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No.33/01/2023-CS-I
Government of India
Ministry of Environment, Forest and Climate Change
CS-I (Mountain) Division
.....

Agni-512, Indira Paryavaran Bhawan,
Jorbagh Road, New Delhi-110003.

Dated, 17th October 2024

To
Registrar General,
Principal Bench,
Hon'ble National Green Tribunal,
Copernicus Marg, New Delhi-110001

Subject: Status Report in pursuance of Order dated 09.03.2022 OA 178/2022 titled as News item published in the Hindu dated 27.02.2022 titled "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic", passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

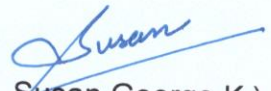
Sir,

In pursuance of Order dated 09.03.2022 passed by the Hon'ble National Green Tribunal (NGT) in OA No. 178/2022 titled as News item published in the Hindu dated 27.02.2022 titled "*Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic*", and order dated 12.07.2024 in M.A No.14/2024, the undersigned is directed to submit herewith the Status Report as on 16.10.2024.

2. This issues with the approval of the Competent Authority.

Encl.: As above

Yours sincerely,


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**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI**

**M.A No. 14 of 2024
In
Original Application No. 178 of 2022**

In Re: News item published in The Hindu, dated 27.02.2022, titled "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic"

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Status Report as on 16.10.2024, in continuation of earlier status reports dated 10.01.2024 and 10.07.2024 on behalf of Ministry of Environment, Forest and Climate Change in OA No. 178/2022, titled as In re: News item published in The Hindu, dated 27.02.2022, titled “Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic”

That the Hon’ble National Green Tribunal vide its Order dated 09.03.2022 in OA No. 178/2022, *In re: News item published in The Hindu, dated 27.02.2022, titled “Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic”*, directed G.B. Pant National Institute of Himalayan Environment (GBPNIHE), Almora to undertake study and to update any study already conducted in light of the inputs available in the media report and Ministry of Environment, Forest and Climate Change to steer preparation of appropriate action plans in all the States of Indian Himalayan Region (IHR) dealing with the mitigation measures to offset the adverse impact of tourism activities on the environment and to file a compliance report.

2. In this regard, this Ministry has earlier filed two status reports dated 10.01.2024 and 10.07.2024 before this Hon’ble Tribunal submitting the progress in consultation with States and UTs on the draft report and requesting more time for finalization of the report.

3. That the process of consultation with all IHR States and UTs has now been completed. Accordingly, the report titled ‘*Environmental Assessment of Tourism in the Indian Himalayan Region*’ prepared by the G.B. Pant National Institute of Himalayan Environment (GBPNIHE), Almora in consultation with this Ministry and other stakeholders is hereby filed as **Annexure-I**.

.....



Environmental Assessment of Tourism in the Indian Himalayan Region



By

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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 Bench,
New Delhi

16th October, 2024

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This report titled, 'Environmental Assessment of Tourism in the Indian Himalayan Region (IHR)' in compliance with the 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 based on the inputs of the committee of scientists of NIHE constituted 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.

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ABBREVIATIONS

ALTOA	All Ladakh Tour Operators Association
AMC	Aizawl Municipal Corporation
AMC	Agartala Municipal Corporation
APTI	Air Pollution Tolerance Index
AQ	Air Quality
AQI	Air Quality Index
Asl	Above sea level
BCM	Billion cubic metre
BOD	Biological oxygen demand
CAAQMS	Continuous Ambient Air Quality Monitoring Station
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	Dimapur Municipal Council
DO	Dissolved Oxygen
E. coli	Escherichia coli

EC	Electrical Conductivity
EN	Endangered
ENVIS	Environmental Information System
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 Plant
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	Himachal Pradesh 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 Corporation
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	Lifestyle for Environment
LRC	Ladakh Regional Centre
MCL	Municipal Committee of <i>Leh</i>
MDF	Moderately Dense Forest
MINARS	Monitoring of Indian National Aquatic Resources
MLD	Million Litres per Day
MNP	Mangan Nagar Panchayat
MoEF&CC	Ministry of Environment, Forest 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	Northeast Regional Center
NGT	National Green Tribunal
NIHE	G. B. Pant National Institute of Himalayan Environment
NITI Aayog	National Institution for Transforming India Aayog

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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 a diameter of 10 microns or less
PM _{2.5}	Particulate Matter with a diameter of 2.5 microns 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
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	Wildlife Institute of India
WUM	Workers' union Manipur

PREFACE

Over the decades, tourism has experienced continued growth and is one of the fastest growing economic sectors in the world. It has 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 the Sustainable Development Goals (SDGs), particularly 8, 12, 14 and 15.

Since decades, a variety of tourists with various human interests have been drawn to the Himalayan region, which is noted for its distinctive ecosystem, quiet beauty, and tranquility. Due to infinite exploring options in the Himalaya throughout the years, tourism sector is going to be pushed to newer dimensions. Tourism is undertaken for a variety of objectives such as leisure, health, fitness, ecotourism, pilgrimage, and many more. The ecological impact of tourism in the Himalayan region is accompanied by economic, lifestyle, and general well-being effects on the local population.

In recent years, sustainable tourism has emerged as a response to lessen the impacts of mass tourism on the Himalayan environment and for 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 the fragility 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 (NGT) 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, 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 queries made in the Hon'ble NGT order and fill up some of the gaps in existing knowledge of the Himalayan tourism.

J.C. Kuniyal, Ph.D., Lead Scientist

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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 floral, faunal and cultural diversity. It attracts tourists, pilgrims, trekkers, and mountaineers not only from India but also from different corners of the world. The Himalayan ecosystem provides a variety of ecosystem services to the region's inhabitants and the people inhabiting the adjacent lowlands. It is also a strategic location from a viewpoint of security of the nation. This region has immense potential for tourism in terms of 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 local community, economy, and overall 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 inadequate waste disposal, air, soil and water pollution, impact on forests and biodiversity, etc., affecting the fragile mountain ecosystems over a period of time.

Tourism and hospitality contribute about Rs. 7150 Crores (USD 71.5 billion) the Gross Domestic Product (GDP) of India, 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. The Ministry of Tourism sanctioned 18 projects covering all the Northeastern States for Rs. 1,456 crores (US\$ 211.35 million) to develop and promote tourism in the region under Swadesh Darshan and Pilgrimage Rejuvenation and Spiritual Augmentation Drive (PRASHAD) schemes. On 29th April 2022, the Ministry of Tourism, Government of India launched National Strategy for Sustainable Tourism for promotion of 6 strategic pillars of sustainable tourism including (i) promoting environmental sustainability, (ii) protecting biodiversity, (iii) promoting economic sustainability, (iv) promoting socio-cultural sustainability, (v) scheme for certification of sustainable tourism, (vi) Information, Education and Communication (IEC) and capacity building, and (vii) governance. All of the aforementioned initiatives will be in harmony with the government of India's "Lifestyle for Environment" (LiFE) programme, The findings of the present study can be summarized as follows:

- In Himachal Pradesh, tourism contributes 7% to SGDP (2020-2021). In the case of Uttarakhand, tourism contributed 2.96 % of the total GSDP directly and 6.59% indirectly pertaining to tourism

industry linkages with other sectors. Considering the revenue receipts in the western Himalayan States, Ladakh received more than Rs 90 million a year. While in terms of revenue generation from tourism in the north-eastern states (NER), Assam stood first amongst all the NER states. Sikkim, on the other hand spends maximum in the tourism sector i.e., around 1.9% of total state expenditure while all other IHR states invest less than 1% of their total expenditure.

- Uttarakhand receives maximum tourists (around 5.94 crore in 2023) among all the IHR States/UTs followed by Himachal Pradesh. Pilgrimage based tourism is pervasive in Uttarakhand as well as Jammu & Kashmir. Another UT in the western Himalaya, viz.; Ladakh receives very small number of tourists compared to other States/UTs. Amongst the State/UTs in north-eastern Himalaya, Assam State has highest tourist influx – it was around 59 lakhs in 2018.
- Among the IHR states/UTs, Uttarakhand generates maximum amount of solid waste (1637.54 MT/day) followed by Jammu and Kashmir (1518.9 MT/day), Assam 1284 MT/day, Sikkim produces around 50–56 MT/day of urban solid garbage per day, which ranks among the lowest production rates.
- Air quality monitoring over the states/UTs of IHR has begun lately. However, these monitoring stations are largely located in states/UTs urban centres and are not specific to tourist hotspots as such. Although, some monitoring stations are setup in areas which are city centre as well as famous tourist spots. For example, air quality is being monitored on Ridge which is a famous tourist spot in Shimla, Himachal Pradesh. The data have shown increasing trends of RSPM concentration during the months of May and June (2012 and 2013) which also coincides with peak tourist season in Himachal Pradesh. Still, at a wider scale, it is difficult to develop a relationship between decreasing air quality and increasing tourism activities. This is fact that the tourist vehicles influx during tourist peak tourist season may influence the air quality of any area.
- Looking at 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 Gurudongmar Lake in Sikkim, Nakhapani, Jorepokhari, and Mirik in West Bengal hills, Loktak in Manipur, Dumboor in Tripura, Umiam in Meghalaya, etc.
- Some gap areas were also identified during the course of this study, including issues like data deficiency on tourist and vehicular (type wise) influx, long-term trends of air and water quality, inadequate infrastructure for solid waste management, purification techniques for air and water, lack

of adequate supply of water (tourist demand and supply), lack of continuous data pertaining to air and water quality of the tourist places, and economic issues including contribution of tourist revenue to state economy, tourist carrying capacity, etc.

Many States and UTs have undertaken *initiatives* in view of waste management, air and water quality as well as forest and biodiversity management. Ladakh UT has developed a centralized wastewater management system and has connected households through sewerage system. Jammu & Kashmir has worked on different aspects of environmental management in view of sustainable tourism through formulation of comprehensive plan for waste management, promotion of eco- and nature-based tourism. Himachal Pradesh levies environmental tax and has been working on providing better sanitation services at some tourist hotspots. Sikkim has initiated mechanism for waste management in Protected Areas by involving NGOs. Arunachal Pradesh has promulgated a policy to promote use of plastic waste for road construction. Mizoram, through its Responsible Tourism Policy, has initiated sanitary and hygiene standards in hospitality sector. Tripura has developed a portal for complaints and grievances in view of environment related issues like air, water and noise pollution. Meghalaya has developed a portal for database management regarding tourists' influx, hotels, individuals engaged in tourism sector, etc. Floating waste generated during Shri Amarnath Yatra is managed by a comprehensive plan, through stop over points in different phase-wise manner, implemented by different government line agencies. Uttarakhand State has implemented a digital deposit refund system to manage plastic waste generated during Kedarnath Yatra.

Different scientific studies and *initiatives* have been also undertaken for waste management by G.B. Pant National Institute of Himalayan Environment (NIHE) as well as MoEF&CC under National Mission on Himalayan Studies (NMHS) for the Indian Himalayan region. These include wet waste management through microbial bio-composting pits, management of plastic waste by synthesizing it into graphene, waste to wealth initiatives, infrastructure development for secondary waste management, use of modelling tools to establish linkage between tourism, local environment, and waste generation, etc.

While it is difficult to relate tourism and their direct and specific impacts on the environment, it was noticed that tourism-related activities in the IHR were much more pervasive in the north-western compared to the north-eastern region. In view of *recommendations*, the following points are worth mentioning:

The north-western States/UTs, viz., Jammu and Kashmir, Himachal Pradesh and Uttarakhand need to carry out tourism carrying capacity assessment to evaluate the limits of tourism development and use of locally available resources. Annual tourism influx in each of these three States/UTs is more than one crore, hence floating waste is generated. This may require separate waste management infrastructure in tourist hot spots.

The state of Himachal Pradesh has implemented a green-tax barrier, which could be implemented by other states/UTs in the IHR. However, it needs to be assured that the fund is utilized for the conservation and management of environment. Volunteer tourism and rural tourism, a part of tourism in Ladakh, can be promulgated throughout the IHR. Air quality needs to be monitored in important tourist places particularly throughout the north-western IHR. Mobile air quality monitoring which helps in evaluating short-distance pollution change could give a clear-cut idea regarding the impact of vehicular influx and other tourism activities on ambient air quality.

Tourism influx in the north-eastern states is less compared to the north-western states of the IHR. However, it has grown throughout the north-eastern IHR states over the recent past decade. Sikkim, known for its adventure tourism, has taken some initiatives such as reducing the use of firewood for cooking by making it compulsory for trekkers to carry with them kerosene stoves. This could be implemented across the IHR states where trekking and other adventurous tourism prevail. Similarly, participatory mode of protection and conservation of bioresources such as in Khanchendzonga National Park (NAP) could be reciprocated across all the Protected Areas famous for tourism activities. Assam hosts the highest number of tourists among the north-eastern IHR states. Although, impacts of tourism activities on environment are not clearly visible, the state could take preemptive measures for introducing environmental management plans for sustainable tourism.

While tourism is contributing to the economy, it needs to go hand in hand with conservation of the environment and preservation of ecosystem-services. There needs to be environmental management plans specific to tourism at micro levels. These action plans could define different tourism hot spots and thereby environmental pressure points. It is necessary to fully execute all National Acts, Guidelines, and Regulations pertaining to environmental protection and sustainable resource use. Regular air and water quality monitoring in urban as well as rural areas need to be practiced for assessing the impact of tourism on these environmental components. In view of bringing under control ambient air quality, introducing electric vehicles in the Himalayan spots could be one of the feasible

solutions. Inventory of different water resources, including their seasonal discharge rates and quality measurements need to be recorded. A study of tourism activity on biodiversity, socio-cultural system and related components is required to be conducted. Also, there is a need to increase the capacity of authorities working in the tourism industry and other relevant departments as well as environmental awareness among travellers and locals involved in tourism about ethical and environment friendly travel. In order to practice sustainable tourism in the IHR, it is necessary to strengthen community-based village tourism.

The Indian Himalayan Region (IHR)

The IHR spreads 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 characterised by a diverse demographic, environmental and socio-economic system. The entire IHR is a paradise for tourists and has experienced 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 issues with solid waste, pollution of the air and water, degraded watersheds, and the depletion of natural resources, biodiversity, and ecosystem services, among others.

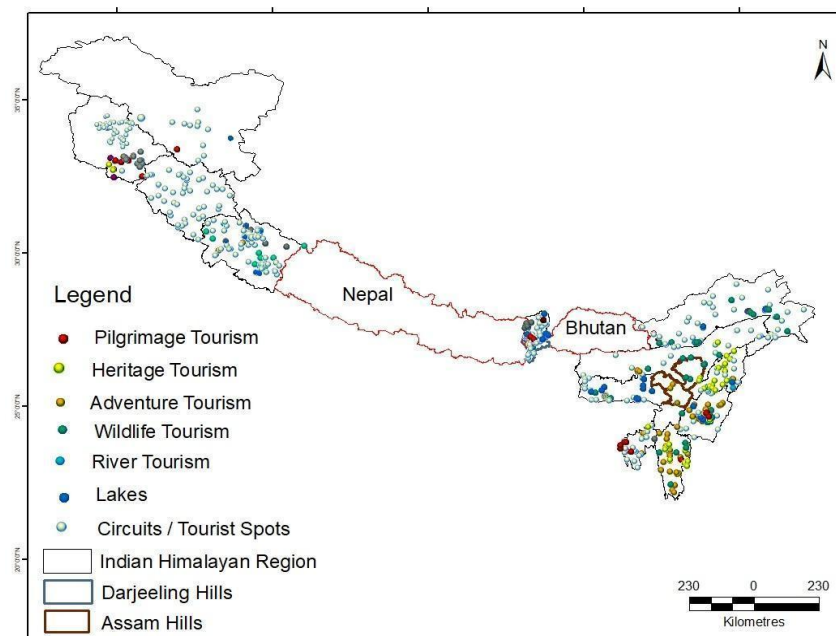


Figure 1. Tourism in Indian Himalayan Region

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 09.03.2022 and directed the G.B. Pant National Institute of Himalayan Environment (NIHE), Almora to undertake study and to update any study already conducted in light of the inputs available in the above media report. The findings of the study would help the preparation of the appropriate action plans in the IHR States/UTs.

Objectives of the Study

The overall objective of this study was to assess the impact of tourism in the Himalayan Region (NGT Order No. 178/2022, dated 09.03.2022). As a follow-up of the NGT order, NIHE has conducted a quick appraisal to prepare the report. Initially, the data/information were collected through secondary sources; thereafter the draft report was shared with the concerned states for vetting as well as providing additional inputs pertaining to the following aspects:

(i) 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 bio-composting); (iv) Impact of tourism on air and water quality and measures taken by the concerned State Govt. for mitigation; and (v) Impact of tourism on forest and biodiversity and compliance of rules and regulations relating to ESZ/ESA to avoid the negative impacts to the environment.

Methodology

Given the short period of the assignment, NIHE constituted a team of experts of its faculty and held a few rounds of consultations among them to develop methodology to accomplish the present 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 departments (viz., Tourism, Transport, Central Pollution Control Board, State Ground Water Board, Forest, 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 the concerned departments 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., PM₁₀, PM_{2.5}, SO₂, NO₂, etc.), facilities for air purification, water quality (physico-chemical parameters) of the tourist towns 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 departments to get the desired data. The data/information thus collected was compiled, synthesized and a report was drafted. Detailed data/information on various aspects of this report for each of the 11 States and 2 UTs are given 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 the Institute's headquarters 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 1st week of June 2022 and subsequently to NGT on 20th June 2022 which was later withdrawn. Thereafter, the report was again shared with Chief Secretaries of the respective State/UTs for suggestions and updated information. The comments/suggestions received from different State Government/UTs time to time were incorporated in the report and the final copy was submitted to MoEF&CC.

Results and Findings

Regarding the tourist influx, the data were available in different time periods for each State/UT in the IHR. Amongst all, Uttarakhand has reported highest number of tourists (5.94 crore; year: 2023). Data for the year 2019 show that Himachal Pradesh recorded 1.72 crore tourists in the year 2019. In the same year, Jammu & Kashmir UT also received more than 50 lakh tourists, mostly pilgrims. In the north-eastern states, Assam reported highest number of tourists (59 lakh; year: 2018).

According to NITI Aayog in 2018, the tourist influx in the IHR was as follows: 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). The upward trends in tourist numbers in the IHR, have direct or indirect impacts 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 28 national parks and 99 sanctuaries that come under the Protected Areas (PA) network of India (ENVIS, NIHE). 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). The Hon'ble NGT order is available regarding the ESZ Notification, which prohibits and regulates activities for the protection of the area, and directs the development of the area to be planned according to a master plan (Order dated 10.03.2021 in O.A. No. 312/2016). The decision to carry out carrying capacity assessments of eco-sensitive areas would put the idea of "Sustainable Development" into practice and be made in accordance with Order dated 17.03.2021 in O.A. No. 462/2018.

In addition, the entire area is characterised 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 the IHR)*" (NITI Aayog, 2018).

State-wise profile of all IHR states/UTs are described illustrating general scenario of tourism, tourism growth vis-a-vis economic growth, transport and tourism, case studies about ill-effects of tourism particularly on different environmental components (**Annexure-I**), waste generation, waste segregation, utilisation 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.

LADAKH

Introduction

The high-altitude region of Ladakh UT is predominantly described as arid, ecologically fragile, and culturally rich. The 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. The area attracts both domestic and foreign tourists and has 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.2).

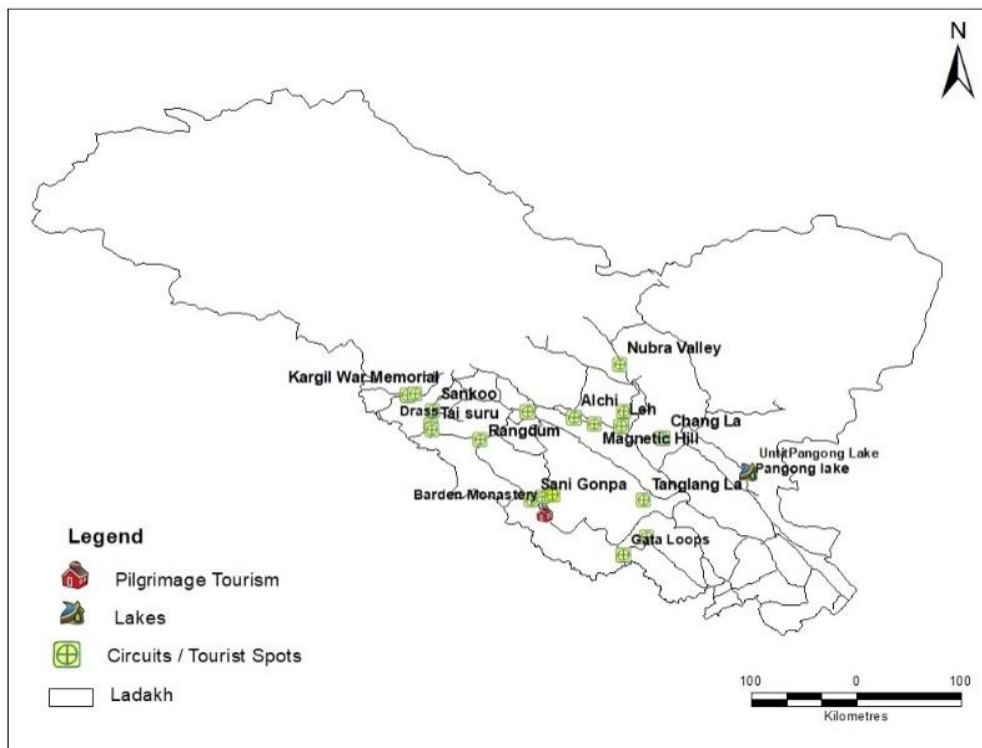
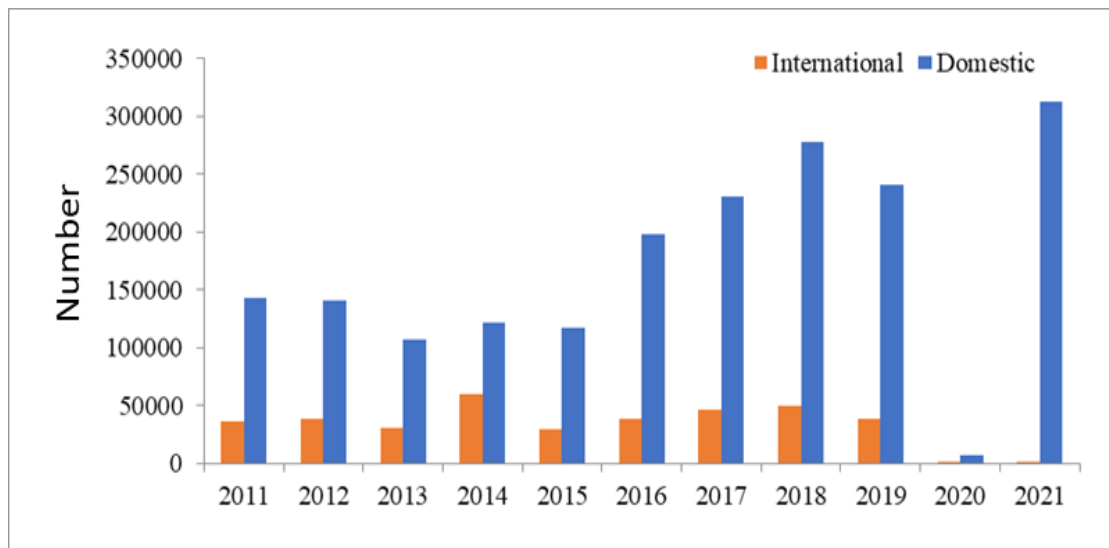


Figure 2. Major tourist spots and circuits in Ladakh

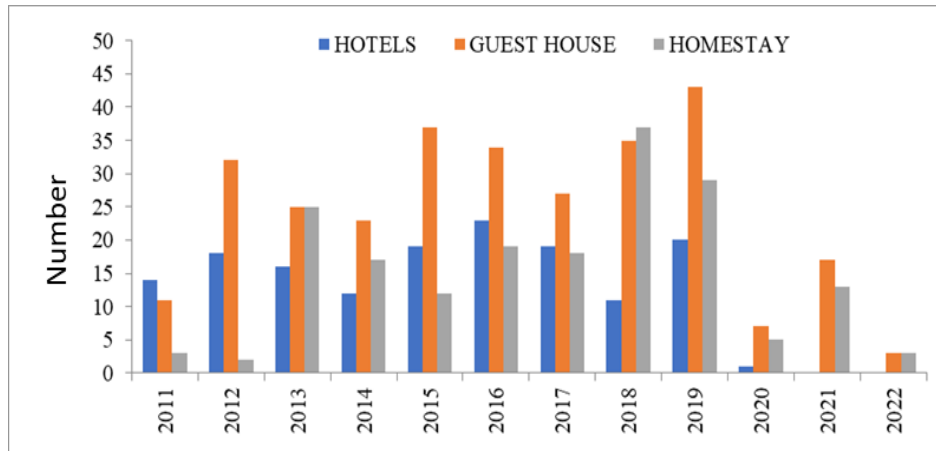
In addition, the UT also harbors a unique and diverse assemblage of wild flora and fauna. A recent checklist on birds of Ladakh (Sharma *et al.* 2021) reported 378 species of birds out of which 27 were reported for the first time from Ladakh. Being located on Asian Flyway, Ladakh hosts a variety of migratory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

In Ladakh, prime tourist attractions are physical (landscape, wildlife, lakes, adventure, winter sports, etc.) as well as socio-cultural aspects (monasteries, heritage sites, etc.). In 1974, when the area was opened for tourists, only 527 visitors travelled to the region and most of them were foreign travelers (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 (Fig. 3). 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. 4). Out of the total 1169 establishments, the maximum are guest houses (59%), followed by hotels (25%), and home stays (16%).



Source: Directorate of Tourism, Ladakh UT

Figure 3. Growth of tourism in Ladakh



Source: Directorate of Tourism, Ladakh UT

Figure 4. Growth of tourism-related infrastructure in Ladakh UT

Largely, summer tourism is prompted by heat waves in the plains of India and vacations in the schools/colleges. Generally, the winters are inhospitable in Ladakh (sub-zero temperature, a limited number of operational hotels / guesthouses, land-locked period, etc.). Despite the fact, the UT is visited for adventure tourism (popular activities like *Chadar* trek) and wildlife tourism (to see snow leopard and other faunal diversity) in the winters. 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 which has reached above Rs 90 million in the year 2021 (Source: Office of Deputy Commissionaire, Leh, and Department of Wildlife Protection, Leh). Majority of this revenue comes from domestic visitors (Table 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. 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 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

Source: Department of Wildlife Protection, Leh

Impact of tourism on environmental components

Assessment of waste generation

A fair quantity of garbage is produced in Ladakh as a result of the rapid anthropogenic pressure brought on by the growth of urban populations, significant seasonal visitor intakes, constantly expanding hospitality industry operations, and an influx of a sizable migrant labour force during the summer.

As per the information obtained by Municipal Committee Leh, around 20917.7 q solid waste was generated during 11 months, i.e., from June 2021 to April 2022. This amounts to 63.3 q per day waste generation. Limited quantity of waste, i.e., around 6.63% (1387 q) of the total generated waste is treated or processed and is subsequently sold to recyclers. Leftover or untreated waste is disposed of at the landfill site.

The district administration, under Project *Tsangda* launched in 2017, has estimated the quantity of non-biodegradable waste in the rural areas of Leh. During the period of 11 months from April 2021 to February 2022, around 1054 q non-biodegradable waste was generated in rural areas of Leh. Around 70% of its quantity (753 q) which includes paper, plastic, glass, metal, etc. was treated and processed. To facilitate such processing, 7 solid resource management centres, viz., Nubra, Nimoo, Khaltse, Durbuk, Choglamsar, Chushot and Kharuhave been established under Project *Tsangda*.

Solid waste quantity variability in the tourist and non-tourist seasons (2021–2022)

Maximum waste was generated in the three months of tourist season (July 2021 to September 2021) which ranges from 3016q to 3883 q. While minimum waste with 739-888 q was generated during three months of lean tourism period (January2022 to March 2022). 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. 5).

Managing Waste in the Markha Valley Trek

Markha trek is one of the most popular trekking routes in Ladakh. Nearly 6000 people use the route annually (~3000 tourists and an equal number of local guides and porters). All Ladakh Tour Operators Association (ALTOA) launched a clean-up drive along the *Markha* trek from 21-28 July 2020 in association with the Department of Tourism, NIHE-Ladakh Regional Centre, and Women's Travel Association. Waste from different camping sites along the *Markha* trek was collected, segregated and brought back to Leh town. Here, it was handed over to the Solid Resource Management Centre under 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. It was observed that camping sites along the mountain trek had more waste accumulation than surrounding villages. The waste collected along the trek is exclusively generated by the trekkers and their associates.

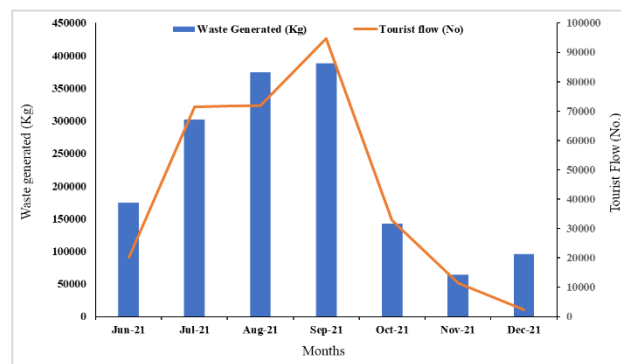


Figure 5. Waste generation and tourist inflow during June 2021- December 21' at Leh town

Segregation/Utilization of waste

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, and a worth of Rs. 14,60,617 revenue was 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, and a revenue worth Rs. 3,35,436 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).

Waste disposal/treatment facilities

In Leh town before 2021, the solid waste was dumped in an open site at Bomb Guard near the 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 tonnes/day capacity Solar Power-based Solid Waste Management Plant (Fig.6a) 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 in Solid Waste Management Plant, however, biodegradable waste (food, etc.) is being standardized for making bio-compost. Moreover, construction of landfill site near solid waste management plant is completed recently. It is spread over an area of 33.4 hectares (Fig.6b).



Figure 6. (a) Establishment of solar power-based solid waste management plant: A new initiative by Ladakh (UT), and (b) Landfill area under construction near Solid Waste Management Plant Skampari, Leh

Impact on Air quality

Automobile growth in Ladakh

Till 2017-2018, introduction of new taxis was growing in Leh district but self-restriction was imposed to avoid cut-throat competition, hence no growth of taxis is visible in Leh district (Fig. 7). However, this was not the case in Kargil district (Fig. 8). 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 minibuses 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 neighboring states.

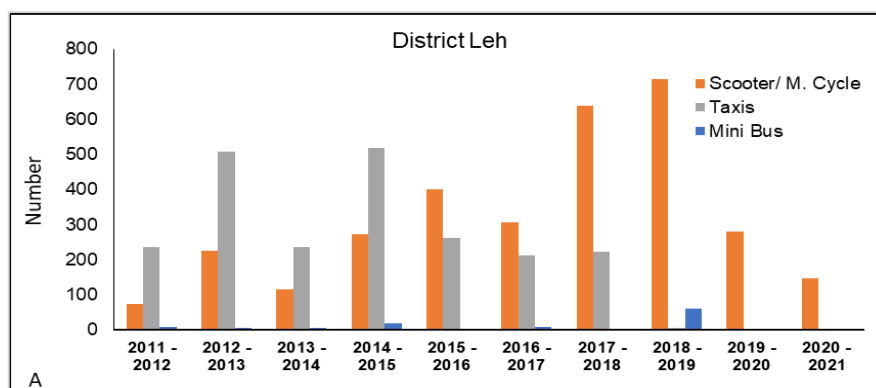
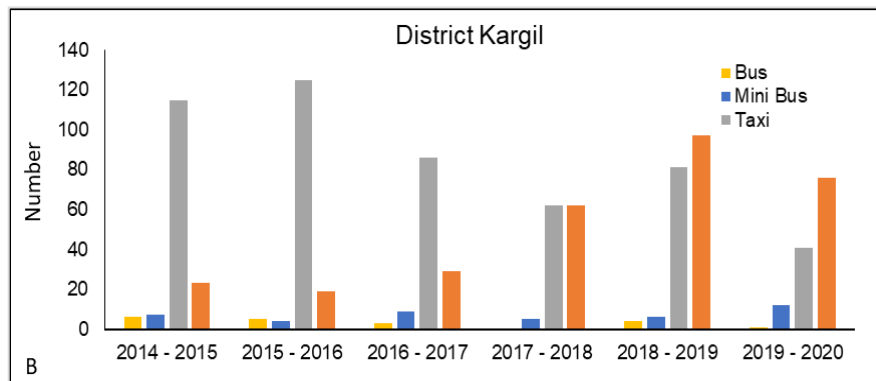


Figure 7. Number of vehicles used in the tourism sector in Ladakh Leh District



Source: Department of Transport

Figure 8. Number of vehicles used in the tourism sector in Kargil District

Monitoring of air quality parameters

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. In the Leh district, only PM₁₀ monitoring was started in September 2019, providing a monthly record for summers. PM₁₀ monitoring in Ladakh during September–November 2019 and June–October 2020 reveals the values ranging from 31 to 68 µg m⁻³. Notably, PM₁₀ values remained well within the NAAQ standard in all months except for October 2021.

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), PM₁₀ values ranged between 7 µg m⁻³ and 112 µg m⁻³ during the period from March 2021 to May 2022. Whereas values for PM_{2.5} ranged between 5 µg m⁻³ and 93 µg m⁻³ during the same period. Based on the information from Ladakh Pollution Control Committee (LPCC), the observed values of PM_{2.5} for the months of July–September, 2019 were within the permissible limits. 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.

Impact on water quality

In terms of water quality assessment, long-term information is not available for UT. As part of the information by State Pollution Control Board of Jammu & Kashmir, water quality monitoring has been initiated at 8 locations along stretches of the river Indus, however, data/information is still not available.

In view of effective wastewater treatment in hotels/guest rooms as well as to mitigate the pollution load and groundwater depletion, the UT administration has made it mandatory for hotels/guest house with 10 to 19 rooms to have an in-house STP for sewage treatment. Subsidies are also provided for the same by the administration. This is in line with the directions of Hon'ble NGT in OA No. 606/2018. Also, the status of groundwater resources in the district Leh were also inquired

by the Hon'ble High Court of Jammu & Kashmir; observations and directives were given in OWP no.1513/2018, dated 16.08.2018.

Impact on forest, biodiversity and eco-sensitive areas

As per FSI (2021), total forest cover of UT is 2272 km². Compared to 2019 assessment, the forest cover has declined by 217.3 km². 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).

Wildlife attracts many tourists in Ladakh, and popular tours are organised for watching snow leopard, brown bear, and enthusiastic bird watchers can be seen everywhere. Protected Area Network (PAN) in Ladakh consists of one National Park and two Wildlife Sanctuaries. PAN occupies an area of 12,350 km². 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 Zaskar, 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. Anthropogenic activities, including tourism such as trekking, vehicles, clothes with synthetic fibres, tents, and disposal of plastic litter like drinking water bottles and food packaging, around the lake sites were found to be the major contributors of micro plastics in the lakes of the area. Micro plastic (MP) concentration was 160–1000 MP/kg dw (dry weight) in Pangong Lake, 960–3800 MP/kg dw in Tsomoriri Lake, and 160–1000 MP/kg dw in Tsokar Lake (Tsering *et al.* 2022).

Initiatives

- Recently, Faecal Sludge Treatment Plants (FSTPs) of 12 KLD and 10 KLD capacity were commissioned at Leh and Kargil town respectively, along with a Common Sewage Treatment Plant (CSTP) with a capacity 3 MLD at Agling, Leh.
- The town follows the centralized wastewater management system under which the existing septic tanks are regularly desludged through suction machine and finally transported to FSTP.

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. Based on the datasets, it has been observed that waste generation exhibits a direct relationship with tourism activities. Analysis revealed almost three times higher waste generation during the tourist season. Although authorities have taken necessary action regarding efficient management of solid waste such as garbage collection, segregation, and disposal from rural and urban regions, yet there is still more work to be done, especially in terms of banning the use of single-use plastic and promoting the use of alternatives. The air and water quality monitoring data, though limited to summer months and recent two years, suggests that both air and water quality, in general, is satisfactory in the Ladakh region and there is no direct influence of tourism.

Few of the most visited tourist spots (e.g., Hanley, Tso Morari, etc.) fall in the Sanctuary/National Park areas. However, no mechanism or framework exists in these locations for waste management and water resources management. Such places require immediate attention for planning and management, in view of sustainable and environment friendly tourism. The role of Wildlife Department becomes important in regulating affairs within the sanctuary area.

Jammu&Kashmir

Introduction

Jammu and Kashmir UT is a popular destination for pilgrims to famous shrines like Shri Amarnath Ji holy cave and Mata Vaishno Devi. Apart from cultural tourism, the region also attracts tourists due to its picturesque landscape, dense temperate forests, wetlands and unique biodiversity (Fig. 9). The UT has a forest cover of 39.15% and has witnessed an increase of 9% in Jammu division and 21% in Kashmir division during the last decade (ISFR 2011 & 2021).

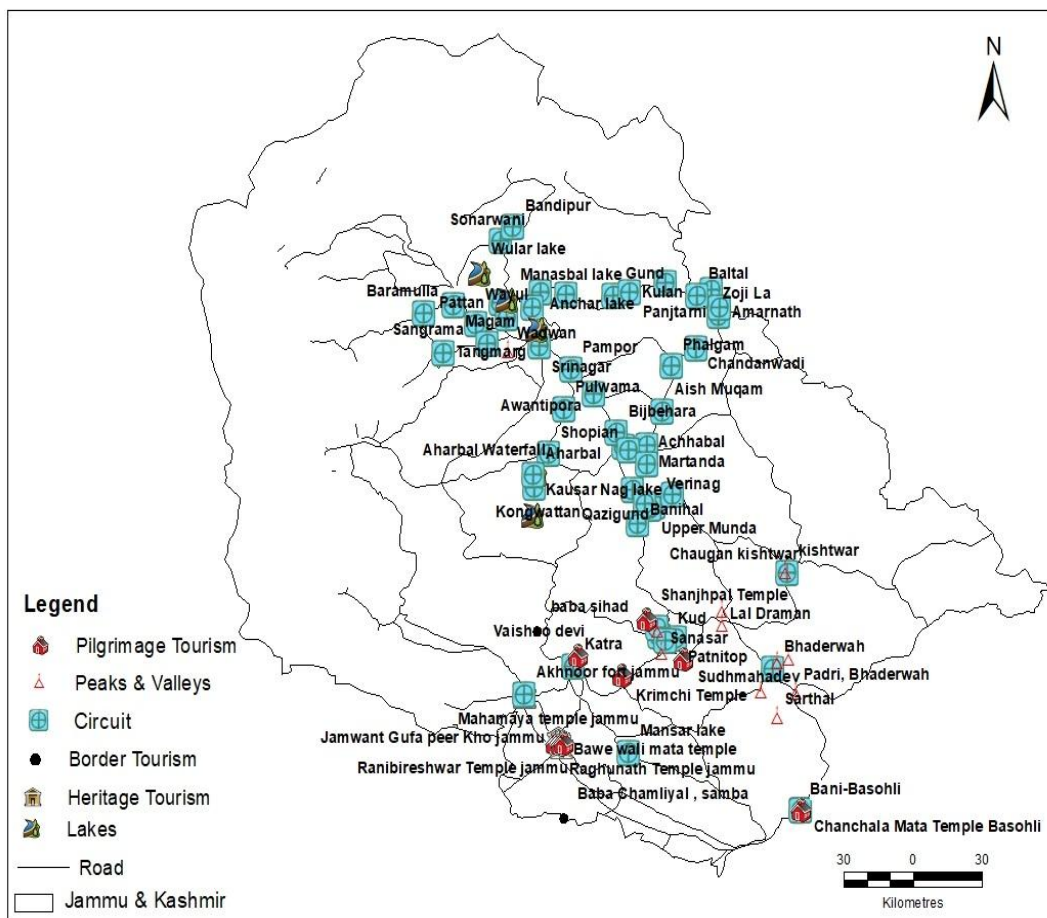


Figure 9. Major tourist spots and circuits in Jammu & Kashmir

One of the main economic activities in the UT is tourism, which has grown steadily over the past few decades. The total number of tourists visiting the Kashmir Valley increased from 10,000 to 5,03,620 between 1951 and 1985. However, later due to political turmoil and terrorist activity, the Kashmir valley witnessed a substantial reduction in the number of visitors till 1997 after which growth was again observed. The years after 2002 show a remarkable increase in visitors to the Kashmir Valley up until the onset of the Pandemic (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%. Tourist activity also translates into ample revenue generation for the UT. For e.g. 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 the park (Bhat & Bhatt, 2019).

In view of regulating the tourist influx in major tourist destinations, the tourism department has taken considerable measures which include capping of trekkers in major trekking routes, levying sanitation/trekking fee, establishing check points to ensure waste management, ban on carrying plastic waste, bags, etc., regular sanitation drives on major trekking routes, and restriction on camping near lakes/rivers/glaciers.

As per Directorate of Tourism, Jammu & Kashmir UT, Pilgrim-tourism is much higher than the traditional tourism in Jammu & Kashmir, ranging between 2.2 lakh to 111.16 lakh per annum between 1950–2019 (Fig. 10). The two most important shrines in Jammu & Kashmir UT, i.e., Shri Amarnath Ji Holy Cave and Mata Vaishno Devi, get pilgrims every year. Following the Supreme Court's directions in Writ Petition (Civil) No. 284/2012 titled, 'Court on its own motion V/s Union of India & Ors', Amarnath Shrine Board has established a mechanism to ensure that the number of pilgrims registered is in accordance with the available carrying capacity for the particular year.

Simultaneously, tourism related infrastructure owned by government (tourist huts and bungalows) and private owners (hotels) are continuously increasing in the union territory. Number of government owned tourist huts and bungalows is less than 250 in the UT.

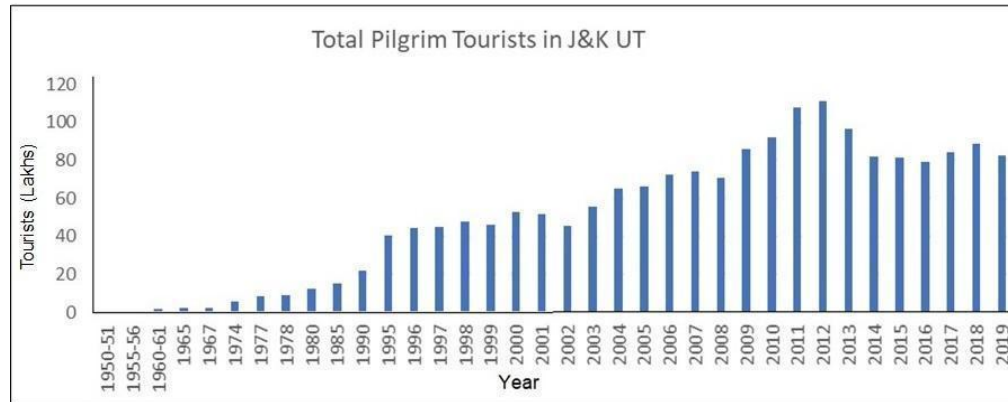


Figure 10. Pilgrim Tourists in Jammu & Kashmir UT

Impact of tourism on environmental components

Assessment of waste generation in Jammu & Kashmir (UT)

Solid Waste Management (SWM) is evolving into a substantial concern in the age of escalating urbanisation and industry. The management of solid waste is the responsibility of 78 municipal local bodies in Jammu and Kashmir UT (2 Municipal Corporation, namely, Jammu Municipal Corporation and Srinagar Municipal Corporation; 19 Municipal Councils; and 57 Municipal Committees) (<https://jkhudd.gov.in/ULBList.html>).

As per the information obtained for the time period of 2019-2020, all the municipalities of Jammu & Kashmir UT were together generating 15189.1 q of solid waste per day: out of which 96.42% (14646.5 q/day) was collected, and 35.56% (5401.9 q/day) was treated/processed (JK-PCB, 2020). Comparing it with the data received from Municipal Corporations Jammu and Srinagar, these both could be the major contributors towards daily waste generation in the UT.

Waste Management at Pahalgam; enroute to Shri Amarnath

Hotels and restaurants generate a large quantity of Municipal solid waste (MSW) at Pahalgam, (a major transit point and a tourist destination) 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 indicates that the maximum amount of waste was generated from hotels and restaurants (74%), followed by local households (18%), and markets (5%) (Bashir and Goswami, 2016) (Fig.11).

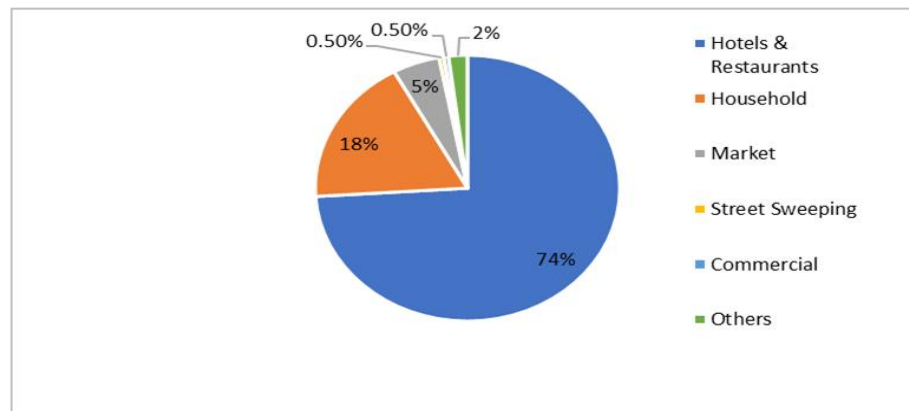


Figure 11. Area wise categorization of MSW generated at different sites at Pahalgam

A similar study was undertaken back in July–August,2011 in view of Municipal solid waste (MSW) generation during Amar Nath *Yatra*. MSW generation was studied at three sites in Pahalgam, 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* (restaurants), etc. The net quantity of observed MSW varied from 55.92kg/day to 442.17 kg/day in different sites. Among the constituents of solid wastes, the net weight (%) was dominated by food wastes (43%) followed by glass (19%), cardboard (13%) and other (Bhat et al. 2012).

Segregation / Utilization of waste

Except a few, many ULBs are practicing door-to-door collection in Jammu division. 13 ULBs have achieved 100% collection, while the same numbers have achieved partial collection. In Kashmir region, all except 12 of 42 ULBs are practicing door-to-door collection of waste. Except Municipal Corporation Jammu, Katra and Srinagar, source segregation has not yet started in Jammu &

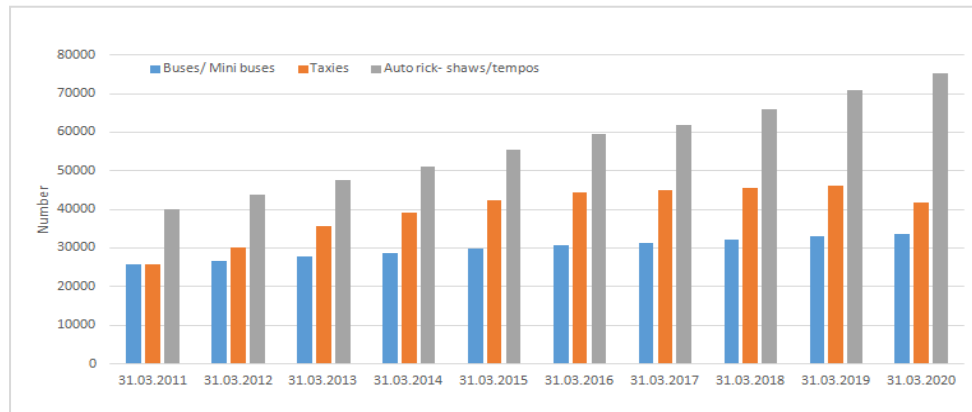
Kashmir region. In both the divisions, waste is transported in a mixed form. ULBs in Jammu division have primary RCC bins, plastic bins, etc. as well as a few secondary storage facilities, while waste from few selected localities is stored in municipal storage containers. In most the areas of Kashmir division, waste is openly dumped along roadside.

Waste disposal/treatment facilities

Limited waste treatment / scientific disposal facilities are available in Jammu & Kashmir region. While Jammu region has, in total, 03 vermin-composting facilities and an incinerator at Udhampur, only Municipal Corporation Srinagar has equipment such as mechanical segregator, composter, etc. for processing municipal solid waste. None of the ULBs in the region have scientific landfill site for waste disposal. The tourism department has made adequate arrangements for disposal of solid and liquid waste in tourist destinations as per the number of tourists. Proper directions have been given for setting up of segregation, collection, and disposal of plastic waste. Moreover, dustbins are installed at various tourist destinations to prevent littering. Tourist places like Pahalgam and Gulmarg have waste treatment as well as disposal facilities. The segregated waste is collected and processed in auto-composters and magnetic disintegrator. Additionally, Tourism Department is also proactive in conducting awareness programmes as a part of initiatives such as Travel for Life, 'Swachata hi Sewa', Swachh Bharat Mission (SBM), etc. Given the invaluable cultural heritage of the region, the department has implemented various cleanliness programs under Swachh Iconic Places (SIP) initiative.

Impact on Air quality

During 1990 to March 2021, the number of buses has increased by 4 times, the number of taxis has increased by 10 times and numbers of auto rickshaws/tempos have increased by 15 times in Jammu and Kashmir (Fig. 12). Waterway is also used by boats that are connected with the tourism industry and related activities in Jammu & Kashmir UT. These include house boats, passenger boats, luggage boats, fishing boats, passenger doon gas, shikara taxis, and residential boats. 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.



Source: Transport Commissioner, J&K

Figure 12. Growth of transportation infrastructure in Jammu & Kashmir UT

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

In view of important tourist spots of Jammu region (namely, Patnitop, Sanasar, Mansar, Surinsar) only PM₁₀ monitoring is done (Table 2). Additionally, air quality monitoring is also carried out in Gulmarg and Sonmarg. Nevertheless, observed values reveal that PM₁₀ exceeded the permissible limit at Surinsar during September-October 2021. During 2022, PM₁₀ 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 PM₁₀. In general, the observed values have not exceeded the standard limits prescribed for 24-hour average (PM_{2.5}- 60 $\mu\text{g m}^{-3}$; PM₁₀- 100 $\mu\text{g m}^{-3}$) and annual average (PM_{2.5}- 40 $\mu\text{g m}^{-3}$; PM₁₀- 60 $\mu\text{g m}^{-3}$). Only one incidence in October 2018 was observed when PM₁₀ values exceeded the standard limit for 24-hour average and reached 87.32 $\mu\text{g m}^{-3}$. Currently, all air quality monitoring stations in Jammu and Kashmir UT are limited in number and situated in the urban

cities and some tourist spots of Jammu and Kashmir. However, it is difficult 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 PM₁₀ ($\mu\text{g m}^{-3}$) monitoring at important tourist locations (year 2021 and 2022)

Month	Patnitop	Sanasar	Mansar	Surinsar
September 2021	46	38	98	117
October 2021	--	--	--	106
December 2021	--	--	92	78
January 2022	--	--	107	94
February 2022	--	--	117	105

--Indicates 'no data available'

Source: Jammu & Kashmir Pollution Control Committee, <http://jkspcb.nic.in>

Commencement of PM_{2.5} and PM₁₀ monitoring in Jammu, Srinagar and Pulwama since 2018 also confirms good quality of PM_{2.5}. The only peculiar feature is that PM₁₀ 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 SO₂, NO₂ and PM_{2.5} but consistently high PM₁₀ in Jammu region between 2017 and 2020. Notably, PM₁₀ remains high round the year in Jammu including peak as well as lean tourist months, hence, cannot be attributed directly to tourism activities. Nevertheless, PM₁₀ 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. Most of the air quality monitoring stations are clustered around Jammu and Srinagar cities. However, some air quality parameters such as PM₁₀ are measured in few tourist places such as Patnitop, Sanasar, Mansar, Surinsar and Purthu-Basohli. Thus, installation of air quality monitoring stations, particularly in tourist places, would present a better picture of the air quality standards in the Jammu & Kashmir UT.

The Transport Department has taken several measures to mitigate the impacts of vehicular pollution in the region. Some of these include: a complete ban on passengers/commercial vehicles on attainment age of 25 years w.e.f 1-04-2007, promotion of electric buses for local commute, strict enforcement of PUC norms, etc. As per JKRTC, based on age profile, the maximum fleet of buses and trucks are in young/healthy category. Moreover, there has been an uptake in the numbers of domestic electric vehicle; so far 16582 electric vehicles have been registered by the Motor Vehicles Department.

Impact on water quality

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. On the contrary, freshwater springs in the Kashmir region have excellent water quality index, except few springs near highly urbanised 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).

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 degradation of water quality during the 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 ± 1.31 µg/l) and orthophosphate (44.6 ± 0.18 µg/l) (Parray *et al.*, 2021).

During lockdown, visible improvement in the water quality of the River Tawi in the polluted stretch in the Jammu city and the nearby areas was observed. A significant decline in BOD and COD values was seen ascertaining anthropogenic activities as the main culprits for degraded river water quality; Automobile washing was also not practised during this period which reduced the amount of waste coming from these activities (Kour *et al.* 2022). 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). The deteriorating water quality of River Ban Ganga due to effluent discharge and solid waste dumping was even highlighted by Hon'ble NGT (OA 338/2021).

Research shows that although water bodies particularly around the urban areas have witnessed deterioration during the last few decades, water springs particularly in rural areas are good in terms of water quality index.

River water quality monitoring is available for 14 districts of Jammu & Kashmir 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. In 2019, due to concerns on shrinking of Dal Lake, the Jammu & Kashmir government set up a committee to declare its surrounding areas as an Eco-Sensitive Zone (ESZ) and prepared a draft notification. Therefore, the physical water quality in tourist lakes is degraded which can somewhat be attributed to the tourism activities.

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 or less). Thus, the chemical water quality varies on spatio-temporal scale and continuous data are needed to assess the impact of tourism.

All the 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.

Impact on forest, biodiversity, and eco-sensitive areas

For the preparation of zonal master plan for Eco-sensitive zones (vide order no. 65-JK(GAD); dated 19-01-2022), a sanction has been accorded for formation of district level committees. Apart from Jasrota Wildlife Sanctuary, Rajparian Wildlife Sanctuary, Hirpora Wildlife Sanctuary, Ramnagar Wildlife Sanctuary and Kishtwar High Altitude National Park, three more ESZs, viz; Limber-Lachipora Wildlife Sanctuary, Kazinag National Park, Gulmarg Wildlife Sanctuary and Surinsar-Mansar Wildlife Sanctuary have been notified by MoEF&CC. As per Department of Wildlife Protection, during the last two years, footfall of visitors in Dachigam National Park has been recorded as 100,876 which is not more than 100 visitors per day and is well-within the carrying capacity of national park. Besides, the tourism zone in the park is well-defined and falls within the buffer zone thereby ensuring least impact on the wildness of the core area of the national park. 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).

One of the cases in Hon'ble NGT (order dated 24-04-2023 in O.A. No. 287/2023—Mushtaq Ahmad Malik Applicant Vs Ministry of Environment, Forest & Climate Change and Ors.) has mentioned the harmful impacts of snow bikes in the local ecology of Gulmarg Wildlife Sanctuary and Eco-Sensitive zone. It highlights the impact of weight of snow bikes on soil and vegetation underneath the snow. The matter has been looked into and remedial measures have been taken by the Forest and Wildlife departments. Tourism also negatively impacted the populations of *Fritillaria roylei*, *Corydalis cashmeriana*, and *Lsgotis Cashmeriana*. In 2011, 1500 mature individuals of *F. roylei* were found in Aparawat (Gulmarg). But only about 367 individuals were able to produce fruits.

The government of Jammu & Kashmir has accorded highest priority to the restoration and conservation of wetlands. Various wetlands have been inventoried and demarcated utilizing remote sensing data, raising embankments, fixing of boundary pillars, etc. Each of these wetlands are assigned a Unique Identification Number. Habitat improvement works (like desilting and de-weeding) are also being undertaken for restoration of wetlands. The first ever integrated management plan has been formulated for 8 Wetland Conservation Reserves in Kashmir, along with management plans for Surinsar-Mansar lakes and Gharana wetland. A restoration project is also underway for Hokersar wetland. Furthermore, the water quality in these wetlands is being monitored on regular basis by J&K Pollution Control Committee.

To develop wetlands into thriving hubs of eco-tourism, some strategies are devised including preservation of biodiversity, eco-friendly infrastructure development, community engagement, educational programs, marketing and promotion, regulatory frameworks, etc.

The tourism department complies with all the orders/rulings of different courts with regard to protection of environment and ecology. There is a strict ban on any illegal construction/repair activities carried out in tourist destinations of Jammu & Kashmir

Various activities in the tourist destinations including Gulmarg are monitored by tourism development authorities through zonal master plans. However, environmental impact assessment studies for popular tourist circuits and destinations in Jammu and Kashmir UT are required for implementing the appropriate regulatory measures to develop a mechanism for sustainable tourism with long-lasting economic gains. Besides, a study for biodiversity assessment of the area shall be undertaken.

Initiatives

- More than 3500 sanitation workers are deployed to carry out requisite waste management activities including collection of bio-degradable waste from yatra camps and tracks on regular basis. The waste is then transported to base camps by ponies/porters and is further processed in the solid waste disposal plant at Sarbal, Pahalgam.

- The Tourism Department has delineated suitable clusters as part of master plan of development authorities for which land use has been kept as green buffer. The Tourism Department is also promoting eco-tourism through practices such as bird watching, nature-based tourism, etc.

Summary

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. 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 so far 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. Similarly, the water quality of River Ban Ganga has been deteriorated because of discharge of effluent and dumping of garbage in the river banks—this was highlighted by Hon'ble NGT in the order dated 30-08-2022 in O.A. No.338/2021(Himanshu Sharma Vs Union Territory of Jammu & Kashmir). Subsequent to this, the Housing and Urban Development Department of Jammu & Kashmir was asked to take remedial measures to restore the river water quality. Both these developments—eutrophication in Dal Lake, Srinagar and deteriorating water quality of River Ban Ganga, Katra town- portrays implicit effect of tourism in these places.

Under the current scenarios of ever-increasing tourists' 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. Thus, all the tourist destinations in the UT should have a well-established waste disposal, segregation and collection mechanism 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 a manifold 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.

HIMACHAL PRADESH

Introduction

Himachal Pradesh spreads over an area of 55,673 sq. km. with a population of more than 60 lakh people. 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 been divided into four major tourist circuits (Fig. 13) and hosts diverse natural resources, including 30 wildlife sanctuaries, 5 national parks, and 3 conservation reserves. The state has the world's highest cricket ground at Chail.

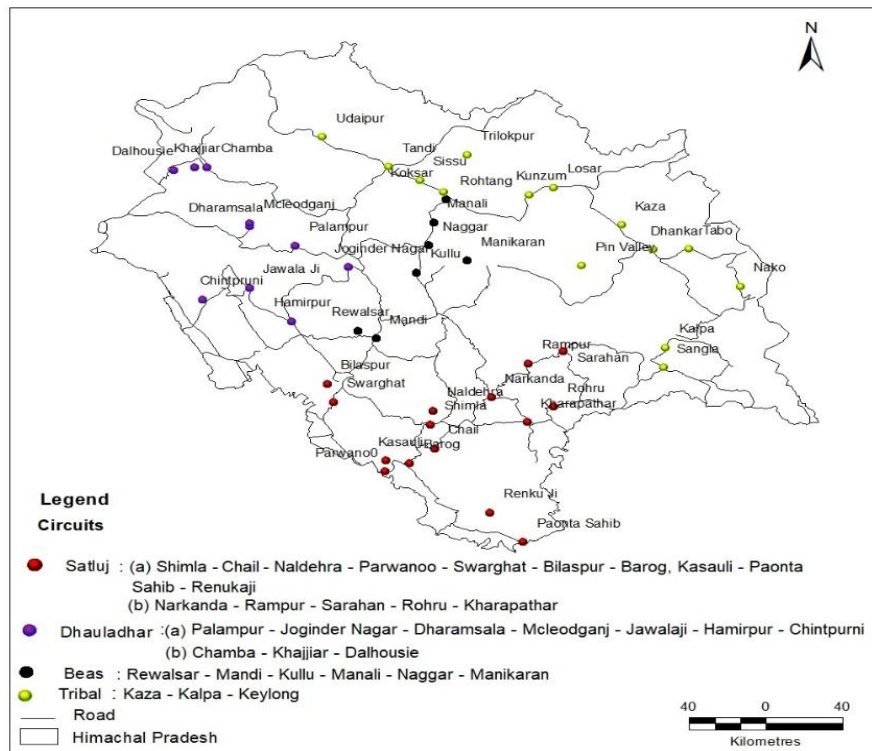
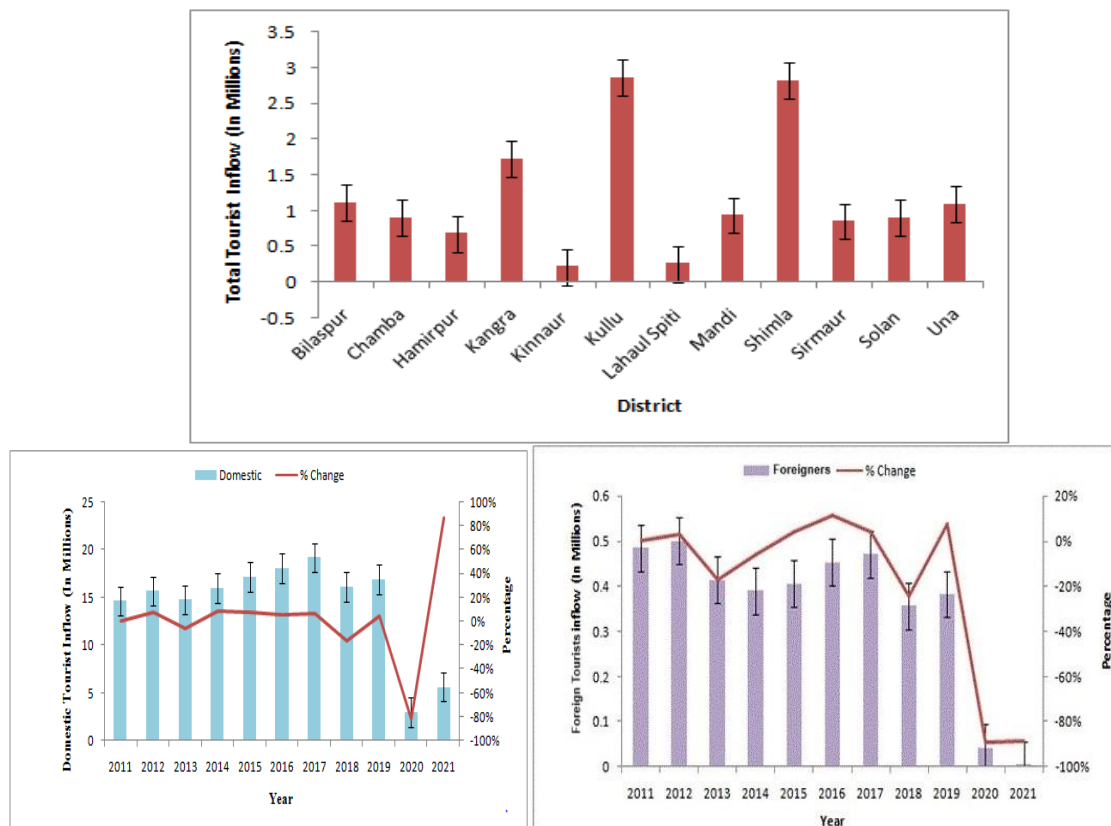


Figure 13. Major tourist destinations and circuit in Himachal Pradesh

Tourism growth vis-a-vis economic growth

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. There was an average decrease of 81% in the year 2020 when compared to 2019. The maximum tourist inflow was recorded in Kullu and Shimla district. For instance, Kullu district wherein Manali exists

recorded 12.91% increase in tourist inflow between 2011 and 2019. Fig. 14 shows total tourist inflow and the rate of change in domestic and foreign tourists in Himachal Pradesh from 2011 to 2021.



Source: Himachal Tourism Website, <https://himachaltourism.gov.in/counter/>, 2022

Figure 14. District wise tourist inflow in Himachal Pradesh (2011-2021), rate of change in domestic tourists in H.P. from 2011 to 2021 and rate of change in foreign tourists in H.P. ;2011–2021

The contribution of the tourism sector to the State Gross Domestic Product (GDP) is about 7% (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/>) (Table 3). 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-19 pandemic. Taxi business for tourists is another source of income. Some major

impacts of tourism in the economy are foreign exchange earnings/balance of payments, income generation, employment generation, entrepreneurial activities, etc.

Table.3 District wise registered hotels, home stays, guides, travel agency, adventurers and photographer registered with Himachal Pradesh Tourism Department

District	Hotel	Home stay	Guides	Travel Agency	Adventure	Photographer
Kinnaur	73	66	12	19	0	0
Lahaul&Spiti	88	258	1	15	0	0
Kullu*	1435	1040	431	1633	203	842
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
Total	3831	2369	1359	3171	351	958

Source: H.P Tourism department website <https://himachaltourism.gov.in/counter/>, 2022

* Latest data (2023-24) by Tourism Development Officer, District Kullu

Effect of tourism on environmental components

Increased tourism is slowly degrading the environment of Himachal Pradesh from the past few years. Tourism, besides being a boon to the economy of Himachal Pradesh, causes adverse impacts on the ecology and environment of the State—This has been mentioned in several rulings of Hon’ble NGT. One such ruling dated 14-12-2020 in O.A. 635/2017 (Ramesh Chand Vs State of Himachal Pradesh &Ors.) has stressed upon the need to conduct carrying capacity assessment in famous tourist places such as Kullu, Dharamshala, and McLeod Ganj. While the issue was concerning the illegal construction activities in these places, the court also stated that the construction of commercial building should only be permitted unless and until adequate provisions for solid waste management and water supply are taken into consideration. Similar ruling was passed in O.A. 218/2016 (Society for Preservation of Kasauli and its Environs (SPOKE) Vs M/s Kasauli Galaxy Resorts and connected matters) dated 05-10-2018 which stressed upon the need to conduct carrying capacity assessment of Kasauli Town. The court directed the Special Expert Committee (constituted in this matter) to study the carrying capacity of town in view of tourist inflow, vehicular inflow, scarcity of groundwater, impact on air quality and biodiversity.

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). Under the current scenarios of ever-increasing tourist inflow in the mountain regions, assessment of tourist carrying capacity is a vital part. Examples of Physical Carrying Capacity (PCC), real carrying capacity (RCC), and effective carrying capacity (ECC) values for specific tourist destinations in Kinnaur are 64,835, 9595, and 5928 visitors per day, respectively (Jangra and Kaushik, 2021). Nako Monastery had the highest PCC, with 20,022 visitors per day, while Durga Temple had the lowest, with 784 visits per day.

Waste Management

The government of Himachal Pradesh has notified that the ULBs, rural local bodies, notified areas, temple trusts, etc. shall quantify the solid waste generated due to tourism activities and ensure scientific disposal of the same. This is given impetus by Hon’ble High Court in the matter CWP 2369/2018, wherein the court has directed that “We should impress upon the State Government to

empower the local bodies to levy solid waste management charges upon tourists in entry point to make solid waste management services sustainable”. The management of solid waste generated from hill spots and trekking/expedition is a challenging task. Different scientific studies, which were carried out in the state, highlighted how tourism impacts waste management. 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 biodegradable 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.

Assessment of waste generation

As per the latest information by the Urban Development Department (UDD), the total waste generated from the 60 ULBs is 375. 38 MTPD (as on 26/04/2024), out of which almost 206.46 MT (55%) is wet waste and 150.14 is dry waste. Previously, the guidebook on solid waste management titled, “State Strategy on Solid Waste Management”, published by UDD in 2019, stated total solid waste generation by the ULBs was estimated 370 MTPD. Table 4 shows the waste generation in important tourist destinations for the year 2017–2021. Shimla has the highest waste generation among all tourist destinations.

State Pollution Control Board Regional Office, Dharamshala, and Office of DC, Shimla have provided the information of waste management activities carried out by major tourist destinations in Kanga and Shimla district—these are mentioned in Table 5 below.

Table.4 Municipal waste generated (in tonnes per day TPD) in important Tourist Destinations

Sr. No.	District	Important tourist destinations ULB's	Total Waste produced in 2020-2021	Total Waste produced in 2019-2020	Total Waste produced in 2018-2019	Total Waste produced in 2017-2018
	Shimla	Shimla	82	82	85	85
	Sirmaur	Paonta	8.65	8.65	8.65	8.65
	Bilaspur	Naina Devi	0.5	1	1	1
	Kullu	Kullu	6-7	7-8	8-9	8-9
		Manali	10	35	35	35
	Mandi	Rewalsar	1	1	1	1
		Mandi	16.50	16.50	24	30
	Kangra	Kangra	4.5	4.5	4.5	4.5
		Bajjnath	4	3	3.45	3.45
		Dharamshala	15	20	25	25
		Jawalamukhi	0.33	0.33	3	3
		Palampur	6	1.4	1.5	1.5
	Chamba	Chamba	6	5	5	8
		Dalhousie	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

Table.5 Waste management activities in major Tourist Destinations of District Kangra and Shimla

Name of District	Tourist Destination	Waste Collection /Segregation and Transportation	Waste Treatment and Disposal
Kangra	Dharamshala	The waste is being collected on daily basis with around 90% segregation. It is then transported to disposal site in GPS fitted multiple compartment vehicle. CCTV cameras are installed on some locations to check waste littering.	Wet waste is processed in waste to energy plant nearby HPCA cricket stadium and dry waste is managed in MRF. The waste processing site is located at Sudher nearby HRTC workshop.
	Palampur	Waste is collected on daily basis in a multiple compartment vehicle.	Segregated wet and dry waste are processed in material recovery facility (MRF) at Aima Panchayat. Additionally, two leachate plants are also constructed at the site.
	Jawalamukhi	Waste is collected on routine basis in a multiple compartment vehicle.	Although, no proper recovery facility is available, yet there are some facilities such as composting pits and bailer, shredder, etc for wet and dry waste, respectively.
	Bajjnath	Waste is collected on routine basis in a multiple compartment vehicle.	Some equipment such as drum composter and bailing machine are available for processing of wet and dry waste (particularly plastic waste), respectively. Legacy waste site near Khir Ganga Ghat is being remediated.
	Kangra	Waste is collected on daily basis in a multiple compartment vehicle.	An organic waste processor is available for wet waste processing while dry waste (particularly

			plastic waste) is managed through bailer and shredder machines. Waste suitable for waste to energy operations is further sent to cement plant.
Shimla	Theog	Segregated waste is collected from 7 wards through door-to-door collection.	MRF facility is developed for waste processing. Organic waste composter is used for managing wet waste. Proper care is being taken for health safety of sanitary workers.
	Narkanda	Door to Door collection of segregated waste is carried out.	MC is having MRF facility for waste processing. Shredder, bailing machine and incinerator facility are used for waste processing and disposal.
	Rampur	—	MC Rampur carries out wet waste processing through organic composter while dry waste such as plastic waste is used as refuse derived fuel (RDF).

Source: (i) Regional Pollution Control Board Office, Dharamshala (2024); (ii) Deputy Commissioner, Shimla (2024)

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 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 segregating waste at source in Municipal Corporation Shimla. Although, the majority of state's urban-rural bodies are dustbin-free, and garbage is managed through door-to-door collection; few incidents of garbage lying open in streets, in seasonal streams (*nala*) have been noticed.

Waste Disposal/treatment facilities

A large quantity of biodegradable waste is managed through composting pits. Moreover, in Municipal Corporation Shimla, the wet waste—through bio-methanation—is converted into biogas. As far as non-biodegradable waste is concerned, some quantity of it is either recycled or is used as Refuse Derived Fuel (RDF) in cement factories and waste-to-energy (WtE) plant. A landfill or other disposal facility is used to dispose of leftover. The leftover waste is disposed of in landfill/dumping sites.

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. According to data analysis, the highest waste production occurred during the years when the most tourists visited in Kullu and Shimla districts. In 2017, the Kullu, Kangra, and Shimla districts produced 46.62, 45.19, and 94.6 TPD of solid waste respectively. 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. 15&16). When the number of tourists visiting was the lowest from 2017 to 2020, waste generation was at its lowest in the districts of Kullu (19.18 TPD) and Shimla (78.21 TPD). 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. The amount of waste generated generally shows a positive correlation with the number of tourists, indicating that as the number of tourists' increases, so does the amount of solid waste produced.

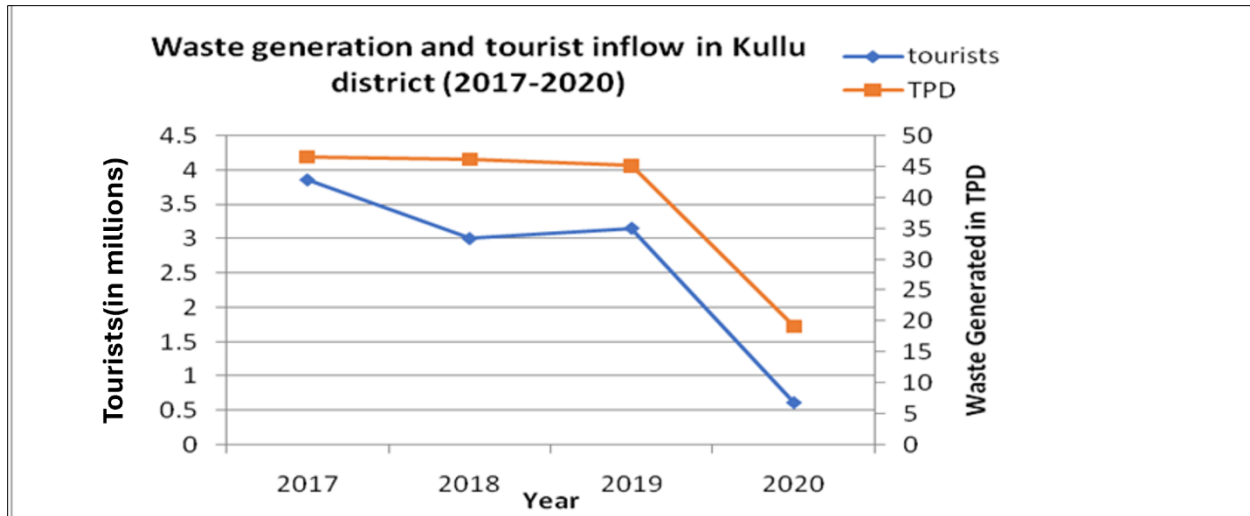


Figure 15. Correlation of waste generation with tourist inflow in Kullu district

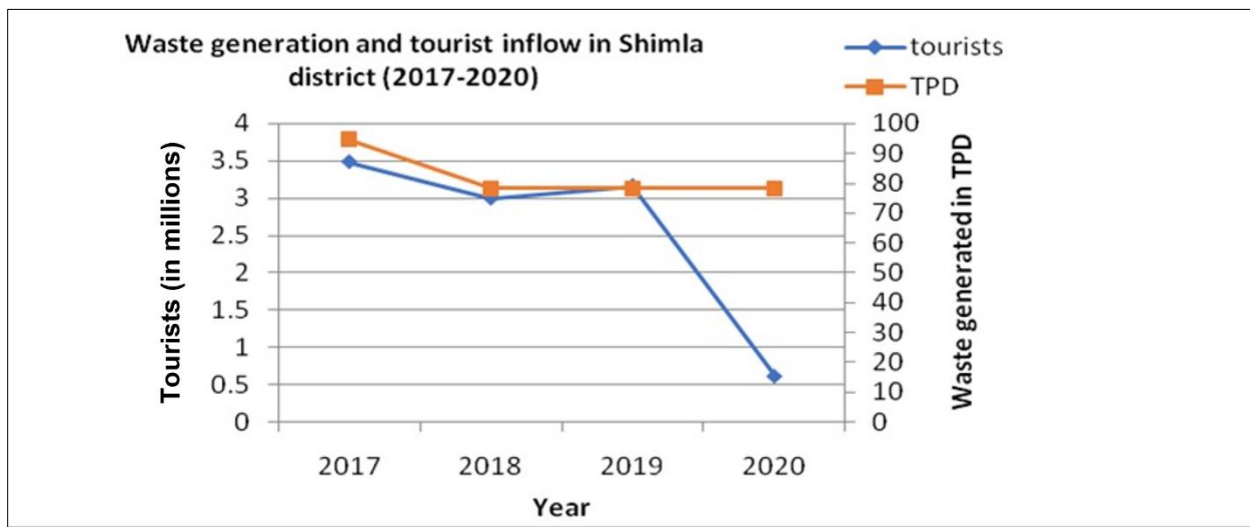


Figure 16. Correlation of waste generation with tourist inflow in Shimla District

Air Quality management

In the past few years, there has been a significant increase in the number of vehicles in Himachal Pradesh each year. 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 districts Kangra and Hamirpur were not available. When compared to 2015 and 2018, the rate of change in the number of vehicles showed a consistent increase from 9% to 11%, while it showed a fall of 21% in 2020.

Effect of tourism on air quality

NEERI reported 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, that there was an increase in concentration of carcinogenic elements. Also, particulate matter such as PM₁₀ and PM_{2.5} showed a decrease during lockdown period by 65.31% and 52.5%, respectively. The overall air quality was improved in the Kullu valley during the lockdown period of the second wave of the COVID-19 pandemic as tourist-related and anthropogenic activities were restricted (Thakur *et al.* 2022). Air quality over the period of time has largely affected the tourist destinations like Kullu-Manali, Shimla, Dharamshala, etc. NIHE conducted air quality research from 2019 to 2022 to gain information about the air quality at Mohal-Kullu (31.9°N, 77.18°E, 1154 m a.m.s.l.). The air quality evaluations found PM₁₀ values of $46.2 \pm 7.8 \mu\text{g m}^{-3}$ in Mohal-Kullu (31.9°N, 77.18°E, 1154m a.m.s.l) region, which were below the permissible limits. In a similar manner, PM_{2.5} levels were found to be $36.1 \pm 3.2 \mu\text{g m}^{-3}$, which indicates compliance with the legal requirements. The levels of SO₂ were determined to be $2.5 \pm 0.2 \mu\text{g m}^{-3}$, while the levels of NO₂ were $5.8 \pm 1.8 \mu\text{g m}^{-3}$, all of which were below the NAAQS.

Tourist Vehicles and air quality

Over time, the number of both private and commercial (taxis) vehicles in Himachal Pradesh has increased. At a Compound Annual Growth Rate (CAGR) of 35%, the number of private vehicles increased from 312 in 2005 to 4615 in 2013. While the 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.

Besides, taxis and private vehicles, recreational vehicles like all-terrain vehicles (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 Hon'ble NGT. Both of these diesel-powered vehicles cause air and noise pollution, spills on the snow, and other types of pollution (Singh, 2015). In June 2017, in addition to locally registered vehicles, almost 4,000 additional vehicles entered Shimla on weekends, illustrating the influence of more tourist-oriented

vehicles on the deterioration of air quality. The level of RSPM was increased by 40% during that period. It was seen that although, average annual value of most of the pollutants remained under prescribed limits of NAAQS, the values increased in peak tourist season.

One recent study conducted in the 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). The tourist inflow data show that it was highest in months of May and June followed by April. High average concentration of RSPM and NO₂ were observed in June, May in 2012 and 2013 in Kullu and Shimla, respectively. From 2014 to 2019 both the pollutants were well within the permissible limits. 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.

Measures/mitigation for air pollution

The Hon'ble NGT, New Delhi in OA No. 681 of 2018 issued an order, dated October 8, 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 the date of finalization of the action plans.

In compliance with this order, Himachal Pradesh Government proposed an action plan (**Annexure II**) for controlling air pollution in non-attainment cities in Himachal Pradesh which are Baddi, Nalagarh, Parwanoo, Poanta Sahib, Kala Amb, Damtal and Sundernagar. These locations are industrial locations except Sundernagar.

The Transport Department is planning to establish Automated Testing Stations wherein, the vehicle fitness test will be done through automated vehicle testing equipment. The norms of Vehicle Scrapping Policy, 2021 are being issued wherein the government vehicles which have completed life span of 15 years from date of registration shall not be sold through auction.

Many existing fleets of government vehicle are set to be replaced by electric vehicles. As of February,2024, there are around 2548 registered personal electric vehicles implying a positive attitude of local people towards e-vehicles.

Impact on water quality

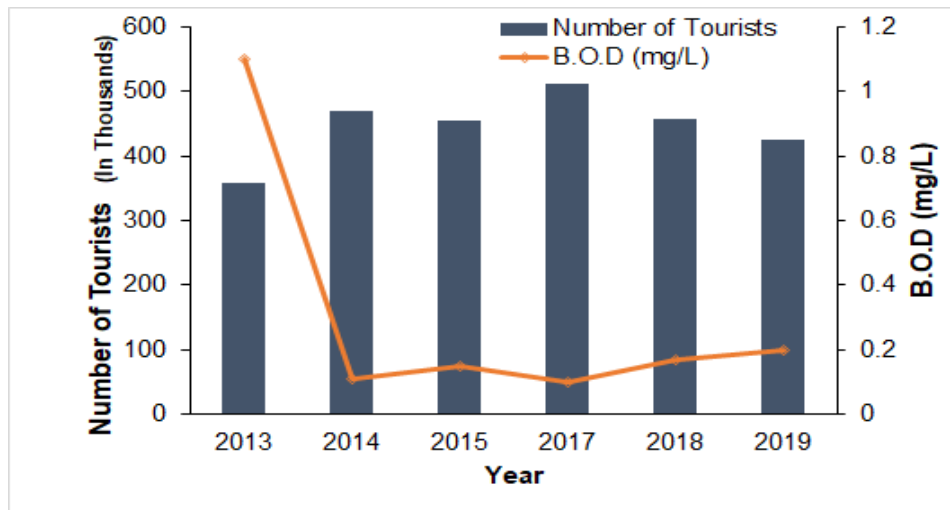
Many towns in the state are located on the banks of rivers, namely, Beas, Satluj, Ravi, etc. Interestingly, these towns (Kullu, Manali, Mandi, Chamba, etc.) are also major tourist destinations of the state. Generally, the river water quality is monitored either in the upstream/downstream course of the river (near to the town) or in close proximity to solid waste disposal/landfill site. The landfill sites are usually in hilly regions are close to riverbanks. Water quality parameters such as pH, DO, BOD and total coliform (TC) are monitored in different locations and the river stretch is then designated as Class A, Class B, etc. These analysis helps in studying the impact on river water quality due to both—wastewater as well as leachate generated in the solid waste landfill site.

In the state, water quality of different waterbodies (rivers, lakes, local streams/*nalas*) is monitored in more than 100 locations. It was found that 43 of these locations were either in close proximity to major tourist destination or near the solid waste dumping site. Based on the data available for the year 2019-20, the average pH level across all sites ranged between 7.4 to 8.2. The pH values were above designated criteria (for outdoor bathing) in one of the monitoring sites of River Parbati (near Kullu). TC values were on the higher side (>1600 MPN/100 ml) in Ashwani *Khad* (a stream in close proximity to Shimla) and Lift *nala* (a drain/*nala* in main Shimla town). The average BOD values, which varied between 0.1 to 8.1 mg/l, were also high in Lift *nala*. Nevertheless, average DO values in all the monitoring stations were found to be between 5.8 to 16.9 mg/l which is under permissible level (6 mg/l or more is considered fit for drinking, outdoor bathing, etc).

Water pollution and Tourist Seasons

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 the month of June when tourist season remains on peak (Kirch, 2002). Further, recent reports suggest that urbanisation and population growth have been tremendous, which are impacting the landuse/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).



Source: HPTDC and HPSPCB

Figure 17. Status of tourist inflow and water pollutants in Kullu, Himachal Pradesh

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. Fig. 17 and Table 6 show the most 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 visitors may result in excessive water use and waste production, which may eventually pollute the water bodies. In view of scientific management of wastewater, the tourist town of Manali has increased the capacity of existing STP from 1.82 to 3 MLD and completed the sewerage scheme at Marhi (on the way to Rohtang Pass (3879 m). Moreover, tender for construction of sewerage scheme at Rangri (nearby Manali) has been awarded and the work is under process. Besides, the tourism department is also making an effort to improve sanitation services at Rohtang Pass, Marhi, Gulaba, Solang Nala, Hadimba temple, etc. Green tax barrier is also imposed for the tourist vehicles (outside Himachal Pradesh) entering into Manali.

Tourism department is also assisting the State Government by providing better sanitation services (in collaboration with Sulabh International at Rohtang Pass, Gulaba, Marhi, Hadimba temple, etc.),

encouraging afforestation in the areas nearby Rohtang Pass, and initiatives such as green tax barriers. Additionally, the tourism department, in line with the recommendations of various rulings of Hon'ble NGT, has taken steps such as installation of check-post at Gulaba, construction of eco-friendly market at Marhi, provision of wayside amenities in Solang, etc. (Hon'ble NGT in OA No. 492 of 2014; dated, July 06,2015). It is proposed that an inter-departmental committee must be constituted to develop a comprehensive strategy for responsible tourism and decongestion of tourist destinations (Kuniyal et al, 2004, Tourism in Kullu Valley: An Environment Assessment)

Table.6 Status of tourist inflow and water pollutants in Shimla, Himachal Pradesh

Year	Month with highest number of tourists	Number of Tourists	BOD (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

Source: HPTDC and HPSPCB

Impact on forest, biodiversity and eco-sensitive area

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.

Initiatives

- Tourism Department is also assisting the State Government by providing better sanitation services (in collaboration with Sulabh International at Rohtang Pass, Gulaba, Marhi, Hadimba

temple, etc.), encouraging afforestation in the areas nearby Rohtang Pass, and initiatives such as green tax barriers.

- Solid Waste Management (SWM) and Material Recovery Facilities (MRF) under NMHS were developed in five (05) locations of urban local bodies (02 at Panchayat and 03 at temple sites) at Shimla, Himachal Pradesh. Municipal Solid Waste (MSW) demonstration sites were developed as per the provisions of the Himachal Pradesh Non-Biodegradable Garbage (Control) Act, 1995.

Summary

Himachal Pradesh hosts a large 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. Accelerated growth of tourism in Himachal Pradesh in the past few years had a substantial impact on its economy, local community and environment.

With the growth in tourism, there is increased waste generation, vehicles, waste disposal into rivers which together have led to degradation of the soil, water and air quality over the period of time. Waste dumping 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. Decentralisation 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.

Regulating the number of tourists entering into the tourist areas and their vehicles, prohibition of the taxis/personal vehicles not conforming to Bharat 6 standards should be allowed. Source apportionment studies for air pollution and taking the biggest polluting sectors would be other steps to bring under control pollution loads.

The annual mean of air pollutants was within the 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.

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.

Data of Eco sensitive zones was also not available; thus, it was difficult to assess the impact of tourism on eco-sensitive zones. Nevertheless, the Hon'ble NGT— in its order dated 22-12-2021 in O.A. No. 389/2018 – has directed the state government to maintain eco-balance in the areas of Manali and Rohtang Pass. Apropos to this, the state government has taken remedial measures such as providing adequate facility for wastewater management in Manali and Marhi, development of solid waste management facilities, deployment of electric buses, etc.

UTTARAKHAND

Introduction

Tourism is an important sector for Uttarakhand in view of its immense contribution to both local employment and income generation. The presence of several hill stations, wildlife parks, pilgrimage places and trekking routes make Uttarakhand an attractive tourist destination (Fig.18).

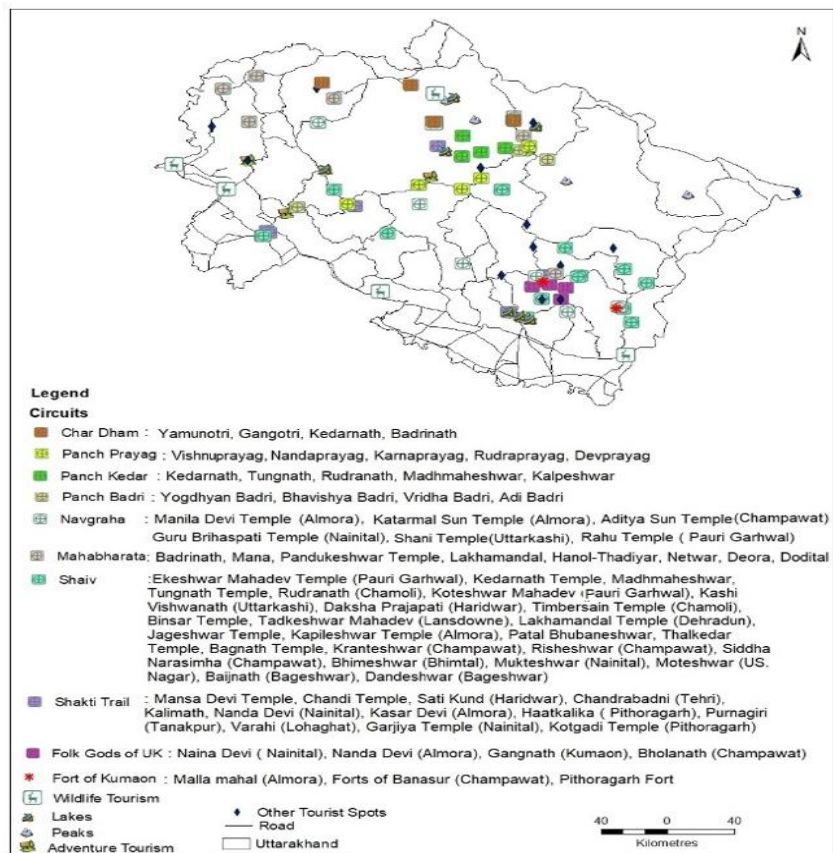
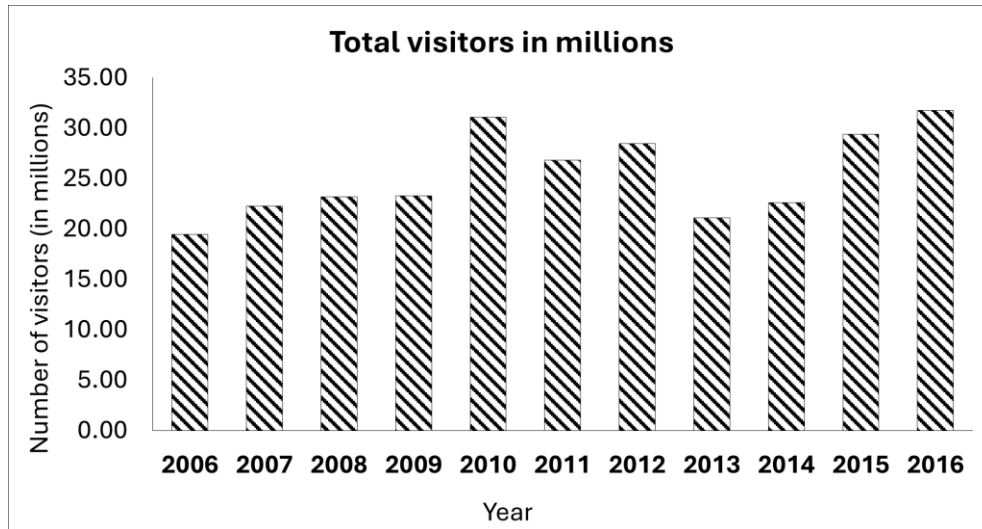


Figure 18. Major tourist spots and circuits in Uttarakhand

In Uttarakhand, where visitors have a strong sense of religion and spirituality, tourism accounts for a sizable share of GSDP. Under the National Mission on Pilgrimage Rejuvenation and Spiritual, Heritage Augmentation Drive (PRASHAD) was launched by Ministry of Tourism, Government of India, through which Badrinath, Kedarnath, Gangotri, and Yamunotri were selected for infrastructural development in Uttarakhand. Katarmal-Jageshwar-Baijnath-Devidhura were also selected under the Swadesh Darshan scheme for the integrated development of the heritage circuit in the Kumaon Region of Uttarakhand (Annual Report 2019-2020, Ministry of Tourism, Govt. of India) and an eco-circuit has been developed at Tehri- Chamba-Sarain around Tehri Lake in Uttarakhand (Annual Report 2020-2021, Ministry of Tourism, Govt. of India).

Tourism growth vis-à-vis economic growth

From the year 2006–2016, a total of 27.9 crore tourist visited Uttarakhand (Figure 19). Latest data for the year 2023 shows that domestic tourists' and visitor inflow in the state was 59.48 million and foreign tourists crossed over 0.14 million.



Source: Uttarakhand Tourism Development Board, 2006-2016

Figure 19. Total visitors in Uttarakhand from 2006-2016

As per the data of Directorate of Economics and Statistics, Uttarakhand, tourism has cumulatively contributed 50% of the total GSDP from 2006-07 to 2016-17 along with the increasing livelihood options for the people residing here (Uttarakhand Tourism Policy, 2018). As per the 2018-19 Tourism Satellite Account, published by National Council of Applied Economic Research (NCAER), the tourism contribution of state tourism industry is 2.96%. With the inclusion of indirect share pertaining to linkages of tourism with other sectors of the economy, these shares work out to be 6.59 % in GVA and 26.9 % in employment. It also indicates that there is likelihood to create well-planned and managed tourism, in which environmental factors and socio-cultural aspects can be well integrated.

Impact of tourism on environmental components

Waste generation

The 110 Urban local bodies (ULBs) of the state of Uttarakhand generate more than 1600 metric tonnes (MT) of solid waste per day. The amount of waste varies greatly, with cities/ULBs in plain regions (Haridwar and Udham Singh Nagar) and mixed topographical regions producing about two-thirds of the total amount (Dehradun and Nainital). The quantity of waste has huge variation—around two-third of its quantity is generated in the cities/ULBs in plain region (Haridwar and US Nagar) and mixed topographical region (Dehradun and Nainital). The quantity of municipal solid waste is more or less similar in other districts which are located in mid-hills and high hills topography (Fig. 20).

Studies were conducted by NIHE in view of waste management in trek routes of Valley of Flowers, Hemkund Sahib and Pindari Glacier. It was observed that 71% of total solid waste in Valley of Flowers was generated in just 37 days (Kuniyal, 2005). Other similar studies were conducted in 2020–2021 and it was observed that solid waste generation is a major concern in the high-altitude trek routes, i.e., Kedarkantha, Gaumukh. In view of per capita waste generation, ~364 g waste generation/visitor/day for Gomukh trek and ~580 g waste generation/visitor/day for Kedarkantha was estimated (Kuniyal et al., 2021).

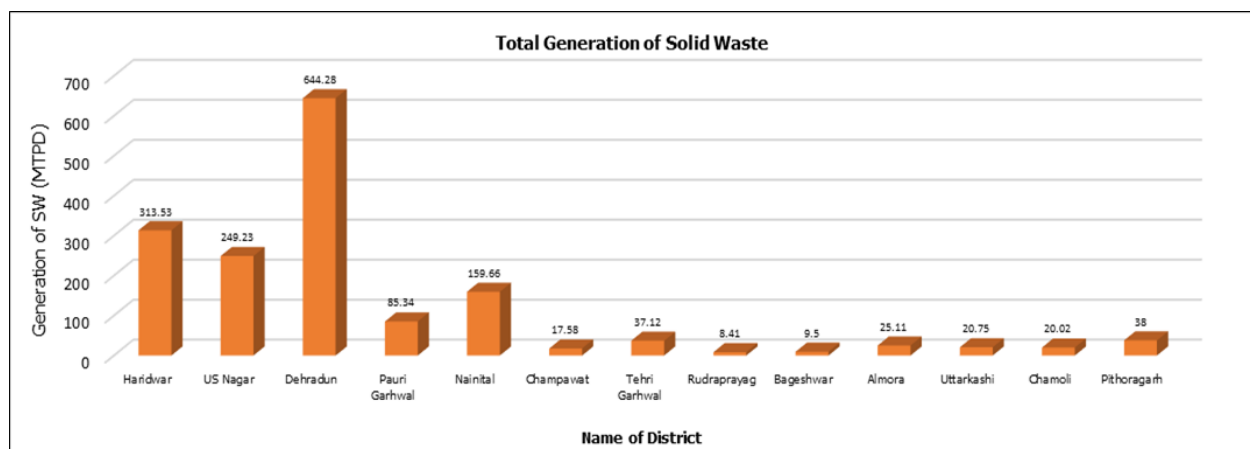


Figure 20. District wise status of waste generation in different years in Uttarakhand

In various parts of the state of Uttarakhand, pilgrimage-based tourism is common. According to data collected for the year 2022, between May and October, the pilgrimage season, around 2.8

crore pilgrims and tourists visited the towns of Haridwar and Char Dham (Table 7). This resulted in the production of a significant amount of solid garbage, which in just six months produced approximately 10,000 metric tonnes of dry waste, mostly plastic waste (Uttarakhand State Environment Plan, 2023). The Hon'ble NGT in its order dated 12-08-2022 in O.A. 561/2022 (Urvashi Shobhna Kachari vs Ministry of Environment, Forest & Climate Change) highlighted the indiscriminate disposal of plastic waste, animal waste, unregulated human waste, etc., in pilgrim tracks of Kedarnath, Hemkund Sahib, etc. Subsequently a team (of which NIHE was also a part) was devised to study about the violation of environment norms along these track routes.

Table.7 Tourists/pilgrims influx and corresponding dry waste generation in major pilgrimage sites of Uttarakhand

Topographical Divisions	Name of District	Pilgrimage Site	No. of tourists/pilgrims visited during 2021-22 ^a	Total Dry Waste generation (MT) ^b
Bhabar and Tarai plain	Haridwar	Haridwar town	2,33,33,669	10167.00
Mid-hills	Rudraprayag	Kedarnath Dham	15,63,275	2.08
High hills	Uttarkashi	Gangotri Dham	6,24,516	15.45
		Yamunotri Dham	4,85,688	10.00
	Chamoli	Badrinath Dham	17,63,549	38.48
Total			2,77,70,697	10233.01

Source: Uttarakhand State Environment Plan, 2023

^aThese data pertain to the six months of tourist season from May to October.

^bThese data pertain to the amount of total dry waste—essentially plastic waste—generated in the six months of pilgrimage season.

Effect of tourism on Air quality

At present, the air quality is being monitored in Uttarakhand state through 20 air quality monitoring stations covering 14 towns/cities. In addition, two Continuous Air Quality Monitoring Stations (CAAQMS) are also installed at Dehradun and Rishikesh. Three cities/towns, viz., Dehradun, Rishikesh and Kashipur are identified as non-attainment cities in Uttarakhand. There is 34%, 24% and 44% reduction in PM₁₀ values compared to base year (2019–20) at Dehradun, Kashipur, and Rishikesh, respectively.

Past studies pertaining to air quality in Dehradun shows that the concentration of gaseous pollutants and particulate matter (SO₂ and NO₂ and PM₁₀) was relatively lower during the monsoon season (except the year 2020). The annual mean concentration of PM₁₀ was much higher than the NAAQS by CPCB and the permissible limit given by WHO (Singh et al. 2023) (Fig. 21). After lockdown, the levels of both gaseous pollutants, SO₂ and NO₂, began to rise in June 2020.

Sundriyal *et al.* (2018) studied the impact of tourism development on environment in Mussoorie by analyzing traffic management, ambient air quality, 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.

Remedial measures such as infrastructure improvement, waste and traffic management, refinement in manufacturing technologies, development of emergency response systems, public awareness programme, etc. have been taken to minimize air pollution in Uttarakhand.

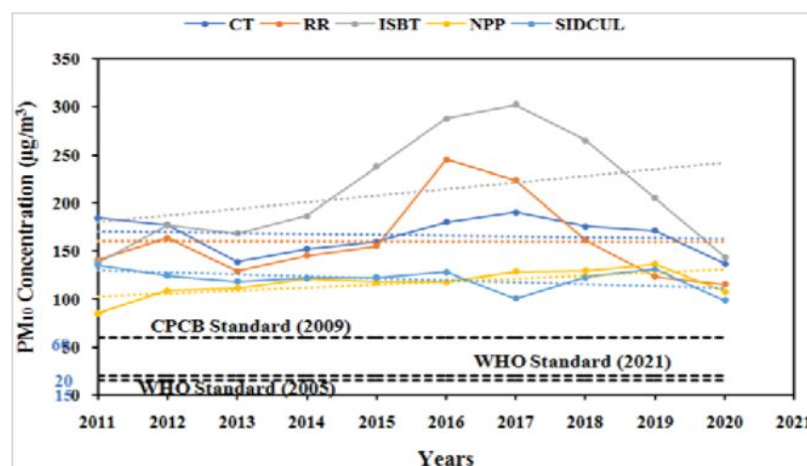


Figure 21. Annual variability of PM₁₀ during the 2011-2020 (Singh et al. 2023)

Studies were conducted by NIHE at Kosi-Katarmal (29.64°N, 79.62°E, 1225m a.m.s.l) site. The concentrations of PM₁₀ were found to be $45.3 \pm 1.8 \mu\text{g m}^{-3}$ while PM_{2.5} levels were measured to be $35.7 \pm 2.2 \mu\text{g m}^{-3}$, demonstrating compliance with the regulatory standards. Additionally, the concentrations of SO₂ were within the acceptable range having the values of $2.2 \pm 0.4 \mu\text{g m}^{-3}$, while the levels of NO₂ were recorded at $12.7 \pm 1.7 \mu\text{g m}^{-3}$, meeting the permissible limits.

Effect of tourism on water quality

Water quality monitoring is regularly carried out at 125 locations in Uttarakhand; out of these 39 monitoring stations are located in main stretch of River Ganga. Many of these are groundwater monitoring stations, wetland water quality monitoring stations, etc. Data of Faecal Coliform and Total Coliform (count in MPN/100 ml) show high values in different monitoring stations along River Ganga at Hardiwar. The values are less based on the monitoring stations located upstream of Rishikesh at Devprayag, Rudraprayag, and Gangotri.

Many wastewater treatment plants have been constructed under '*Namami Gange*' mission to reduce river water contamination. Around 70 STPs are located in Uttarakhand; 42 of them are currently operational in the Ganga priority towns. Many of these towns are located enroute of the famous *Char Dham Yatra*. Hence, the treatment of wastewater before draining into the river system is helping in reducing the degrading river water quality. The degradation of water bodies might be sometimes due to unsustainable tourism.

Impact of tourism on forest, biodiversity and eco-sensitive area

Protected areas cover nearly 15% area of Uttarakhand and there is regulated access to the tourists bounded by strict rules. No tourist is allowed to take any biological material from these areas. Data on loss of biodiversity due to waste disposal so far has not been studied properly. 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. As per the action plan for management of eco-sensitive zones, there should be proper facilities of waste treatment, prohibition in construction activities, proper traffic regulations but there is no data available as per the web records, including tourist visit

details, vehicles entering with the ESZ, along with other prescribed guidelines which will enable the setting up of such facilities.

Initiatives

- Kumaon University, under the project funded by NMHS has developed a unique method to produce graphene from plastic waste. A collaborative effort from the university and municipality have also been planning to install one such facility (based on this method) at Nainital. This could address the concern regarding the increase in plastic waste generation in the town and its periphery.
- Dry Waste Collection Centre (DWCC), Bio-methanation and Pyrolysis plants are installed at Mussoorie, Uttarakhand, to make the city self-sustaining in its waste processing and disposal.

Summary

In Uttarakhand, the tourism sector contributes immensely towards both the revenue generation as well as for the employment generation. Due to the presence of many holy shrines, the Government is putting a lot of effort for enhancing different types of tourism activities and upgrading the facilities for tourists. Tourist data are being collected by the Tourism department which is shared with the Ministry of Tourism on a monthly basis. The State tourism department also has a robust online tourist registration system on the Char Dham Yatra Route, which over the years has been modified and improved to include ICT enabled technologies. The registration systems aid the state government for better planning and management.

Generation of solid waste during the tourist season in the pilgrimage sites like Har ki Pauri in Haridwar and the Chota *Char Dham* circuit, etc. (in just six months produced approximately 10,000 metric tonnes of dry waste for six months of pilgrimage season, mostly plastic waste) are a matter of concern. However, the State is taking progressive steps to control the plastic waste being generated in the region. Initiatives such as waste warriors, *paryawaran mitras*, plastic free zones, etc., are the steps in the right direction.

In view of ensuring the hotel industry to minimize the harmful effects on the environment particularly in ecologically sensitive areas like tiger reserves, national parks, sanctuaries, etc., requires a combination of various regulations, permits and licenses which are under the purview of the State Pollution Control Board. Environmental Clearance (EC) is required before constructing or expanding hotels in the State. EC is conducted to assess potential environmental and social impacts of these projects. Projects are approved or modified based on these assessments and provided category ratings based on the project impact on air, water and waste management in the area. Accordingly, the projects are awarded ratings of Red, Orange, Green and White. After the EC is granted, the project proponents require a Consent to Establish followed by a Consent to Operate before finally starting the operations formally. The above permits/NOCs ensure pollution mitigation and control facilities are installed (CTE) and operated (CTO). The above process ensures minimal pollution impact and promote treat ability and waste management.

The dataset highlighting the impact of tourist-based activities on the Himalayan environment 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 the carrying capacity in the places like Dehradun, Haridwar, Mussoorie, Almora, Char Dham Circuit, high altitude trek routes, etc., should be one of the guiding principles for making tourism a sustainable activity over the long run.

Tourism growth *vis-à-vis* economic growth

The Government of Sikkim's Department of Tourism and Civil Aviation and the Government of India's Department of Tourism Statistics both have records showing that the number of visitors visiting the state has been steadily rising since 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). From 2011 to 2019, the domestic tourist arrivals have registered an average growth rate of over 11.3% per annum (from 5-14 lakh approximately). Similarly, the international tourist arrivals also increased with an average growth rate of over 27.4 % p.a. during 2011-21 (from 23,602 to 1,33,388 numbers). The total number of tourists visiting Sikkim (Source: Tourism Statistics, Govt. of India and Tourism & Civil Aviation Department, Government of Sikkim) during 2011-2021 is illustrated in Fig. 23.

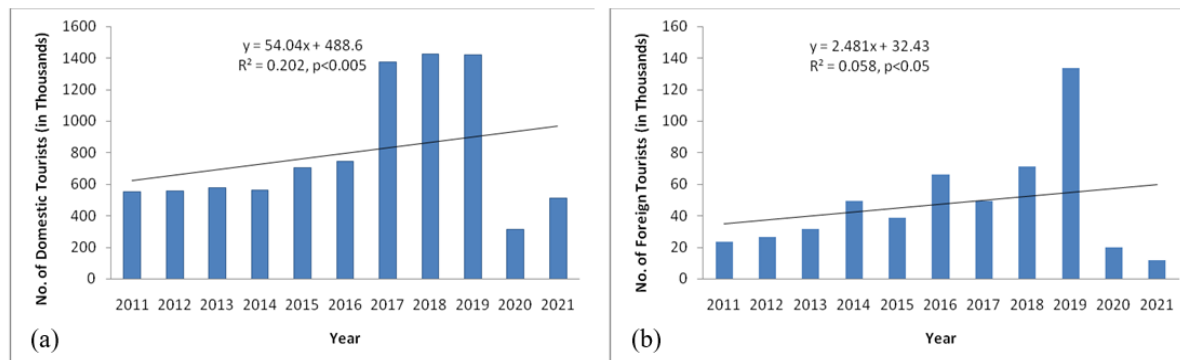


Figure 23. Trends of tourists [(a) Domestic and (b) Foreign] flow in Sikkim

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 & Dhyan 2009).

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%. All mountain states show a slightly decreasing contribution of tourism to the GDP of the respective state (NITI Aayog, 2018).

In the last decade, the tourism sector in Sikkim has seen a growth rate of 10-12 %. The total contribution of tourism sector to the Gross State Domestic Product during 2016-2017 was 7.68 % (DESME, State Income Unit). 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.

Transport & tourism: Number of vehicles

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. The careful analysis of the registered vehicles during 2011-2021 in the state showed that the private vehicles are increasing at higher rate) than that of tourist/taxi vehicles Owing to the increasing demand for services in the tourism sector, the rapid development of transportation facilities has been stimulated in the state.

Impact of tourism on environmental components

Assessment of waste generation in Sikkim

In Sikkim, seven municipal corporations / ULBs are collecting and managing the solid waste from the urban and rural areas on daily basis. As per the recorded data from 2016 to 2021 by the SPCB, GoS, on average; 271253 ± 3048 q/yr. solid waste is generated in the state. 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 around 86% (for the year 2017–2018). GoS has also passed several gazette notifications regarding management of municipal waste in the State.

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 of 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 landfill or dumping sites. Whereas, during 2020-2021, total 28% (74277.50 q/yr.) waste was treated and remaining 72% (188157.50 q/yr.) was land-filled and dumped. Hence, in Sikkim, the treatment of the waste has improved in 2020-2021 as compared to 2016-2017. For the management of solid waste in the state, 01 landfill site (42600 m²) is operational at Martam in East Sikkim district and 02 landfill site (132460.3 m²) are under construction, one at Sipsu, West Sikkim (112460.3 m²) and another at Rindang in North Sikkim district (20000 m²). Recently, one compost plant has been made operational at Martam, East Sikkim district with 50 tonne/day capacity. One organic waste converter is functional at vegetable market, Mangan, and 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. However, the State Government is working on improving solid waste management through augmentation of waste processing/disposal facilities in ULBs and Gram Panchayats and ban on use, manufacture, import and sale of plastic water bottles (capacity 2 litres and below), w.e.f. 1st January, 2022. Also, there has been a proposal for enhancing scientific wastewater treatment facilities.

Effect on air quality

SPCB, Sikkim established eight Air Quality (AQ) monitoring stations at Rangpo, Singtam, 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 station which is progressively decreasing toward north. 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. In

all the stations, the recorded values (October 2017-December 2021) are less than 100. The data of all the stations show that the air quality of Sikkim falls under prescribed value.

Effect on Forest, biodiversity and eco-sensitive area

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 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 had 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 *et al.* 2002, 2006, 2010). However, lately, this has reduced significantly owing to the rapid economic development and social welfare schemes of the government over the last two decades.

Joshi and Dhyani (2009) had highlighted that there has been a change in land use of agricultural land towards cultivating cash crops as well as developing tourism infrastructure. However, as per the information from Forest and Environment Department, majority of homestays have come-up in homestead land to decongest popular tourist destinations, while many ecotourism sites are in forest and wildlife areas. Moreover, local communities are involved to preserve and protect high altitude wetlands. For example, Pokhri Sanrakshan Samities (lake conservation committees) have been formed for such purposes.

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). Khangchendzonga 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 as per the data given by KNP/KBR Division, Forest and Environment Department, Govt. of Sikkim (Fig. 24). However, their numbers decreased during 2020-2021 due to covid-19 pandemic. 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). 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).

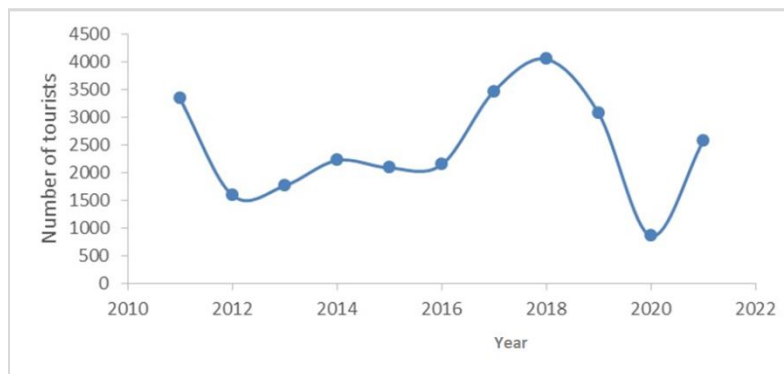


Figure 24. Flow of tourists in Khangchendzonga National Park (2011- 2021)

Tsomo go lake, located in the fringes of Kyongnosla Alpine Sanctuary, is a popular tourist destination visited by four lakh people in 2012 (Tambe and Arrawatia, 2012) that rose to over five lakhs in 2018-19. In and around the lake, approximately 180 shops have been set up by locals for tourists which are an additional source of pollution in the region.

Initiatives

- Making the reserve forests and protected areas grazing free, LPG for cooking in trekking campsite is introduced to reduce biotic pressure to some extent in the trekking route.
- There has been restrictiveness in wilderness areas through regulating use of fuelwood, adequate solid waste management facilities, use of policy and regulations such as Sikkim Wildlife (Regulations of Trekking) Rules, 2005, etc.
- 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 into

the National Park and after exiting these items are checked to ensure that all the wastes are brought back. If any tourist violates the rule and fail to account for rubbish that was not brought back, he or she is likely to be penalized with a total amount of Rs 5000.

- 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.
- 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 partnership with the concerned Gram Panchayat Unit.

Summary

The high frequency of the tourists in Sikkim offers employment to marginal people and contributes to generating state revenue. Natural, cultural, sacred values and heritage sites of the state have potential to draw enormous benefits from ecotourism enterprises. 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. Sikkim is a role model for promoting ecotourism, managing solid waste, and building ecotourism capacity, but it faces significant challenges from new risks associated with mass tourism, such as uncontrolled travel, waste generation, an increase in the number of vehicles, frequent traffic jams, and vehicle emissions that cause air and water pollution. The rapidly increasing tourist influx in Sikkim also poses concerns regarding carrying capacity of these tourist destinations and circuits. Notwithstanding, the Government of Sikkim adheres to the legal provisions in view of Water Act 1974, Air Act 1981, Environment Protection Act, 1986, SWM Rules, 2016, etc. 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.

WEST BENGAL

Introduction

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 Himalaya, which is situated at the pedestal of Mt. Kanchenjunga and Eastern Himalaya, is an attractive tourist destination (Fig. 25). It is a noteworthy example of India's booming home-stay tourism market and is also known as one of the 'Queen of the Hills' for its picturesque beauty, charming 'European' hill station ambience, and world-renowned tea industry (Roy *et al.* 2021).

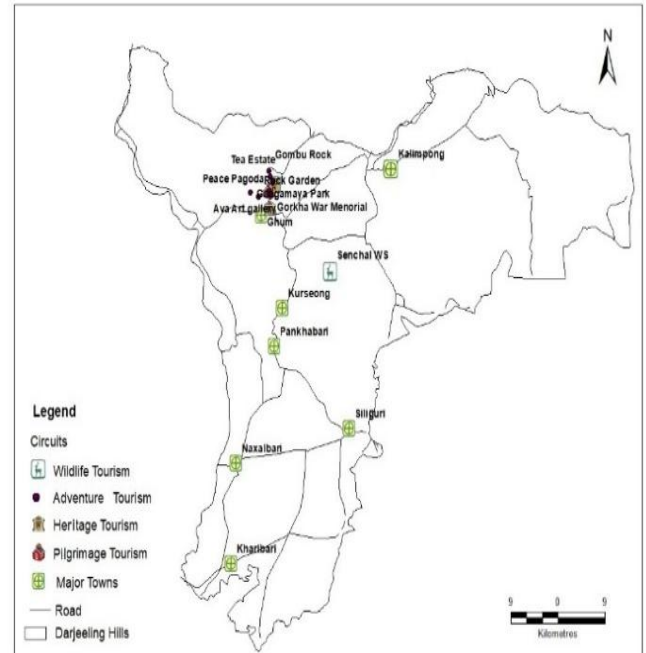
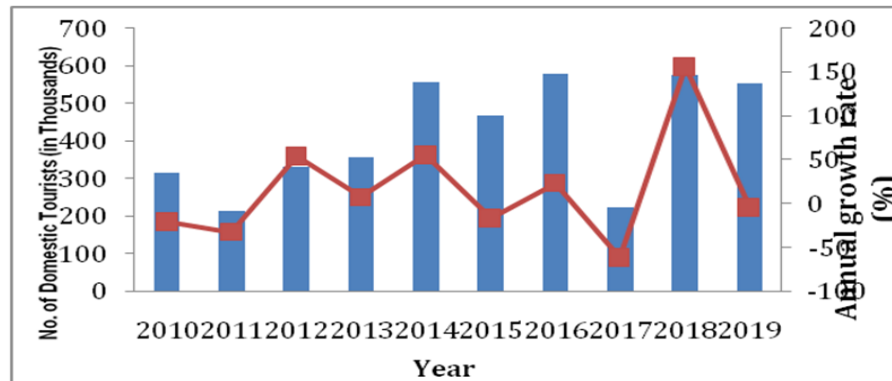


Figure 25. Major tourist spots and circuits in Darjeeling, West Bengal Hills

Also, there are now much more tourists visiting Darjeeling than there were in 2000 - over 240,000 tourists, including both domestic and foreign visitors - an increase of almost 50,000 (West Bengal State Tourism Department, 2014). 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 whole 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).

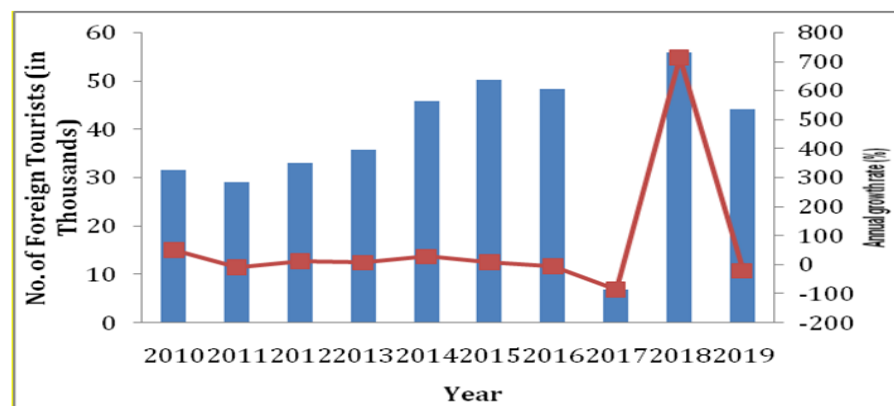
Tourism growth *vis-à-vis* economic growth

The maximum number of tourists (6,32,637) visited Darjeeling in the year 2018 (Fig.26&27). Similarly, the international tourist arrivals also increased from 31,562 in 2010 to 44,057 in 2019 with an average growth rate of over approximately 70% per annum during 2010-19.



Source: Tourism Department, Darjeeling, Government of West Bengal

Figure 26. Trends of Domestic tourists' inflow in Darjeeling town during 2010-2019



Source: Tourism Department, Darjeeling, Government of West Bengal

Figure 27. Trends of Foreign tourists' inflow in Darjeeling town during 2010-2019

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.

The domestic tourists visit is maximum in the month of May–June and the foreign tourists visit especially in the month of October–November. Darjeeling, being the tourist hotspot and a famous hill station, contributes a large amount of revenue to state GDP.

Effects of tourism 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 site), trekking, water rafting, butterflies' tours, forest Safaris, and wellness tourism. Additionally, according to Das and Roy (2016), there are now about 4.5 lakh tourists visiting the region annually, making it extremely difficult to accommodate all of these visitors. 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).

Assessment of waste generation in Darjeeling hills

The problem of solid waste generation in Darjeeling hills is increasing. There are seven ULBs in the district; 1 Municipal Corporation (Siliguri), 3 Municipalities (Darjeeling, Kalimpong and Kurseong), 1 Notified Area Council (Mirik), and 2 Cantonment Boards (Jalapahar and Labong). As per the District Environment Plan (2021), 66.38 MT/day solid waste is generated from Darjeeling Municipality. Amongst all the ULBs, maximum waste is generated by Municipal Corporation Siliguri (350-400 MT/day).

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. Wet-waste management is done on-site, and the composting is done by bulk waste generators which are limited. There are no facilities for central composting or bio-methanation of moist waste (District Environment Plan, Darjeeling-2021).

Waste disposal / treatment facilities

There are limited waste deposition centres for domestic waste in Darjeeling, which is inadequate for deposition of waste generated in bulk due to increase in urban population and tourists' inflow. Hence, as per the District Environment Plan of Darjeeling- 2021, there is a need to setup 604

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).

Impact on Air quality

According to yearly average values for air quality for urban local bodies (ULBs) in the Darjeeling district, PM₁₀ value for Darjeeling (57.6 µg m⁻³) was virtually the same as the NAAQ standard (60 µg m⁻³), however it is significantly higher for Siliguri (90 µg m⁻³). The annual mean NO₂ values for Darjeeling and Siliguri were found to be 35.20 µg m⁻³ and 37.54 µg m⁻³ respectively. These NO₂ levels are on the higher side, although being less than the NAAQ threshold of 40 µg m⁻³ for NO₂.

The annual average concentration of PM₁₀ was recorded to be 55 ± 18 µg m⁻³, which is close to National Ambient Air Quality Standard (NAAQS; 60 µg m⁻³ for annual PM₁₀) of India. The concentration of PM₁₀ showed maximum in pre-monsoon season (63 ± 21 µg m⁻³) followed by post-monsoon (56 ± 16 µg m⁻³), monsoon (51 ± 13 µg m⁻³) and winter seasons (49 ± 17 µg m⁻³) (Rai *et al.* 2020).

Impact on water quality

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 may adversely 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. 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 10⁵ CFU mL⁻¹ - 6.2 X 10⁵ CFU mL⁻¹) vividly 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).

Impact on forest, biodiversity and eco-sensitive area

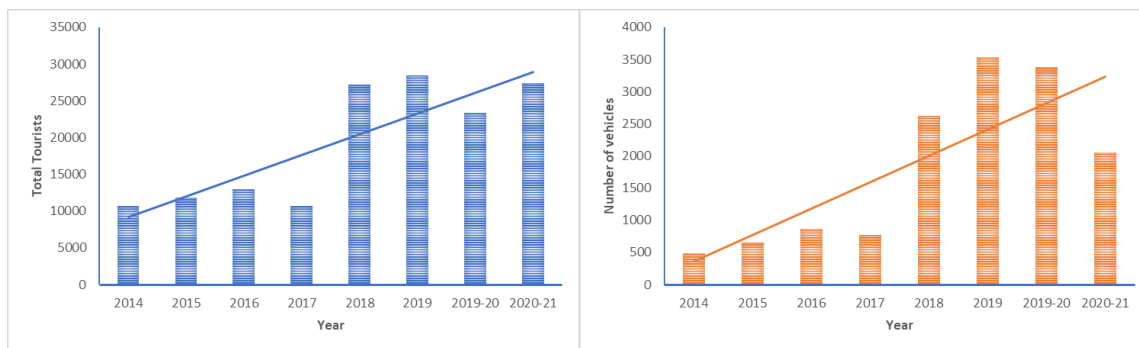
The numbers of visitors have substantially increased over the past two decades which have a direct impact on geo-environmental settings of Darjeeling Himalaya. Deforestation is the most

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). 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.

There are three designated Eco-Sensitive Zones/ Areas in West Bengal hills (Neora Valley National Park, Singalila National Park, and Senchal Wildlife Sanctuary). Singalila National Park, which is a 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 at 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 showed continuous increasing trend (Fig. 28). 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 matter of concern for the sustainability of the ecosystem of the national park and red panda habitat.



Source: Sherpa and Mondal, 2021

Figure 28. Increasing flow of tourists in Singalila National Park in the last 8 years.

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 (*Lophuraleucomelanos*).

Summary

The hilly regions of West Bengal (Darjeeling and Kalimpong districts) rely heavily on tourism as a source of revenue, income, and employment for the local populace.

Facilities and services (e.g. supply of drinking water, electricity, municipal waste management, public transport and accommodation) deteriorate drastically in Darjeeling district during the peak tourist season. Therefore, regulation of tourism is utmost necessary in the hill districts of West Bengal.

Number of tourists visiting Darjeeling has increased over a period (2010–2019). Maximum influx was recorded in the year 2018 when more than 6 lakh tourists visited the hill station. Seasonal trend shows that maximum tourists flock the region during summer season (43.2% of yearly influx).

Considering the ever-increasing tourist's influx, the carrying capacity assessment of Darjeeling town and key tourist destinations in the West Bengal hills is urgently required.

Other effects of the tremendous rise in tourism include sewage, solid waste, noise, air, and water contamination. Given the large number of visitors, the districts have seen great expansion in the development of hotels, restaurants, resorts, recreational facilities, and other infrastructures. Therefore, it is necessary to adhere to sustainable building rules and examine the harm that these development initiatives are doing to the environment.

Waste management is a big challenge in the entire region and in all the eco-sensitive zones in the region. The ability to separate garbage at the source is lacking. It is crucial to handle waste properly, which includes sorting and recycling it. It is necessary to enable trash separation at the source, enabling decentralized processing of organic wastes. Though Waste Deposition centres (for domestic waste) are available, however due to the bulk amount of waste generated owing to

increase in urban population and tourists' inflow there is need for additional Waste Deposition centres. There is a complete lack of comprehensive plan for hazardous waste management.

There are shortages of drinking water, electricity cut, deterioration of municipal services, congestion in public transport and lack of accommodation which leads 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, and 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 also caused the imbalance in the ecological set up.

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 CO₂ 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.

ASSAM

Introduction

Assam, the most populous state in the north-eastern region, recognized tourism as one of the sectors of the income way back in 1958.

The domestic tourist inflow in Assam in 2017 was the maximum among the other northeast regions registering about 6.05 million domestic tourist visits, followed by Sikkim, Meghalaya and Tripura. The most important tourist season prevails from May to October. 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 Assam.

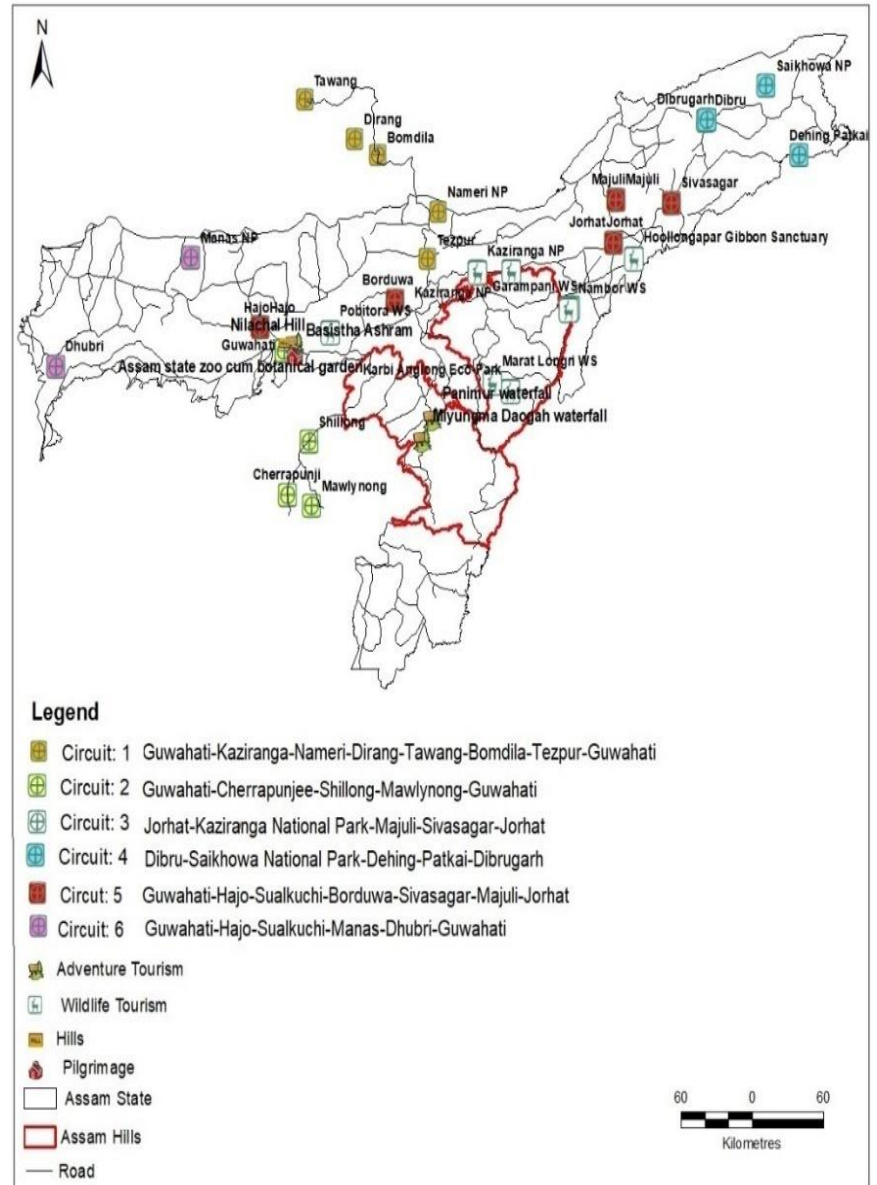


Figure 29. Major tourist spots and circuits in Assam

Tourism growth

Assam has an influx of over 4 million tourists annually from all across the nation and the world (Assam Tourism Development Corporation Limited, 2019). The trend of tourists' influx to Assam

has witnessed continuous growth from about 2.2 million in 2004 to about 5.9 million in 2018 (*Assam Tourism Development Corporation Limited, 2019*).

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% of the total employment of the state (Gogoi, 2017). The government's substantial efforts to promote tourism in Assam together with the state's general infrastructure development have encouraged more and more people to become involved in this industry. Consequently, many people have started to get associated with it, leading to a continuous hike in revenue generation from this sector. Table 8 shows revenue generation through government tourist lodges (except Kaziranga) in major tourist areas of Assam. To promote and adopt sustainable tourism, the Tourism Department has introduced Assam Tourism (Development and Registration) Act, 2004 with a view to promote environmental sustainability.

Table.8 Total revenue earned (Rs) across five tourist areas from tourists only

Tourist spots	2014-15	2015-16	2016-17	2017-18	2018-19
Kaziranga ^a	28392304	41976727	49315104	56022295	482229
Sivasagar	700310	735175	762694	802957	1027444
Bhalukpong	156000	177000	85600	51600	144200
Chandubi	91500	107400	214800	178040	524800
Barpeta Road	140300	163100	262400	376100	350800
Total	29480414	43159402	50640598	57430992	2529473

^aIncludes total revenue generated from Kaziranga NP, including Government and Private lodges.

Source: Field Director Kaziranga National Park; *Statistical Handbook of Assam 2018, 2019*

The locals make a living by operating small-scale home stay businesses, where they give guests a traditional view of life among the locals. 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.

Study of Environment Indicators in Assam

Solid Waste Management in Assam

There are total 104 ULBs in Assam (including Guwahati), out of which 8 are newly formed. As per the data available for the years 2021–2022, ULBs of Assam together generate 1284 tonnes waste per day. Out of this, 1030 tonnes waste is collected, and 652 tonnes waste is treated (PCBA, 2022). Waste, particularly dry waste processing and treatment, is carried out in Material Recovery Facilities (MRFs) which are 144 in number and have combined capacity of 487 MTPD. Moreover, facilities are available for treatment/processing of biodegradable waste—the state also has one bi-methanation plant having a capacity of 5 MTPD. The state has 45 dumpsites for waste disposal out of which one site has been remediated. Timeline has been prepared to clear remaining dumpsites (CPCB, 2021). Moreover, PCBA has banned PET bottles less than 500 ml and has initiated legacy mining of solid waste dump sites.

Some steps such as installation of litter bins in major tourist spots, organizing cleanliness drives, awareness campaigns have been taken by the Department of Housing and Urban Affairs, Government of Assam towards effective solid waste management. Also, special initiatives including Rally for ‘Garbage Free Beaches’, ‘World Tourism Day Celebrations’, etc. are carried out by the department.

Impact on Air quality

It has been 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 have shown high numbers after 2021 (Fig. 30). 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.

In Dima Hasao district (Haflong) after the monsoon, October month reported an increasing registration with the tourist flow in the area. In Karbi Anglong district, registration of vehicles has increased in the month of March. Numbers of diesel and petrol-operated vehicles at Dima Hasao district have been increased 42% and 27% in 2018 and 2021, respectively. Similar trend is also found at Karbi Anglong with 9% and 11%, respectively. Unrestrained tourism accelerates threats to many natural areas around the Assam Hills like Haflong in the eastern Indian Himalaya. It often creates stress on water resources, and it pushes local populations to use critical resources.

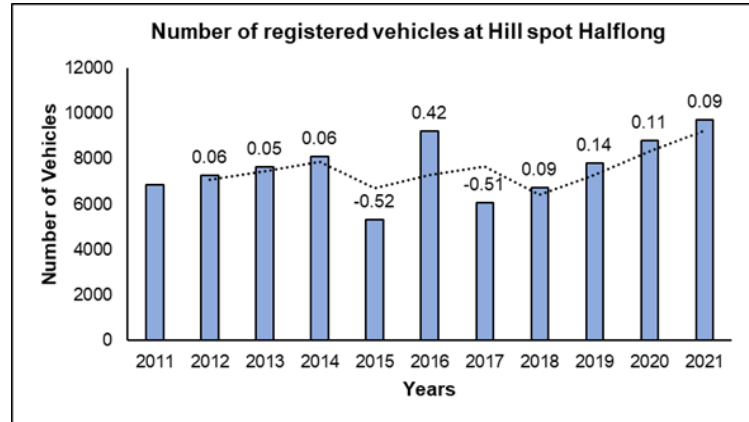
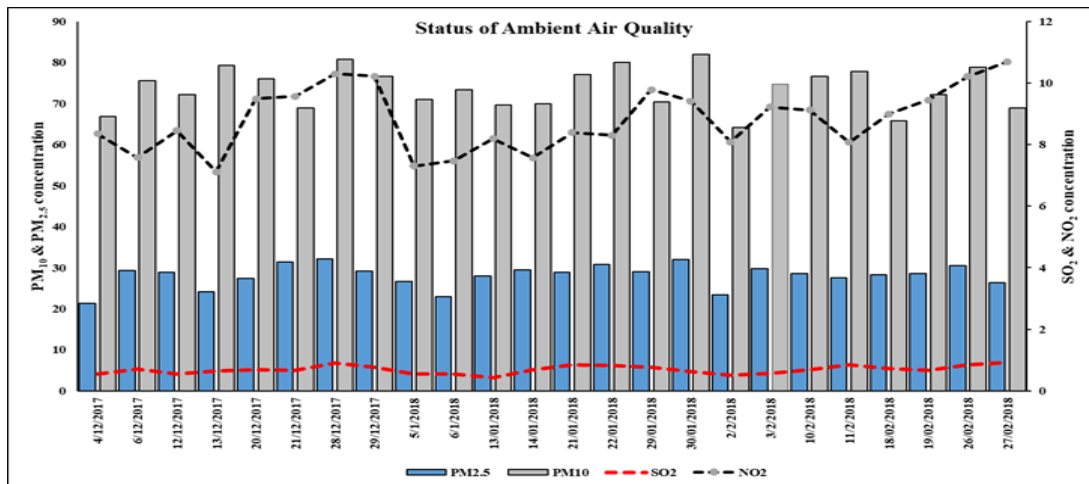


Figure 30. Number of registered vehicles in Haflong (2011-2020)

Air quality data were generated by M/s Eco Laboratories & Consultants Pvt. Ltd. for the selected sites of Dima Hasao district from December 2017 to February 2018. These sites are close to the tourist destination Haflong. Fig. 31 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. 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.

Pollution Control Board, Assam is also monitoring ambient air quality under National Air Quality Monitoring Programme (NAMP) at Haflong, Dima Hasao (3 monitoring stations) and is planning to install one monitoring station each at Karbi Anglong and Karbi Anglong (West). Data for past six months show that the air quality parameters are well within the permissible limit. PM_{10} varied from 41 to 49 $\mu\text{g m}^{-3}$ at Haflong Government College during December 2023, while $PM_{2.5}$ ranged from 20 to 26 $\mu\text{g m}^{-3}$ at the same location.



Source: M/s Eco Laboratories & Consultants Pvt. Ltd

Figure 31. Status of Ambient Air Quality near Halflong area Dima Hasao district

Impact on water quality / groundwater

Dima Hasao district has different facilities of surface irrigation and groundwater availability. Majority of surface irrigation demand is met through tanks, lift irrigation, rainwater harvesting, treated wastewater from sewage treatment plant and perennial source of water. Groundwater facilities such as open well, deep tube well, medium tube well and shallow tube well are available in Dima Hasao district of Assam. In Assam hills, the mineral formation does not contain any harmful elements, which could percolate into the ground and pollute the groundwater (Statistical Handbook of Assam 2011-19). At present, both surface water and ground water quality are being monitored under National Water Monitoring Programme (NAMP) in hill district of Karbi Anglong. Also, water quality is being monitored in one location at Haflong town in Dima Hasao district. Under SBM 2.0, construction of 34 aspirational toilets in 32 ULBs are proposed specifically in areas with high tourists' footfall. However, most of the tourist areas fall within forests or restricted areas, hence it has become difficult to undertake such construction activities.).

Effect on forest, biodiversity and eco-sensitive area

The total area of humid primary forest in Dima Hasao has decreased by 8.4% during 2011-21. Dima Hasao lost 69.0 kilo-hectare of tree cover between 2001 and 2021, which is equivalent to a 16% decline between 2000 and 28.5 MT of CO₂ emissions. Karbi Anglong lost 27.9 kilo hectares of moist primary forest between 2002 and 2021, accounting for 17% of the region's overall cover loss during that time. The total area of humid primary forest in Karbi Anglong decreased by 9.8%

during this period. Karbi Anglong saw a 105-kilo hectare loss in tree cover between 2011 and 2021, resulting in 47.3 MT of CO₂ emissions and a 13% decline in tree cover since 2000.

The government has declared seven protected areas as ESZ: 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. Assam Government has made clear that the eco-sensitive zone would categorize activities inside it as prohibited, regulated and promoted.

There have been published literature on mitigation measures of tourism activities being undertaken in Kaziranga National Park. Under one study by Hussain (2021), it showed that the park's management authority has made efforts to engage with local villagers, organisations such as Kaziranga Development and Jeep Safari Association, local hoteliers, Parivesh Samannay Smiti, etc. to promote eco-tourism. It is also highlighted that the local residents in Kaziranga are involved not only in safari activities but also in various cultural pursuits. This encourages the tourists to dwell into the indigenous culture which motivates the locals to conserve their valuable heritage.

Summary

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 from across the country and around the world. Assam has witnessed continuous growth from about 2.2 million in 2004 to about 5.9 million in 2018. With increased tourism in the Assam region, there has been increased waste generation, degradation of air and water quality which could lead to negative impact on the surrounding environment. During 2021–2022, ULBs of Assam together generated 1284 tonnes waste per day—approximately 80% of this waste is collected. The quantities of waste are growing at the rate of 3% annually with the increasing per capita generation. 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.

Although all the parameters of air and water quality were within prescribed standards, mitigation measures, mainly nature-based solutions are needed for improvement of air and water quality in the region. 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. The Assam government has designated seven protected regions, where no construction is allowed, as eco-sensitive zones. It is essential to maintain the local flora and fauna in addition to providing ecological and environmental security around national parks.

Launching a public awareness campaign for air pollution control, vehicle maintenance, minimizing the use of personal vehicles, lane discipline, etc. for controlling the air pollution in the region would be a prime need of the hour. Organising awareness campaigns, capacity building programs will make local inhabitants and tourists more aware regarding the harmful effect of anthropogenic activities on the environment which will make possible the paths of sustainable tourism development in the region.

ARUNACHAL PRADESH

Introduction

Arunachal Pradesh lies between 26°28' N, and 29°30' N latitudes and 91°30'E and 97°30' E longitudes and spreads over an area of 83,743 sq km. A major part of the Eastern Himalayan ranges in Arunachal Pradesh is the most picturesque tourist destination of India. Arunachal Pradesh has enormous potential for the growth of tourism, especially adventure and eco-tourism, thanks to its numerous turbulent streams, roaring rivers, deep gorges, tall mountains, snow-capped summits, thousands of species of flora and fauna, and an unlimited variety of visual beauty.

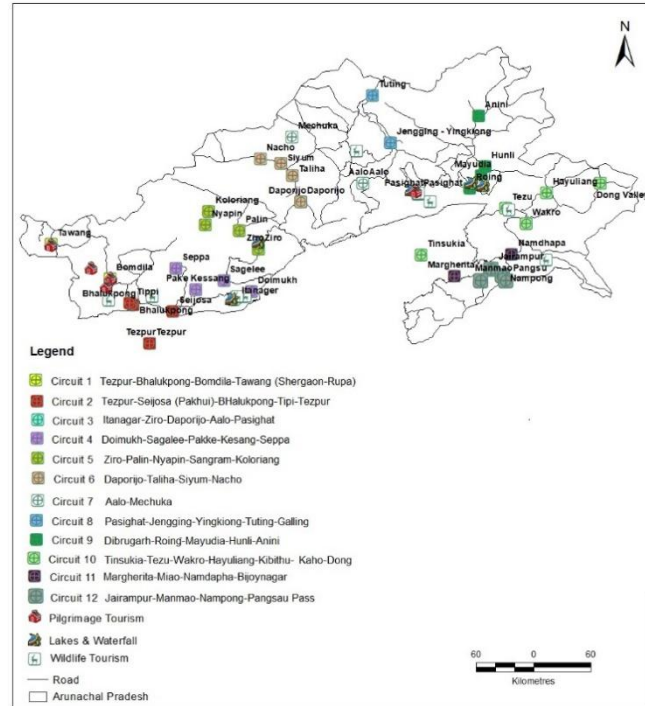


Figure 32. Major tourist spots and circuits in Arunachal Pradesh

The state has a vast potential for offering various attractions to the tourists like paragliding, river rafting, angling, hiking, trekking, mountaineering, land gliding, snow skiing, etc. Arunachal Pradesh boasts a variety of wildlife sanctuaries, national parks, and biosphere reserves in consideration of the wildlife enthusiasts and nature lovers, and its lush green tropical forests are filled with animals. Arunachal Pradesh is also famous for the Buddhist Circuit. Though the state has high tourism potential yet 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. There are twelve important tourist circuits in the state as shown in Fig.32.

Tourist growth

Fig. 33 shows the tourist footfall in the state for the past 10 years (2011 –2021) including both domestic as well as foreign tourists. Average tourist footfall per year is around 3.3 lakh. A dip in tourist activity was observed in the year 2020 due to covid pandemic. Based on the data for the years ranging from 2015–2021, tourism activity has generated around Rs. 5.3 crores revenue (Fig. 34). The revenue generation has been above Rs. 1 crore per year during the period 2015–2018. Thereafter, this revenue has fallen by around 27% in the following years except 2020-21 when there was significant decline due to covid pandemic.

Tourist inflow is maximum in Lohit and Tawang districts. Tourist inflow in Lohit district is largely due to the Parsuram-Kund, a Hindu pilgrimage site, while Tawang and West Kameng attract tourists during the winter season. Dirang and Bomdila are major tourist attractions in West Kameng district.

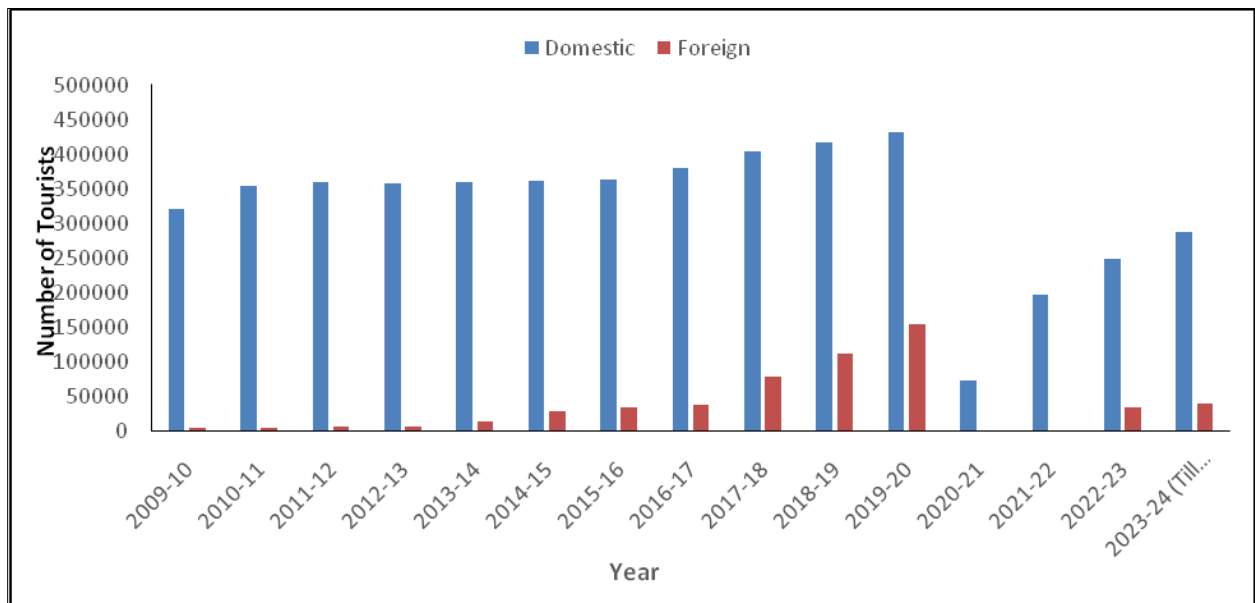


Figure 33. Tourist footfall in Arunachal Pradesh for the years 2015–2021

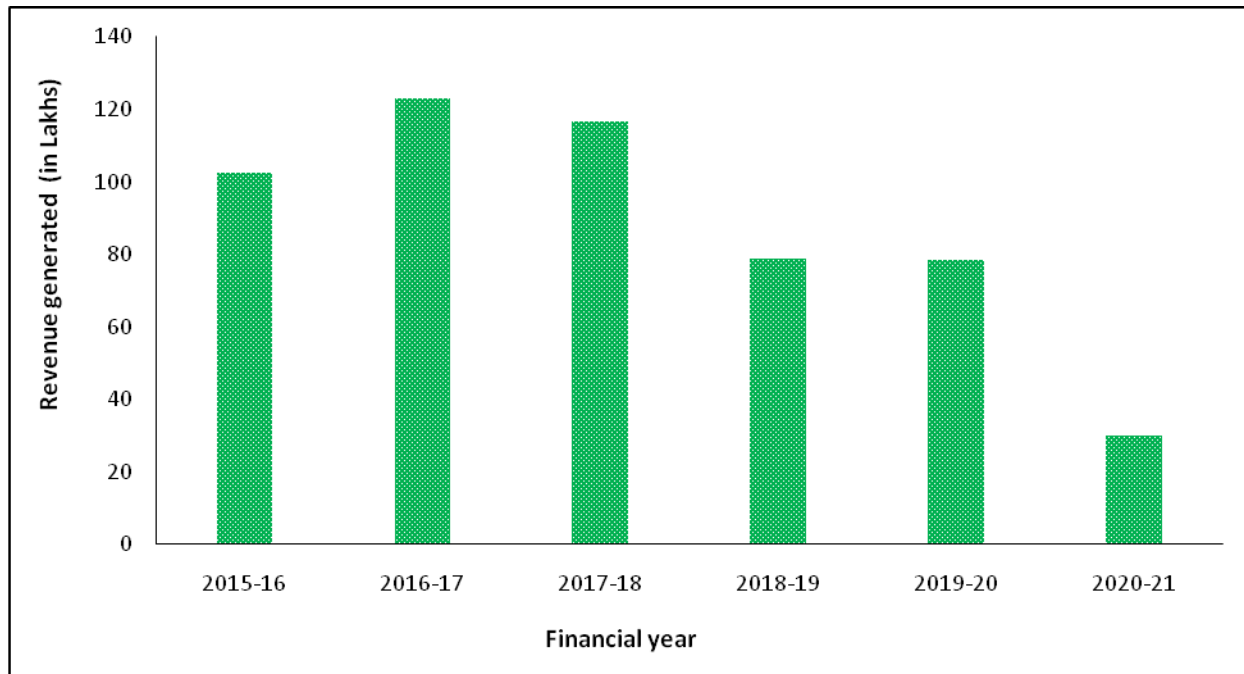


Figure 34. Graphical representation of revenue generation through tourism activities

Effects of tourism on environmental components

Assessment of waste generation in Arunachal Pradesh

Around 214.02 MT solid waste is generated daily in the urban areas of the state—MC Itanagar is the largest contributor amongst all the ULBs. 86.96% (186.13 MT) of the total waste is collected; 28.37% (60.72 MT) is segregated (APSPCB, 2022; State Urban Development Department, 2022). The state has also notified 10 model towns amongst the ULBs. Moreover, three model villages have also been recognized in each district of the state. These model towns/villages need to have compliance towards different environment norms. In view of waste management, special funds are allocated, especially to the model towns for setting up MRFs as well as legacy waste management (SPCB, 2022; State Urban Development Department, 2022). One important category of solid waste is plastic waste. As per the affidavit cum status report (2021-22) by the state in the matter of compliance of Municipal Solid Waste Management Rules, 2016 (OA no. 606/2018 of Hon'ble NGT), the state is encouraging the use of plastic in road construction.

Effect on Air Quality***Number of Vehicles***

Arunachal Pradesh registered 3,84,480 vehicles between the years of 2011 and 2021, including both transport and non-transport vehicles. Out of these, 31,490 are transport vehicles and 3,52,990 are non-transport vehicles. The number of automobiles is highest in the capital complex (2,64,553) and lowest in Kamle (31 vehicles). As per the data from the year 2018 to 2021, Arunachal Pradesh has registered 73,458 petrol vehicles and 20,053 diesel vehicles.

At present, the ambient air quality is being monitored through NAMP in Itanagar Capital Region at Itanagar and Naharlagun. As per the information available for the months from January to March'24, air quality standards in these two stations are within the permissible limits. However, at times, a sudden rise in PM₁₀ values is observed which could be attributed to heavy vehicular movements, earth cutting for various purposes, road construction activities, etc.

Data for vehicular air pollution in major tourist destinations of the state is not available due to unavailability of air quality monitoring stations in these locations. However, Arunachal Pradesh State Pollution Control Board is in the process of expanding the air quality monitoring network.

Effect on water quality/groundwater

Arunachal Pradesh has 2.56 BCM annual replenishable ground water resources and net annual groundwater availability of 2.30 BCM. The State Pollution Control Board has been monitoring water quality of 16 selected streams/rivers at selected locations under National Water Quality Monitoring Programme (NWMP). Data are regularly uploaded in Environment Water Quality Data Entry System (EWQDES) portal of CPCB (<http://ewqdes.cpcb.gov.in/ewqdes/>)

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. However, turbidity in water bodies of Arunachal Pradesh shows wide variation ranging from 0–160 NTU depending upon the season and other anthropogenic factors.

At River Pachin, Naharlagun, the water samples indicate turbidity as minimum as 1.75 NTU (AP SPCB, 2017). 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. The DO of the Arunachal Pradesh datasets that are currently available exhibits some irregularity. The DO value of the water samples from the Ganga, Dikrong, and Pachin rivers that were gathered in November 2021 is less than 6.5, which is the minimum standard for wholesome 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. Other physio-chemical parameters such as pH and BOD are within permissible limits.

Overall, the data on different water quality parameters indicate that so far, the major surface water sources (particularly rivers) are having moderately good quality water. However, 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 purposes. The state pollution control board is in the process of upgrading the laboratories for monitoring these parameters.

Effect on Forest and Biodiversity

Arunachal Pradesh is considered one of the forest-rich states in the eastern Himalaya. 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. Due to lack of data, correlation between tourism activities and biodiversity could not be established.

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 have 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.

Initiative

- The state is encouraging the use of plastic for road construction. In view of this, road stretches, namely, Pasighat-Bomjur (8.30 km), Changlang (1.16 km) and Akajan-Likabali-Bame (0.63 km) have been constructed by utilizing plastic waste.

Summary

The average number of visitors to Arunachal Pradesh per year is around 3.3 lakhs according to data gathered during a ten-year period (from 2011 to 2021). This shows that compared to other IHR states, Arunachal Pradesh has a considerably lower inflow of tourists.

In order to establish a clear connection between tourism and its impact on these environmental parameters, data on various forms of pollution (such as water quality, soil waste, pollution, etc.) related to tourism were gathered from various sources. 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 a database on direct income and direct impacts of tourism in the state. Although the capital complex (Itanagar-Naharlagun-Nirjuli) of the state is facing a solid waste problem and its management is a serious issue, which needs to be taken up seriously.

NAGALAND

Introduction

The State of Nagaland 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. (Fig. 33) 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.

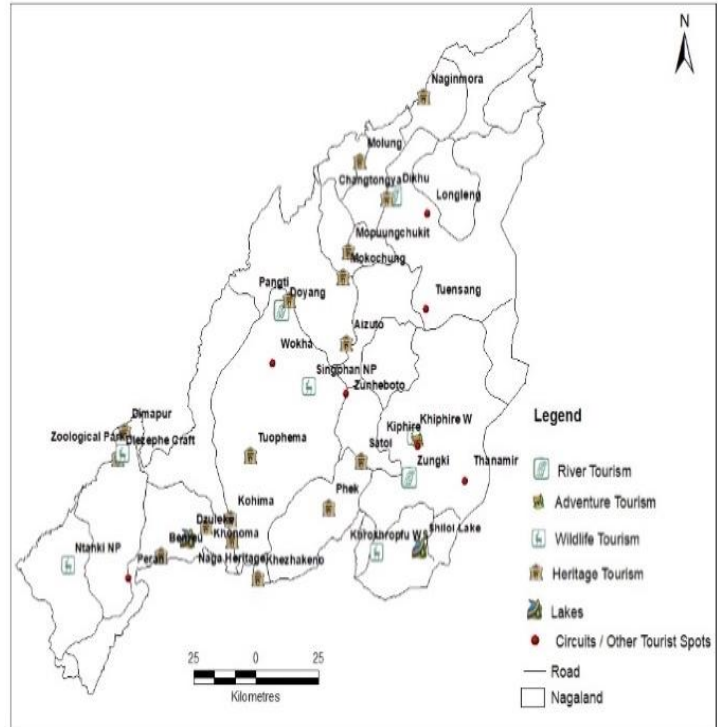


Figure 35. Tourist spots and circuit map of Nagaland

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 strategy also calls for the creation of tourism development committees at the state and district levels for departmental coordination, infrastructure improvement, tourism activity regulation, human resource development, and private sector involvement in the tourism industry. There are four tourist circuits identified and proposed to be developed phase-wise in order to priority. 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.

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 first project carried out in the State under the programme was "Development of Tribal Circuit: Peren-Kohima-Wokha" for Rs. 97.36 crores. Various tourist facilities, including a tribal tourist village, eco-log huts, an open-air theatre, a centre for tribal rejuvenation, a cafeteria, a helipad, a tourist interpretation centre, wayside amenities, last-mile connectivity, public conveniences, a multipurpose hall, hiking trails, and trekking routes, among others, have been developed and inaugurated in 2018. The other project "Development of Tribal circuit: Mokokchung–Tuensang-Mon" of Rs. 99.67 crores is under progress (<https://pib.gov.in/PressReleasePage.aspx?PRID=1554645>).

Tourism growth

The inflow of tourists, both international and domestic, to the State of Nagaland showed an increasing trend from the period 2010 to 2021 (Department of Tourism, Nagaland). 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. The mean monthly visitor influx varies significantly across certain months throughout a range of years (Kruskal-Wallis chi-squared = 31.038, df = 11, p 0.05). Specifically, tourist inflow in all December months is different from all other months. Whereas it is higher as compared to other months. This month also coincides with the popular Hornbill festival, which attracts a number of domestic and foreign tourists.

A study conducted by the National Council of Applied Economic Research estimated that the total share of tourism (both direct and indirect) to total Gross Value Added (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).

Effects of tourism on environmental components

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) 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.

We also performed linear regression to find out relation between yearly tourist visit and yearly mean of solid waste generated (tonne per day; TPD) within Nagaland. In both cases, the statistical relationship is very weak (Fig. 36). We also tried to build a relationship between monthly tourist inflow and increasing cumulative number of various types of vehicles during 2018–2021. However, no significant correlation was observed.

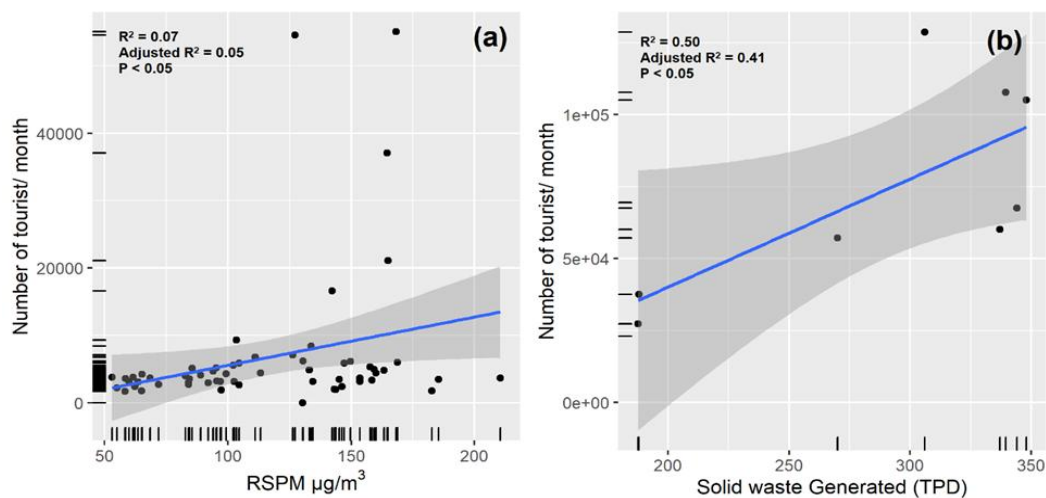


Figure 36. Relationship between RSPM ($\mu\text{g m}^{-3}$) and number of tourist/ month, (b) Relationship between solid waste generated in tonnes/day and number of tourist/month

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 a particular tourist destination/route would also be needed in order to determine how the growth of tourism can affect the air quality and to design regulating measures to minimise the impacts.

Assessment of waste generation in Nagaland

Solid waste generation for the past decade (2010–2020) and other relevant data were retrieved from annual review reports by CPCB on municipal solid waste. Waste generation and collection have shown a steady rise up to 2017–18, then a minor reduction until 2019–20 (Fig. 37).

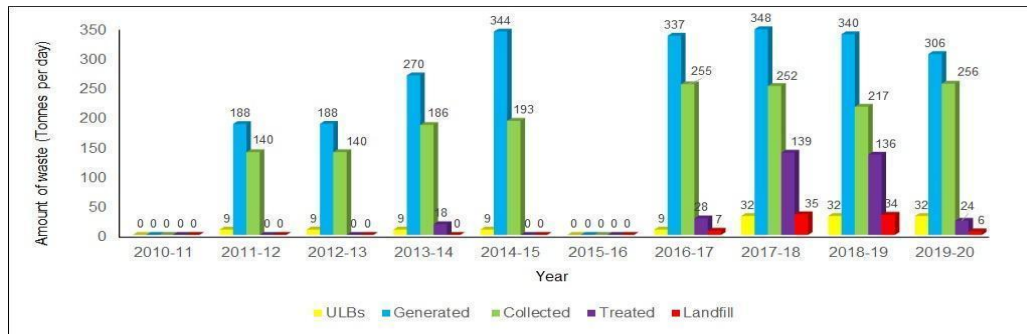


Figure 37. Year-wise waste generation, collection and management of solid waste in Nagaland (2010-11 to 2019-20)

As per the latest data for the year 2021, the state is generating 331.49 MT of solid waste daily. Around 78% of the total waste is collected. Facilities are also available for waste processing, especially plastic waste recycling (CPCB, 2021).

Number of vehicles registered

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. There has been a steady increase in the number of vehicles registered from 2018 to 2021 (Fig. 38). There were 1,01,092 automobiles in Nagaland as of December 2021. Out of this, the number of vehicles registered in Dimapur and Kohima comprise about 91% of the total with Kohima having the highest (51%) and lowest at Phek, Tuensang and Zunhebo to 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. In terms of districts, Kohima had the most diesel vehicles ($n = 42,433$), whereas Dimapur had the most petrol vehicles ($n = 32,719$).

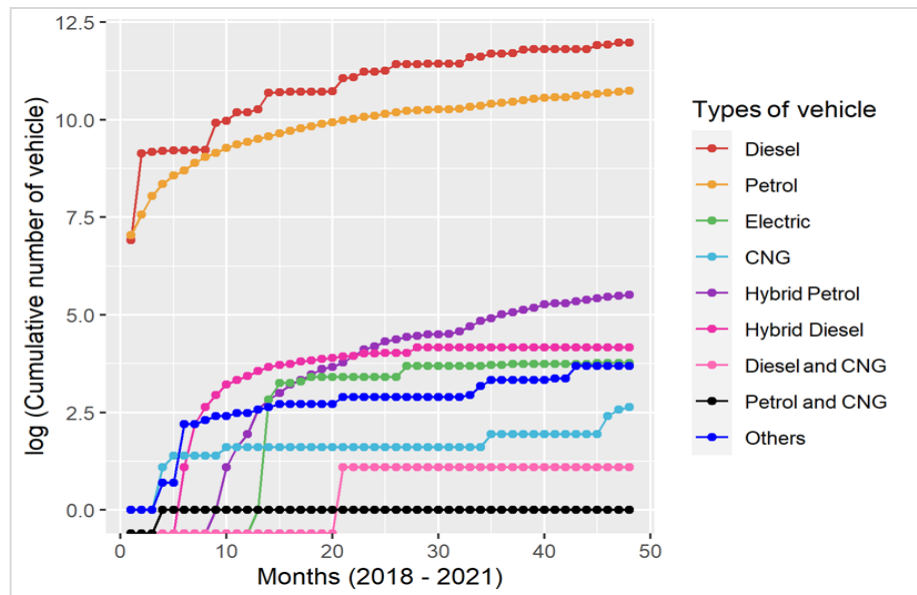


Figure 38. Trend of increase in number of vehicles (by fuel type) registered in the state of Nagaland during 2018-2021

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. 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 categorised in red, orange, and green. The particulate matter has been a major concern for both the cities, and due to Graded Response Action Plan (GRAP) initiatives, there has been a 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 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. In Kohima, PM_{10} concentration increased till year 2018 after which it started declining till year 2020. The annual permissible limit for PM_{10} is $60 \mu\text{g m}^{-3}$ but the data show that it is higher in all the years from 2011 to 2020. In Dimapur town,

NO₂ concentration rose from 2014 to 2018 and then fell until 2020. However, there was no change in the values at Kohima throughout the entire observation period.

SO₂ concentration remained constant throughout the monitoring period, i.e., 2013 to 2020 in both Dimapur and Kohima cities. The monitoring stations in both towns show that sulphur dioxide (SO₂) and nitrogen dioxide (NO₂) are considerably below the national criteria for air quality (CPCB, 2009). Dimapur and Kohima towns have been placed under non-attainment cities (2011-2015), the air quality in case of PM₁₀ 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 GRAP have also been incorporated to monitor and improve air quality.

Other organizations, such as the Municipal Board, Transport Department, PWD, District Administration, and Traffic Police, in addition to the Nagaland Pollution Control Board, have been tasked with carrying out these mitigating measures in accordance with their respective domains of expertise.

Impact on water quality

The results of the physico-chemical characteristics of River *Dhansiri* were analysed. The results revealed that the average minimum DO in all the years was below 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. BOD < 3 mg/l is designated as most suitable for its best use. However, the BOD level in the early years (2012 to 2015) was found higher. Thereafter, it shows a decrease in the BOD values. The higher BOD may be attributed due to the discharge of domestic wastewater mostly in untreated form and the municipal waste is thrown into the water bodies without treatment. 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 comes after crossing Dimapur town. The TDS and chloride content in all the three-monitoring years (2016, 2017 & 2018) was found well below the acceptable limit of BIS standard. Given the current situation, it appears that the River Dhansiri might be used for irrigation and bathing, and for this reason,

generated municipal sewage should be appropriately treated (Action plan for rejuvenation of River Dhansiri in Nagaland, 2019).

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. Nonetheless, the minimum doses are below the advised use of >4 mg/l. The BOD values are also within the permitted use at many stations, with the exception of Paper Nagar, Tuli in Mokokchung in 2018 in both years.

Further, there is no data on other parameters, viz., TDS, COD, chloride, phosphate and thus need to be studied.

Effect on forest, biodiversity and eco sensitive area

According to the 2021 FSI report, Nagaland's state forest covers 12251.14 km², or 73.89% of the state's total area. 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. However, no studies are available to date to show the impact of waste disposal on the state's forest ecosystem and overall biodiversity.

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.

Summary

The tourism sector is an emergent industry having great potential for economic development in 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.

The Ministry of Tourism, Govt. of India under the *Swadesh Darshan* scheme has sanctioned 2 projects since 2018 to develop tourism infrastructure in two tourist circuits of the state, viz., Peren-Kohima-Wokha and Mokokchung–Tuensang-Mon.

In spite of the limitations due to scarce infrastructural and communication facilities, the tourist inflow to the state, both domestic and international, has been increasing over the last 10 years (2010-2021). The number of domestic tourists contributed about 90% of the total tourist inflow to the state. The Hornbill festival which happens every year in December month attracts a number of tourists which was evident from the exceptionally high tourist inflow in the month of December compared to other months. However, tourism only makes up approximately 6% of the state's economy.

Assessment of waste generation from data available from the Municipal Town councils of Kohima, Dimapur, and Mokokchung could not ascertain the impact of tourism growth on increasing waste generation. A study in Kohima revealed that residential areas contributed the highest percentage (57%) of waste generated daily. Correlation analysis between the number of tourists per month with solid waste generated and Respirable Suspended Particulate Matter (RSPM) in the air revealed a very weak correlation. Another dimension of the data available for Nagaland is that it is either for state level or for major towns and rivers and not specific for certain tourist destinations or circuits. Therefore, based on available information, there are no studies so far to directly link the impact of tourism growth on waste generation, air quality, water quality, forest ecosystem and biodiversity.

MANIPUR

Introduction

India's north-eastern state of Manipur has international borders with Myanmar to the south and east, as well as the Indian states of Nagaland to the north, Assam to the west, and Mizoram to the southwest. Total geographical area of the state is 22,327 sq km with a population of 2,855,794 individuals as per the 2011 census statistics. Manipur meaning “land of gems” is blessed with the diverse tourist attractions (Fig. 39) 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.

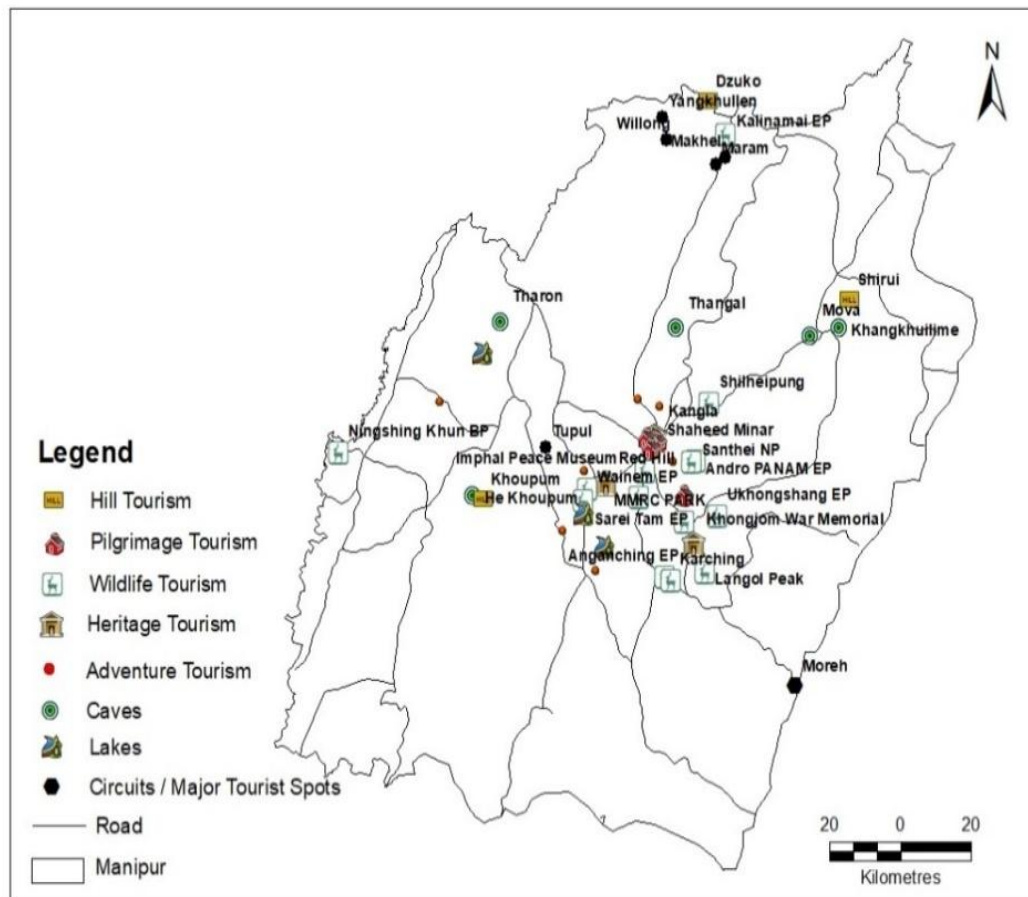


Figure 39. Major tourist places in Manipur

Tourism in Manipur

Despite Manipur's huge tourism potential, a number of factors prevented the area from developing in terms of tourism. The major obstacles to utilizing the state's tourism potential include the Protected Area Permit (PAP) regime for entry of foreigners, the remote geographic location of the state, poor resource availability, a lack of appropriate infrastructure, facilities, and amenities to cater to various types of tourists, the lack of trained guides, etc.

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.

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 the maximum (13,608) in the year 2019, the overall tourist influx declined significantly after 2019 (Fig.40). In addition, it is clear that the rate of change in the number of visitors fell sharply (70.85%) in the year 2020 as a result of the COVID-19 pandemic, and that the positive rate of change peaked (26.35%) in the year 2015.

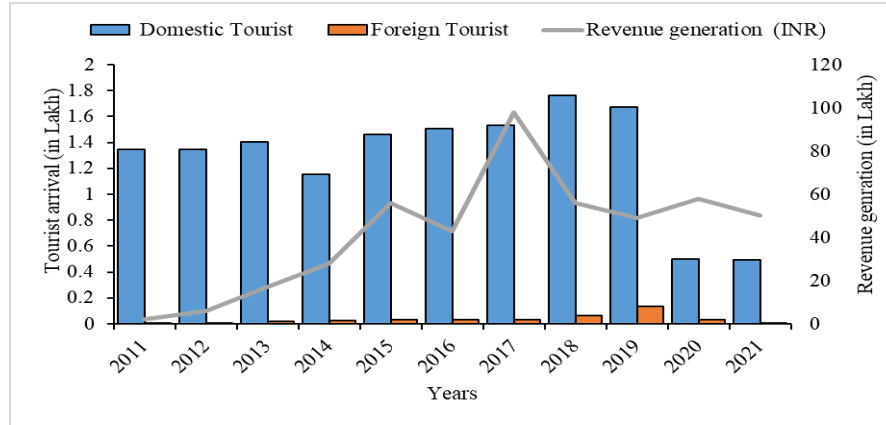


Figure 40. Tourism growth and revenue generation in Manipur

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 Rs. 2 lakhs in the year 2011 which was recorded maximum (Rs.98 lakh) in the year 2017 and it was Rs. 50 lakhs in the year 2021. 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.

Effects of tourism on environmental components

Solid waste and its management

As per the information received from the Department of Municipal Administration (Housing and Urban Development, Manipur), the total municipal solid waste generated in the State (December 23) is 290 MTPD. Out of this, 79% is managed and processed. According to the report Swasth Bharat Sampann Bharat assessed on May 2022, Manipur generates a total of 178 tonnes per day (TPD) solid wastes, of which 67% (120 TPD) comes from the city of Imphal alone. Out of the total waste generated by the state, only 70% is collected by the civil authorities, while 30% waste remains uncollected.

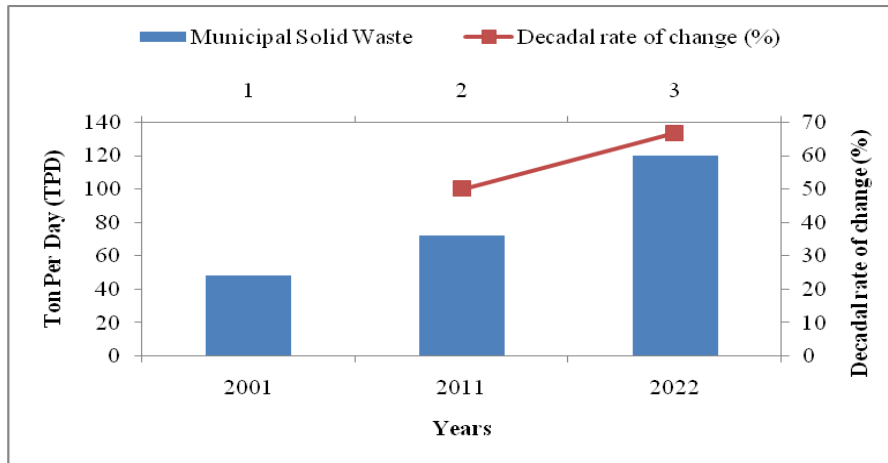


Figure 41. Decadal rate of change in municipal solid waste in Imphal City

At a temporal scale, a continuous increase in waste generation can be seen in the Imphal city (Fig. 41). According to the study on urban solid waste management in Imphal, the Imphal municipality generated 48 TPD of MSW in 2001 which increased to 72 TPD in 2011. At present, it has 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).

Imphal's municipal solid waste (MSW) management still faces difficulties as a result of the city's predominant reliance on traditional waste collection, transportation, and disposal techniques. Segregation of waste is not done at source even though the municipal laws stress its importance. Furthermore, there is also no requisite expertise for municipal solid waste management in the Department of Municipal Administration, Housing & Urban Development (MAHUD) Directorate which controls 28 local urban bodies. 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 practice in Manipur (Sophia and Devi, 2020).

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 and keep them outside the corridor of a house. Second, NGOs or municipal trucks collect the assembled waste and dispose it off in landfill sites. 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.

Effect of tourism on Air quality

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

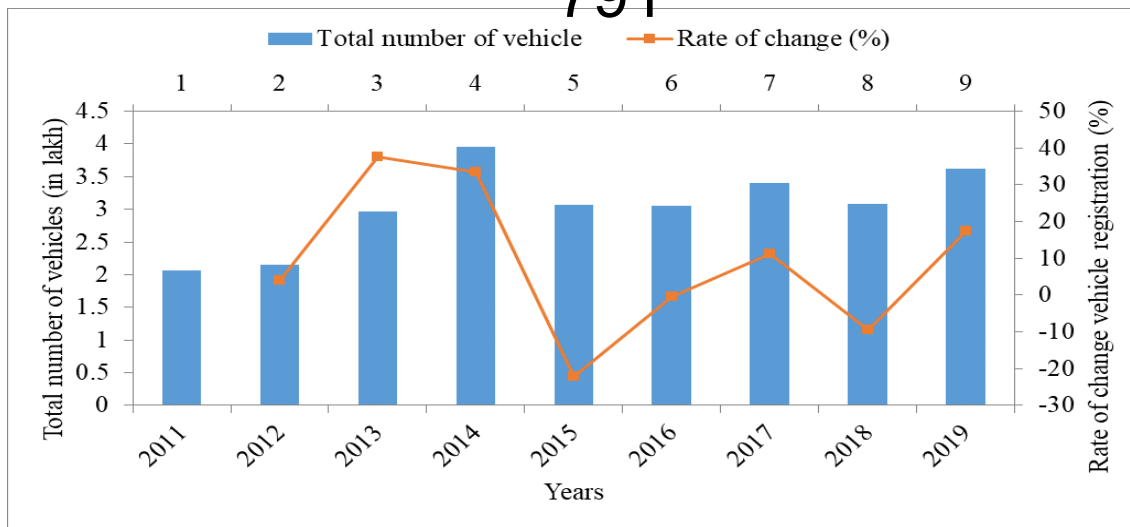
Air quality and pollutants

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, other miscellaneous commercial earthmoving activities and nature of soil leading to high concentration of particulates in the ambient air during dry season. The slash and burn activities in forest during February-March every year for preparation of the field for agricultural crop under Jhum practices add huge amounts of fumes and particulates into the atmosphere.

The level of growth in private modes of transport in comparison with public transport is a significant contributory factor for urban air pollution. The use of a large number of second-hand vehicles as transport is another cause of concern. In the valley, the air quality is not regarded as poor. The total number of vehicles in Manipur as of December 2017 has increased to 367,035. Another problem is the continuous increase in construction activities.

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 from 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 noticed. 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, there was found a negative rate of change as compared to 2014 (Fig.42).



Source: Ministry of Road Transport and Highways (India) © Statista 2021

Figure 42. Total number of registered motor vehicles across Manipur from the financial year 2011 to 2019

Parameter wise air quality

The Manipur Pollution Control Board monitors ambient air quality at Lamphelpat station. Moreover, there are two continuous ambient air quality monitoring stations at Dhanamanjuri University, Imphal. The observed values depict moderate air quality for the past four years with seasonal variations. However, the data related to air quality was retrieved from the online portal of Indiatstat wherein it was observed that the data on the ambient air quality is too scanty to assess the impact of tourism activity. Rather, whatever the pollution is being measured, this pertains largely to the impact of overall mixed activities. The PM₁₀ between 2016 and 2018 indicated good air quality (40 $\mu\text{g m}^{-3}$), but 2019 and thereafter showed poor quality (80–120 $\mu\text{g m}^{-3}$). Similarly, PM_{2.5} data is available from the 2019 onwards and indicates slightly poor air quality with the values between 50-100 $\mu\text{g m}^{-3}$. However, SO₂ and NO₂ concentrations were observed under good conditions.

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. 43).

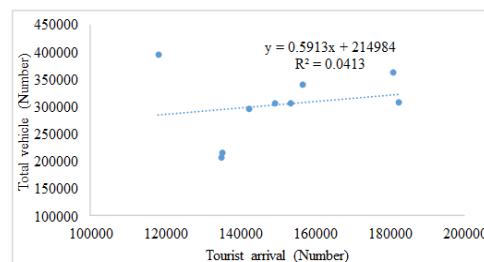


Figure 43. Correlation analysis with total tourist influx and vehicles between 2011 to 2019

Effect of tourism on water quality

The River Nambul, 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). The dissolved oxygen 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. Furthermore, it was observed that the activities like cloth washing, bathing, fishing are contaminating the riverbeds up to some extent (Manipur Pollution Control Board, <https://manipcb.nic.in/>). Lately, it has been observed that from the past three years, the river water quality has improved owing to the restoration work undertaken by the state government.

Effect of tourism on forest, biodiversity, and eco-sensitive area

The threat to the biodiversity of the state has been reported; however, data on the impact of tourism on the biodiversity is lacking. The Sangai, brow-antlered deer, which is found in Keibul Lamjao National Park, among others, is one of the most distinctive wildlife species of Manipur. Although, the population of Sangai, has increased from 14 in 1975 to 251 in 2018 census. The long-term survival of Sangai and its co-associate species including Hog Deer is threatened due to its low genetic diversity in the world, continuous inundation and flooding by high waters of the artificial reservoir of the National Hydroelectric Power Corporation (NHPC), Loktak, pollution due to direct discharge from other rivers, ecological change of the Loktak Lake (Singh, 2017). The Loktak Lake, on which the Phumdi floats, is significantly contaminated in part by man-made, occasionally toxic pollutants, and in part by detritus that rivers bring down to 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.

Summary

While tourism benefits the local residents, it also has negative consequences on the ecology and wildlife. In the urban centres of Manipur like Imphal, various polluting factors such as (i) vehicle emission, (ii) domestic solid waste, (iii) excessive dust fall, and (iv) unwarranted noise generation by vehicular traffic are reported. The urban living environment is adversely impacted due to pollution.

The major environmental problems caused by the development of the tourism sector in the state is: (i) enhanced vehicular emission due to the 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 when planning for the development of the tourism sector in the state. In addition, effective management of solid waste is lacking, which may hamper tourist flow in the state.

The research on the different aspects of solid waste management and its relation with tourism is lacking. It is recommended that the state implement proper solid waste management through infrastructure development, trash recycling, involvement of local non-governmental organisations, and coordination with the national cleanliness programme. It is also advised that the state work with other organisations to record the state's biodiversity, cultural practices, and physical characteristics in a campaign mode.

arrivals were recorded for the same period. Based on the collected literature, it is evident that the rate of change in tourist influx increased from 0.22% to 80.11% from 2009-2010 to 2019-2020. However, during the period of complete lockdown due to COVID-19 pandemic in 2020-2021, the rate of change in tourist arrival declined to -87.28%, while in the successive years, it was noticed an increasing rate of change.

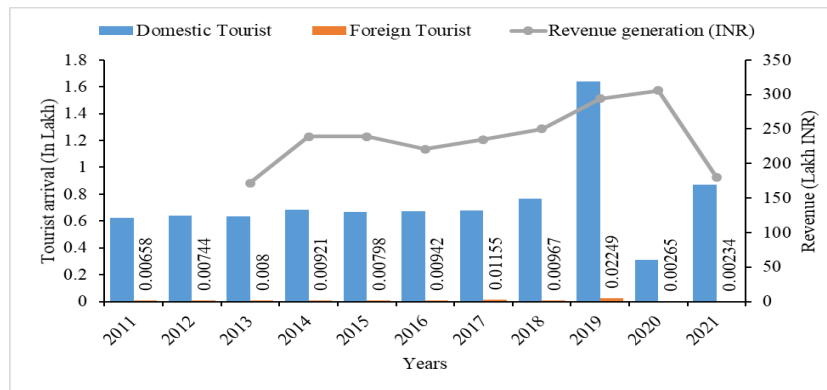


Figure 45. Tourist influx and revenue generation in Mizoram state

The state government is working to draw in quality visitors, and as a result, revenue generation has been continuously rising except during COVID-19 pandemic. 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 by 41.11%.

Effects of tourism on environmental components

Assessment of solid waste generation

Urban areas of Mizoram generate 348.19 MT of solid waste per day which roughly estimates to 520 gm/day per capita (MPCB, 2019–20). Aizawl, being the capital city has MRF for waste processing apart from mechanized composting plant (MPCB, 2022). Other urban areas have facilities for bio-degradable waste management but automated operations for dry waste management is still lacking in many of these areas. For example, in Siaha district, source segregation and segregated waste transportation is practiced. However, the district lacks solid waste management centre which has been a detrimental factor towards effective waste management. Similarly, Saitual town is generating 4.36 TPD solid waste which is collected and

transported to dump site. Land for construction of solid waste management centre is identified. Amongst all, Kolasib town is frontrunner in solid waste management. The town is declared as “Model Solid Waste Management Centre” in Mizoram by Urban Development & Poverty Alleviation (UD&PA) Department.

Other studies show that the decadal per capita waste generation has also increased from 470 gm/day/person in the year 2011 to 525 gm/day/person in the year 2020 (Lalneihzovi and Lalchhuanawma, 2017). 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.

Solid Waste Management in Aizawl

The waste generated in Aizawl city of Mizoram had shown an increasing pattern over the years. The total waste generated was 137.91 MT/day (i.e., biodegradable: 52.4; recyclable: 53.78 and others: 31.72) in the year 2011—in the year 2020, it reached 167.91 MT/ day. According to the available monthly solid waste data for the years 2020–2021 (*source: <https://smartcities.data.gov.in>*), there is a noticeable increase in solid waste quantity from November to January. The unexpected increase in garbage may be a result of the city's or state's increased tourism. Also, a considerable rise in solid waste quantity is noticed in the months from November to January pertaining to Christmas and New Year celebrations. Moreover, floating population in Aizawl also contribute to rising waste quantity.

Air quality and pollutants

Air quality monitoring is conducted by Mizoram State Pollution Control Board (MSPCB) and reports regarding the annual average concentrations of SO₂, NO_x and PM₁₀ are available in the website of MSPCB, GoM. Since 2012, the number of air quality monitoring stations have substantially increased from 3(only in Aizawl) to 19 stations located at Aizawl, Lunglei, Kolasib and Champhai districts. On the whole, the AQI ranged from 7 to 87. Summarized values of major air quality parameters in these monitoring stations are as follows: SO₂– 2 ug^m-³; NO₂ – 4.5 ug^m-³ (minimum) and 24.3 ug^m-³(maximum); PM₁₀– 4ug^m-³(minimum) and 343 ug^m-³(maximum).

The Aizawl capital city of Mizoram has the largest population among all the towns/cities in the state which is 293,416 as per 2011 census. Based on the year-round observations, the 24-hour average SO₂ concentration in all the AQMS was 2 µg m⁻³. Similarly, the average NO₂ concentration ranged between 5-8 µg m⁻³ and average value PM₁₀ ranged from 8-48 µg m⁻³.

Number of vehicles

The number of registered motor vehicles across Mizoram has been increased continuously from financial year 2011 to 2021. The registered vehicles in Mizoram were about 93,000 in the year 2011, which was increased up to 3,19,000 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. In total, 3,19,214 vehicles were registered as of March 2022 and among the nine districts of Mizoram state, maximum number (2,22,845) of vehicles were registered at Aizawl urban followed by Lunglei (27614) and minimum (5998) in Mamit district, respectively. It is anticipated that this vehicular influx would have a negative influence on the air quality in the state's inhabited cities. Written evidence on the inflow of automobiles (tourist vehicles) harming the state's environmental health is not yet available.

Parameter-wise air quality (PM₁₀, SO₂, NO₂, etc.)

The decadal trend (2011-2021) of average air quality parameters of the state indicates that the PM₁₀ concentration ranged between 53.82 µg m⁻³ in the year 2012 while it decreased reasonably up to 24.2 µg m⁻³ in the year 2020. This could be due to lockdown. Similarly, NO₂ concentrations ranged between 4.5 µg m⁻³ in the year 2014 to 9.3 µg m⁻³ in the year 2011. However, SO₂ concentration remained constant (2 µg m⁻³) over the years, which was within permissible limit (Fig.46).

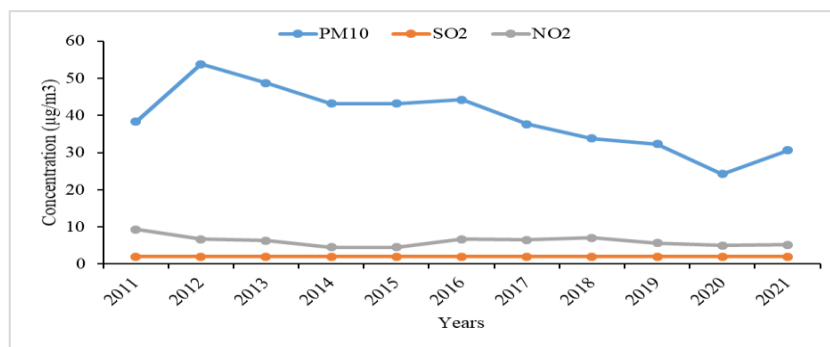


Figure 46. Concentration of different air quality parameters in the state of Mizoram

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. There was no significant relationship ($p < 0.05$; $r^2 = 0.060$) between these variables (Fig.47).

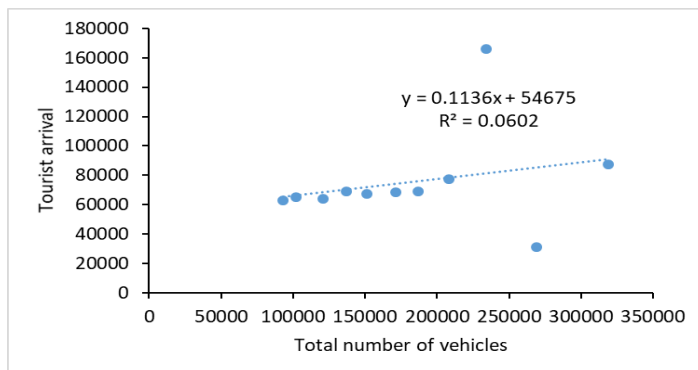


Figure 47. Correlation analysis of tourist arrivals and total number of vehicles (2011 to 2021)

Water quality and pollutants

As per a report of Mizoram State Pollution Control Board (MPCB) and Central Pollution Control Board (CPCB), the water quality (surface water) analysed from 36 observation points showed that all parameters, viz., dissolved oxygen (DO), pH, conductivity, BOD, FC and TC were in conformity within the permissible limit 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 Tuiri in Mizoram also indicate a satisfactory water quality status (<https://mpcb.mizoram.gov.in/page/water-quality-ind>). 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, whereas conductivity, BOD, nitrate, FC and TC were reported within the permissible limit. Data analysis reveals that values of most of the water quality parameters in all districts of Mizoram are within the permissible range.

Effect of tourism on forest, biodiversity and eco-sensitive areas

According to the information available in the MoEF&CC, GoI (accessed on 25.04.2022), a total of 10 eco-sensitive zones (two National Parks & Eight Wildlife Sanctuaries) proposals were finalized. In total, 717.225 km² area (5.89% of total geographical area of the state) is covered under the Eco-sensitive zone and provides effective conservation of wildlife habitat. Moreover, in pursuance to order by Hon'ble NGT in OA 462/2018, the state has constituted a committee to

undertake carrying capacity assessment of eco-sensitive areas. As of now, no information is available to correlate the impact of tourism on eco-sensitive zones/areas.

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). No information is available to correlate the impact of tourism on eco-sensitive zones/areas.

Initiatives

- 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 commitment of Tourism Department for responsible tourism is embodied in Mizoram Responsible Travel Pledge, which tourism service providers and travelers visiting the state are required to follow.
- The department in partnership with State PHE Department has recently initiated “Swachhta Green Leaf Rating System” to increase sanitary and hygiene standards in hospitality industry.

Summary

Mizoram has a number of potential tourism-related industries, such as adventure and adventure sports tourism, wildlife and ecotourism, cultural tourism, rural tourism including home stays, nature-based tourism, wellness, health and herbal tourism, music tourism, and fashion tourism. Annual tourist influx for the years 2011–2021 shows that tourists visiting Mizoram stayed below 1 lakh except for the year 2019 when it reached 1.6 lakhs. In Mizoram, most of the monitoring and management initiatives, such as AQMs, SWMS, etc., focus only on the capital city and/or selected locations. So, finding a solution to these problems is essential. Despite the state's efforts to handle solid waste in metropolitan areas effectively, some of it is still dumped in surrounding streams or burned openly. Therefore, improved solid waste management centres consisting of engineered landfills, composting (vermi- and mechanical compost), and resource recovery centres need to be built in the major tourist attraction ULBs. The impact of tourism on air, water quality as well as on waste generation is hard to establish.

TRIPURA

Introduction

Tripura is the second smallest state of the North-eastern India covering an area of 10491.69 km². The state encompasses five parallel hill ranges (Jampui, Sakhantlang, Langtarai, Atharamura, and Baramura-Deotamura), covered in varying densities of forests, and ten major rivers, namely, Langai, Juri, Deo, Manu, Dhalai, Khowai, Haora, Gumti, Muhuri, and Fenny (Fig.48). With increased interest in the tourism industry and awareness of the immense economic, ecological, recreational, and conservation potential, it is crucial to advance and market the industry in the state (Lal and Das, 2012). The tourist traffic increased substantially after the removal of the entry permit system in the state in May 1995. During 2009-10, the State Government established Tripura Tourism Development Corporation Ltd.

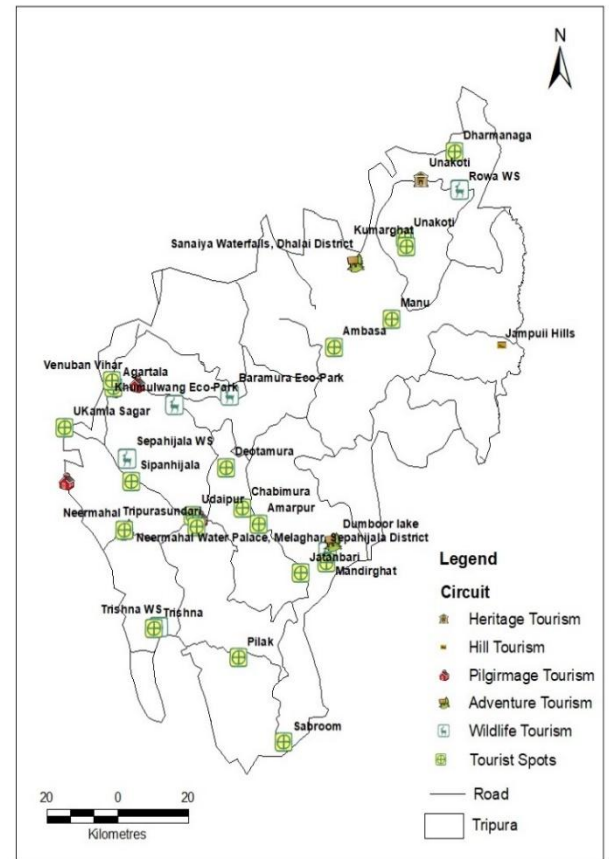


Figure 48. Major tourist places in Tripura

Evidence collected from the literature indicates that there is a gradual increase in the number of tourist arrivals in Tripura state from 2008 to 2019. In the decade between 2008 to 2019, the domestic tourist influx increased about 50% in the state, whereas the foreign tourist inflow increased 34 times during this period (Directorate of Economics & Statistics Planning –Statistics, Department Government of Tripura). The rate of change in tourists' influx continuously increased in the state which ranged between 2.24% to 30.71% in a decade. Although not comparable, the vehicles registration has also increased in the past decade, reaching maximum in 2018 (Fig.49).

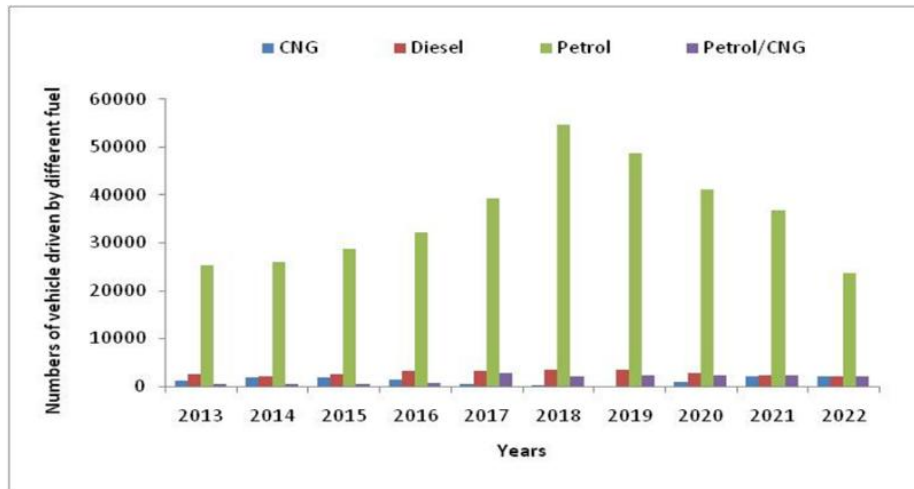
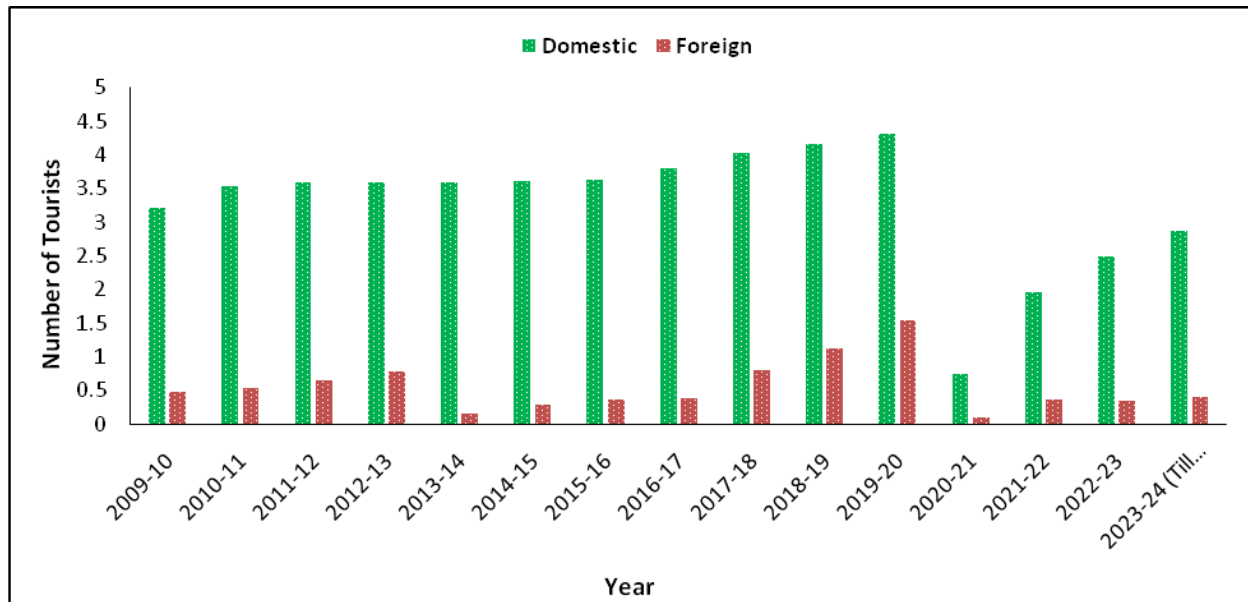


Figure 49. Numbers of vehicles registered under different fuel category in Tripura State

As per the data received from the TSPCB, except for the year 2020-21 and 2021-22, the number of tourists visiting the state have seen a gradual increase—both in domestic as well as foreign tourists. The numbers were around 3.2 lakhs in 2009-10 which reached around 5.8 lakhs during 2019-20. Total number of tourists have seen a spike in the year 2017-18 and thereafter have grown with a reasonable pace till year 2020-21 when covid-19 spread (Fig. 50).



Source: Government of Tripura, through TSPCB, 2024

Figure 50. Graphical representation of tourist footfall in Tripura from 2009–2023

The amount of money the state made from tourism in the years 2008 to 2009 was Rs. 64.66 lakhs. In ten years from 2008 to 2019 it was Rs. 345.76 lakhs. The total vehicles registered in the state during the period of 2012-2013 was 2,44,106 which 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%. However, the increasing numbers of vehicles may cause the concern of environmental pollution and climate change impacts in the region. Considering the increasing numbers of vehicles to meet the demand of the public transport, the state started to encourage vehicles driven by clean fuel like CNG and petrol and CNG mix to reduce the air pollution.

Effects of tourism on environmental components

Assessment of waste generation/segregation/disposal and treatment

Data indicate that the quantity of solid waste generation is steadily increasing over the years. With the exception of 2019–20, garbage generation has risen steadily during the past ten years. Despite an increase in quantity, the percentage of total garbage collected and transported has stayed relatively constant (CPCB, 2012-2020).

As per the latest information from Tripura State Pollution Control Board (TSPCB), total municipal solid waste generated in 20 ULBs of Tripura amounts to be 333.1 TPD. Comparing it with the data from past decade, the solid waste generation has increased at a very gradual pace (Fig.51). 85 secondary waste sorting and segregation centres, in total, are functional in 20 ULBs of Tripura. Municipal Corporation Agartala has an operational waste processing facility with a capacity 250 MTPD.

According to TSPCB, waste management operations in the ULBs include source segregation, door to door collection, wet waste and dry waste processing in wet waste processing plant and secondary segregation centres, respectively. In view of these activities along with sweeping and drain cleaning, around 149 women SHGs (1204 members) and 2715 Safai Karamcharis are engaged.

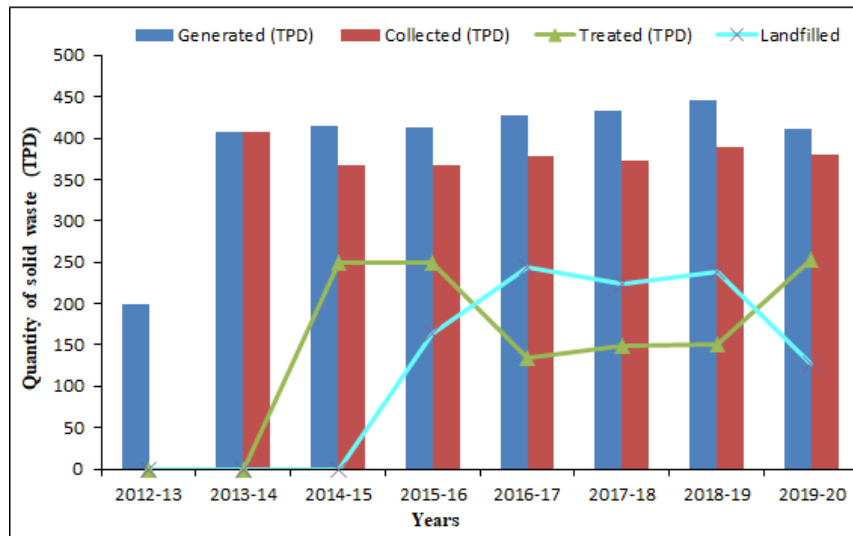


Figure 51. Solid waste generation/collecton/treatment and landfilled in Tripura

Awards and Accolades under SBM-U

- Municipal council Mohanpur has been awarded as the “Cleanest City” (north-east zone-population between 15,000-25,000) and “Cleanest City within Tripura” (population <1,00,000) in Swachh Survekshan2023.
- Municipal corporation Agartala has received the “Cleanest city in Tripura” award in the category of city within Tripura (population > 1,00,000) in Swachh Survekshan2023.
- Smt. Droupadi Murmu, President of India, conferred the glorious award of most clean state in India (small states category) to Tripura under Swachh Survekshan Survey2022.
- Municipal corporation Agartala is awarded under “special mentions3 lakhs-10 lakhs category” under Indian Swachhata League.
- Municipal council Khowai has been awarded “1st prize in fastest mover Swachh city within northeast zone in Swachh Survekshan-2021”.
- Municipal council Belonia has been awarded “best city in citizens feedback population less than 25,000 in Swachh Survekshan-2020”.

The state has good coverage for door-to-door collection. For waste processing, the state has MRFs as well as plastic waste recycling facilities. For facilitating effective solid waste management, Agartala city has been identified as a model city. Moreover, the state has identified 24 villages for implementation of Solid Waste Management Rules, 2016 (CPCB, 2021). Not much has been

published in view of tourism and its impact on waste management. However, a report suggests that the increasing number of tourist inflow may lead to waste dumping, air pollution, sound pollution and water quality in the state (<http://trpervis.nic.in/test/tourism.html>).

Effect on Air quality

Entire state of Tripura is declared as Air Pollution Control Area. Moreover, TSPCB has prepared an action plan for controlling air pollution and submitted to CPCB. Moreover, the state has taken steps such as use of cleaner fuels for transportation, introduction of E-rickshaws, extensive roadside plantation, etc. to mitigate the impact of air pollution. The TSPCB has introduced some control measures to maintain the air quality, which include sprinkling of water on roadside, covering of unpaved roadside using grass, control on open burning of waste, etc. At present, regular air quality monitoring is carried out in Agartala, wherein two manual air quality monitoring stations and 2 CAAQMS are operational. For air quality monitoring in other towns/cities, TSPCB has 3 additional air quality monitoring equipment that are generally used during the festive seasons.

Based on the data for the year 2017–2022 particularly from monitoring stations in Agartala, it reveals that particulate matter PM_{10} was maximum ($368 \mu\text{g m}^{-3}$) in the year 2021 and minimum ($47 \mu\text{g m}^{-3}$) in 2018. Similar trend was observed in $PM_{2.5}$ values. While maximum concentration of NO_2 ($49.03 \mu\text{g m}^{-3}$) was observed in the year 2022, and minimum was in the year 2021.

There are number of brick kilns being operated in and around West Tripura District, although these are all fitted with fixed chimney having a height of at least 130 feet. To reduce the emission levels from the kilns, many brick industries have opted for zigzag systems.

Impact on water quality

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 Faecal coliforms. The value of pH ranged from 5.6 to 7.7 between 2012 to 2023 which is under permissible limit. Similarly, ground water pH is 6.5-8.5, which is under the permissible limit. The BOD available were found to be maximum 0.8 (mg/l) in 2012 and minimum 0.7 (mg/l) in 2015. The range of nitrate/nitrite N (mg/l) ranged between 0.23 (mg/l) to 1(mg/l) during the period of 2012 to 2023.

Total Faecal coliform (MPN/100ml) in ground water was recorded 2 for the entire period between 2017-2019 (<http://trpervis.nic.in/test/tourism.html>).

Effect of tourism on forest, biodiversity, and eco-sensitive areas

The state has two National Parks and four Wildlife Sanctuaries that constitute the Protected Area network of the State covering 5.76% of its geographical area. As per the ISFR (2017), based on the interpretation of IRS Resourcesat-2 LISS III satellite data for the period October to December 2019, the Forest Cover in the state is 7,721.52 sq km, which is 73.64% of the State's geographical area. Though Tripura is a small state, it is botanically one of the richest as it harbours about 1463 flowering plants out of 17000 species accounted in India.

Over the year, the state has faced degradation in the quality of its forest over due to some anthropogenic and natural drivers that have impacted the quality of its biodiversity. At least, 15 of species recorded from Tripura are known to be rare or endangered. Similarly, the faunal diversity of the State is quite rich. The state is also facing degradation and extinction of its biodiversity due to some anthropogenic and natural drivers. As a result, some of the species are on the edge of being classified as threatened or may be going extinct. However, a report indicates that the increasing numbers of tourist inflow may lead deforestation, rare and endangered flora and fauna and land use change in the state (<http://trpervis.nic.in/test/tourism.html>).

Initiative

- TSPCB has developed a public grievance portal named “TRIPURA PARIBESH” – similar to “Sameer” app of CPCB. Through, this portal public can submit complaints/grievance regarding various environmental related issues like air, water, and noise pollution.

Summary

Except during the Covid times (2020 and 2021), the tourist's influx in the state has gradually increased from 2010 till date. The numbers were around 3.2 lakhs in 2009-10 which reached around 5.8 lakhs during 2019-20.

A total of 331.1 MT per day solid waste is generated in the State. Waste management operations include source segregation, door to door collection, waste processing sheds, etc. Moreover, SHGs

are involved in waste management operations. The State has won several accolades under SBM-U. Air quality monitoring station is only available at Agartala. Particulate matter values have sometime exceeded the permissible limit as recorded in these monitoring stations. There is a need to cover more locations so as an average quality of the air could be obtained. However, data related to tourist visits to protected areas is lacking and needs to be documented through close monitoring. Study on impact of tourists' influx on biodiversity is almost lacking in the state. A sound management plan for conservation and management of these protected areas is highly needed.

MEGHALAYA

Introduction

Meghalaya, one of the smallest states of North-Eastern India, encompasses an area of 22,429 sq km with 76% 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 lie in the most populated districts of East Khasi Hills in the state of Meghalaya (Fig.52). The state is home to 500 naturally occurring limestone and sandstone caverns, including the longest and deepest tunnels in the subcontinent, two National Parks, three Wildlife Sanctuaries, and more (Nayak and Mishra, 2013).

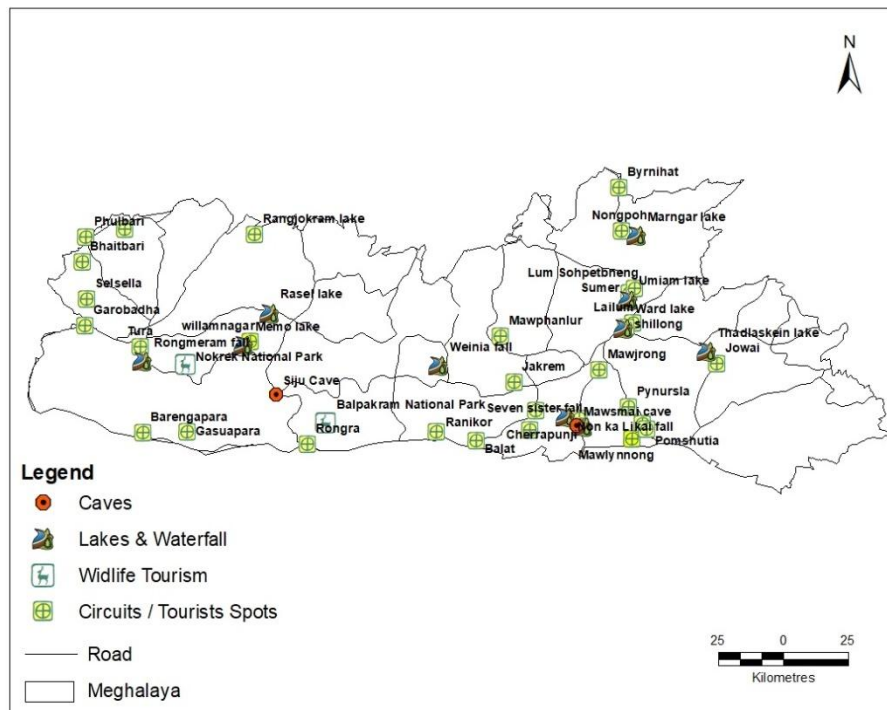


Figure 52. Major tourist spots and circuits in Meghalaya

Tourism growth in the state of Meghalaya

Meghalaya's statistical data show that during the years 2008 – 2017, the state had a significant increase in the number of tourists—it was 5.5 lakhs in 2008 and reached more than 10 lakhs in 2017. Figure 53 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>).

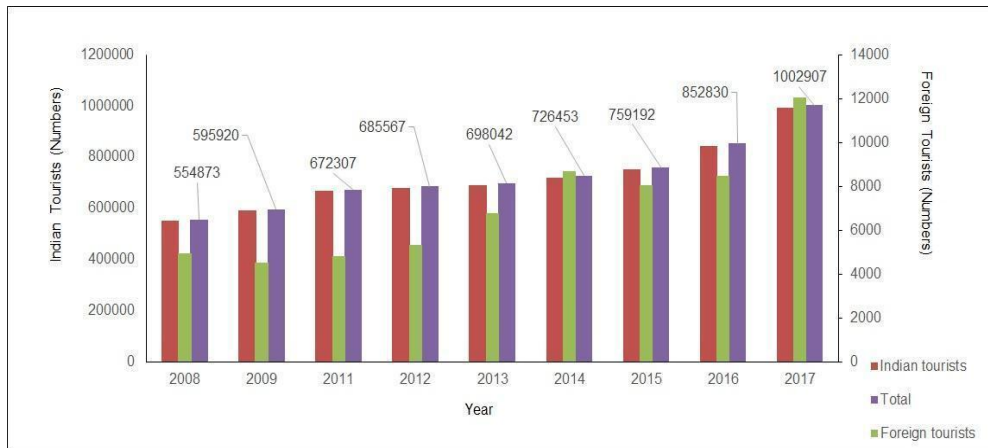


Figure 53. The graph showing the year-to-year growth of tourist influx in Meghalaya

Growth in domestic tourist arrivals has been significant from 2016 onwards. The foreign tourists make only 1% of the total tourist arrivals in the state of Meghalaya. As compared to other Northeastern 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 north-eastern states). But after 2017, Sikkim is holding the second position in terms of tourist arrival (15% of the total tourist influx in the north-eastern states).

Effects of tourism on environmental components

Assessment of waste generation

Out of 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. The amount of rubbish produced has dramatically increased with each passing year. Considering the year 2015-16, the total MSW generated was 187 TPD out of which 156 TPD was collected (120 TPD treated and 36 TPD land filled), rest 31 TPD

(16.5%) of the MSW left untreated. Similarly, in the year 2016-2017 and 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. 54).

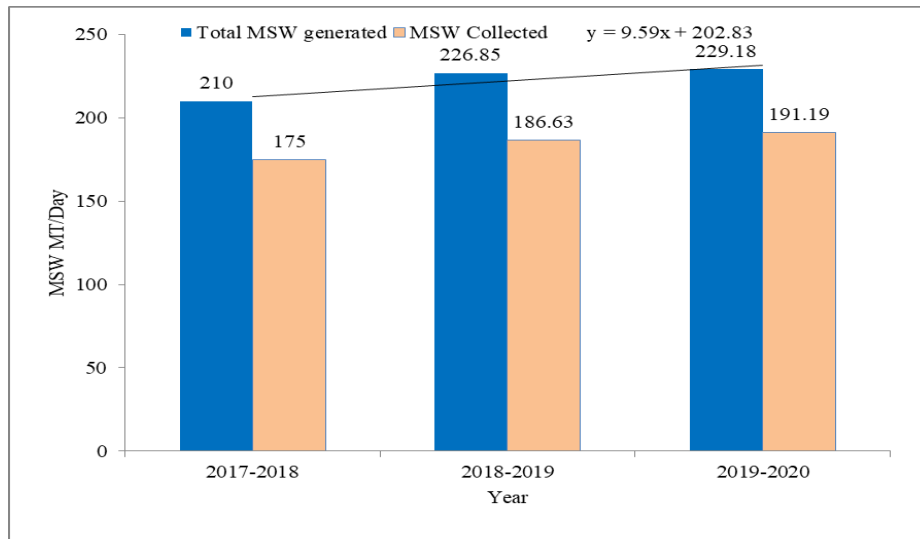


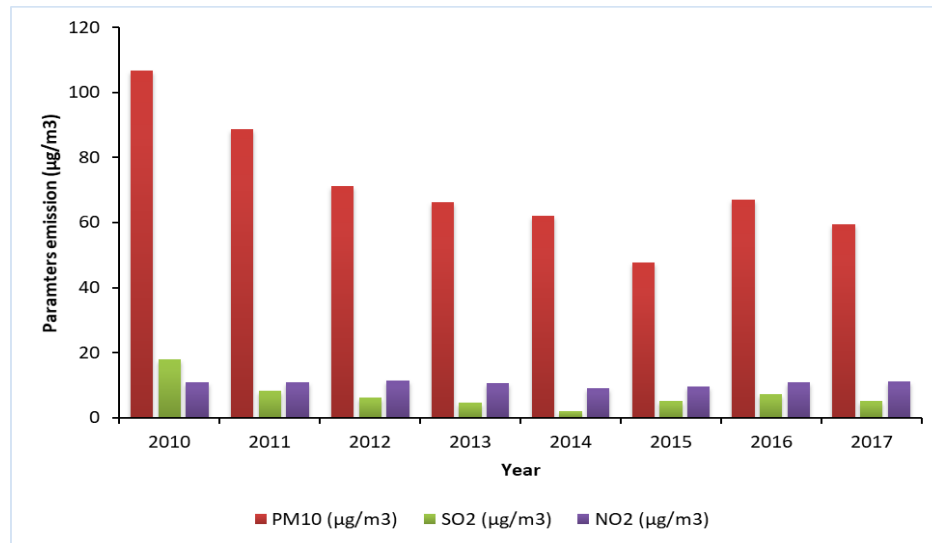
Figure 54. Status of Solid Waste Management and the progress made by some local bodies (viz. Shillong Municipal Board (SMB), Shillong Cantontment Board (SCB), Jowai Municipal Board (JMB))

Effect on Air quality

Ten separate stations dispersed over several districts are used by the Meghalaya State Pollution Control Board to monitor the air quality. Concentration of Particulate matter (PM₁₀), sulphur dioxide (SO₂) and nitrogen dioxide (NO₂) released in the atmosphere is measured.

A graphical representation of the average air quality parameters of the stations for the Meghalaya state from the year 2010 to 2017 is represented in Fig. 55. It can be observed that from 2010 to 2014 as well as in 2016, PM₁₀ emission had surpassed the permissible limits, with highest particulate matter of 106.78 $\mu\text{g m}^{-3}$ emitted in the year 2010. The only years observing a dip in the PM₁₀ values with the emission rate being below the permissible limit are 2015 and 2017 with 47.5 and 59.5 $\mu\text{g m}^{-3}$, respectively. The other measured air quality parameters like NO₂ and SO₂ are within the permissible limits and vary annually. The SO₂ value was maximum in the year 2010 (18 $\mu\text{g m}^{-3}$), while the lowest was only 2 $\mu\text{g m}^{-3}$ recorded in the year 2014. Similarly, the maximum value NO₂ was recorded in the year 2017 (11.27 $\mu\text{g m}^{-3}$) and the lowest was 9.025 $\mu\text{g m}^{-3}$ during

2014. In general, the air quality parameters monitored here from 2010 - 2017 show a marginal decline over the years, except for NO₂, which is more or less stable.



Source:http://megspcb.gov.in/annual_reports.html

Figure 55. Average air quality concentration in Meghalaya

Number of vehicles

A total number of vehicles (government and private) were registered in the state of Meghalaya from 2014 to 2017. A substantial increase can be observed during the three time periods with vehicles on roads (Fig. 56). These values increased from 2.5 lakhs in 2014-2015 to 3 lakhs in 2016-2017 and thus increased by almost 18% in the state. High concentrations of PM₁₀ are observed at limited locations (Annual Report 2018-2019, CPCB) which could be attributed to vehicular emission.

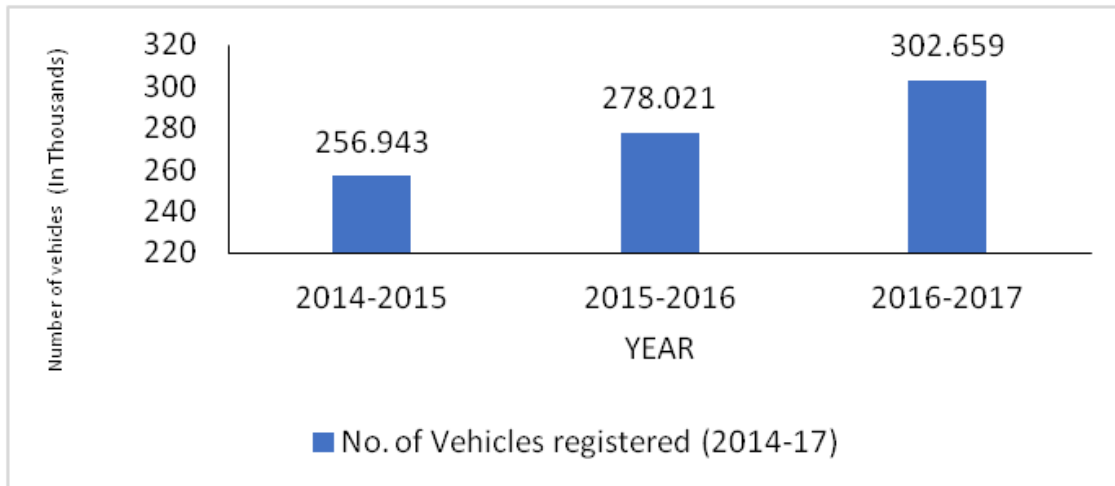


Figure 56. Number of vehicles registered in Meghalaya for the time span 2014-17

Effect on surface and ground water quality

Surface Water Quality

The state can be divided into three zones based on the locations of the rivers: the Garo hills, eastern central region of Meghalaya plateau and Khasi hills in the south region. Considering its geographical locations, many rivers originate here, although most of them are seasonal in nature. Some of the major rivers in the state are River Digaru, Myntdu, Umngot, Umkrah, Umshyrpi, etc. River water quality is monitored in the state under National Water Monitoring Programme (NWMP). During the year 2019-20, the water quality monitoring network showed that in all the monitoring stations in the East Khasi Hills, pH was well within the permissible limits, i.e., 6.5 to 8.5 (Meghalaya State Pollution Control Board, 2019-20). The DO was found to be low in Rivers Umkrah and Umshyrpi. Moreover, Faecal Coliform (FC) count was also observed to be above prescribed standards in these two rivers. In the rivers draining the West Khasi hills and South West Khasi hills, the water quality parameters were within the prescribed standards except River Nanbah with total coliform count slightly above 500mpn/100ml.

The BOD levels in lake Umiam and River Umtrew (district Ri-Bhoi) were above the permissible limit of 3 mg/l. Moreover, the FC counts in these water bodies were also high. The observed FC values in the lake Umiam could be due to the fact that the lake receives the wastewater generated in Shillong city from two rivers: Umkrah and Umshyrpi. A few water bodies in East and West Jaintia hills recorded low pH values. River Thlumuwi at Thlumuwi had pH value of 2.3 indicating

high acidic property. Each district has tourist places; however, no such study has been performed to assume that the deteriorated water quality (in rivers/lakes) is directly or indirectly linked to tourist activities. Similar is the case with River Myntdu, wherein the deterioration in river water quality cannot mainly be due to tourism activities but also due to residential areas and other business activities.

Effect of tourism on forest, biodiversity and eco-sensitive areas

Nongkhylllem Wildlife Sanctuary and Narpuh Wildlife Sanctuary are classified as Eco-Sensitive Zones and notified by the Ministry of Environment, Forest and Climate Change (MoEF&CC) in the year 2017. 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.

Initiative

- The Tourism Department has developed a portal which will collect and store data related to tourist arrivals, number of hotels, people engaged in the tourism sector, etc.

Summary

Under the present assessment study, the impacts of tourism could not be directly linked so specifically in terms of solid waste, water pollution, biodiversity and others due to lack of supporting datasets.

Average tourist inflow in the state for the years 2008 – 2017 was around 6.5 lakh. The year 2017 witnessed maximum tourist influx of over around 10 lakhs. Thereafter, the growth has been significant for the subsequent years barring 2020 and 2021.

Municipal solid waste data for the year 2019–2020 shows that the State generated 229.18 MT/day. More than 80% of this quantity was collected. MSW generation has increased linearly for the years 2017 – 2020 (from 210 to 229.18 MT/day).

Management of solid waste is urgently needed in places like Lady Hydari Park, Ward's lake and Umiam lake (Barapani) in Shillong. The state government though has taken a number of steps to

improve the tourism sector, yet it is at early stage to formulate and develop a proper management plan for its management.

The annual report of Meghalaya State Pollution Control Board (MSPCB) (2017-2018) pointed out that the air quality levels, particularly PM₁₀ concentration, has exceeded the NAAQS (annual average) at two stations, The high pollution level in River Myntdu, and Jowai hills, caused due to solid waste generated from tourism activity, is also a matter of concern. Management of solid waste is also urgently needed in the places like Lady Hydari Park, Ward's Lake and Umiam Lake (Barapani) in Shillong.

Report Summary

In order of tourist inflow, the states from high to low are Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Assam Hills, Sikkim, Meghalaya, Tripura, Ladakh, Arunachal Pradesh, Manipur, West Bengal, Mizoram. Besides mass tourism, pilgrim tourism is found in increasing trend in some places like the Kashmir Valley (Fig. 57). Every year pilgrims visit the major shrines (Shri Amarnath Ji Holy Cave and Mata Vaishnav Devi) of Jammu & Kashmir UT.

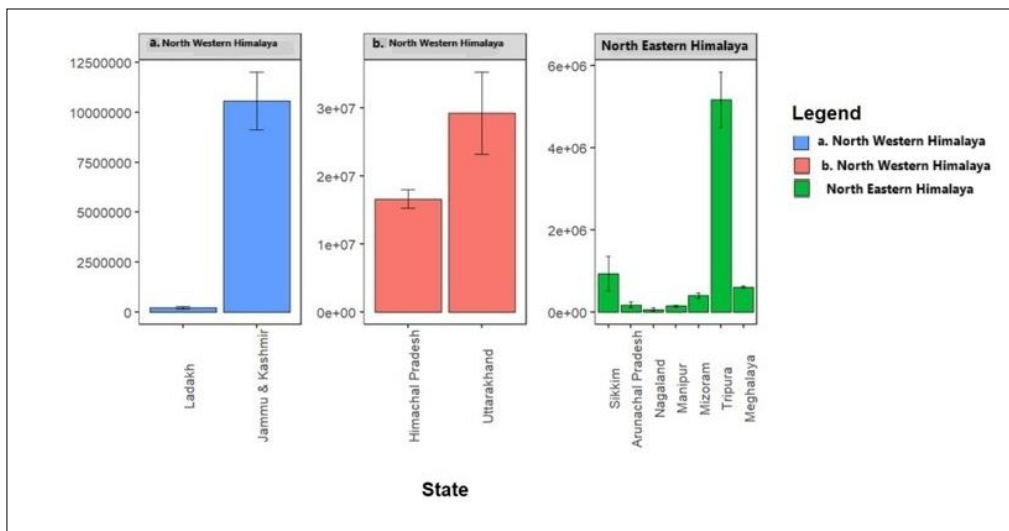


Figure 57. Yearly average tourist influx in the IHR

- 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 ($r^2=0.92$; $p<0.01$) was observed between waste generation (collected month wise) and number of tourists (monthly arrival in a year, June-December 2021) at Leh town. Municipal solid waste (MSW) generation also increased 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) ($r=0.41$).

- Regarding 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 has 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 a 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 inflow 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 0.5×0.625 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 Arunachal 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., dissolved 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, BrariNambal, 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. Hon'ble NGT—through its order dated 25-11-2021 in O.A. No. 351/2019(Raja Muzaffar Bhat Vs State of Jammu & Kashmir and Ors) has emphasized on protection of all wetlands in the country (although this order pertains to the prevention of unscientific dumping of waste and encroachment of Hokersar Wetland, Wular Lake and Kreentchoo Chandhara Wetland). This is in light to the observations of the Hon'ble Supreme Court that conservation of wetlands is of immense ecological importance.
- 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 (*Lophuraleucomelanos*).
- The Hon'ble NGT (through its orders dated 17-03-2021 in O.A. No.462/2018) and even the Hon'ble Supreme Court has stressed upon the need of carrying capacity assessment, preparation of Zonal Master Plan as well as Tourism Master Plan in the Eco-Sensitive Zones. However, limited studies have been undertaken till date. Accordingly, the concerned State/UTs have been asked to carry out such study for at least one eco-sensitive area in their respective regions—one short study has been performed by CPCB (through CSIR-NEERI) in this matter for the carrying capacity assessment of Sanjay Gandhi National Park, Mumbai. Hon'ble NGT has passed this

order referring to its past rulings dated 29-07-2019 in OA 635/2017 (related to carrying capacity assessment in Manali and McLeod Ganj); dated 10-03-2021 in OA 312/2016 (in context of Mount Abu eco-sensitive zone)

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 de-carbonisation 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, 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 Ladakh which require carrying capacity study for developing a planned infrastructure and amenities including waste management, 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 Zaskar), *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. Studies should be conducted to distinguish the different sources (tourist vehicles) of air pollution in the area. Use of electric vehicles should be encouraged.
- Overall, some of the suggested measures for environment assessment in tourist places are as follows:
 - Waste recycling units for the segregated wastes instead of transporting kilometres away to other states.
 - Applying appropriate technologies for direct use, like use of shredded plastic chips in road constructions.
 - Building a network of Water ATMs (urban centers) and promoting Clean Water Springs for drinking water purposes on the famous travel routes/destinations. This could be an alternative to packaged drinking water.
 - Encouraging use of non-fossil fuel powered vehicles.
 - Regulating tourism in protected areas after estimation of carrying capacity. 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).
 - Developing a master plan of urban growth to support tourism-related infrastructure and amenities without developing conflict with diverse user groups.
 - 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.

Jammu & Kashmir

- 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 needs to be done to ensure quality tourism in the state.
- 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.
- 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 picnic spots for tourists. So, these need to be strictly controlled to preserve biodiversity heritage.
- Use of carbon neutral buses and cabs should be promoted in the state. Taxi/personal vehicle that does not conform to Bharat 6 standards should not be allowed to ply within the tourist circuits/ spots within the state. Use of electric vehicles should be encouraged in the UT.
- Proper database needs to be prepared on the impacts of the tourism activities on the wildlife and biodiversity of the UT. Simultaneously, tourists should be made aware about the practices for conservation of biodiversity.

Himachal Pradesh

- Shimla, Kullu, Kangra, Lahaul & 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.
- 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 Dharamshala.
- 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. Use of carbon neutral buses and cabs should be promoted in the state. Taxi/personal vehicle that does not conform to Bharat 6 standards should be prohibited in the state.
- 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 and tourist about biodiversity conservation, low-carbon sources of energy and adapting practices for promoting NDC, SDGs and LiFE.
- Expansion in the institutional capacity of local government for climate change planning is urgently needed.

Uttarakhand

- Clean fuel energy-based vehicles like electric vehicles, carbon neutral buses and cabs, could be promoted as the ecofriendly options for minimising vehicular pollution in the fragile tourist spots like Nainital, Mussoorie, Almora, Dehradun, Haldwani, etc. Taxi/personal vehicles with Bharat 6 standards only should be allowed in such areas. Use of electric vehicles should be encouraged in the State.
- 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.

- The network of scientific wastewater management facilities need to be enhanced. This step would be able to save river system from the repercussions of unsustainable tourism. Further, this step may be used for landscape management and would stop the wastage of fresh water.
- In high altitude trek routes practices like use of ‘low carbon’ sources of energy, biodiversity conservation etc., should be promoted.
- Institutional capacity building in context of changing climate and practices concerned with LiFE for promotion of SDGs should be done by local Government.

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.
- Use of electric vehicles should be encouraged in the State.
- Research Initiative (e.g. Tsomgo Pokhri Sanrakshan Samiti) for protection and conservation of the lake, cleanliness drive at Yuksum Dzongri 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 in awareness raising, through education, and marketing tourism, institutional capacity of local government for climate change planning, 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-managed traffic, so it is necessary to control the number of tourists through exploring threshold value. There is a need of bio methanation / composting for wet waste and more waste disposition centers for managing the bulk waste generated due to growth of urban population and tourist inflow in the hills.
- Studies should be conducted to distinguish the different sources (tourist vehicles) of air pollution in the area. Use of carbon neutral buses and cabs should be promoted in the state. Taxi/personal vehicles that do not conform to Bharat 6 standards should not be allowed in the state.
- Continuous monitoring of 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 to 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 and biodiversity conservation.
- 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.

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. The local management committees should encourage management of tourism in the hill regions.

- Proper monitoring is required for air pollution to assess its impact on tourism. Launching a public awareness campaign for air pollution control, vehicle maintenance, minimizing the use of personal vehicles, lane discipline, etc. for controlling the air pollution in the region would be a prime need of the hour.
- Use of electric vehicles should be encouraged in the State.
- Waste management is another challenge that a hill is facing; proper segregation, and disposal method is needed under waste to energy initiatives. There is a need for the digitalization or web portal of waste collection and disposal data.
- Expansion in the institutional capacity of local government for climate change planning will require adaptation planning, based on NDC and SDGs implementation.
- Awareness about the values of biodiversity and conservation practices should be promoted among the tourists.
- 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.

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 to design proper infrastructure for proper waste disposal and its treatment so that the impacts on environment (water, soil, ecosystem, etc.) can be minimized. 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. 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. Expansion in the institutional capacity of local government for climate change planning is also urgently needed.
- It is recommended to establish a system in the state which can help the government to gather data for cost-benefit basis (environmental and economic both) due to tourism sector. At present, there is no any such system in place which makes it difficult to assess direct impacts of tourism.
- 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 which will in turn promote the SDGs Use of electric vehicles should be promoted in the State.

Nagaland

- Strengthening community-based tourism (e.g. Khonoma Green village, and Toupheema 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/wastewater. 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 these important issues.
- Based on available information, there are no studies so far to directly link the impact of tourism growth on waste generation, air quality, water quality, forest ecosystem and biodiversity. So, there is a need to carry out such a study.
- 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.
- Awareness about the values of biodiversity and conservation practices should be promoted among the tourists.
- Use of electric vehicles should also be encouraged.
- 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.

Mizoram

- 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. Tourists should be made aware about the biodiversity conservation practices.

- 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. Use of electric vehicles should also be encouraged.
- The local government should expand institutional capacity for climate change mitigation and promote adaption practices related to LiFE for successful achievement of SDGs.
- 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.

Manipur

- 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.
- Systems should be set up for monitoring the influx of tourists and its impact on waste generation, and air and water quality.

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.
- 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 generated.
- Awareness about the values of biodiversity and conservation practices should be promoted among the tourists. The State should promote the use of electric vehicles.

Meghalaya

- The new Meghalaya Tourism Policy (2023) has laid down core guidelines for achieving development objectives. These include as under:
 - Sustainable and responsible tourism
 - Employment generation & entrepreneurship
 - Community partnership
 - Synergy with different departments.
 - Additionally, the new tourism policy also addresses issue related to long-term sustainability of the tourism as a driver of economic and environmental sustainability.
- 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 disinfected through microwave technology to avoid pollution in the downstream areas, and reservoirs/water bodies. Management of solid waste is also urgently needed in the places like Lady Hydari Park, Ward's Lake and Umiam Lake (Barapani) in Shillong.
- In view of managing the solid waste, the state has started Swachhata Green Leaf Rafting System in Hospitality sector. This is jointly managed by Department of drinking water and sanitation and ministry of tourism. It is envisaged to create awareness about sustainable tourism and to nudge the tourists and tourism business towards sustainable development.
- 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. Use of electric vehicles should be encouraged.
- Institutional capacity building for climate change planning should be implemented by the Local Govt. Green tourism initiatives should be initiated for promotion of SDGs.

BIBLIOGRAPHY

Aayog, N.I.T.I. (2018) National institution for transforming India (N.I.T.I) Contributing to sustainable development in the Indian Himalayan region. Available: https://niti.gov.in/writereaddata/files/document_publication/Doc2.pdf (Accessed November 25, 2020).

Action Plan for Control of Air Pollution in Non-Attainment City of Dimapur City and Conglomerates, Nagaland (2019) Air Quality Monitoring Committee, Nagaland 1-14. <https://npcb.nagaland.gov.in/?p748> .

Action Plan for Municipal Solid Waste Management Himachal Pradesh (2017) Government of Himachal Pradesh, Directorate of Urban Development 6-16.

Action Plan for Non-Attainment Towns/Cities with Respect to Air Quality Management in Kohima City, Nagaland (2019) Air Quality Monitoring Committee, Nagaland 1-13. <https://npcb.nagaland.gov.in/?p735>.

Action Plan for Rejuvenation of Polluted River Stretches Priority III/IV/V in Nagaland (2019) *River Rejuvenation Committee* 1-15. <https://npcb.nagaland.gov.in/revised-action-plan-for-rejuvenation-of-polluted-river-stretches-priority-iiiivv-in-nagaland/>.

Action Plan for Rejuvenation of River Dhansiri, Dimapur, Nagaland (2019) *Nagaland River Rejuvenation Committee* 1-43. <https://npcb.nagaland.gov.in/action-plan-for-rejuvenation-of-river-dhansiri-dimapur-nagaland-priority-i/action-plan-for-dhansiri-river-priority-i-1/>.

Aienla and Sarma, T. R. (2014) Sustainability of the Waste Management Practices in Tourist Destinations of Nagaland: A Critical Review. *International Journal of Research in Commerce, IT & Management* 4(5), 28-32.

Anand, S. & Singh, A. (2014) Tourism and Solid Waste Management. In: Singh, R. B. & Hietala, R. (Eds.), *Livelihood Security in Northwestern Himalaya: Case Studies from Changing Socio-economic Environments in Himachal Pradesh, India* (pp. 189–202). Springer Japan. https://doi.org/10.1007/978-4-431-54868-3_14.

Annepu, R. K. (2012) Sustainable solid waste management in India, Columbia University, New York. 2(1), 1-189.

Annual Administration Report 2018-2019 (2019) Forest Environment Department, Government of Sikkim, 1-125.
<http://sikenvis.nic.in/WriteReadData/UserFiles/file/Annual%20Administrative%20Report%202018-19.pdf>.

Annual Final Report (2015) Tourism Survey for the State of Mizoram (March 2014-February 2015) Ministry of Tourism, Market Research Division Govt. of India. Submitted by Datamation Consultants Pvt. Ltd, Patparganj Industrial Area, New Delhi 10-205.

Annual Report 2019-20 (2020) Implementation of Solid Waste Management Rules, 2016-Annual Report on Solid Waste Management (2019-20), CPCB, Delhi (23582/2022/UPC-II-HO) 145-287.
https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2019-20.pdf

Annual Report for the year 2018-19 (2019) Implementation of Solid Waste Management Rules, As per provision 24(4) of SWM, Rules,16) 1-63. [https://cpcb.nic.in/uploads /MSW/MSW_AnnualReport_2018-19.pdf](https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf).

Annual Report under SWM Rules 2016 (2017-2018) Directorate of Urban Development, Government of Himachal Pradesh, 2-79.

Annual Report under SWM Rules 2016 (2018-2019) Directorate of Urban Development, Government of Himachal Pradesh, 6-85.

Annual Report under SWM Rules 2016 (2019-2020) Directorate of Urban Development, Government of Himachal Pradesh, 2-82.

Annual Report under SWM Rules 2016 (2020-2021) Directorate of Urban Development, Government of Himachal Pradesh, 3-107.

Anonymous (2018a) 1st Annual Biodiversity Assessment, Neora Valley National Park, Gorumara Wildlife Division (3rd to 13th March 2018). Chief Conservator of Forests, Directorate of Forests, Government of West Bengal, 7-64.

Anonymous (2018b) 2nd Annual Biodiversity Assessment, Neora Valley National Park, Gorumara Wildlife Division (30th September to 11th October 2018). Principal Chief Conservator of Forest (Wildlife) & Chief Wildlife Warden, Directorate of Forests, Government of West Bengal, 8-159.

Arrawatia, M. L and Tambe, S. (2011) Biodiversity of Sikkim - Exploring and Conserving a Global Hotspot. Information and Public Relations Department, Government of Sikkim 542.

Ashok, S., Behera, M. D., Tewari, H. R. & Jana, C. (2022) Developing ecotourism sustainability maximization (ESM) model: A safe minimum standard for climate change mitigation in the Indian Himalayas. *Environmental Monitoring and Assessment*, 194(12), 914. <https://doi.org/10.1007/s10661-022-10548-0>.

Asif, M. & Mahajan, P. (2022) Impact of COVID-19 lockdown and meteorology on the air quality of Srinagar city: A temperate climatic region in Kashmir Himalayas. *Hygiene and Environmental Health Advances*, 4, 100025. <https://doi.org/10.1016/j.heha.2022.100025>

Assessment of Noise Pollution in the State of Manipur (2007) Manipur Pollution Control Board 1-32.

Audit Report (2019) Social and Economic Sectors for the year ended 31 March 2019, Chapter-II, Economic Sector 50-84, (<https://cag.gov.in/ag/meghalaya/en/audit-report/details/114013>).

Bashir, S and Goswami, S. (2016) Tourism induced challenges in municipal solid waste management in hill towns: Case of Pahalgam. *Proc. Environmental Sciences* 35, 77-89.

Basu, S. R. (2006) A comprehensive study of landslides and related phenomena in the Darjiling hills and their control. Ph.D. Thesis, University of Calcutta, <https://shodhganga.inflibnet.ac.in/handle/10603/156023>

Bhat, M. Y and Bhatt, M. S. (2019) Economic valuation of biodiversity in South Asia: The case of Dachigam National Park in Jammu and Kashmir (India). *Asia & the Pacific Policy Studies* 6, 59–72. DOI: <https://doi.org/10.1002/app5.266>.

Bhat, R. A; Dar, G. H; Jehangir, A; Bhat, B. A and Yousuf, A. R. (2012) Municipal solid waste generation and present scenario of waste management during Yatra season in Pahalgam: A tourist health resort of Kashmir valley. *International Journal of Current Research* 4(10), 004-009.

Bhat, S. A and Pandit, A. K. (2014) Surface Water Quality Assessment of Wular Lake, A Ramsar Site in Kashmir Himalaya, Using Discriminant Analysis and WQI. *J. Ecosyst.* 724-728.

Bhat, S. U; Dar, S. A and Hamid, A. A. (2022) Critical appraisal of the status and hydrogeochemical characteristics of freshwater springs in Kashmir Valley. *Sci. Rep.* 12, 5817.

Bhutia, S. (2017) A Situational Analysis of Water Resources in Darjeeling Municipal Town: Issues and Challenges. *International Journal of Research in Geography (IJRG)*, 3 (4), 52-60. <http://dx.doi.org/10.20431/2454-8685.0304007>.

BIS (Bureau of Indian Standards) (2012) *Indian Standards, Drinking Water Specifications*, 2nd Revision, IS10500: 1-4.

Biswas, S. S and Pal, R. (2016) Causes of landslides in Darjeeling Himalayas during June–July, 2015. *Journal of Geography and Natural Disasters* 6, 173 DOI: <https://doi.org/10.4172/2167-0587.1000173>.

Central Ground Water Board (CGWB) (2010-2018) *Ground water quality data for Different districts of H.P.* <http://cgwb.gov.in/wqreports.html>.

Central Pollution Control Board (2009) *National Ambient Air quality standards.* https://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf 1-164.

Central Pollution Control Board (2015) (<https://cpcb.nic.in/namp-data/>). https://cpcb.nic.in/uploads/NAMP_Data_for_2011_to_2015.pdf 1-12.

Central Pollution Control Board (2019) National Ambient Air Quality Monitoring NAAQMA/45/2019-20201-164. (www.cpcb.nic.in).

Chand, K., Kuniyal, J. C., & Sharma, D. D. (2014) Assessment and sources of particulate matter in the semi urban atmosphere in the Kullu valley of the northwestern Himalaya, India. *International Journal of Interdisciplinary Research*, 01(04), 1.

Chettri, A. (2019) Tourism and its impact on solid waste management: a study of Singalila National Park, Darjeeling. *National Seminar on Development and Ecological Sustainability: Issues in Emerging India- DESIEI at Christ University, Bangalore*, 1-15.

Chettri, N and Sharma, E. (2006) Assessment of natural resource use patterns: a case study along a trekking corridor of Sikkim Himalaya. *Resource, Energy Conservation* 3, 21-24.

Chettri, N. (2010) Cross-taxon congruence in a trekking corridor of Sikkim Himalayas: Surrogate analysis for conservation planning. *Journal for Nature Conservation*, 18(2), 75–88. <https://doi.org/10.1016/j.jnc.2009.03.003>.

Chettri, N; Sharma, E; Deb, D. C and Sundriyal, R. C. (2002) Effect of firewood extraction on tree structure, regeneration, and woody biomass productivity in a trekking corridor of Sikkim Himalaya. *Mountain Resource Development* 22, 150-158.

CPCB (2019) Annual Report Implementation of Solid Waste Management Rules (As per provision 24(4) of SWM Rules,16) INTRODUCTION, 1-63.

CPCB (2019) Direction for industries *under Section 5 of the Environment (Protection) Act, 1986*, <https://cpcb.nic.in/directions-industries-authorities>, 1-3.

CPCB (2019) National Inventory on Hazardous waste generation and its Management (2017-18). Central Pollution Control Board, MoEF& CC, GoI,1-607.

Dar, S. A; Bhat, S. U; Rashid, I and Dar, S. A (2020) Current Status of Wetlands in Srinagar City: Threats, Management Strategies, and Future Perspectives. *Front. Environ. Sci.* 7(199), 1-8.

DCHB (2011) District Census Handbook and Darjiling. Census of India, Government of India. https://censusindia.gov.in/2011census/dchb/DCHB_A/19/1901_PART_A_DCHB_DARJILING.pdf.

Dimapur Municipal Council Waste assessment report (2021) Living for environment, 10-136.

District Environment Plan (2021) – Darjeeling, West Bengal, 1-34.

Dutta, N., Ghosh, A., Debnath, B. & Ghosh, S. K. (2020) Climate Change in Hilly Regions of India: Issues and Challenges in Waste Management. In S. K. Ghosh (Ed.), *Sustainable Waste Management: Policies and Case Studies* (pp. 657–669). Springer Singapore. https://doi.org/10.1007/978-981-13-7071-7_59.

ENVIS bulletin (2018) Himalayan ecology Meghalaya, India. 24, 87-100. <https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf>.

ENVIS Centre (2015) Ministry of Environment, Forest & Climate Change, Govt. of India (manervis.nic.in/Database/Air_2721.aspx?format=Print), 1-50.

ENVIS Nagaland (2017) *An Envis Newsletter* 1(1), 8.

Ezung, Z. T. (2011) Rural Tourism in Nagaland, India: Exploring the Potential. *International Journal of Rural Management* 7(1&2), 133–147. DOI: 10.1177/0973005212459833.

Ganguly, R and Thapa, R. (2016) An assessment of Ambient Air Quality in Shimla City, *Current Science* 111(3), 509-516.

Ghosh, D. K and Mallick, J. K. (2014) *Flora of Darjeeling Himalayas and Foothills (Angiosperms)*. Bishen Singh Mahendra Pal Singh, Dehradun, 450-777.

Gogoi, P. (2017) Tourism Sector in Assam: Its Economic Contribution and Challenges. *International Journal of Humanities & Social Science* 5(2), 214-219.

Gogoi, R; Sherpa, N; Franklin Benjamin, J. H; Agrawala, D. K; Rai, S. K and Dash, S. S. (2021) Flora of Sikkim - A Pictorial Guide. *Botanical Survey of India, Kolkata and Forest & Environment Department, Sikkim*, 566.

Government of Himachal Pradesh (2021) Report of the Comptroller and Auditor General of India on Social, General and Economic Sectors (Non-Public Sector Undertakings) for the year ended 31 March 2019, 1-160. file:///C:/Users/acer/Downloads/Report%20No.%20of%202021_N-PSUs%202018-19_English-061164670ed24b6.45465549.pdf

Gupta, V., Bisht, L., Deep, A., & Gautam, S. (2022). Spatial distribution, pollution levels, and risk assessment of potentially toxic metals in road dust from major tourist city, Dehradun, Uttarakhand

India. *Stochastic Environmental Research and Risk Assessment*, 36(10), 3517–3533.
<https://doi.org/10.1007/s00477-022-02207-0>.

Hamid, M; Khuroo, A. A; Ahmad, R; Rasheed, S; Malik, A. H and Dar, G. H. (2020) Threatened Flora of Jammu and Kashmir State. In: *Biodiversity of the Himalaya: Jammu and Kashmir State*, Topics in Biodiversity and Conservation (eds. Dar, G.H. &Khuroo, A.A.). Springer, Singapore, 957–995.

IBEF (2011) Report of Himachal Pradesh, 1-59.
https://www.ibef.org/download/Himachal_Pradesh_271211

India state of forest Report (2021) Forest Survey of India, Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India, 333-336.

ISFR (2011) Forest Survey of India. Dehradun, 236-246.

ISFR (2017) Forest Survey of India. Dehradun, 308-317.

ISFR (2021) Forest Survey of India. Dehradun, 491-500.

Jangra, R., & Kaushik, S. P. (2021) Estimating Carrying Capacity in a High Mountainous Tourist Area: A Destination Conservation Strategy. In R. B. Singh, D. Wei, & S. Anand (Eds.), *Global Geographical Heritage, Geoparks and Geotourism: Geoconservation and Development* (pp. 427–447). Springer. https://doi.org/10.1007/978-981-15-4956-4_22.

Joshi, R and Dhyani, P. P. (2009) Environmental sustainability and tourism – implications of trend synergies of tourism in Sikkim Himalaya. *Current Science* 97 (1), 33-41.

Khamaru, L., Chakraborty, J., Samanta, S., Banerjee, D., & Dutta, S. B. (2022) Assessment and monitoring of urbanisation on Himalayan lacustrine environment-a case study in Mirik municipality area. *GeoJournal*, 87(4), 703–722. <https://doi.org/10.1007/s10708-022-10677-6>.

Kirch, A. (2002) Impact of Tourism and Urbanization on Water Supply and Water Quality in Manali, Northern India. *Canadian Water Resources Journal* 27(4), 383-400. DOI: <https://doi.org/10.4296/cwrj2704383>.

Kour, G., Kothari, R., Dhar, S., Pathania, D., & Tyagi, V. V. (2022). Impact assessment on water quality in the polluted stretch using a cluster analysis during pre- and COVID-19 lockdown of Tawi river basin, Jammu, North India: An environment resiliency. *Energy, Ecology and Environment*, 7(5), 461–472. <https://doi.org/10.1007/s40974-021-00215-4>.

Kumar, R; Raina, A and Sharma, N. (2019) Dataset on water quality characteristics of a hill stream in Bhaderwah, Jammu and Kashmir. *Data in Brief* 26, 1-11. DOI:10.1016/j.dib.2019.104462.

Kumari, K; Kumar, S; Rajagopal, V; Khare, A & Kumar, R. (2019) Emission from open burning of municipal solid waste in India. *Environmental Technology (United Kingdom)*40(17), 2201–2214. DOI: <https://doi.org/10.1080/09593330.2017.1351489> .

Kuniyal, J.C., Sekar, K.C., S.C. Arya (2021) ‘Undertaking a study to define the extent and intensity of habitat degradation, to identify the drivers of degradation and prepare a study proposal for developing model mitigation plan in alpine and sub-alpine areas in SECURE Himalaya project landscapes of Uttarakhand’. *Habitat Degradation*, FTR Submitted to UNDP-GEF, pp.1-197.

Kuniyal, J. C. (2005) Solid waste management in the Himalayan trails and expedition summits. *Journal of Sustainable Tourism* 13(4), 391–410. DOI: <https://doi.org/10.1080/09669580508668564>.

Kuniyal, J. C; Jain, A. P and Shannigrahi, A. S. (2003a) Solid waste management in Indian Himalayan tourists’ treks: a case study in and around the Valley of Flowers and Hemkund Sahib. *Waste Management* 23(9), 807-816.

Kuniyal, J. C; Jain, A. P and Shannigrahi, A.S. (2003b) Environmental impacts of tourism in Kullu-Manali Complex in North Western Himalaya, India. Part 1: The Adverse Impacts. *International Journal of Fieldwork Studies* 1(1), 1-20. [http://www.virtualmontana.org/ejournal/vol1\(1\)/tourism.htm](http://www.virtualmontana.org/ejournal/vol1(1)/tourism.htm).

Kuniyal, J.C., Thakur, H.K. (2013-14) User manual on microbial biocomposting technique for solid waste management, G.B. Pant Institute of Himalayan Environment and Development, Shamshi-Kullu, pp. 1-34.

- Laishram, R. J and Alam, W. (2019) Geochemical Assessment of Nambul River Water Quality for Domestic and Irrigation Uses, Imphal, Manipur. *Taiwan Water Conservancy* 67 (4), 23-40.
- Lalengzama, C and Zoramani F. (2018) Domestic Waste Disposal and Management in Lunglei District Mizoram. *Senhri Journal of Multidisciplinary Studies* 3(2), 64-80.
- Lalneihzovi and Lalchhuanawma, H. C. (2017) Urban Solid Waste Management System and People's Participation in Aizawl City. Proceedings of 2017 International Conference on Public Administration (12th) & International Symposium on West African Studies (1st)25-33.
- Lepcha, J; Rai, Y. K and Rai, L. K. (2015) Fambonglho Wildlife Sanctuary (Sikkim, India) and Promotion of Ecotourism: Perspectives from Ground Zero. *Int. J. of Multidisciplinary and Current research* 3, 1204-1209.
- Limbu, D. (2014) Solid waste management in the town of Darjeeling: Environmental concern. *International Journal of Humanistics and social science invention* 3(6), 22-34.
- Malik, M. I; Bhat, M. S and Kuchay, N. A. (2011) Anthropogenic impact on forest cover in the Western Himalayas: A case study of Lidder catchment in Kashmir valley. *Transactions of the Institute of Indian Geographers* 33, 55–65.
- Meghalaya Tourism Policy (2011) Government of Meghalaya, Tourism Department, No. Tourism.74/2009/85, 1-16. (<https://Tourism.Gov.In/Sites/Default/Files/2019-10/Meghalaya.Pdf>)
- Monthly Progress Report (2020) the State of Mizoram for November. Mizoram State Pollution Control Board, Mizoram, 15.
- Monthly Progress Report (2021) the State of Mizoram for August. Mizoram State Pollution Control Board, Mizoram, 13.
- Mushtaq, J., Dar, A. Q., & Ahsan, N. (2020) Spatial–temporal variations and forecasting analysis of municipal solid waste in the mountainous city of north-western Himalayas. *SN Applied Sciences*, 2(7), 1161. <https://doi.org/10.1007/s42452-020-2975-x>.
- Nasim, H and Keng, T. (2012) Directory of lakes and waterbodies of Jammu & Kashmir state, 4-108.

National Green Tribunal (2019) order dated 28.03.2019 and 04.07.2019 in O.A No. 67/2019 and O.A. No. 138/2019, to the Chief Secretaries/ Administrators of States Governments/Union Territory Administrations to 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.

Nayak, P and Mishra, S. K. (2013) Problems and prospects of promoting tourism in Meghalaya. In National Seminar on 'promotion of international tourism circuits in North East India: prospects, priorities and strategic options' organized by the Department of Business Administration, Assam University, Silchar, India, 8-9.

Pandey, P., Dhiman, M., Chopra, P., & Adlakha, A. (2022). Investigating the Role of Tourists and Impact of Knowledge, Behaviour, and Attitude Towards Plastic Waste Generation. *Circular Economy and Sustainability*. <https://doi.org/10.1007/s43615-022-00216-3>.

Parray, S. Y; Koul, B and Shah, M. P. (2021) Comparative assessment of dominant macrophytes and limnological parameters of Dal lake and Chatlam wetlands in the Union territory of Jammu & Kashmir, India. *Environmental Technology & Innovation* 24, 101978. DOI: [10.1016/j.eti.2021.101978](https://doi.org/10.1016/j.eti.2021.101978)

Rai, A., Mukherjee, S., Chatterjee, A., Choudhary, N., Kotnala, G., Mandal, T. K., & Sharma, S. K. (2020) Seasonal Variation of OC, EC, and WSOC of PM10 and Their CWT Analysis Over the Eastern Himalaya. *Aerosol Science and Engineering*, 4(1), 26–40. <https://doi.org/10.1007/s41810-020-00053-7>.

Rashid, I., & Romshoo, S. A. (2013) Impact of anthropogenic activities on water quality of Lidder River in Kashmir Himalayas. *Environmental Monitoring and Assessment*, 185(6), 4705–4719. <https://doi.org/10.1007/s10661-012-2898-0>.

Rawat, S. (2020) Rural Tourism and Sustainable development in Darjeeling Hills, West Bengal: Case study of Lepchajagat. *JuniKhyat* 10(5), 18-34. ISSN: 2278-4632.

Roy, S; Bose, A and Mandal, G. (2021) Modeling and mapping geospatial distribution of groundwater potential zones in Darjeeling Himalayan region of India using analytical hierarchy

process and GIS technique. Model. *Earth Syst. Environ.* 1–22 DOI: 10.1007/s40808-021-01174-9.

Sahani, N., & Ghosh, T. (2021) GIS-based spatial prediction of recreational trail susceptibility in protected area of Sikkim Himalaya using logistic regression, decision tree and random forest model. *Ecological Informatics*, 64, 101352. <https://doi.org/10.1016/j.ecoinf.2021.101352>.

Sahoo, U. K; Singh, S. L; Lalnundanga, L; Devi, A. S and Zothanzama, J. (2018) Climate Change Impact on Forest and its Adaptation Study in Mizoram (Technical Report), 44.

Saleem, S; Kamili, A. N; Kakru, D. K; Bandh, S. A and Ganai, B. A. (2011) Isolation, identification and seasonal distribution of bacteria in Dal Lake, Kashmir. *International Journal of Environmental Sciences* 2(1), 185.

Sarkar, C., Chatterjee, A., Majumdar, D., Ghosh, S. K., Srivastava, A., & Raha, S. (2014) Volatile organic compounds over Eastern Himalaya, India: Temporal variation and source characterization using Positive Matrix Factorization [Preprint]. *Gases/Field Measurements/Troposphere/Chemistry* (chemical composition and reactions). <https://doi.org/10.5194/acpd-14-32133-2014>.

Sarkar, C; Chatterjee, A; Singh, A. K; Ghosh, S. K and Raha, S. (2015) Characterization of black carbon aerosols over Darjeeling-A high altitude Himalayan station in eastern India. *Aerosol and Air Quality Research* 15(2), 465-478.

Seth, R., Singh, P., Mohan, M., Singh, R., & Aswal, R. S. (2013) Monitoring of phenolic compounds and surfactants in water of Ganga Canal, Haridwar (India). *Applied Water Science*, 3(4), 717–720. <https://doi.org/10.1007/s13201-013-0116-z>.

Sharma, A; Gupta, A. K and Ganguly, R. (2018) Impact of open dumping of municipal solid waste on soil properties in mountainous region. *Journal of Rock Mechanics and Geotechnical Engineering* 10(4), 725-739.

Sharma, G; Lata, R; Thakur, N; Bajala, V; Kuniyal, J.C and Kumar, K. (2021) Application of multivariate statistical analysis and water quality index for quality characterization of Parbati River, Northwestern Himalaya, India. *Discov. Water* 1,5. DOI: <https://doi.org/10.1007/s43832-021-00005-3>.

Sharma, N and Walia, Y. K. (2017) Water Quality Investigation by Physicochemical Parameters of Satluj River, Himachal Pradesh, India. *Current World Environment* 12(1), 174-180. DOI: <https://doi.org/10.12944/CWE.12.1.21>.

Sharma, P; Sood, A; Sharma, S; Bisht, S; Kumar, V; Pandey, P; Gusain, M. P and Gusain, O. P. (2010) Bacterial indicators of faecal pollution and physicochemical assessment of important North Indian lakes. *RMZ- Mater. Geoenviron* 57(1), 25-40.

Sharma, R. P. (2012) Comparative study of past and present environment. A study in environmental degradation in the Darjeeling Hill areas, 65-73 (shodhganga.inflibnet.ac.in).

Sharma, R., Kumar, R., Sharma, D.K. *et al.*(2022) Water pollution examination through quality analysis of different rivers: a case study in India. *Environ Dev Sustain* 24, 7471–7492. <https://doi.org/10.1007/s10668-021-01777-3>.

Sharma, R.P. (2012) A Study in environmental degradation in the Darjeeling hill areas. Ph.D. Thesis, University of North Bengal, West Bengal. <https://shodhganga.inflibnet.ac.in/handle/10603/165832>

Sharma, S and Walia, Y. K. (2016) Water Quality Assessment of River Beas during Winter Season in Himachal Pradesh, India. *Current World Environment* 11(1), 194-203.

Sharma, S; Wangmo, R and Rana, S. K. (2021) A Comprehensive Account of the Birds of Ladakh: Commentary, Notes, and Field Guide. *Walnut Publication* 1-368.

Sherpa, S and Mondal, A. (2021) Carrying capacity of Singalila National Park. *International Journal of Environment, Ecology, Family and Urban Studies* 11(2), 105-116.

Shiteo, C. (2017) Development and Growth of Tourism in Nagaland. *South Asian Journal of Tourism and Heritage. SAJTH* 10(2), 76-89.

Singh, A., Deep, A., Pandey, C., & Nandan, H. (2023) Comparative study of gaseous pollutants for major cities in foothills of Garhwal Himalaya of Uttarakhand. *MAUSAM*, 74(1), Article 1. <https://doi.org/10.54302/mausam.v74i1.1013>

- Singh, G., & Rawat, G. (2012) *Depletion of Oak (Quercus spp.) Forests in the Western Himalaya: Grazing, Fuelwood and Fodder Collection*. <https://doi.org/10.5772/33554>.
- Singh, J. (2017) The Loktak Hydro Electricity Power Project in Manipur and its Impact on the Socio-Economic Conditions to the Catchment Areas. *IOSR Journal of Humanities and Social Science* 22(11), 11-17.
- Singh, K. (2015) *Tourism in Manali: A Quest for Sustainability Evaluating 2005 Tourism Policy of Himachal Pradesh*, The Hague, The Netherlands November 2015.
- Sophia, A and Devi, M. S. (2020) Environmental Problems of Manipur. *Holistic Approach Environ.* 10(4), 124- 140.
- State Environment Report of Mizoram (2016) Department of Environment, Forests and Climate Change, Government of Mizoram, Mizoram, 1-352.
- Sundriyal, S., Shridhar, V., Madhwal, S., Pandey, K., & Sharma, V. (2018). Impacts of tourism development on the physical environment of Mussoorie, a hill station in the lower Himalayan range of India. *Journal of Mountain Science*, 15(10), 2276–2291. <https://doi.org/10.1007/s11629-017-4786-0>.
- Sunlu, U. (2003) Environmental impacts of tourism. In: Camarda D. (ed.), Grassini L. (ed.). *Local resources and global trades: Environments and agriculture in the Mediterranean region*. Bari: CIHEAM 263-270. (Options Mediterranean's: Série A. Séminaires Méditerranéens; n. 57
- SWM (2016) Municipal solid waste management. In: The Gazette of India, 222-445.
- Tali, B. A., Ganie, A. H., Nawchoo, I. A., Wani, A. A., & Reshi, Z. A. (2015) Assessment of threat status of selected endemic medicinal plants using IUCN regional guidelines: A case study from Kashmir Himalaya. *Journal for Nature Conservation*, 23, 80–89. <https://doi.org/10.1016/j.jnc.2014.06.004>.
- Tamang, P. and Jana, S. K. (2017) Water scarcity in the hill town of Darjeeling: Effects on women's health. *International Journal of Human resource research review* 5(7), 113-120. ISSN: 2320-9704.

Tambe, S. and Arrawatia, M. L. (2012) Climate Change initiatives in sikkim. Climate Change in Sikkim Patterns, Impacts and Initiatives. Information and Public Relations Department, Government of Sikkim, Gangtok, 369-412.

Tambe, S. and Rawat, G. S. (2006) An Ecological Study of Pastoralism in the Khangchendzonga National Park, West Sikkim. The Mountain Institute – India, Sikkim, 53.

Thakur, I., Lata, R., & Kuniyal, J. C. (2022) *Impact of COVID-19 Lockdown on the Air Quality in the Northwestern Himalaya, India*. in Proceedings of the 5th International Electronic Conference on Atmospheric Sciences, 16–31 July 2022, MDPI: Basel, Switzerland, doi:10.3390/ecas2022-12875

Thakur, I., Lata, R., Kuniyal, J. C., & Ghosh, S. (2022). Assessing the Impacts of Anthropogenic Activities on Air Quality: A study during the Lockdown in 2nd Wave of COVID-19 Pandemic in the Kullu Valley of North-Western Himalaya. In: Yulihastin, E., Abadi, P. Sitompul, P. & Harjupa, W. (Eds.) *Proc. of the International Conference on Radioscience, Equatorial Atmospheric Science and Environment and Humanosphere Science*, 2021 (pp. 675–686). Springer Nature. https://doi.org/10.1007/978-981-19-0308-3_53.

Thakur, N; Rishi, M and Sharma, D. A. (2018) Tirumalesh Keesari Quality of water resources in Kullu Valley in Himachal Himalayas, India: perspective and prognosis. *Applied Water Science* 8, 20. DOI: <https://doi.org/10.1007/s13201-018-0668-z>.

Thind, P. S., Kumar, D., Singh, S., Chohan, J. S., Kumar, R., Sharma, S., Li, C., Di Bona, G.,

Tourism Policy (2020) Tourism Department, Government of Mizoram 1-29.

Tourism Survey for State of Nagaland - Final Report (2017) (June 2014 - May 2015), Ministry of Tourism, Govt. of India. 1-51.

Tsering, T., Sillanpää, M., Viitala, M. & Reinikainen, S.-P. (2022) Variation of microplastics in the shore sediment of high-altitude lakes of the Indian Himalaya using different pretreatment methods. *Science of The Total Environment*, 849, 157870. <https://doi.org/10.1016/j.scitotenv.2022.157870>.

Vijay, R; Kushwaha, V. K; Chaudhury, A. S; Naik, K; Gupta, I; Kumar, R and Wate, S. R. (2015) Assessment of tourism impact on land use/land cover and natural slope in Manali, India: A geospatial analysis. *Environmental Earth Sciences* 75(20), 1-9. DOI: <https://doi.org/10.1007/s12665-015-4858-9>.

Vikal, P. (2009) Multivariant analysis of drinking water quality parameters of lake Pichhola in Udaipur, India. *Biological Forum. Biological Forum- An International Journal* 1(2), 97-102.

WHO (2013) World Health Organisation, Guidelines for Drinking Water Quality. 4th Edition. Geneva: WHO Chronicle 38(4), 104–108.

Wilson, M. C; Chen, X. Y; Corlett, R. T; Didham, R. K; Ding, P; Holt, R. D; Holyoak, M; Hu, G; Hughes, A. C; Jiang, L, and Laurance, W. F. (2016) Habitat Fragmentation and Biodiversity Conservation: Key Findings and Future Challenges. *Landscape Ecology* 31 (2), 219-227.

World Bank (2015) Document on Environmental & Social Policy & Procedures (ESPP), 1-142.

WTO (2010) World Tourism Organization- Tourism and Biodiversity – Achieving Common Goals towards Sustainability, 1-51. ISBN: 978-92-844-1371-3.

Yadav, I. S, and Devi, N. L. (2016) Municipal Solid Waste Management in Imphal Town, Northeast India: A Critical Analysis of Existing Management Practices and Proposed Action Plans. *International Journal of Waste Resources* 6(3), 1-8.

Websites Used

Ban on expeditions to Stok Kangri peak <https://trekkersofindia.in/stok-kangri-trek-banned-for-trekkers-till-2022/>

<https://www.tripoto.com/leh-ladakh/trips/the-mighty-stok-kangri-banned-for-trekkers-and-climbers-for-three-years-from-2020-2022-5df2072880813>

https://aqicn.org/station/india/leh/nasa_aqcs_119

<http://jkspcb.nic.in/Content/MonitoringatPollutedRiverStretchesinJandK.aspx?id=454>

www.cpcbenvi.nic.in

<http://jkspcb.nic.in>

<http://jkspcb.nic.in/Content/MonitoringatPollutedRiverStretchesinJandK.aspx?id=454>

Biodiversity GBIF (www.gbif.org)

IUCN assessment (www.iucnredlist.org)

Protected Area (http://wiienviis.nic.in/Database/npa_8231.aspx).

Protected Area of J&K http://wiienviis.nic.in/Database/npa_8231.aspx

Committees to prepare Zonal Master Plans for Eco-Sensitive Zones
<https://www.dailyexcelsior.com/committees-to-prepare-zonal-master-plans-for-eco-sensitive-zones/>

<https://thewire.in/environment/jammu-and-kashmir-environment-conservation-tourism>

Jammu and Kashmir govt sets up panel to declare Dal Lake as eco-sensitive zone
<https://www.thehindu.com/news/national/jammu-and-kashmir-govt-sets-up-panel-to-declare-dal-lake-as-eco-sensitive-zone/article29945443.ece>

Adarsh Batra Himalayan Ecotourism in Shimla. <http://www.au.edu> (2015).

Himachal Pradesh Economic survey. Department of Economics & Statistics HP.
[https://himachalservices.nic.in/economics/pdf/economic_survey_2020-21\(2020-21\)](https://himachalservices.nic.in/economics/pdf/economic_survey_2020-21(2020-21)).

<https://himachaltourisum.gov.in/counter/>

<https://hppcb.nic.in/airquality.pdf>

E Vahan Portal, <https://vahan.parivahan.gov.in/vahan4dashboard/>

Air quality in Shimla, Manali declines due to tourist influx-
<https://www.hindustantimes.com/india-news/air-quality-in-shimla-manali-decline-due-to-tourist-influx/story-FF8AzMKA4sFgNjMqRKkuAO.html>

Himachal Pradesh: Area around Nargu sanctuary to be declared eco-sensitive zone
<https://indianexpress.com/article/cities/shimla/himachal-pradesh-area-around-nargu-sanctuary-to-be-declared-eco-sensitive-zone-7056673/1>

Statista Website-<https://www.statista.com/statistics/1116932/number-of-vehicles-in-himachal-pradeshindia/#:~:text=There%20were%20over%201.6%20million,end%20of%20fiscal%20year%202019.>

(<https://www.downtoearth.org.in/blog/waste/divide-and-conquer-segregation-is-the-key-60597>)

<https://hpforest.nic.in/pages/display/ZjY1NHhjhnJmNjU0cw==--ecosensitive-zone>

https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-19/learningcentre/presentations/May%202%20am/1%20-%20Memon%20-%20ISWM.pdf

Ministry of Tourism, Govt. of India. (ON1788) and Past Issues www.ibef.org

Directorate of Urban Development Uttarakhand, Dehradun on the basis of Swachh Sarvekshan Based on Urban MSW action plan 2017

District administration, 2021

Forest Survey of India, Dehradun. India State of Forest Report 2021.

Central Pollution Control Board

ENVIS Sikkim: <http://sikervis.nic.in/writereaddata/sd71.pdf>.

Carrying Capacity Survey Department of Tourism and Civil Aviation, Government of Sikkim (2017).

Anonymous <https://ejatlas.org/conflict/khangchendzonga-conservation-committee> (2017).

Management Plan Khangchendzonga National Park 2008-2018. MoEF, Government of Sikkim.

Ministry of New and Renewable Energy, Government of India (2018).

Kyongnosla Alpine Sanctuary <http://www.sikkimforest.gov.in/docs/IBA/sk5.pdf> (2022).

ENVIS Hub: Sikkim http://sikervis.nic.in/Database/Eco-Sensitive-Zones_4136.aspx (2021).

Gorkhaland territorial administration. Department of tourism.

Tourist bureau, Darjeeling; foreigner's registration office, DIB, Darjeeling.

<https://www.sentinelassam.com/topheadlines/eco-sensitive-zone-gets-assam-cabinet-nod-584088>

https://des.assam.gov.in/sites/default/files/menu/document/ecostat_medhassu_in/Statistical%20H and%20Book%20Assam%2C%202012.pdf

[Report of the Evaluation Study on Hill Area Development Programme in Assam and West Bengal.pdf \(dmeo.gov.in\)](#)

Assam Tourism Development Corporation Limited, 2019. <http://www.assamtourisonline.com/>

Ministry of Tourism, Govt. of India, <https://tourism.gov.in/>

Central Pollution Control Board, 2019. <https://cpcb.nic.in/>

Statistical Handbook of Assam 2011-19. <https://des.assam.gov.in/portlets/statistical-handbook>

Department of Tourism, Nagaland, <https://tourism.nagaland.gov.in/> accessed on 18th April, 2022.

IUCN red list; <https://www.iucnredlist.org>, accessed on 16th April, 2022.

Department of environment, forest and climate change, govt. of Nagaland, <https://forest.nagaland.gov.in/> (2022).

Central Pollution Control Board. National Waster Quality Monitoring Programme. *Water Quality Data (Yearly)*, <https://cpcb.nic.in/nwmp-data/>.

<https://www.cseindia.org/imphal-municipal-corporation-imphal-manipur-8288>

<https://manipcb.nic.in/document/NOISE.pdf>

<https://www.cleanfuture.co.in/2018/01/10/manipur-gets-waste-management-plant/>

<https://www.statista.com/statistics/1116901/number-of-vehicles-in-manipur-india/>

<http://www.manipur-tourism.gov.in/site-map/>

<https://www.ceicdata.com/en/india/revenue-receipts-manipur/manipur-revenue-receipts-non-tax-state-economic-services-tourism>

<https://www.ceicdata.com/en/india/non-resident-visits-by-states/visitor-arrivals-foreigner-mizoram>

<https://greentribunal.gov.in>

<https://www.statista.com/statistics/1116913/number-of-vehicles-in-mizoram-india/>

<https://smartcities.data.gov.in/catalog/solid-waste-management-aizawl?>

<http://scstsenvis.nic.in/index4.aspx?sslid=196&subsubsublinkid=512&langid=1&mid=1#:~:text=Habitat%20loss%2C%20hunting%20and%20over,systems%2C%20have%20caused%20this%20loss.>

THE MEGHALAYA STATE BIODIVERSITY STRATEGY AND ACTION PLAN-2016-2026, WII (<https://megbiodiversity.nic.in/sites/default/files/mbsap-6th-march-2017.pdf>)

<https://vahan.parivahan.gov.in>

<http://trpenvis.nic.in/test/tourism.html>

<https://www.cseindia.org/agartala-1754>

http://www.megforest.gov.in/forest_overview.html#

<https://nehu.ac.in/envis/database.html>

<https://www.ceicdata.com/en/india/resident-visits-by-states/visitor-arrivals-local-meghalaya>).

http://megspcb.gov.in/annual_reports.html

<https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf>

<https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf>"<https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf>

http://megspcb.gov.in/annual_reports.html

http://www.megforest.gov.in/wildlife_zones.html

http://www.megforest.gov.in/forest_sacredgroves.html

Meghalaya State Pollution Control Board Annual Reports (2010-2018).

Annual Reports (2012-2018), Meghalaya State Pollution Control Board (http://megspcb.gov.in/annual_reports.html)

TOURISM IN THE 2030 AGENDA <https://www.unwto.org/tourism-in-2030-agenda>.

(<https://www.thesangaiexpress.com/Encyc/2019/5/8/Contd-from-previous-articleSegregation-at-source-Till-date-to-my-knowledge-there-is-no-report-of-segregating-the-household-waste-at-source-in-Imphal-This-is-one-of-the-major-challenges-where-the-c.html>) (2019).

World Travel and Tourism Council, 2010. <http://www.wttc.org/>

ENVIS Centre: Tripura State Pollution Control Board <http://trpenvis.nic.in/test/tourism.html>

<https://mpcb.mizoram.gov.in/page/water-quality-ind>

ANNEXURES

Annexure I: Impacts of tourism on different environmental components-some case studies in the IHR during last 10 years (2012-2022)

Ill-impacted environmental component	Name of tourist place in IHR	Method	Cause	Impact	References
Water pollution					
Microplastic contamination	i. Pangong Lake, ii. Tsomoriri Lake and Tsokar Lake, Ladakh (NWH)	Sampling of lakes shore sediment Microplastics identification was performed with Raman imaging microscope	Trekking, vehicles, clothes with synthetic fibers, tents, and disposal of plastic litters like drinking water bottles and food packaging, around the lake	Microplastic concentration (MP) was 160–1000 MP/kg dw in Pangong Lake, 960–3800 MP/kg dry weight (dw) in Tsomoriri Lake, and 160–1000 MP/kg dw in Tsokar Lake	Tseringet <i>et al.</i> 2022
Biological Oxygen Demand (BOD)	River Tawi, Jammu city (NWH)	Water quality data based upon the real-time water monitoring	Ritualistic, Automobile washing, tourism and other anthropogenic activities	A significant decline in BOD (2.95 mg/L to 1.50 mg/L) values was seen.	Kour <i>et al.</i> 2022
Chemical Oxygen Demand (COD)				A significant decline in COD (13.90 mg/L to 6.75 mg/L) values was seen.	
Chlorides, orthophosphate phosphorus	Lidder valley, Phalgam (NWH)	Water quality analysis	Accelerated flow of tourists from June to August causes	The highest value of correlation coefficient was shown by chlorides (0.77) followed by orthophosphate phosphorus (0.65), while a	Rashid & Romshoo, 2013

			deterioration in water quality of River Lidder	negative correlation was shown by dissolved oxygen ($\rho=0.62$).	
Elemental carbon (EC)	Manali (NWH)	Field Sampling & Laboratory analysis	Fossil fuels-powered vehicles during tourist season	Water body receiving water from Hamta glacier was reported to be contaminated from 19.02 ppb to 54 ppb of EC.	Thind <i>et al.</i> 2022
Demand- Supply gap	Mussoorie (CH)	Official documents, field observation	The total drinking water supply, both by means of pumping and gravitational pull was estimated to be 7.67 million litres per day (MLD). The corresponding water requirement during the lean season was estimated to be 7.76 MLD which increased to 14.40 MLD during peak season.	Demand and supply gap of 6.73 MLD during the peak tourist season was noticed as compared to the 0.09 MLD during the lean season.	Sundriyal <i>et al.</i> 2018
Surfactants	River Ganga, Haridwar, (CH)	Chloroform extraction method (APHA, 5530-C) and methylene blue active substance (APHA, 5440-C) using UV-VIS spectrophotometer.	Bathing and washing clothes along the route of Ganga canal	Higher amount of surfactants in water samples. The maximum value of surfactant concentration was found 1.18 mg/l in May, 2012 at SN2 and 3.20 mg/l in July, 2012 at SN4. The lowest concentration was found 0.31 and 0.45 mg/l at SN5 and SN2, respectively. In May and July 2012 i.e. more than desirable limit of 0.20 mg/l as per BIS.	Seth <i>et al.</i> 2013
Air pollution					
Air quality index	Srinagar city (NWH)	Air quality monitoring	Average values of air pollutants such as PM _{2.5} , PM ₁₀ , NO ₂ , SO ₂ , O ₃ and NH ₃ were compared from pre-lockdown conditions.	An overall decrease of 6.15% in the air quality index was found during lockdown with respect to pre-lockdown.	Asif & Mahajan, 2022

			PM ₁₀ , NO ₂ , and NH ₃ decreased during lockdown, whereas overall they increased during partial lockdown.	A maximum decrease was seen in the concentration of NO ₂ , and NH ₃ with 75.11% and 69.18% and minimum decrease was seen in PM _{2.5} and AQI with 3.85% and 6.15%, respectively. A decreasing trend in the NO ₂ /SO ₂ ratio highlights the decreasing emissions from the transport sector.	
Elemental carbon (EC)	Manali (NWH)	Field Sampling & Laboratory Analysis	Fossil fuel-powered vehicles during tourist season	The atmospheric EC was observed to be contaminated with $880 \pm 43 \mu\text{g m}^{-3}$ of the EC	(Thind <i>et al.</i> 2022)
Carbon monoxide (CO)	Kullu (NWH)	Field Sampling & Laboratory Analysis	Vehicular emissions	Average concentration of CO with 0.59 ± 0.03 ppm in the PLD period. While it decreased to 0.35 ± 0.01 ppm in the LD period indicating how CO is largely influenced by vehicular emissions in the valley.	Thakur <i>et al.</i> 2022
Particulate matter (PM)	Kullu (NWH)	Field Sampling & Laboratory Analysis	Vehicular emissions during lock down	PM ₁₀ and PM _{2.5} showed a decrease in lockdown period by 65.31% and 52.5%, respectively	Thakur <i>et al.</i> 2022
	Kullu (NWH)	HYSPLIT and CALIPSO model	Increasing anthropogenic activities in Himalayan tourist destinations	The annual averages for PM _{2.5} , PM ₁₀ ranged from $23.5 \mu\text{g m}^{-3}$, $38.7 \mu\text{g m}^{-3}$ respectively	Chand <i>et al.</i> 2014

	Mussoorie (CH)	Ambient air quality assessment	Vehicular emissions during tourist season	The values for PM ₁₀ exceeded the limit prescribed by Central Pollution Control Board (CPCB, India) in both the seasons (100 µg m ⁻³ , 24-h average for PM ₁₀). However, the mean PM fine values exceeded the permissible limit (60 µg m ⁻³ , 24-h average for PM _{2.5}) in the summer months only. The range of PM fine - PM coarse for the summer season (0.50 - 0.83) was comparatively higher than the winter season (0.23 - 0.56).	Sundriyal <i>et al.</i> 2018
	Darjeeling (NEH)	Sampling and Chemical Analysis; Air-Mass Backward Trajectories	The pre-monsoon season is considered to be the peak season for tourism in Darjeeling when a huge amount of anthropogenic aerosols released in the atmosphere.	The annual average concentration of PM ₁₀ was recorded to be 55 ± 18 µg m ⁻³ , which is close to National Ambient Air Quality Standard (NAAQS; 60 µg m ⁻³ for annual PM ₁₀) of India. The concentration of PM ₁₀ showed maximum in pre-monsoon season (63 ± 21 µg m ⁻³) followed by post monsoon (56 ± 16 µg m ⁻³), monsoon (51 ± 13 µg m ⁻³) and winter seasons (49 ± 17 µg m ⁻³).	Rai <i>et al.</i> 2020
Black carbon (BC)	Kullu (NWH)	HYSPILT and CALIPSO model	Increasing anthropogenic activities in Himalayan tourist destinations	Annual average of PM _{2.5} was 3.7 µg m ⁻³	Chand <i>et al.</i> 2014
Heavy metal	Dehradun (CH)	Acid digestion and rigorously analyzed through inductively coupled plasma-mass spectrometry (ICP-MS)	Traffic activities	HMs comes from mixed sources such as Zn, Cu, Pb, and Ni mainly come from different traffic activities. The average concentration of Zn, Cu, Pb, Cd, Cr, Ni, and As were 172.14, 59.64, 109.83, 1.80, 32.69, 23.29, and 2.72 mg·kg ⁻¹ , respectively.	Gupta <i>et al.</i> 2022

Total volatile organic compounds (TVOC)	Darjeeling (CH)	Sampling and Chemical Analysis	Post-monsoon and pre-monsoon are the tourist seasons over Darjeeling. Darjeeling experiences huge emissions of fossil fuel burning from large numbers of tourist vehicles during these two seasons compared to other seasons.	Concentration of TVOC showed well defined seasonal variations with maximum in post-monsoon ($1649.9 \pm 875.4 \mu\text{g m}^{-3}$) followed by monsoon ($117.1 \pm 88.3 \mu\text{g m}^{-3}$), winter ($60.4 \pm 28.2 \mu\text{g m}^{-3}$) and minimum during pre-monsoon ($35.9 \pm 9.7 \mu\text{g m}^{-3}$).	Sarkar <i>et al.</i> 2014
Solid waste					
Municipal solid waste management	Srinagar (WH)	Field sampling	Tourist influx	The overhead population due to tourism contributes additional 80 MT day^{-1} of MSW during the tourist season, and it brings pressure on the existing MSW management system.	Mushtaq <i>et al.</i> 2020
	Dharamshala, Kangra (WH)	Field survey	The increased tourism in town leads to air pollution and sewerage problems, along with an increased quantity of solid waste.	The total solid waste generated in town is about 14,000 kg/day, and the town does not have enough infrastructures to dispose of all the waste.	Anand & Singh, 2014
	Mussoorie (CH)	Official documents & field observation	Littering by tourists all over the places, & unattended waste bins.	MSW generation was maximum during the tourist season, i.e., May to July (i.e., 23 MT per day) during which the town also experienced the highest inflow of tourists (1,069,267). During other months, MSW generation decreased with a corresponding decrease in the number of tourists visiting the town.	Sundriyalet <i>et al.</i> 2018

		Primary survey and statistical analysis	Tourists are the key factors in generation of plastic waste materials in Mussoorie region.	More than 300 g/day of plastic wastes was generated at each selected shop in which tourists were the major source for generation.	Pandey <i>et al.</i> 2022
	Darjeeling (EH)	Field sampling	Tourist influx	The amount of solid waste generated is 30 MT daily, which goes up to 50 MT during the peak tourist season. In respect of Darjeeling Municipality that solid waste generation is @ 465 gm/capita/day	Dutta <i>et al.</i> 2020;; Limbu, 2014
Forest and biodiversity disturbances					
Habitat destruction of threatened plants	Kashmir Valley (WH)	Extensive field explorations	Every year, the rush of tourists is increasing. The number of tourists is always higher than the carrying capacity of the particular health resort resulting in a threat to biodiversity (Author's personal observation).	Negatively impacted the populations of <i>Fritillaria roylei</i> , <i>Corydalis cashmeriana</i> , and <i>Lsgotiscashmeriana</i> . In year 2011, 1500 matured individuals of <i>F. roylei</i> were found in Apherwat (Gulmarg). But only about 367 individuals were able to produce fruits and among these only 112 plants reached fruit maturity due to high heavy grazing and huge tourist pressures.	Taliet <i>al.</i> 2015
Forest degradation, Oak (<i>Quercus</i> spp.)	Kedarnath Wildlife Sanctuary, Chamoli (CH)	Field survey and analysis	High tourist season and low temperature at higher altitude, use of fuelwood was quite high compared to permanent residents of villages.	0.9 q/day/dhaba to 3 q/day/dhaba of fuelwood is used in tourist season.	Singh & Rawat, 2012;
Habitat destruction and forest fragmentation	Yuksam–Dzongri trekking corridor, (NEH)	Field survey, Ecotourism sustainability	Human pressure such as firewood extraction, fodder lopping, and cattle grazing have increased manifolds in	Major factors of habitat destruction and forest fragmentation wherein about 53% of the total corridor area is already in a degraded condition.	Chettri, 2010; Ashok <i>et al.</i> 2022)

		maximization (ESM) model	the past two decades due to demographic growth and the increase in tourism. The frequent movement of pack animals, including herders with additional herds of yaks and sheep owned by the local inhabitants causes an immense pressure on vegetation along with the trekking corridor, mainly on camping sites and immediate vicinity of the corridor stretching 300 to 400 m on either side of the trail.		
Biodiversity	Singalila National Park (NEH)	GIS and machine learning algorithm of binary logistic regression (LR), decision tree (DT) and random forest (RF) model	The numbers of visitors have substantially increased over the past two decades which has a direct impact on geo-environmental settings of this trail.	The construction of trail and recreational activities have distorted the ecological stability along with this trail and its surrounding environment through trail widening, trail incision, creation of multiple trails, muddiness, vegetation trampling, and waste generation.	Sahani&Ghosh, 2021
Biodiversity	Mirik (NEH)	Remote Sensing and GIS	Waste disposal, landfill pollution, etc.	Gradual shrinkage in the lake area and the raised level of suspended sediment concentration (3724.26 mg/lit in 2020) near the boundaries.	Khamaru <i>et al.</i> 2022

Annexure II Action Plan of Himachal Government in compliance with Hon'ble 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 and garbage burning	Restriction on open burning of municipal solid waste, biomass, plastic, agriculture and horticulture, etc.	January 2019
		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.	Industries	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-authorized fuel in boilers	April 2019
		Conversion of brick kiln 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
		Fugitive emission control	January 2019

6.	Traffic and Transportation	Restriction on movement of goods vehicles in certain areas during daytime 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.	Strengthening of AAQM monitoring	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