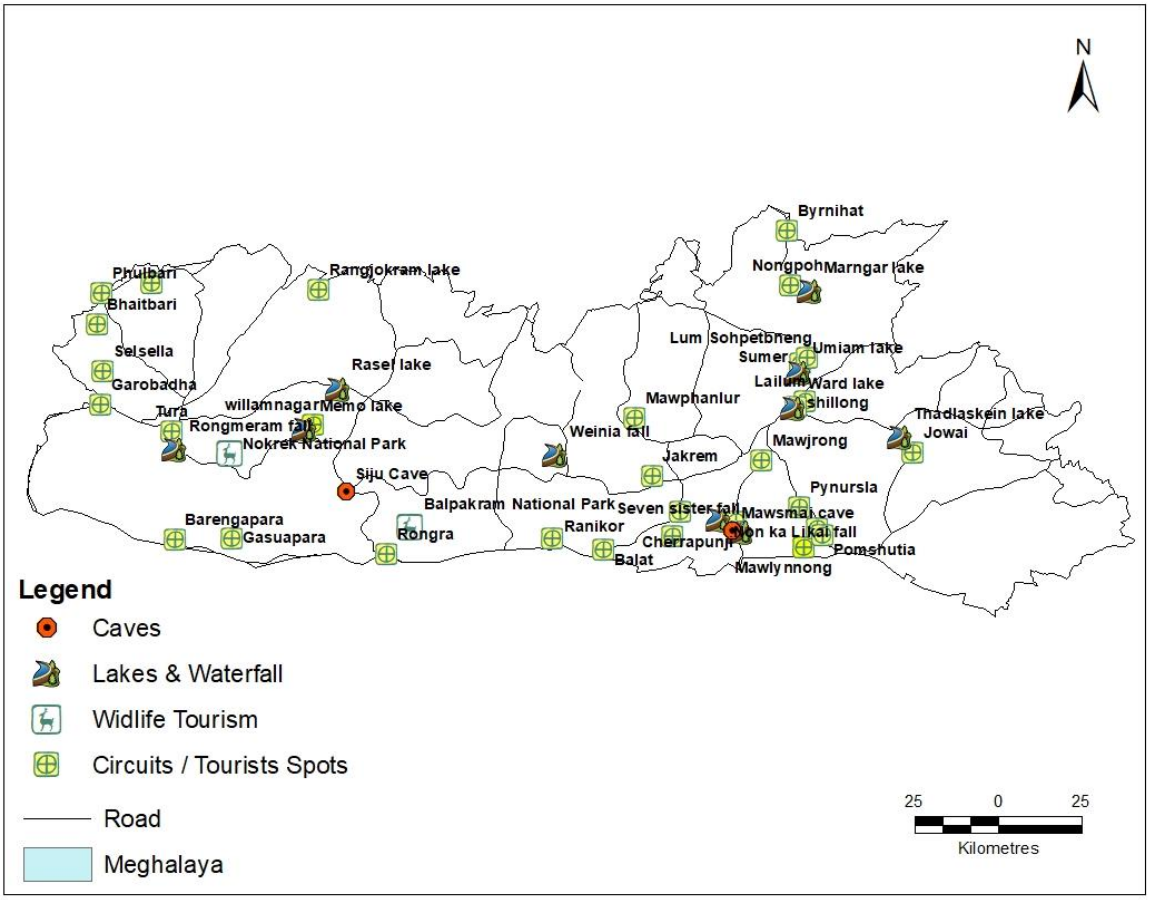


Fig. 13.1: Major tourist spots and circuits in Meghalaya

As far as the state of environment or environmental problems is concern for the state, the latest available annual report of 2017-2018 available in the Meghalaya State Pollution Control Board (MSPCB) website (https://megspcb.gov.in/annual_reports.html#) highlights the following relevant concerns:

a) Mining activities causing severe water pollution,
b) Small stone crushing units as well as the cement industry are causing ecological imbalance,
c) Indiscriminate garbage dumping, disposal of domestic sewage, solid waste generated from the urban areas are deteriorating the environment,
d) Air quality deterioration (PM_{10} levels) exceeded the NAAQS (annual average) at two stations namely, (i) Export Promotion Industrial Park (EPIP), Byrnihat, (Stn-III-Industrial area) and (ii) Umiam Industrial Estate, Ri-Bhoi District (Industrial area), and
e) Under National Air Monitoring Programme (NAMP) monitoring network, 10 Ambient air quality-monitoring stations, and 54 stations in the State under the National Water Monitoring Programme (NWMP) covered rivers, lakes, springs/well and ambient noise level monitoring in capitol town of Shillong at three locations.

The figures of solid waste management for the 2017-2018 indicate that only 20% (36 MT/Day) is treated out of collected 175 MT/Day of solid waste in the seven municipal bodies. Interestingly, a recent audit report in the financial year 2018-2019 on findings of audit for the State Government units under Economic Sector has a chapter on Performance Audit on "Tourism Development in Meghalaya" which highlights that the contribution of tourism sector to State Gross Domestic Product (SGDP) was found to be 3% year-on-year over a period of five year (2014-2019). Although, the SGDP (increased from 23,235 crores to 34,389 crores) and the tourism GSP have increased from 698 crores (2014) to 982 crores (2019).

Following pertinent findings needs to highlighted in the present context as the state of Meghalaya had the maximum number of tourist influx between 2014 to 2017 and possibly holds second position after Sikkim if one considers the total tourist arrival in the eight NE states of India.

a) Impact of tourism on local economy in terms of income generation and employment creation was found to be positive.
b) Audit observed that even after more than eight years of having a policy (Meghalaya Tourism Policy, 2011), no plans or targets (medium and long-term) was fixed for the Department/ DoT/ MTDC to fulfill the goals laid down in the important policy document.
c) Infrastructure (Hotels and other amenities) created did not adhere to the important component of sustainability.
d) Reliable dataset of tourist influx, people/households engaged in tourist sector rural tourism was found to be missing.
e) The report mentioned that lack of medium term/ long term action plan and declining percentage of expenditure on the tourism sector, and ineffective implementation and management of tourism infrastructure projects have largely contributed to the reduction in the State's position in North Eastern states.
f) Most importantly, it was found that no provision for solid waste management with incinerators and rain water harvesting could be physically verified in homestays/resorts

which have received subsidy through Meghalaya Tourism Development and Investment Promotion Scheme, 2012 (MTDIPS).

g) The audit report further highlights the non-compliance of CPCB/SCPCB order in installation of dustbin at River Myntdu to regulate the high pollution level in Myntdu River, Jowai Hills caused by the waste generated by tourism activity.
h) The audit also highlighted many more shortcoming and departments may have addressed to some of the pertinent issues related to the long-term sustainability of the tourism as a driver of economic and environmental sustainability.

As per the Provision 24 (4) of the Solid Wastes Management Rules, 2016, the Central Pollution Control Board (CPCB) is required to prepare a consolidated annual report and forward it to the Ministry of Environment, Forest and Climate Change. A rank based system is developed to categories the states and UTs based on Environmental performance using criteria's such as on waste processing, waste disposal and gap in the solid waste management. The state of Meghalaya could get only 37.5 marks (Manipur and Mizoram scores 51 marks) due to treating only 9.64 ton/day **(**8**%)** out of 119.19 ton/day of collected solid waste and overall generated solid waste of 153.18 ton/day (Annual Report on Solid Waste Management (2019-20, CPCB).

13.1.1. Tourism growth in the state of Meghalaya:

According to the statistical records of the state of Meghalaya, the state has observed a substantial growth in the tourist influx, from the year 2008 to 2019 (Fig. 13.2). With an influx of around 5.5 lakhs tourists (domestic and foreign), the state experienced a massive tourist arrival, with a growth of more than 100% (over 12 lakhs tourists) visited in the year 2019. Figure 13.2 shows the yearly statistics of the tourist influx (Source: Directorate of Tourism, Meghalaya and https://www.ceicdata.com/en/india/resident-visits-by-states/visitor-arrivals-local-meghalaya). Growth in domestic tourist arrival had been significant from 2016 onward and foreign tourist makes only 1% of the total tourist arrival in the state of Meghalaya. As compared to other NE states, after Assam, the state of Meghalaya was the second state witnessing the high tourist influx till 2017 (nearly 10% of the total tourist influx in Northeastern states). But after the 2017,Sikkim is holding the second position in terms of tourist arrival (15% of the total tourist influx in the Northeastern states).

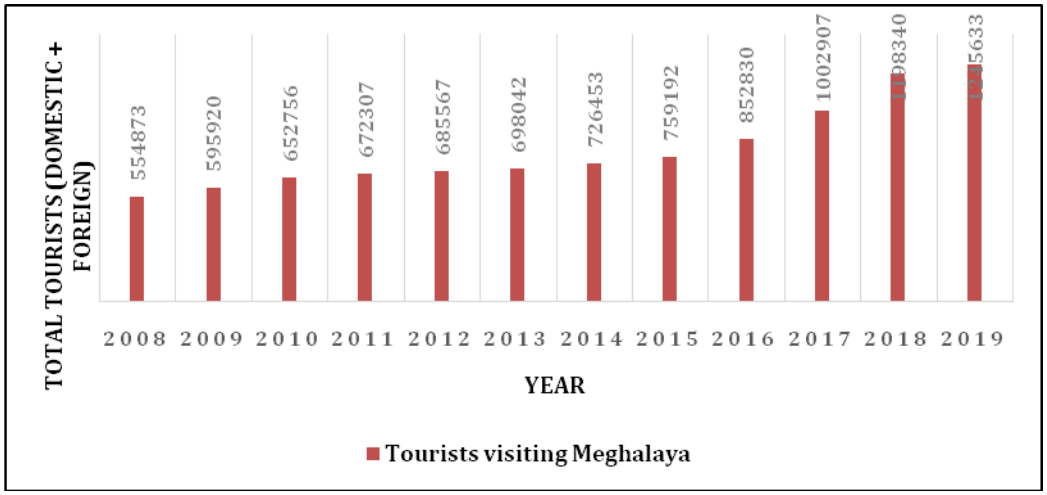


Fig. 13.2: The graph showing the year-on-year growth of tourist influx in Meghalaya

13.1.2. Number of vehicles (state/district wise)

The total number of vehicles (government and private) registered in the state of Meghalaya from the year 2014 till 2017 is given in Fig. 13.2. A substantial increase can be observed during the three time periods with vehicles on roads increasing from 2.5 lakhs in the year 2014-2015 to up to 3 lakhs in the year 2016-2017 and thus increasing by almost 18% in the state.

Table 13.1: Number of vehicles tested for the compliance to substances emission standards (01.04.2017 to 31.03.2018)

Type of Vehicles	Total no. of vehicles tested	Percentage of vehicles complying to emission standard	Percentage of vehicles non-complying to emission standards
Petrol-Driven LMV	10312	99.4%	0.6%
Diesel-DrivenLMV	2371	98.5%	1.5%

(*Source:* *http://megspcb.gov.in/annual_reports.html*)

High concentrations of Particulate Matter (PM_{10})is observed at limited location (Annual Report 2018-2019, CPCB) which could be attributed to vehicular emission but as it can be observed from Table 13.1 majority of the vehicles, whether petrol driven or diesel, comply to the emission standards. Thus, indicating that vehicular pollution control measures are strictly followed in Meghalaya.

13.1.3. Assessment of waste generation/segregation and Waste disposal/ treatment facilities

An ENVIS Newsletter published in 2018 present an overall assessment of MSWM in the urban areas of Meghalaya. The state of Meghalaya is having seven urban local bodies (ULBs) namely, Shillong Municipal Board (SMB), Shillong Cantonment Board (SCB), Jowai, Tura, Williamnagar, Baghmara and Resubelpara. As per the Newsletter, 5 Municipal Boards have reported for implementation of MSW Rules (Shillong, Jowai, Tura, Resubelpara and William Nagar) and

authorization was granted to 4 ULBs (Shillong, Jowai, Tura and Williamnagar). Six dumpsites are used for disposal of MSW namely Shillong, Shillong Cantonment, Jowai, Tura, Williamnagar and Resubelpara. The dumpsite of Shillong has been converted to landfill site. Ambient air, groundwater and leachate quality is being monitoring at Shillong dumpsite only. The Shillong Municipal Board collects 45TPD (Tons per Day) of Municipal Solid Waste and having an aerobic compost plant whereas the Tura Municipal Board is supported with vermin culture processing for biodegradable waste. Jowai MSW collects an average daily of 48 MT of MSW and dumps in the existing dump yard but do not have any facilities to proper management of MSW. Other two municipal areas collect less than 10MT of Solid waste and dump it in landfill site (William Nagar) and open dumping is practiced in Resubelpara and do not have waste processing facility. As far as the solid bio-medical waste is concerned which is generated from the medical facilities and should be incinerated properly through the incinerator but sadly, as reported, the incinerator installed was found non-functional and hazardous BMW disposed and burnt in the open at the dumping site that could seriously impact the environment and pose health hazards to the people.The Newsletter also highlights that the dumping site affecting the overall public health at large including workers and rag pickers with its foul smell and smoke. Under the Swachh Bharat Mission a Sanitary landfill site of 170 TPD Compost Plant is created under the Shillong Municipal Broad.

Figure 13.3 highlights the total amount of municipal solid waste (MSW) generated, total MSW collected, treated and land filled per annum from the year 2015 to 2018. The data clearly show that the total amount of MSW that is generated throughout the state, only a fraction (37% in 2017-18) of the total volume collected is treated, and with each advancing year the quantities of waste generated have increased significantly. Considering for the year 2015-16, the total MSW generated was 187 TPD (tones per day) out of which 156 TPD was collected (120 TPD treated and 36 TPD land filled), rest 31TPD (16.5%) of the MSW left untreated. Similarly, in the year 2016-2017 & 2017-2018, 16% and 26% of the solid waste were left untreated respectively. In 2017-18, about 50% of the total waste collected was treated.

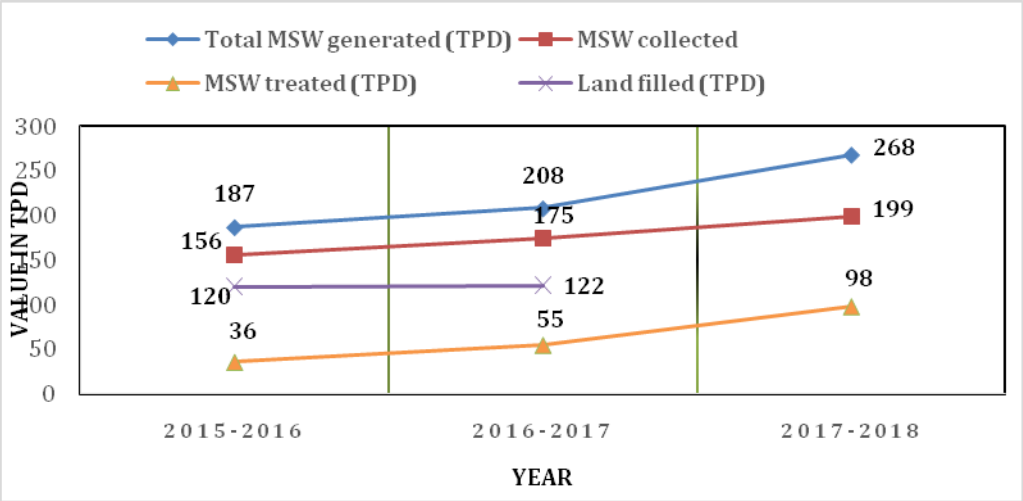


Fig. 13.3: The assessment of the total municipal waste generated in tonnes per day in Meghalaya; (*Source: https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf*)

An inventory report (https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf) on Hazardous Waste in Meghalaya highlights lack of a centralized hazardous waste management facility or in the neighboring State, and the units store their landfillable waste within their own premises in a concrete lined pit.

Per annum generation of hazardous waste from different dominant industrial sectors of the state is shown in Fig. 13.4. Zinc ash residue is the highest hazardous waste generated during the year 2016. The oil wastage and the acid residues as compared to zinc ash are quite nominal. However, the long term trend of hazardous waste generation could not be available.

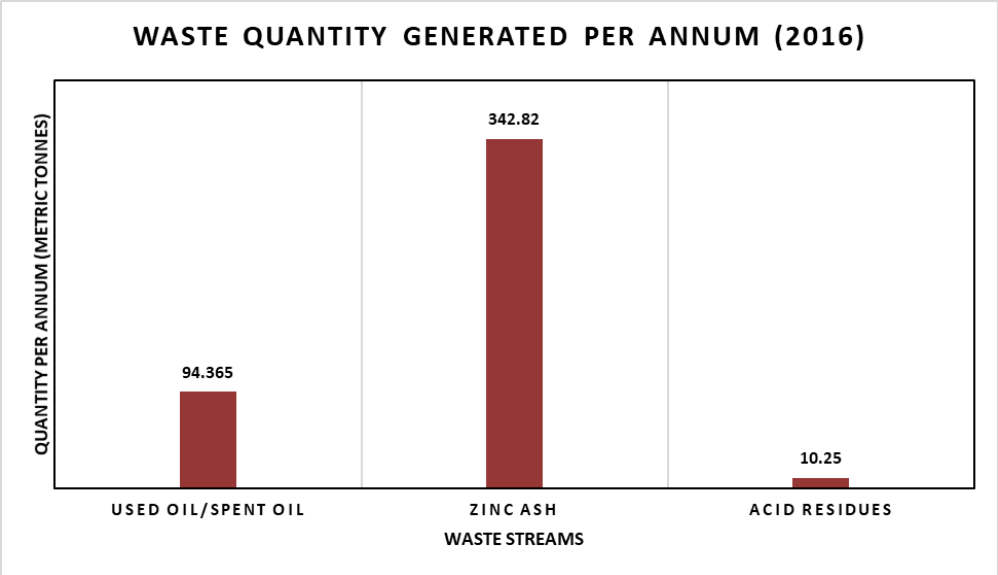


Fig. 13.4: Hazardous waste inventory in Meghalaya
Source :(HYPERLINK "https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf"https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf)

13.2. Ill-effect on Air quality

The Meghalaya State Pollution Control Board monitors the air quality at ten different stations spread out in different districts. Quantities of Particulate matter (PM_{10}), Sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2) released in the atmosphere is measured (Fig.13.5). The permissible limits as mentioned by the state pollution control board are mentioned as follows:

i) PM_{10} – 60µg/m^3, ii) SO_2 – 50µg/m^3, and iii) NO_2– 40 µg/m^3.

A graphical representation of the measured average air quality parameters of the stations for the Meghalaya state from the year 2010 to 2017 is represented in Fig. 13.5. It can be observed that the year 2010 to 2014 as well as in 2016, the PM_{10} emission had surpassed the permissible

limits, with highest particulate matter of 106.78 µg/m^3 emitted in the year 2010. The year 2014 emitted 62.175 µg/m^3 and the year 2016 emitted 67.075µg/m^3. The only years observing a dip in the values with the emission rate being below the permissible limit are 2015 and 2017 with PM_{10} of 47.5 and 59.5 µg/m^3, respectively. The other measured air quality parameters like NO_2 and SO_2 are within the permissible limits and vary annually. The SO_2 value was maximum in the year 2010 (18 µg/m^3), while the lowest was only 2 µg/m^3 recorded in the year 2014. Similarly, for NO_2, the maximum value was recorded in the year 2017 (11.27 µg/m^3) and the lowest 9.025 µg/m^3 during 2014. In general, the air quality parameters monitored here from 2010 - 2017 show a marginal decline over the years, except for NO_2, which is more or less stable.

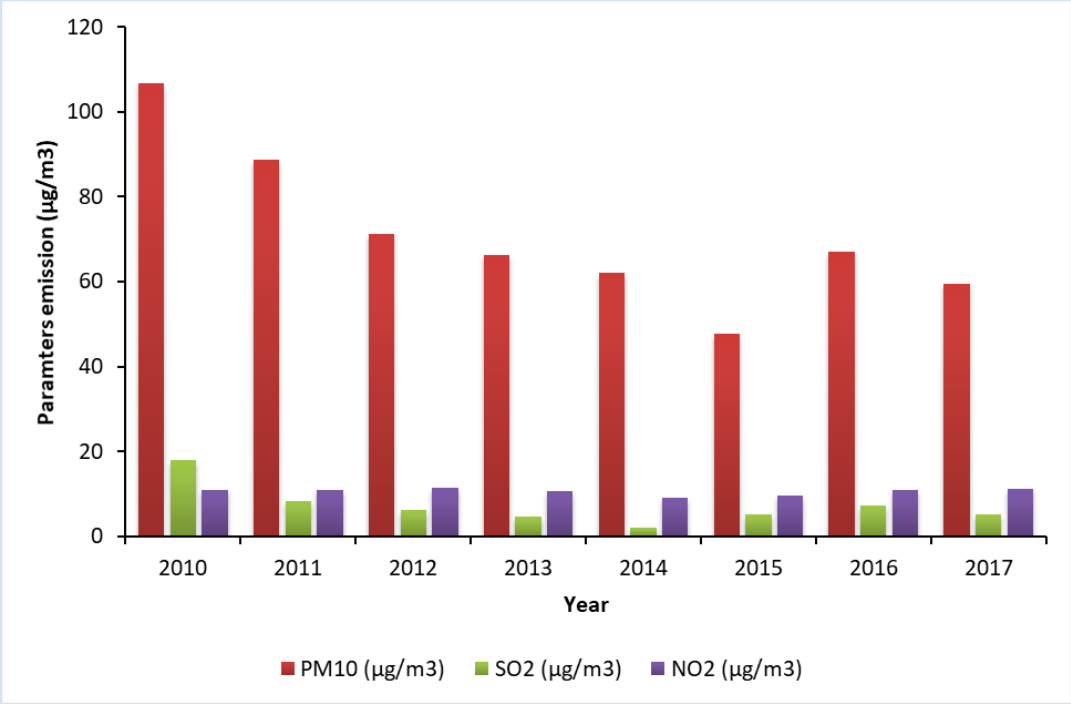


Fig. 13.5: Average air quality parameter in Meghalaya (http://megspcb.gov.in/annual_reports.html)

13.3. Ill-effect on surface and ground water quality

The state is endowed with several rivers and streams, which have comparatively smaller stretches but are quite important due to their water use for drinking, irrigation, industries, waste disposal etc. Surface and groundwater contamination have become a serious concern in the state in recent decades as a result of indiscriminate discharge of untreated municipal effluents, industries and mining effluents, agricultural runoff, open defecation, and dumping of solid wastes along river banks. The water quality of selected water bodies in Meghalaya is regularly monitored by the State Pollution Control Board as part of the National Water Monitoring Programme (NWMP).

Groundwater is an important freshwater resource that caters to the need of agriculture, industrial and domestic water demands. Water quality influences lives in many ways more than drinking. A total of seven ground water sources located all over the state are monitored by Meghalaya State Pollution Control Board. Monitoring stations quantifies the Iron, Fluoride concentration and Total coliform.
The permissible limits as mentioned by the Bureau of Indian Standards (IS 10500:2012) are mentioned as follows:
i) Iron – 0.3 mg/l, ii) Fluoride- 1.5 mg/l, and iii) Total Coliform: Nil/100ml

A graphical representation of the quantities of above mentioned water quality parameters in the monitored stations from the year 2010 to 2018 is shown in figure 13.6. There is no data recorded for iron and fluoride concentration during 2010 to 2012. The sources were affected by bacterial contamination which was probably caused by percolation of polluted surface water. As it can be observed that from 2010 to 2014 there is decrease in bacterial contamination. The concentration of Iron was recorded to be high at Ri-Bhoi district which was probably due to the geology of the area. The fluoride content at the hot spring, Jakrem (West Khasi Hills), was found to be high (more than 20 mg/l), as is typical of any hot spring. It can be stated that water quality is not alone based on the sources of pollution but also the parental rock material contributes to its quality.

As per the reports of Central Ground Water Board (CGWB) higher concentration of iron is reported in groundwater also. The presence of high iron content both in shallow and deeper aquifer is reported from some part of the Ri-Bhoi, West Khasi Hills, as well as in the East Khasi Hills districts. The comparison of iron content in shallow and deeper aquifer shows a higher concentration of iron in deeper aquifer than in shallow aquifer. Apart from iron, the other parameters are within the permissible limits. In Garo Hills, as per Ground Water Exploration, higher concentration of iron is reported in groundwater, where the depth of the well ranges from 113 to 202 m below ground level. Presence of iron in groundwater can be attributed to local geogenic causes. In Jaintia Hills, as per water quality analysis data, it was found that there is a very low pH value in most of the springs, and the iron and fluoride concentration are within permissible limit. Fluoride concentration is within permissible limit for all the districts.

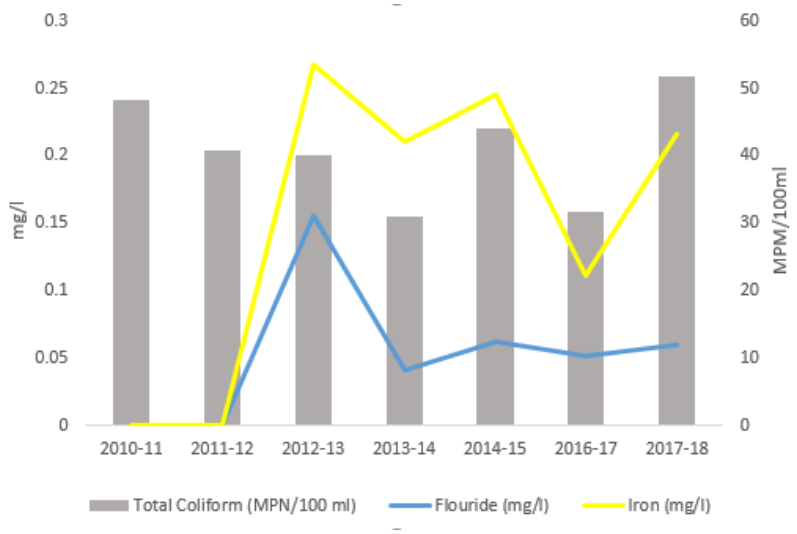


Fig. 13.6: Groundwater Quality Monitoring 2010-18; (*Source: Annual Reports: (2010-2018), Meghalaya State Pollution Control Board*)

13.3.1. Surface Water Quality

The sampling stations of Meghalaya State Pollution Control Board for surface water quality monitoring are located in East Khasi Hills (17 Sampling stations), West Khasi Hills (8 Sampling stations), Ri-Bhaoi(6 Sampling stations), Jaintia (8 Sampling stations) and Garo Hills (8 Sampling stations. Monitoring stations quantify BOD, Total Coliform and Ammoniacal Nitrogen.

Graphical representation of above mentioned water quality parameters in these stations from the year 2012 to 2018 is shown in Figure 13.7. During the period 2012-18, the Bio-chemical Oxygen Demand in Ward's Lake, Umkhrah, and Umshyrpi Rivers was found to be greater than 3 mg/l. The overall coliform count in the Umkhrah and Umshyrpi rivers was found to be above 5000 mpn/100ml, which is quite alarming. The concentration of ammoniacal nitrogen in the Umkhrah and Umshyrpi rivers exceeds the permissible limit of 0.5 mg/l. These findings reveal that the predominant pollutants in the water bodies were organic and bacterial. This was primarily due to untreated waste water dumped directly from residential and business areas into the water bodies. The amount of waste collected by the two rivers, the Umkhrah and Umshyrpi, was far in excess of their capacity to absorb it, causing the water quality to deteriorate to the point where the water of these rivers is now unsafe to drink. In River Nanbah at Nongstoin, the BOD was found to be above 3 mg/l and the total coliform count was found to be above 500 mpn/100ml. The river, which runs through the heart of the West Khasi District headquarters, has been contaminated by direct trash disposal from residential and business areas, vehicle workshops and service centers, and agricultural runoff. In the Ri-Bhoi District the total coliform count in the water bodies was also observed to be high. The Umiam Lake received the waste that was generated in the Shillong city through the two rivers, Umkhrah and Umshyrpi whereas the River Umtrew is subjected to pollution originating from the residential, commercial and industrial areas.

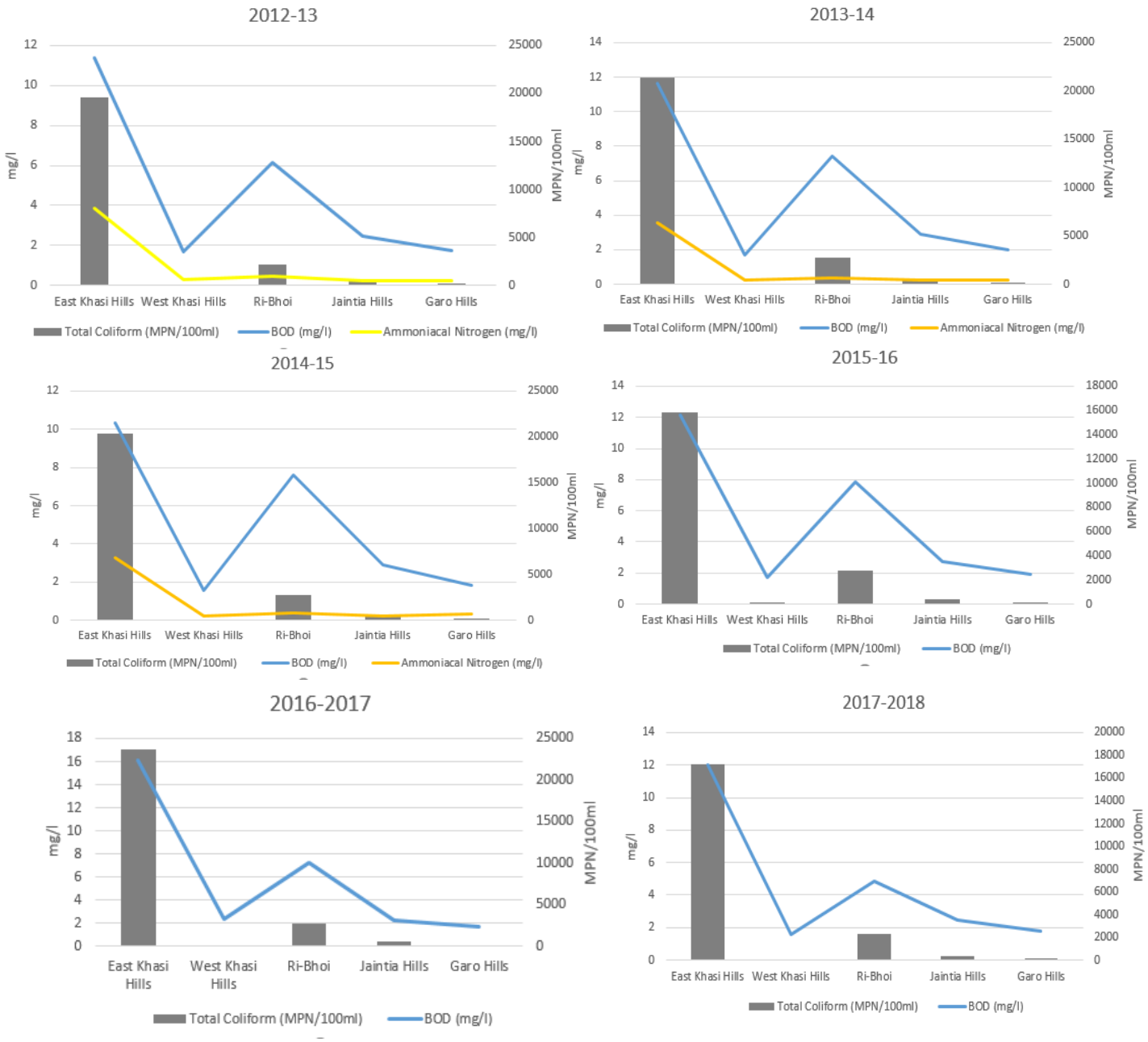


Fig. 13.7: District wise surface water quality for 2012-2018 in Meghalaya (*Source: Annual Reports (2012-2018), Meghalaya State Pollution Control Board*).

13.4 Ill-effect on Forest and Biodiversity

According to the forest reports generated by Forest Survey of India in the year 2017, the state Meghalaya ranks 4th in the country in terms of its forest cover. The forest covers an area of 17,146 square kilometers, occupying 76.44% of the total geographical area of Meghalaya. The Figure 13.8 highlights the quality of the forest cover in the state according to the FSI report. Majority of the area is covered by open and moderately dense forests, only 21% of the area falls under the non-forest category. Out of the 17,146 km^2 of the total forest area, 626.55 km^2

of the area is under reserved forests, while 12.39 km^2 falls under protected forests category under the East Khasi Hills, Ri-Bhoi district, and Shillong jurisdiction.

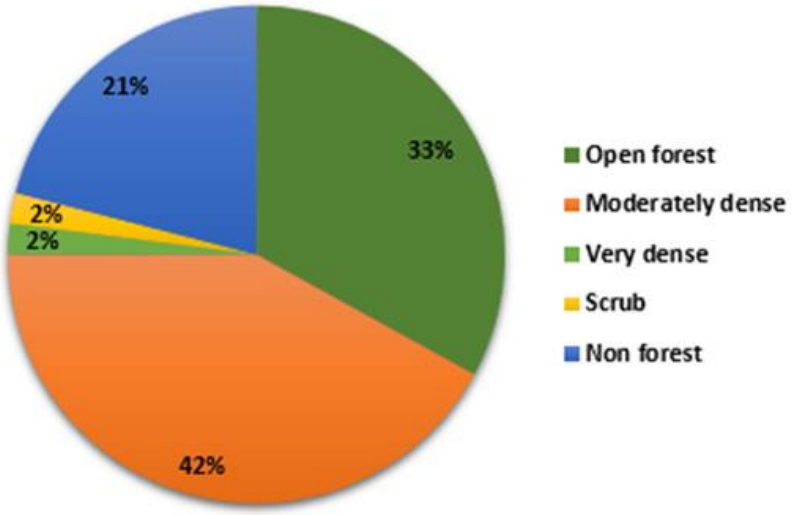


Fig 13.8: Categories of the forest cover in the state of Meghalaya (*Source: http://www.megforest.gov.in/forest_overview.html*)

13.4.1 Groves of Meghalaya

A total of 125 sacred groves are in the state with Mawphlang sacred grove, encompassing an area of around 78 hectares, located in the East Khasi Hills district, and internationally acclaimed as an important and educational tourist center. Sacred groves also referred as 'virgin forests' which are left untouched and protected by the local inhabitants due to their cultural beliefs. According to the FSI report, the sacred groves in the present times are facing threats and mainly because of the changing lifestyles of the tribal people. The threats mentioned in the report are:

1. The area under sacred groves is shrinking and few of them have been turned into degraded forests. Sacred groves in Meghalaya are now increasingly coming under a threat as the tribal way of lifestyle is changing. The deterioration of sacred groves in recent times is a matter of concern.

2. Some sacred groves though protected in the past have fallen prey to encroachments and degradation (http://www.megforest.gov.in/forest_sacredgroves.html).

13.4.2. Ill-effect on Forests

Two interesting reports published by FRI and Rain Forest Research Institute, Indian Council of Forestry Research & Education, Dehradun indicate towards the drivers of deforestation as well as the threat to biodiversity in the biologically rich state of Meghalaya. Its causes depletion in forest cover and loss of biodiversity due to shifting cultivation, wood collection, mining, population increase and settlement expansion, and fragmentation of community forests.

However, net change in the forest cover for the entire state of Meghalaya is very minimal. But negative change in most of the dominant class of forest area under moderate dense forest has decreased over a period of 2011-2017. However, none of the reports have mentioned tourism or tourism related activities impacting the forest and biodiversity.

13.5 Eco-sensitive zones

Nongkhyllem Wildlife Sanctuary and Narpuh Wildlife Sanctuary are classified as Eco-sensitive Zone and notified by the Ministry of Environment, Forest and Climate Change (MoEF& CC) in the year 2017. Nongkhyllem Wildlife Sanctuary Eco-sensitive Zone and the Reserve Forests are classified as a global biodiversity hot spot under the Eastern Himalayan Endemic Bird Area. The Narpuh Wildlife Sanctuary Eco-sensitive Zone in East Janita hills Jowai, Meghalaya having an area of 194.23 km^{-2}. A Zonal Master Plan is prepared in consultation with all the concerned State Departments, for integrating the ecological and environmental considerations of an eco-sensitive zone. The Department of Tourism in consultation with State Departments of Environment and Forests should prepare a Tourism Master Plan which should form a component of the Zonal Master Plan (http://www.megforest.gov.in/wildlife_zones.html).

13.6 Gaps & Plan of Action

Sr. No.	Gaps	Plan for Action
1.	Regular solid waste quantification by municipal bodies and assessment of the composition of solid waste generated is not available fairly.	Municipal bodies should stop open dumping of solid waste. It is essential to recommend different scientific measures for management of urban solid waste by way of reduce, reuse and recycling practices. Biomedical waste should be disinfected through microwave technique to avoid pollution in the downstream areas, and reservoirs/water bodies.
2.	Separate information on air,water as well as pollution caused by solid waste generated due to tourism activities in the state is not available	There is a need for scientific investigation of air and water quality parameters as well as solid waste generation during a peak tourism season in Meghalaya.

13.7 Summary

In spite of having Meghalaya Tourism Policy 2011, no plans or targets (medium and long-term) were fixed for the Department / DoT/ MTDC to fulfill the goals laid down in the important policy document. Tourist infrastructure (hotels and other amenities) created in the State did not adhere to the important component of sustainability. Simultaneously, reliable dataset of tourist influx, people, households engaged in tourist sector including rural tourism was found to be missing. Lack of medium term / long term action plan and declining percentage of expenditure on the tourism sector, and ineffective implementation and management of tourism infrastructure projects have largely contributed to the reduction in the State's position in the North Eastern states. Most importantly, it was found that no provision for solid waste management with incinerators and rainwater harvesting could be physically verified in homestays /resorts which have received subsidy through Meghalaya Tourism Development and Investment Promotion Scheme, 2012 (MTDIPS). The high pollution level in River Myntdu, Jowai hills caused by the waste generated by tourism activity is also a matter of concern.

The annual average **growth of tourism** (based on one decade 2011-2020) reveals that the number of tourists visiting Uttarakhand were: 27,041,965 ± 9065417 tourists/yr which is the highest in view of tourist influx. This is followed by Himachal Pradesh (16,035,126±4217317 tourists/yr), Jammu & Kashmir (6,524,418±3584903 tourists/yr), Assam hills (5,175,956 tourists/yr), Sikkim (893,221±422771 tourists/yr), Meghalaya (624,127±346095 tourists/yr), Tripura (372,081±124626 tourists/yr), Ladakh (195,209±90979 tourists/yr), Arunachal Pradesh (164,388±76925 tourists/yr), Manipur (145,780±36797 tourists/yr), West Bengal (90,000 tourists/yr), Mizoram (74,032± 34550 tourists/yr), and Nagaland (62,042 ± 3601 tourists/yr). In case of percentage change (2011-2019), highest change was observed in Nagaland (387.1%) followed by Sikkim (169.81%), Mizoram (164.21%), Arunachal Pradesh (161.88%), West Bengal hills (145.79%), Meghalaya (85.27%), Ladakh (55.96%), Tripura (47.45%), Uttarakhand (44.75%), Manipur (34.11%), Assam hills (31.52%), Himachal Pradesh (11.37%) and Jammu & Kashmir (-27.01%).

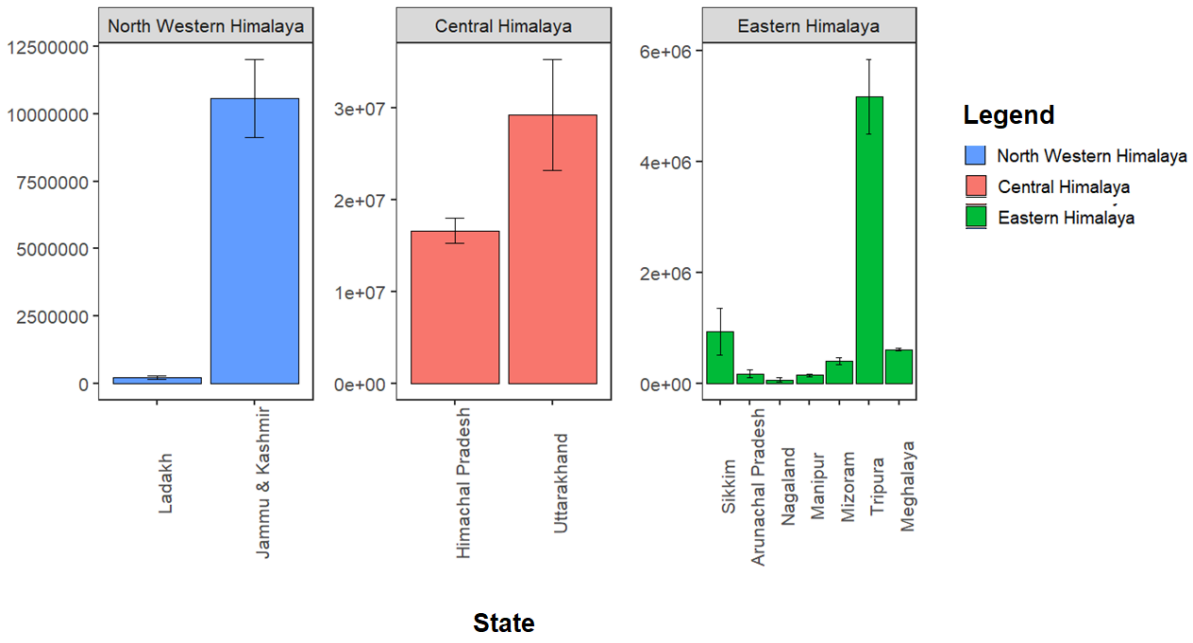


Fig. 14.1: Yearly average number of tourist influx in the IHR states

In the Western and Central Himalayas, besides mass tourism, pilgrim tourism is found in increasing trend in some places like the Kashmir Valley. Every year pilgrims visit the major shrines (Shri Amarnath Ji Holy Cave and Mata Vaishnav Devi) of Jammu & Kashmir UT. Pilgrim tourism is much higher than traditional tourism in Jammu & Kashmir ranging between 2.2 lakh to 111.16 lakh per annum. While in Uttarakhand, during Char Dham Yatra, the number of

pilgrims in the year 2018 recorded 1,058,490 in Badrinath, 694,934 in Kedarnath, 447,585 in Gangotri and 394,395 in Yamunotri. However, during COVID-19, the pilgrim inflow was 155,055 in Badrinath, 135,349 in Kedarnath, 23,774 in Gangotri and 7,728 in Yamunotri. On the other hand, a reasonable upsurge during post COVID-19 was noticed and visitor numbers increased alarmingly as 199,409 in Badrinath, 243,012 in Kedarnath, 33,771 in Gangotri and 33,311 in Yamunotri (Tourism department, Uttarakhand, 2022).

Regarding **solid waste generation**, significant positive correlation with tourists was found in some places of the IHR. Starting from the Western Himalaya, a strong relationship ($r2 = 0.92$; $p < 0.01$) was observed between waste generation (collected month wise) and number of tourists (monthly arrival in a year, June-December 2021) at Leh town. Then municipal solid waste (MSW) generation also increases during the Year Season (June to August) during Amarnath Yatra in Jammu and Kashmir. In Himachal Pradesh, Shimla and Kullu-Manali are in danger due to huge quantities of garbage and significant positive relation was found between tourist arrival and MSW, i.e., Shimla ($r=0.80$) and Kullu ($r=0.96$). In Uttarakhand, highest solid waste was found to be generated in Dehradun and Haridwar districts. However, in north eastern states like in Sikkim, solid waste management is found well regulated. In Singalila National Park of Darjeeling, the tourist inflow was positively correlated with the waste generation. A sharp increase in the volume and composition of the solid waste was observed during the peak tourist seasons. The waste generated in Aizawl city of Mizoram shows an increasing trend over the years. The available monthly solid waste data of the year 2020-2021 indicates that there is a significant hike in solid waste quantity during November to January. The sudden hike of waste has significant relationship ($r=0.86$) with the tourist influx in the city/state. Whereas, no impact was observed in Nagaland between tourist visit and yearly mean of solid waste generated (TPD) ($r=.41$).

Thereafter, considering **air quality**, vital parameters of air quality in Ladakh region have not been monitored rigorously and continuously. Therefore, no long-term records are available to assess district-wise air quality or even in regional/UT scale. Only PM_{10} monitoring has been initiated in Leh district in September 2019. In Jammu and Kashmir from 1990 to March 2021, the number of buses have increased by 4 times, the number of taxis increased by 10 times and number of Auto rickshaw/Tempos have increased by 15 times. Notably, the PM_{10} remains high round the year in Jammu including peak as well as lean tourist months, hence, cannot be attributed directly to tourism activities. Nevertheless, PM_{10} is frequently observed high in the selected tourist destinations but the sporadic nature of monitoring hampers establishing its direct relationship with tourism. In Himachal Pradesh, air quality over the period of time has largely affected the tourist destinations like Kullu-Manali, Shimla, Dharamshala. The number of private vehicles has grown from 312 in 2005 to 4615 in 2013 recording a Compound Annual Growth Rate (CAGR) of 35% whereas number of taxis have increased from 165 in 2005 to 2725 in 2013, registering a CAGR of 10.46%. In total, the local vehicles in Manali recorded a CAGR of

37%, speaking of its negative effect on valley's ambient air. Significant positive correlation was found between tourist influx and level of RSPM ($\mu g/m^3$) in air in places like Dharamshala (r=0.73), Shimla (r=0.59) and Kullu (r=0.45).In Sikkim, a statistically significant positive correlation between the tourists' inflow and total numbers of registered taxis in Sikkim was found at 5% level ($p < 0.05$). The regions where the tourist influx is more, the air quality index values are high. Whereas, tourist flow and vehicle influx have no drastic impact on air quality of both the districts of Assam Hills. As per the available data (*Data Source: State Pollution Control Board, A.P.*) for Itanagar and Naharlagun townships of Capital Complex (from 2016 – 2021), the values of most of the air quality parameters ($PM_{2.5}$, SO_2, NO_2) are within the safe or permissible limits. In Nagaland, and Manipur, the impacts are not so significant. Correlation analysis was also performed on the decadal (2011-2021) data sets on tourist influx and total number of registered vehicles of Mizoram state; there was no significant relationship ($p<0.05$; $r^2=0.060$) between these variables was observed. Additionally, air quality trend over a decade (2011-2020) for some of the selected states/UTs like Ladakh, Uttarakhand, Sikkim, Arunachal Pradesh, etc. reveal that air quality parameters such as $PM_{2.5}$ is on rise. However, there is a need to monitor air quality across the important tourist destinations in the region, particularly in the states such as Uttarakhand, Himachal Pradesh, Sikkim, etc. We have analyzed the relationship between tourists' arrival and $PM_{2.5}$ for some representative sites of the IHR during the period 2011-2019. $PM_{2.5}$ data set was extracted from Average Total Surface Mass Concentration- $PM_{2.5}$ monthly 0.5 x 0.625 deg [MERRA-2 Model M2TMNXAER v5.12.4]. The analysis shows that in the North-western Himalaya, the rate of $PM_{2.5}$ increases with the increase in a number of tourists for last one decade in Ladakh region as revealed by significant positive correlation ($r=0.60$, $p<0.05$). While for the Central Himalaya, we found a positive correlation between number of tourists and $PM_{2.5}$ for the important Chardham shrines such as Kedarnath ($r=0.50$, $p<0.05$), Badrinath ($r=0.38$, $p>0.05$), Gangotri ($r=0.32$, $p>0.05$) and Yamunotri ($r=0.43$, $p<0.05$). Similarly, in the Eastern Himalayan region, we observed an increase in $PM_{2.5}$ values with the increase in tourist's arrival for Arunanchal Pradesh ($r=0.28$, $p>0.05$) and Sikkim ($r=0.49$, $p>0.05$) states, however the relationship is not significant statistically.

In terms of **water quality assessment**, long-term information is not available for UTs. As a part of the information on State Pollution Control Board of Jammu & Kashmir, water quality monitoring has been initiated at 8 locations along with the stretches of the River Indus, however, data are still not available. In Jammu region, studies in the River Tawi which flows across the Jammu city, shows that the physico-chemical water quality of the river falls under the permissible limits. Data available from secondary sources for the State of Tripura in different seasons revealed that the water quality is not so poor particularly in respect to pH, BOD, nitrate and fecal coliforms. As per a report of Mizoram State Pollution Control Board (MSPCB) and Central Pollution Control Board (CPCB), the water quality (surface water) analyzed from 36 observation points showed that all parameters, viz., dissolve oxygen (DO), pH, conductivity, BOD, FC and TC were in conformity with the desired levels required for riverine environment. According to MSPCB data records, BOD, TO, FC and TC for the years 2016-2019

of River Tlawng (Daleshwari) and River Tuirial in Mizoram also indicate a satisfactory water quality status (https://mpcb.mizoram. gov.in/ page/water-quality-ind). However, decreasing water quality of lakes associated with tourist spots like wetlands around Srinagar (i.e. Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar, etc.), Wular, Rewalsar, Renuka, Nanital, Sattal, Tsomgo, Mirik, Nakhapani and Jorepokhari lakes of Darjeeling Loktak Lake, etc. are a matter of concern.

In view of **biodiversity**, wetlands in Ladakh, e.g., Pangong, Tso Kar, and Tso Morari are popular tourist destinations which are also important habitats for a large number of waterfowl species. Close encounters of tourists in these wetlands lead to disruption in the life cycle of migratory and other birds. Tourism in Sikkim Himalaya has shown its impact on forests in terms of extraction pressures for firewood, fodder and timber, changes in species composition, and poor regeneration status of firewood along the trekking corridors of Yuksam–Dzongri area. In Singalila National Park, Darjeeling, the tourist inflow was positively correlated with the waste generation. A sharp increase in the volume and composition of the solid waste was observed during the peak tourist seasons. The direct influence of the mismanaged waste was observed on the feeding habits of endangered species such as Red Panda (*Ailurus fulgens*) and Kaleej Pheasant (*Lophura leucomelanos*).

UTs/State Specific Recommendations

Promotion of sustainable tourism requires ubiquitous planning exercise when the context comes with fragile and eco-sensitive IHR region. In many circumstances, a gap occurs between planning and implementation so planned approach for tourism development needs to be adopted. Ideally, a plan should be implementable in practice. However, planners are frequently challenged by the fact that their choices "are nuanced and have to balance idealism [what ought to happen by and for society] with pragmatism [what can happen with private sector investment]". In the IHR, 'tourism planning research gap' exists due to tourism often being naively and incorrectly viewed in prospective of 'marketing and promotion' avoiding the fact of ecological sensitiveness of the areas. Therefore, for an effective implementation of sustainable tourism, identified gaps in the IHR which require future action are suggested.

Some common suggested action for the entire IHR may include: estimation of tourist carrying capacity, promotion of green tourism, accelerate the decarbonisation of tourism operations, carbon taxes, biofuel subsidies - vehicle purchase subsidies, planning and zoning restrictions, restriction on use of vehicles in eco-sensitive areas, feed-in-tariffs for renewable energy - capital subsidies and insurance for 1st generation Carbon Dioxide Capture and Storage (CCS), establishment of proper waste segregation and management systems in tourist spots, establishment of eco friendly bio-digester toilets in high altitude trek routes, etc.

Ladakh

- *Pangong Tso lake, Nubra and Siachen Valley, Kargil, Drass*, world's highest motorable road (*Umlingla Pass*; 19,024 feet), along with some of the most popular monasteries, such as, *Hemis, Alchi, Lamayuru, Shey and Thiksay, etc. are* famous tourist places in Ladhak which require carrying capacity study for developing a planned infrastructure and amenities in consultation with diverse user groups.
- Protected areas (like *Hemis National Park*, *Changthang Cold Desert Sanctuary* and *Karakoram Sanctuary)* require vigilance and regular patrolling to reduce unwanted wildlife-tourist interaction, habitat destruction due to off-road driving, and encroachment. Simultaneously, there is a need to promote wildlife-based tourism along with periodic assessment of such activities on the natural habitat of wild flora and fauna.
- With high influx of tourists in *Chadar trek* (on frozen River Zanskar), *Markha Trek, Stok Kangri* expedition, there is a need of proper monitoring regarding issues like throwing of waste and its generation, conversion of productive land, parking area, water availability and pollution, energy needs, threats to wildlife and habitats, etc..
- There is a need to work on creation of alternate sources of drinking water in view of the water demand of the tourists and availability of local capacity to supply safe water.
- Air quality assessment need to be done to know background values in and around tourist destinations.
- Projects like *Tsangda* should be promoted for the sustainable tourism development in the region.

Jammu & Kashmir

- Lakes like Dal, Wular, Manasbaal, Nigeen, ANchar, Hokersar, Mansar, Surinsar, Sanasar, Gharana etc. are interspersed with a large number of groundwater springs. Thus, conservation and effective management of these lakes through third party monitoring need to take action on priority.
- Studies on water quality assessment of wetlands around Srinagar (i.e. Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar, etc.) are required as these have witnessed a significant reduction in the surface area and the water quality has been deteriorated since 1970's up to the present period.
- Prior monitoring of carrying capacity in terms of tourist inflow of vehicles, air quality and solid waste management largely in the Kashmir region or pilgrims visiting Shri Amarnath Ji holy cave and Mata Vaishnav Devi in Jammu need to be done to ensure quality tourism in the state.
- Regular air quality monitoring at tourist spots of Jammu region (namely, Patnitop, Sanasar, Mansar, Surinsar, Purthu-Basohliand pilgrims' sites, etc.) and in Kashmir Valley is required.
- Wilderness areas like National Parks and Sanctuaries in Jammu & Kashmir are used as if picnic spots for tourists. So these need to be strictly controlled to preserve biodiversity heritage.
- Proper database needs to be prepared on the impacts of the tourism activities on the wildlife and biodiversity of the state.

Himachal Pradesh

- Shimla, Kullu, Kangra, Lahual & Spiti, Chamba, Kinnaur, etc. districts are famous tourist destinations where mass tourism is prevailing. Here, there is an ample scope for regulation in developing sustainable tourism within a carrying capacity. In view of discouraging mass tourism, there is a need to create theme-based tourism such as eco-tourism, agri-tourism, snow tourism, adventure tourism, pilgrimage tourism, culture and heritage tourism, health and wellness, etc.
- Assessment of carrying capacity of popular tourist places like Chandra tal, Pin valley, Great Himalayan National Park (GHNP), etc. would maintain the spots sustainably. Decentralization of tourists from surrounding tourist resorts to tiny spots or from overcrowded destinations could be other ways for developing responsible tourism or ecotourism. Development of new tourist sites would minimize the problem of over-crowding.
- Implementation of efficient solid waste management system need to be strengthened with upgraded technologies or methods under waste to energy recovery systems. In view of making budgetary provision for the same, green tax is being collected from the tourists upon entering into tourist spots like Shimla, Manali and Dharmshala.
- In view of minimizing air pollution, introducing clean fuel buses like electric buses need to further expand. These have already been in use at Rohtang Pass (3978m) and other different routes in Himachal Pradesh.

- NGOs need to be involved in conducting public awareness programs on waste minimization, substitution and management among different stakeholders including tourists. Also, proper signboards would go a long way in making aware the public.

Uttarakhand

- Online registration of all the upcoming tourists irrespective to ages to major sensitive and fragile tourist locations need to be done at an entry place. The purpose of tourists (adventure, wellness and health, ecotourism, wildlife tourism, etc.) may be incorporated under the online registration. There is a need for mentioning the details separately private or commercial vehicles.
- Clean fuel energy based vehicles like electric vehicles could be one of the ecofriendly options for minimising vehicular pollution in the fragile tourist spots like Nainital, Mussorrie, etc.
- Air and water quality monitoring should be done on continuous basis and waste management practices need also to be followed as per the action plan of the ESZ.
- More sewage treatment facilities (9 STPs operational in Ganga priority towns as envisaged under Namami Gange project) need to be introduced. This step would be able to save river system from the repercussions of unsustainable tourism and purification units for grey water to set up in major resorts or hotels. Further, this step may be used for landscape management and would stop the wastage of fresh water.
- The commercial vehicle drivers/owners need to be trained for not allowing the tourists to throw their garbage on roads or any other open places. Ban on plastic needs to be properly imposed as per guidelines in various tourist stations.

Sikkim

- There is an urgent need to consolidate all existing missions (Sikkim Tourism Mission-2015) and plans. This step together with strong participation of the different tourism stakeholders would develop a 'Policy' for sustainable Sikkim Tourism.
- Carrying capacity assessment is needed for the existing fragile destinations (i.e. Tsomgo Lake, Yumthang Valley and Lake Gurudongmar).
- Sustainable use of natural, social and cultural resources and their conservation practices for tourism over recreational (e.g.,Tsomgo Lake) or leisure tourism are very crucial. Therefore, tourism should be planned and managed within environmental limits along with due regard to the long-term appropriate use of natural and human resources.
- Research Initiative (e.g. Tsomgo Pokhri Sanrakshan Samiti) for protection and conservation of the lake, cleanliness drive at YuksumDzongri in KNP, garbage monitoring for tourist at parks, and complete ban on construction in Eco-sensitive zones have already been under process which further need to be encouraged in different ways. Its few examples are: staff training, involvement of local people and making aware, through education, and marketing tourism, etc. These steps could further minimize the impact of mass tourism.

- Wildlife depletion has to be checked and to be increased in their numbers by appropriate conservation programmes. Also, there is a need for improvement in other related infrastructure in view of maintenance of the Sikkim eco-tourism.

West Bengal, Darjeeling Hills

- As Darjeeling has been facing a problem of ill-manged traffic, so it is necessary to control the number of tourists through exploring threshold value. This step would care capacity of the tourist places / eco-sensitive zones.
- There is a need of biomethanation composting for wet waste and more waste disposition centres for managing the bulk waste generated due to growth of urban population and tourist inflow in the hills.
- Continuous monitoring air quality is required for knowing the status of emissions in the hills. The study conducted by Sarkar *et al.* (2015) showed that there is a high concentration values of Black Carbon (BC) observed during pre-monsoon season and winter season (2010-2011). This study reflects that the direct influence of tourist activities on air quality is due to high inflow of tourists in Darjeeling and surrounding areas.
- There is a need to protect biodiversity of the national park (Singalila NP, a home of the Red Pandas). Here, tourist inflow was observed more than its carrying capacity.
- Nature based tourism may have long lasting benefits if the environmental losses in different forms could be controlled. The eco-friendly planning process is required for promotion and sustainable development in tourism industry.

Assam Hills

- Complete inventory and documentation of wild flora and fauna is required. Extensive field-based research and consultation with local stakeholders for documentation of the hills would further help documentation of biodiversity in the region.
- Community-Based Tourism (CBT), enhancing local people's involvement and participation in tourism planning and development in their areas would help in uplifting the status of tourism. It has been observed that such activities would have a positive impact on the social, economic, and environmental conditions of the tribal communities of Assam.
- Proper monitoring is required for air pollution to assess its impact on tourism.
- Waste management is another challenge that a hill is facing, proper segregation, and disposal method is needed under waste to energy initiaves.
- Expansion in the institutional capacity of local government for climate change planning will require adaptation planning, based on NDC and SDGs implementation.

Arunachal Pradesh

- Carrying capacity, management of resources, conservation of cultural and environmental asset is required in the state for sustainable tourism.
- The state's concerned department has started collection of domestic waste in major townships but its disposal/dumping is unplanned. Therefore, there is a need on designing

proper infrastructure for proper waste disposal and its treatment so that the impacts on environment (water, soil, ecosystem, etc.) can be minimised. Proper waste management is also directly related to the tourism sector, which would help in attracting more tourists.

- Arunachal Pradesh is among the states which has very rich biodiversity and this natural wealth is one of the main attractions for tourists especially foreigners. However, the state is facing challenges like deforestation, urbanization and other developmental activities which are damaging the forest cover and biodiversity of the state. Climate change is another threat to the biodiversity of the state. Thus, it is strongly recommended to immediately adopt appropriate strategies which may help in conserving biodiversity of the state and at the same time promote future adaptation to deal with climate change impacts.
- This state is already having in place its 'State Eco-tourism Policy'. However, the tourism sector in Arunachal Pradesh could not develop as its hub for 'eco-tourism destination'. Efforts should be made to make Arunachal Pradesh as a hub for community driven eco-tourism. The people and government agencies can work together to make it a success.
- It is recommended to establish a system in the state which can help the government to gather categorical information on cost-benefit basis (environmental and economic both) due to tourism sector. At present, there is no any such system in place. That's why, it's very difficult to assess direct impacts of tourism. Generation of reliable knowledge including scientific data is always essential to understand the magnitude of issues, so all the concerned departments should have a well-established mechanism to regularly collect data and keep it updating regularly so that these can be used properly in future studies and planning.
- Arunachal Pradesh, owning a very distinct landscape, has a very special value for the nature lovers. That's why government or any other agency needs only promotion of nature-based tourism in the state. This is the only way by which the state can always keep its special status of biodiversity hotspot and promote sustainable tourism for the well-being of the people and environment.
- Knowledge generation need also to be prioritised to understand the magnitude of a problem. It is therefore strongly recommended that the state needs to conduct specific studies to review present status of problems (w.r.t. environmental pollution) so that actions and strategies can be developed for future planning.
- Encouraging energy conservation practices, water conservation methods, green protocols in the state through awards for green practices need to be promoted.

Nagaland

- Strengthening community-based tourism (e.g. Khonoma Green village, and Touphema Heritage village practice community tourism management) and developing Eco-Tourism models with participation of local people and government departments in several tourist spots in Nagaland is a need of the hour.
- Plantation of native trees, creation and maintenance of natural parks and greenery should be made a priority in urban areas such as Dimapur, Kohima city, etc. in Nagaland.

- Focus should be on expansion of protected area network and augmentation of wildlife protection.
- Waste management (sewage and solid waste) seems to be one of the major issues related to environmental pollution in Nagaland. The study elaborates that the major reason for water pollution in Dimapur city is sewage/waste water. Likewise, Kohima municipal council dumping site is a major source of water pollution. Therefore, the state government should immediately act on designing proper infrastructure to deal with alike important issues.
- In view of actions being taken and future strategies development, studies need to be conducted linking growth of tourism along with environmental problems, such as, waste generation, sewage treatment facilities, loss of forest and biodiversity.

Mizoram

- Green taxes/cases may be levied on tourist vehicles similar to some other resorts.
- The collected green tax needs to be spent on maintaining the sanctity and serenity of the tourist destinations in state. Further, it can be utilized in improving solid waste management infrastructure such as resource recovery centres, engineered landfill areas, etc.
- Prior online registration can be made mandatory for tourists visiting the state especially in the eco-sensitive zones/areas to ensure quality tourism in a sustainable manner. For example, our neighboring hill country like Royal government of Bhutan is also following this approach to promote quality tourism in the country and ensuring equitable benefit sharing to the home stay owners.
- Assessment of carrying capacity of tourist destinations, eco-sensitive zones and major cities will help a lot in managing the tourist influx and catering them in order to promote quality tourism in the state.
- Installation and/or improvement of air quality monitoring stations, solid waste management units and water quality monitoring systems at district level can be done in order to sustain the healthy ecosystem of the state.

Manipur

- Manipur lies in the biodiversity hot spots region of the world, hosting many important, rare, and endemic species. However, hilly areas of the state are characterized by poverty and food insecurity. The important traditional knowledge associated with the flora and fauna are vanishing before being scientifically investigated. Therefore, proper documentation of this wealth of the state should be a prerequisite prior to tourism management in the state.
- Some of the main threats to biodiversity are forest fire, fuel wood collection, hunting bush meat, indiscriminate agri-chemical uses, and lack of awareness. Capacity building programs need to be organized to sensitize the resident community towards the importance and intangible services of the biodiversity.
- Proper solid waste management systems through capacity building, infrastructure development (such as engineered landfill areas, resource recovery centres, biodegradation

mechanism, etc.), waste recycling needs to be done in order to attract tourists and its sustenance.

- Assessment of carrying capacity of tourist destinations, eco-sensitive zones and major cities needs to be done in order to manage the tourist influx and catering them in order to promote quality tourism in the state.

Tripura

- Data related to tourist visits to protected areas is yet to be documented through close monitoring. A sound management plan for conservation and management of these protected areas is highly needed.
- Installation of water functional system equipped with advanced instrumentation for water purification and distribution to households is a need in the entire state including rural areas.
- Study on impact of tourists' influx on biodiversity is almost lacking in the state which is an important element for understanding the future implications of tourism and developing action plan accordingly.
- Some facility for processing of garbage exists (e.g. Debendra Chandra Nagar Dumpyard), but proper scientific and sufficient information about processing should be provided.

12. Meghalaya

- Tourism is benefitting the local economy and substantial growth is anticipated in Meghalaya in future. However, it needs proper strategies of management to safeguard the environment.

- Regular solid waste quantification by municipal bodies and assessment of the composition of solid waste generated is very essential to recommend different scientific measures for management of urban solid waste and its reuse. Municipal bodies should stop open dumping of solid waste and biomedical waste should be incinerated to avoid pollution in the downstream areas, and reservoirs/water bodies.

- The present impacted area due to unscientific mining should have remedial measures like filling of mine pits, channeling of acidic seepage for checking AMD contamination of water bodies and crop fields, extensive afforestation, neutralization of acidity, conservation of topsoil, etc. coupled with scientific management of present day mining operations.

- Ground water in the area is generally fine and suitable for drinking, domestic and industrial use. However, concentrations of greater than 1 mg/litre iron in groundwater in some

pockets have been reported. The presence of iron in drinking water should be managed through proper filtration technique.

- Separate information on air,water as well as pollution caused by solid waste generated due to tourism activities in the state is not available. Hence, we recommend scientific investigation of air and water quality parameters as well as solid waste generation during the peak tourism season in Meghalaya.

Action plan for the IHR

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
Ecological sustainability	Using resources sustainably by maintaining tourist carrying capacity in over-crowded spots / places	Determination of tourists inflow at a place within carrying capacity considering Spatio-temporal dynamics, physical-ecological , infrastructural and Socio-demographic parameters	Famous tourist circuits / places like Chardhams, Shri Amarnath Ji holy cave, Mata Vaishnav Devi, high altitude camp sites, picnic spots like Rothang Pass, Hemkund Sahib, Darjeeling,	District tourism department , District Administration	Mandatory registration of tourists entry within the estimated capacity	CPCB, NIHE	2 to 3 years	Minimization in pollution load, less pressure on endangered species,less soil erosion, less deposits of black carbon (BC) over snow & less darkening of snow due to BC	Action for bugyals already taken: Hon'ble High Court Uttarakhan, Nainital, in WPPIL No.123 of 2014 order (i.e.200 tourists per day restricted for bugyal areas); Hon'ble NGT order

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		Establishing online entry registration system	bugyals, etc.						dated 3rd July, 2018 is available in this issue. Carrying capacity assessment of eco-sensitive areas.
	Proper management of solid waste	Segregation of waste: biodegradable (composting) and non-biodegradable (re-use, recycling, etc.), Reducing single-use plastic,	Over-crowded hill spots, high altitude treks, picnic spots, NPs especially in J&K, H.P., U.K., etc.	Municipal Committees, village Panchayats, Local community-based organizations (CBOs) etc.	Regular monitoring of waste generation & disposal (landfilled waste to energy initiatives, etc.) and record maintenance		Up to 2 years	Converting waste into wealth, Contributing to environmental protection, Creation of alternative livelihood options	Hon'ble NGT order dated 8th October, 2018 also mentions a need for solid waste management

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		Graphene from plastic, Use of shredded plastic chips in road constructions. Establishment of eco-friendly and bio-digester toilets in high altitude routes, Solar power-based solid waste manageme							

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		nt plant for source segregation , Recovery to generate revenue from recyclables and organic compost, Minimising pollution & seeking possibilities in geo-thermal energy							
	Establishing air quality monitoring stations	Addition in air quality monitoring stations other than	High altitude tourist spots in the north-	State Pollution Control Board (SPCB)	Regular monitoring of basic air quality parameters	NIHE, ARIES, IIRS, WIHG, etc.	1 year	Clean air & positive health implications ,	Hon'ble NGT order dated 21st October, 2010

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		industrial towns for knowing background values, Planning and zoning restrictions in sensitive areas, Needs for restriction on use of vehicles in eco-sensitive areas	western Himalayan states (J&K, H.P. (Manali, Shimla, and Dharamshala), U.K., etc.)		like NO_2, SO_2, O_3,BC, PM_{10}, $PM_{2.5}$, etc.			Attraction to more tourists, Revenue generation, Creation of more green belts	highlights issues to control vehicular movement in Manali and Rohtang Pass for maintaining ecology. As a preventive measure for dealing with the air pollution in eco-friendly way first urban forest known as

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
									Anand Van (City Forest) is developed in Jhajra Forest Range of Dehradun. The plant / tree species, found in Uttarakhand, which are having capacity to reduce the harmful effect of gaseous pollutants.
	Establishment of water	As per the standard protocol,	Important lakes/rivers associated	Municipalities, Public Health	Regular monitoring of water	SPCB, CBCBs	1 year	Clean drinking water,	No boat house in lakes

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
	monitoring stations	physico-chemical, biological parameters of drinking water need to be studied covering all tourist spots / lakes with sewerage treatment plants	with tourist spots like wetlands around Srinagar (i.e. Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar, etc.), Wular, Rewalsar, Renuka, Nanital, Sattal, Tsomgo, Mirik, Nakhapani and Jorepokhari lakes of	Engineering Department, State Ground Water Board	quality parameters like pH, EC, TDS, BOD, COD, TC, etc.			Minimization of pollution load, Eradication of weeds, Stability in fresh water availability	should be allowed to drain effluents into lakes. Strict online monitoring is needed.

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
			Darjeeling Loktak Lake, etc.						
	Promotion of green transport	Encouraging electric vehicles, e-snow scooters, addition in rope ways to connect high altitude picnic spots, regular servicing & maintenance of vehicles surveillance & monitoring of pollution	Hill towns like Srinagar, Gulmarg, Sonmarg, Dharamshala, Kullu, Mussoorie, Almora, Nainital, etc.	State Transport Department, pollution measuring agencies, etc.	Carbon taxes, fossil fuel subsidy removal - feed-in-tariffs for renewable energy - capital subsidies	SPCB	5 years	Reduction in GHGs (CO_2, CO, O3, etc.) & other emissions (BC, trace gasses (NO_2, SO_2, etc.), Increase in green belts around spots	

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		monitoring agencies through online data recording, Introducing other non-polluting ways like cycling, etc. Planting more and more native vegetation species							
	Increase in public awareness on ecosystem degradation	Sign boards depicting the impact of tourism on flora & fauna, mainly	Eco-sensitive zones like Gangotri NP, Govind NP, wildlife sanctuary,	Forest, wildlife, tourists, natives, local government	Establishment and maintenance of strict surveillance teams	BSI, ZSI other research organizations	1 year	Enhanced public awareness about ecosystem degradation,	

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		IUCN category plants and animals, Sign boards to tourists– Do's and Don'ts	Valley of Flowers NP, Singalila National Park, etc.					Conservation of ecotourism sites, Development of responsible tourism	
Economic Sustainability	Supporting local Economies by promoting eco-tourism	Promotion of nature based tourism (e.g. geo tourism, bird watching, trekking, paragliding, Heli-skiing, etc.), Marketing tourism that would strengthen	Every picnic spot, Himalayan villages, etc.	District tourism department, village Panchayats, District administration	Development of ecotourism portal for record maintenance, capacity building and training	Hospitality or Tourism management departments	3 years	Promotion of tourism as a source of local revenue generation, Local livelihood generation, Local employment in different universities / organizatio	

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
		network in respect to natural, social and cultural aspects of different destination areas						ns	
	Reducing seasonality in tourist season	Creation of recreational resources (winter sports like skiing, snowfall seeing, etc.), Identifying picnic spots having potential	Snowfall experiencing hill spots, treks, expedition summits, within concerned states	District tourism department, Local district administration	Online registration	Adventure tourist deptt., Mountaineering Institutes	1-2 years	All weather tourism, Local employment, Alternative livelihood generation	
Cultural Sustainabil	Establishment of	Mapping of places with	All the IHR states	District tourism	Development of	Archalogical suvery of	2 years	Promotion of the	

Goal	Implementation							Impact	Remarks
Addressing issues / Pillars	Action agenda	Mode / mechanism of action	Suggested places	Responsible stakeholder	Monitoring mechanism	Knowledge partner, if required	Tentative time frame	Outcome / Benefit	
ity	sustainable tourism apps	traditional importance and establishment	having a special cultural heritage	department	regional apps	India, MoT, etc.		traditional values, Maintenance of age-cultural sites	
Local communities & sustainability	Promotion of green economy initiatives	Monitoring of illegal /over-constructions of buildings, Promotion of cuisines, Promotion of local handicrafts	Hill towns, spots, etc.	District administration	Regular monitoring following the URDPFI (vol. ii) guidelines for towns	Sate Forest deptt.,	1 year	Prohibition in overloading of constructions in eco-sensitive hill areas	Hon'ble NGT orders, dated 3rd July, 2019 explains restriction of building construction in Manali & 5th October, 2018 highlights construction of Kasauli Geotextile resort.

Conclusion

There has been increasing concerns over the sustainability of the tourism industry, particularly in the fragile Himalayan mountains. In general, tourism in the Himalayan ecosystem is considered as contributing to several environmental challenges, including carbon emissions that lead to global warming and ultimately climate change. On the other hand, tourism has been featured in at least three SDGs–SDGs 8 (Decent Work), 12 (Sustainable Consumption and Production) and 14 (Life in Water). In the Indian Himalayan Region, growth of the tourism industry is extensive in the states of West Bengal, Uttarakhand, Himachal Pradesh followed by other states. Simultaneously, adverse impacts include: increased waste generation, increased vehicles, increased waste disposal into rivers. These together have led to degradation of the soil, water and air quality over a period of time. In the states/tourist destinations where the air quality has become worst

Therefore, establishment of regulated tourism practices with promotion of sustainable agendas are required for the IHR. This could be achieved through maintenance of the proper tourist capacity in every tourist place of the IHR which will in turn minimize mainly the generation of solid waste, and pollution level in the water, air and destruction of biodiversity. Some of the successful ecofriendly representative illustrations in this regard include: measures taken by the Himachal Pradesh Govt. (e.g. vehicles regulation rules on Rohtang Pass), Hon'ble High Court Uttarakhand, Nainital (maintenance of 200 tourists per day for bugyal (alpine pastures)), the Sikkim Govt. (ban in disposable plastic bags in Sikkim), etc. Further, sate specific adaptation measures in this regard are described under the recommendation section of the report. These include: levying green tax/cases on tourist vehicles, renewable energy-based vehicles, proper solid waste management systems, installation of equipment's with latest technologies for air quality monitoring, strengthening community-based tourism, etc. Ultimately, establishment of responsible and sustainable tourism is a need of the hour for the Himalayan region which will have a large future impact in the socioeconomic well-being of the entire area.

On the basis of the available information, the direct impact of tourism on the persons' economic prosperity and environmental impact is therefore difficult to justify the statement, "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic". In some of the over-crowded and mass tourism circuits within Himachal Pradesh and Uttarakhand, some pockets might have gained economic prosperity due to tourism but this could not be true in case of every state of the IHR particularly the north-eastern states. It is therefore a requirement of more data and/or studies in terms of economic growth, environmental cost, and tourist carrying capacity to fill up these gaps in the north-eastern states in particular and other remaining states/UTs in general.

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