



Environmental Assessment of Tourism in the Indian Himalayan Region



By

Govind Ballabh Pant National
Institute of Himalayan
Environment (NIHE)

(An Autonomous Institute of Ministry of
Environment, Forest & Climate Change,
Govt. of India)

Website: <https://gbpihed.gov.in>



Original Application
No.178/2022

Date of hearing: 09.03.2022

A

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

3 June, 2022

List of contributors

Lead Scientists (GBPI-NIHE, HQs, Kosi-Katarmal, Almora)

- **Dr. J. C. Kuniyal**, Scientist-G & Head, CEA & CC;
- **Dr. G.C.S. Negi**, Scientist-G & Head, CSED

Ladakh UT (GBPI-NIHE, LRC, Leh)

- **Dr. Subrat Sharma**, Scientist-F & Head, LRC;
- **Dr. P.K. Garg**, Scientist-C; **Dr. Suresh Kumar Rana**, Scientist –B; **Dr. Lalit Giri**, Technical Assistant (II); **Ms. Stanzin Zangmo**, Junior Research Fellow

Jammu & Kashmir UT (GBPI-NIHE, LRC, Leh)

- **Dr. Subrat Sharma**, Scientist-F & Head, LRC;
- **Dr. P.K. Garg**, Scientist-C; **Dr. Suresh Kumar Rana**, Scientist –B; **Dr. Lalit Giri**, Technical Assistant (II); **Ms. Stanzin Zangmo**, Junior Research Fellow

Himachal Pradesh (GBPI-NIHE, HRC, Mohal-Kullu)

- **Er. R.K. Singh**, Scientist-F & Head, HRC;
- **Dr. Renu Lata**, Scientist -C; **Dr. Kesar Chand**, Scientist-C; **Ms. Smriti Thakur**, Junior Research Fellow.

Uttarakhand (GBPI-NIHE, HQs, Kosi-Katarmal, Almora)

- **Dr. Vasudha Agnihotri**, Scientist-D; **Ms. Parnika Gupta**, Ph.D. Scholar

Sikkim (GBPI-NIHE, SRC, Pangthang)

- **Dr. Rajesh Joshi**, Scientist-E & Head, SRC;
- **Dr. K.S. Gaira**, Technical Assistant (II); **Dr. Sandeep Rawat**, Scientist -C; **Dr. Devender Kumar**, Scientist-D; **Dr. Mayank Joshi**, Scientist-C

Arunachal Pradesh (GBPI-NIHE, NERC, Itanagar)

- **Er. M.S. Lodhi**, Scientist-E & Head, NERC;
- **Er. Tridipa Biswas**, Scientist-C

Nagaland (GBPI-NIHE, NERC, Itanagar)

- **Er. M.S. Lodhi**, Scientist-E & Head, NERC;

- **Dr. Wishfully Myllemngap**, Scientist-C; **Dr. Mriganka Shekhar Sarkar**, Scientist-B; **Er. Om Prakash Arya**, Technical Officer

Manipur (GBPI-NIHE, HQs, Kosi-Katarmal, Almora)

- **Dr. I.D. Bhatt**, Scientist-F & Head, CBCM;
- **Dr. Aseesh Pandey**, Scientist-C; **Dr. Satish Arya**, Scientist- D; **Dr. Vikram Negi**, Scientist – E; **Dr. K.C. Sekar**, Scientist -F

Mizoram (GBPI-NIHE, HQs, Kosi-Katarmal, Almora)

- **Dr. I.D. Bhatt**, Scientist-F & Head, CBCM;
- **Dr. Aseesh Pandey**, Scientist-C; **Dr. Satish Arya**, Scientist- D; **Dr. Vikram Negi**, Scientist – E; **Dr. K.C. Sekar**, Scientist-F

Tripura (GBPI-NIHE, GRC, Garhwal-Srinagar)

- **Er. S. Tarafdar**, Scientist-E & Head, GRC;
- **Dr. Lakhpatt Singh Rawat** (Technical Assistant-II); **Mr. Sudhansu Chamoli**, Junior Research Fellow

Meghalaya (GBPI-NIHE, GRC, Garhwal-Srinagar)

- **Er. S. Tarafdar**, Scientist-E & Head, GRC;
- **Mr. Dhruv pandey**, Junior Project Fellow; **Mr. Ajar Hakkim**, Junior Project Fellow

Assam Hills (GBPI-NIHE, HRC, Mohal-Kullu)

- **Er. R.K. Singh**, Scientist-F & Head, HRC;
- **Dr. Renu Lata**, Scientist -D; **Dr. Kesar Chand**, Scientist-C; **Ms. Smriti Thakur**, Junior Research Fellow

Darjeeling, West Bengal Hills (GBPI-NIHE, SRC, Pangthang)

- **Dr. Rajesh Joshi**, Scientist-E & Head, SRC;
- **Dr. Sandeep Rawat**, Scientist -C, **Dr. Devender Kumar**, Scientist-D; **Dr. Mayank Joshi**, Scientist-C; **Dr. K.S. Gaira**, Technical Assistant (II)

Other contributors (GBPI-NIHE, HQs, Kosi-Katarmal, Almora)

- **Dr. Priyanka Maiti**, Research Associate; **Ms. Nidhi Kanwar**, Senior Project Fellow; **Ms. Sheetal Chaudhary**, Senior Project Fellow; **Mr. Rupesh Dhyani**, Senior Project Associate

Acknowledgements

The report titled, 'Environmental Assessment of Tourism in the Indian Himalayan Region (IHR)' in compliance to Hon'ble National Green Tribunal (NGT) has been attempted to prepare within three months duration. In view of finding facts and Figures, the study was carried out in relation to a statement made in Hindu Newspaper, 'Tourism has brought economic prosperity to the Himalayan Region but the environmental cost has been catastrophic'. This assignment is a part of an important activity which was assigned by Hon'ble National Green Tribunal (NGT), Principal Branch, New Delhi to Govind Ballabh Pant National Institute of Himalayan Environment' (GBNIHE), Kosi-Katarmal, Almora. This effort within a very short period was not so easy task to complete without the support of so many persons, departments within different states and other published or unpublished sources. It was rather a coordinated effort made by the researchers, concerned district administration and various departments without which the present work could not be possible to cover all 13 UT/ states of the IHR.

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

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

We would also like to thank Tourism & Civil Aviation Department, Govt. of Sikkim; Forest & Environment Department; Urban Development and Housing Department; Municipal Cooperation, Khangchendzonga Conservation Committee (KCC) Yuksam, West Sikkim. Our special thanks are also due to Ms. Uden T. Bhutia, Dr. P.G. Bhutia, Dr. B K Acharya, Dr. Sarla Khaling and many others for their valuable inputs which helped lot in improving the content of the report. We extend our thanks to Tourist bureau, foreigner's registration office, DIB, Darjeeling, and Gorkhaland Territorial Administration for providing relevant data and necessary support. The authors are thankful to all the academic institutions and other govt. departments of the different state governments for sharing their immense knowledge on the subject through secondary information.

We acknowledge the support received from different government agencies/department of forest and data retrieved from reports available at websites and the web pages of different departments, research papers are greatly acknowledged. Support received from the members of a Centre for Biodiversity Conservation and Management are greatly acknowledged. Meanwhile, we also acknowledge different websites used for obtaining some secondary data in the report.

Authors

Contents

Contents	Page(s)
List of Contributors	ii
Accknowledgement	iv
Abbreviations	vi
List of tables	ix
List of Fig.ures	xi
Preface	xiv
Executive summary	xv
Introduction	1
1. Ladakh	3
2. Jammu & Kashmir UT	17
3. Himachal Pradesh	35
4. Uttarakhand	62
5. Sikkim	78
6. West Bengal Hills, Darjeeling	94
7. Assam Hills	107
8. Arunachal Pradesh	118
9. Nagaland	137
10. Manipur	155
11. Mizoram	167
12. Tripura	180
13. Meghalaya	189
14. UTs/State specific recommendations	200
15. Concusion	207
Bibliography	208

Abbreviations

ADB	Asian Development Bank
ALTOA	All Ladakh Tour Operators Association
AMC	Aizawl Municipal Corporation
AMC	Agartala Municipal Corporation
AMDCZ	Areylungchok Musk Deer Conservation Zone
APTI	Air Pollution Tolerance Index
AQ	Air Quality
AQI	Air Quality Index
asl	above sea level
BCM	billion cubic meter
BOD	Biological oxygen demand
CAAQMS	Continuous Ambient Air Quality Monitoring Sensor
CAMP	Conservation Assessment & Management Prioritisation
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CBT	Community Based Tourism
CCA	Community Conserved Areas
CEC	Court-appointed central empowered committee
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CRED	Centre for research on environmental development
CYMA	Central Young Mizo Association
DD	Data Deficient
DMC	Dhansiri. Dimapur Municipal Council
DO	Dissolved Oxygen
E. coli	Escherichia coli
EC	Electrical conductivity
EN	Endangered
EPA	Environmental Protection Agency
ESPAY	Ecotourism Service Providers Association of Yuksam
ESPP	Environmental & Social Policy & Procedures
ESZ/ESA	eco-sensitive zones / area
ETP	Effluent treatment 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	H.P. State Pollution Control Board
HRC	Himachal Regional Center
ID	Indeterminate
IHM	Institute of Hospitality Management
IHR	Indian Himalayan region
IMC	Imphal municipal corporation
IMC	Itanagar Municipal Cooperation
ISWM	Integrated Solid Waste Management
IUCN	International Union for Conservation of Nature
JMC	Jorethang Municipal Council
KCC	Khangchendzonga Conservation Committee
KMC	Kohima Municipal Council
LAHDC	Ladakh Hill Development Council
LC	Least Concern
LiFE	Living for Environment
LRC	Ladakh Regional Center
MCL	Municipal Committee of <i>Leh</i>
MDF	Moderately Dense Forest
MINARS	Monitoring of Indian National Aquatic Resources
MLD	megalitres per day
MNP	Mangan Nagar Panchayat
MoEFCC	Ministry of Environment, Forests and Climate Change
MSPCB	Mizoram State Pollution Control Board
MSW	Municipal solid waste
MSWM	Municipal solid waste management
MTB	Mountain Biking Himalaya
N	Nitrate
NAAQ	National Ambient Air Quality
NAMP	National Air Monitoring Programme
NASA_RTI	National Aeronautics and Space Administration_Research Test and Integration
NCAER	National Council of Applied Economic Research
NEERI	National Environmental Engineering Research Institute
NERC	North East Regional Center
NGT	National Green Tribunal

NITI Aayog	National Institution for Transforming India Aayog
NMC	Namchi Municipal Council
NO ₂	Nitrogen Dioxide
NPCB	Nagaland Pollution Control Board
NWMP	National Water Quality Monitoring Programme
OF	Open Forest
PAN	Protected Area Network
PAP	Protected Area Permit
PM ₁₀	Particulate Matter with with a diameter of 10 microns or less
PM _{2.5}	Particulate Matter with with a diameter of 2.5 micrometers or less
PPP	Public-Private Partnerships
q	quintals
R	Rare
RDF	Refuse Derived Fuel
RDS	Respirable Dust Sampler
RET	Rare, Endangered and Threatened
RIMS	Regional Institute of Medical Sciences
RNP	Rangpo Nagar Panchayat
RRC	Resource Recovery Centers
RSPM	Respirable Suspended Particulate Matter
SEIAA	State Environment Impact Assessment Authority
SNP	Singtam Nagar Panchayat
SO ₂	Sulphur dioxide
SPCB	State Pollution Control Board
SRC	Sikkim Regional Center
SSF	Seven security force
STDC	Sikkim Tourism Development Corporation
SWM	Solid Waste Management
T.D.S.	Total Dissolved Solids
TC	Total Coliform
TDP	ton per day
TPD	Tonnes Per Day
TPSS	Tsomgo Pokhri Sanrakshan Samiti
ULBs	Urban local bodies
UTs	Union territory
VDF	Very Dense Forest
VOC	Volatile organic compounds
VU	Vulnerable
WII, ENVIS	Wildlife Institute of India, Environmental Information System network
WUM	Workers' union Manipu

List of tables

Description	Page No.
Table 1.1: Share of revenue generated by domestic and foreign tourists	4
Table 1.2: Revenue (in Rs) generated from visitors to Wildlife Protected Areas of Leh District	5
Table 1.3: Solid waste generated and treated in urban and rural area of Leh, Ladakh UT.	7
Table 1.4: Urban biodegradable or non-bio-degradable waste generated and treated (in Quintals) month wise in Leh Municipal Committee (MCL), Leh, Ladakh.	7
Table 1.5: Rural non-biodegradable waste generated and segregated (in Quintals) in the Leh district (07 sites) of Ladakh	8
Table 1.6: Urban waste utilization (in Quintals) in Leh District from June 2021 to April 2022	10
Table 1.7: Rural waste utilization (in Quintals) in Leh district from April 2021 to Feb 2022	10
Table 1.8: Air quality monitoring at Leh District during 2019 & 2020	11
Table 1.9: Air quality parameter for Leh town based on the NASA_RTI monitoring station	12
Table 2.1: Municipal Solid Waste generated, collected and treated in Jammu & Kashmir (UT)	21
Table 2.2: Year wise Municipal Solid Waste generated, processed and recycled in Jammu Municipal Corporation, J&K from 2017-2022	21
Table 2.3: Month wise and Year wise Municipal Solid Waste generated in Srinagar Municipal Corporation, J&K from 2019-2022	21
Table 2.4: Estimation (Kg/day) of Municipal solid waste (MSW) generation at representative sites of Pahalgam during 2011 Yatra Season.	23
Table 2.5: Municipal waste disposal/treatment facilities in the State	24
Table 2.6: Air quality monitoring. District: Jammu	24
Table 2.7: Air quality monitoring. District: Pulwama and Srinagar	25
Table 2.8: PM ₁₀ (µg/m ³) monitoring at important tourist locations (Year 2021 and 2022)	26
Table 2.9: General statistics of the physical parameters for various lakes and rivers of Jammu & Kashmir	28
Table 2.10: Forest cover of Jammu & Kashmir UT	30
Table 2.11: Summary of the species reported from Jammu & Kashmir on GBIF and threatened species as per IUCN assessment	30

Table 2.12: Details on the Protected areas of Jammu & Kashmir UT (Web reference).	31
Table 3.1: District wise registered Hotels, Homestays, Guides, Travel Agency, Adventurers and photographer registered with Himachal Pradesh Tourism Department	36
Table 3.2: Municipal waste generated (in Tons Per Day TDP) in important tourist destinations	41
Table 3.3: Details of waste processing for and Waste disposal/treatment facilities for important tourist destinations (2017-2021)	43
Table 3.4: Action Plan of Himachal Govt. in compliance with NGT order for air pollution	49
Table 4.1: Plans/ tree having the potential to reduce gaseous and particulate matter contamination from the environment	69
Table 4.2: Faecal coliform (max count in MPN/100 mL) status in some of the glacier fed rivers of Uttarakhand	70
Table 4.3: Total Coliform (max count in MPN/100 mL) status in some of the glacier fed rivers of Uttarakhand	70
Table 4.4: Status of some of the water quality parameters in stretches of polluted rivers of UK	71
Table 5.1: Details of the non-tax revenue raised during the period 2013-14 to 2017-18 from Tourism sector (Rs. in crore)	80
Table 5.2: State-Wise solid waste generation in urban areas of IHR	81
Table 7.1: Total tourist arrival in Assam in different years	107
Table 7.2: Total Revenue earned across five tourist areas from tourist only	108
Table 7.3: Total number of Homestays and visitors to these Homestays across Assam (2012-2020)	108
Table 10.1: Ambient air quality in Imphal city of Manipur, India	160
Table 11.1: Quantity of waste received at Aizawl solid waste management centre (July 2020 -January, 2021)	170
Table 11.2: Types of waste disposed in Lunglei District of Mizoram state	171
Table 11.3 Ambient air quality in different cities of different districts in Mizoram, India	173
Table 12.1: Forest area of the state Tripura	183
Table 13.1: Number of vehicles tested for the compliance to substances emission standards	189

List of Figures

Description	Page No.
Fig..1: Indian States/Union Territories and hilly districts of some states in the Indian Himalayan Region	1
Fig. 1.1. Growth of tourism in Ladakh UT	3
Fig.. 1.2 Growth of tourism-related infrastructure in Ladakh UT	4
Fig.. 1.3: Revenue generated by the government as a direct fee from visitors (Inner Line Permit Mechanism - Red Cross, Wildlife, and Environment) in Leh District	5
Fig.. 1.4: Number of vehicles used in the tourism sector in Ladakh (A) Leh District, and (B) Kargil District	6
Fig.. 1.5: The waste generation and tourist flow during July 2021-December 2021 at Leh Urban town, Ladakh (UT).	8
Fig.. 1.6: Composition of solid waste collected during the cleanup drive (A) Percentage of waste collected along the <i>Markha</i> trek; (B) Composition of the miscellaneous waste.	9
Fig.. 1.7: (a) Establishment of solar power-based solid waste management plant: A new initiative by Ladakh (UT) , (b) Landfill area under construction near Solid Waste Management Plant Skampari, Leh	11
Fig.. 2.1: Contribution of domestic visitors and foreign nationals to the total tourists visiting Kashmir valley of J&K UT	17
Fig.. 2.2: Pilgrim Tourists in J&K UT	18
Fig.. 2.3: Pilgrim Tourism in two major destinations in J&K UT - (a) Shri Amarnath Holy Cave, and (b) Mata Vaishnav Devi	18
Fig.. 2.4: Growth of government and private accommodations in the tourism sector of J&K UT	19
Fig.. 2.5: Growth of hotels and restaurants in J&K UT	19
Fig.. 2.6: Growth of tourism-related transportation infrastructure in J&K UT	20
Fig.. 2.7: Total contribution of categorized Municipal Solid Waste generated at different sites at Pahalgam	22
Fig..3.1:(a) District wise tourist in flow in Himachal Pradesh (2011-2021) (b) Rate of change in domestic tourists in H.P from 2011 to 2021 (c) Rate of change in Foreign tourists in H.P from 2011 to 2021	35
Fig..3.2: (a) Growth rate in GSDP with current prices in H.P (b) Growth rate in GSDP in constant price in H.P (c) Tourist influx and growth rate with current price (d) Tourist influx and growth rate in GSDP at constant price in H.P from 2011-2020.	37
Fig..3.3: (a) Number of registered vehicles in H.P (District wise 2011-2020), (b) Rate of change in number of vehicles in H.P (2011-2020)	38
Fig..3.4: (a) Concentration of RSPM in different districts of Himachal Pradesh from 2010 to 2020	45

(b) Yearly Average concentration of RSPM and rate of Change of RSPM in Himachal Pradesh 2010 to 2020	
Fig.. 3.5: (a) Concentration of PM _{2.5} in different districts of Himachal Pradesh from 2018 to 2020, (b)Yearly Average concentration of PM _{2.5} and Rate of Change of PM _{2.5} in Himachal Pradesh from 2018-2020	46
Fig..3.6: (a) Concentration of NO ₂ in different districts of Himachal Pradesh from 2010 to 2020 (b) Yearly Average concentration of NO ₂ and rate of Change of NO ₂ in Himachal Pradesh from 2010-2020	46
Fig..3.7: (a) Concentration of SO ₂ in different districts of Himachal Pradesh from 2010 to 2020 (b) Yearly Average concentration and Rate of Change of SO ₂ in Himachal Pradesh from 2010-2020	47
Fig.. 3.8: (a) Concentration of O ₃ in different districts of Himachal Pradesh from 2018 to 2020 (b) Yearly Average concentration and rate of Change of O ₃ in Himachal Pradesh from 2018-2020	47
Fig.. 3.9: (a) Concentration of O ₃ at Mohal- Kullu Himachal Pradesh from 2010 to 2015, (b) Concentration of O ₃ at Kothi, Manali Himachal Pradesh from 2016 to 2018 and at Mohal in 2020, (c) Yearly Average concentration and rate of Change of O ₃ in Kullu from 2010-2020	48
Fig..3.10: (a) Concentration of Black Carbon in Mohal-Kullu from 2009 to 2021, (b)Yearly Average concentration and rate of Change of BC in Mohal- Kullu from 2009-2021	49
Fig.. 3.11: Yearly average Concentration of Dissolved oxygen and rate of change in DO in different districts of H.P from 2011-2020	52
Fig.. 3.12: Yearly Average Concentration of BOD and rate of Change in BOD in different districts of H.P from 2011-2020	52
Fig.. 3.13: Yearly average total Coliform and rate of change in Coliform from 2011 to 2020	54
Fig.. 3.14: Number of species recorded from different dumping sites	56
Fig.. 4.1: Percentage change in tourist during 2011-2020	63
Fig.. 4.2: Variation in number of registered vehicle in different places of Uttarakhand during 2011-2021	64
Fig.. 4.3: Percentage vehicle types among all the vehicles in Uttarakhand during 2011-2015	64
Fig.. 4.4: Distrct wise status of waste generation in different years in Uttarakhand	65
Fig.. 4.5: Solid waste management bodies and segregation of wet and dry waste in some of the districts of Uttarakhand	65
Fig.. 4.6: Air pollutants distribution in Uttarakhand in different years	67
Fig.. 4.7: Air quality monitoring parameters in some of the cities of Uttarakhand	68
Fig.. 4.8: Forest cover of Uttarakhand in 2021	72
Fig.. 4.9: Changes in different type of forest cover during 2011-2021	72

Fig.. 4.10: Percent distribution of plant found in Uttarakhand classified under IUCN threat categories	73
Fig.. 5.1: Trends of tourists [(a)Domestic and (b) Foreign] flow in Sikkim	79
Fig.. 5.2:Trends of Air quality at selected sites in Sikkim	85
Fig.. 5.3: Flow of tourists in Khangchendzonga National Park (2011- 2021)	88
Fig.. 6.1: Trends of Domestic tourists inflow in Darjeeling town during 2010-2019	94
Fig.. 6.2: Trends of Foreign tourists inflow in Darjeeling town during 2010-2019	95
Fig.. 6.3: Monthly trend of domestic tourist arrivals in Darjeeling hills in 2012 to 2014	95
Fig.. 6.4: Monthly trend of foreign tourist arrivals in Darjeeling hills in 2005 to 2010	96
Fig.. 6.5: Trend of tourists inflow and revenue generated at Tiger hill, Darjeeling	97
Fig.. 6.6: Increasing flow of tourists in Singalila National Park in last 8 year	101
Fig.. 7.1: Number of registered vehicles in Halflong (2011-2020)	109
Fig..7.2: Month-wise registration of the vehicles in Dima Hasao and Karbi Anglong hill districts (2018-21)	110
Fig..7.3:Status of Ambient Air Quality in near Halflong area Dima Hasao district	112
Fig.. 7.4: (a&b) Primary forest loss and tree cover loss of Dima Hasao district.	113
Fig.. 7.5: (a&b) Primary forest loss and tree cover loss of Karbi Anglong district.	113
Fig.. 8.1: Arunachal Tourist Circuits Map	119
Fig.. 8.2: Domestic Tourist visited in Arunachal Pradesh (Jan-Dec) during the period 2011-21	119
Fig.. 8.3: International Tourist visited Arunachal Pradesh during the Year 2011-21.	120
Fig..8.4: Yearly Tourist inflow to different district of Arunachal Pradesh (2011-2021).	120
Fig..8.5: Yearly Tourist inflow to different district of Arunachal Pradesh (2011-2021).	121
Fig..8.6a: Town wise Municipal waste generated and collected (2011-12 to 2014-15).	123
Fig. 8.6b: Town wise Municipal waste generated and segregated (2015-16 to 2020-21)	124
Fig..8.7: PM ₁₀ in Itanagar (Jan-Dec) during the period (2016-21)	126
Fig..8.8: SO ₂ in Itanagar (Jan-Dec) during the period (2016-21)	126
Fig..8.9: NO ₂ in Itanagar (Jan-Dec) during the period (2016-21)	126
Fig..8.10: PM ₁₀ in Naharlagun (Jan-Dec) during the period (2016-21)	127
Fig..8.11: SO ₂ in Naharlagun (Jan-Dec) during the period (2016-21)	127
Fig..8.12: NO ₂ in Naharlagun (Jan-Dec) during the period (2016-21)	127
Fig..8.13: Turbidity of water samples collected from different water bodies in Arunachal Pradesh.	129
Fig..8.14: TDS of water samples collected in different water bodies in Arunachal Pradesh	129
Fig..8.15: DO of water samples collected in different water bodies in Arunachal Pradesh	130
Fig.. 9.1: Annual trends in tourist inflow to Nagaland during 2011-2020	135
Fig.. 9.2: Trends in tourist inflow in Nagaland during Hornbill Festival (2011-2020) held annually from 1 st to 10 th December at Naga Heritage Village, Kisama	136
Fig.. 9.3: Number of Transport vehicles registered in Nagaland state during 2011-	137
Fig.. 9.4: Number of Non-Transport vehicles registered in Nagaland state during 2011-	137

2021

Fig.. 9.5: Number of Government vehicles registered in Nagaland during 2011-2021	137
Fig.. 9.6: Year-wise waste generation, collection and management of solid waste in Nagaland	141
Fig.. 9.7: Annual data of air quality in Dimapur and Kohima towns of Nagaland	142
Fig.. 9.8: Monthly data of RSPM (PM ₁₀) value in Dimapur, Nagaland	143
Fig.. 9.9: Monthly data of RSPM (PM ₁₀) value in Kohima, Nagaland	143
Fig.. 9.10: Physicochemical characteristics of Milak River in Mokokchung, Nagaland	146
Fig.. 9.11: Change in Very Dense Forests across different districts of Nagaland during 2011- 2021	149
Fig. 10.1: Tourist influx and revenue generation in Manipur state	153
Fig.. 10.2: Rate of change in tourist arrival and revenue generation in Manipur	154
Fig. 10.3: Total number of registered motor vehicles across Manipur from the financial year 2007 to 2019	154
Fig. 10.4: Decadal rate of change in municipal solid waste management in Imphal City	156
Fig. 10.5: Physical composition of Municipal Solid Waste in Imphal city	158
Fig. 11.1: Tourist influx and revenue generation in Mizoram state	165
Fig.. 11.2: Rate of change in tourist arrival and revenue generation in Mizoram	166
Fig.. 11.3: Total number of registered motor vehicles across Mizoram state from financial year 2007 to 2021	167
Fig.. 11.4: District wise registered vehicles in Mizoram as on 31 March 2022.	167
11.5: Status of waste growth under different categories over the years w.r.t. to population growth.	170
Fig. 12.1: Tourist Influx and revenue generation in Tripura state	178
Fig. 12.2: Rate of change in tourist influx and revenue generation in Tripura	178
Fig. 12.3: Total vehicle registered in a decade in Triupura state	179
Fig. 12.4: Solid waste generation/collection/treatment and land filled in Tripura	180
Fig. 12.5: Impact on air quality of Tripura state	181
Fig. 12.6: Impact on ground water quality in Tripura state	182
Fig. 13.1: The graph showing the year-on-year growth of tourist influx in Meghalaya	188
Fig. 13.2: Number of vehicles registered in Meghalaya for the time span 2014-17.	189
Fig. 13.3: The assessment of the total municipal waste generated in tones per day in Meghalaya	190
Fig. 13.4: Hazardous waste inventory in Meghalaya.	191
Fig. 13.5: Average air quality parameter in Meghalaya	192
Fig. 13.6: Groundwater Quality Monitoring 2010-18	194
Fig. 13.7: District wise surface water quality for 2012-2018 in Meghalaya	195

Preface

In a recent decade of the United Nations sustainability (2030), tourism is considered to be as the fastest growing industry in the world. It might have significant impact on foreign exchange and employment. While being closely linked to social, economic, and environmental well-being of the country, tourism has the potential to contribute, directly or indirectly, to all of the goals, in particular, Goals 8, 12 and 14. The Himalayan region is known for its unique ecosystem, serene beauty and its tranquility have been attracting tourists for decades with a wide range of human interests. Due to infinite exploring options in the Himalaya throughout the years, tourism sector is going to be pushed to newer dimensions. It may cover everything from adventurous, recreational, health fitness, ecotourism, or many more. Tourism in the Himalaya not only affects the ecology, but also affects the local people's quality of life, and their overall well-being. In recent years, sustainable tourism has emerged in response to lessening impacts of mass tourism on the Himalayan environment and boosting its socio-economic success. In context of the sustainable tourism development, number of extremely hit fragile regions within the Himalayan complex have been designated as eco-sensitive zones in order to encourage eco-friendly activities. Safeguarding the Himalayan delicate ecology and unique character along with tourism development has to maintain long-term viability and growth. In this regard, Hon'ble National Green Tribunal has considered the matters relating to environmental safeguards in some of the Eco-Sensitive Zones/area, including some of the areas in the Himalayan region. 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 study and update studies relating to 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 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 for action plans to prohibit and regulate activities adversely affecting the environment. In the same framework, the whole report is prepared in view of its geographical expansion starting from north-western to the north-eastern Himalayan region. We hope that the report would be able to respond the quarries made in the Hon'ble NGT order and fill up some of the gaps in existing knowledge of the Himalayan tourism. The would also be able to suggest a way forward for sustainable or responsible tourism in the Himalaya usually known by its nature- topographically fragile and ecologically delicate.

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

Executive summary

The Indian Himalayan Region (IHR) is well known for its snow-capped peaks, scenic beauty, subalpine and alpine pastures, beautiful landscapes, rich biodiversity, and cultural diversity and attracts domestic and international tourists, pilgrims, trekkers and mountaineers from different corners of the world. The Himalayan ecosystem not only provide a variety of ecosystem services to the individuals but also has a strategic location and works as a guard to the whole nation. While mentioning about Tourism, in particular, it has an ample potential for economic growth, local employment, livelihood and income to the mountain residents, and has been a source revenue generation to different states/UTs. Accelerated growth of tourism in some of the pockets of the IHR in the past few years had substantial impact on its economy, local community and environment. The tourism industry sometimes has served an important industry in economic development of people in the IHR. At the same time, it is realised that due to mass tourism in certain pockets of the IHR, environmental degradation was also viewed in respect to increase in tourist inflow, waste generation, plying vehicles, etc. These impacts all together have increased waste disposal load alongside valleys and sometimes along rivers in absence of adequate land under valley topography in the mountains. This has caused degradation of land, soil, water, air quality and others over a period of time.

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

Tourism in the IHR has shown a persistent upward trend over many decades except during pandemic situation in 2020-21. In case of tourist's arrival in Uttarakhand, it ranked second after West Bengal state (29305017 tourists in 2020) with overall inflow with 26,070,907 in 2011 which increased up to 70,46,603 tourists in 2020. The pilgrim tourists within a state at Char Dhams were estimated to be 34,77,957 in 2019 which dropped sharply to 157 tourists in 2020 due to COVID-19. Uttarakhand was followed by Himachal Pradesh with 149,90,444 visitors in 2011 which increased sharply to 172,12,107 visitors in 2019. Here, maximum tourist flow was found in Kullu and Shimla districts. In Jammu & Kashmir, more than 11 lakhs (2011 - 2020) pilgrim tourists to Mata Vaishnav Devi Shrine were higher than the total tourists visiting the Kashmir valley. In case of North-Eastern Himalayan region, Assam state stood first in terms of tourist arrival and had witnessed continuous growth from about 43,55,885 in 2011 to about 54,74,683 in 2019. Sikkim being a centre of more recreational tourists recorded

overall from 5,76,055 (2011) to 15,55,211 (2019) tourists in spite of having geographically a small state.

With the ever increasing number of tourist arrivals, tourism in the Himalayan ecosystem could be developed and managed sustainably. Tourism may contribute in achieving the Sustainable Development Goals (SDGs) mainly SDGs 8 (Decent work and economic growth) and SDGs 12 (Responsible consumption and production). With the increase in tourist flow, it becomes important to assess the increasing demand on the part of its supply side. In view of the revenue receipts in the western Himalayan States, Ladakh- received more than Rs 90 million in a year. While Himachal Pradesh contributes 7% in SGDP (2020-2021). In case of the Central Himalaya, Uttarakhand state contributed 50% of the total GSDP from 2006-07 to 2016-17. While north-eastern states like Assam stood first amongst all the NER states. It was followed by Sikkim as a second highest contribution about 7.68 % GSDP in tourism sector. On the other hand, Nagaland state recorded the lowest income from tourist industry. Among all the IHR states, Sikkim accounts for the highest investment in the tourism sector, i.e., 1.9% of the total state expenditure. While all other IHR states invest less than 1% of the total expenditure. Sikkim has low fiscal deficit of Rs. 6 billion for 2016-17.

Due to COVID-19 pandemic, tourism industry has been hit tremendously. For example, Assam had a loss of around Rs. 1000 crore in the month of December and January alone (The times of India, 31st December 2019) among the NER states. Similarly, tourism sector in Sikkim suffered a loss of about Rs. 600 crore in the year 2020. The other NER states like Arunachal Pradesh, Nagaland, Mizoram, and Manipur would take some more time to be benefited from the current "Go East Policy" of the central government and then is likely to contribute to GSDP through tourism.

The developmental trends and activities in the IHR have a direct or indirect cause and effect relationship with the environment, economy and society. Environmental impacts such as pollution (land, soil, air, water, biodiversity loss, etc.), exploitation of natural resources, sprawling urbanization, traffic congestion, loss of indigenous culture, food insecurity, and so on have been noticed due to mass tourism and its seasonality. It is endorsed that waste management has been a big challenge in the IHR and would continue to more threatening as the number of tourists grow within decades.

Managing tourism within available civic amenities and infrastructural carrying capacity within threshold limit have been a challenging task. For example, Ladakh is a water deficit area. It is mostly dependent on snow/glacial melt and flow of River Indus. Here, average use of water by a local resident is 75 L/day, whereas a tourist consumes about 100 L/day.

According to the data from the Ministry of New and Renewable Energy, Government of India (2018), urban areas of eleven states of the IHR generate a total of 6346 MT solid waste per day and this leads to 23.16 Lakh MT of solid waste per annum. In other words, this is 4.35% of the national average of 531.53 Lakh MT. Jammu and Kashmir (1792 MT/day) generates highest amount of solid waste followed

by Uttarakhand 1528 tonnes per day (TPD), Assam 1134 MT/D, and Himachal Pradesh 370 TPD waste. Sikkim is one of the least producers of urban solid waste, which amounts to be 89 MT/D. As such there could not be available a specific report regarding segregating the household waste at source. This is one of the major challenges where the concerned authority needs to take appropriate measures for segregation of waste at source. Upon recycling and reusing waste, Ladakh has generated revenue worth of Rs. 14,60,617.00 after sale to Jammu and Kashmir. Monitoring of air and water quality parameters is limited to a few stations in the IHR, e.g., PM10 observations are available (2018 and 2019) for Srinagar City in Kashmir region.

With the mass-tourism scenario, social and economic development in the IHR is increasingly challenging. Even states with best practices in tourism like Sikkim are at risk from the negative effects of mass tourism regarding deforestation. Its repercussions do not mention the destruction of forest cover. According to FSI, 2021 report, major loss in forest cover was noticed in the North Eastern states of Arunachal Pradesh (257 km²), followed by Manipur (249 km²), Nagaland (235 km²), Mizoram (186 km²) and Meghalaya (73 km²). Although this deforestation may largely be attributed to shifting cultivation, felling trees, anthropogenic pressure, natural calamities and developmental activities. Yet, responsible tourism anyway has to take care of this aspect, too.

Some of the study pertaining gaps are also identified which include environmental problems like solid waste management, water consumption crises (tourist demand and supply), non-availability of continuous data pertaining to air and water quality of the tourists places and eco-sensitive zones, inadequate assessment of forest cover and biodiversity losses and socio-economic issues (including contribution of tourist revenue to state economy, tourist carrying capacity, data deficiency on visitors and vehicle inflow, data absence on tour guides and awareness).

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

Introduction

The Indian Himalayan Region (IHR) spread across 2 Union Territories and 11 Indian States. These geographically from north-west to north-east direction are, namely, Ladakh (UT), Jammu and Kashmir (UT), Uttarakhand, Himachal Pradesh, Sikkim, West Bengal Hills, Assam Hills, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, and Meghalaya (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 hill region, which is characterized by a diverse demographic, and versatile economic, environmental, social and political system. Entire IHR is a paradise for tourists. The IHR, has experienced a continued tourism growth and increasing diversification over the last few decades to become one of the fastest growing economic sectors of India. At the same time, specific negative impacts in some of the areas are linked to the current form of tourism in the IHR. These include inadequate solid waste management, air pollution, degradation of watersheds and water sources, and the loss of natural resources, biodiversity, ecosystem services, etc. If proper management aspects toward this side is also paid, long-term tourism development prospects could be made far better in the IHR.

Thus, the entire area provides a diverse range of prospects for modern tourists, ranging from distinct cultural attractions, trekking, skiing, and more daring resorts of tourism. Rafting, kayaking, rock climbing, mountain biking, bungee jumping, paragliding, and other modern (western) trend sports in recent years have been popular in the Himalayan region. In the Himalaya, mass tourism has had a significant impact on the ecology, economy and society. Today, Himalaya has been a centre of attraction and an object of reverence to a global community.

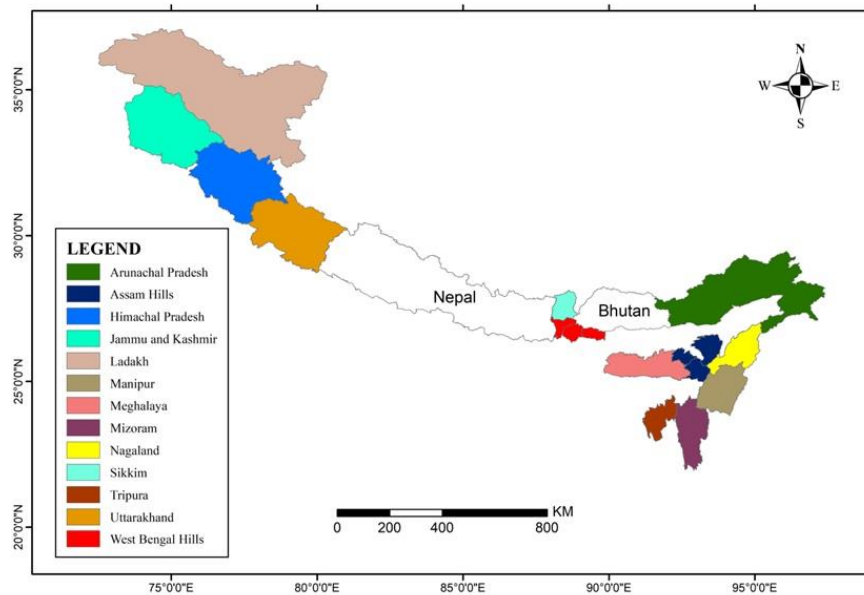


Fig. 1: Indian States/Union Territories and hilly districts of some states in the Indian Himalayan Region

Among all states, the highest number of tourists is reported from West Bengal (39,260,173) followed by Uttarakhand (24,951,541), Himachal Pradesh (16,042,225), Jammu & Kashmir (11,616,180), Assam (4,790,361), Meghalaya (708,048), Sikkim (624,925), Tripura (378,524), Arunachal Pradesh (279,123), Manipur (136,130), Mizoram (65,705), and Nagaland (46,658) (NITI Ayog, 2018).

With upward trends in tourist numbers in the IHR, it is assumed that environmental and social systems will be subjected to change. Apparently, these developmental impacts in the IHR have, direct or indirect, bearing on the Himalayan ecosystem such as sprawling urbanization, traffic congestion, pollution, exploitation of natural resources, loss of indigenous culture, and so on. In the IHR, there are 15 national parks and 59 sanctuaries covering 9.6% of the geographical area within the Protected Areas (PA) network of India (Rawal and Dhar, 2015). Eco sensitive zones (ESZ's) also known as Ecologically Fragile Areas (EFA's) are the areas notified by the MoEFCC around Protected Areas, National Parks and Wildlife Sanctuaries. These ESZ's act as transition zones between highly protected areas and low protection areas. The purpose of declaring ESZ's is to create some kind of a harbourage to the protected areas and sensitive corridors by regulating and managing the activities around such ecologically important patches. Peripheries of the protected area network are often vital ecological corridor links and need to be protected to prevent isolation of fragments of biodiversity which will not survive in the long run. Therefore, all the identified areas around Protected Areas and wildlife corridors are to be declared as ecologically fragile under the Environment (Protection) Act, 1986 (National Wildlife Action Plan, 2002-2016).

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

Therefore, the present report is focused on the current status of tourism, its impact on environment and an attempt to analyse whether 'Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic'. It is a part of an important activity given by Hon'ble National Green Tribunal (NGT), Principal Branch, New Delhi to 'Govind Ballabh Pant National Institute of Himalayan Environment' (GBNIHE). State wise profile of the 13 IHR states/UTs are described illustrating general scenario of tourism, tourism growth vis-a-vis economic growth, transport and tourism, ill-effects of tourism particularly on environmental components, waste generation, waste segregation, utilization of waste, tourism impact on air, water and biodiversity, eco-sensitive zones and specific gaps and state specific recommendation for developing sustainable tourism in the Himalayan Region.

Ladakh

1.1. Introduction

Ladakh became a union territory on 31 October 2019 after the reconstitution of the erstwhile Jammu and Kashmir state as separate entities (two UTs). The high-altitude region of Ladakh UT is predominantly described as arid, ecologically fragile, and culturally rich. Ladakh, which attracts both domestic and foreign tourists, is being emerged as an important global tourist destination comprising various tourist spots, viz., *Pangong Tso lake, Nubra and Siachen Valley, Kargil, Drass*, the world's highest motorable road (*Umlingla Pass*, 19,024 feet), along with some of the most popular monasteries, such as *Hemis, Alchi, Lamayuru, Shey and Thiksay*. However, due to rapid anthropogenic pressure on account of increases in urban populations, enormous seasonal tourist inflows, ever-increasing hospitality industry operations and an influx of a huge migratory labour force during the summer season, these generate huge amounts of waste.

In Ladakh prime attractions are physical (landscape, wildlife, lakes, adventure, winter sports, etc.) and socio-cultural environments (monasteries, heritage sites, etc.). In 1974, when the area was opened for tourists, nearly 527 visitors travelled to the Ladakh region and most of them were foreign travellers (500 in number) while domestic visitors were only 27. This trend continued till 2008 when the number of domestic tourists surpassed the number of international visitors. Since 2010, Ladakh is witnessing a several-fold increase in the number of tourists and reached above 3,00,000 persons in 2021. Data on domestic visitors are not available for 1982-1984.

In 2011, 2.3 times more volume of total tourists was observed in Ladakh, while for domestic visitors this growth was 2.5 times greater than in 2009 & 2010 and the increasing trend continues upto 2021 (Fig.. 1.1). A big quantum of tourist inflow accelerated infrastructure growth in the private sector, as reflected by the number of hotels, guesthouses, and homestays (Fig.. 1.2). Out of the total 1169 establishments, maximum are guesthouses (59%), followed by hotels (25%), and homestays (16%).

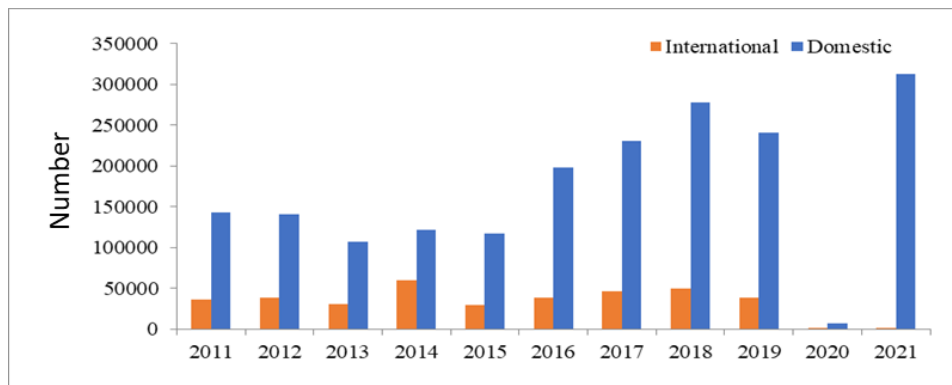


Fig.. 1.1. Growth of tourism in Ladakh UT (Source: Directorate of Tourism, Ladakh UT)

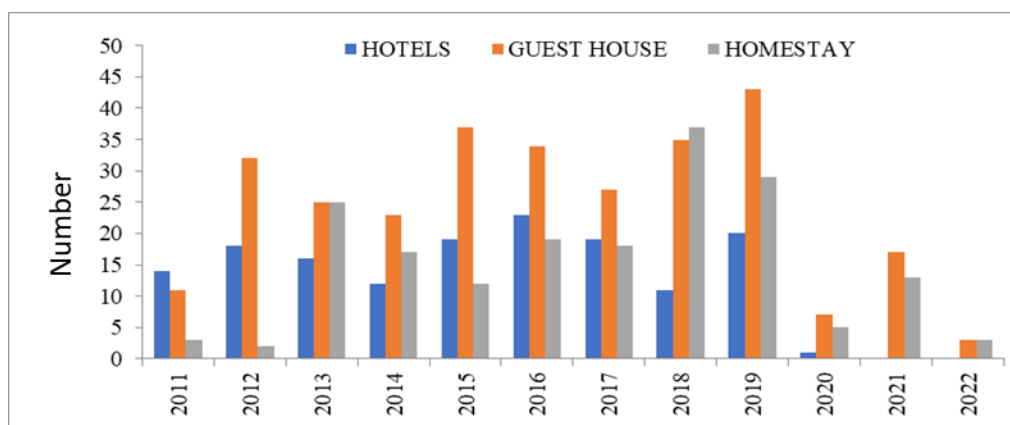


Fig.. 1.2 Growth of tourism-related infrastructure in Ladakh UT (*Source: Directorate of Tourism, Ladakh UT*)

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

The government is also receiving direct revenue as (entry fee which includes Environment Fee, Red Cross Donation, and Wildlife Protection Fee) from the visitors for Inner Line Permit/Protected Area Permit (Fig..1.3) which has been reached above Rs 90 million in a year, i.e., 2021. Majority of this revenue comes from domestic visitors (Table 1.1.). Ladakh landscape also attracts movie makers (wildlife or other) hence is also a source of revenue (entry/filming fee) for the Department of Wildlife Protection (Ladakh UT). Visitors to *Hemis National Park* and Wildlife Sanctuaries in the Leh district provided more than Rs 1 Crore in the years of mass tourist inflow to Ladakh UT (Table 1.2). Number of people who visited *Changthang Cold Desert Sanctuary* ranged from 2543 to 22,879 between 2014 and 2016 while for *Karakoram Sanctuary* it ranged from 11066 to 13088 in the same years.

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

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

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

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

Source: Department of Wildlife Protection, Leh

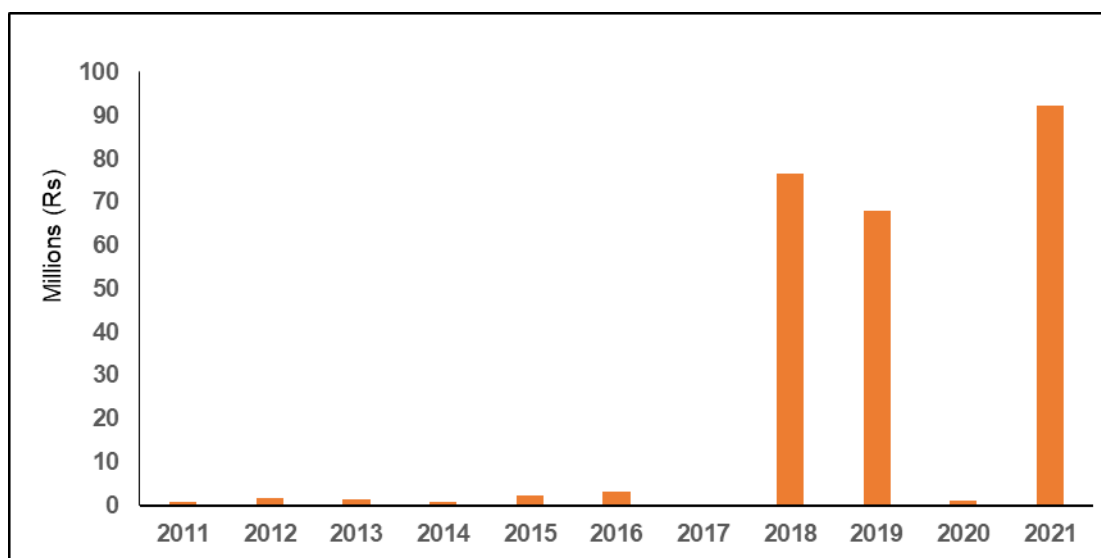


Fig.. 1.3: Revenue generated by the government as a direct fee from visitors (Inner Line Permit Mechanism - Red Cross, Wildlife, and Environment) in Leh District (*Source: Office of Deputy Commissioner, Leh, and Department of Wildlife Protection, Leh*)

Such vogue for far destinations is supported by the transportation sector which is apparent from the number of vehicles (tourism-related activities) registered. Till 2017-2018, induction of new taxis was growing in Leh district but a self-restriction was imposed to avoid cut-throat competition, hence no growth of taxis is visible in Leh district (Fig.. 1.4 A), however, this was not the case in Kargil district (Fig.. 1.4 B). A new trend of motor-biking in high altitudes has surfaced as solo or group riding in two-wheelers. Group tourism has also contributed to the growth of mini-buses in Ladakh. Despite of self-imposed restrictions on the induction of new taxis, inter-/ intra-regional conflicts have been arising within the Ladakh UT or neighbouring states (see web reference, 1-3). Other than motorable destinations of Ladakh, trekking routes also attract visitors including global tourists but visitors are concentrated on a few popular trails. Associated problems with trekking include wastes disposed of at dumping sites along trails, and most of them are informal solid waste dumping sites near campsites for overnight stops. *Chadar trek* (on frozen Zaskar river), *Markha Trek*, *Stok Kangri* expedition, were few popular routes. The highest mountain in the Stok range in Ladakh is *Stok Kangri* (6,154 m asl), and is located within the *Hemis National Park*. Expedition to the peak has been banned due to the negative

impact of trekking groups on natural resources, particularly water (webreferences,4-6). Growing human population coupled with a high tourist influx and tourism-related infrastructure has attributed to several management issues, e.g., generation of waste, conversion of productive land, parking area, water availability and pollution, energy needs, threats to wildlife and habitats, etc. The tourism industry is susceptible to many factors such as CORONA 19 Pandemic, An unstable environment of the region etc.

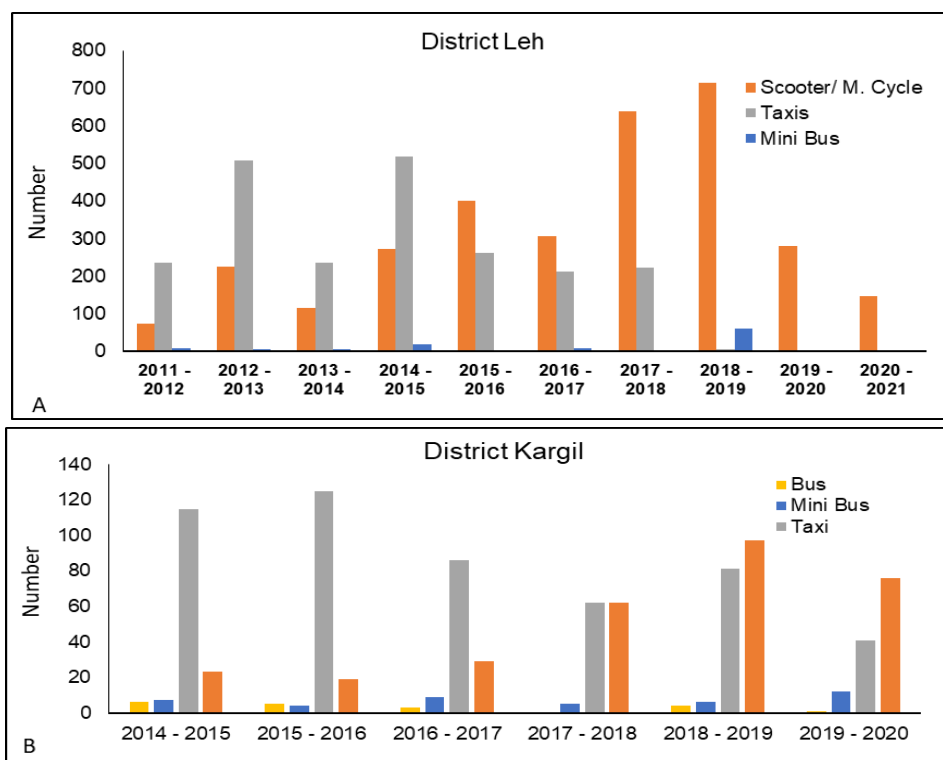


Fig.. 1.4: Number of vehicles used in the tourism sector in Ladakh (A) Leh District, and (B) Kargil District (*Source: Department of Transport*)

1.2. Assessment of waste generation

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

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

to Feb 22). Moreover, 752.18 qof non-biodegradable waste was sold (treated) for reusing and a total of 301.89 q was still left.

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

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

**Only non-bio-degradable waste*

Month-wise (June 21 to April 22) total waste (biodegradable and non-biodegradable) collection in Leh town is presented in Table 1.4. Maximum waste was generated in three months of tourist season (July 2021 to Sep 2021) which ranges from 3016 to 3883 q, while minimum waste was generated during three months of lean tourism period (Jan 22 to March 22; 739-888 q). A strong relationship ($r^2 = 0.92$; $p < 0.01$) was observed between waste generation (collected month wise) and number of tourists (monthly arrival in a year, June -December 2021) at Leh town (Fig.. 1.5).

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

Month	Total Waste generated (q)	Waste treated (q)	Untreated (q)
Jun-21	1740.06	34.6556	1705.4044
Jul-21	3016.3	352.6611	2663.6389
Aug-21	3741.68	77.1000	3664.5800
Sep-21	3882.96	153.5000	3729.4600
Oct-21	1427.05	159.7000	1267.3500
Nov-21	639.05	235.2000	403.8500
Dec-21	958.44	0.0000	958.4400
Jan-22	754.96	0.0000	754.96
Feb-22	738.63	0.0000	738.63
Mar-22	887.55	0.0000	887.55
Apr-22	3131.05	374.2000	2756.8500
Total	20917.73	1387.02	19530.71

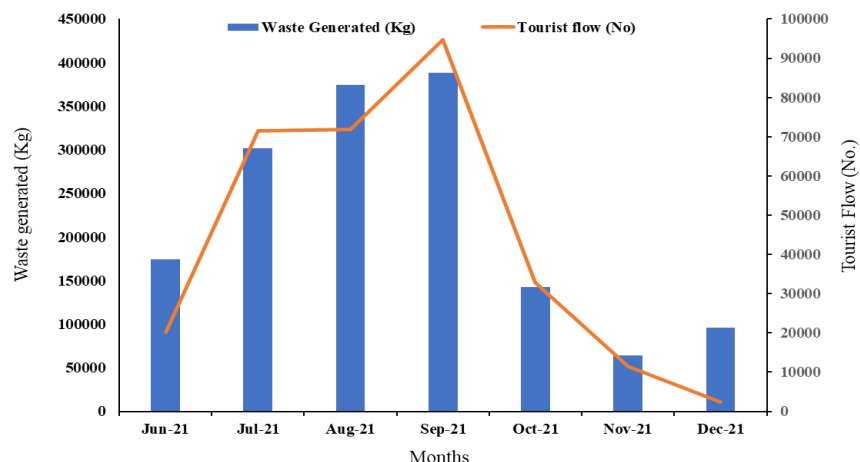


Fig.. 1.5: The waste generation and tourist flow during July 2021-December 2021 at Leh Urban town, Ladakh (UT).

Rural solid waste segregation (Project *Tsangda*, Leh district) indicates that total solid wastes generated (Apr-Dec, 2021) ranged from 57 q to 142.00 q and maximum was generated in the month of July (Table1. 5), which again co-inside with number of tourists. Following similar trend of urban waste, minimum waste in rural areas was generated in peak winter months of Dec 2021 (57.00 q) and January 2022 (63.57 q). Composition analysis indicates that paper waste (35.63%) and plastic waste (33.54%) are the major contributors to the total solid waste, followed by metal (7.42%) and rubber (4.89%).

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

Month	Paper Waste	Plastic waste	Metal	Glasses	Rubber	Other s	Total Waste
Apr-21	21.09	25.82	8.35	1.18	3.72	30.79	90.95
May-21	49.81	25.01	6.47	0.41	3.65	19.02	104.37
Jun-21	29.13	33.03	8.66	1.21	7.87	25.54	105.44
Jul-21	48.94	57.57	11.01	1.2	3.19	20.09	142.00
Aug-21	43.35	36.5	8.44	0.9	6.46	20.77	116.42
Sep-21	39.01	50.54	6.45	0.49	7.7	9.67	113.86
Oct-21	35.82	32.14	3.45	0.35	4.31	7.31	83.38
Nov-21	39.09	28.89	7.1	0.44	3.89	10.41	89.82
Dec-21	37.06	26.23	6.55	0.33	5.22	11.87	87.26
Jan-22	13.62	17.24	5.73	0.21	3.54	16.66	57.00
Feb-22	18.6	20.54	5.99	0.39	1.98	16.07	63.57
Total	375.52	353.51	78.2	7.11	51.53	188.2	1054.07

Source: Project *Tsangda* Leh, 2022

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

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

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

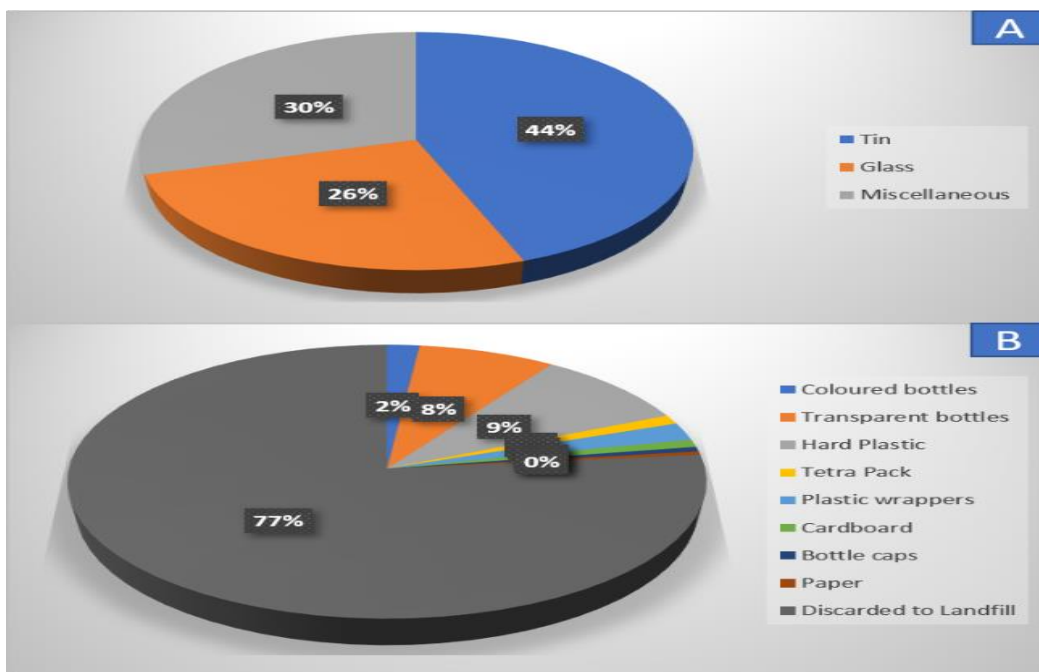


Fig.. 1.6: Composition of solid waste collected during the cleanup drive (A) Percentage of waste collected along the *Markha* trek; (B) Composition of the miscellaneous waste.

1.3. Segregation / Utilization of waste

Waste utilization means the utilization of waste that is separated and recovered in many ways such as reuse, transformation, energy use, fertilizer, alternative fuel, commerce, and other activities that are not disposed of. In Ladakh, still, as such the functional waste processing unit is not available.

Segregated wastes from urban and rural Leh are being transported to other states or UTs for reuse and recycle. As a result, some revenue is being generated to make the systems as a self-sustaining mode.

A total 1387 q solid waste from urban Leh was transported for sale (for recycling and reusing) to Jammu and Kashmir (UT) from June 2021 to April 2022 (Table 1.6), and a worth of Rs. 14,60,617.00 revenues were generated. This solid waste was comprised of paper (801 q), plastic waste (417 q), metal (63 q) and others (106 q). A total 752 q solid waste from rural Leh was transported to Jammu & Kashmir during April 21 to Feb 2022 for recycle and reuse (Table 1.7), and a worth of Rs. 3,35,436.00 revenues were generated by Project *Tsangda*. Among the transported wastes, maximum was contributed by paper (403 q) followed by plastic waste (289 q), metal (53 q), rubber (0.9 q) and others (7 q). Till Feb 2022, a total of 8027 q waste was unutilized (dumped) and ready for sale purposes at Project *Tsangda*, Leh Centre.

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

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

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

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

*Total unutilized waste from since 2017

1.4. Waste disposal/ treatment facilities

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

waste (food, etc.) is being standardized for making bio-compost. Moreover, constructing of Landfill area near Solid Waste Management Plant is being constructed by MCL (Fig..1.7 b).



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

1.5. Impact on 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 PM₁₀ monitoring has been initiated in Leh district in September 2019 which provides monthly record for summers. PM₁₀ monitoring in Ladakh during September-November 2019 and June-October 2020 reveals the values were ranging from 31 to 68 µg/m³. Notably the PM₁₀ values remained well within the NAAQ standard in all months except for October 2021 (Table 1.8).

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

Year	2019	
Month	District	PM ₁₀ (µg/m ³)
September	Leh	36.46
October	Leh	31.08
November	Leh	33.77
	2020	
Month	District	PM ₁₀ (µg/m ³)
June	Leh	54.28
July	Leh	48.96
August	Leh	45.23
September	Leh	50.71
October	Leh	68.24

As per the information obtained from an Air Quality Monitoring Station maintained by NASA_RTI at Leh (https://aqicn.org/station/india/leh/nasa_aqcs_119), PM₁₀ values ranges between 7 and 112 during the period of March 2021 to May 2022. Similarly, values for PM_{1.0} ranges between 3 and 57 whereas, values for PM_{2.5} ranges between 5 and 93 during the same period. Air quality for most of the months was within permissible limits as per the standards of Central Pollution Control Board (CPCB) expect for the month of March, April, August and December 2021 (Table 1.9).

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

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

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

1.5. Impact on water quality/ground water

Ladakh (UT) has two districts: Kargil and Leh, and considering Nubra as geographically distinct region in the Leh district, a separate assessment is given (viz., Kargil, Leh and Nubra). Since 2018, water quality in Ladakh is been monitored for Hand-pumps and springs during warmer months (March to November). As per Indian Standard (IS: 10500: 2012), the acceptable quality of T.D.S. in drinking water is 500 mg/L in ideal cases and 2000 mg/L in the absence of alternate source. The monthly average values show that the T.D.S. ranges from 0 to 348 mg/L, and no observation in any district/region and in any month has ever exceeded the prescribed limit. The acceptable limit of Chloride in drinking water is 250 mg/L in normal cases and 2000 mg/L in the absence of alternate source. All the observed values of chloride were within 250 mg/L except for two individual incidences when slightly high values of 5000 mg/L were observed in Leh during July 2019. The maximum permissible limit of Iron in drinking water is 0.3 mg/L and no relaxation is granted even if alternate source is not available. Most of the recorded values for iron were within the acceptable limit. Only one individual observation in Leh (April, 2018; 0.5 mg/L) exceeded the prescribed criteria. Moreover, Coliform Bacteria was found to be entirely absent from the water in all the years and in all the districts/region of Ladakh (UT).

As per the report on water in Liveable Leh (Gohel et al. 2019) per person average water demand in Leh is 135litres per day (L/day) with a total demand of 5.0 megalitres per day (MLD) in summers and 1.55 MLD in winters. However, the required demand as per Central Public Health and Environmental Engineering Organisation (CPHEEO) is 12.66 MLD in summers and 4.17 MLD in winters as per the population level in Leh town. Among the different users, tourists in Leh uses approximately 100L water per day whereas local resident uses 75L/day and migrant workers use 30L/day. Water supply in Leh (Gohel et al. 2019) is supplied through borewells owned by Public Health Engineering Department (63%), natural springs (8%) and private borewells (29%). As per the information on National Jal Jeevan Mission dashboard (<https://ejalshakti.gov.in/jjmreport/JJMState.aspx>), 13,843 households (32%) of the total population have been connected with tap water until May 2022 including 7854 households in Leh and 5989 households in Kargil district.

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

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

- **Para 7-** *".....It also comes to fore that establishment of restaurants/hotels/guest houses/home stays/ camps/resorts is on spree in District Leh, depleting ground water level because innumerable borewells and handpumps are at galore."*
- **Para 11-** *"Ladakh Region, it is germane to mention here, does not have rain water harvesting system and as a sequel whereof, groundwater level in Ladakh Region is depleting day by day. Consequently, it is bounden duty and responsibility of District Administration, Leh, that groundwater resources (aquifers) are protected from such activities that impact the equity of access and sustainability of the resource. All the precautionary measures and steps shall be taken by the District Administration, Leh, at all levels to protect groundwater from depletion, deterioration, biological and chemical pollution as well as to prevent and/or reduce adverse impacts on the environment. Effective schemes and measures are to be formulated and implemented to conserve, replenish, recharge and manage groundwater in an equitable and sustainable manner. Any use of groundwater, surface water or land and forest resources or activity in relation to these resources, which are likely to have significant negative impacts on natural sources as also to local sources of groundwater shall be sternly prevented and all protective, preventive and precautionary measures in this regard shall be set in*

motion by District Administration of Leh. This apart, Public Health Engineering, Leh, shall ensure that potable water is provided to the colonies/habitations, in discharge of their public obligation and while doing so it shall inhibit illegal extraction of groundwater."

1.6. Impact on Forest and Biodiversity

Ladakh landscape is characterised by rugged mountains interspersed with lakes, wetlands and river basins, resulting in a wide variety of habitats with unique and diverse species of plants and animals. The forest cover in Leh and Kargil districts of Ladakh UT was 129 km² in 2011 which increased to 138 km² in 2017 accounting for a 6.5% increase in the forest cover during seven years. This includes 15 km² of moderate forest and 123 km² of open forest. However, information on forest types is not available for Leh and Kargil districts of Ladakh UT. Major reasons for the increase in the forest cover include afforestation activities carried out by the State Forest Department, conservation efforts by the concerned agencies and improvements in the methodology of FSI.

A recent checklist on birds of Ladakh (Sharma et al. 2021) includes 378 species of birds out of which 27 were reported first time from Ladakh. Being located on Asian Flyway, Ladakh hosts a variety of migratory birds and their breeding grounds, thus making Ladakh and its Wetlands an important area to maintain global bird diversity, e.g., the only known breeding site in India for Black-necked crane (*Grus nigricollis*) and Bar-headed goose (*Anser indicus*) exists in Ladakh. Many wetlands are tourists' destinations (e.g., Tso Kar, Tso Morari) thus a close encounter may lead to disruption in the life cycle of migratory and other birds through habitat loss. 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 opened to tourism only recently, and therefore have few hotels and tourism infrastructures. A total of 665 wetlands have been documented in Ladakh region which constitutes a vast habitat for the migratory waterfowl and other birds (Nasim & Keng, 2012). Other taxonomic groups like reptiles, amphibians, fishes, insects etc. are represented by a few species in the region, and many of these are highly threatened with restricted to very limited habitats and their wild populations are under threat (Sharma, 2017).

About 43 species of mammals have been reported from Ladakh and most of them are placed in Scheduled Lists of animals in India, and in threat categories assessed by IUCN. Wildlife also attracts tourists in the area, and the most common organized tours around snow leopard or brown bear, however, enthusiastic bird watchers can be seen anywhere.

Vegetation is predominantly dry alpine steppe consisting of widely spaced shrubs or sub-shrubs, Juniper (*Juniperus* spp.) are culturally important for local communities in Ladakh and thus has traditionally been exploited very heavily resulting in a severe decline in the wild.

Ladakh is also rich in its medicinal plant wealth. A total of 397 medicinal plant species have been recorded for their use in pharmaceutical and nutraceutical industries as well as in traditional medicinal uses in the indigenous Sowa Rigpa medicine system (Gairola et al. 2014). Global Biodiversity

Information Facility (GBIF) has reported 2470 species from Ladakh among which 69 species have been placed under various threatened categories as per the assessments of the IUCN.

Protected Area Network 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.

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

- *"Many of our rivers arise from the lakes at higher altitudes in the Himalayan ranges. Qua Pangong Lake, also known as Pangong Tso, is a beautiful endorheic lake situated in the Himalayas, which falls within Changthang Cold Desert Wildlife Sanctuary. Pangong Lake is one of the biggest tourist attractions of the country. The beauty and allure of this lake attracts people from all over the country and beyond. Having said that, Pangong Lake requires preservation and conservation from being contaminated and polluted under the guise of developmental works, construction and erection of structures around the lake."*
- *"Perusal of report, produced by learned counsel for respondents, reveals that a slew of camps/restaurants/ structures has been set up illegally and are being operated along bank of Pangong Lake without any permission, generating constantly all type effluences and contaminants and as a consequence whereof posing serious threat to the very existence of the Pangong Lake, besides snuffing out ecologically fragile region as also wildlife."*
- *In view of above discourse, District Administration of Leh is directed to take well planned, sustainable and scientific efforts and steps to prevent degradation, or say ultimate death, of Pangong Lake. And for this purpose, District Administration will remove all structures around the Pangong Lake, including take up the matter with the authorities of Army to shift the structure(s) erected by Army, around the lake to any other place/area where it is found appropriate having regard to security scenario and given preservation of Lake as well. Not only this, a scheme/ policy is also important to be formulated by the State Government, if not already formulated, for preservation and conservation of Pangong Lake. District Administration of Leh shall also endeavour to save, protect and preserve the flora and fauna in and around Lake. Insofar as borewells and handpumps are concerned, District Administration shall seal all borewells and handpumps, which are operating illegally, unauthorizedly and without permission from the authority".*

1.7. Summary

Several segments of Ladakh Tourism are structured, regulated and well-advertised (e.g., defined tourist circuits, taxi fare and operation, homestays, accounting of tourist numbers and hotels, etc.) but some sectors require more attention. A mechanism exists to address issues of waste collection, segregation, and disposal from rural and urban areas but still miles to go, particularly on reducing the single use plastic and wider adoption of alternatives. Few of the most visited tourist spots (e.g., Hanley, Tso Morari, etc.) fall in the Sanctuary/National Park areas where new facilities to cater need of tourism sector are appearing but no mechanism exists for waste management and water treatment. Such places require immediate attention for planning and management, and role of Wildlife Department becomes important in regulating affairs within the sanctuary area.

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

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

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

Para 9 – *"In view of above discourse, District Administration of Leh is directed to take **well planned, sustainable and scientific efforts** and steps to prevent degradation, or say ultimate death, of Pangong Lake. And for this purpose, District Administration will remove all structures around the Pangong Lake, including take up the matter with the authorities of Army to shift the structure(s) erected by Army, around the lake to any other place/area where it is found appropriate having regard*

*to security scenario and given preservation of Lake as well. Not only this, a scheme/ policy is also important to be formulated by the State Government, if not already formulated, for preservation and conservation of Pangong Lake. District Administration of Leh shall also **endeavour to save, protect and preserve the flora and fauna in and around Lake**. Insofar as borewells and handpumps are concerned, District Administration shall seal all borewells and handpumps, which are operating illegally, unauthorizedly and without permission from the authority."*

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

Jammu & Kashmir UT

2.1. Introduction

Present Jammu and Kashmir UT became a union territory on 31 October 2019 after the reconstitution of the erstwhile Jammu and Kashmir State as two separate entities (J&K UT and Ladakh UT). Erstwhile Jammu & Kashmir State has been a popular destination for visitors as tourists to natural beauty (largely Kashmir region) and/or pilgrims to famous shrines (Shri Amarnath Ji holy cave which extends from Jammu region to Kashmir region, and Mata Vaishnav Devi in Jammu region). From 1951 to 1985 number of total tourists visiting to Kashmir Valley in the J&K state increased several fold from 10,000 to 5,03,620 persons. In an unstable environment due to political turmoil and terrorism crisis in the erstwhile state of J&K, Kashmir valley witnessed a substantial reduction in the number of visitors in the following years till 1997 but further growth was observed. Phase after year 2002 shows a tremendous tourist growth in the Kashmir Valley till the rise of the Pandemic Situation (2020-21). Five years in the last decade (2011-2020) witnessed more than 11 lakh visitors in a year.

However, the number of foreign tourists visiting the Kashmir valley in a year may range from 1,250 (1951) to 59,320 (1978) but the continuous substantial growth was after the year 2003 but their proportion to the total number of tourists remained below 5% due to surge of domestic tourists (Fig.. 2.1). Interestingly, in the turbulent years (1995-1997) number of foreign visitors was several-fold higher than the number of domestic tourists (320 *vs* 8200 in 1995; 370 *vs* 9590 in 1996; 7020 *vs* 9110 in 1997).

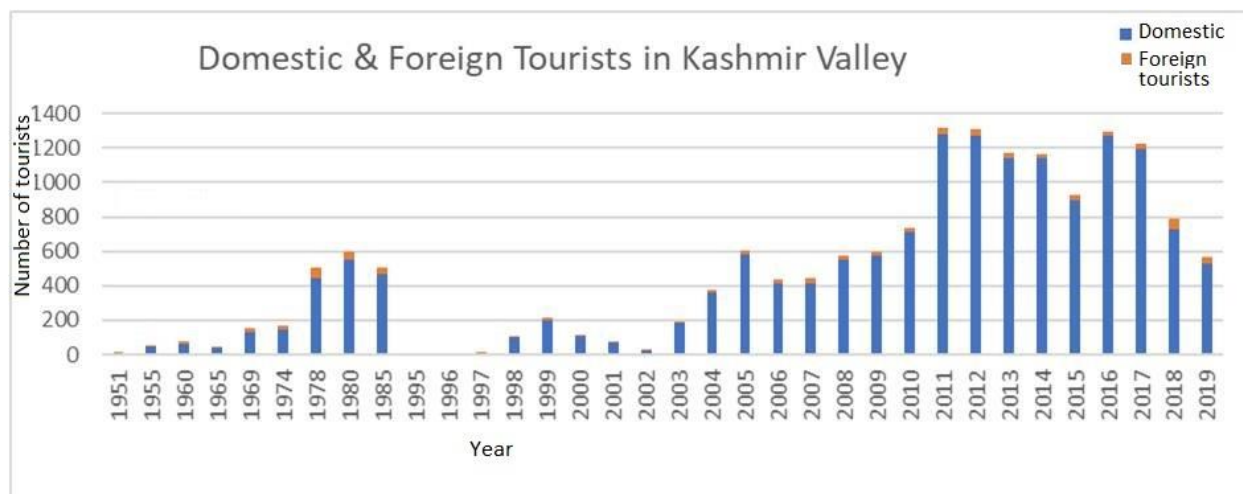


Fig.. 2.1 Contribution of domestic visitors and foreign nationals to the total tourists visiting Kashmir valley of J&K UT (*Source: Directorate of Tourism, J&K UT*).

Besides the tourists to Kashmir Valley, every year pilgrims visit the major shrines (Shri Amarnath Ji Holy Cave and Mata Vaishnav Devi) of J&K UT. Pilgrim tourism is much higher than that of other tourists, and the number of pilgrim tourists ranges from 2.2 lakh to 111.16 lakh in a year. Pilgrim tourists in a typical year were 2 to 29 times higher than the total tourists visiting Kashmir valley in a

year. The number (Fig.. 2.2) has increased several times from 1965 (2370 pilgrims) to 1,11,160 pilgrims in a year (2012)., and a majority of these visits to Mata Vaishnov Devi Shrine (93 to 98% of the total pilgrims in a year) (Fig.. 2.3). Due to its location in the outer part of the J&K UT, interestingly, in the turbulent years of the valley (1999-2002), pilgrim tourism did not stop or reduced (40.7 to 52.8 lakh pilgrims in a year) which can be attributed to the locational advantage of the shrine.

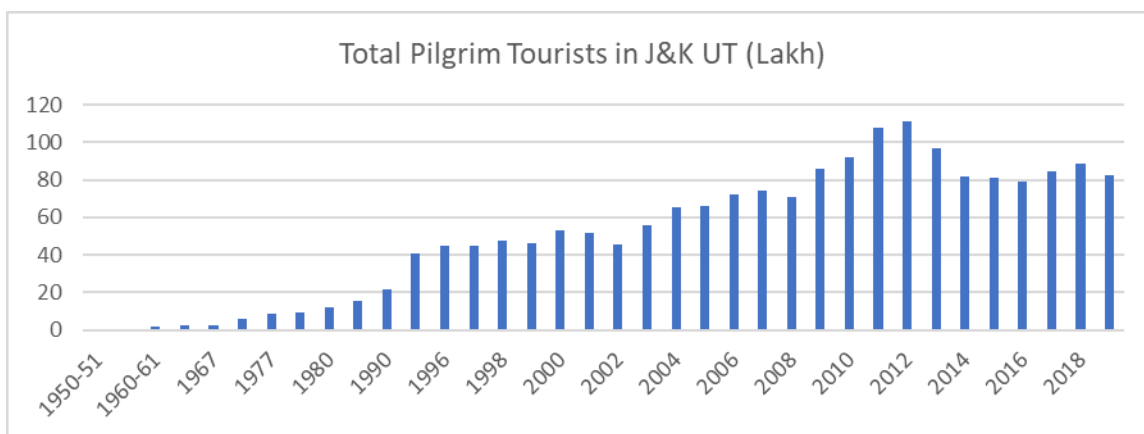


Fig.. 2.2: Pilgrim Tourists in J&K UT (Source: Directorate of Tourism, J&K UT)



Fig.. 2.3: Pilgrim Tourism in two major destinations in J&K UT - (a) Shri Amarnath Holy Cave, and (b) Mata Vaishnav Devi (Source: Directorate of Tourism, J&K UT).

Among the tourism infrastructure government owned (Tourist Huts and Bungalows) and private (Hotels) are common in the J&K UT and both types are growing in the union territory (Fig.. 2.4). However total tourist huts and tourist bungalows are less than 250 in number, tourist huts constitute most of this type of accommodation (nearly 200 in number). Due to high influx of tourists, number of hotels in the UT was reached to 1674 and number of restaurants 326 in 2018-19 (Fig.. 2.5).

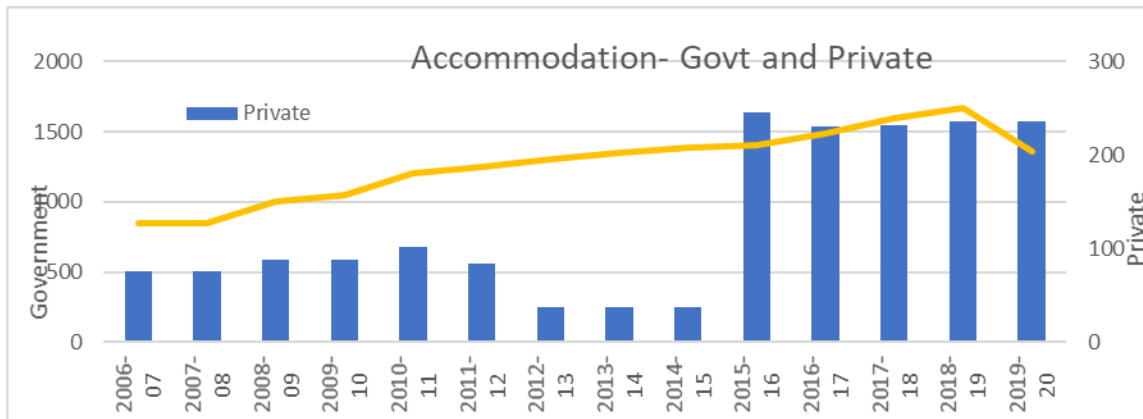


Fig.. 2.4: Growth of government and private accommodations in the tourism sector of J&K UT (Source: Directorate of Tourism, J&K UT).

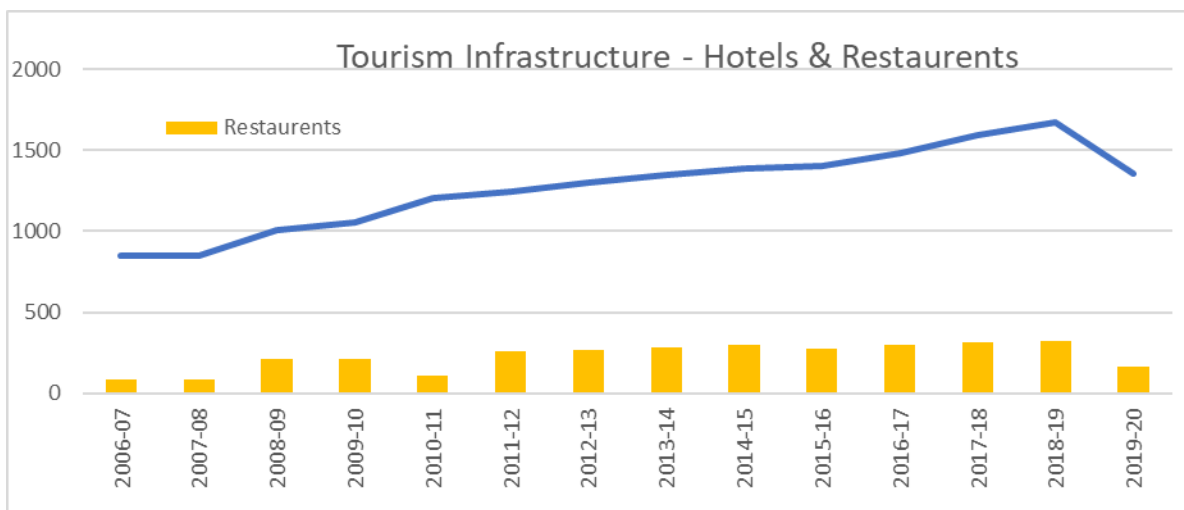


Fig.. 2.5: Growth of hotels and restaurants in J&K UT (Source: Directorate of Tourism, J&K UT).

Since 1990, number of buses has increased 4 times till the end of March 2020, while the growth in number of Taxis was nearly 10 times in the same time frame. Combined number of Auto Rick-shaws/Tempos (Fig.. 2.6) grows much beyond these numbers (more than 15 times).

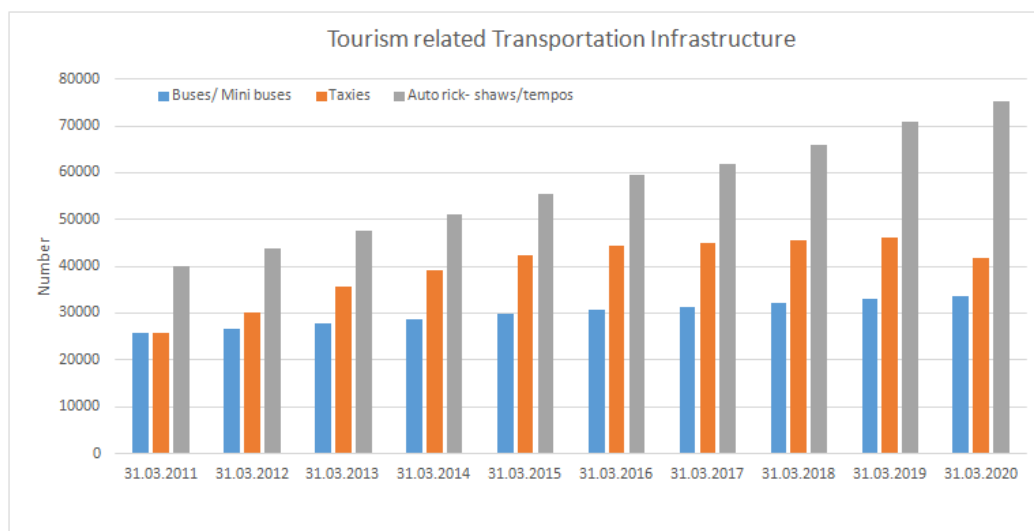


Fig.. 2.6: Growth of tourism-related transportation infrastructure in J&K UT (*Source: Transport Commissioner, JK*).

J&K UT has also a water transport system, which is limited to Kashmir region and is confined to the boats only (Houseboats, Passenger boats, Luggage boats, Fishing boats, Passenger Doongas, Shikara Taxis and Residential boats). However, most of the types are associated with the tourism sector and allied activities; taxi shikaras a big attraction, hence a tremendous growth was observed in this category with a growing number of tourists.

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

Increasing trend of urbanization and industrialization, solid waste management (SWM) is becoming a significant challenge and creating various issues in the different eco-sensitive regions. In Jammu and Kashmir (UT) for the management of solid waste responsible civic local bodies are 80 (2 Municipal cooperation, viz., Jammu Municipal Corporation and Srinagar Municipal Corporation; 6 Municipal Councils; 70 Municipal Committees; and 2 Cantonment Boards). In the year 2019-2020, the total solid waste generation in all the Corporation/Local bodies of J&K UT was 15133.94 q/d, out of which 14593.8 q/d was collected, and 5382.46 q/d was treated (Table 2.1, source: Jammu and Kashmir-Pollution Control Board). Year wise data obtained from Jammu Municipal Corporation, Jammu and Kashmir showed an increasing trend of total solid waste generation (Table 2.2) from 2017 (10,03,75.0 t/yr) to 2021 (12,48,30.0 t/yr). Waste processing and recycling was started from 2019 and 2020, respectively, and waste processed ranged between 2.5% (2019) to 11.70% (2021). Urban waste (Srinagar Municipal Corporation) from 2019 to 2022 shows increasing trend of solid waste generation from March to November in different years (Table 2.3).

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

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

*q/d- Quintal per day

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

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

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

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

Months	Total Solid Waste Generated (q)			
	2019	2020	2021	2022
Jan	73950	90050	92910	96280
Feb	73460	101760	97630	97660
Mar	93090	113430	143900	146220
Apr	113790	100110	173280	151330
May	125860	105690	139400	-
Jun	127150	118890	136760	-
Jul	127150	NA	140810	-
Aug	94150	NA	138020	-
Sep	91430	NA	138240	-
Oct	113440	NA	141030	-
Nov	109410	NA	125700	-
Dec	97900	NA	116140	-
Total	1240780	629930	1583820	491490

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

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

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

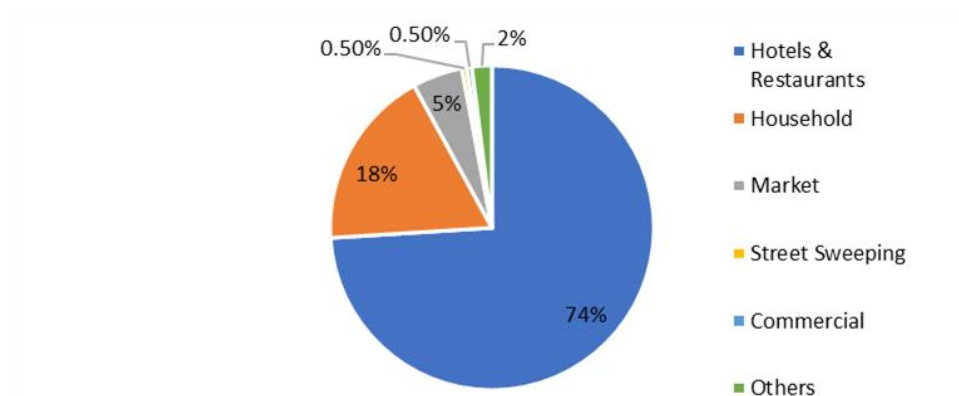


Fig.. 2.7: Total contribution of categorized Municipal Solid Waste generated at different sites at Pahalgam (Source: Municipal Committee Pahalgam, 2015)

2.2. Segregation / Utilization of waste

In the Jammu division, door to door collection is being done by NGO namely "*Faith and Samiti*" from 1500 HHs. Total 100% collection of waste is being achieved by 13 local bodies. No segregation is being done except partial segregation in 02 local bodies i.e., segregation of bio-waste (Katra and Jammu Municipal corporation). Secondary waste segregation was started at Katra town, as a pilot project, with segregation of approx. 14.95 q/d of waste and channelization for further recycling (JK-PCB 2019-2020). In the Kashmir division, door to door collection of municipal solid waste is done by Srinagar Municipal Corporation (80% households). Door-to-door collection is being done in Urban local bodies, expect 12 Municipal Committees (Yaripora, Frisal, Kulgam in district Kulgam, Shopian Municipal Committee Khansahiv, Baramulla, Sopor, Pattan, Hajin in Bandipoura, Kupwara, Handwara, Langate in Kupwara district). Construction and demolition waste was separately collected and disposed of, while other wastes (garbage, dry leaves) were occasionally burnt (JK-PCB 2019-2020).

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

A study on municipal solid waste (MSW) generated during Amar Nath Yatra season (July-August 2011) in Pahalgam was conducted at three sites viz., Aru, Chandanwari, and Nunwan *Yatra* Base Camp to

assess the composition and generation of Municipal Solid Waste (MSW) during the *Yatra* season. At these sites, pilgrims spend more time on food consumption before leaving for Holy Cave. These sites have hotels, shops, nomadic tents of Gujars, pony sheds, and *Yatries Bhandaras* (restaurant), etc. The total net weight of solid wastes generated was highest in July month at all the sites (38.55 - 429.98 kg/day), and was lowest in the month of August (12.19 - 21.56 kg/day), which was due to the closing session of pilgrims, only local tourists contributed to the generation of MSW (Table 2.4. Bhat et al. 2012). Among the solid waste generated, food wastes (382.07 kg/day) contributed highest to the total net weight, followed by cardboard (67.93 kg/day), glass (51.82 kg/day), paper (37.18 kg/day), and plastic (25.53 kg/day).

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

Composition	Site 1		Site 2		Site 3		Site 1+2+3		Total solid Waste
	July	August	July	August	July	August	July	August	
Food Wastes	15.16	7.11	50.82	10.11	296.1	2.77	362.08	19.99	382.07
Plastic	1.72	0.68	4.33	0.11	18.43	0.26	24.48	1.05	25.53
Paper	1.79	0.99	10.5	0.99	22.79	0.12	35.08	2.1	37.18
Rubber & Leather	0.15	0	0.09	0.21	1.28	0	1.52	0.21	1.73
Glass	2.72	2.72	20.73	3.12	15.75	6.78	39.2	12.62	51.82
Cloth Rags	0.8	0.067	5.84	0.33	8.21	0.25	14.85	0.647	15.497
Cardboard	7.4	2.34	19.64	2.11	35.21	1.23	62.25	5.68	67.93
Metals	1.33	0.13	3.57	0.89	9.11	0.22	14.01	1.24	15.25
Bones	4.97	1.21	0	0	0	0	4.97	1.21	6.18
Wooden Chips	1.6	1.22	14.5	3.15	16.9	0.54	33	4.91	37.91
Inert Materials	0.91	0.91	3.53	0.54	6.2	0.02	10.64	1.47	12.11
Total	38.55	17.38	133.55	21.56	429.98	12.19	602.08	51.127	653.207

2.3. Waste disposal/ treatment facilities:

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

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

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

2.4. Impact on Air quality

Monitoring of air quality parameters (SO₂, NO₂, PM₁₀, PM_{2.5}) in Jammu & Kashmir UT is limited to a few stations in the Jammu region. In the Kashmir region, only PM₁₀ observations are available (2018 and 2019) for Srinagar City (Table 2.6, 2.7).

Table 2.6: Air quality monitoring. District: Jammu

Year	Sulphur Dioxide (SO ₂) (24 hrs)			Nitrogen Dioxide (NO ₂) (24 hrs)			Particulate Matter (PM ₁₀) (24 hrs)			Particulate Matter (PM _{2.5}) (24 hrs)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2010	2.3	14.3	7.0	6.7	26.0	15.0	-	-	-	-	-	-
2011	2.7	8.7	6.7	6.3	17.0	11.7	-	-	-	-	-	-
2012	2.0	16.7	5.7	3.0	25.7	10.7	-	-	-	-	-	-
2013	2.0	12.3	4.7	5.7	29.0	14.3	-	-	-	-	-	-
2014	2.0	21.0	5.3	3.7	22.0	13.0	-	-	-	-	-	-
2015	2.0	9.7	3.3	7.3	24.0	16.7	-	-	-	-	-	-
2016	2.0	8.0	3.3	24.3	24.3	17.0	-	-	-	-	-	-
2017	2.0	6.0	4.0	9.0	26.0	18.0	-	-	-	-	-	-
2018	2.0	7.7	4.0	10.3	24.3	18.7	64.0	313.7	164.3	16.0	78.0	45.0
2019	2.0	4.7	2.7	11.3	25.0	17.0	84.3	179.7	138.3	14.0	59.5	38.3

2020	2.0	6.7	3.0	10.7	29.3	18.7	99.7	274.0	167.3	14.5	64.0	32.0
-------------	-----	-----	-----	------	------	------	------	-------	-------	------	------	------

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

Table 2.7: Air quality monitoring. District: Pulwama and Srinagar

	Pulwama (24 hrs)						Srinagar (24 hrs)		
	Particulate Matter (PM₁₀)			Particulate Matter (PM_{2.5})			Particulate Matter (PM₁₀)		
Row	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2018	49.0	170.0	104.0	12.0	63.0	35.0	51.3	395.7	153.0
2019	43.0	269.0	120.0	12.0	49.0	35.0	61.3	485.7	132.3
2020	67.0	228.0	128.0	16.0	64.0	34.0	47.3	319.3	134.3

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

SO₂ observations from three stations in the Jammu region indicate that the average SO₂ value varies between 2 and 12 µg/m³ between 2010 and 2020 with an average value of 4.5 µg/m³. The average minimum (24 hrs) and maximum (24 hrs) SO₂ values, during 2010-2020, were ~2 µg/m³ and 10.5 µg/m³, respectively. The highest SO₂ value of 23 µg/m³ was recorded in M.A. Stadium, Jewel Chowk station in 2014. No trend was observed for minimum SO₂ values, while a clear decreasing trend was observed for maximum and average SO₂ values in the same time frame. SO₂ observations at all the stations and all the years are within the National Ambient Air Quality Standard (NAAQS) (i.e., 50 µg/m³). NO₂ observations at three stations in Jammu region indicate that average annual NO₂ value was 4.5 µg/m³ between 2010 and 2020. The minimum (24 hrs) NO₂ value varies between 2 µg/m³ and 25 µg/m³ with an average of 8.9 µg/m³. The maximum NO₂ value (24 hrs), on the other hand, ranged between 17 to 35 µg/m³ with an average being 24.8 µg/m³. NO₂ values at any station or any time period have not ever exceeded the NAAQ standard (i.e., 40 µg/m³).

Annual average observations of PM₁₀ during 2010-2020 range from 72 to 258 µg/m³ with an average of 137 µg/m³ which clearly shows that each and every value exceeds the NAAQ standard (i.e, 60 µg/m³). The minimum (24 hrs) values range between 18 to 112 µg/m³ with an average of 66.8 µg/m³. Out of total 45 observations of minimum PM₁₀ values across all the stations, PM₁₀ values exceed NAAQS standard 27 times. The maximum (24 hrs) PM values vary from 133 µg/m³ to 858 µg/m³ with an average of 254 µg/m³ which again shows that maximum PM₁₀ remains above NAAQS standard in the Jammu region.

Since 2018, PM_{2.5} is being monitored at three sites (M.A. Stadium and Bari Brahamana Industrial Area of Jammu, and Khrew of Pulwama), and in 2020 one more station (Regional Office, Jammu) has been operational for monitoring. Minimum PM_{2.5} (24 hrs) values ranged from 12 to 18 µg/m³ with an average of 14 µg/m³ during 2018-2020. Maximum PM_{2.5} (24 hrs) values ranged from 49 to 79 µg/m³ with an average of 64 µg/m³ indicating that all the values exceed NAAQ standard. Annual average PM_{2.5} values cover a range of 31 to 45 µg/m³ and averaging 37 µg/m³. Average PM_{2.5} values exceeded NAAQS only

in the two stations of the Jammu region (year 2018). Rests of the values were within the specified standard.

Monthly air quality monitoring data at three locations of Jammu region namely SPCB Building Complex, M.A.M Stadium and Bari Brahmana Industrial Area was made available by J&K Pollution Control Committee for the year 2019, 2020 and 2021. Almost continuous data (except for January-March, 2019) is available for Respirable Suspended Particulate Matter (RSPM), PM_{2.5}, SO₂ and NO₂. Observations suggest that RSPM has exceeded the standard limit for 24-hours average (i.e., 100 µg/m³) as well as annual average (i.e. 60 µg/m³) for all the months during 2019-2021 and at all the three locations. Only in April-May months of 2020 at SPCB Building Complex and May and September months of 2021 at M.A.M Stadium, the RSPM values were within the standard limit. Also, RSPM values tend to be high during winters (Mainly in December) and tend to be low during summers (Mainly in May).

The 24-hours average and annual average PM_{2.5} values also remained well within the standard limit for all the months during 2019-2021. PM_{2.5} exceeded the permissible limit only once in the month of October, 2021 at SPCB Building Complex, Jammu.

The standard limit for SO₂ is 80 µg/m³ for 24-hours average and 50 µg/m³ for annual average. Interestingly, observations reveal much low SO₂ values in all the three monitored locations of Jammu region and for all the months during 2019-2021. The annual average of SO₂ values ranges only between 2.8 µg/m³ and 3.46 µg/m³. NO₂ was also found to be within the standard limit for 24-hours average (80 µg/m³) and annual average (40 µg/m³). It has never exceeded the prescribed limit during 2019-2021. The annual average of NO₂ ranges between 16.35 µg/m³ and 20.6 µg/m³.

For important tourist spots of Jammu region (namely Patnitop, Sanasar, Mansar, Surinsar and Purthu-Basohli), only PM₁₀ monitoring is available which too is not continuous (Tables 2.8). Nevertheless, observed values reveal that PM₁₀ exceeded the permissible limit at Surinsar during September-October, 2021 and at Purthu Basohli during during October 2021. During 2022, PM₁₀ values exceeded at Mansar in January-February and at Surinsar in February.

Table 2.8: PM₁₀ (µg/m³) monitoring at important tourist locations (Year 2021 and 2022)

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

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

Monthly air quality monitoring data has been made available by J&K Pollution Control Committee for the districts Baramulla and Ganderbal for the years 2017 and 2018. The monthly data is not continuous and limited to the parameters PM_{2.5} and PM₁₀. The observed values have, in general, not exceeded the standard limits prescribed for 24-hours average (PM_{2.5}- 60 µg/m³; PM₁₀- 100 µg/m³) and annual average (PM_{2.5}- 40 µg/m³; PM₁₀- 60 µg/m³). Only one incidence in October 2018 was observed when PM₁₀ vales exceeded the standard limit for 24-hours average and reached 87.32 µg/m³.

As per the 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 includes phasing out 15-year-old commercial vehicles, introduction of cleaner fuel, regular checking of vehicular emissions, regulation and management of traffic, promotion of e-vehicles, construction of peripheral roads, plantation, and greening of roads, etc are some of the measures. Most of the air qualities monitoring stations are clustered around Jammu and Srinagar city, and such stations are still lacking in other cities, towns, and rural areas of other districts. Thus, more air quality monitoring stations in all districts would present a better picture of the air quality standards in the Jammu & Kashmir UT.

2.5. Impact on water quality/groundwater

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

2.5.1. Physical parameters:

2.5.2. River water quality monitoring is available for 14 districts of J&K, since 2013 (Table 2.9). pH observations reveal that it falls within the permissible limit (i.e., 6.5-8.5) for all the districts and for all the observed years. The D.O. is also found within the permissible limit (i.e., 6 mg/l) for most of the districts except for Rajouri (year 2015), Srinagar (2012 and 2013) and Udhampur (2012, 2013 and 2015). The E.C., though within the permissible limit for irrigation and industrial uses (i.e., <2250 µmhos/cm), exceeds in some districts for drinking purposes (i.e., <400 µmhos/cm; as per WHO) such as in Kathua (2020), Rajouri (2018), Reasi (2018), Samba (2018, 2020) and Srinagar (2013). The E.C. for Udhampur remained above 400 µmhos/cm for all the observed years (2012-2020). The permissible limit of B.O.D. is 2 mg/l and 3 mg/l for different categories. B.O.D. values come under "ii" and "iii"

categories in most of the districts except for Anantnag, Ganderbal and Kathua (excluding 2020). The B.O.D. remained exceptionally high in Udhampur. The T.D.S. observations are only available for Kathua (2020), Samba (2020) and Udhampur (2020) which exhibit the values ranging between 264 and 320 and hence can be considered acceptable. As per the quarterly data provided by Jammu & Kashmir Pollution Control Committee for Banganga, Katra which is a heavily touristed region due to the Mata Vaishnu Devi shrine, values of dissolved oxygen (DO) ranges between 5 to 9 mg/L with no sign of seasonal or temporal decreasing trend in the values.

Table 2.9. General statistics of the physical parameters for various lakes and rivers of Jammu & Kashmir

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

The water quality of selected tourist spots viz., Dal Lake, Wular Lake, Mansar Lake, Surinsar Lake and Katra region is presented here. The assessment for physical parameters suggests that pH is within i-category for all the selected spots. The D.O. is also within i-category except for Mansar Lake (2011) and Surinsar Lake (2011, 2019 and 2020) which falls in ii-category. The E.C.in not available for Wular Lake but for other spots, E.C. exceeds for drinking purposes in Dal (2011) and Surinsar Lake (2018) and remained within the permissible limit for other spots. The T.D.S. observations are not available for these spots. Noticeably, B.O.D. was found to be within the permissible limit for Katra but was exceeded for all other selected spots. In 2019, over to concerns over its shrinking size of Dal Lake, J&K

government set up a committee to declare its surrounding areas as an eco-sensitive zone (ESZ), and prepare a draft notification.

2.5.3. Chemical parameter:

Chemical characteristics were rarely assessed to determine the quality of river, groundwater and tourist spots in J&K UT. Only Nitrate- N+ Nitrite-N (mg/l) (hereafter Nitrate) records are available for rivers of the UT, which indicate that Nitrate values were within the permissible limit (i.e., 1.2 mg/l or less) in most of the districts but exceeded the limit in Rajouri (2017, 2018), Reasi (2017, 2018), Srinagar (2013) and Udhampur (2015, 2017, 2018, 2019).

Chemical Oxygen demand (COD) in Banganga ranged between 5 to 32 mg/L except again for the months of April to June during 2011 to 2016 which ranged between 24 to 68 mg/L. Values for Chloride ranged between 16 and 38 mg/L whereas values for Phosphate were >2 mg/L except for the quarter of January to March 2013 when the values touched 6.7 mg/L in Banganga.

For groundwater, Nitrate was within the permissible limit for Anantnag and Ganderbal. In Jammu, Nitrate often exceeded the limit. For other districts, values exceeded slightly. Srinagar shows an exceeding trend in Nitrate. Notably, very high Nitrate values were observed in Kulgam and Udhampur in 2018. In selected tourist spots, Nitrate values were found to be within the permissible limit. Only in Srinagar, the values were exceeded in 2018.

2.5.4. Biological parameter observations:

Biological parameters are not available for rivers. For groundwater, Fecal Coliform observations are available for Jammu (2018, 2019), Kathua (2018), Rajouri (2019), Reasi (2018, 2019), Samba (2018, 2019) and Udhampur (2018, 2020) which show values to be within the permissible limit (i.e., MPN/100 ml 50 or less). Biological parameters for the selected tourist spots are not reported.

Among the 350 polluted stretches of rivers across the country, five are present in Jammu and four are present in Kashmir region. The polluted river stretches in Jammu includes Banganga, holy spring, Katra, river Bansntar in Samba, river Deval in Udhampur and river Chenab at Akhnoor, all of which are monitored for the water quality parameters on monthly basis by SPCB J&K. Similarly, all polluted river stretches in Kashmir region i.e., Chantkol, to Chatabal weir, Gowkadal and Dodherhama are also monitored for the water quality parameter every month. However, all these water quality monitoring stations are clustered around the urban regions of Jammu and Srinagar. Very few water quality monitoring stations are 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 of the water quality in the UT.

Tourism and related activities have also been reported to impact the physical and biological quality of water bodies in the region. For example, the Dal Lake in Srinagar with nearly 50,000 inhabitants in the houseboats in addition to a large population of locals and tourists in the surroundings has witnessed

extreme loss of water quality during last four decades (Kumar et al. 2022). The lake has been infested with 12 dominant macrophytes with an average values of Biological oxygen demand (27.5 ± 1.49 mg/l), Chemical oxygen demand (61.75 ± 0.85 mg/l), nitrate nitrogen (636.5 ± 1.04 µg/l), ammoniacal nitrogen (137 ± 1.31 µg/l) and orthophosphate (44.6 ± 0.18 µg/l) (Parray *et. al.*, 2021).

2.6. Impact on Forest and Biodiversity:

During the past decade (2011-21) the forest cover of erstwhile state of Jammu & Kashmir has increased from 22,539 km² to 23,659 km² accounting to an increment in ~5% of the forest cover during the decade (ISFR 2011 & 2021). In 2021, Jammu & Kashmir with a forest area of 21,387 km² covers 39.15% of the geographic area which includes 4,155 km² of dense forest, 8,117 km² of the moderate forest, and 9,115 km² of open forest. In Jammu division the forest cover, in 2011, was 10,906 km² which was increased to 11,986 km² in 2021, accounting to an increase in forest cover by 9% during the decade. In Kashmir division, the forest cover (2011) was 5,021 km² which was increased to 6,353 km² by 2021 accounting to an increase in 21% of the forest cover.

Major reasons for an increase in the forest cover include afforestation activities carried out by the State Forest Department, conservation efforts by the concerned agencies and improvements in interpretation due to better radiometric resolution of the recent satellite data. The slight decrease in forest cover in 2013 was mainly because of road widening work in the Udhampur district. Overall, the state has witnessed a consistent increase in total forest cover during the past decade (Table 2.10).

Table 2.10: Forest cover of Jammu & Kashmir UT

Year	Very dense forest (km ²)	Medium dense forest (km ²)	Open forest (km ²)	Total forest cover (km ²)	Percent cover	Change (km ²)
2021	4,157	8,629	10,873	23,659	10.64	418
2019	4,280	8,612	10,719	23,611	10.63	371
2017	4,075	8,579	10,587	23,241	10.46	253
2015	4,061	8,815	10,112	22,988	10.34	450
2013	4,140	8,760	9,638	22,538	10.14	-1
2011	4,140	8,760	9,639	22,539	10.14	

So far, no comprehensive checklists of species under various taxonomic groups are available for the newly created UT. Most of the previous compilations included the erstwhile state of Jammu & Kashmir which included Ladakh as well. Global Biodiversity Information Facility (GBIF) has reported 4748 species from Jammu & Kashmir UT among which 136 species have been placed under various threatened categories through IUCN assessment criteria (Table 2.11).

Table 2.11: Summary of the species reported from Jammu & Kashmir on GBIF (www.gbif.org) and threatened species as per IUCN assessment (www.iucnredlist.org).

Sr. No.	Taxonomic group	Total species	Critically endangered	Endangered	Vulnerable	Near Threatened
1.	Mammals	145	1	4	8	12
2.	Birds	773	1	5	20	26
3.	Herpetofauna	17	-	1	-	6
4.	Fishes	45	2	2	3	2
5.	Invertebrates	583	-	-	3	-
6.	Seed Plants	2847	5	9	11	12
7.	Lower Plants	63	-	-	1	-
8.	Fungi	143	-	1	-	1
9.	Bacteria	132	-	-	-	-
	Total	4748	9	22	46	59

429 plant species (256 genera of 87 families) have been listed as threatened in erstwhile state of Jammu & Kashmir. Among these, 24 species have been recognized as critically endangered, 88 endangered, 75 vulnerable, 3 near threatened, and 32 least concern (IUCN), whereas the remaining species belonging to rare and indeterminate categories used by previous workers (Hamid et al. 2020). Among the animals, 71 threatened and near-threatened species have been reported (33 species of birds, 26 species of mammals, 5 species each of reptiles and fishes and 2 species of amphibians; Bhat et al. 2020a). In terms of the protected area network at total of 4161 km² is currently covered under 4 National Parks and 14 Wildlife Sanctuaries (Table 2.12). In addition, a total of 37 conservation reserves and 4 Ramsar sites are designated in different regions for conservation of the local flora and fauna.

Table 2.12: Details on the Protected areas of Jammu & Kashmir UT (Web reference)

Sr. No.	Protected area	Notification year	Area (km ²)
1.	City Forest (Salim Ali) National Park	1992	9.07
2.	Dachigam National Park	1981	141
3.	Kazinag National Park	2000	90.88
4.	Kishtwar High Altitude National Park	1981	2191.5
5.	Baltal-Thajwas Wildlife Sanctuary	1987	210.5
6.	Gulmarg Wildlife Sanctuary	1987	180
7.	Hirapora Wildlife Sanctuary	1987	341.25
8.	Hokersar Wildlife Sanctuary	1992	13.75
9.	Jasrota Wildlife Sanctuary	1987	10.04
10.	Lachipora Wildlife Sanctuary	1987	37.65

11.	Limber Wildlife Sanctuary	1987	21.76
12.	Nandni Wildlife Sanctuary	1981	33.34
13.	Overa-Aru Wildlife Sanctuary	1987	511
14.	Rajparian Wildlife Sanctuary	2002	20
15.	Ramnagar Wildlife Sanctuary	1981	31.5
16.	Tral Wildlife Sanctuary	2019	154.15
17.	Surinsar Mansar Wildlife Sanctuary	1981	97.82
18.	Tatta Kuti Wildlife Sanctuary	2012	66.27

Currently, limited information is available on the impacts of the tourism activities on the wildlife and biodiversity of the region. For example, a study on the economic valuation of biodiversity values in Dachigam National Park in Kashmir reported that consumer surplus per visitor per visit was Rs. 12,470 which translates into an annual monetary recreational value of about Rs. 247,614,828 but do not consider the negative impacts of tourism on the biodiversity in the Park (Bhat & Bhatt, 2019). Another study shows that increasing demographic pressure with the growing energy demands for domestic and tourism sectors have resulted in heavy pressure on the available forest stock thus posing a serious threat to the ecological sustainability of the catchment (Malik et al. 2011). A recent article in newspaper *Daily Excelsior* highlights that a large number of tourists are attracted towards the wilderness areas like National Parks and Sanctuaries in Jammu & Kashmir however many of them consider it as a picnic which needs to be strictly controlled to preserve our biodiversity heritage. (<https://www.dailyexcelsior.com/tourism-and-environment-2/>). Another article by *The WIRE* highlights that commercial tourist enterprises in the state has overridden the ecological concerns needing formulation of stringent regulations and their enforcement for environmental sustainability (<https://thewire.in/environment/jammu-and-kashmir-environment-conservation-tourism>).

2.7. Eco-sensitive zones/Areas:

Seven Ecosensitive Zones have been notified in the J&K UT around the boundaries of National Parks (Kazinag National Park, Kishtwar High Altitude National Park) and Wildlife Sanctuaries (Limber Wildlife Sanctuary, Lachipora Wildlife Sanctuary, Hirpora Wildlife Sanctuary, Jasrota Wildlife Sanctuary, Rajparian Wildlife Sanctuary, Ramnagar Wildlife Sanctuary, and Surinsar-Mansar Wildlife Sanctuary). Limits of Ecosensitive Zones may extend from the boundary of a National Park/Sanctuary to a distance of 10km. Very recently, Ministry of Environment, Forest and Climate Change, Govt of India has declared 62.2 km² around Gulmarg Wildlife Sanctuary as eco-sensitive zone.

Jammu & Kashmir government has accorded sanction to the constitution of the district level committees for the preparation of the zonal Master Plans for notified five Eco-Sensitive Zones (wildlife sanctuaries, national parks) in the union territory. These includes Jasrota wildlife sanctuary in Kathua; Rajparian wildlife sanctuary in Anantnag, Hirpora wildlife sanctuary in Shopian; Ramnagar wildlife sanctuary in Jammu and Kishtwar High Altitude National Park. The committees will prepare zonal

master plans in the manner as specified in the notifications and the guidelines issued by the central government.

2.8. Summary

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

However, various activities (horticulture, agriculture, forestry, industry, etc.) contribute in the economy of J&K, tourism and allied sectors provide major employment and revenue. Limited information is available on the impacts of tourism activities on the natural resources and environment of the region. Major concern highlighted at various forums and addressed through various actions is health of Dal Lake but the goal has not been achieved so far. Researchers have largely attributed eutrophication process to deteriorate the health of Dal Lake. The Union Territory of Jammu & Kashmir is mainly drained by three rivers i.e., Jhelum, Chenab and Ravi along with their tributaries. In addition, the region is also home to more than 1200 water bodies including prominent lakes like Dal, Wular, Manasbaal, Nigeen, Anchar, Hokersar, Mansar, Surinsar, Sanasar, Gharana etc. Further, the region is interspersed with a large number of groundwater springs. Studies on the water quality assessment of the region shows that the quality of water as well as surface area of the water bodies has reduced significantly during past few decades. For example, wetlands around Srinagar i.e., Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar etc. have witnessed a significant reduction in the surface area and the water quality has deteriorated during 1970's to the present (Dar et al. 2020; Kumar et al. 2022). Studies further shows that most of the freshwater springs in Kashmir region have excellent water quality index, however water quality of some of the springs was found poor to very poor which are mostly present nearby the highly urbanized area (Bhat et al. 2022, 2020). Similarly, water quality assessment at five sites in one of the largest wetlands in Asia i.e., Wular was also found good in condition in terms of its water quality index (Bhat and Pandit, 2014). 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, but increasing anthropogenic pressure is worsening the water quality 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 Neeru river in Bhadarwah region shows that the water quality was better in tributaries away from the town, but river stretch below the town show a moderate to heavy level of water pollution (Kumar et al. 2019).

Lake conservation and effective management through third party monitoring appears on top list of action priorities because waterscape of Kashmir valley is in the centre of tourist attraction. Solid waste management in Ecosensitive zones and regulated tourism is one of the major concerns to be addressed.

Himachal Pradesh

3.1. Introduction

Himachal Pradesh spreads over an area of 55,673 sq. kms with a population of more than 60 Lac people. It extends from 75°47'55" to 79°04'20" East Longitude and 32°22'40' to 33°12'40' North latitude. Tourism is fast emerging 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 and the Govt. is giving main priority to tourism. Himachal has a diverse range of natural resources, including 30 wildlife sanctuaries, five natural parks, and three game reserves. The state has the world's highest cricket ground in Chail and also the World's most beautiful cycling trek. The MTB HIMALAYA & Himalayan Adventure Sports & Tourism Promotion Association has given a new face to the biking in India and has further added to the tourist attraction of the state. Availability of natural resources has made the state an attractive destination for investments in tourism, agricultural, hydroelectric power and cement. The average Gross State Domestic Product (GSDP) growth rate between 2004-05 and 2009-10 was about 11.4%. Himachal Pradesh is a leading producer of apples, producing 2.8 lakh metric tons of apple in 2009-10 (IBEF Report on Himachal Pradesh, November 2011).

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

There have been significant increases in number of tourists in Himachal Pradesh from past few years. The total inflow of tourists has increased significantly from 149, 90,444 in 2011 to 172, 12,107 in 2019 which decreased to 30, 56,879 in the year 2020 as lockdown was imposed during this year (Fig. 3.1 a). There was an average increase of 14.29% in total inflow of tourists from 2019 when compared to 2011, while an average decrease of -81% inflow of tourist in the year 2020 when compared to 2019. The maximum tourist inflow was recorded in Kullu and Shimla districts. The rate of change in domestic tourist showed a continuous increase from 2014 to 2017 from 5% to 8% while a decrease of -82% in 2020 due to COVID-19 when compared to 2019. Further after the pandemic there was an increase of 87% in domestic tourist in 2021 when compared to 2020, while rate of change in foreign tourist showed an increase from 2015 to 2017 while a decrease of -89% in 2020 and still the decreased continued to -89% in 2021 as international travel was banned till 2021. Figure 3.1 (b) shows rate of change in domestic tourists and Figure 3.1(c) shows the rate of change in foreign tourists in H.P from 2011 to 2021.

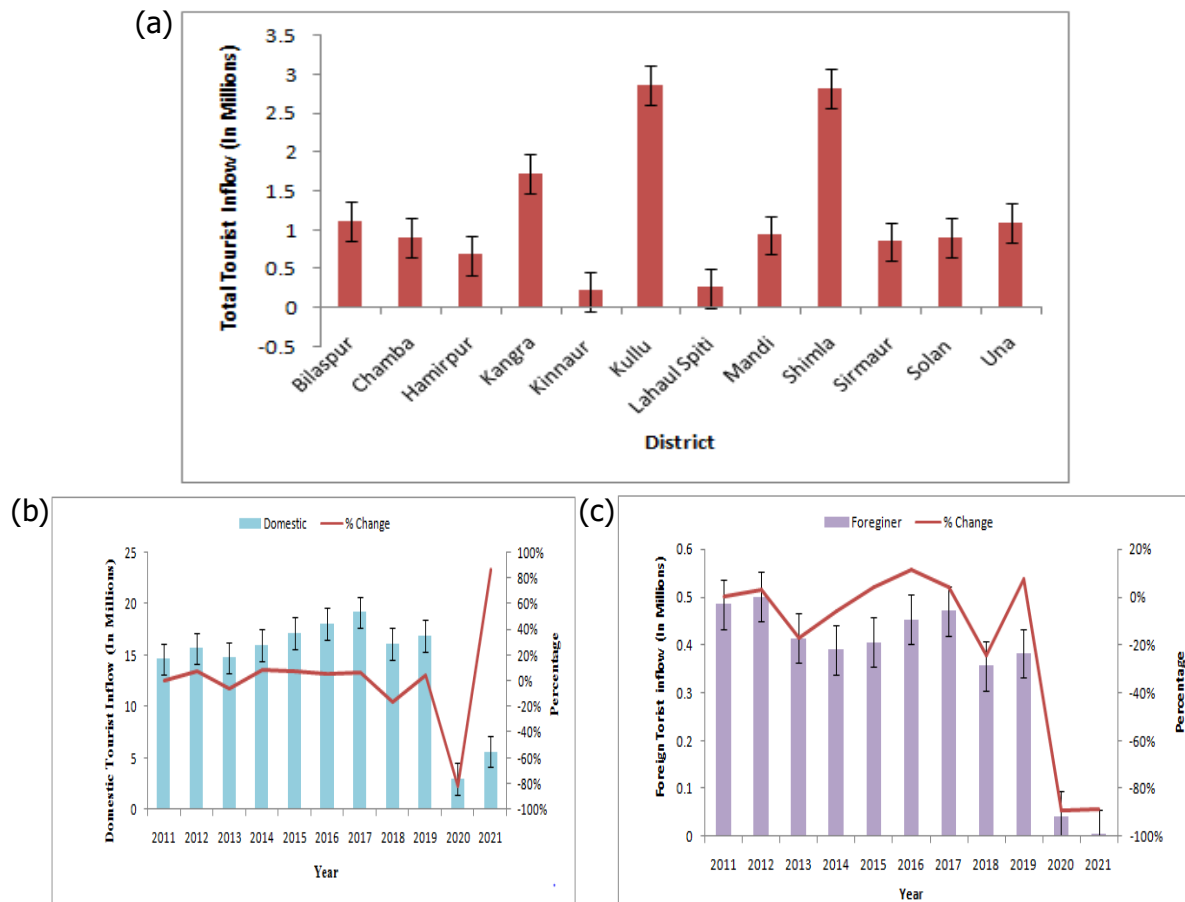


Fig..3.1:(a) District wise tourist in flow in Himachal Pradesh (2011-2021), (b) Rate of change in domestic tourists in H.P from 2011 to 2021, and (c) Rate of change in Foreign tourists in H.P from 2011 to 2021(*Source: Himachal Tourism Website*)

3.1.2. Tourism and Economic Growth

Himachal Pradesh is a major tourism destination and tourism is contributing greatly to the growth, development and economy of the State. The tourism sector acts as an engine for economic growth and a major source of revenue and employment in the state. This is the reason that Government of Himachal Pradesh has developed infrastructure i.e. roads, airports, helipads, communication network, public utility services, transportation facilities, water and sanitation facilities and other amenities for growth and development of tourism sector. The contribution of the tourism sector to the State Gross Domestic Product (GDP) is about 7% which is quite significant (Himachal Pradesh Economic Survey 2020-2021).The tourism sector has provided estimated 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/>). Providing taxi for tourist tour is another source of income. Activities like horse riding, yak photography, rabbit photography is also proving income to the people in and around of the state. Table 3.1 shows district wise number of hotels, homestays, guides, travel agency, adventurers and photographers in Himachal

Pradesh which was maximum in Kullu district. The State is endowed with all the basic resources necessary for thriving tourism activity like geographical and cultural diversity, clean and peaceful environment and beautiful streams, sacred shrines, historic monuments and the friendly and hospitable people. Tourism plays an important role in economy of the state. The importance of tourism is evident from the fact that tourism and hospitality sector in Himachal Pradesh has recorded a loss of 46% in turnover during Covid pandemic. (Growth rate of GSDP at constant price varied from 6.4% (2011-2012) to 6.5% (2018-2019) and was 4.9% in 2019-20 (Fig.. 3.2b). Figure 3.2 (c) & 3.2 (d) shows the year wise tourist influx from 2011-2020 and growth rate in state GSDP with current and constant price respectively (Himachal Pradesh Economic survey; Department of Economics & Statistics HP, 2020-21). Thus tourism plays an important role in economic growth of the state. Some major impact of tourism in economy is foreign exchange earnings/Balance of payments, income generation, employment generation, entrepreneurial activities etc.

Table 3.1: District wise registered Hotels, Homestays, Guides, Travel Agency, Adventurers and photographer registered with Himachal Pradesh Tourism Department

District	Hotel	Homestay	Guides	Travel Agency	Adventure	Photographer
Kinnaur	73	66	12	19	0	0
LahaulSpiti	88	258	1	15	0	0
Kullu	953	327	386	1374	73	783
Chamba	225	106	106	51	5	17
Kangra	672	267	128	231	97	3
Shimla	493	335	451	978	6	91
Mandi	198	100	75	115	38	4
Bilaspur	84	14	29	28	2	1
Hamirpur	60	7	2	6	0	0
Sirmaur	111	42	55	7	0	0
Solan	286	125	69	81	0	0
Una	106	9	0	7	0	0

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

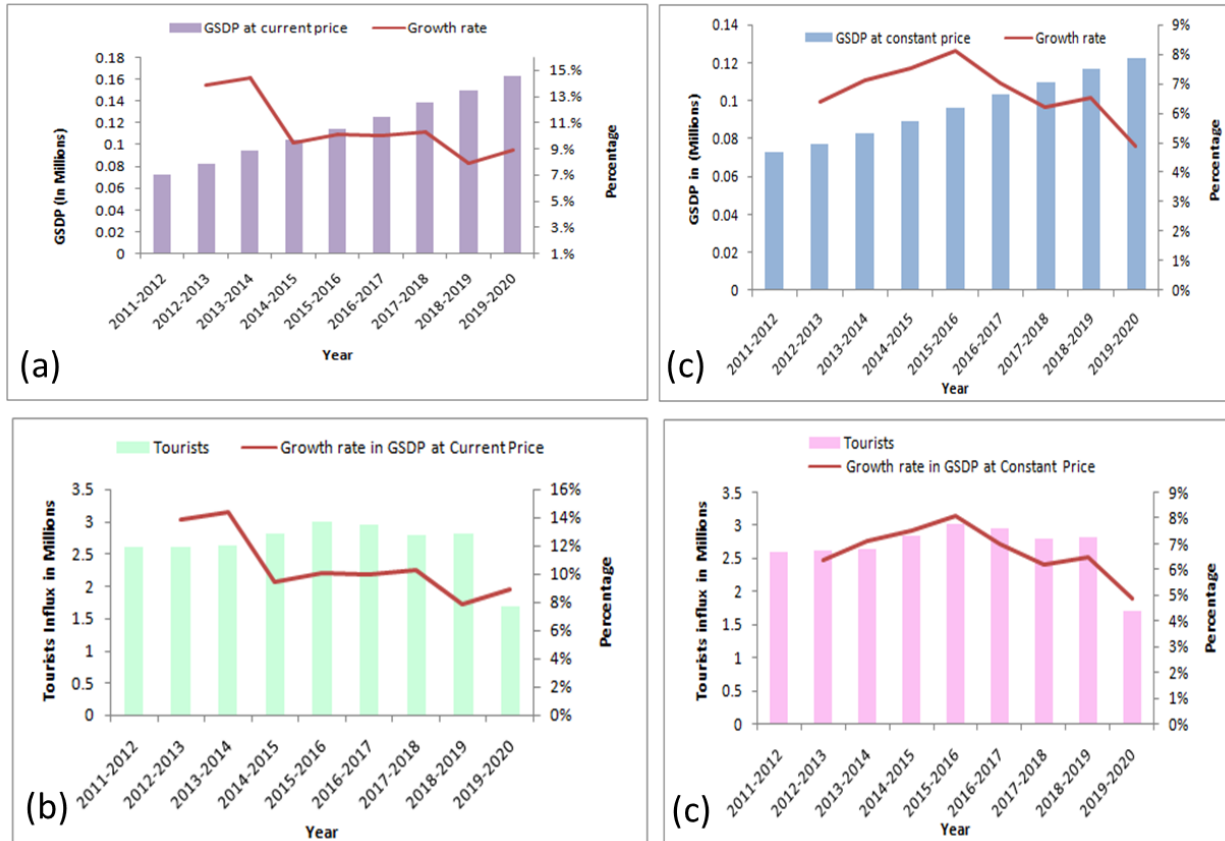


Fig..3.2: (a) Growth rate in GSDP with current prices in H.P (b) Growth rate in GSDP in constant price in H.P (c) Tourist influx and growth rate with current price (d) Tourist influx and growth rate in GSDP at constant price in H.P from 2011-2020.

3.2. Number of Vehicles (State/District Wise)

In the past few years there is a significant increase in the number of vehicle in H.P. with every upcoming New Year. In the year 2007 there were 0.3 million registered vehicles in Himachal Pradesh which almost doubled as 0.6 million in 2011. Further this increased to 1.3 million in 2018 and presently there were over 1.6 million registered vehicles across the Indian state of Himachal Pradesh at the end of fiscal year 2019. There has been an approximate increase of 1.3 million vehicles in Himachal Pradesh from 2007 to 2019. As per the data of Economics & Statistics Department of Himachal Pradesh (2021) the maximum number of registered vehicles is 0.14 million in district Solan while least as 3729 in Lahaul Spiti from 2011 to 2020. Data of district Kangra and Hamirpur was not available (Fig..3.3 a). The rate of change of number of vehicles showed a continuous increase from 9% to 11% from 2015 to 2018 while it showed a decrease of -21% in 2020 when compared to 2019 (Fig.. 3.3 b).

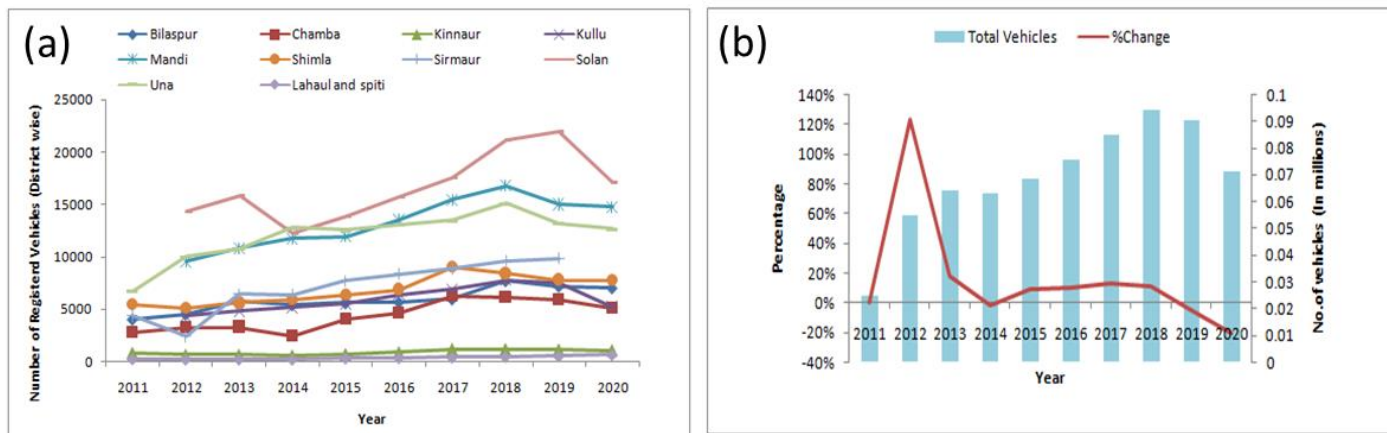


Fig..3.3: (a) Number of registered vehicles in H.P (District wise 2011-2020), and (b) Rate of change in number of vehicles in H.P (2011-2020) (Source: Economics & Statistics Department of Himachal Pradesh 2021)

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

Increased tourism is slowly degrading the environment of Himachal Pradesh from past few years. Tourist destination like Shimla and Kullu- Manali is in danger of being buried by huge quantities of garbage, which are left behind by visiting tourists. Cole and Sinclair (2002) measured ecological footprint of tourism in Manali and found that unplanned nature of development with immense speed has led to many environmental concerns. Problems of water scarcity, quality degradation and open sewage disposal in the Beas River are the most striking effects of tourism industry. Heavy tourism, besides being a boon to the economy of Himachal Pradesh, it causes the adverse impacts on ecology and environment of the State. The NGT order states that "The State Government has neither formulated nor issued any specific guidelines – statutory or otherwise – on prevention and control of environmental degradation and damage in relation to the glacier of Rohtang Pass valley". It needs to be mentioned that Himachal Pradesh is considered to be one of the leading mountains states and yet it is not able to halt environmental damage due to increasing tourism and despite its updated policies and development master plans (NITI Aayog, 2018).

3.2.2. Ill effect of tourism on waste generation

The waste generated from hill spots and trekking expedition is a challenging part of the Solid Waste Management in the state. The average waste generation was 200 gm – 300 gm/person/day in hill spots and 200 gm – 288 gm during trekking expeditions during 2003. 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 the case of non- biodegradable waste, its components were majorly glassware, polythene, plastic bottles, and wrappers. Among non-biodegradable waste, it was recommended that 60.68% of waste was able to be recycled if collected and transported properly. In the Kullu and Manali region, the bio-degradable waste generated from the tourist influence was found to be 47.6% - 65.5%

of the total waste generated in both cities (Kuniyal et al. 2003). Himachal Pradesh generates the maximum amount of garbage in May and June when people from plains head to the mountains to cool off. Reportedly, the garbage generation in the state's hill station has gone down to an unusual amount during the lockdown season.

3.2.3. *Ill effect of tourism on water quality*

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

3.2.4. *Ill effect of tourism on air quality*

Burning of garbage and increased number of vehicles during peak season of tourism is leading to increase in pollutant such as Nox (NO_2 & NO), PM_{10} , $\text{PM}_{2.5}$. Air pollution studies over a four-year (1996-99) period shows that suspended particulate matter (SPM) have gone up to $112 \mu\text{g}/\text{m}^3$ at Manali during summers. Trace gas concentrations, such as SO_2 and NO_2 during 1996-97 were between $12\text{-}29 \mu\text{g}/\text{m}^3$ and $16\text{-}28 \mu\text{g}/\text{m}^3$ at Kullu, and $12\text{-}40 \mu\text{g}/\text{m}^3$ and $12\text{-}34 \mu\text{g}/\text{m}^3$ at Manali respectively. SO_2 and NO_2 concentrations were in excess under specified 24-hour standard duration for sensitive areas ($15\text{-}30 \mu\text{g}/\text{m}^3$) during summer season in Manali (Kuniyal et al. 2003). Similar results were reported by NEERI after 12 years in its study carried out in 2011-2012 both in summers and winters at different stations on way to Rohtang, Marhi, Solang and Kothi, where an increase in concentration of carcinogenic elements. As (the chemical element arsenic) and Ni (Nickel) was recorded exceeding the CPCB limits except Pb (lead) which was found within stipulated standards. Besides these several other factors, such as inadequate and poorly maintained roads as well as inadequate practices of inspection and maintenance of vehicles, unplanned traffic flow, and non-availability of effective emission control technology, etc., also contributes to the air pollution from vehicular sources. Air quality has majorly effected the tourist destinations over the period of time.

3.2.5. *Ill effect on loss of greenery/biodiversity*

Conversion of land to tourism uses results in loss of the biodiversity that it otherwise supports and may also affect biodiversity in surrounding areas (World Tourism Organization). Demand for tourism has exaggerated the pressure on hill stations and is becoming a major concern for change in land use/land cover. According to a study conducted in Manali built-up has increased from 4.7% to 15.7% during 1989 to 2012 indicating fast growing development in the area. At the same time, exponential increase

in number of tourists from 1.4 to 28 lakhs from 1980 to 2011, respectively confirms excessive pressure of tourism in the region. Even, number of hotels has also been increased over the years (Vijay *et al.* 2016) indicating a loss of greenery and biodiversity in the region. There is thus a need to pre-empt the disastrous effects of unregulated tourism and learn lessons from the over-exploited tourist destinations of the state and devise mechanisms to help achieve tourism growth in the landscape in a sustainable manner, having minimal impacts on biodiversity, while providing sustainable livelihood options for the local community.

3.2.6. *III effect on land/soil contamination and ground water*

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

3.3. Assessment of waste generation

Himachal Pradesh is divided into 12 districts, each of which is subdivided into tehsils and blocks. Different villages and urban areas are controlled by urban local bodies and village panchayats in these blocks. Nagar Panchayats, Municipal Councils, and Municipal Corporations are the three types of urban local bodies based on population. In Himachal Pradesh, there are four municipal corporations (Shimla, Solan, Palampur, and Dharamshala), as well as 56 municipal councils and Nagar Panchayats. These urban local bodies are authorized to deal with problems related to solid waste. According to a guidebook on Solid Waste Management for ULB's "State Strategy on Solid Waste Management-Himachal Pradesh" released by Department of Urban Development Himachal Pradesh in 2019 it was estimated that total waste generated per day by the ULB's was 370 TDP (approx.) which consisted of 190 TDP of biodegradable/wet waste and 150 TDP of non-biodegradable/ dry waste. The highest waste generation recorded in the area under municipal cooperation in Shimla. In addition, solid waste generated due to local communities, ever increasing tourism in the form of recreation, trekking and religious place visits have also contributed to the higher production of solid waste in the state. In Table 3.2, a summary of waste generation for various ULBs located in popular tourist destinations in Himachal Pradesh is shown. Shimla has the highest municipal waste generation pattern for the years 2017–2021. The municipal solid waste majorly consists of domestic waste collected from houses. This waste majorly composed of Biodegradable waste or wet waste consisting Kitchen waste and paper. Small proportion of this is made of non-biodegradable waste or dry waste. Very few scientific studies have been conducted in Himachal on the composition of Solid waste in one such study conducted by NEERI on solid waste characteristic it was found that 52% of solid waste generated was biodegradable, 24% consisted of paper, 10% plastic, 4% textile, 1% glass,1% rubber,1% metal and 7% inert material composed the waste (State Strategy on Solid Waste Management-Himachal Pradesh 2019). Sharma *et al.* 2018 conducted a similar study on waste composition for Solan, Mandi, Sundernagar, and Baddi, and obtained the same results as NEERI's previous study. The majority of Municipal solid waste is made up of easily biodegradable kitchen garbage which can be easily converted into manure through

compositing, which readily reduces the chances of diseases and environmental hazards caused by biodegradable waste. Non-biodegradable waste can be recycled and reused, decreasing the amount of waste going to landfill.

Table 3.2 Municipal waste generated (in Tons Per Day TDP) in important tourist destinations

Sr.N o.	District	Important tourist destinations ULB's	Total Waste produced (TPD)	Total Waste produced in 2020-2021	Total Waste produced in 2019-2020	Total Waste produced in 2018-2019	Total Waste produced in 2017-2018
1.	Shimla	Shimla	90	82	82	85	85
2.	Sirmaur	Paonta	9	8.65	8.65	8.65	8.65
3.	Bilaspur	Naina Devi	1	0.5	1	1	1
4.	Kullu	Kullu	10	6-7	7-8	8-9	8-9
		Manali	12	10	35	35	35
		Banjar	0.50	0.5	0.5	0.6	0.52
5.	Mandi	Rewalsar	0.60	1	1	1	1
		Karsog	1	1	-	-	-
		Mandi	23	16.50	16.50	24	30
6.	Kangra	Kangra	6	4.5	4.5	4.5	4.5
		Baijnath	7.80	4	3	3.45	3.45
		Dharamshala	18	15	20	25	25
		Jawalamukhi	2.10	0.33	0.33	3	3
		Palampur	1.50	6	1.4	1.5	1.5
7.	Chamba	Chamba	8.50	6	5	5	8
		Dalhousie	2.50	3.6	25-30	25.30	25.30

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

3.4. Segregation /utilization of waste

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

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

3.5. Waste Disposal/treatment facilities

In Himachal Pradesh, the same garbage disposal pattern as the rest of India is followed, specifically, depositing it in landfill sites. However, in recent years, the lack of a dumping site owing to the closure of an existing dumping site has caused a dilemma for ULBs in terms of storing and managing the trash. Because the state's hilly terrain prevents the establishment of big landfill sites, unlike plain regions, the majority of the trash collected is decomposed into compost and processed into RDF, which is then supplied to cement plants as a fuel for burning. Only Manali and Shimla ULBs have waste-to-energy power plants, with the Manali facility still not completely operational due to unforeseen circumstances (table 3.3). Except for the space for waste processing, not much information about the dumping site is mentioned in the Annual Report under SWM standards 2016 for the different years 2020-2021. Sharma et al. (2018) conducted a study for the four dumping sites in Himachal Pradesh. The data on municipal solid waste management has been provided for the different ULB's from the year 2017 onwards after the municipal solid waste management rules of 2016 came into effect. Therefore, this report has been compiled according to the data available.

As per the Hon'ble Tribunal vide latest order dated 20.11.2017,09.10.2018,10.10.2019 and 08.06.2021. A status report was filed on 25.10.2021 by the Additional Chief Secretary. The Hon'ble Tribunal vide latest order dated 08.06.2021 has directed as under:

"We have considered the report. It is seen that the ropeway project has not been completed for want of requisite EC. Steps are in progress for setting up of STP at Marhi and upgradation of STP at Manali, for parking facilities, Solid Waste Management facility, Nature Park, Electric Buses. The said steps need to be expedited. We find it difficult to understand the delay in grant of electric connection to the STP at Marhi. With regard to the upgradation of STP at Manali, though it is stated that the work was likely to be completed by June, 2021, the latest status is not known. Steps for Solid Waste Management facility at Manali and other pending jobs need to be expedited."

The department wise steps taken/Compliance status with respect to implementation of the orders of the Hon'ble National Green Tribunal was submitted. Under the development of solid waste management facility at Manali following steps have been taken:

The Deputy Commissioner, Kullu has informed that as per the report of the Executive Officer, Municipal Council Manali, the Waste to Energy Project for the Management of the Solid Waste is being established at the existing site at Rangri, Manali. First section of the Solid Waste Management facility

for the production of the Refuse Derived Fuel (RDF) is operational. RDF is being sent to ACC Barmana Cement Plant. The Municipal Council, Manali has signed Memorandum of Understanding (MOU) with M/s Nextgen Chemicals Pvt. Ltd. on 05.08.2017 to setup Waste to Energy Plant (second section) of the capacity to treat 35 Tons of Waste /garbage per day to generate 1MW electricity. Efforts are being made to set up the second section.

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

S.No.	District	Important tourist destinations	Dumping site availability	Area Available for waste processing	waste Processed (TDP)	Waste processed for Compost	Compost produced	RDF	Landfilled waste
2020-2021									
1.	Shimla	Shimla	Land available 9.923 Hectare.	2.45 Hectare	60-80	0.5 tpd	50 kg	35	5-8
2.	Kullu	Manali	No sanitary landfill sites available.	1.5 Bigha	7	-	-	-	-
3.	Kangra	Dharamshala	No sanitary landfill sites available.	2.96 Hectare	4	30 ton	20 ton	-	-
4.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891Hectare	3.6	100kg	50 kg	-	-
2019-2020									
5.	Shimla	Shimla	Land available 9.923 Hectare.	2.45 Hectare	60-80	0.5 tpd	50 kg	25	5-8
6.	Kullu	Manali	No sanitary landfill sites available.	1.5 Bigha	35	-	-	-	-
7.	Kangra	Dharamshala	No sanitary landfill sites available.	2.96 Hectare	4	600 kg	200 kg	-	16
8.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891Hectare	-	-	-	-	25-30 quintal
2018-2019									
9.	Shimla	Shimla	A new waste to energy plant having 100 Tonnes/day capacity is set up on Tara Devi bye Pass road. RDF section	2.45 Hectare	60-80	0.5 tpd	50 kg	40	5-8

			has been made functional.						
10.	Kullu	Manali	There is no waste processing facility is being setup	1.5 Bigha	35	-	-	-	35 (tourist season) 12 (off season)
11.	Kangra	Dharamshala	No sanitary landfill sites available.	1.5 Hectare	-	4 MT	-	-	20
12.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891	-	-	-	-	25-30 quintal
2017-2018									
13.	Shimla	Shimla	A new waste to energy plant having 100 tdp capacity is set up on Tara Devi bye Pass road. RDF section has been made functional.	2.45 Hectare	60-80	0.5 tpd	50 kg	40	5-8
14.	Kullu	Manali	There is no waste processing facility is being setup	0.75	22	-	-	-	17
15.	Kangra	Dharamshala	No sanitary landfill sites available.	1.5 Hectare		2	-	-	-
16.	Chamba	Dalhousie	No sanitary landfill sites available.	0.0891 Hectare	-	-	-	-	25-30 quintal

3.6. Impact on Air Quality

Presently Himachal Pradesh has established air quality monitoring stations at different cities.

The monitoring station is established in industrial areas, residential areas and ecological sensitive areas under the national ambient air quality program of CPCB.

3.6.1. Parameter wise Air Quality

3.6.1.1. RSPM (Respirable suspended particulate matter)-The yearly average concentration of RSPM in Himachal Pradesh showed that highest concentration was seen in Poanta Sahib monitoring station of district Sirmaur with 150.80 $\mu\text{g}/\text{m}^3$ in 2012, 129.44 $\mu\text{g}/\text{m}^3$ in 2010 and 129.30 $\mu\text{g}/\text{m}^3$ in 2011. A possible reason behind high level of RSPM in Poanta Sahib is that it is an industrial area. The second

highest concentration of RSPM was seen as $93.4 \mu\text{g}/\text{m}^3$ in Una (2013), followed by $91.63 \mu\text{g}/\text{m}^3$ in Kullu in 2011. The lowest concentration was observed as $30.56 \mu\text{g}/\text{m}^3$ in Kangra in 2010. Figure 3.4(a) shows the monthly average concentration of particulate matter in Solan, Kangra, Una, Sirmaur and in major tourist destination Kullu Manali and Shimla from 2010 to 2020, although levels of RSPM showed a decrease in all districts after 2016. The rate of change in RSPM ranged from -19% to 3% in a decade. Further during COVID 19 lockdown a decrease of -0.34% was seen in concentration in 2020 as compared to 2019. Figure 3.4(b) shows yearly average concentration of RSPM and rate of Change of RSPM in Himachal Pradesh 2010 to 2020. The rising pollution is a matter of serious concern, especially high level of particulate matter exceeding National ambient air quality standards, 2009; CPCB issued direction for industries under Section 5 of the Environment (Protection) Act, 1986 as Further in compliance of Hon'ble NGT order dated 28.03.2019 and 04.07.2019 in O.A No. 67/2019 and O.A. No. 138/2019, CPCB issued directions under Section 5 of the Environment (Protection) Act, 1986 to the Chief Secretaries/ Administrators of States Governments/Union Territory Administrations vide letter dated 23.08.2019 directing as below.

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

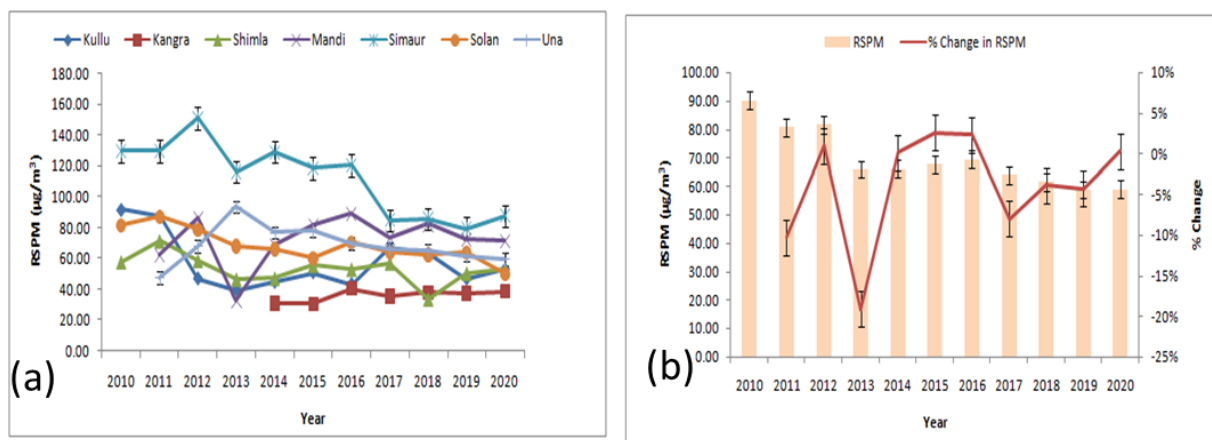


Fig..3.4: (a) Concentration of RSPM in different districts of Himachal Pradesh from 2010 to 2020
(b) Yearly Average concentration of RSPM and rate of Change of RSPM in Himachal Pradesh 2010 to 2020 (Source-Himachal Pradesh State Pollution Control Board (HSPSCB))

3.6.1.2. Particulate Matter 2.5 ($\text{PM}_{2.5}$) - $\text{PM}_{2.5}$ data was available from 2018 to 2020. The results revealed that average concentration of $\text{PM}_{2.5}$ from 2018 to 2020 was highest in district Sirmaur $48.2 \mu\text{g}/\text{m}^3$ (2018) followed by $42.32 \mu\text{g}/\text{m}^3$ in Mandi (2018), Una $34.7 \mu\text{g}/\text{m}^3$ (2019), Shimla ($34.2 \mu\text{g}/\text{m}^3$) in 2018, and the lowest in Kangra ($14.19 \mu\text{g}/\text{m}^3$) (Fig..3.5a). The rate of change of $\text{PM}_{2.5}$ showed a

decrease of -26% in 2020 as compared to 2019. Fig. 3.5(b) shows yearly average concentration of $PM_{2.5}$ and rate of change of $PM_{2.5}$ in Himachal Pradesh from 2018-2020.

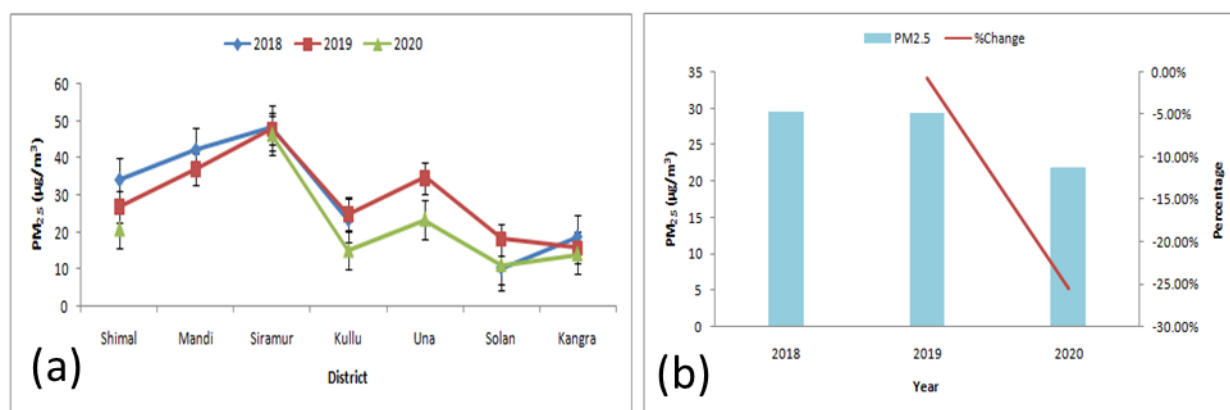


Fig.. 3.5: (a) Concentration of $PM_{2.5}$ in different districts of Himachal Pradesh from 2018 to 2020, (b) Yearly Average concentration of $PM_{2.5}$ and Rate of Change of $PM_{2.5}$ in Himachal Pradesh from 2018-2020 (Source-Himachal Pradesh State Pollution Control Board (HPSPCB))

3.6.1.3. Nitrogen Dioxide (NO_2) - NO_2 is a major pollutant released by vehicular emission. It is primary pollutants and is a precursor of secondary harmful pollutant such as surface ozone. NO_2 was within permissible standards of NAAQS as per HPSPCB data. The yearly average concentration of NO_2 showed highest average concentration of 26.5 $\mu g/m^3$ in 2018 in district Shimla followed by 25.45 $\mu g/m^3$ in 2019 in Shimla (Fig. 3.6 a). The concentration of NO_2 was within permissible standards of NAAQS in all districts from year 2010-2020. The rate of change of NO_2 ranged from -16% to 6%. While in 2020 NO_2 decreased to -17% as compared to 2019 due to the Covid restrictions in year 2020. Figure 3.6 (b) shows yearly average concentration of NO_2 and rate of change of NO_2 in Himachal Pradesh from 2010-2020.

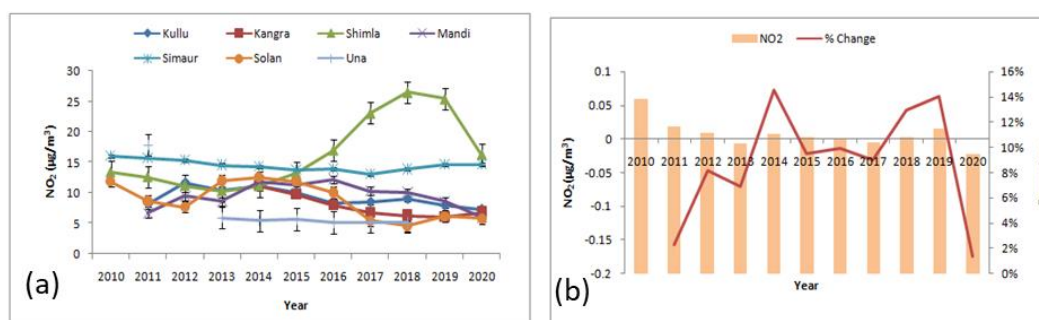


Fig..3.6: (a) Concentration of NO_2 in different districts of Himachal Pradesh from 2010 to 2020 (b) Yearly Average concentration of NO_2 and rate of Change of NO_2 in Himachal Pradesh from 2010-2020 (Source-Himachal Pradesh State Pollution Control Board (HPSPCB))

3.6.1.4. Sulphur Dioxide (SO_2) - Sulphur dioxide is mainly released by burning of fossil fuel and other waste product. It was within the permissible standards of NAAQS in all the monitoring stations of

Himachal Pradesh as per HPSPCB data. SO_2 showed highest average concentration $6.08 \mu\text{g}/\text{m}^3$ in 2011 in Una followed by $3.3 \mu\text{g}/\text{m}^3$ in 2019 in Sirmaur followed by $2.5 \mu\text{g}/\text{m}^3$ in Shimla in 2018. Figure 3.7 (a) shows yearly average concentration of SO_2 in different districts of Himachal Pradesh. The rate of change of SO_2 ranged from -24% to 6% in a decade while in 2020 it showed a decrease of -3% when compared to 2019 (Fig. 3.7 b).

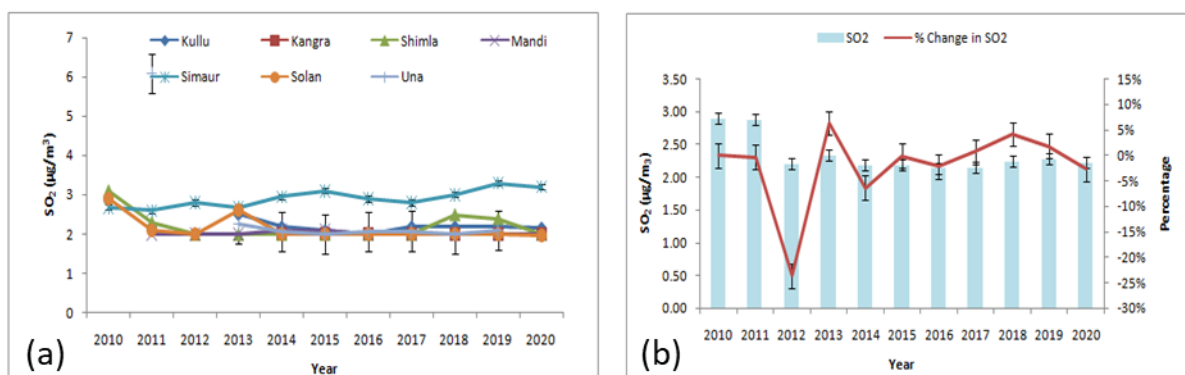


Fig.3.7: (a) Concentration of SO_2 in different districts of Himachal Pradesh from 2010 to 2020, and (b) Yearly Average concentration and Rate of Change of SO_2 in Himachal Pradesh from 2010-2020 (Source-Himachal Pradesh State Pollution Control Board (HPSPCB))

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

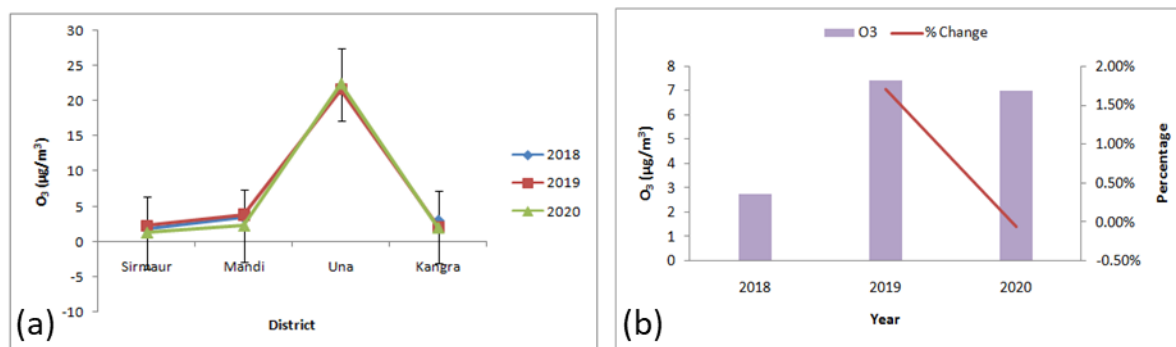


Fig.. 3.8: (a) Concentration of O_3 in different districts of Himachal Pradesh from 2018 to 2020 (b) Yearly Average concentration and rate of Change of O_3 in Himachal Pradesh from 2018-2020 (Source-Himachal Pradesh State Pollution Control Board (HPSPCB))

Surface ozone data of Kullu district was not available with HPSPCB, but, G.B. Pant National Institute of Himalayan environment, Himachal Regional Centre has also been monitoring Surface Ozone from 2010 to 2015 (At Mohal) 2016 to 2018 at Kothi and again at Mohal from 2019 under ISRO funded long-term project. Figure 3.9 (a) and 3.9(b) shows concentration of Surface ozone at Mohal and Kothi (2010-2020). The average concentration of surface ozone showed highest concentration of $49.72\mu\text{g}/\text{m}^3$ at Kothi in 2018 and lowest as $15.98\mu\text{g}/\text{m}^3$ in 2015 at Mohal-Kullu. The rate of change for surface ozone varied from -32% to -20% from 2011 to 2015 at Mohal-Kullu while the rate of surface ozone showed an increase of 51% in 2017 and 252% in 2018 at Kothi (Manali) while at Mohal again rate of change showed a decrease of surface ozone by -64% in 2020 at Mohal-Kullu (Fig..3.9 c).

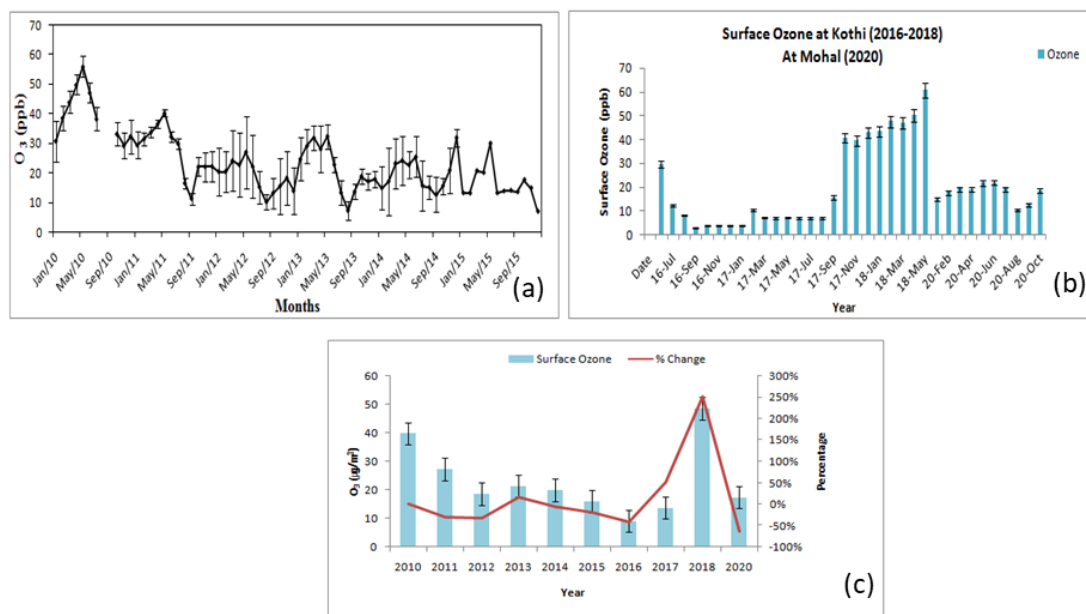


Fig.. 3.9: (a) Concentration of O_3 at Mohal- Kullu Himachal Pradesh from 2010 to 2015, (b) Concentration of O_3 at Kothi, Manali Himachal Pradesh from 2016 to 2018 and at Mohal in 2020, and (c) Yearly Average concentration and rate of Change of O_3 in Kullu from 2010-2020

3.6.1.6. Black Carbon (BC) -Black Carbon data was not available for any district with HPSPCB. G.B. Pant National Institute of Himalayan Environment Himachal Regional Center is continuously monitoring Black Carbon in Mohal - Kullu under ISRO funded long-term project. Black carbon showed bimodal peak in this region. The highest average concentration was 4394.9 ngm^{-3} in 2009 followed by 4154.7 ngm^{-3} in 2010 and lowest as 1226.2 ngm^{-3} in 2016 (Fig..3.10 a). The rate of change of Black Carbon ranged from -5% to 43% for a decade and showed a decrease of -27% in 2021 when compared to year 2020 at Mohal- Kullu (Fig..3.10 b). To prevent air pollution in ecological sensitive area, The Hon'ble NGT has directed order to run electric buses in Rohtang.

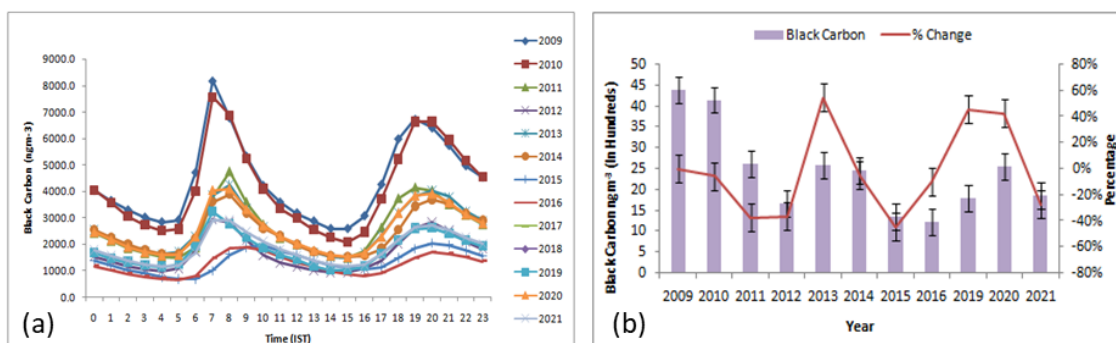


Fig..3.10: (a) Concentration of Black Carbon in Mohal-Kullu from 2009 to 2021, and (b) Yearly Average concentration and rate of Change of BC in Mohal- Kullu from 2009-2021

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

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

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

Table 3.4 Action Plan of Himachal Govt. in compliance with NGT order for air pollution

Sr.No	Source group	Action Point	Target date from date of approval
1.	Vehicles	Restriction on plying and phasing out 15 year old commercial diesel driven vehicles.	The matter will 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-authorised fuel in boilers.	April 2019
		Conversion of brick klin to forced/Induced Draft	April 2019
		Action against non-complying industrial units.	January 2019
		Disposal of Boiler ash & other non hazardous wastes into the designated dumping sites.	January 2019
		Fugative emission control.	January 2019

6.	Traffic and Transportation	Restriction on movement of goods vehicles in certain areas during day time and peak hour.	January 2019
		Action to check visibly polluting vehicles through routine checking.	January 2019 & continue as regular activity
		Action to check overloaded vehicles.	January 2019 & continue as regular activity
		Ensuring commercial vehicles carrying husk, sand ,construction debris etc are properly covered.	January 2019
7.	Strengthening of AAAQM monitoring	Installation of more CAAQMS at different stations	August 2019
		Up gradation of existing NAMP stations for monitoring of 12 parameters.	June 2019

3.8. Impact on water quality/ ground water:

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

3.8.1. Physical Parameters:

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

Dissolved oxygen is an important parameter in assessing water quality because of its influence on the organisms living within a body of water Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. (Vikal, 2009). Data Analysis of HPSPCB was done which showed that DO was highest (14.97mg/L) in district Shimla in 2012 followed by Mandi (11.93 mg/L) in 2020 and 10.24 mg/L in Kullu. The decadal rate of change in dissolved oxygen varied from -8% to 7%. In 2020 DO levels increased by 4% when compared to 2019 (Fig.. 3.11).

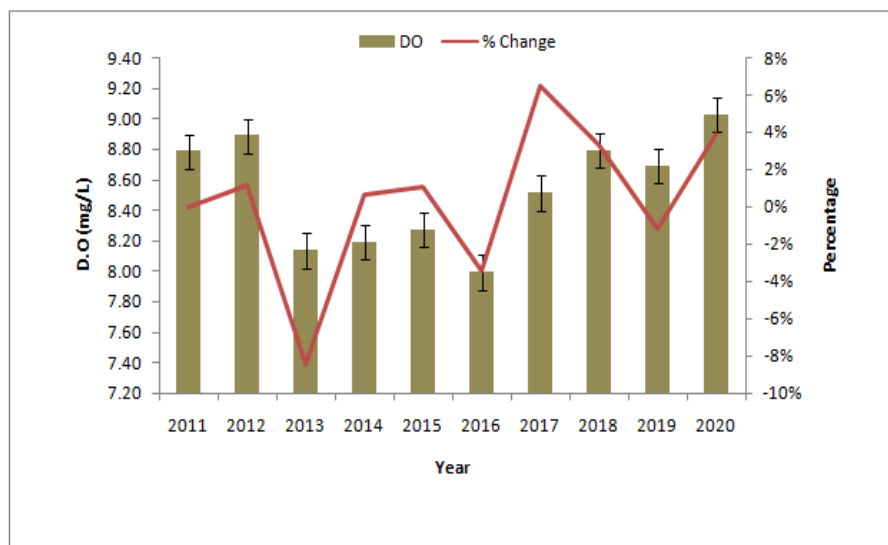


Fig.. 3.11: Yearly average Concentration of Dissolved oxygen and rate of change in DO in different districts of H.P from 2011-2020 (*Source-Himachal Pradesh State Pollution Control Board (HPSPCB)*)

BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials (e.g., iron, sulfites). As per CGWB the values of BOD in the groundwater in all the districts ranges from not detectable to 0.9 (in district Sirmaur, 2014). Further, monthly data was analyzed from HPSPCB which was highest (15.13mg/L in 2012) at Solan followed by 7.34 in 2011 again at Solan, indicating high pollution level at Solan while it was lowest (0.10 in 2016) in district Kinnaur. The decadal rate of change in BOD levels varied from -68% to 58% while there was a decrease of -53% in BOD levels in 2020 as compared to 2019 (Fig.. 3.12).



Fig.. 3.12: Yearly Average Concentration of BOD and rate of Change in BOD in different districts of H.P from 2011-2020 (*Source-Himachal Pradesh State Pollution Control Board (HPSPCB)*)

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

3.8.2. Chemical Parameters:

Both BOD and COD are key indicators of the environmental health of a surface water supply. The COD is amount of chemical oxidant for oxidation of organic water that is present in water. The mean value of COD in water of river Beas was 1.92 ± 0.94 mg/L (Sharma & Walia, 2016), while at Satluj river basin the COD varied from 34.25 to 121.75 mg/l, further an increasing trend of COD was seen at Khab Kinnaur and Rampur indicating increased population activities, garbage dump and sewage mixing (Sharma & Walia 2017). This trend of increase in COD indicates increasing level of pollution in the region. Chlorides are formed when chlorine combine with other elements. The mean value of chloride in water of river Beas was 15.45 ± 7.9 mg /L, while the chloride levels varied from 8.750 to 150 mg /L. in satluj river basin, which was within the prescribed limit of 250 mg/L prescribed by BIS 2012. Further as per the CGWB report from year 2011-2020, the lowest value of chloride ranges from 19.5 mg/l in district Hamirpur (2011) to 93.2 mg/l in district Mandi (2014). According to CGWB yearly report from 2011-2020 The values of phosphate maintained consistent trend throughout the past ten years in almost all the districts and the value calculated was <0.1 to Below Detectable Limit. Iron (Fe) usually occurs in groundwater in solution as ferrous (Fe^{2+}) ions. When this ion is exposed to air, they form the insoluble ferric (Fe^{3+}) forms making the water turbid and unacceptable to most people. According to CGWB yearly report from 2011-2020 The values of iron remained well below detectable limit in Himachal Pradesh.

3.9. Biological Parameters:

3.9.1. Escherichia coli and Total Coliform

As per the WHO (2011) and BIS (2012) drinking water should be free from Coliform and *E. coli* (Sharma & Walia, 2016). Total coliforms (TC) are the bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste. The monthly data was taken from HPSPCB for 2011 to 2020 which showed that TC was highest as 692 CF in 2016 in district Mandi followed by 625.25 in 2015 again in Mandi followed by 540 CF in 2012 at district Bilaspur, while lowest Coliform was 12.58 in 2011 at district Kinnaur. The decadal rate of change in total Coliform value ranged from -2% to 55% for 2011 to 2019 while it decreased to -31% in the year 2021 (Fig.. 3.13).

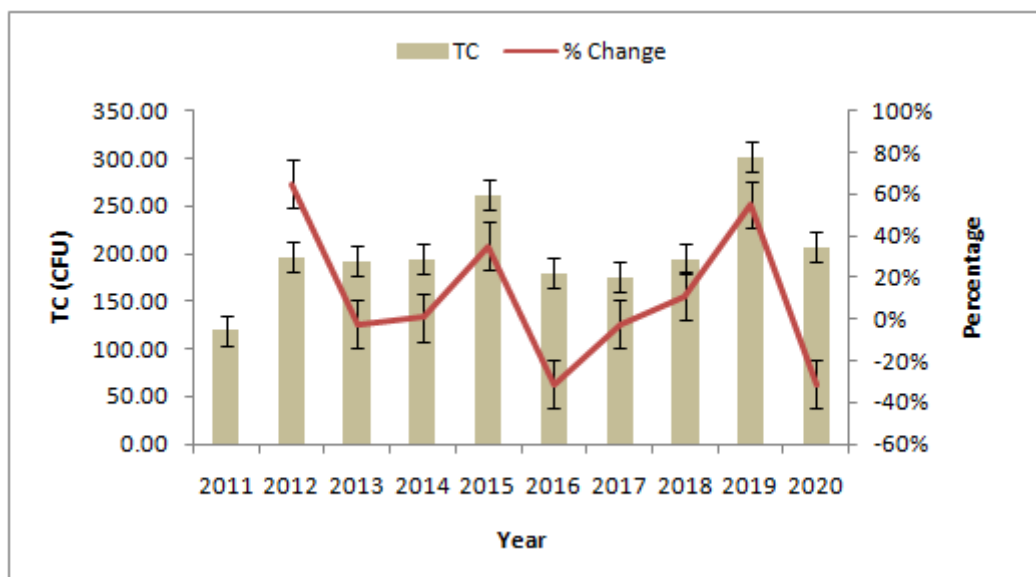


Fig.. 3.13: Yearly average total Coliform and rate of change in Coliform from 2011 to 2020

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

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

3.10. Impact on Forest and Biodiversity

3.10.1. State wise RET categories species wise / forest cover

- According to the India State of Forest Report 2021 published by the Forest Survey of India, forest cover of the state is 27.73% of the total geographical area, i.e., 15,443 sq.km. Under the various categories of forest cover, very dense forest covers 3,163 sq. km. of the total geographic area, moderate dense forest covers 7,100 sq. km. of geographical area while open forest covers 5,180 sq. km. of geographic area. In comparison to the year 2019 reports, forest cover has increased by 9 sq. km.
- Himachal Pradesh due to its unique geographical location and climatic conditions is rich in floral and faunal species. This region's distinctive flora is valued for its ethno-medical characteristics, making it economically important. Many plants, particularly medicinal plants, and rare native animals are facing extinction in recent years as a result of habitat loss, overexploitation, climate change, and other factors, posing a severe threat to the state's floral and faunal diversity. As a result, the Himachal State Compensatory Afforestation Fund Management and Planning Authority (CAMPA) and committee for threatened animals are working to list these vulnerable plants and animals to priorities conservation efforts in order to manage and conserve this Himalayan plant and animal biodiversity. According to the Red-list status of candidate species as per the Shimla conservation assessment management prioritization, December, 2010 Report, and committee for threatened animals February 2017 report, Himachal Pradesh state biodiversity board, there are 57 plant species of plants and 16 species of animals that are classified as threatened.

3.10.2. Loss of biodiversity due to waste disposal (Population, etc.)

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

3.10.3. Growing vegetation nearby dumping sites with altitude

A total 175 plant species belonging to 137 genera and 48 families were recorded during the study carried out by G. B. Pant National Institute of Himalayan Environment, Himachal Regional Centre,

Mohal- Kulluin and around dumping sites of Manali, Kullu, Mandi, Bilaspur, Hamirpur, Kangra and Chamba (Fig.. 3.14). The largest number of species was noted from the family Asteraceae (26 spp.), followed by Poaceae (18 spp.), Malvaceae (11 spp.), Fabaceae & Solanaceae (08 spp. each), Amaranthaceae (07 spp.), Euphorbiaceae & Rubiaceae (06 spp. each), Plantaginaceae (05spp. each). The genus *Solanum* exhibited highest diversity with 5 species followed by *Amaranthus*, *Erigeron*, *Euphorbia* & *Ipomea* (04 species each). Most of the species growing in these areas were herbaceous (113 spp.), followed by trees (42 spp.) and shrubs (20 spp.). It can be pointed out that due to more garbage disposal the alien and inferior plants will preponder and encroach into the habitats of native vegetation.

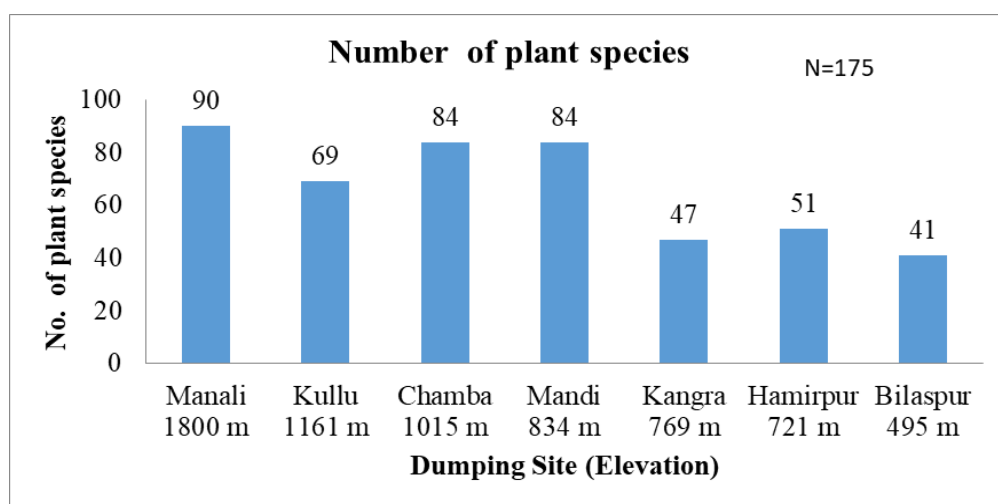


Fig.. 3.14: Number of species recorded from different dumping sites

3.11. Eco sensitive zone/area

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

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

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

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

3.12 Gaps & Plan of Action

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

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

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

3.13. Summary

Accelerated growth of tourism in Himachal Pradesh in the past few year had substantial impact on its economy, local community and environment. The tourism industry has served an important industry in economic development of people in the state, but as a coin has two sides similarly tourism has two sides as well, with increase in tourism there is increased waste generation, increased vehicles, increased waste disposal into rivers has led to degradation of the soil, water and air quality over the period of time. Waste disposition has become a huge problem which needs immediate attention. Decentralization of waste management, introduction of latest technologies such as automatic bio-

composters, plastic brick making machines etc can help in robust waste management especially on the hilly cities with limited area for dumping of waste.

Further with increased number of vehicles, burning of waste there is a slow decrease in air quality in the region which can be only measured by regular monitoring of pollutants and understanding their diurnal and seasonal variability in the region. Some of the mitigating measures to combat degrading air quality such as: (i) nature based solution can be used as a sustainable way to combat air pollution. Some of the sensitive species such as lichens, algae, and trees have been used as bio-indicators of air quality, (ii) improving the vegetation cover/greenery will also help in reducing air pollution, and (iii) some of the plant species have the potential to reduce air pollution through mechanisms such as bioaccumulation and deposition. The tolerance and sensitivity of the plant species vary depending on the type of stress (pollutant) and plant physiology. Air Pollution Tolerance Index (APTI) is a measure developed by Singh and Rao (1983) to assess the plant's tolerance to air pollutants. The plant species with high APTI value can be used to mitigate air pollution and the species with low APTI value can be used as bio-monitors due to their high sensitivity can be used to help combat degrading air quality. Regular monitoring of water quality especially monitoring of natural water resources, Capacity building and awareness among the local community and tourists about Water quality degradation will help improve the water quality in the region further proper management of Sewage waste so that it does not mix with other natural water resources will also help to prevent degradation of air quality. Regular monitoring of water quality especially monitoring of natural water resources, capacity building and awareness among the local community and tourists about Water quality degradation will help improve the water quality in the region further proper management of Sewage waste so that it does not mix with other natural water resources will also help to prevent degradation of air quality. Several efforts are being made by government of Himachal Pradesh to protect eco-sensitive zones recently the central government has published a draft notification declaring 50 square kilometre area around the Nagru Wildlife sanctuary as an eco sensitive zone. The area declared as eco-sensitive zone includes 17 revenue villages in Jogindernagar and Mandi forest division of H.P (The Indian Express 19 Nov 2020). Eco sensitive zone acts as a buffer zone between protected areas and residential areas which makes implementation of different laws and policies thus proper tourist management in eco sensitive zone is needed in Himachal Pradesh.

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

Thematic based tourism, ecotourism and awareness and capacity building programs should be organized to sensitize the Govt. officials those are field based, local as well as tourist community about the ill effect of tourism in environment. Installation of more equipments with latest technologies is required at all districts both in urban as well as rural area to monitor air quality which will be helpful to assess the exact impact of tourism on air pollution. Further industrial areas should use dust setters and scrubbers to minimize pollution. Biofuel can be used as an alternate to minimize the pollutants, further plantation of green belts in urban areas will minimize the effect of air pollution in the region. Parameters and frequency (seasonal) of water quality monitoring should be expanded; monitoring of heavy metals is also suggested. Proper waste disposal of waste should be done by municipal corporations so the generated waste could not have disposed in rivers. Further more water purification systems should be installed in the region. In many regions, waste generated in urban areas is generally collected in a segregated manner. However, garbage collection must be more efficient and frequent. Also, the appropriate places for constructing scientific landfills to dispose of waste left over after vermicomposting and RDF production should be selected. To fill in gaps in reports for more efficient waste management, data on the quantity and kind of waste produced should be generated. Decentralization of trash management should be encouraged to improve waste collection and management efficiency.

Uttarakhand

4.1. Introduction

4.1.1. General scenario of tourism in Uttarakhand

Tourism sector is important for Uttarakhand in view of its immense contribution to both revenue generation as well as employment creation. Uttarakhand ranks 12th for tourism in India, essentially represents a significant window to improve the ranking. The state is situated in the foothills of Himalayas. The presence of several hill stations, wildlife parks, pilgrimage places & trekking routes make Uttarakhand an attractive tourist destination. Mussoorie, Corbett National Park, Almora, Ranikhet, Bhimtal, Kausani, Dhanaulti, Chakrata, Lansdown, Mukteshwar, Chamba, Auli, Binsar, Pauri, Valley of flowers, Chopta and Nainital are some of the most popular tourist destinations in Uttarakhand. Some of the holiest Hindu shrines are also situated in the region such as the temples at Haridwar, Rishikesh, Badrinath and Kedarnath where pilgrims are visiting in the hope of salvation and purification from sin. The state is considering development of spiritual and religious theme-based circuits for tourism. With very heavy religious and spiritual tourism in Uttarakhand, tourism contributes major portion of GSDP. The Government of India had launched Swadesh Darshan scheme during 2014-15 based on the principles of high tourist value, competitiveness, and sustainability in an integrated manner by synergizing efforts to focus on needs and concerns of all stakeholders to enrich tourist experience and enhance employment opportunities. Under this scheme, National Mission on Pilgrimage Rejuvenation and Spiritual, Heritage Augmentation Drive (PRASHAD) was launched through which Badrinath, Kedarnath and Gangotri- Yamunotri (Char Dham) were identified for development in Uttarakhand. For the integrated Development of Heritage Circuit in Kumaon Region of Uttarakhand, Katarmal – Jageshwar-Bairnath-Devidhura are also taken under Swadesh Darshan scheme (Annual report 2019-2020, Ministry of Tourism, Govt. of India). Eco-circuit is being developed at Tehri- Chamba- Sarain around Tehri Lake in the state (Annual report 2020-2021, Ministry of Tourism, Govt. of India). In January 2018, to boost tourism, Centre has launched the regional connectivity scheme as 'Udan' which will help the low-income group people to fly easily affordable air fares (India Brand Equity Foundation: ibef).

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

Sundriyal et al. (2018) studied impact of tourism development on environment in Mussoorie by analyzing traffic management; ambient air quality; Municipal Solid Waste (MSW) generation; water demand and supply; infrastructure availability and development during 2014-15. Heavy traffic congestion was observed during peak tourist season. Fine particulate matter was found higher during

summers which might be associated with the higher inflow of vehicles while in winters, coarse particulate matters were higher. No significant difference in average BC concentrations was observed during winters and summers, although the contributing factors were found varying in both the seasons. In winters 23% contribution was from biomass burning while it was only 8% during summers. So, vehicles might be the main contributors in BC during summers. Littering by tourists all over the places was also observed along with attended waste bins. Municipal solid waste (MSW) production was found correlated with the tourist inflow. The MSW composition was also studied which consisted of 66% wet waste and 34% dry waste. Plastic waste was the major contributor in dry waste. Another problem was of water shortage during peak tourist season (Sundriyal *et al.* 2018).

Construction of hotels, restaurants and commercial centres is also increasing rapidly to cater tourists in different parts of the state, which is adding up the problem of water shortage and liquid and solid waste generation. So, all these areas along with other issues need to be worked out. The tourist's inflow is on the one hand economically beneficial while on the other hand can be harmful for the environment if not managed in a sustainable way.

4.1.2. Tourism growth vis-a-vis economic growth

During 2012-2016, Uttarakhand ranked 2nd in terms of tourist inflow with the total tourists of 24,951,540.6 (NITI Aayog, 2018). Highest tourists' inflow was observed during 2014-15 between 2011 and 2020. In 2019, domestic tourist inflow in the state were 35.60 million and foreign tourist visits had crossed over 0.15 million (India Brand Equity Foundation). It is observed that tourist arrivals can be strongly affected by disasters which is visible from Uttarakhand data in 2013 (20 million) when numbers dropped. Highest drop (appx. 80%) was in 2020 due to lockdown during COVID-19 pandemic (Department of Planning, 2018) (Fig.. 4.1). As per the data of Directorate of Economics and Statistics, Uttarakhand, tourism contributed 50% of the total GSDP during 2006-07 to 2016-17 along with the increasing livelihood options for the people residing here (Uttarakhand Tourism Policy, 2018). Hindustan Times dated 22 May 2022 mentioned that 'According to the State TSA, tourism is estimated to contribute 2.96 per cent directly to the State's Gross Value Added and 11.8 per cent to the State employment. With the inclusion of indirect shares pertaining to linkages of tourism with other sectors of the economy, these shares work out to 6.59 per cent in GVA and 26.8 per cent in employment. It also indicates that there is the likelihood to cultivate well-planned and managed tourism, in which environmental factors and socio-cultural aspects can be well integrated.

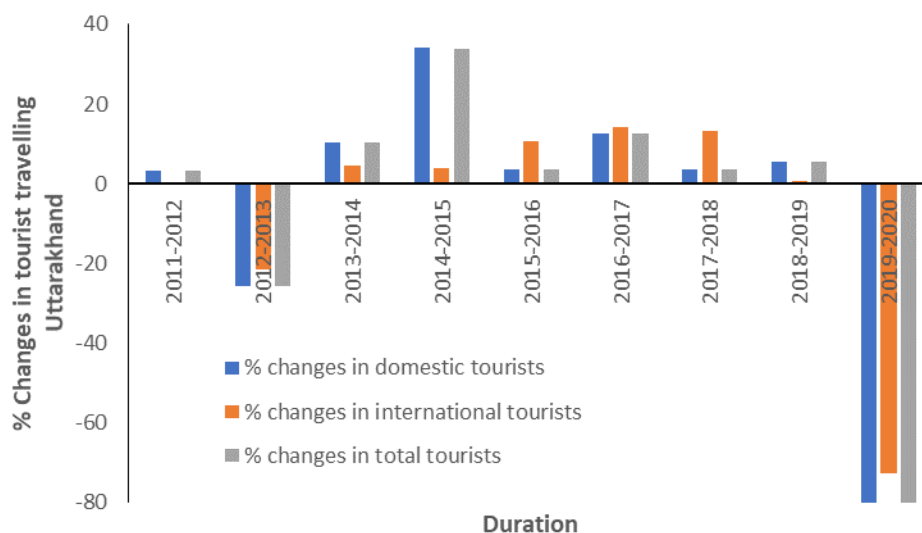


Fig.. 4.1: Percentage change in tourist during 2011-2020

(Source : Ministry of Tourism, Govt. of India. (ON1788) and Past Issues)

4.1.3 Number of vehicles (state/district wise)

One of the drawbacks of increase of tourism is the vehicular emissions, which can contaminate the clean air of the different mountain districts of Uttarakhand. While going through the datasets of registered vehicle of the state during 2011 to 2021, continuous increase was observed in the number of registered vehicles. Major increase in vehicle numbers were observed in Rishikesh, Rudaprayag and Bageshwar (Fig.. 4.2). There were over 3.32 million registered vehicles across Uttarakhand at the end of fiscal year 2022. Through the data set available for the duration 2011-2015 for different types of vehicles registered in Uttarakhand, it was observed that maximum percentage is of two wheelers, followed by cars/ jeeps (Fig.. 4.3). So not only the tourists, but the residents can also contribute to the degradation of air quality. Vehicles also contribute towards addition of extra heavy metal through road dust which may also affect the human health. In a case study done by Bisht et al. (2022), the impact of vehicles on road dust was observed in 70 different locations of Dehradun, including residential, commercial, national highway and silent zone, during 2019 winters and observed contribution of vehicular pollution by addition of heavy metals, due to tire wear, brake pad wear particles, corrosion of metallic components (Fe, Zn, Cu, and Ni), fuel and lubrication oil residues and chrome-based paints (Pb and Cr).

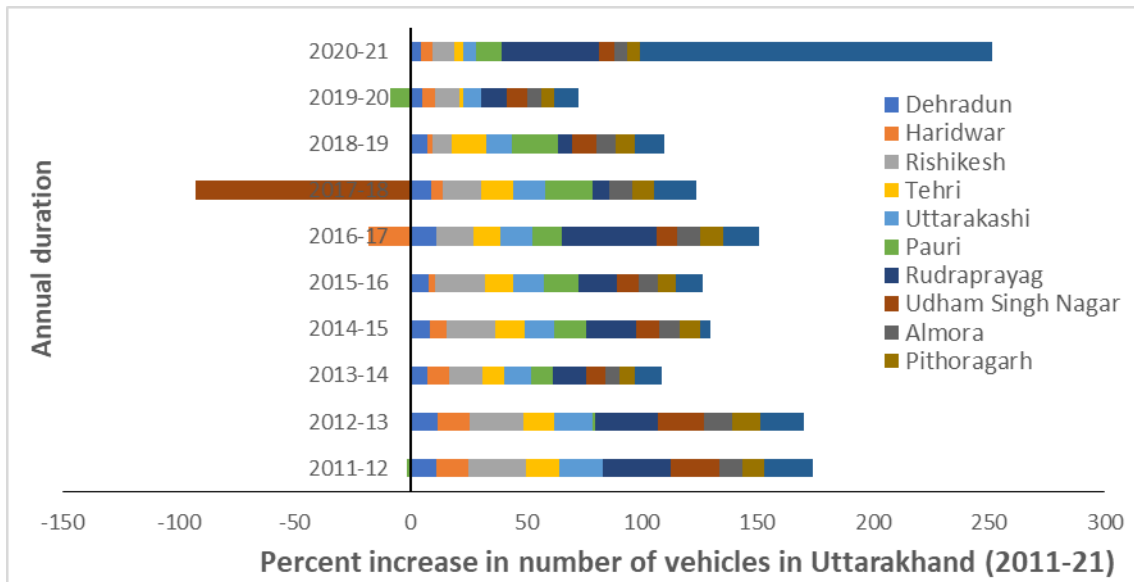


Fig.. 4.2. Variation in number of registered vehicle in different places of Uttarakhand during 2011-2021

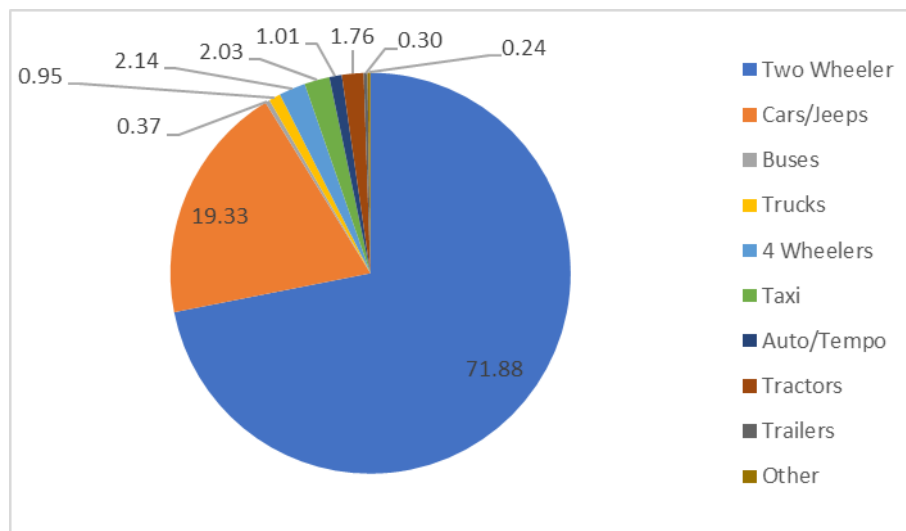


Fig.. 4.3. Percentage vehicle types among all the vehicles in Uttarakhand during 2011-2015

4.2. Assessment of waste generation in Uttarakhand

Worldwide, average waste generated per person per day is appx. 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. So, solid waste management has become a major environmental issue. In the name of mountain ecotourism or adventure tourism, the number of tourists, trekkers and mountaineers is increasing rapidly. Consequently, the load of human-induced pollution, solid waste, being deposited in these ecologically sensitive and topographically fragile areas of the mountains is also increasing. In the absence of any formal waste management bodies, and the absence of infrastructural services, the practice of 'leaving behind' self-generated wastes is the major factor increasing the load of garbage in the trekking and expedition locations (Kuniyal, 2005). Rivers, lakes and other water

bodies are also being polluted with uncontrolled disposal of solid wastes. As per the available data (2009-2012) IHR states are accumulating 22,372 metric tonnes (MT) of municipal solid waste per day. Fig.. 4.4 is showing comparative status of total waste generated in different districts of Uttarakhand during 2007-2020 and it is showing continuous increase of total waste generated (TPD).

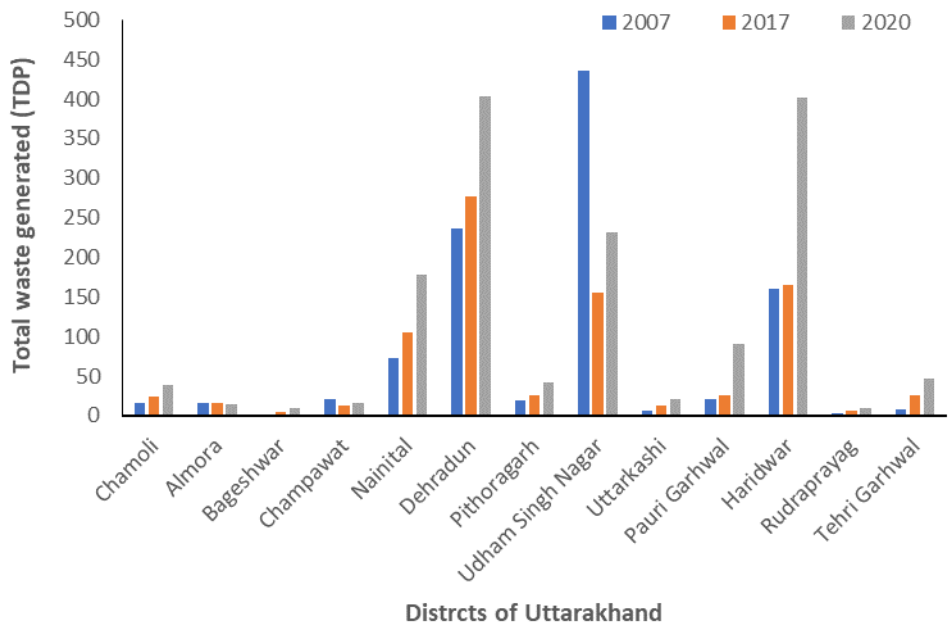


Fig.. 4.4: District wise status of waste generation in different years in Uttarakhand (*Source: Directorate of Urban Development Uttarakhand, Dehradun on the basis of Swachh Sarvekshan Based on Urban MSW action plan 2017*).

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

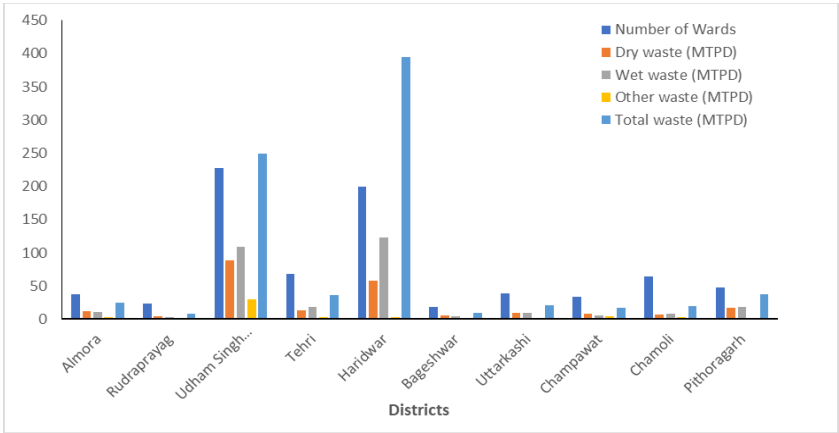


Fig.. 4.5. Solid waste management bodies and segregation of wet and dry waste in some of the districts of Uttarakhand (*Source: District administration, 2021*)

4.3. Waste disposal/ treatment facilities

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

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

In the year 2016, the Government of India enacted "Solid Waste Management Rules, which is the upgraded form of Municipal Solid Wastes (Management and Handling) Rules, 2000 (SWM, 2016). There is total 90 ULBs and 09 Cantonment Boards responsible for implementation of the SWM Rules, 2016, in the State, but most of the ULBs in the Uttarakhand do not comply with the prescribed guidelines. Although it has been professed that door-to-door collection of solid waste is practiced in all the wards but the segregation of waste at source is not carried out in all wards. Appropriate technology is often not adopted for disposal and processing of wastes owing to limited number of treatment plants.

As per the office order of Ministry of Housing and Urban Affairs (No.1/18/2015-SBM) dated 2 December 2020, Uttarakhand Government is working on SWM in different areas. 11 SWM projects are completed; 11 SWM projects are in first phase targeting the cities such as Dehradun, Haridwar, Almora, Jaspur, KarnPrayag, Joshimath, Gaucher, Uttarkashi, Muni-ki-Reti, Purola, Pokhri; 4 SWM projects are in first phase in Pithoragarh, Sitarganj, Badrinath, and Tehri-Garhwal; 2 SWM projects are completed in Srinagar, and Naogaon; 3 SWM projects are in first phase in Ramnagar, Nanakmatta, Piran Kaliyar; 6

SWM projects are in second phase in Chamoli, Gopeshwar, Agastmuni, Joshimath, Gauchar, Kapkot, and Almora; and 17 SWM projects are in first phase in Nand Prayag, Ranikhet, Chilyanaula, Gangolihat, Badahaat, Uttarakshi, Gangotri, Gadarpur, Gairsain, Ukhimath, Bhikyasen, Chapawat, Didihat, Satpuli, Dharcula, Gaja, Lambgan, Tanakpur, Banbasa, Chinyalisaudah and Khatima.

There are 71 STPs installed in Different areas of Uttarakhand with the total capacity of 448.18 MLD and the operational capacity of 345 MLD while the total sewage generation is around 627 MLD. The District of Uttarakashi has a great religious significance as it is referred to as the Kashi of North. Two out of the four major Dhams, namely Gangotri and Yamunotri are also in this district, thus becoming the birthplace of two most important rivers of India, Ganga and Yamuna, respectively. This place invites a number of tourists in the Char Dham Yatra season and the number is ever increasing. As per the District Administration, Uttarakashi 2021, the quantity of sewage generated from the households is 0.010 MLD during the Yatra Season and 0.005 MLD in the non-Yatra season. The STP installed at Gangotri is of capacity 1 MLD. Good practices are implemented in the towns of Dehradun and Haridwar. Door-to-door waste collection is initiated in 1106 wards out of total 1170 wards. Source segregation of waste is being carried out in 366 wards. There are two composting facilities setups in the State. 13 landfill sites are identified in the State, 2 landfill sites have been constructed (Nagar Nigam Dehradun and Nagar Nigam Haridwar) while 2 landfill sites are in operation. Total number of existing dumpsites in the States are 42 (CPCB, 2019).

4.4. Impact on Air quality

Due to high inflow of vehicles during tourist season and open burning of waste and biomass during different seasons, quality of air is also getting deteriorated due to the production of harmful gases such as sulphur dioxide, nitrogen oxides, carbon dioxide, carbon monoxide, ozone and particulate matters (PM₁₀ and PM_{2.5}). Fig.. 4.6 is showing the actual and projected concentration of different types of air pollutants reported in Uttarakhand during 2014, 2016 and 2021 (Kumari *et al.* 2019). Black carbon is also generated due to open burning of biomass and through fuel combustion. Forest fire is another major cause of air quality deterioration particularly during summer as has been monitored by GBPNiHE at Kosi-Almora.

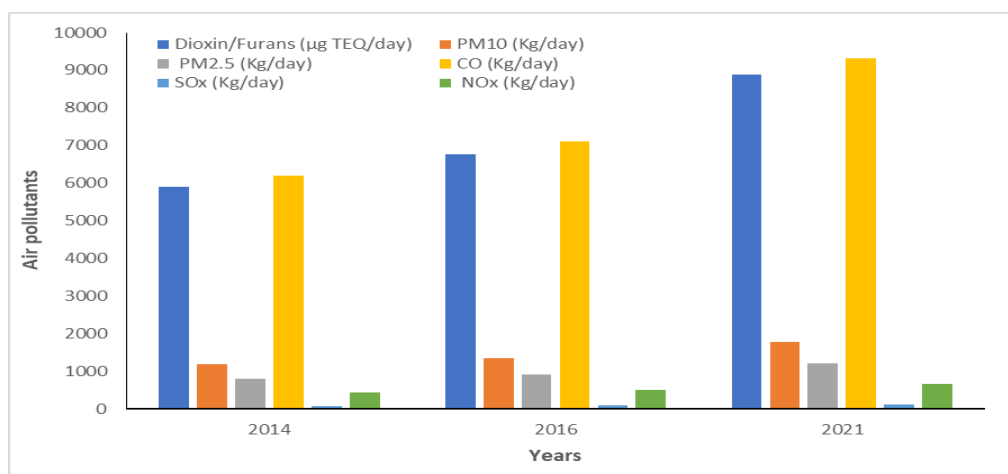


Fig.. 4.6. Air pollutants distribution in Uttarakhand in different years (Kumari et al. 2019)

To tackle the problem of air pollution in the cities, Government of India has taken many steps, one of them being National Clean Air Program (NCAP) 2019. Goal of National Clean Air Program (NCAP) is to meet the prescribed annual average ambient air quality standards at allocations in the country in a stipulated time frame. Under this programme, 122 cities in the country are identified as non-attainment cities which include three cities from the Uttarakhand (*Dehradun, Rishikesh and Kashipur*). These are the cities that have fallen short of the National Ambient Air Quality Standards (NAAQS) for over five years. For continuous monitoring of air quality, air monitoring stations are being installed at different locations (Fig.. 4.7). SO_x and NO_x gas levels were found satisfactory while particulate matter content was observed at higher side, which need to be taken care of by the concerned department.

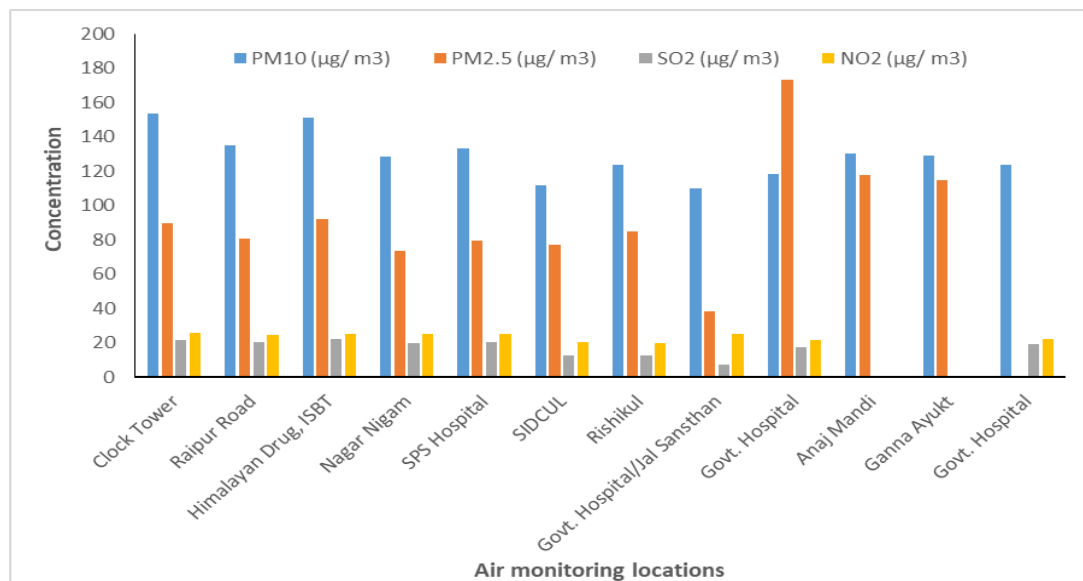


Fig.. 4.7. Air quality monitoring parameters in some of the cities of Uttarakhand (Source: Central Pollution Control Board) *Average data based on 2019-2021 datasets, Time weighted annual average for PM_{10} is $60 \mu\text{g}/\text{m}^3$, SO_2 is $50 \mu\text{g}/\text{m}^3$ and NO_2 $40 \mu\text{g}/\text{m}^3$ as per National ambient air quality standards in India

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

Table 4.1. Plans/ tree having the potential to reduce gaseous and particulate matter contamination from the environment

S. No.	Scientific Name	Vernacular Name
1	<i>Butea monosperma</i>	Purasu
2	<i>Cassia fistula</i>	Sarakkonnai
3	<i>Cassia siamea</i>	
4	<i>Casurina equisetifolia</i>	Casurina (Savukku)
5	<i>Caderella toona</i>	Sandana Vembu (Hill Neem Tree)
6	<i>Dalbergia Sissoo</i>	Sisu
7	<i>Ziziphus mauritiana</i>	Beri
8	<i>Acacia nilotica</i>	Kikar/babul
9	<i>Melia azedrach</i>	Neem
10	<i>Prosopis spicegera</i>	Jand
11	<i>Ficus bengalensis</i>	Bohar
12	<i>Ficus religiosa</i>	Pipa
13	<i>Salvedora oleioides</i>	Van
14	<i>Albizzia lebbek</i>	Siris
15	<i>Acacia leucocephala</i>	Reru
16	<i>Dillenia indica</i>	Naithekku
17	<i>Erythrina suberosa</i>	Mulmurungai
18	<i>Ficus religiosa</i>	Pipal (Arasu)
19	<i>Hardwickia binnata</i>	Aachaan
20	<i>Madhuca indica</i>	Iipai
21	<i>Millingtonia hortensis</i>	Maramalle

4.5. Impact on water quality / ground water

The state of Uttarakhand is filled with natural sites which play an important social and religious role. This leads to a heavy influx of unsustainable tourism and in return a heavy toll on the environment. Kumaon region of Uttarakhand is blessed with scenic beauty and a variety of natural lakes such as Nainital, Bhimtal, Naukuchiatal, Khurpatal, Sattal, Garurtal and Shyamalatal. The lakes of this region are susceptible to degradation as most of them have developed into famous tourist spots. As per UKPCB, water quality monitoring has been conducted for the Naini lake at Nainital and Bhimtal lake. It can be seen that over the years, DO and BOD has remained more or less the same in both the lakes however Total Coliform (MPN/100) was more in Naini Lake, Nainital. The concentration of Coliforms in water bodies indirectly signals towards contamination with human or animal excreta. On the contrary the amount of DO and the BOD signifies that the water quality of the lake comes under Category A. While analysing the dataset available for important glacial fed rivers of Uttarakhand, it is observed that the general water quality parameters such as pH, conductivity, dissolved oxygen etc. are found within the prescribed limits while the bacterial contamination is very high in most of the cases (Table 4.2 & 4.3). This might be due to fecal contamination of water resources due to tourist influx in larger number along with the increased settlement in the area.

Table 4.2. Faecal coliform (max count in MPN/100 mL) status in some of the glacier fed rivers of Uttarakhand

YEAR	2012	2013	2016	2017	2018	2019
BHAGIRATHI AT GANGOTRI	NA	NA	NA	2	7	7
ALKANANDA B/C MANDAKINI AT RUDRA PRAYAG	NA	NA	NA	240	2300	2
MANDAKINI B/C ALKALNADA AT RUDRAPRAYAG	NA	NA	NA	170	450	2
ALKANANDA A/C MANDAKINI AT RUDRAPRAYAG	NA	NA	NA	NA	780	2
ALKANANDA B/C TO BHAGIRATHI AT DEVPRAYAG	NA	NA	NA	NA	780	2
BHAGIRATHI B/C WITH ALAKNANDA AT DEVPRAYAG	NA	NA	NA	NA	36	2
ALKANANDA A/C WITH BHAGIRATHI AT DEVPRAYAG	NA	NA	NA	NA	490	2
GANGA AT RISHIKESH U/S	NA	NA	NA	22	26	40
GANGA AFTER CONFL. OF RIVER SONG NEAR SATYANARAYAN TEMPLE D/S RAIWALA	NA	NA	NA	90	110	110
GANGA AT HARIDWAR D/S	NA	NA	NA	NA	NA	230
UPPER GANGA RIVER D/S ROORKEE	NA	NA	NA	NA	NA	90

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

YEAR	2012	2013	2016	2017	2018	2019
BHAGIRATHI AT GANGOTRI	NA	NA	NA	11	179	9
ALKANANDA B/C MANDAKINI AT RUDRA PRAYAG	NA	NA	NA	9500	7000	2
MANDAKINI B/C ALKALNADA AT RUDRAPRAYAG	NA	NA	NA	16000	4900	2

ALKANANDA A/C MANDAKINI AT RUDRAPRAYAG	NA	NA	NA	NA	24000	2
ALKANANDA B/C TO BHAGIRATHI AT DEVPRAYAG	NA	NA	NA	NA	24000	2
BHAGIRATHI B/C WITH ALAKNANDA AT DEVPRAYAG	NA	NA	NA	920000	630	2
ALKANANDA A/C WITH BHAGIRATHI AT DEVPRAYAG	NA	NA	NA	NA	2400	2
GANGA AT RISHIKESH U/S	NA	NA	NA	80	70	401
GANGA AFTER CONFL. OF RIVER SONG NEAR SATYANARAYAN TEMPLE D/S RAIWALA	NA	NA	NA	280	350	280
GANGA AT HARIDWAR D/S	NA	NA	NA	1600	350	350
UPPER GANGA RIVER D/S ROORKEE	NA	NA	NA	1600	220	170

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

Table 4.4 Status of some of the water quality parameters in stretches of polluted rivers of U.K.

Name of Polluted River stretches		pH	DO (mg/L)	BOD (mg/L)	COD (mg/L)	EC (μ S/cm)	TDS (mg/L)	TSS (g/L)	Total coliform (MPN/100 m)	Faecal coliform (MPN/100 m)
Dhella	US	7.9	4.8	4	10	410	244	90	430	220
	DS	7.3	1	48	160	910	684	164	1600	540
Bhella	US	7.9	3	6.9	30	540	348	50	240	130
	DS	7	1	30	150	730	486	142	1600	920
Kichha	US	8.2	6	3.8	16	660	405	70	350	170
	DS	8.1	2.8	7.1	36	920	750	68.75	≥ 1600	920
Suswa	US	7.6	2.8	28	106	916	620		≥ 1600	≥ 1600
	DS	7.8	7.8	2	6	805	530		84	48
Kalyani	US	8.1	3.4	6.5	30	590	377	85	220	140
	DS	7.3	0.8	28	90	710	420	81.25	1600	540
Kosi	US	8	4	6.2	20	750	495	98	920	430
	DS	8.1	1.8	10	40	780	497	76	≥ 1600	920
Pilakhar	US	8.3	5.2	4.8	20	800	521	20	350	110
	DS	8.2	6	4.2	24	770	503	25	540	280
Nandhour	US	Stream dried								
	DS	8.4	8	3.4	12	420	288	92	920	540
Ganga	US	7.59	8.2	1.2	6	242	155		110	70
	DS	7.75	8.8	1.6	8	229	148		130	70

*US: Upstream; DS: downstream

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

4.6. Impact on Forest and Biodiversity

Uttarakhand state is popular for its biodiversity which is protected through various National parks such as Valley of Flowers (national park), Nanda Devi National Park, Rajaji National Park, Corbett National Park and wildlife sanctuaries such as Askot Sanctuary, Kedarnath Sanctuary, Govind Wildlife Sanctuary etc. The state government is committed towards increasing forest cover and for protecting floral and faunal diversity. India's first Snow Leopard Conservation Centre is going to be developed in *Bhairoghati area of Uttarkashi district with the collaborative efforts of forest department of Uttarakhand and United Nations Development Programme (UNDP)*. Total forest cover including very dense, medium dense and open forest cover (Fig.. 4.8). While analysing the forest cover changes during 2011-2021, appx.10% decrease in medium dense forests was observed as per the ISFR 2021 (Fig.. 4.9). Data on loss of biodiversity due to waste disposal is not properly studied, but the unprecedented wastes are significantly changing the wildlife habitats scenario in the Himalayas as extensive littering has altered the hunting abilities of many critically endangered species and other wildlife (Puri et al. 2020; Thakur et al. 2021).

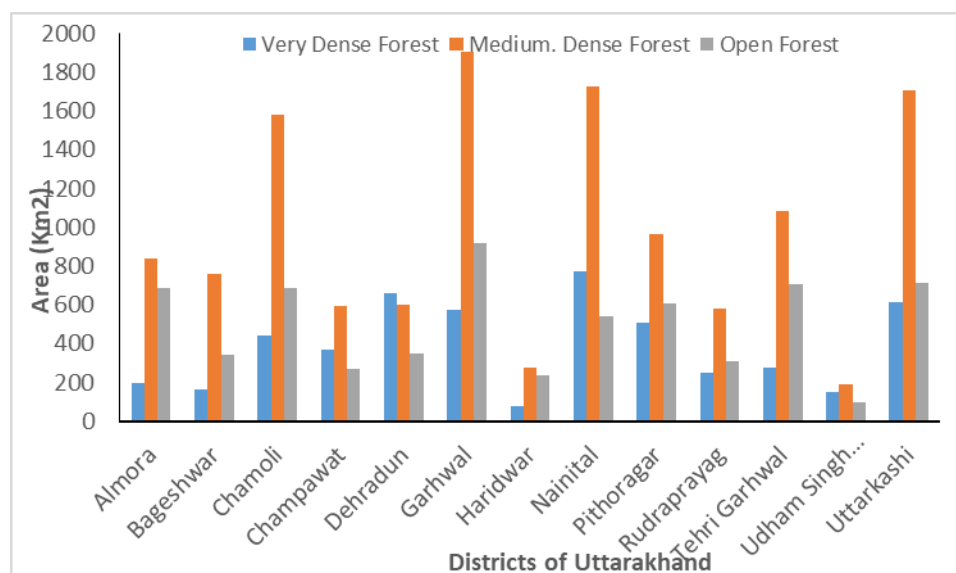


Fig.. 4.8: Forest cover of Uttarakhand in 2021 (ISFR, 2021)

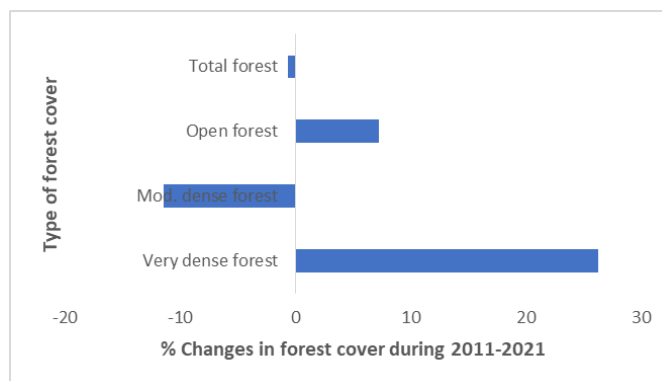


Fig.. 4.9. Changes in different type of forest cover during 2011-2021
(Source: Forest Survey of India, Dehradun. India State of Forest Report 2021)

4.6.1. RET categories species wise / forest cover

Biodiversity is an integral element of the global ecosystems which provides stability to the ecosystem and essential for maintaining the ecological balance. It also plays an important role in economic sectors that drive development, including agriculture, forestry, fisheries and tourism. As the tourist attracts towards the natural environment of Uttarakhand, so they can unknowingly harm the plant diversity present in the natural habitat. So, the exact status of plants, mainly the threatened plants enlisted in IUCN list, should be known for making favourable policies for their protection. Fig.. 4.10 depicts that out of IUCN categorized threatened plant, 84.68% plant diversity is of least concern, 3.23% is critically endangered, 4.84% is endangered, 2.42% is vulnerable, and 4.03% is data deficient.

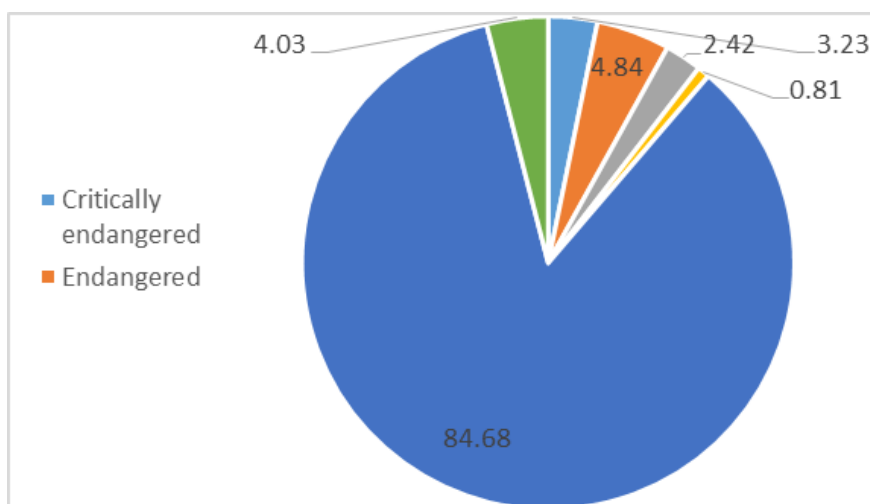


Fig.. 4.10: Percent distribution of plant found in Uttarakhand classified under IUCN threat categories

4.7. Eco-sensitive zones/ Areas

Uttarakhand have Nandhaur Wildlife Sanctuary Eco sensitive Zones (ESZ), Bhagirathi ESZ, Nanda Devi National Park ESZ, Askot Wildlife Sanctuary, Binsar ESZ and many others are in the line of ESZ notification for protection of environment and biodiversity. Nandhaur tiger reserve was declared a

sanctuary in 2012 and opened its gates to visitors in 2015. Sprawled over an area of 270 sq km, it is the home to tiger, wild elephant, leopard, jungle cat, nilgai, small Indian civet, jackal, wild boar, flying foxes and sloth bears, as well as over 200 species of birds.

In 2012, MoEFCC declared an area between Gaumukh to Uttarkashi, spread over 4,179.56 square kilometers, including 88 villages, an Bhagirathi ESZ. The total area of Uttarkashi is 7,951 square kilometers. Of this, 3,347 square kilometers have already been declared a protected area. With the inclusion of Bhagirathi, 80% of the land in Uttarkashi came under a protected area, and only 3.5 per cent of land was left for agricultural activities. Binsar Wildlife Sanctuary in the State of Uttarakhand about 22 km from Almora city and 112 km from Haldwani Railhead, is an important and well-known sanctuary known for rich flora & fauna diversity. The area of Binsar Wildlife Sanctuary is 47.07 Sq. Km. In a dense pine and oak forest, a rich fauna is present having wild animals like Panther, Himalayan Black bear, Goral, Barking deer, Wild boar, Porcupine, Monkeys, reptiles and various avifauna. Inside the Sanctuary various Himalayan herbs & plants are present along with lush green oak and pine forest and need a protection and conservation. The extent of Eco-Sensitive Zone varies from 300 meter to 3 kilometers around the Binsar Wildlife Sanctuary. The area of the Eco-Sensitive Zone is 81.63 square kilometers. The state government is also contemplating to declare ESZs in all the buffer areas of the remaining national parks and wildlife sanctuaries, including the world-famous Corbett National Park. Jim Corbett to be declared an ESZ: The Uttarakhand cabinet approved a 377 sq. km area for the proposed [eco-sensitive zone](#) (ESZ) for the [Corbett Tiger Reserve](#) (CTR). No village has been included in the ESZ, for which the maximum area has been defined as 7.96 km². Action Plans of each of the eco-sensitive zones (ESZ)/ area (ESA) lying in the respective states (e.g., Bhagirathi valley ESZ).

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

4.8. Summary

Gap areas & Plan of Action

Sr. No.	Gap areas	Plan of Action
1.	No proper documentation of tourists inflow in hill stations except few places.	Online registration of all the tourists (of all the ages) coming to major sensitive and fragile tourist areas / tourism types may be incorporated in the guidelines along with the details of private or commercial vehicles (if registered for tourism purposes).
2.	Documentation of vehicles used	In online tourist registration form, details of

	by the tourists is completely missing.	personal vehicles used for travel should be made essential. All the commercial vehicles used for tourism purpose may have a barcode system which may be used for automatic scanning at major locations where vehicles are entering into the hill station. Renewable energy based and economic common vehicles from a definite location might also be a good option for stopping vehicular pollution in the fragile areas. Nainital is following such option, but have a scope of further modification.
3.	The initiatives on waste collection data, segregation of such waste and further usages is being taken care by different district administration of the state, but proper management as per SWM guidelines are yet to be completed. Along with this, the waste management works are mainly concentrated in specific areas while, the exact tourist locations are missing as most of the resorts or hotels are being developed at outskirts of the main stations, specially for the tourists who want to enjoy the natural beauty of the area.	All the resorts / hotels and similar type of set-ups should be directed to develop waste management sites. Wet and dry waste should be taken care by the local administration. The pictorial banners should also be installed at various places on the route to hill stations. So it is important to make aware the touri about not throwing waste here and there.
4.	Air quality monitoring is localized in definite locations only and its remediation measures was missing, although ecological measures are taken care in some of the big cities of Uttarakhand.	Air quality monitoring stations (solar energy based) should be installed at all the major hill stations. In view of getting the actual background concentration of particulate matter, monitoring of SO _x , NO _x , black carbon and other gaseous pollutants are important.
5.	River quality data along with polluted stretches is available but water availability data is missing in most of the hill	Water crisis during tourist season is very common in hill stations of Uttarakhand, which are situated in higher altitudes. So inventorization of such water resources, their

	stations and tourist locations is missing.	seasonal discharge rates, and quality measurements are essential, so that tourists inflow can be regularized in those areas. The major resorts or hotels should be directed to set up purification units for grey water, so that it can be used for landscape management in the sites. It will stop the wastage of fresh water.
6.	IUCN list of some of the threatened plants are available for most of the important national parks and sanctuaries but the exact information of impact of tourism on plant diversity is not available.	The areas where tourists come in contact with the plant diversity, should have the information of such important plants. This will be enable to become aware of such plants and they will not harm them.
7.	Information of tourists inflow, vehicle details, biodiversity, solid waste, water, and air quality management practices are not available in the form of any report. Although in most of the sites, manual entries are being done by the forest staff at the entry gate.	Online entry system should be developed for managing the tourist/ vehicle inflow in the sensitive zones. Renewable energy-based vehicles should be encouraging, wherever possible. Air and water quality monitoring should be done on continuous basis and waste management practices should also be followed as per the actions plan of the ESZ.

Sikkim

5.1. Introduction

5.1.1. General scenario of tourism in Sikkim

Sikkim is the least populous state (total population 610,577 as per Census, 2011) in India and the smallest state (geographical area of 7,096 km²) in Indian Himalayan region (IHR). Climate of Sikkim ranges from subtropical to high alpine. Kanchenjunga, the world's third-highest peak, is located on Sikkim's border with Nepal. Development and promotion of tourism in Sikkim is relatively recent. Until 1990, there were virtually marginal tourism activities primarily because of stringent and the cumbersome Inner Line Permit system which did not help much in promoting tourism. However, with the sustained effort of the state government, Inner Line Permit was relaxed in the year 1990, which led to unprecedented flow of tourist in the successive years. The tourism centres and circuits began slowly developing from Gangtok (East district) and gradually extended to Namchi and Ravongla (South district), Pelling and Yuxsum (West district), and Lachen and Lachung (North district). Further, the adventure tourism (e.g. trekking along the Yuksom- Dzongri- Goechala trail) also begun to pick up. From 1988 onwards, tourists were allowed to visit Tsongmo Lake and Nathula Pass. Similarly, relaxation permits for Zuluk in East Sikkim and Gurudongmar Lake, Yumthang Valley and Yumesamdong in North Sikkim, witnessed a surge of tourist flow to these areas. These major milestones in Sikkim's tourism history led to increase in tourist influx in the state. The tourism in the state further got boost from Government of India's decision to allow leave travel concession (LTC) by Air to the Northeast region (NER) in 2010 for central Government employees and the recent "Go East Policy" of the Government that greatly helped socio-economic development of NER including Sikkim. As an impact, tourism sector received an escalating boost during the period 2010-2019 (except for 2020 & 2021 due to the pandemic) with total tourist arrival numbers equalling and surpassing (in some years more than double) the state population. The government upgraded in house facilities in departmentally run hotels and lodges and encouraged the private sector to cope up with the tourist accommodation facilities. As a result, there has been a boom in the hotel business today. The natural strength of Sikkim has been aptly supported by the government policies and Sikkim is the first state to have a policy on ecotourism that is strictly implemented. Sikkim has popular home stays where tourists can have firsthand experience of rural Sikkim to adventure sports; from ancient monasteries and

flamboyant festivals to all the amenities of the modern world. The key features of tourism in Sikkim include, Eco-Tourism and Wildlife Tourism, Village Tourism, Adventure Tourism, Wellness, Religious, Culture, Heritage and Pilgrimage Tourism and Community Based Tourism (CBT).

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

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

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

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

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

The maximum number of tourists (15,55,216; including 14,21,823 domestic and 1,33,388 international) visited Sikkim in the year 2019 (Fig..5.1 a & 5.1 b). The highest growth for domestic tourists from the base period (2010-11) was recorded (51%) in 2018 and for the international tourists (87.4%) in 2019. However, the number of tourists declined drastically in the year 2020 due to spread of COVID-19 pandemic and subsequent lockdown across the country. During 2021, the tourists inflow again witnessed rise in total number of tourist visiting the state (5,22,997) and registered approximately 55% growth from previous year.

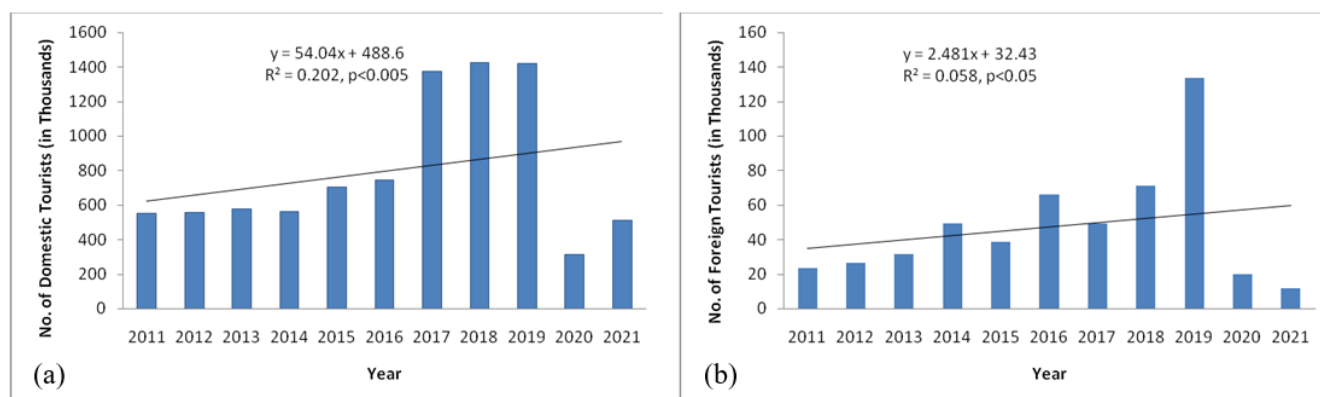


Fig.. 5.1: Trends of tourists [(a)Domestic and (b) Foreign] flow in Sikkim (Source: Tourism Statistics, Govt. of India and Tourism & Civil Aviation Department, Government of Sikkim)

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

Seasonal trend analysis of tourist volume showed that 43% tourists influx was received in Sikkim in summer months (April–June) and approximately 24% influx during winter months (December–

February) and 14% during post monsoon months (October–December). The remaining months (i.e. July–September) have an inflow of approximately 7% of the annual inflow of tourists per month. Similar trends were also observed in earlier studies (Joshi & Dhyani 2009).

Financial aspects of investments made by Sikkim in the tourism sector – with an ever-increasing number of tourist arrivals – become a very significant parameter in assessing whether increasing demand is being met by the supply side. As per the NITI Aayog (2018), revenue receipts in Sikkim are second highest amongst NER states after Assam and accounts worth approximately Rs. 45000 (thousands) annually against the annual expenditure of Rs. 1180622 (Thousands) on tourism sector and total expenditure of the state of Rs. 62218255 (thousands). Among all the IHR states, Sikkim accounts for the highest investment in the sector i.e. 1.9% of the total state expenditure. All other IHR states invest less than 1%. Tourism sector in Sikkim has been contributing 2-3% to the GDP in state and barring Sikkim, all mountain states show slightly decreasing contribution of tourism to GDP of the respective state (NITI Aayog, 2018). As per the information from Sikkim Tourism Development Corporation (STDC), the tourism sector suffered losses to the tune of Rs. 600 crore in the year 2020 due to the COVID-19 pandemic (Table 5.1).

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

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

(Source: CAG Report, 2018)

There is a proportionate relationship between the infrastructural development and the number of tourist influx. Based on the Figures of tourist accommodation available and the number of service providers, direct employment generated by this sector can be roughly estimated to be around 12,000 to 15,000 jobs at present. At the same time, the human development index also notes that the industry has 61 percent direct workers employed from outside the state. Even a significant proportion of the transport sector also engages employees similarly. The local youth are reluctant to take up jobs offered by these service providers. In the last decade, the tourism sector in Sikkim has seen a growth rate of 10-12 percent. The Gross State Domestic product of the tourism sector in 2016-2017 has been Rs. 1,44,735 lakhs with a total contribution of the tourism sector to GSDP being 7.68 percent (DESME, State Income Unit). In terms of existing capacity and strength and as per Figures available, there are currently 1,021 hotels, (with over 16,945 rooms and 34,133 beds capacity), 1,119 travel agents, 69 restaurants, 66 Tourist guides and 371 homestays registered with the department. In addition, there

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

5.1.3. Transport & tourism: Number of vehicles

In the tourism sector, transportation plays an important 'flow' function in the tourism value chain. In Sikkim, transportation is dominated by the road transport and connects tourists from various parts of the world. Over the years, road network, flight connectivity, and means of transport have improved. As a result, the tourist inflow to Sikkim is on increase since the last decade. With the increasing inflow of tourists and the expected growth in tourist inflow, the number of vehicles, especially public transport and other tourist vehicles have been increased so as to meet the growing demand of the tourism sector. As per information from the Sikkim Nationalized Transport Department (2021), total 95,251 vehicles (private- two and four wheelers, government vehicles, tourist taxis, bus, luxury taxis, good carriages, etc.) were registered in the state with the high growth rate of 268.85% recorded for the year 2020-2021 from the base year 2011, until then only 25,824 vehicles were registered. From 2011 to 2021, total 69,427 new vehicles (all types) were registered in the state; out of which 13,639 vehicles are engaged in tourism services. However, during the Covid-19 pandemic period (2020-2021), few number of tourist/taxi vehicles (505) were registered in comparison to the private vehicles (7015). The growth of vehicles during last decade has offered employment to the nearly 11% of families/households in the state as more than 13639 persons got employment through transport services in the tourism industry. The careful analysis of the registered vehicles during 2011- 2021 in the state showed that the private vehicles are increasing at higher rate (1903.16% per decade) than that of tourist/taxi vehicles (819.07%), which would be increasing the carbon emission in the environment with alarming rates. Further, owing to the increasing demand for services in the tourism sector, the rapid development of transportation facilities has been stimulated in the state.

5.1.4. Ill-effects of tourism particularly on environmental components

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

these nature tourism areas and resources may also hamper their participation in resource conservation in absence of sufficient incentives.

5.2. Assessment of waste generation in Sikkim

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

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

Sr. No.	States	Total waste generation (MT/D)	Total waste generation (in Lakh MT/Annum)
1	Arunachal Pradesh	181	0.66
2	Assam	1134	4.14
3	Himachal Pradesh	342	1.25
4	Jammu and Kashmir	1792	6.54
5	Manipur	176	0.64
6	Meghalaya	268	0.98
7	Mizoram	201	0.73
8	Nagaland	342	1.25
9	Sikkim	89	0.32
10	Tripura	421	1.54
11	Uttarakhand	1400	5.11
12	West Bengal (Darjeeling Municipality)	465 gm/capita/day.	

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

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

As per the recorded data from 2016 to 2021 by the State Pollution Control Board (SPCB), Government of Sikkim, average 271253.40 ± 3048.07 Q/yr municipal solid waste is generated annually in the state. In Sikkim, seven municipal corporations / urban local bodies (ULBs); namely, Gangtok Municipal

Corporation (GMC); Gyalshing Municipal Council (GyMC); Mangan Nagar Panchayat (MNP); Namchi Municipal Council (NMC); Rangpo Nagar Panchayat (RNP); Singtam Nagar Panchayat (SNP); and Jorethang Municipal Council (JMC) are collecting and managing the solid waste from the urban and rural areas on daily basis. As per the record of SPCB for 2020-2021, highest waste was generated by GMC 182500.00Q/yr (69%) and followed by RNP 21900.00Q/yr (8%), JMC 18250.00Q/yr (7%), NMC 14600.00qt/yr (6%), GyMC 12775.00 Q/yr (5%), SNP 9855.00Q/yr (4%), and MNP 2555.00Q/yr (1%). Due to the improvement in infrastructure, 100% generated solid waste was collected from each 07 ULBs during the year 2020-2021 which earlier used to be collected approx. 86% (229950.0 Q/yr) of the total generated waste (267691.0 Q/yr) in the year 2017-2018. The Government of Sikkim has also passed several gazette notifications regarding management of municipal waste in the State.

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

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

As per the records (SPCB, GoS), almost all generated waste is being collected. During 2020-2021 generated municipal waste was 262435.00 Q/yr and collected waste was 262435.00 Q/yr). This shows that the process of solid waste collection is scrupulously followed in the Sikkim state. The state government has developed a mechanism for waste collection in the state and the waste is collected from the households located in accessible areas (connected to road head within the municipal areas) through the designated waste collection vehicles of municipal cooperation. Whereas, in case of the inaccessible areas, the designated staff of municipal cooperation/ individuals manually collect the waste and take it up to the road head where the same is handed over to the waste collection vehicles. The designated pickup collection vehicle has a capacity of transporting approximately 500 to 600 kg of waste. All the collected waste is delivered at the waste transfer station located in a convenient location. Further, tipping trucks of about 10 MT capacity transports the waste from the transfer station to the

waste management plant (dumping/ landfill area) located at Martam, East Sikkim and Sipsu, West Sikkim including Chandey, North Sikkim.

5.3. Segregation / Utilization of waste

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

The practice of community bins/secondary waste storage facilities has been stopped in the state; instead, bins have been placed for local public and tourists in the main market area. Also, all the wards coming under urban local body (ULB) are covered with segregation bins for wet and dry waste. The state government provided separate bins for bio-degradable and non-bio-degradable waste to majority of households. The practice of community waste receptacle for recyclable items cardboard, plastics, news paper, metals, glass, etc., is performed at community level. Total 1027 Q/yr plastic waste was collected during 2021, which was reused for the construction of roads and highways by the NHIDCL (as per information available by the State).

5.4. Waste disposal/ treatment facilities

Based on the analysis of solid waste for 2016-2021 in Sikkim, 20% of the collected waste (47750.03 ± 8572.46 Q/yr) was treated and the remaining 80% (195449.47 ± 8384.81 Q/yr) was disposed in dumping/landfill areas. As per the record of SPCB, GoS in the year 2016-2017, only 17.82% of the generated waste was treated and the remaining 82.18% waste was disposed as landfill and dump. Whereas, during 2020-2021, total 28 % (74277.50 Q/yr) waste was treated and remaining 72% (188157.50 Q/yr) was disposed as landfills and dumps. Hence, in Sikkim, the treatment of the waste has improved in 2020-2021 as compared to 2016-2017. State Pollution Control Board suggested for setting up of a Refuse Derived Fuel Plant at Martam and Sipsu to reduce the solid waste load and increase the life of these two sites. For the management of solid waste in the state, 01 landfilled area (42600 m^2) is operational at Martam in East Sikkim district and 02 landfilled areas (total area= 132460.3 m^2) are under construction, one at Sipsu, West Sikkim (112460.3 m^2) and another at Rindang in North Sikkim district (20000 m^2). Recently, one compost plant has been made operational at Martam, East Sikkim district with 50 ton/day capacity and with a capacity of 500 kg/day. One organic waste converter is functional at Vegetable market, Mangan, North Sikkim district. In addition, one bio-digester plant has been installed at Tikjuk, Gyalshing, West Sikkim with a capacity of 7000 litters. Based on the analysis of the tourist influx and municipal waste generated data (2016-2021), the result indicates no significant correlation ($p > 0.05$), but the positive correlation between year and collected waste ($r = 0.892$) significantly ($p < 0.04$) reveals that the waste collection mechanism in the state is improving.

5.5. Impact on air quality

The State Pollution Control Board (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 stations which are progressively decreasing toward north (Fig.. 5.2). The similar values are also observed at the Singtam. The Rangpo station is the entry point of Sikkim whereas Singtam is the commercial hub of Sikkim. The regions where the tourist influx is more, the AQ values are high. In the north region of the state, the tourist influx is limited. Therefore, the AQ values are less throughout the year and air quality is good. The AQ values are maximum from November to April months whereas minimum in the months of May, June, July, August, September and October. The less values months are coinciding with the monsoonal months. In all the stations the recorded values (Oct 2017-Dec 2021) are less than 100. The data of all the stations shows that the air quality of Sikkim falls under the good and satisfactory condition.

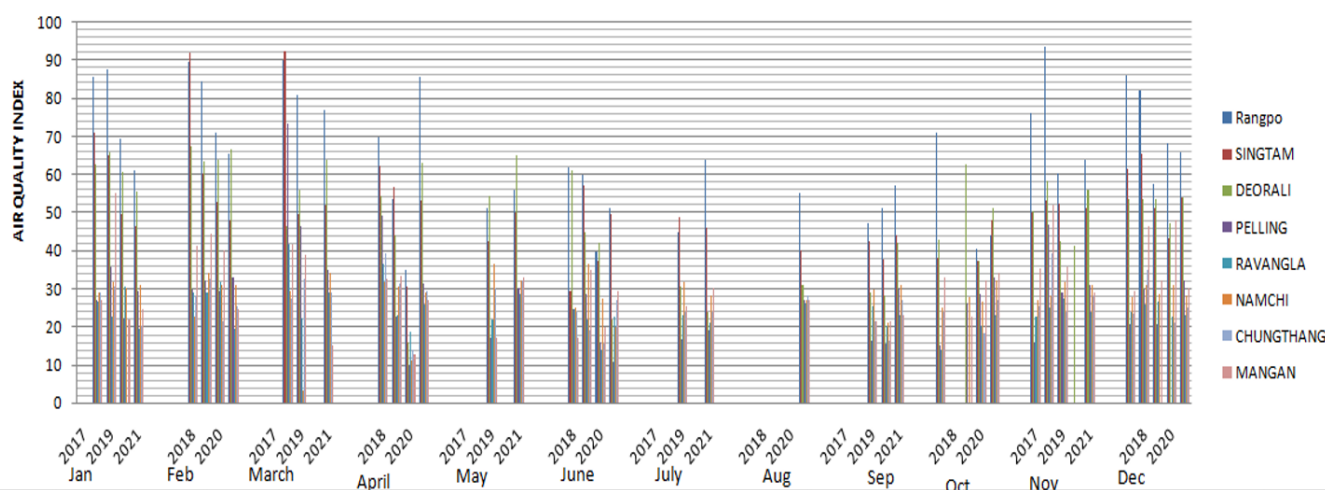


Fig.. 5.2: Trends of Air quality at selected sites in Sikkim

5.6. Impact on water quality / groundwater

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

5.7. Impact on Forest and Biodiversity

Sikkim is notable for its biodiversity, including alpine and subtropical climates, as well as being a host to *Khangchendzonga*, the highest peak in India and third highest on Earth. The State is endowed with rich floral and faunal diversity. Species wise, the State harbors over 5,068 flowering plants in 1491

genera belonging to 209 families, 542 Orchids, 38 Rhododendrons, 16 Conifers, 28 Bamboos, 362 Ferns and its allies, 9 Tree Ferns, 30 Primulas, 11 Oaks, 1681, Medicinal plants, 144+ mammals, 568 Birds, 48 Fishes, and over 689 Butterflies and 7000 species of Moths (Arrawatia and Tambe, 2011; Gogoi *et al* 2021).

Apart from the rich diversity of the state, it is facing several threats which mainly cause the loss of natural resources. The main threats being development activities, unplanned trekking tourism, hunting and trapping of wild animals, smuggling of medicinal and aromatic plants and lack of awareness amongst the forest security forces (Tambe and Rawat, 2006). The impacts of unmanaged tourism are accelerating the rate of destruction in areas, which were once regarded as inaccessible. The negative impacts of unplanned tourism like deforestation due to the use of firewood, unhygienic conditions, garbage accumulation, smuggling of plants and animals have to be regulated and at the same time, the benefits arising from this enterprise are equitably shared. Unplanned tourism also threatens sensitive and biologically important high-altitude wetlands (Annual Administration Report 2018-2019, F&E Dept. Govt. of Sikkim). Furthermore, it is threatening the natural habitats of several climate sensitive wildlife species such as globally endangered Musk Deer (*Moschus chrysogaster*) in Areylungchok Musk Deer Conservation Zone (AMDCZ) falls within the Khangchendzonga National Park, which is protected under schedule I of Wildlife Protection Act-1972 (Tambe and Rawat, 2006). In addition, seasonally migrating livestock herds, as well as livestock imported into the region for the tourism enterprise pose a serious risk of spreading exotic diseases to wildlife. Furthermore, unplanned tourism threatens sensitive and biologically important high-altitude wetlands.

5.7.1 RET categories species wise

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

5.7.2 Changes in Forest cover

The total forest cover in the state is 3341.03 km² which is 47.08% of the state's geographical area. In terms of canopy density classes, the state has 1102 km² (15.52%) under very dense forests, 1551 km² (21.86%) under moderately dense forests and 688 km² (9.70%) under open forests, 296 km² under Scrub (4.17%) and 3459 km² under Non-Forest (48.75%). In the last one decade (2011 to 2021) the total forest cover declined by 0.25% of the total geographical area of the state. The main reason behind decline in forest cover is due to diversion of forest land for non-forestry purposes like establishment of hydropower projects, construction of border roads for national security purpose, rural connectivity roads for economic upliftment of rural masses, and development of ecotourism centres (Annual Administration Report 2018-2019, F&E Dept. Govt. of Sikkim).

Tourism in Sikkim Himalayas has shown its impact on forests in terms of extraction pressures for firewood, fodder and timber, changes in species composition, and poor regeneration status of firewood along the trekking corridors of Yuksam–Dzongri area (Chettri *at al.* 2002, 2006). Impacts of tourism in Sikkim in terms of pressure on resources and degradation of forests and lands, deterioration of pastures and changes in pastoralist traditions, problem of litter and garbage, waste management, and huge tourist influx has also been reported by earlier researcher. In such studies apprehensions has also been raised that tourism growth could also lead to habitat destruction, resource depletion and changes in subsistence agricultural economy of the state. The decreasing trends of livestock population and food crops, and increase in the area and production of cash crops was reported as a consequence of monetization of village economy owing to promotion of home stays and ecotourism/ tourism in pristine village ecosystems. In some of the rural areas, diversion of agricultural land for tourism purposes is common (Joshi and Dhyani 2009).

5.8. Eco-sensitive zones/ Areas

Sikkim has currently 8 eco-sensitive zones, including one national Park (Khangchendzonga National Park) and seven wildlife Sanctuaries (namely; Kitam Bird Sanctuary, Kyongnosla Alpine Sanctuary, Shingba Rhododendron Sanctuary, Maenam Wildlife Sanctuary, Fambonglho Wildlife Sanctuary, Barsey Rhododendron Sanctuary and Pangolakha Wildlife Sanctuary) all were declared as eco-sensitive zone in 2014 (ENVIS Hub: Sikkim 2021).

Eco-sensitive Zones in Sikkim:

i. Khangchendzonga National Park

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

ii. Kitam Bird Sanctuary

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

iii. Kyongnosla Alpine Sanctuary

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

iv. Shingba Rhododendron Sanctuary

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

v. Maenam Wildlife Sanctuary

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

vi. **Fambonglho Wildlife Sanctuary**

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

vii. **Barsey Rhododendron Sanctuary**

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

viii. **Pangolakha Wildlife Sanctuary**

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

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

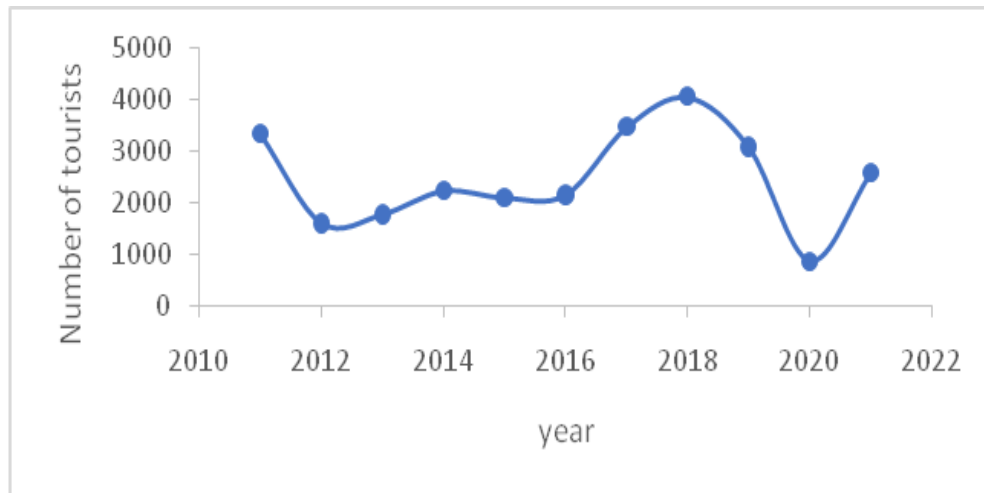


Fig.. 5.3: Flow of tourists in Khangchendzonga National Park (2011- 2021) (*Source: KNP/KBR Division, Forest and Environment Department, Govt. of Sikkim*)

Tsomgo lake located in fringes of Kyongnosla Alpine Sanctuary is a popular tourist destination visited by four lakh persons in 2012 (Tambe and Arrawatia, 2012) that rose to over five lakh in 2018-19. In and around the lake, approximately 180 shops have been set up by locals for tourists which are additional source of pollution in the region. The Tsomgo Pokhri Sanrakshan Samiti (TPSS) is a part of the Forest Department's initiatives to promote nature conservation and ecotourism in the state and serves the purpose of protection and conservation of the lakes in the state in partnership with the concerned Gram Panchyat Unit (Department's Notification No. 355/f-Sikkim Gazette No. 244, Monday 11 August 2006). Tsogmo Pokhri Sanrakshan Samiti (TPSS) was formed in 2008 with the support of Department of Forest, Government of Sikkim, and WWF-India and removed around 20 trucks of waste in a week in 2009. There are around 180 households in the three villages (Thegu, Changu, and Chipsu) in the vicinity of Tsogmo lake. Two members of each of the three villages around the lake serve on the TPSS, as well as other stakeholders such as representatives of the police and shopkeepers' associations. As per the guidelines, Rs. 10 is collected from every visiting tourist as Pokhri Sanrakshan Shulk or Lake Conservation Fees. The fees collected is credited with the revolving fund account of TPSS on a monthly basis. 50% of it is transferred to the Forest & Environment Department of State and the rest of it is used by TPSS for the conservation of Tsomgo lake (Tambe and Arrawatia, 2012).

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

Fambonglho Wildlife Sanctuary located in vicinity of the capital town Gangtok was declared as protected area in 1984 and tourist flow in 2 decades between 1995 to 2014 indicated that after initial

decrease up to 2004, a steady increase was recorded and maximum visitors (253 numbers) were recorded in 2014 (Lepcha *et al.* 2015).

- **Status in compliance of waste treatment facility:** In KNP, segregation of waste is carried out at the exit point of the national park. Most of the plastic waste is placed into dumping sites outside the national park. Cleanliness drive are carried out regularly (once in a year) with the involvement of local stakeholders. Around 800 kg of waste is collected per year from trekking route of Yuksum Dzongri in KNP since 2017 (Anonymous 2017).
- **Measures taken for waste management:** A garbage monitoring form is issued at entry check-post where the detail of all dry items taken inside the park are entered and on exit through the check-post, it is assured that all the plastic waste are brought back. There after the segregation bins are kept. In case of non-compliance penalty fee of Rs. 5000.00 is levied on tourists. Garbage bag on security deposit of Rs. 300.00 is issued to collect and bring back the plastic waste to be checked to the post. It is mandatory for every tourist visiting the park. Cleaning drives inside the park with involvement of local stakeholders is a regular feature.
- **Prohibition of Construction:** As per the government notifications, construction is completely banned in all the Eco-sensitive zones in Sikkim, except road construction in strategic locations near Indo-China borders and a few approach roads developed by the Forest & Environment Department.
- **Traffic regulation:** Traffic regulation is strictly followed in all the Eco-sensitive zones except in the Kyongnosla WLS. In KNP, vehicle movement is not possible due to non-availability of road inside the National Park. However, in Kyongnosla WLS, 3000 vehicles per day are permitted for tourists and other visitors to Tsomgo lake & Nathula Pass by the Tourism department, Government of Sikkim and entry is checked at different check-points.

5.9. Gap area and Plan of Action

1. Carrying capacity assessment of eco-sensitive zones and major tourist destinations and circuits.
2. Promotion of community-based ecotourism for sustainable use of bio-resources. The community-based ecotourism is an important source of seasonal income for the villagers residing in remote areas.
3. Comprehensive data on income generation from tourism related activities from hotels, transport agencies, eco-sensitive zones, and major tourist destinations.
4. A holistic assessment and periodic monitoring on impacts of tourism activities on environment and ecology of eco-sensitive zones and key destinations.
5. Enforcing guidelines for a regulated tourism, and sensitization and awareness building among visitors/ tourists.
6. A systematic and comprehensive record of tourist's inflow, particularly in eco-sensitive zones and major tourist destinations and circuits.

7. Identification of the key biodiversity rich areas in potential tourist destination sites and impact of tourist's activities on the flora and fauna.
8. The uncontrolled growth of number of tourist can lead to damage in natural resources and increase conservation costs. The suitable management options for natural resources are, therefore, needed.
9. As per the information available, the waste treatment and management facilities at tourist destinations and eco-sensitive zones are lacking. Therefore, there is urgent need for proper disposal and management of waste at such potential tourist sites.
10. Strengthening environmental awareness and consciousness of people will help in identifying the potential ecotourism sites based on the environmental management.
11. Presently, tourism is churning good revenue for the state and sufficient funds for the conservation efforts; yet the efficacy of the system of fees, permits, and quota that is in practice, towards long term management of tourism environments through conservation of nature resources and by way of regulation of tourist inflow needs a revisit.
12. The high altitude zones of the state that are ecologically fragile areas having a large inflow of tourist which has serious environmental concerns, disturbance to wildlife, garbage accumulation, and vehicular pollution are some of the immediate major challenges turned up by tourism which needs to be addressed. The recent Indian State Forest Report reveals that the negative growth rate of forest cover.
13. Tourism should cater a wide range of local economic activities, taking environmental costs and benefits into account, but it should not be permitted to become an activity which dominates the economic base of an area.
14. The conservation and sustainable use of natural, social and cultural resources are very crucial. Therefore, tourism should be planned and managed within environmental limits along with due regard for the long term appropriate use of natural and human resources.
15. All stakeholders of tourism should be aware of the need to develop more sustainable forms of tourism which include staff training and raising awareness, through education and marketing tourism responsibly, of sustainability issues amongst host communities and tourists themselves.
16. Research should be undertaken throughout all stages of tourism development and should monitor impacts, to solve problems and to allow local people and others to respond to changes and to take advantages of opportunities.
17. Wildlife depletion has to be checked and to be increased in its number by appropriate conservation programmers and improvement of other infrastructures as stated above at the earliest.
18. Need to conduct frequently Seminars, conference, and workshops to discuss the problems and prospects of tourism and development at the local, national and international level.
19. Waste treatment and reuse facilities should be increased as so far only about 20% of the waste is treated and the rest is disposed off / landfilled.

5.10. Summary

The high frequency of the tourists in Sikkim offers employment to marginal people and contributes in generating state revenue. Natural, cultural, sacred values and heritage sites of the state have potential to draw enormous benefits from ecotourism enterprises. Hence, development in tourism sector invariably leads to economic growth of the area, which is manifested in terms of increase in income and employment opportunities, infrastructural growth, and improvement in the standard of living of the community. With regard to tourism infrastructure development, Sikkim has excelled in leveraging central funds for the construction and development of different attractive tourist wayside amenities, destination and circuit development, and unique tourist attractions such as ropeways, skywalks, and landmark religious monuments. Religious tourism has been augmented with the construction of several unique and gigantic religious monuments which includes, statues of Guru Padmasambhava in Samdruptse, the Chardham at Solophok, Namchi and Lord Buddha's Statue at Tathagata Tsal in Rabong. Ropeways have been built in Namchi and Tsomgo Lake. A skywalk, the first of its kind, in Pelling town has been attracting number of tourists while a Greenfield airport started in 2018 in Pakyong has been helping increase in tourist inflow in the state. Owing to its diversity of communities, Sikkim has a number of traditional religious festivals that attract tourists, notable amongst which are the Pang Lhabsol, Drukpa Tseshe, Tendong Lho Rum Faat, Dasain and Tyohar, Losoong, Bhumchu, Saga Dawa and Sakewa. There are also a number of tourism focused festivals held every year in different locations around the state. To further enhance employment opportunities and tourism in the state, the government of Sikkim has initiated hosting "Global Film Festival" since last few years. The State government in the past years has given top priority and importance to the development of sufficient and required infrastructure and services for the development of tourism sector in the state. The tourism in the state has been exponentially increasing during last decade (barring COVID-19 pandemic period) particularly owing to pro-active policy of the state government to promote tourism/eco-tourism and promotional schemes by central Government such as "Go East Policy" leading to socio-economic development and economic prosperity in the state. Further, Ministry of Tourism, Government of India has provided funds under centrally sponsored schemes for the implementation of various programme/projects like angling, computerization, wayside amenities, and refurbishment of monasteries, tourist's lodges, lake and waterfall development, trekking routes/trails, basic amenities, development of destinations and circuits, parking, landscaping and gardens, restoration of monuments.

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

Darjeeling, West Bengal Hills

6.1. Introduction

6.1.1 General scenario of tourism in Darjeeling

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

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

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

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

Apart from traditional tourist attractions, tourism activity in the form of "homestay" has expanded in popularity in recent years (DCHB report, 2011). According to the West Bengal Interim Report, Darjeeling district (excluding Siliguri sub-division), as a part of the Darjeeling Himalayan region, is "the most highly frequented tourist destination in all of West Bengal" with more than 500,000 domestic and 50,000 international visitors annually (Kannegieser, 2015). While the state of West Bengal is ranked as the 6th most visited state in India, nearly 87% of those visitor's flock to the district of Darjeeling (World Travel and Tourism Council, 2010).

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

As per the record of Tourism Department, Darjeeling, Government of West Bengal;, trends of tourist influx in Darjeeling shows increasing number of tourists during 2010-19, both Domestic as well as Foreign. Though it is increasing, the tourist arrival in Darjeeling, both domestic and foreign, during 2010-19 does not show any significant trends. The maximum number of tourists (6,32,637; including 5,53,862 domestic and 44,057 international) visited Darjeeling in the year 2018 (Fig..6.1 & 6.2). The average annual growth for all kind of the tourists was recorded nearly 17% during the period 2010-2019. From 3,15,462 in 2010, the domestic tourist arrival has gone up to 55,38,62 in 2019 registering

an average growth rate of over nearly 16.5 % p.a. during the said period. Similarly, the international tourist arrival also increased from 31,562 in 2010 to 44057 in 2019 with an average growth rate of over approximately 70% p.a. during 2010-19.

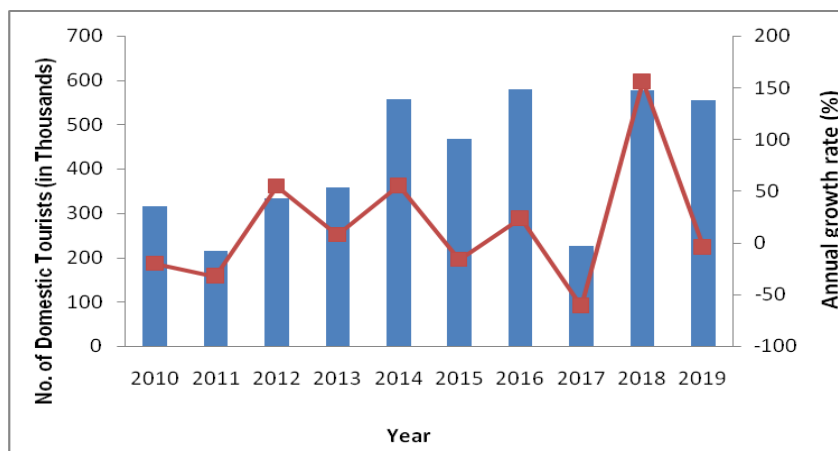


Fig.. 6.1 Trends of Domestic tourists inflow in Darjeeling town during 2010-2019 (*Source: Tourism Department, Darjeeling, Government of West Bengal*)

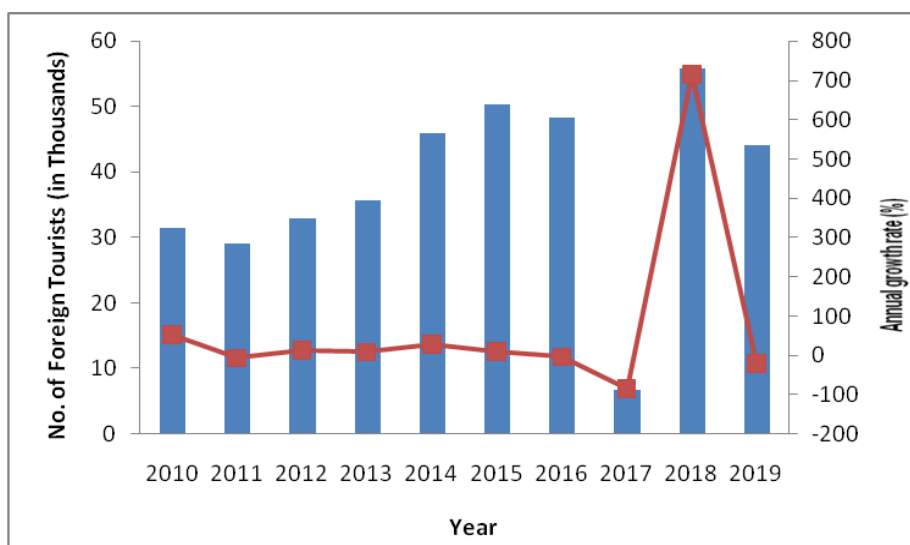


Fig.. 6.2 Trends of Foreign tourists inflow in Darjeeling town during 2010-2019 (*Source: Tourism Department, Darjeeling, Government of West Bengal*)

Due to non-availability of long-term monthly tourist data, the seasonal patterns of domestic tourist volume to Darjeeling was analysed for the period 2012-2014 only. Seasonal trend analysis of domestic tourist volume for 2012-14 showed that 43.2% tourist influx was received in Darjeeling in summer months (April–June), approximately 27% influx is received during winter months (December–March) and 18 % during post monsoon months (October–November). The remaining months (i.e. July–September) have an inflow of approximately 12% of the annual inflow of tourists per month (Fig.. 6.3).

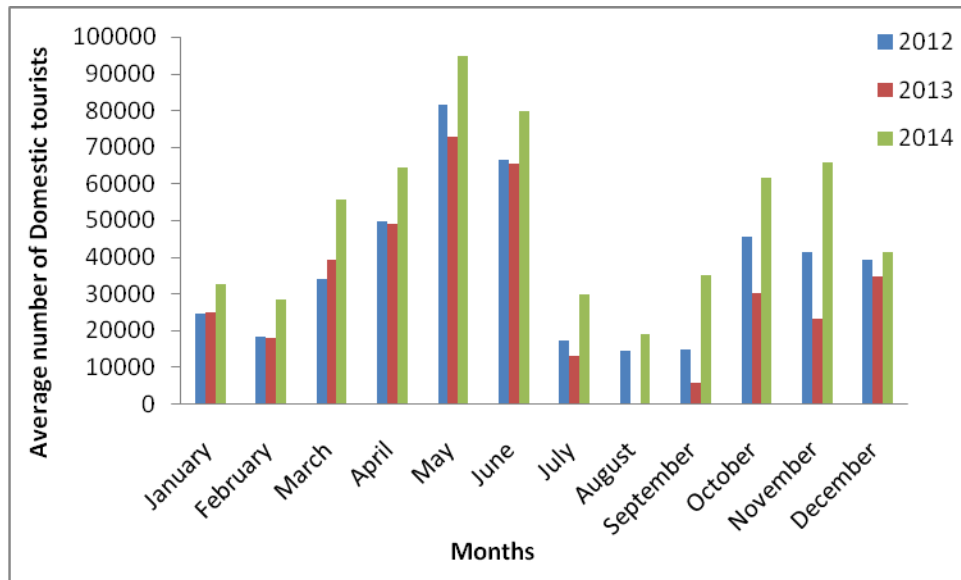


Fig.. 6.3: Monthly trend of domestic tourist arrivals in Darjeeling hills in 2012 to 2014 (*Source: Gorkhaland territorial administration, department of tourism, Government of West Bengal*)

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

Similarly, seasonal trend analysis of foreign tourist volume for 2005-10 showed that maximum (33%) tourist influx is received in Darjeeling in summer season (March-May), followed by post monsoon season and during onset of winters (30%). The influx during monsoon season (June–September) is approximately 17% of the annual inflow of tourists per month (Fig.. 6.4).

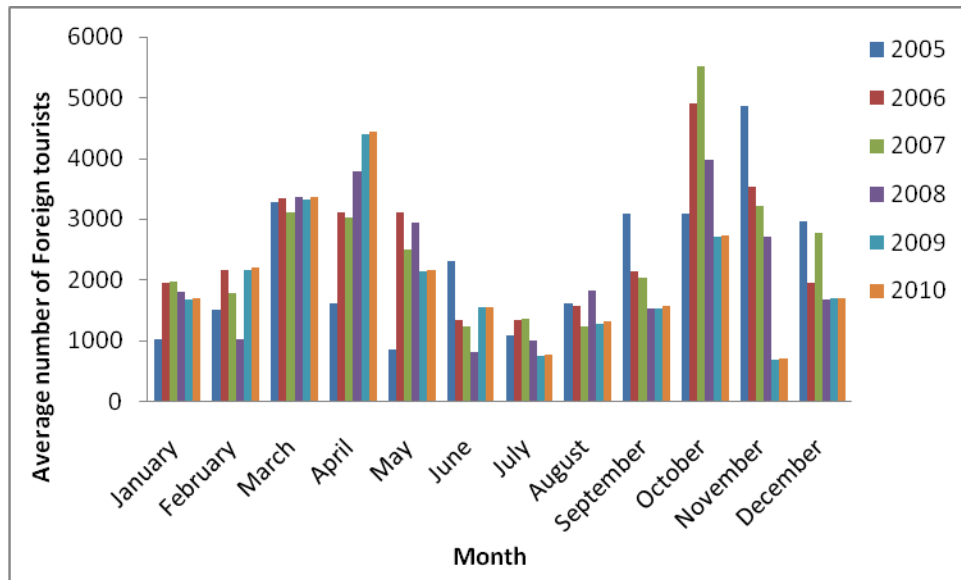


Fig.. 6.4 Monthly trend of foreign tourist arrivals in Darjeeling hills in 2005 to 2010 (*Source: Source: Foreigners registration office, DIB, Darjeeling, Government of West Bengal*)

It may, however, be noted that there have been year-to-year fluctuations in tourist volume. Darjeeling, being the tourists hot spot and a famous hill station, contributes a large amount of revenue to state GDP. Though the data on revenue generated from tourism for West Bengal hills was available, a case study of Tiger hill (tourist spot in Darjeeling) is depicted below (Fig.. 6.5). The data reveals that during the reporting period over 10 lakh tourists visited Tiger hill, which lead to a collection of Rs. 2,29,65,000.0 as revenue from tourism in Tiger hill (Darjeeling).

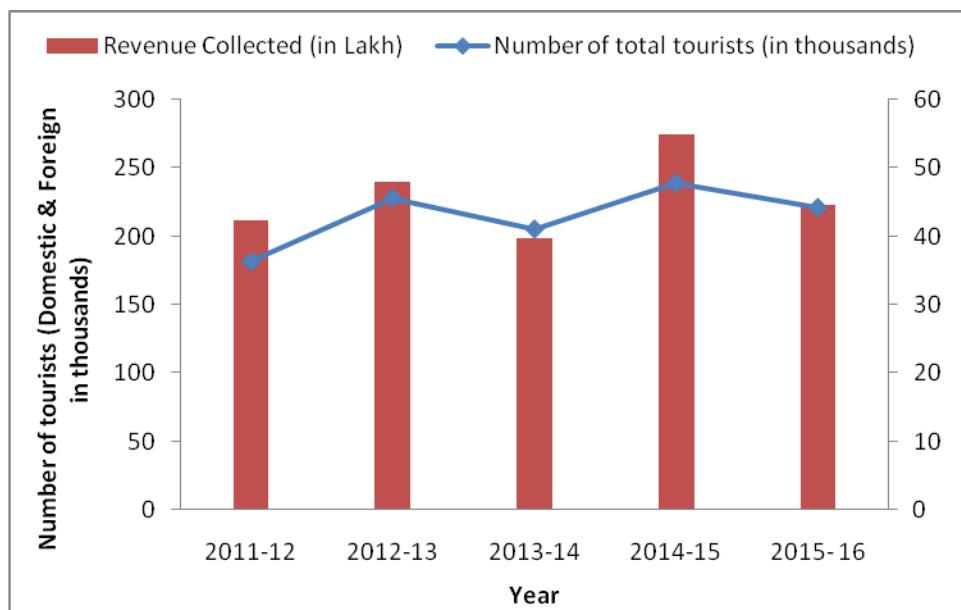


Fig.. 6.5: Trend of tourists inflow and revenue generated at Tiger hill, Darjeeling (*Source: Tourism Department, Darjeeling, Government of West Bengal*)

6.1.4. Ill-effects of tourism particularly on environmental components

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

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

Water is the most important natural resource. Tourism industry uses water much more for hotels and personal use by tourists resulting in a water crisis. Many hill stations in the Himalayan region face water scarcity during tourist season; Darjeeling is one of them. Darjeeling district suffer with water shortage; this problem becomes more severe when tourist flux increases. The total demand for water in the Darjeeling town is 75 lakh liters per day while total supply is 24 lakh liters per day with a deficit of 50 lakh litres per day (Jana and Tamang, 2017). The demand of water increases with the tourist influx. During the tourist season, on an average, each hotel is forced to buy around 2-3 tankers of water every day (Merinews, 2013).

6.2. Assessment of waste generation in Sikkim

The problem of generating solid waste in Darjeeling hills is quite alarming. In mountain areas of Darjeeling, trekking tourists generate a great deal of waste. The main source of solid waste is coming from hotel and tourist activity. About 50 tons of solid waste is generated daily, out of which only 62% is disposed-off daily (Limbu D., 2014). The major type of solid waste are Vegetable waste (20-65%), Paper and carton (15-40%), Fines (sand, ash, broken glass) (15-40%), and the plastic waste contributing to 2-13% (Limbu, 2014). Further, As per the District Environment Plan (2021), 350-400 MT/Day solid waste is generated from Siliguri Municipal Corporation, 66.38 MT/Day solid waste is generated from Darjeeling Municipality, 11 MT/Day solid waste is generated from Kurseong Municipality, and 3.6-4 MT/Day solid waste is generated from Mirik Municipality.

6.3. Segregation / Utilization of waste

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

6.4. Waste disposal/ treatment facilities

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

6.5. Impact on Air quality

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

Another study by Sarkar et al. (2015) on continuous monitoring of black carbon (BC) aerosols in

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

6.6. Impact on water quality / ground water

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

6.7. Impact on Forest and Biodiversity

The Darjeeling Himalaya is the part of Singalila range of the Eastern Himalaya located in the eastern region of India covering an area of $3,149 \text{ km}^2$ geographical area. The major forest types are northern tropical wet evergreen forests (plains up to 150 m), northern subtropical semi-evergreen forests, North

India moist deciduous forests, northern subtropical broad-leaved wet hill forests (300- 1650 m), northern montane wet temperate forests (1650-3000 m), East Himalayan moist temperate forests (1500-1800 m) and sub-alpine forests (3000 - 3700 m) (Ghosh and Mallick 2014). Due to great variation in elevation in this region, wide arrays of climatic zones are available, which favored the high floral and faunal diversity. Das (2011) estimated 3,362 species of vascular plant whereas Ghosh and Mallick (2014) has estimated over 2900 species in Darjeeling Himalaya. In term of faunal diversity this regions adobe 130 mammals, 550 birds, 125 freshwater fish, 51 reptiles, 25 amphibians, 43 moths and 24 butterflies (Anonymous 2018a & b).

6.7.1 RET Categories species wise

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

6.7.2 Changes in Forest cover

The total forest cover of Darjeeling Himalayan region is 2367.80 km² which is 75.19% of total geographical area of the district (ISFR, 2019). Forests often suffer negative impacts of tourism in the form of deforestation caused by fuel wood collection and land clearing for construction (Banu 2019). Deforestation is the most significant environmental component adversely affected by tourism. Percentage of forest has changed drastically in Darjeeling during 1901-2001 (Basu 2006). The changing patterns of land use and land cover is in a precarious condition due to the rapid increase in cultivated land, expansion of settlement, and construction of roads since the last 150 years (Basu 2006). However, in the last one decade (2011-2019) the total forest cover has increased by 2.50% of total geographical area of the state (IFSR 2011-19). There has been vast change in forest cover and population of rhododendron trees, which are the main attraction for tourists in the past and present are on the verge of extinction (Sharma, 2012). Construction of resort accommodation and facilities frequently requires clearing forestland.

6.8. Eco-sensitive zones/ Areas

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

1. Neora Valley National Park: Declared on 14/09/2017. Order no. 179.S.O. 2994 (E) [12.09.2017] Final Notification declaring Eco Sensitive Zone around zero (Nepal Border on Western Side and Sikkim on Northern Side) to two kilo-meters from the boundary of Neora Valley National Park, West Bengal.
2. Singalila National Park: Declared on 20/11/2017. Order no. 180.S.O. 3613(E) [17.11.2017] Final Notification declaring Eco Sensitive Zone around zero (Northeren side-Pangolakha Wildlife Sanctuary in the State of Sikkim) to two kilometres from the boundary of Neora Valley National Park, West Bengal.

3. Senchal Wildlife Sanctuary: Declared on 18/01/2019. Order no. 183.S.O. 319(E) [15.01.2019]
Final Notification declaring around one kilometer from the boundary of the Senchal Wildlife Sanctuary, West Bengal.

Singalila National Park, which is home to the Red Pandas, attracts nearly 26000 tourists annually and a sharp increase in tourist inflow has been observed in last few years. The effective carrying capacity, has estimated as 5,601 (excluding Nepal infrastructure), exceeding which results in biodiversity degradation (Sherpa and Mondal, 2021). The inflow of vehicles and tourists into the national park stood around 13,000 till the year 2017 whereas the number increased to maximum 33,000 with an average of 30,000 from 2018 onwards (Fig.. 6.6). If this trend continues, the effective carrying capacity will be decreased further from 5601. Further, pollution caused by increasing number of visitors and vehicles into the park results in environmental degradation (Sherpa and Mondal, 2021). It is a serious matter of concern for the sustainability of the eco-system of the national park and red panda habitat. To protect the bio-diversity of the national park, the entry of tourists and vehicles should be restricted to check the pollution and maintain a balanced effective carrying capacity.

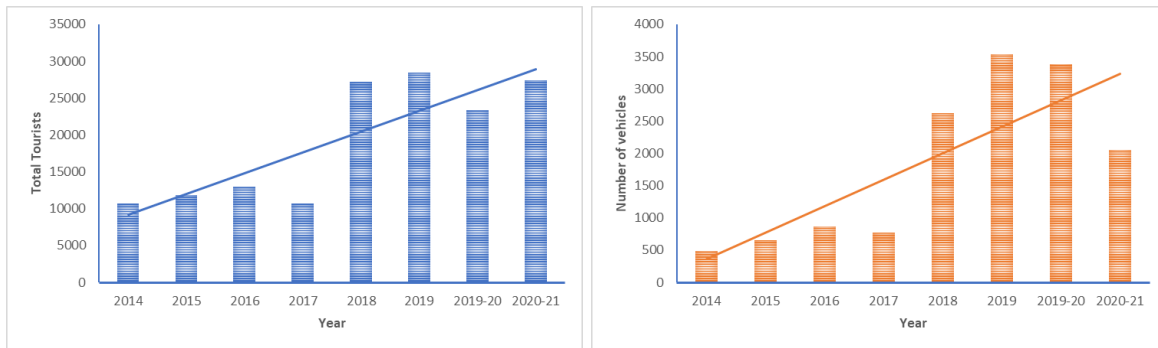


Fig.. 6.6 . Increasing flow of tourists in Singalila National Park in last 8 year (data Source: Sherpa and Mondal, 2021).

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

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

In this aspect, there is a deficiency of data/information. However, a study indicated that at Icchey Gaon in Neora valley National Park, solid wastes are collected in bins for disposal. Every family burns all the solid waste once a week, or bury the waste under the ground. There is no waste management system developed for segregating, transporting and processing of the waste materials. Sometimes

plastic and glass bottles are recycled by selling in the local markets after use (Bhattacharya et al. 2019).

- **Prohibition of Construction**

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

- **Traffic regulation**

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

6.9. Gap area & Plan of Action

1. One of the greatest threats to tourism is the risk of disasters especially for the hilly region of Darjeeling where it has increased with time. Earthquakes and landslides are an annual phenomenon here especially during the rainy season which has intensified in the past decades. The lack of technology and irregular monitoring of climate risks results in devastating effects on the tourist destination therefore it is necessary to equip the State with such technology which shall also assure optimal use of resources by preventing damages to infrastructures.
2. The main hurdle of achieving sustainable tourism is the lack of research and knowledge. The greatest challenge to successful implementation of sustainable tourism is climate change and the dearth of research hinders in progressing in the way forward. Therefore, there is a need not only to study the intricacies of sustainable tourism but also its linkage with climate change.
3. There is a thin line between unsustainability and sustainability since the road to attaining sustainable tourism is also sustainable development. Darjeeling is in a dire need of a proper urban planning. Overcrowding, broken roads and illegal constructions are common features of Darjeeling. The Darjeeling Himalayan Railway, renowned as the UNESCO heritage, suffers from lack of maintenance and continues to deteriorate. In addition, waste is dumped on the tracks. The World Heritage committee also took a note on the deteriorating condition. Thus, construction and development needs to be done by adhering to proper urban planning, developing building codes, and adopting efficient sources of energy to make it resilient to climate changes.
4. The tourism policies realise the need for Sustainable Tourism as it emphasizes on development of tourism sector in harmony with environment and interest of local communities, however, in reality the focus on development is greater to that of environment preservation. Therefore, keeping the sustainable development goals in mind, laws should be framed that balances the pillars of Sustainable tourism -Environment, Development and Socio-cultural dimensions.
5. One of the main problems in Darjeeling is the broken roads and ill managed traffic which leads to hours of traffic jam and it becomes overly crowded during the tourist season which also leads

to generation of immense pollution in the form of waste, air and water. Therefore, for tourism to be sustainable it is necessary to control the number of tourists visiting so that it does not lead to over tourism.

6. Restriction of tourist number through exploring threshold value for carrying capacity is required in all the 3 eco-sensitive zones.
7. Neora Valley National Park (NVNP) has been known as virgin area due to lack of information. The rich heritage of NVNP was unknown to the external world up until December 1982, when the Himalayan Club, along with Zoological Survey of India, Department of Botany, Calcutta University, West Bengal Forest Development Corporation and Indian army organized the first expedition to the then uncharted Neora Valley forest from Lava (Mallick et al. 2010). Besides rapid biodiversity surveys, extensive assessment report need to be carried out in such regions.
8. Waste management is a big challenge in all these eco-sensitive zones. Proper management including, listing and declare all the non-biodegradable plastic & waste products before the entry, and rechecking of all the non-biodegradable plastic & waste products brought back to ensure the waste not lifted in these zones.
9. The major impediment to promoting sustainable tourism and understanding the impact of climate change is the lack of awareness of the concept among the local communities, the local authorities and tourism operators. Therefore, the appropriate state authorities or local experts in tourism should educate about the benefits of sustainable tourism and how it shall benefit them and how adaptation methods could aid in sustaining tourism. Further efficient tourism information centres should be set up especially in the rural and remote areas which is the hub of most of the eco-tourism and rural tourism.
10. Nature based tourism can have long lasting benefits only if the environmental loss are controlled. The eco-friendly planning process is required for promotion and sustainable development in tourism industry.
11. There is lack of facility for segregation of waste at source. Payment based on waste segregation not based on weight of mixed waste is required. There is need to enable waste segregation at source, facilitating processing of organic wastes at a decentralised level.
12. Though Waste Deposition centres (for domestic waste) are available, however due to bulk amount of waste generated owing to increase in urban population and tourist's inflow there is need for additional Waste Deposition centres.
13. There is a complete lack of comprehensive plan for hazardous waste management. Hence, there is a need to make a comprehensive action plan of hazardous waste management at subdivision, block, ULB level.
14. Considering the sprawl of the district and tourist influx, additional number of air quality monitoring stations are required for identification of hotspots or areas of concern pertaining to Air pollution in association with SPCB.
15. There is need to mitigate data gaps on air and water quality and storage, prepare an inventory of water bodies.

16. There is also a need to install continuous Real Time air and Water Quality Monitoring Station at key tourist's destination including water bodies/ lakes. Additionally, need is to create an air and water quality monitoring cell in the district.
17. Also, it is imperative to conduct groundwater survey to identify quality of groundwater. Build awareness campaigns on the impact of water pollution on public health.
18. It is also necessary to disseminate information pertaining to water quality in the form of hoardings on riverbanks, official websites, etc.
19. Need to check trends of air and water quality and identify hotspot of air pollution, surface water and ground water. Implement action points for restoration of water quality in association with SPCBs and department of environment.
20. Action plan need to be prepared for control river side open defecation, dumping of Solid waste on river banks, for idol immersion etc.
21. The conservation and sustainable use of natural, social and cultural resources is crucial. Therefore, tourism should be planned and managed within environmental limits and with due regard for the long term appropriate use of natural and human resources.
22. Research should be undertaken throughout all stages of tourism development and operation to monitor impacts, to solve problems and to allow local people and others to respond to changes and to take advantage of opportunities.
23. Local communities should be encouraged and expected to participate in the planning, development and control of tourism with the support of government and the industry. Particular attention should be paid to involving indigenous people, women and minority groups to ensure the equitable distribution of the benefits of tourism.
24. All stakeholders within tourism should be educated about the need to develop more sustainable forms of tourism. This includes staff training and raising awareness, through education and marketing tourism responsibly, of sustainability issues amongst host communities and tourists themselves.
25. Forest cover has to be improved as per the National Forest Policy direction that hill station like Darjeeling should have 60% forest cover of its total geographic areas.
26. Seminars, conference and workshops, should be conducted to discuss the problems and prospects of tourism and development at the local, national and international level.

6.10. Summary

Tourism is an important economic activity of hill areas of Darjeeling District generating incomes and employment for the local population. Darjeeling receives around 3.5 lakhs domestic tourists and 50,000 foreign tourists per year that generates nearly 30% of the total tourism business of the region worth around Rs. 350 crore per annum. Apart from an increase in the income and the demand for local products, tourism also results in a multiplier effect. The facilities and services deteriorate sharply during the peak season as the amenities available cannot cope up with the huge rush. There are shortages of drinking water, electricity cut, deterioration of municipal services, congestion in public transport and lack of accommodation all these leading 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, over-looking government regulation, dumping of dirt and filth has

robbed the scenic beauty. Uncontrolled and widespread falling of trees for the urban expansion have not only defaced the scenic beauty and grandeur but has caused the imbalance in the ecological set up. In spite of so many adverse effects of tourism in the Darjeeling hill areas, there is not denying the fact that the economy of Darjeeling relies on the three 'T's, Tourism, Tea and Timber, among which the Tourism plays vital role. Darjeeling is located in the lap of nature with diverse culture of different ethnic communities; rich is heritage, harbouring a myriad of wildlife and forests against the background of snow-clad hills. Regulation of tourism is necessary which is evident by the tourism increase in hill stations in the pandemic. Though eco tourism and rural tourism are emerging in the past few years with tremendous success, the pillars of sustainable tourism are still ignored. Sustainable building codes are nowhere to be seen, roads are underdeveloped, and projects undertaken are done so without assessing the damage to the environment by removing huge forest covers. Even at the State level the government agencies are largely ignorant of the linkage of climate change and tourism. Water pollution, air pollution, noise pollution, solid waste and littering, sewage are major of them. 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 area surrounding tourist attractions, damaging the flora and fauna. And sewage pollution can threaten the health of human and animals.

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

Assam Hills

7.1. Introduction

7.1.1. General scenario of tourism in the Himalayan states

North-Eastern state, Assam took a step to recognize tourism as a sector of the income as back as 1958. When the British acknowledged Kaziranga as a game reserve in 1916 and a wildlife sanctuary in 1950, Assam was anticipated as an attractive destination for tourists, mostly those who are interested in nature and wildlife observation. Apart from it, Shillong, the administrative headquarter of the Assam province during the British period witnessed an environment of outdoor recreation initiated by the colonial ruler. At least some people from inside and outside the state started visiting Kaziranga, and also the Kamakhya temple (Guwahati) in the later part of 1930s which may be considered to be the opening of the tourism sector in the region. Since then, significant changes have taken place in the region's tourism sector because of the efforts made by the central and the respective state government in this direction. However, the tourism sector is recently originated in Northeast India and in spite of it has a history of both international and domestic tourists, witnessing merely 0.57% and 0.62% of the domestic and foreign tourist arrivals, respectively of the country. The domestic Tourist inflow in Assam

in 2017 was the maximum among the other northeast region at 6.05 million domestic tourist visits, followed by Sikkim, Meghalaya and Tripura. The most important tourist season prevails from October to May. With the overall development in the basic infrastructures along with roads and other facilities, the number of tourist places has accelerated rapidly in North-East India (Devi, 2012). Only two districts, namely Dima Hasao (earlier called North Cachar Hills) and Karbi Anglong, form the hill tourist destinations of the Assam. Almost 75-80% of the tourists visit the region for soothing weather and local festivals (Duarah and Milli, 2013). Following two hills regions of the Assam emerged as a new tourist destination in a short time.

Hills Districts

i) Dima Hasao

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

ii) Karbi Anglong

Karbi Anglong or the land of the Karbis may well be called the heartbeat of Assam. This beautiful, large sprawling district lies in the centre of Assam. This hill district with its diversity of rare flora and fauna has remained untouched and undiscovered. The peculiarity in the topography of the district lies in the fact that there are two parts in this district. The western part is bifurcated from the Eastern side by a part of the Nogaon district. Thus, we have the Hamren Sub-division in the Western part with its rolling hills, dense forests, waterfalls, rivers and streams. The East part has a combination of flat paddy lands, and green hills interspersed with blue meandering rivers. While summer in Karbi Anglong can be hot and humid and generally lasts from June to August, the remaining parts of the year are pleasant. The Peak season for tourists to visit the district is October to March.

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

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

Table 7.1: Total tourists arrival in Assam in different years

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

(Source: Assam Tourism Development Corporation Limited, 2019)

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

Tourism has been playing an important role as a means of livelihood for many people in the region. The share of tourism employment is more than 2.5 per cent of the total employment of the state (Gogoi, 2017). The overall infrastructural development and the initiatives taken by the Government to promote tourism in Assam extensively have led to the integrated development of this sector encouraging more and more people to get attached to it. Consequently, many people have started to get associated with it, leading to a continuous hike in revenue generation from this sector (Table 7.2).

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

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

Source: Statistical handbook of Assam 2018, 2019

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

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

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

Source: Statistical handbook of Assam (2018, 2019)

Although the hill tourist regions of Assam have been progressing in tourism very fast, but it is not on the top ten list of India in respect of domestic and foreign tourists (Devi, 2012). It is not even having a 2.5% share, which was the lowest, earned by other states like Gujarat in respect of domestic tourists and Goa, in respect of foreign tourists. Assam had only 0.6% of India's total domestic tourists and 0.1% of the foreign tourists in 2009 (Ministry of Tourism, Govt. of India). Assam state stood at the 18th position among the states of India, in respect of tourist inflow and income. Again, in a 2011 survey, Assam ranked 27 among 28 states in the country in the tourism survey based on various parameters. (The Telegraph, Calcutta, 28 September 2011).

7.1.3. Number of Vehicles (State/District Wise)

Transportation is one of the important components of tourism activities. The relationship between transport and tourism development is very important because it contributes significantly to the development of tourism. It overcomes the physical social and economic development of human beings. It is observed that registered vehicles in Halflong hill station of Dima Hasao district are varies year to year over the period 2011-21. In 2016, 9208 vehicles were registered in Halflong which has shown a high number after 2021 (Fig.. 7.1). The rate of change in the number of vehicles showed a fluctuating

trend from 0.06% to 0.09% from 2011 to 2021 while it showed a decreasing trend of -0.52 and -0.51 % in 2015 and 2017 respectively.

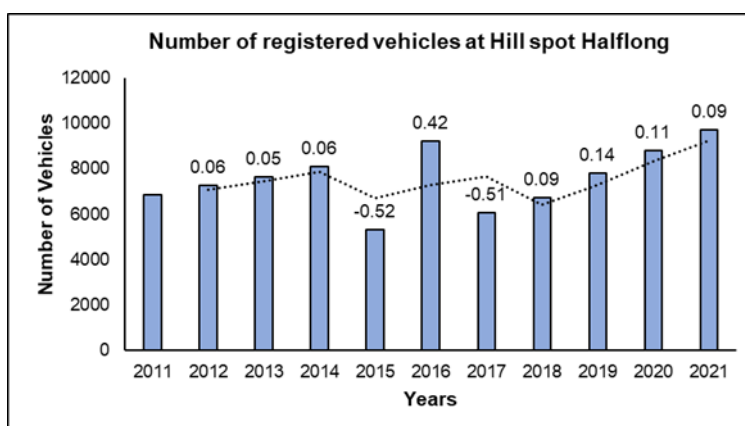


Fig.. 7.1. Number of registered vehicles in Halflong (2011-2020)

Month wise registrations of vehicles in two hill districts of Assam from 2018 to 2021 are given in the Figure 7.2 based on the tourist inflow in the particular region. In Dima Hasao district (Halflong) 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.

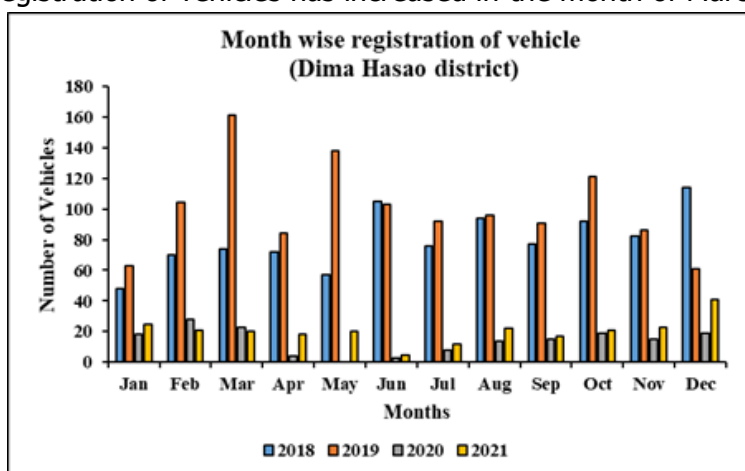


Fig..7.2 Month-wise registration of the vehicles in Dima Hasao and Karbi Anglong hill districts (2018-21)

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

Karbi Anglong district has one authorised industry of HW generation and 13 (Mt) HW is recyclable waste (CPCB, 2019).

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

Environmental damages are one of the ugly faces of tourism activities. Tourism is continuously causing sufficient damages to the natural environment of popular tourist destinations. Tourism can dramatically increase transportation services and loss of vegetation which can result into air and water pollution. Infrastructure services continuously grow around the popular tourist destinations in the form of hotels, restaurants, shops, stores and other related industries. This growing infrastructure eventually destroys the natural environment of the tourist spot, if not controlled by the rules and regulation in view of Environment Protection Act. Many of the negative impacts from tourism occur when the amount of visitors is greater than the environment's ability to cope with the visitor volume. Some of the consequences of exceeding the environmental capacity include strain on already scarce resources such as water, energy, food and natural habitat areas. In addition, unchecked tourism development may lead to soil erosion, increased pollution and waste, discharges into the sea and waterways, increased pressure on endangered species of animals and plants, and heightened vulnerability to deforestation, as well as loss of biodiversity. It also causes increased pollution through traffic emissions, littering, increased sewage production and noise. Different types of environmental damage due to tourism are described below. The most common problem in tourism areas is the littering of debris on the landscape. This is due to large number of people using the area of picnicking. Improper disposal of solid waste from hotel restaurants, and resorts generate both litter and environmental health problems, disease and pollution. It can also lead to the degradation of tourist sites. If a proper sewage disposal system has not been installed for hotels, resorts and other tourist facilities, there may be pollution of ground water from the sewage, or if a sewage outfall has been construed into a nearby river, lake or coastal sea water and the sewage has not been adequately treated, the effluent will pollute that water. This situation is common in beach resort areas where the hotels construct an outfall into the adjacent water area which can also be used for swimming by tourists or for fishing by locals. Recreational and tourist transportation motor boats in surface water result in pollution in river, lakes and sea water due to spilling oil and gas and cleaning their bilge in water. This is usually common in enclosed harbor and places where natural water circulation is slow. Tourism is generally considered a "smokeless industry." But it can also result in air pollution by tourist vehicles in a particular area, especially at major attraction sites, that are accessible only by road. This is due to improperly maintained exhaust systems of the vehicles. Also, pollution in the form of dust and dirt in the air generated from open, revegetated area if the tourism development is not properly planned, developed and landscaped or is in an interim state of construction.

7.2. Assessment of waste generation in Assam

During 2009-2012, Assam state on average generates about 1146 Metric Tonnes of waste per day. The quantities of waste are growing at the rate of 3% annually with the increasing per capita generation

and change in the living standards, especially in the bigger cities. It is endorsed that waste management is a huge challenge in hills tourist spot and become much more threatening as the number of tourists grows. Assam has 0.03 gm per capita solid waste generation by tourism and its allied sectors but it reflects waste generation and disposal as a key focus area for sustainable tourism (Niti Aayog, 2018).

7.3.Segregation / Utilization of waste

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

7.4. Waste disposal/ treatment facilities

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

7.5. Impact on Air quality

Air quality data were generated by M/s Eco Laboratories & Consultants Pvt. Ltd. for the ambient air of selected sites of Dima Hasao district from December 2017 to Feb 2018. This site is close to the tourist destination Halflong. Fig.. 7.3 shows the variation in air pollution during selected days in 2017 and 2018. All the analysed pollutants were well within the permissible limit prescribed by NAAQS The major contribution of air pollution is by opencast mining, such as excavation, loading and transportation etc. which leads to a momentary rise in the suspended particulate matter (PM₁₀). The dust liberated in mining and other related operations is injurious to health if inhaled in sufficient quantity. As such there is no noticeable impact on air quality.

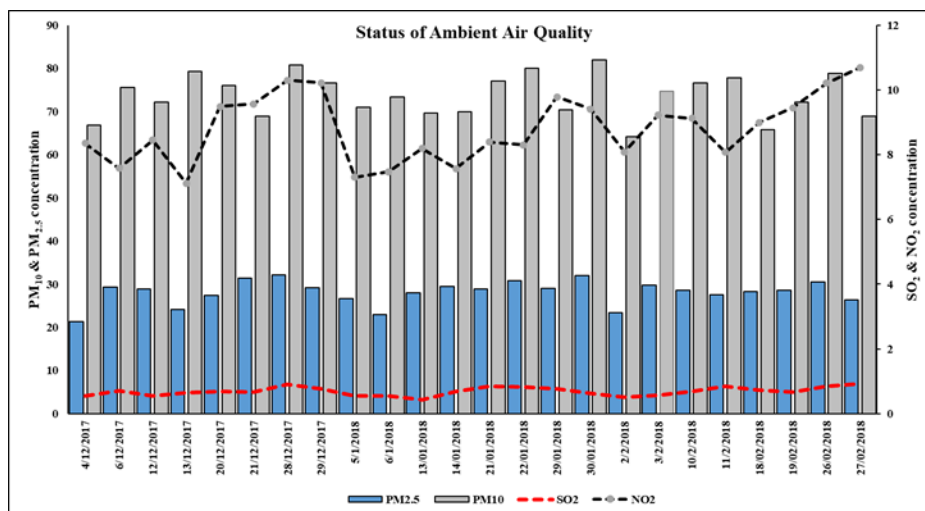


Fig..7.3: Status of Ambient Air Quality in near Halflong area Dima Hasao district (Source: M/s Eco Laboratories & Consultants Pvt. Ltd.....)

7.6. Impact on water quality/groundwater

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

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

7.7. Impact on Forest and Biodiversity

In 2010, Dima Hasao had 31.millihectares of natural forest, extending over 11% of its land area. In 2021, it lost 127 kilohectares of natural forest, equivalent to 64.6 Mt of CO₂ emissions. From 2002 to 2021, Dima Hasao lost 12.0 kilohectares of humid primary forest, making up 18% of its total tree cover loss in the same time period. The total area of humid primary forest in Dima Hasao decreased by 8.4% in this time period (Fig.. 7.4 a&b). From 2001 to 2021, Dima Hasao lost 69.0 kilohectares of tree cover

equivalent to a 16% decrease in tree cover since 2000 and 28.5 Mt of CO₂e emissions. From 2002 to 2021, Karbi Anglong lost 27.9kha of humid primary forest, making up 17% of its total cover loss in the same time period. The total area of humid primary forest in Karbi Anglong decreased by 9.8% in this period (Fig.. 7.5 a&b). From 2011 to 2021, Karbi Anglong lost 105kha of tree cover, equivalent to a 13% decrease in tree cover since 2000, and 47.3 Mt of CO₂ emissions.

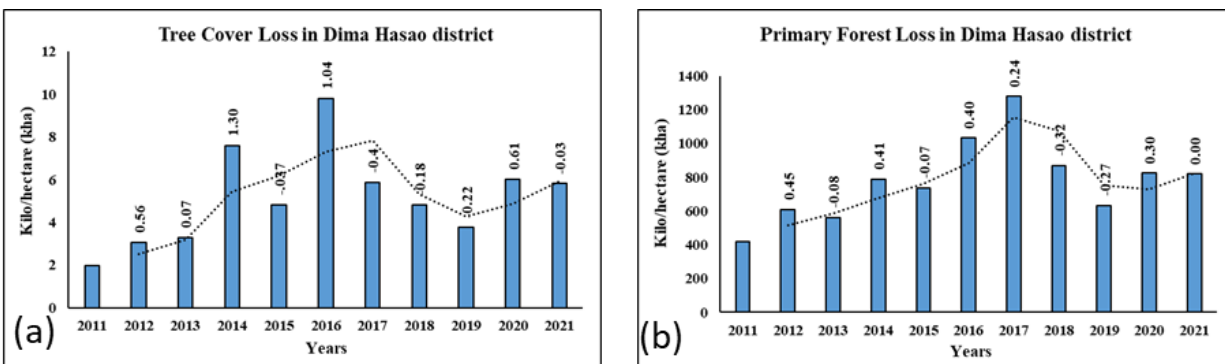


Fig.. 7.4 (a&b) Primary forest loss and tree cover loss of Dima Hasao district.

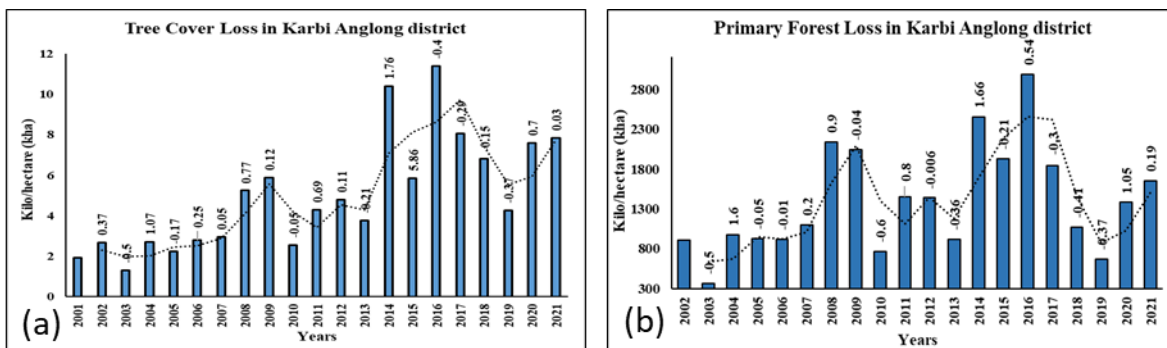


Fig.. 7.5: (a&b) Primary forest loss and tree cover loss of Karbi Anglong district.

In Dima Hasao district, no protection around the forest area of Halflong and various disturbances and their effects on the normal growth of natural flora were found. Invasive species like *Chromolaena odorata* and *Mikania micrantha* are available in the area. Conservation of habitat and ecosystem by means of protected area network, ecological restoration and sustainable resource management is very important for biodiversity conservation (Angermeir, 2001). It has been observed that the Sacred Groves of Halflong are examples of conservation carried out by the community but it has also been observed that more importance is given to the actual deities and religious beliefs than the forest. This has changed ideas over time, which has led to the degradation of the forests. Assam control of Tree Felling Rules, 2002 implemented by the government, to control felling of trees, these rules provide for the registration of the tree plantation raised on non-forest land with the Divisional Forest Officer except for trees including *Aam*, *Jamun*, *Kathal*, *Eucalyptus*, *Poplar*, a species of homegrown *Bamboo*, *Leteku*, *Paniol*, *Madhuriam* which do not require felling permission. It has been documented that the usage of

at least 15 animals listed under the Endangered, Vulnerable and Near Threatened category of the IUCN Red List in the hills of Dima Hasao. While several are listed under Least Concern in the IUCN Red List, there has been a drastic change in the abundance of the species even within the last ten years. Species like *Gekko gecko*, *Gallus gallus*, *Canis aureus*, *Macaca assamensis*, *Nycticebus coucang* are less abundant now as compared to the last ten years. At present, at least 24 are hunted for their meat as much as it is hunted for its medicinal value. Smoked meat of *Sus scrofa*, *Trachypithecus pileatus*, *Hoolock hoolock* etc. are in high demand (Lalduhawma and Betlu, 2013).

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

The Assam government decision came after the Supreme Court-appointed central empowered committee (CEC) pulled up the government earlier this month (17 May 2022) over slackness in protecting the animal corridors. The government declared seven protected areas; Kaziranga National Park and Tiger Reserve, Burachapori Wildlife Sanctuary, Laokhowa Wildlife Sanctuary, Garampani Wildlife Sanctuary, Nambor-Doigrong Wildlife Sanctuary, East Karbi Anglong Wildlife Sanctuary, and North Karbi Anglong Wildlife Sanctuary. No construction could be done in these eco-sensitive areas. Assam Government cleared, "The eco-sensitive zone will categorize activities inside it as prohibited, regulated and promoted. The zone is intended to protect flora and fauna, besides ensuring ecological and environmental security around the national park.

Environmental damages are one of the ugly faces of tourism activities in the hills town of Himalayan states. Tourism is continuously causing sufficient damage to the natural environment of popular tourist destinations. Tourism is dramatically increasing the transportation services and deforestation which can result in air and water pollution. Infrastructure services are continuously growing around the popular tourist destinations in the form of hotels, restaurants, shops, stores and other related industries. This growing infrastructure eventually destroys the natural environment of the tourist spot, if not controlled by the rules and regulations in the form of the environment protection act. Himalayan destinations have their own limited natural and infrastructure to carry out tourism development. Sustainable use of available resources by the local community for tourism purposes has the right approach for socio-economic development of the hill area of Assam. Control mechanisms need to be local context-specific and inevitable to make Carrying Capacity Concept.

7.9. Gap areas & Plan of Action

Gap	Plan of Action
In-situ conservation of all wild flora and fauna/Research-based plan	Complete inventory and documentation of wild flora and fauna/extensive need based on field-based research and consultation with local stakeholders for documentation.
Community-based Tourism	With Community-Based Tourism (CBT), local people enhance their involvement and

	participation in tourism planning and development in their areas, having a positive impact on the social, economic, and environmental conditions of the tribal communities of Assam.
Collection and Segregation of waste	Assam Hills manage or make arrangements for the house to house waste collection and identify the generation points to minimise the negative impacts. Data on waste generation, collection and its treatment need to be generated and documented.
Monitoring of Air pollution data	Data deficit in air pollution has been observed. Local authorities should develop a data base based regular monitoring for obtaining changes in coming future.
Lack of Institutional Capacity for Climate Change Planning	Expansion in the institutional capacity of local governments for climate change planning is needed. This will require adaptation, based on NDC and SDGs.

7.10 . Action plan for mitigation

Developments of tourism in rural hill areas provide an opportunity for a wide range of benefits, both direct and indirect, to the local community. So the local management committees should encourage for management of tourism in hills regions. It has been observed that municipalities do not keep/maintain regular data on waste generation and its composition. Presently no systematic and authentic data on MSW generation is available. There is a need for the digitalization or web portal of waste collection and disposal data. Issues of water highlight the need for a database on water availability, water quality as well as access to data sources for different uses and applications of the hilly region. Launch public awareness campaign for air pollution control, vehicle maintenance, minimizing the use of personal vehicles, lane discipline, etc. for controlling the air pollution in this particular area. The environment and wildlife resources are major attractions to bring in tourists to the North East region. Environmental and wildlife protection is therefore perceived as an essential component for the long-term success of tourism in this region. The tourism development activities should also include increasing awareness towards the conservation of natural and cultural assets both among the locals and tourists. It is expected that through the cooperation and productive interaction of the tourism industry, environmental protectors and the local community, it will ensure regulated tourism that will benefit all and achieve environmental sustainability in the region.

7.11 Summary

Due to improving and affordable connectivity, particularly air travel, tourism sector is booming in India and related growth in infrastructure. Landscape of IHR caters different types of tourism needs (viz.,

nature and religious) of the domestic population and other nationalities. Accelerated growth of Tourism in IHR in the past few years had substantial impact on its economy, local community and environment. The tourism industry has served an important industry in economic development of people in the IHR, but as a coin has two side similarly tourism has two side as well, with increase in tourism there is increased waste generation, increased vehicles, increased waste disposal into rivers has led to degradation of the soil, water and air quality over the period of time. Decentralization of waste management, introduction of latest technologies can help in robust waste management especially on the hilly cities with limited area for dumping of waste.

Further with increased number of vehicles in the tourist places, some parts is facing its impact on air quality in the that particular area which can be only measured by regular monitoring of pollutants and understanding there diurnal and seasonal variability in the region. Some of mitigating measures to combat degrading air quality such as (i) Nature based solution can be used can be used as a sustainable way to combat air pollution. Some of the sensitive species such as lichens, algae, and trees have been used as bio-indicators of air quality (ii) Improving the vegetation cover/greenery will also help in reducing air pollution (iii) Some of the plant species have the potential to reduce air pollution through mechanisms such as bioaccumulation and deposition. The tolerance and sensitivity of the plant species vary depending on the type of stress (pollutant) and plant physiology. Regular monitoring of water quality especially monitoring of natural water resources, Capacity building and awareness among the local community and tourists about Water quality degradation will help improve the water quality in the region further proper management of Sewage waste so that it does not mix with other natural water resources will also help to prevent degradation of air quality. It is important to note that several leading mountain states such as Himachal Pradesh, Sikkim, J&K and Uttarakhand have specific best practises. Many governmental and commercial initiatives have the potential to be upscaled and out scaled in the future. However, on ground things are of tremendous concern. The NGT's orders to mountain states e.g. Himachal Pradesh on Rohtang Pass, J&K on Vaishno Devi make this very clear. Travelers to IHR are reporting drug usage among minors, prostitution, labour exploitation, and illegal property transactions despite the fact that states have put strict standards for outsiders in place. Mass tourism/pilgrimage is causing serious harm to the Indian Himalayan States. Our country is selling the natural and cultural splendour of the Himalayas at a very low premium and allowing development in IHR like we do in the plains of India. The recommendations, if incorporated into action, have the potential to help preserve IHR landscapes while also enhancing the well-being of local residents.

Arunachal Pradesh

8.1. Introduction

Arunachal Pradesh is one of the 13 states/union territories of the Indian Himalayan Region, is an ideal destination for tourists (Fig..8.1). It's located at the top of North-Eastern India; this is the first Indian land to greet the morning sun. It's also called the 'Land of the Dawn-lit Mountains'. It lies between 26°28' N and 29°30' N Latitude and 91°30'E and 97°30' E Longitude. It spreads over an area of 83,743 sq.km touching the international boundaries with Bhutan (160 Km) in the west, China (1080 Km) in the

north, Myanmar (440 Km) in the south-east and the plains of Assam to the south. It borders the states of Assam in the south and Nagaland to the east and southeast. It is the largest of the Seven Sister States of northeast India by area. The state extends from the snow-covered Himalayas to the Brahmaputra plains.

Physiographically the state is divided into 4 major division- namely, a) The Greater Himalaya b) The Shivalik c) The Purvanchal d) The Brahmaputra Plains. Terrain of the state has deep valleys rising to steep mountains. Much of the state is covered by the Eastern Himalayas. However, parts of Lohit, Changlang and Tirap districts are covered by the Patkai hills. The state has complex hill system with varying elevations ranging from 50 m in the foot hills gradually ascending to about 7000 m. The important hill systems are Kangto Massif and Namcha Barwa Massif. A picturesque and hilly terrain, Arunachal Pradesh is criss-crossed by innumerable mighty rivers and rivulets. The five major rivers – Kameng, Subansiri, Siang, Lohit, and Tirap with a large number of tributaries drain the waters of this vast area and subsequently join river Brahmaputra.

Climate of the state is influenced greatly by the Himalayan mountains and large variations in altitude across the state. Areas that are at a very high elevation in upper Himalayas close to the Tibetan border experience alpine and tundra climates. In the middle Himalayas temperate climate is experienced. Areas at the sub-Himalayan generally experience humid sub-tropical climate with hot summers and mild winters. The rainfall of Arunachal Pradesh is amongst the heaviest in the country receiving more than 3000 mm in a year. Higher regions experience snowfall during the winter. Winter months have average temperatures in the range 15°C – 21°C, and the monsoon month temperatures are in the range of 22°C – 33°C, and the summer months temperatures sometimes are higher well over 37°C.

The vegetation of the whole of Arunachal Pradesh varies greatly in relation to the elevation of the different regions. It ranges from a wide belt of swampy rain forests along the foothills and the low-lying areas to tropical and subtropical. There is a great variety of plantations to be found. There are climbers and an abundance of cane, bamboo, and orchids. The lower altitudes are remarkable for their deciduous forests with patches of evergreen tropical vegetation. Arunachal Pradesh is one of the forest-rich states in the Eastern Himalayas, its being considered as one of the top 18 global biodiversity hotspots.

Arunachal Pradesh is the home of 26 major tribes and acknowledged to be one of the most splendid, variegated and multilingual tribal areas of the world. In 2022, Arunachal Pradesh has 26 districts with a population of 17,11,947 of which 883,358 males and 828,589 females according to unique identification aadhar India and a literacy rate of 65.38%. Arunachal Pradesh is the state with lowest population density in India. Itanagar, Naharlagun, Tawang, Rupa, Bomdila, Bhalukpong, Seppa, Ziroand, Daporijo are some of the major towns in the state. Itanagar is the state capital of Arunachal Pradesh, which is also its largest city.

Agriculture is the main stay of the economy of Arunachal Pradesh. It is largely dependent on 'jhum' cultivation. Topography and climate of Arunachal Pradesh is conducive for cultivation of rice, millets, wheat, maize, pulses, sugarcane and potatoes. Varied agro-climatic zone and high adaptability to hilly topography of the state is favourable for Horticulture. It comprises of cultivation of fruits such as apple, kiwi, walnut, orange, pine apple, litchi, lemon, ginger and banana. The state is largest producer of kiwis in India and the second largest producer of large cardamom. The traditional agriculture practices also adds tourism value to the beauty of state along with cultural diversity.

8.1.1. General scenario of tourism in the Arunachal Pradesh

The major part of the Eastern Himalayan ranges in Arunachal Pradesh is the most picturesque tourist destination of India. With its numerous turbulent streams, roaring rivers, deep gorges, lofty mountains, snow-clad peaks, thousands of species of flora and fauna, and an endless variation of scenic beauty, there is tremendous potential for the development of tourism in Arunachal Pradesh; especially, adventure and eco-tourism. The state has vast potential for offering various attractions to the tourists like paragliding, river rafting, angling, hiking, trekking, mountaineering, land gliding, snow skiing etc. For the wildlife enthusiasts and nature lovers, Arunachal has a number of wildlife sanctuaries, national parks, and biosphere reserves, its lush-green tropical forests teeming with wildlife. Arunachal Pradesh is also famous for the Buddhist Circuit.

But, the tourism potential of the state for generating much-needed income & employment remains underutilized. Though the state has high tourism potential, owing to a lack of infrastructure facilities such as transport, communication facilities, accommodation, and other tourism-supported facilities, most part of it remains out-of-bound to the tourist.

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

- i) Places of Religious Importance and Archeological/Historical Sites,
- ii) Wildlife Sanctuaries and National Park,
- iii) Adventure tourism,
- iv) Arts and Craft,
- v) Culture Tourism (Fairs & Festivals, Dances).

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

There are twelve tourist circuits in the state. They are as follows:

- Tezpur – Bhalukpong – Bomdila - Tawang
- Itanagar – Ziro – Daporijo – Aalo – Pasighat
- Pasighat – Jengging – Yingkiong – Tuting
- Tinsukia – Tezu – Hayuliang
- Margherita – Miao – Namdhapha – Vijoynagar

- Roing – Mayudia – Anini
- Tezpur – Seijosa – Bhalukpong
- Ziro – Palin – Nyapin – Sangram – Koloriang
- Doimukh – Sagalee – PakeKessang – Seppa
- Aalo – Mechuka
- Daporijo – Taliha – Siyum – Nacho
- Jairampur - Manmao- Nampong – Pangsau Pass

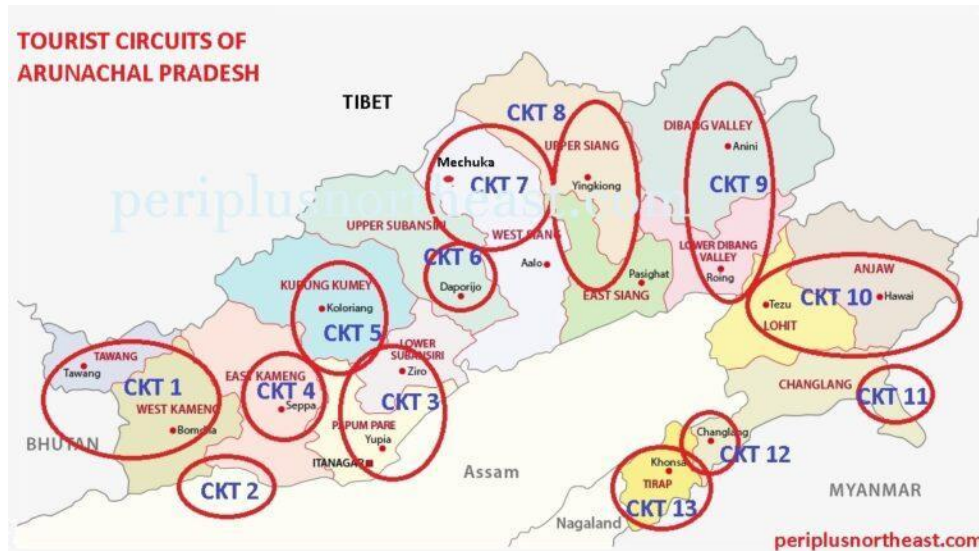


Fig.. 8.1: Arunachal Tourist Circuits Map (Source: <https://periplusnortheast.com>)

8.1.2. Tourist growth

The state is visited by many domestic and international tourists. Fig.. 8.2 & 8.3 shows the detailed Figures of domestic & international tourists visited Arunachal Pradesh in all the months during the period of year 2011 – 2021.

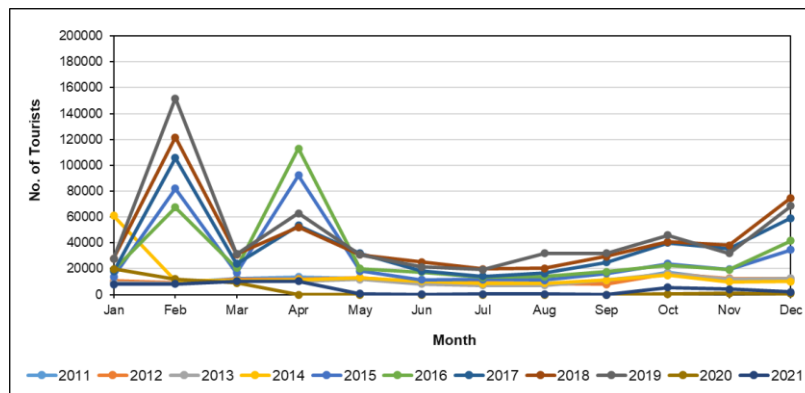


Fig.. 8.2: Domestic Tourists visited in Arunachal Pradesh (Jan-Dec) during the period 2011-21

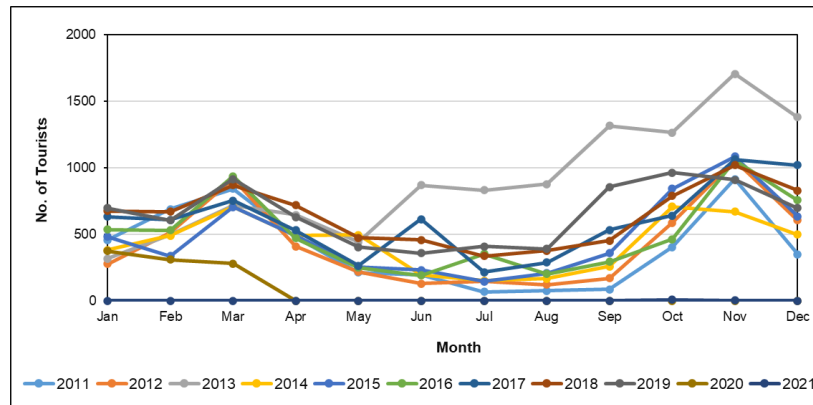


Fig.. 8.3: International Tourists visited in Arunachal Pradesh during the Year 2011-21

The data from the year 2011 to 2021 (Fig.. 8.4 & 8.5) shows that the average number of tourists per year is roughly around 2,70,000 in Arunachal Pradesh. During the mentioned period, maximum tourist visited the state in the Year 2019 (Total 5,63,464), and 98.6% were domestic tourists among total. If we talk about only international tourists, then the maximum number of international tourists visited the state in Year 2013 (10,846). The overall data as presented in Fig.. 8.4 and 8.5, shows that the highest number of visitors are seen during the months of January, February and March. On contrary, the months July, August and September can be considered as the lean period for tourism in Arunachal Pradesh. The main cause of this seasonal difference is the climate and monsoon. The month of February receive higher number of tourists because of the cold weather, snow clad mountains and beautiful snowfalls. The year of 2020 and 2021 reported the lowest number of tourist due to the COVID-19 pandemic. But during the other years many domestic as well as international tourists have visited the state of Arunachal Pradesh.

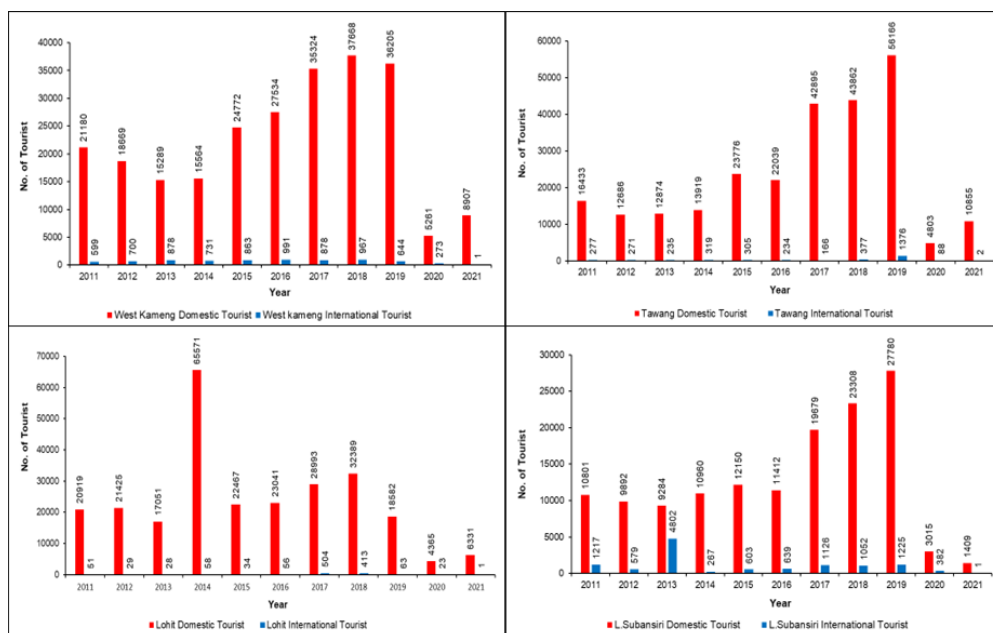


Fig.. 8.4. Yearly Tourist inflow to different district of Arunachal Pradesh (2011-2021)

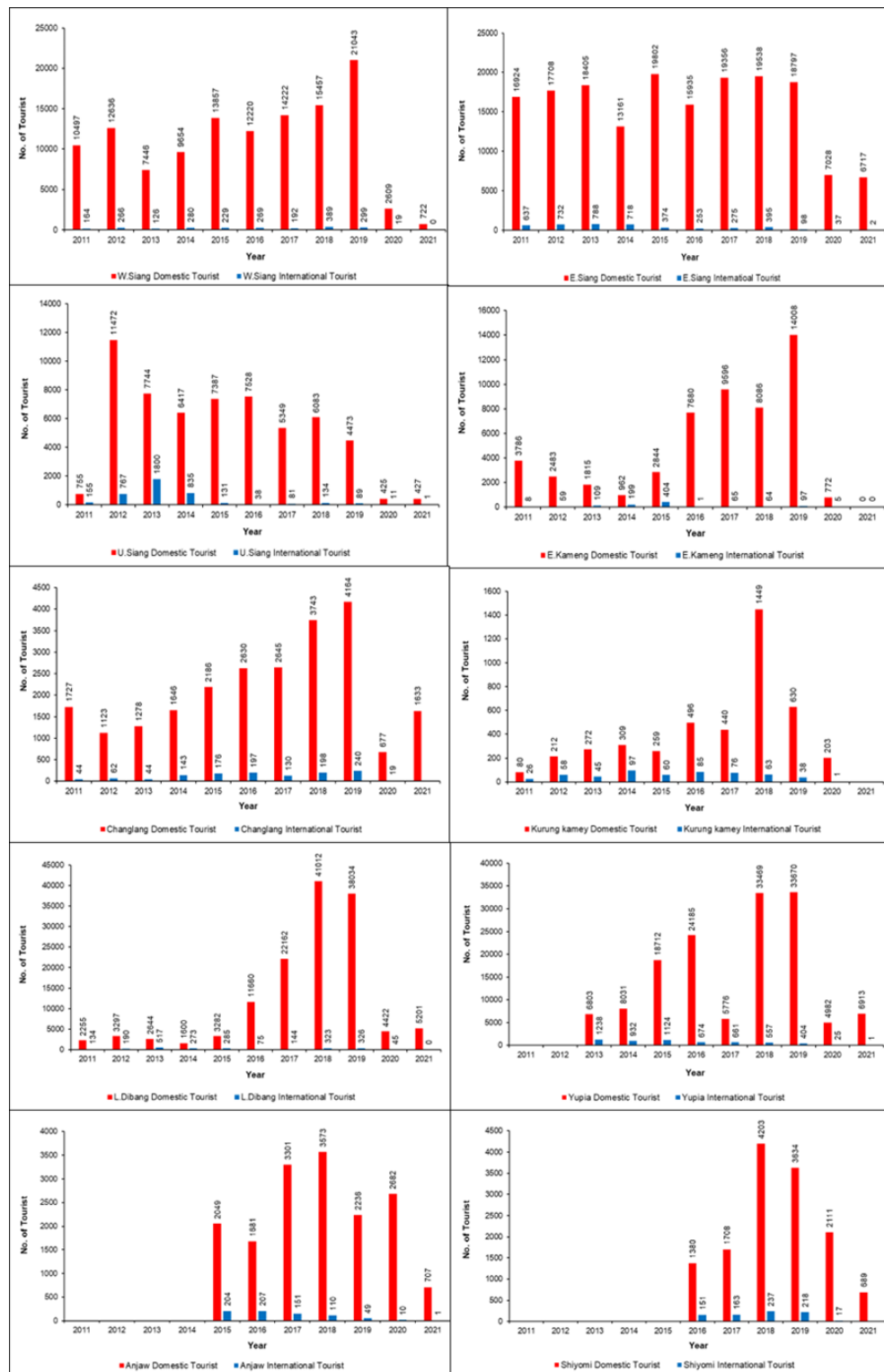


Fig.. 8.5. Yearly Tourist inflow to different districts of Arunachal Pradesh (2011-2021)

The Department of Tourism collects revenue sent by districts in which a total revenue received is compiled each month which is inclusive of PAP, Leased assets ILPs etc. The revenue for the financial Period of 2015-16 is Rs.1,02,48,797; 2016-17 is Rs.1,23,05,748; 2017-18 is Rs.1,16,83,137; 2018-19 is Rs. 78,44,936; 2019-20 is Rs. 78,72,484 and 2020-21 is Rs. 29,99,642.

District-wise distribution of tourists in Arunachal Pradesh from 2011–2021; shows that the tourist inflow is highest in Lohit District (2,61,134) followed by Tawang District (2,60,308) and West Kameng (2,46,373). While Upper Subansiri District received the lowest tourist inflow (160) followed by Kurung Kamey (4,350). The reason behind the maximum inflow of tourist in Lohit district is due to the Hindu Pilgrimage site, Parsuram-kund. Tawang and West Kameng also experiences high inflow of tourist during the winter where tourist come to experience the snowfall and scenic beauty. Dirang, Bomdila are the main tourist attractions in West Kameng district where most of the tourists visit every year. On the other hand, because of the poor connectivity and bad road condition Upper Subansiri and Kurung Kamey districts experience the low inflow of tourists. There was a gradual increase of tourist of both domestic and international till 2019, after that steep decline of tourist due to COVID-19 pandemic. Maximum tourist visited the West Kameng district in Years 2011, 2015 & 2016; Lohit district in 2012 & 2014; East Siang district in 2013, Tawang in 2017, 2018, 2019 & 2021; West Siang in 2020.

8.1.3. Number of Vehicles

As per records from the year 2011 to 2021, Arunachal Pradesh has registered 3,84,480 vehicles which includes transport and non-transport vehicles both. Out of this, 3,52,990 are non-transport vehicles and 3,14,90 are transport vehicles. The capital complex has the highest number of vehicles i.e. 2,64,553 vehicles and Kamle with the lowest i.e. 31 vehicles. The number of transport and non-transport vehicles of Arunachal Pradesh are shown in details in

8.1.4. Ill-effects of tourism particularly on environment components

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

If tourism is not well planned and managed, it can generate several types of negative environmental impacts. In general, development of mountainous tourist spots at first involves the construction of roads/highways, hotels, restaurants, nature trails, viewpoints etc., which certainly causes some degree of direct impact on the forests of that area. Secondly, there are various indirect but visible impacts such as increased vehicular traffic, increased solid waste generation, exploitation of natural resources like water, forests, etc. At last, there are many more indirect impacts which may or may not be visible directly but they are capable of putting serious stress on entire eco-system of that area, for example air

pollution, water pollution, habitat destruction, etc. Apart from sewage disposal in water bodies, garbage disposal seems to be the most acute problem contributing to soil and environmental pollution. Usually, only scanty service of garbage collection exists in the urban areas which hardly includes a proper management plan after dumping of the waste. As a result, the waste/garbage dumping sites becomes the sources for air pollution, water pollution, soil pollution, and more.

As per the data collected from various departments on solid waste generation, its door-to-door collection and dumping, the government of Arunachal Pradesh is moving in right direction so far by improving the basic facilities in its major towns (nearly 30 towns). However, as far as management of dumping sites or treatment of waste at source or dumping site is concerned, the government authorities has a lot to do in immediate future. Detailed information on waste generation and collection is given in Section 2 of this report.

The central government and state government agencies are taking up adequate positive steps to promote nature sensitive community based eco-tourism in the state of Arunachal Pradesh. That involves promotion of community-based approaches like homestays, nature-based tourism, adventure tourism, declaration of Community Conserved Areas (CCAs) for tourism purpose, etc. This approach is a good strategy to move further for developing a sustainable tourism model in the state.

8.2. Assessment of waste generation in Arunachal Pradesh

Presently Arunachal Pradesh has 33 notified urban areas or towns namely Aalo, Anini, Basar, Boleng, Bomdila, Changlang, Daporijo, Deomali, Dirang, Doimukh, Dumporijo, Hawaii, IMC, Jairampur, Khonsa, Kimin, Koloriang, Longding, Mariyang, Miao, Namsai, Palin, Pangin, PMC, Raga, Roing, Sagalee, Seppa, Tawang, Tezu, Yingkiong, Yupia, and Ziro. The details of garbage generated and collected. The town wise distribution of solid waste generation and collection per day has been shown in the Fig..8.6a and Fig.. 8.6b.

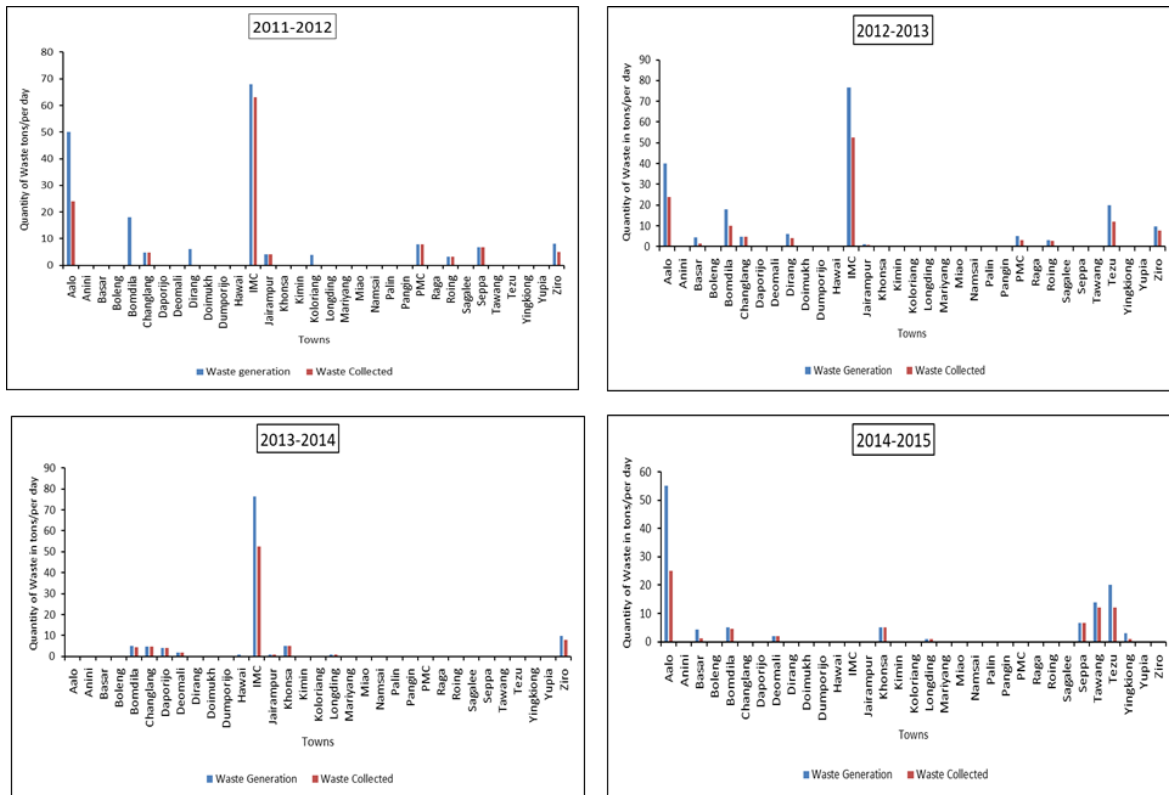


Fig.. 8.6 a: Town wise Municipal waste generated and collected (2011-12 to 2014-15).

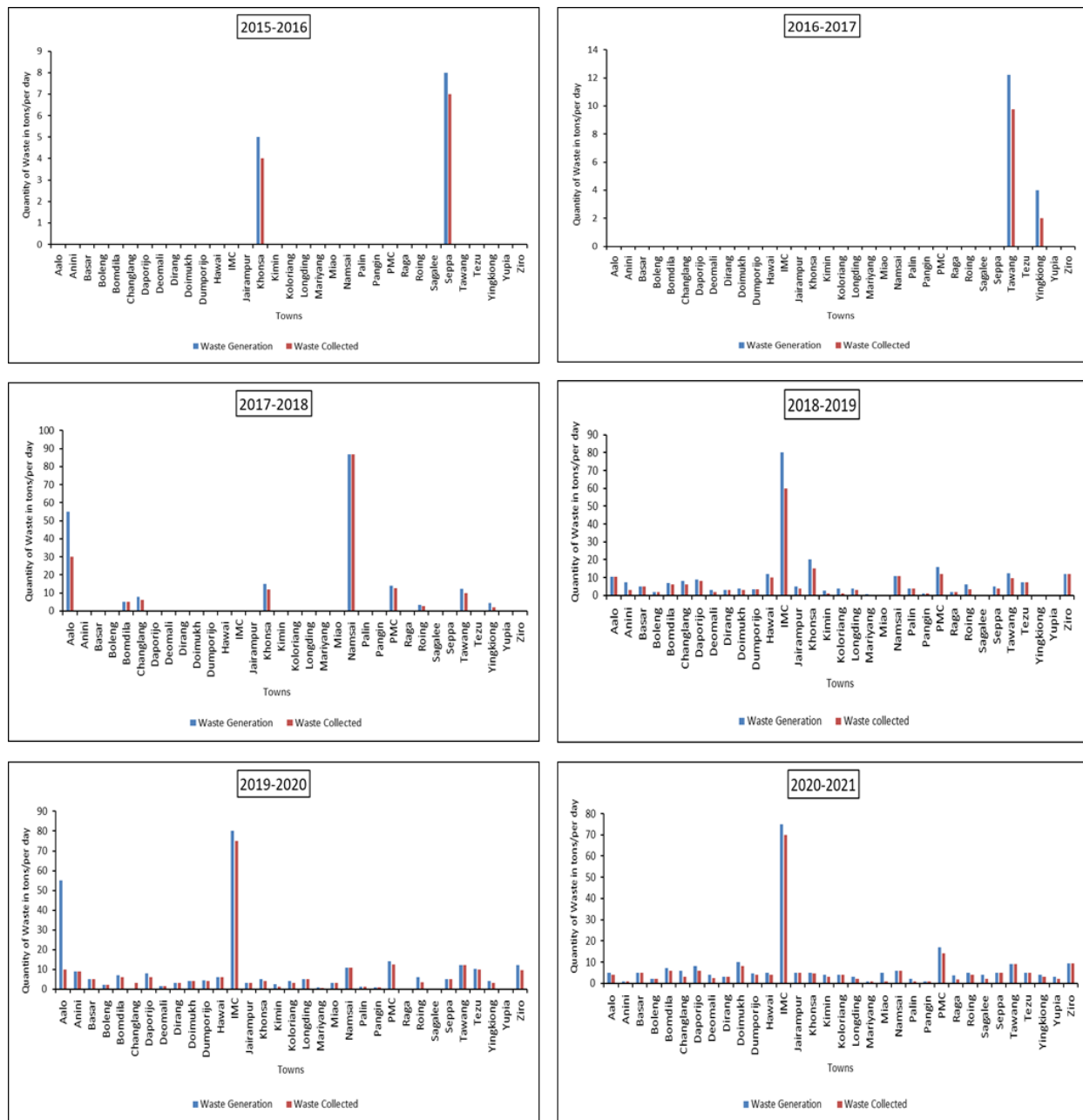


Fig.. 8.6 b: Town wise Municipal waste generated and segregated (2015-16 to 2020-21)

In recent years, Arunachal Pradesh has witnessed the construction of a large number of roads and buildings along with an increasing population and tourists. One of the direct impacts of urbanization and population increase is the generation of domestic, medical and other types of solid waste. Solid waste can be defined as any unwanted or useless solid materials generated from human activities in residential, industrial or commercial areas. It includes both biodegradable and non-biodegradable materials. Biodegradable waste such as kitchen, restaurant, and hotel trash can be composted to make manure (weed-compost or vermin-compost). Non-biodegradable waste such as plastic, glass, metal,

and other junk can be recycled. Solid waste generation is directly linked to the tourism sector as it increases with the increasing tourist. Useful for general Introduction

The garbage or solid waste generated due to an increase in tourists have been causing severe pollution of water bodies (including ground water), air, soil, etc. Sewage disposal is also affected either through septic tanks and absorption pits or as in tourist projects, disposal of wastewater through biochemical treatment plants, into inland drainage, which may have detrimental effects on the fauna in areas of disposal owing to certain substances that may be contained in the disposed effluent. In areas with high concentrations of tourist activities, waste disposal is a serious problem and improper disposal can be a major despoiler of the natural environment. In Arunachal Pradesh, trekking tourists generate a significant amount of waste. Tourists on expedition leave behind their garbage such as plastic bags and bottles, cans oxygen cylinders and even camping equipment.

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

As per the data collected from the concern state department, there has been a gradual increase in quantity of waste generation (domestic only) from the period of 2011 to 2019, and always the waste collected has been lesser than the waste generation. It has been seen that Itanagar Municipal Cooperation (IMC) have the highest amount of waste generation (more than 829 MT/day) as compared to other towns of the state, certainly due to the large population size, lifestyle of the people living here, market and hotels etc. The town of Aalo also produces the huge amount of waste (nearly 397 MT/day) in comparison to the other towns. It is to be noted that in other towns the waste generation was very low initially, but in the recent years it's gradually increasing. Till now, a total 30 dumping yards are present in Arunachal Pradesh, which covers an area 2,22,896.50 m², which is really a very small area. However, on the other hand, it is also an important fact to mention that most of the dumping sites are located on river bank sides or inside the forest areas. Therefore, it is causing negative impacts as discussed above. So far, in Arunachal Pradesh, there is no proper system in place for proper treatment of the collected waste or for management of the dumping sites. In future, if the scenario remains same this is going to affect the local environment very seriously.

5. Impact on Air Quality

Tourism has been impacting air quality directly or indirectly for decades. Air pollution resulting from excessive use of internal combustion vehicles (cars, taxis, buses, motorcycles, etc.) in tourism areas is a major problem. The details of air quality parameters monitored at Itanagar and Naharlagun has been incorporated. The variation of various air quality parameters (PM₁₀, SO₂, NO₂) monitored at Itanagar and Naharlagun for the time period 2016 –2021 are shown in Fig.. 8.7 to 8.12.

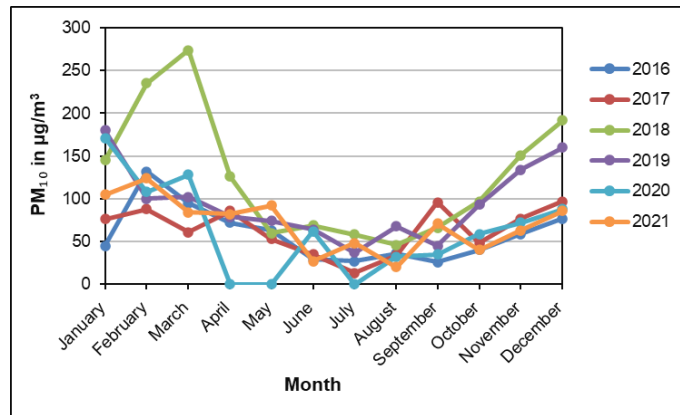


Fig..8.7: PM₁₀ in Itanagar (Jan-Dec) during the period (2016-21)

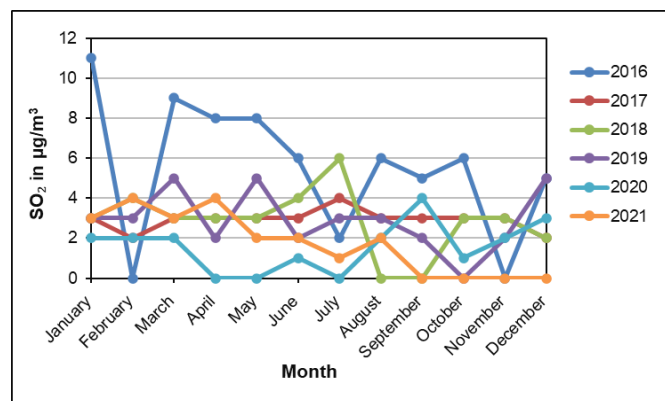


Fig..8.8: SO₂ in Itanagar (Jan-Dec) during the period (2016-21)

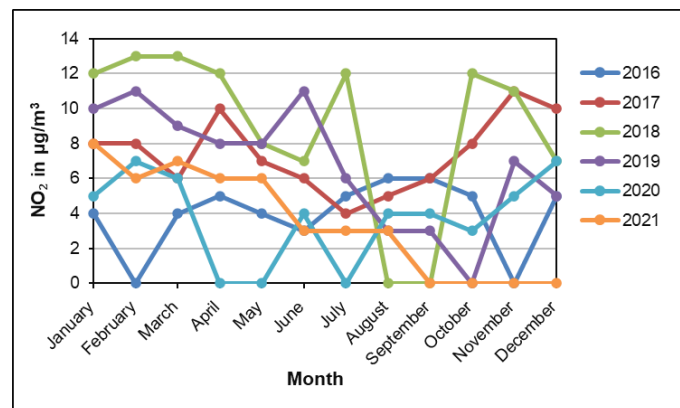


Fig..8.19: NO₂ in Itanagar (Jan-Dec) during the period (2016-21)

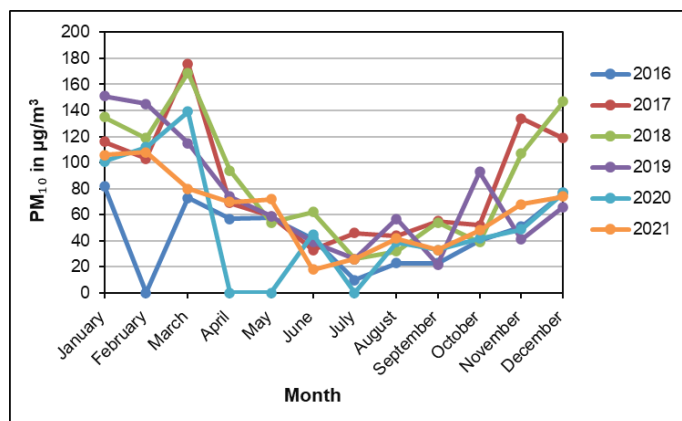


Fig..8.10: PM₁₀ in Naharlagun (Jan-Dec) during the period (2016-21)

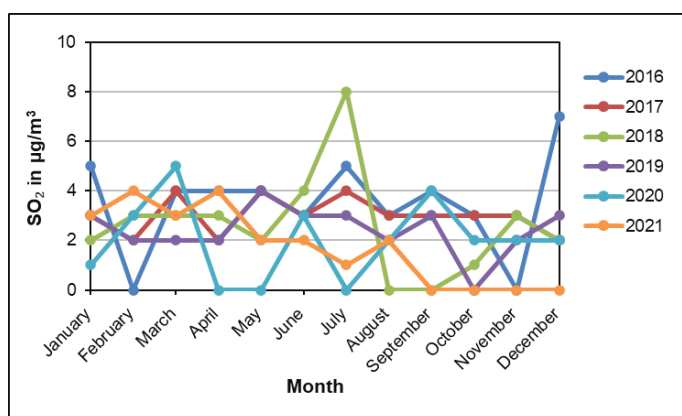


Fig..8.11: SO₂ in Naharlagun (Jan-Dec) during the period (2016-21)

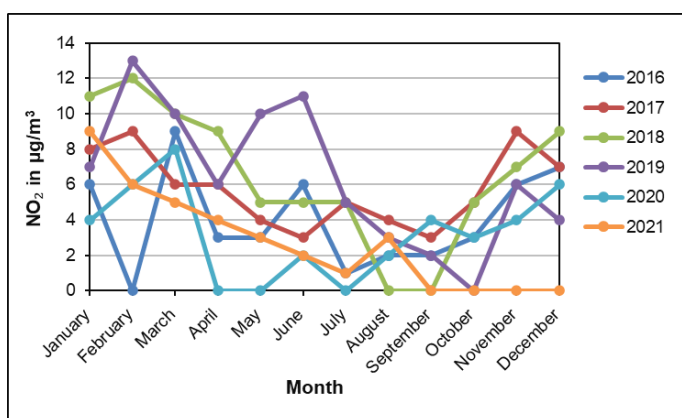


Fig.. 8.12: NO₂ in Naharlagun (Jan-Dec) during the period (2016-21)

As per the available data (*Data Source: State Pollution Control Board, A.P.*) for Itanagar and Naharlagun townships of Capital Complex (from 2016 – 2021), the values of most of the air quality parameters (PM_{2.5}, SO₂, NO₂) is within the safe or permissible limits (See Box-1) for human health except the values of PM₁₀ particulate matter for both the stations. At both the stations, PM₁₀ values during the months of January, February and March are exceeding the standard value (ie. 100 µg/m³).

Since both the monitoring stations are located in close proximity of roads, so these higher values of PM₁₀ may be due to movement of vehicles and availability of fine soil near the sites. In general, if we talk about the air quality of the Itanagar Capital Complex and also the entire state, it can be said that the air quality of the state is of good quality. However, in future the rapid urbanization and rapidly increasing number of vehicles may lead to poor air quality particularly in capital complex and other urban/sub-urban areas of the state.

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

8.6. Impact on water quality/groundwater

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

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

The State Pollution Control Board has been monitoring water quality of nearly 14 selected streams/rivers (at selected locations) on regular basis in the state and same data was collected from them. A brief description of the different parameters monitored on regular basis by the State Pollution Control Boards is given below:

Turbidity: Based on the available data of turbidity in different locations 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. Where the water samples are shown turbidity between 1.75 NTU to 308 NTU (Fig.. 8.13).

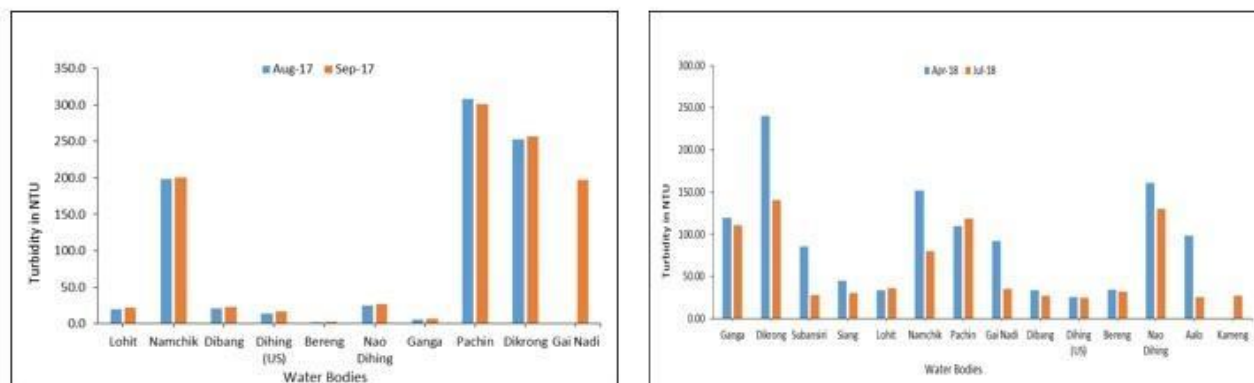


Fig. 8.13: Turbidity of water samples collected from different water bodies in Arunachal Pradesh.

Total Dissolved Solid (TDS): Based on the available data of TDS in different location shows that the TDS in the water is within the permissible limit as suggested by BIS i.e., below 500 mg/L (Fig..8.14).

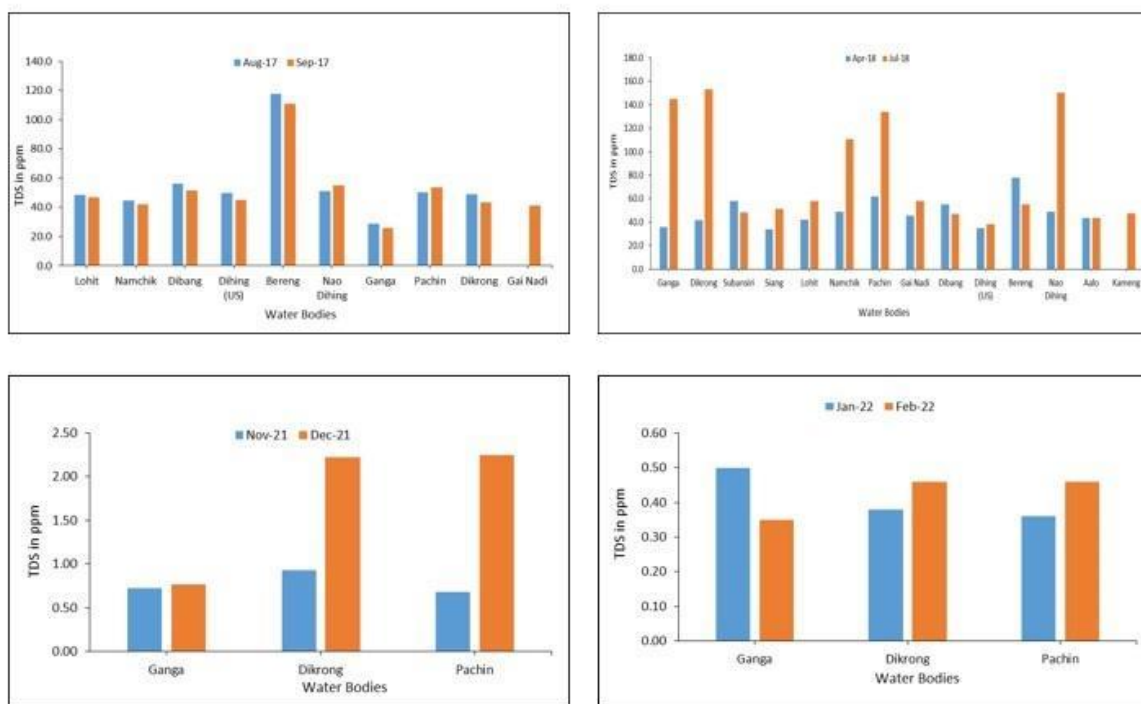


Fig.. 8.14: TDS of water samples collected in different water bodies in Arunachal Pradesh

Dissolved Oxygen (DO): The DO of the available datasets of Arunachal Pradesh shows some abnormality (Fig.. 8.15). The DO value of the water samples collected in the month of November 2021 from Ganga, Dikrong and Pachin is less than 6.5 which is the minimum requirement of healthy water. It is observed that the DO concentration during the year 2022 is showing increased value but still it's not up to the minimum required level.

Thus, overall, the data on different water quality parameters indicates that so far the major surface water sources (particularly rivers) are having moderately good quality water. Although this data doesn't include any information on micro pollutants (biological organisms such as *E. coli*), heavy metals, etc., which are very important parameters for drinking purpose.

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

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

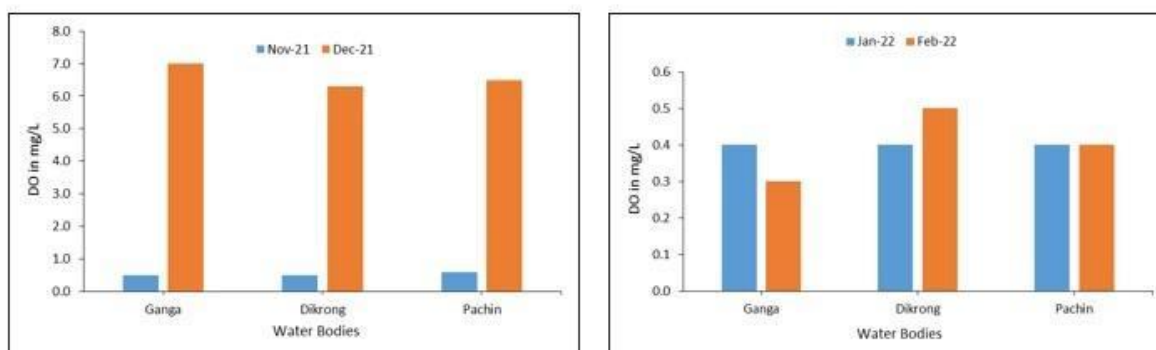


Fig..8.15: DO of water samples collected in different water bodies in Arunachal Pradesh

8.7. Impact on Forest and Bio-diversity

Arunachal Pradesh, is the second-largest forested state in India. The vegetation of Arunachal Pradesh varies greatly in relation to the elevation of the different regions. It ranges from a wide belt of swampy rain forests along the foothills and the low-lying areas to tropical and subtropical. Evergreen forest covers more than 60% of Arunachal Pradesh and is rich in magnificent trees of high economic value. There is a great variety of plantations to be found. The state is called Paradise of Botanists and also called the Orchid state of India. There are climbers and an abundance of cane, bamboo, and orchids. The lower altitudes are remarkable for their deciduous forests with patches of evergreen tropical vegetation. The forest products also contribute to its economy. Forest is the most important resource in Arunachal Pradesh with the predominantly large tribal population living in close association with forests and highly dependent on it. Traditional shifting cultivation also known as Jhum cultivation is practiced

by the people and has devastating effects on the ecology of the region thereby degrading the local environment.

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

Due to human activities, in the past few decades there has been pressure on biodiversity and widespread disturbance in the structure and vegetation of Arunachal Pradesh. Some of the prominent cause include increase in population, expansion of agriculture and other land use, jhum cultivation, deforestation for various purpose, urbanization, industrial expansion, over exploitation of natural resources, other biotic factors like grazing, collection of rare ornamental plants for trade, collection of medicinal plants and other NTFPs, unscientific means of extraction, soil erosion, floods, landslides and forest fire have added to the problem. These can be broadly grouped as deforestation, developmental activities, over exploitation, natural calamities and biotic pressures.

Human activities have caused changes in the structure and diversity of vegetation. Some of the prominent causes include increase in population, expansion of agriculture and other land use, jhum cultivation, deforestation for various purposes (e.g. urbanization, industrial expansion), over exploitation of natural resources, collection of rare ornamental plants for trade, collection of medicinal plants and other NTFP, unscientific means of extraction, soil erosion, floods, landslides, and forest fire have added to the problem. Over the past 40 years due to an increase in population coupled with immigration of people is causing stress on biodiversity. Forest based industries have also added to tremendous pressure on the biodiversity.

It is a well-known fact that unmanaged tourism leads to serious environmental and socio-cultural problems throughout the world. Unregulated mass tourism triggers construction of large-scale tourism facilities and infrastructures which eventually leads to fragmentation or degradation of the

environmental resource including forest and biodiversity. The development of tourism related facilities such as accommodation, water supplies, restaurants and recreation facilities may also involve sand and gravel mining, timber extraction, soil erosion and extensive paving. In addition, road and airport construction can lead to land degradation and loss of wildlife habitats and deterioration of natural landscapes. Similar to many parts of the world, natural resource depletion-land use change characterised by deforestation or forest fragmentation, environmental degradation and pollution-related problems are major environmental impacts of mass tourism. In case of Arunachal Pradesh, till present it may be accepted that mass tourism is not taking place at any of the tourist destinations, however, the state authorities has be vigilant in advance.

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

Conservation initiatives taken by the state are as under:

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

8.9. Summary

In 2021, the “Pakke Tiger Reserve 2047 Declaration on Climate Change Resilient and Responsive Arunachal Pradesh” was adopted by the state government and aims to promote development that is climate-resilient in the state. This declaration also focuses on multi-sectoral approaches for climate-resilient development and low emission which are based on five themes which are Health and Well-being for all; Environment, Forest, and Climate Change; Livelihoods, and opportunities; Sustainable and Adaptive living; and Evidence generation, and collaborative action. This recent development is a positive move by the state in the direction of sustainable development of all sectors including tourism in the state. There are other sectors/areas on which the state departments and also the central agencies working in the state/region are taking up action-based work in the state, such as:

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

Some of the work done by NERC-GBPNIHE for promotion of sustainable eco-tourism in some parts of Arunachal Pradesh. So, in general it can be said the state of Arunachal Pradesh is not facing any immediate challenges specifically due to tourism development. Although there are many associated sectors which certainly requires immediate and effective actions (particularly solid waste management, water resources management, rural livelihoods etc.) on the ground. The state and central agencies (including academic and research organizations) are already making

The aim of this particular task was to identify impacts of tourism on different sectors with special reference to the Himalayan states. However, particularly talking about the state of Arunachal Pradesh, although a lot of baseline data was collected on all related aspects however, it is difficult to establish a direct relationship with tourism and its impacts on all the studied sectors. The possible reason is relatively very less inflow of tourists in the state and also non-availability of database on direct income and direct impacts of tourism in the state.

Nagaland

9.1 Introduction

9.1.1 General scenario of tourism in the Himalayan states (Nagaland)

Nagaland, known as 'The Land of Festivals', is blessed with rich biodiversity, diverse topography, scenic beauty and unique cultural heritage. The State of Nagaland was inaugurated as the 16th State of India on the 1st December, 1963 with its capital at Kohima. The State is bounded by Assam in the west, Myanmar on the east, Arunachal Pradesh and parts of Assam on the north and Manipur in the south. The State has great potential for developing the tourism sector for economic development, especially in eco-tourism, adventure tourism, village tourism, community-based tourism, agro-tourism, and culture-tourism. 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 policy constraints, the tourism industry has not been able to progress to its full potential. Under the Industrial Policy of Nagaland (2000), the State Government has identified the tourism industry as one of the 'thrust areas' for industrial development to harness the tourism potential of the State. The Tourism Policy of Nagaland was launched on 27th September 2000 to develop the sector as a significant employment generator in the State. The policy emphasized eco-tourism development and community participation through village councils and village development boards. The policy also envisions setting up tourism development committees at state and district levels for coordination among different departments, infrastructure development, regulation of tourism activities, human resource development, and private sector participation in the tourism sector.

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

As of 2021, there are as many as 33 tourist spots in the State of Nagaland, covering districts of Kohima, Mokokchung, Phek, Zunheboto, Peren, Wokha, Kiphire, Mon, and Dimapur. A survey conducted by the Ministry of Tourism (2017) reported that Kohima has the highest average of overnight visits by leisure tourists from domestic and foreign countries. For same day destination visits, Kohima topped the list for domestic tourists, while for foreign tourists, the revenue was equal to Phek, Dimapur and Mokokchung districts.

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

9.2.1 Tourism growth (number of annual tourists visiting) vis-à-vis economic growth (annual income from tourism)

The inflow of tourists, both International and Domestic, to the State of Nagaland showed an increasing trend from the period 2011-12 to 2019-20 (Fig.. 9.1). The drastic decline in the tourist inflow during 2021-21 was due to the occurrence of the COVID-19 global pandemic which has restricted the movement of people into the State, like in other parts of the country and the world over. The annual tourist inflow was higher for domestic tourists estimating more than 90% of the total number of tourists visiting the State.

The Hornbill Festival of Nagaland organised by the State Government annually during first week of December is a Naga cultural festival to showcase the State's diverse cultural traditions and rich heritage. The festival took place at Naga Heritage Village, Kisama, Kohima, and has become one of the major tourist attractions for the State, by both international and domestic visitors. Tourist inflow into the State during the Hornbill festival showed a steady rise from 2011-12 to 2019-20. The absence of data during 2021-21 was due to the outbreak of the COVID-19 pandemic, and the festival was celebrated virtually. Thus, no physical visits of tourists took place during the pandemic period (Fig.. 9.2).

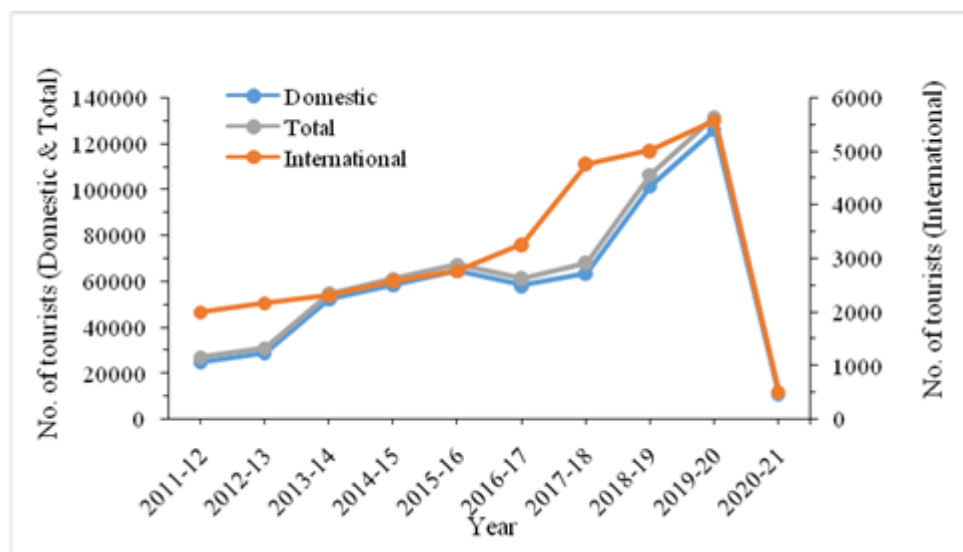


Fig.. 9.1: Annual trends in tourist inflow to Nagaland during 2011-2020 (*Data source: Statistical Handbook of Nagaland, 2012, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021; <https://tourism.nagaland.gov.in/>*)

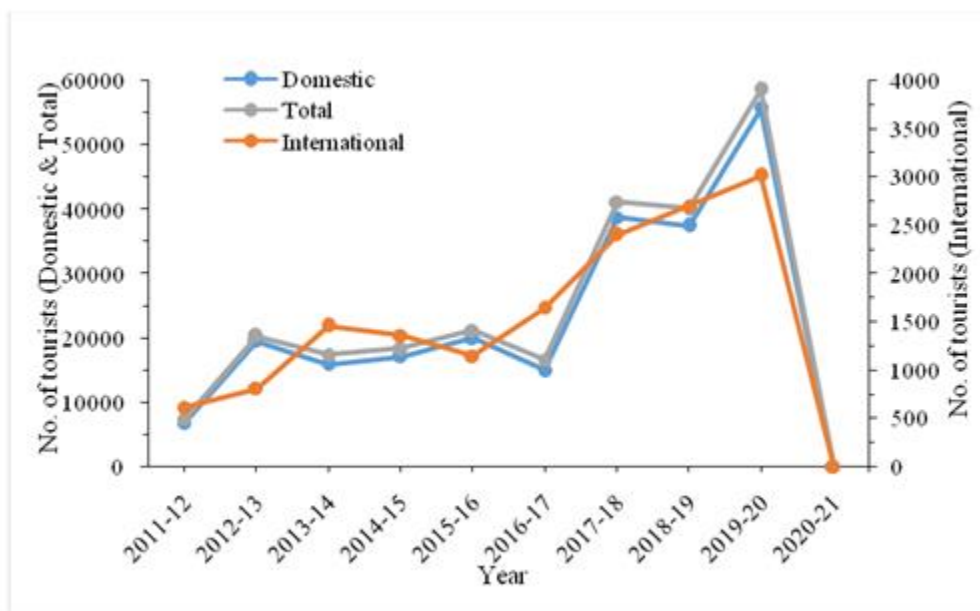


Fig.. 9.2: Trends in tourist inflow in Nagaland during Hornbill Festival (2011-2020) held annually from 1st to 10th December at Naga Heritage Village, Kisama (*Data source: Department of Tourism, Nagaland, <https://tourism.nagaland.gov.in/>*)

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

9.3.1 Number of vehicles (state/district wise) Nagaland

Registered vehicles in the State of Nagaland have been categorized into three types, viz., Transport, Non-transport and Government vehicles. In both Transport and Non-transport categories, Dimapur reported the highest number of vehicles registered, followed by the Kohima district (Fig.s. 9.3 & 9.4). There was a sharp increase in the number of registered vehicles from 2017-18 to 2019-20, while the number declined during 2020-21. In other districts other than Kohima and Dimapur, there is no clear annual trend in number of vehicle registration. Government vehicles were registered only in the Kohima district (Fig. 9.5). The number of registered government vehicles showed a sharp increase from 2016-17 to 2019-20, while a drastic decline was observed in 2020-21. Overall, the total number of vehicles registered in the State of Nagaland during a decade (2011-12 to 2020-21) were: 24,688 transport, 1,10,592 non-transport, and 5,354 government vehicles.

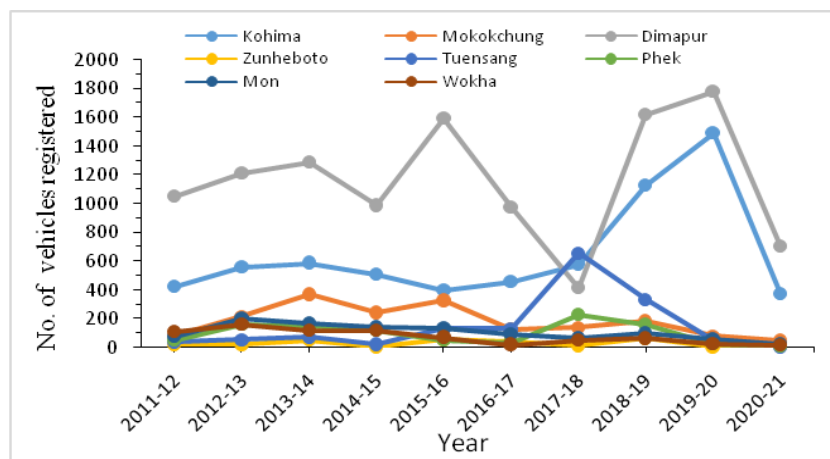


Fig.. 9.3: Number of Transport vehicles registered in Nagaland state during 2011-2021 (*Data source: O/o Transport Commissioner, Kohima, Nagaland*)

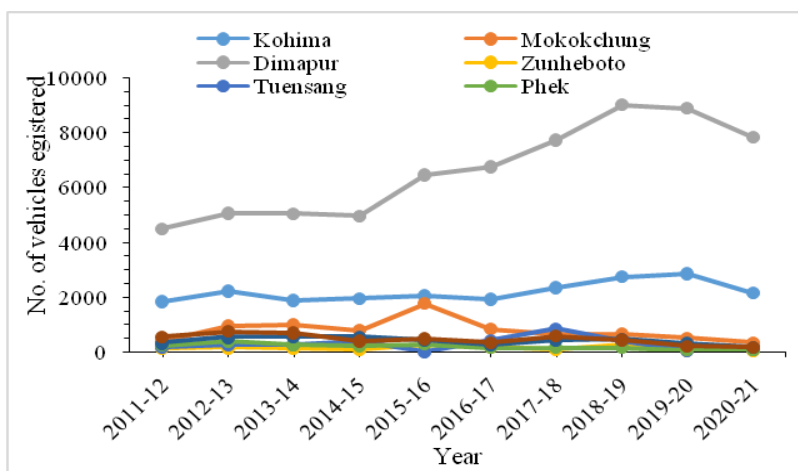


Fig.. 9.4: Number of Non-Transport vehicles registered in Nagaland state during 2011-2021 (*Data source: O/o Transport Commissioner, Kohima, Nagaland*)

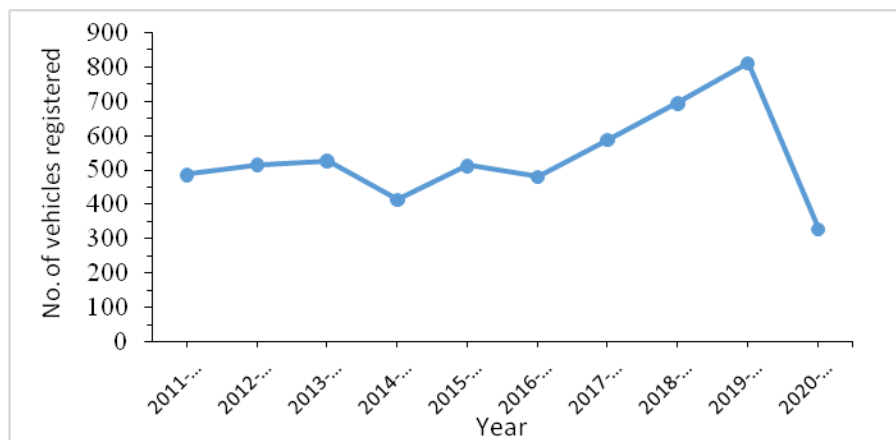


Fig.. 9.5: Number of Government vehicles registered in Nagaland during 2011-2021 (*Source: O/o Transport Commissioner, Kohima, Nagaland*)

9.4.1 Ill-effects of tourism, particularly on environmental components (waste generation, air & water quality deterioration, loss of greenery & biodiversity), land/soil contamination and groundwater (with some data/trends & literature review, references, etc.)

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

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

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

Appropriate data are not available.

9.3. Segregation / Utilization of waste

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

(i) Kohima Municipal Council

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

The solid waste generated in the Kohima Municipal Council (KMC) area is very heterogeneous, as a result its composition varies from place and time. As per study carried out by NPCB, the composition and characteristics of solid waste in Kohima City are found to be 42% of combustible materials and 58% non-combustible. The KMC carries out the primary solid waste collection through daily street sweeping and storage bins. During the last few years, only 50-60 % of the waste has been collected daily from the sources and dumped at a site 8 km away from the city on NH-39. Based on a scientific study in 2010, the amount of waste generated from Kohima city is around 54 MT per day. Out of this, about 35-40% of wastes are collected from the entire city as per the data available. The daily generation of wastes (54 MT) is collected mainly from the primary sources, such as, residential (57%), commercial (19%), institutional (15.50%), industrial (3%), biomedical wastes (0.50%) and construction and demolition (5%) (Chatterjee, 2010). To date, the current disposal system is not in compliance with the Municipal Solid Waste (Management and Handling) Rules 2000 since KMC does not have a proper and scientific method of Solid Waste Management.

(ii) Dimapur Municipal Council

The Dimapur Municipal Council's jurisdiction falls within the municipal area measuring 18.13 km², divided into 23 wards comprising about 96 colonies. With the assistance of Living for Environment (LiFE), Dimapur Municipal Council conducted a waste assessment study for 24 days starting from 12th February to 13th March 2019. In the study, it has been estimated that Dimapur Municipal area generates 111.12 tons per day (TPD). This estimate does not include the data from two colonies/areas as there was an issue with the non-payment of RST. The estimate above is more than the previous year's estimate (June 2018 estimate). Projection of the waste generation could not be ascertained. However, it can be assumed that in a year's time, the waste generation will increase by at least 15 TPD. In Dimapur, waste is categorized into mainly three types. They are: dry waste, wet waste and mixed waste. Dry waste comprises all non-biodegradable and biomedical waste, sanitary waste, e-waste, clothes, shoes, construction and demolition waste, inert, etc. Wet wastes are comprised of all biodegradable waste, such as, kitchen waste, garden waste, poultry waste (slaughter waste), hairs, etc. Mixed wastes are all other types of garbage where segregation was either dry or wet waste are not possible. Further, specific wastes such as, glass, alcohol bottles, PET bottles, sanitary waste, biomedical waste, earth and vegetation, clothes, single-use plastics, multi-layered plastics, etc. are separated.

(iii) Mokokchung Municipal Council

Mokokchung is one of the districts in Nagaland, the home to the Ao Naga tribe. It covers an area of 1,615 km². It is bounded by Assam to its north, Wokha to its west, Tuensang to its east, and Zunheboto to its south. Mokokchung jurisdiction falls within the municipal area of 7 km² which is divided into 18 wards. Households store the waste they generate, which is collected via door-to-door collection. At present, out of 18 wards under MMC, door to door collection of waste has been introduced in six wards, namely, Alempang, Artang, Majakong, Kumlong, Kichutip, and Mongsenbai wards. Apart from this, concrete/open dustbins have been provided 18 wards for areas like residential, markets, main roads, institutions, offices, etc. Daily collection is made from such bins. The collection of

waste in the 12 wards follows this type of collection. Segregation of waste has not been implemented in Mokokchung Town. However, MMC is setting up to sensitize the waste generators on segregation of waste, specifically on bio-degradable, plastics and e-waste.

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

9.3. Waste disposal / treatment facilities

In recent years, Nagaland has witnessed an inflow of tourists and an increase in population, due to which there has been the construction of a large number of roads and buildings. One such environmental challenge, a direct consequence of increasing urbanization, is waste accumulation. Waste material can be defined as any material that we no longer need, and it includes both biodegradable and non-biodegradable materials. Biodegradable waste such as kitchen, restaurant, and hotel trash can be composted to make manure. Non-biodegradable waste such as plastic, glass, metal, and other junk can be reused or recycled.

Another significant impact of increased tourist activity is that the large scale of tourist development also brings a large number of people together, leading to marked changes that are detrimental to the ecosystem. The influx of many tourists is likely to increase the piles of litter and garbage. This garbage and solid waste generated due to an increase in tourists have been causing severe pollution of rivers, lakes, etc. Sewage disposal is also affected either through septic tanks and absorption pits or in tourist projects, disposal of wastewater through biochemical treatment plants into inland drainage. This may have detrimental effects on fauna in the areas of disposal owing to certain substances that may be contained in the disposed effluent.

At present, Nagaland has 32 Urban Local Bodies (ULBs) where a solid waste management policy has been implemented. In 2010-11, there was no waste processing and disposal facility in the State; only Kohima municipal council applied for authorization was granted. Then until 2016-17, only nine ULBs started implementing the solid waste management policy. After that 32 ULBs started implementing the solid waste management policy. The details of garbage generated and collected have been incorporated in Fig.. 9.6. There was a gradual increase in the generation and collection of solid waste up to 2017-18, followed by a slight decline until 2019-20. This may be due to Covid-19 pandemic outbreak. The garbage treatment and landfill facility were only available from 2016 to 2017 onwards. The year 2015-16 has no data could trace back on solid waste from the central pollution control board report. In case of solid waste processing facilities, only composting and vermi-composting facilities are available in Kohima from the year 2012-13.

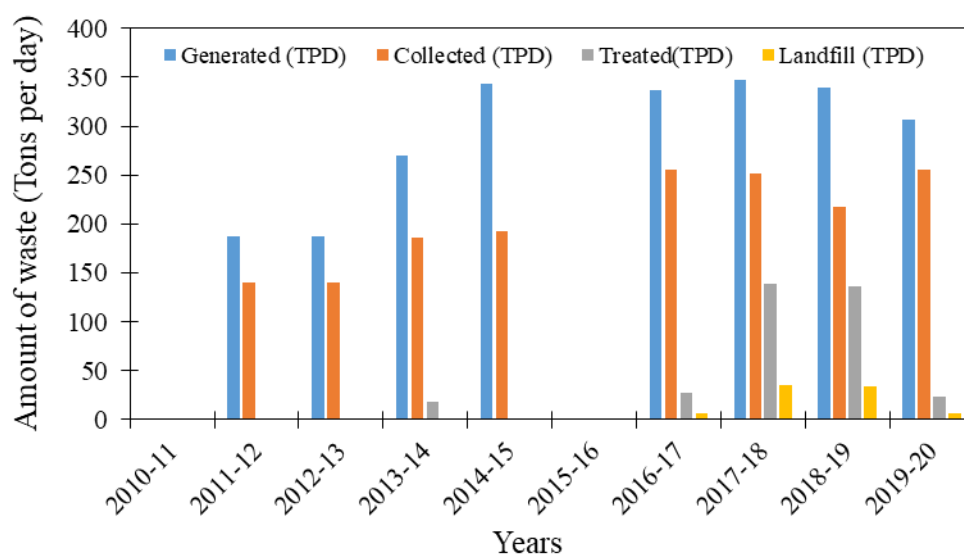


Fig.. 9.6 Year-wise waste generation, collection and management of solid waste in Nagaland (2010-11 to 2019-20)

9.4. Impact on Air quality

9.4.1. Parameter wise air quality

Nagaland Pollution Control Board under the National Air Monitoring Programme (NAMP) is monitoring the air quality on a regular basis at Dimapur and Kohima towns in Nagaland. Dimapur is the commercial hub and the largest town amongst all the other districts of Nagaland. It is bounded by Kohima district on the south and east, Karbi Anglong district of Assam on the west, and stretch of Golaghat district of Assam in the north. According to 2011 census, it is the most populous district of Nagaland. Dimapur is a gateway to Nagaland and it is the only railhead. Kohima is a hilly district and share its boundary with Dimapur in the West, Phek district in the East, Manipur State and Peren district in the North. Kohima town is located on the top of a high ridge and the town serpentines all along the top of the surrounding mountain ranges.

Under NAMP, two monitoring stations, i.e., in Opposite NST Office (609) and Opposite War Cemetery (610) set up in Kohima. However, station Opposite War Cemetery (610) has been shifted to a new location in PWD junction. In Dimapur, two monitoring stations have been set up, i.e., in Bank colony (317) and Dhobinala (448). Three air pollutants are monitored and analyzed, viz., Nitrogen dioxide (NO₂), Sulphur dioxide (SO₂), and Respirable Suspended Particulate Matter (RSPM). The monitoring of pollutants is carried out for 24 hours (4 hourly sampling for gaseous pollutants (NO₂ & SO₂) and 8 hourly sampling for particulate matter (RSPM) twice in a week (CPCB, <https://cpcb.nic.in/namp-data/>; NPCB, <https://npcb.nagaland.gov.in/?p=763>).

The average concentration of PM₁₀ and NO₂ were found to be higher at Dimapur than at Kohima. In Dimapur, an increasing concentration in PM₁₀ was observed from the year 2012 to 2018 after which its concentration declined during 2019-20 (Fig.. 9.7). In Kohima, the PM₁₀ concentration increased till year 2018 after which it started declining till year 2020. The annual permissible limit for PM₁₀ is 60 µg/m³ but the data show that it is higher in all the years from 2011 to 2020. NO₂ concentration increased from year 2014 to 2018 and declined till 2020 in Dimapur town, while in Kohima there was no change in the values during all the observance years. SO₂ concentration remained constant throughout the monitoring period, i.e, 2013 to 2020 in both Dimapur and Kohima cities. Nitrogen dioxide (NO₂) and sulphur dioxide (SO₂) in both the towns are well within the national air quality standards in both the monitoring stations (CPCB, 2009).

The Respirable Suspended Particulate Matter (RSPM) values of every month of Dimapur and Kohima is shown in Fig.. 9.8 and 9.9 respectively RSPM value for every year shows a similar trend, i.e., it is high in the dry seasons of the starting years and gradually decreases during the monsoon season. After the monsoon ends it increases again. The data shows that RSPM is mostly higher than the permissible limit in every month of each year in both the cities.

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

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

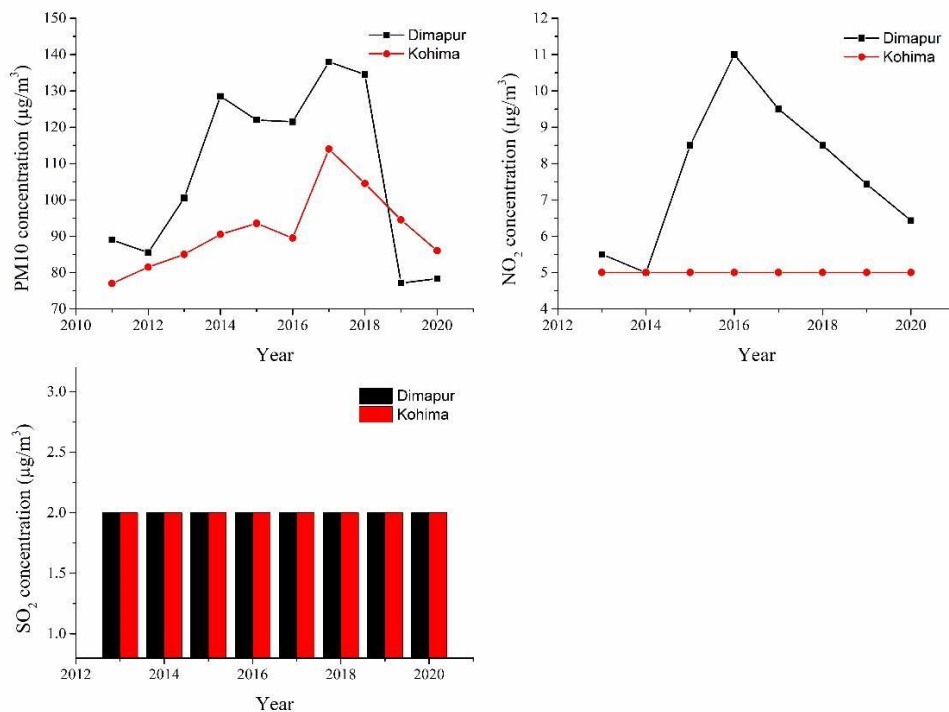


Fig.. 9.7. Annual data of air quality in Dimapur and Kohima towns of Nagaland

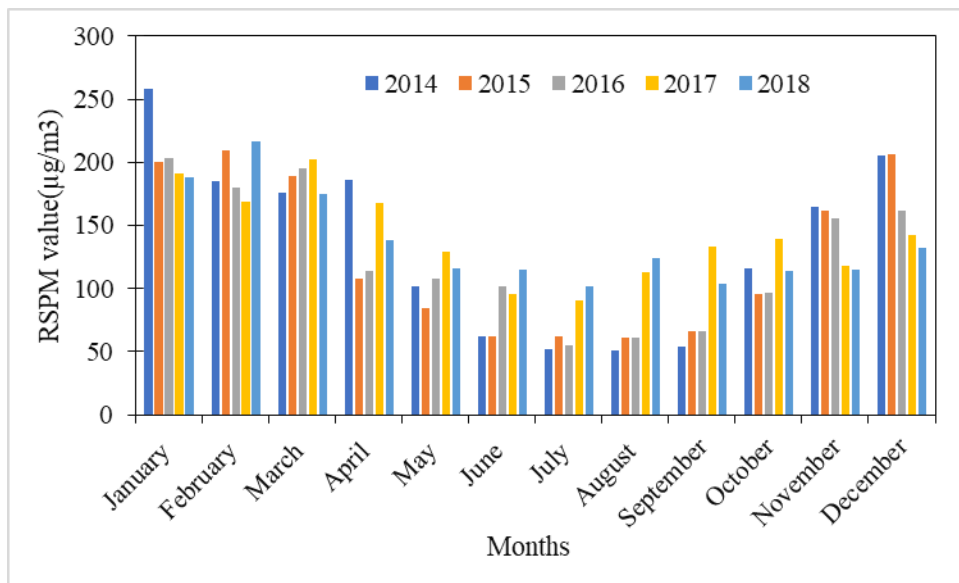


Fig.. 9.8. Monthly data of RSPM (PM₁₀) value in Dimapur, Nagaland

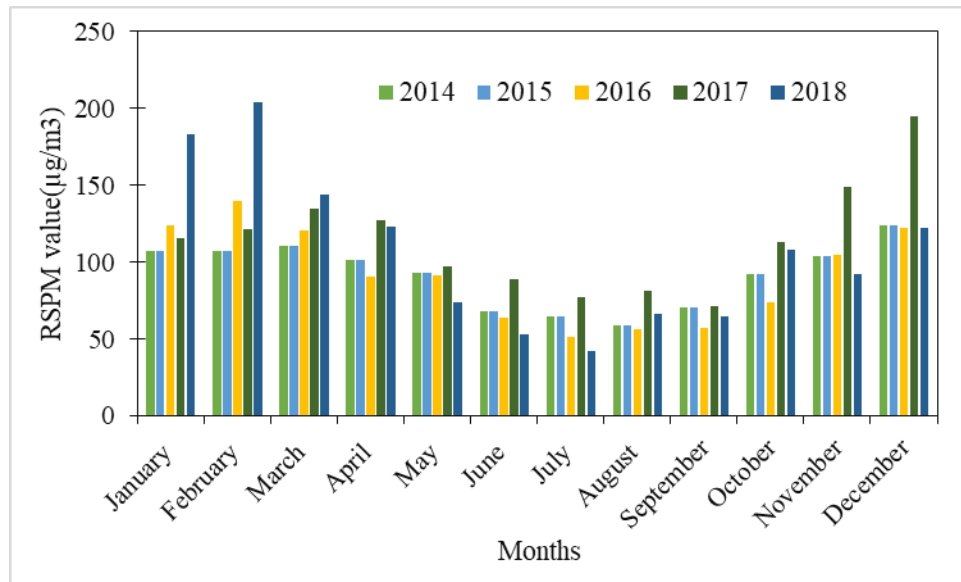


Fig.. 9.9. Monthly data of RSPM (PM₁₀) value in Kohima, Nagaland

9.5 Measures/mitigation measures for air quality

Dimapur and Kohima towns have been placed under non-attainment cities because it was found that for a period of 5 years (2011-2015), the air quality in case of 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 Graded response Action Plan (GRAP) have also been incorporated to monitor and improve air quality as follows:

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

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

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

9.6. Impact on water quality / ground water

9.6.1. Monitoring of Water quality/ground water

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

9.6.2. Physico-chemical parameters of river water

Dhansiri and Chathe (Diphu) are the main rivers of Dimapur district of Nagaland. River Dhansiri originates from Laisang peak of Nagaland. It flows through a distance of 352 km from south to north before joining the Brahmaputra on its south bank. Its total catchment area is 1220 km² (NPCB, <https://npcb.nagaland.gov.in>).

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

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

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

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

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

The River Milak flows through Mokokchung district in Nagaland. The main tributary of River Milak is Tsurong. The physicochemical characteristics of the River Milak shows that the maximum DO values are well above the designated use. However, the minimum values are below the best use (>4 mg/l) (Fig..9.10). The BOD values are also within the designated use at different stations except for both the years except at Paper Nagar, Tuli in Mokokchung in 2018. Further, there is no data on other parameters, viz. TDS, COD, chloride, phosphate and thus need to be studied.

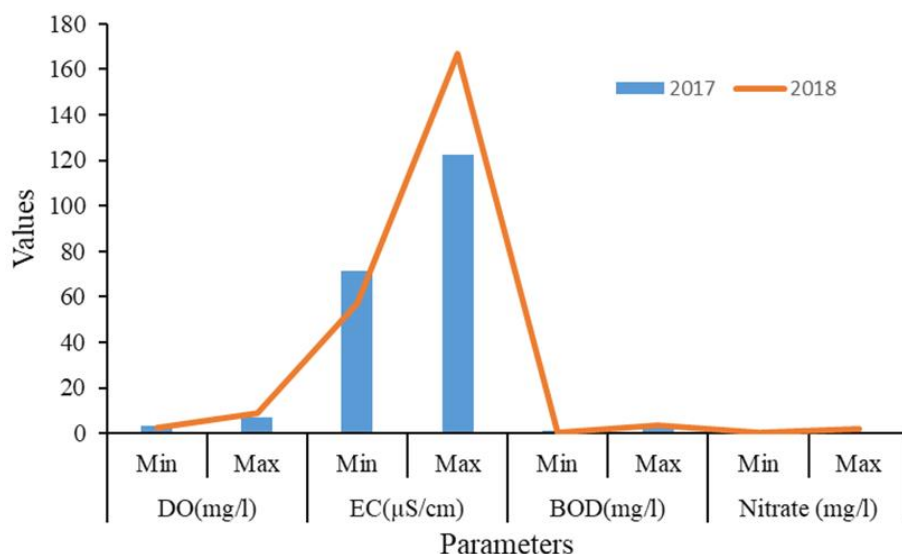


Fig.. 9.10. Physicochemical characteristics of Milak River in Mokokchung, Nagaland

9.6.3. Physico-chemical parameters of groundwater

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

9.6.4. Measures/mitigation facilities

The major towns attributing to River Dhansiri are Dimapur town and East Dimapur which are the main contributors of pollution load. Dimapur town has a total population of about 1,22,834 (Census 2011) and the population is expected to grow 2,71,350 by 2035. While, East Dimapur has a population of 27,000 which is expected to grow by 59,644. Main source of water supply for these two towns are groundwater supply, i.e., ring wells and bore wells. Considering, water supply is consumed at 135 LPCD, the sewage flow is considered as 80% of the net water supplied to the consumer which accounts to waste water generation of 16.19 MLD. At present, there are no STP in the Dimapur city. The total sewage generation of both Dimapur town and East Dimapur is about 16.19 MLD. However, the present STP which is under construction has a total capacity of 25.43 MLD. Therefore, it has a gap analysis of -9.24 MLD. Septic tanks have been made by individual households for disposal of sewage and supernatant is directly or indirectly disposed off in nearby drains which joins into the 3 major drains and these finally merges into River Dhansiri. Dimapur Municipal Council (DMC) under the AMRUT SAAP-I had constructed Septage Management Plant of 30 KLD capacity at Burma camp, Dimapur. The septage management plant is in operation. There are 615 number of industries in Dimapur city comprising of 6 in red category, 296 in orange category, 294 in green category and 19 in white category largely comprising of stone crushers, brick kilns, steel fabrication, tyre retreading, mechanised furniture unit, etc. The total amount of water consumption by different category of industries is about 157 KLD and the amount of industrial effluent generated is 44.3 KLD. There are four (4 nos.) hospitals with ETPs with a total capacity of 259 KLD and generating waste water of about 156 KLD. All the 615

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

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

- Comprehensive inventorisatation of industries in the catchment of water bodies has been completed by Nagaland Pollution Control Board (NPCB).
- NPCB has notified on local dailies not to dispose/discharge spent oil/waste into the drains.
- No industry should discharge effluent directly into drains without treatment. They have to set up effluent treatment plant (ETP) for operation of units. Kohima Municipal Council (KMC), Dept. of Industries & Commerce, and NPCB have been given responsibility to jointly inspect and direct such units for compliance.
- A solid waste management facility was developed by Kohima Municipal Council at Lerie Kohima. This waste management facility was funded by Asian Development Bank (ADB) and commissioned on February 2016 for quantification, characterization and processing of solid waste as per municipal solid wastes rules, 2016.
- Awareness and social action/public participation for cleaning work in 19 wards in Kohima-by-Kohima Municipal Council.
- For construction of community toilets, and construction of septage management at Kohima, KMC was the responsible agency. A total of 44 community toilets/public toilets had been sanctioned under Swachh Bharat Mission. The septage management facility with 90000 litres/day funded by ADB was in the final stage and supposed to be commissioned in December 2019.

9.7. Impact on Forest and Biodiversity

9.7.1. State wise RET category species and forest cover

Unique geographical location, including diverse terrain, varying altitudes and climatic conditions, provides the Nagaland state with rich floral and faunal diversity that attracts many tourists to the State. Another significant reason for Nagaland's contribution to biological diversity is that it is located between the Indian, Indo-Malayan and Indo-Chinese regions. This unique location of the State also makes it a bio-geographical gateway for plant migration. The overall effect of the above factors has resulted in diversified and luxurious vegetation across the State. However, most floral and faunal species appear to be endangered in recent days due to heavy biotic pressure/ interference and reckless deforestation. Followings are the popular important species. *Dipterocarpous macrocarpous* (Hollong), *Shorea assamica* (Makai), and *Mesua ferra* (Nahar), are rare and endangered species. *Panax ginseng* (Ginseng) is found only in the Tuensang district at higher altitudes. The species is also endangered. Several popular, rare and endangered species of orchids are available in Nagaland. These are namely: *Thunia* 1 sp. *Arundinari agraminifolia* (Bamboo orchid), *Renanthera* (Red vanda), *Rhynchostylis* (fox tail orchid), *Pleone*, *Phaius* (ground orchid) 2 spp., *Paphiopedilum* 1 sp, and *Cymbidium tigrinum*. The Government is taking measures for the propagation to conservation and protection of these species through different afforestation schemes (Nagaland Forest Department; www.forest.nagaland.gov.in/biodiversity). As per the record of the Botanical Survey of India, there are three plant species which are extinct or possibly extinct in Nagaland. Total 13 endemics, 4 rare, 3 vulnerable and 4 endangered plant species are found in the State.

As per the IUCN red list documentation, the State currently holds 1 critically endangered, six endangered, and 17 vulnerable mammal species. Three vulnerable categories of amphibians are found here. These are: 4 critically endangered, 7 endangered, and 6 variety of vulnerable reptiles are inhabited the region. Among birds, 6 are critically endangered, 3 endangered, 23 near threatened and 15 are vulnerable. Based on the 2021 FSI report, the Forest Cover in the Nagaland state is 12251.14 km² which occupied 73.89 % of the State's geographical area. In terms of forest canopy density classes, the State has 1272.04 km² under Very Dense Forest (VDF), 4449.04 km² under Moderately Dense Forest (MDF) and 6530.03 km² under Open Forest (OF). The total forest cover of Arunachal Pradesh in 2021 was 12251.14 km². However, the entire forest cover in 2019 was 12486 km² which means the State has lost 235 km² of its forest cover within the last two years of time frame (Indi State of Forest Report 2021, Fig..9.11).

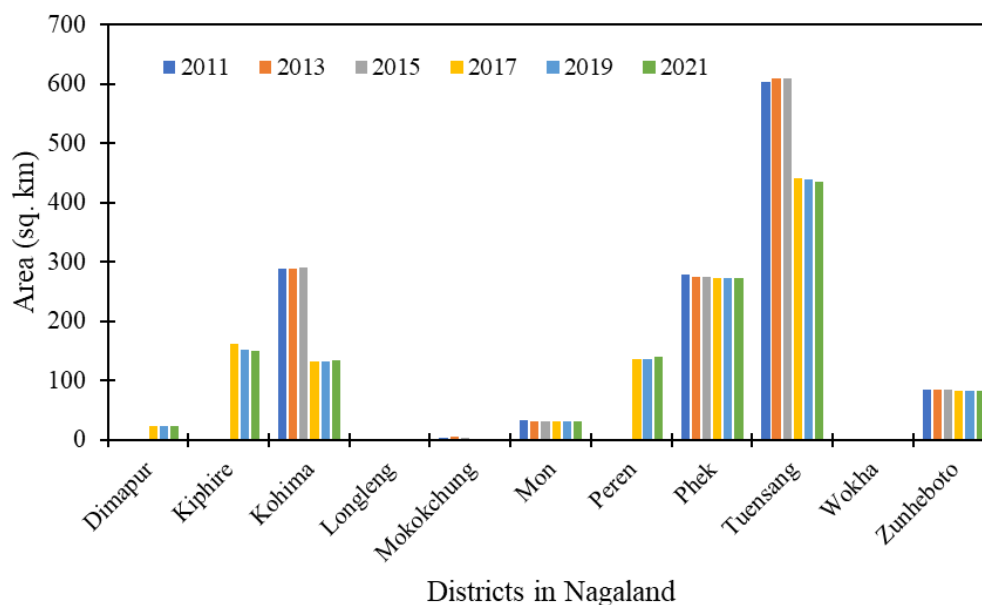


Fig.. 9.11. Change in Very Dense Forests across different districts of Nagaland during 2011- 2021

9.7.2. Loss of biodiversity due to waste disposal

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

9.7.3. Growing vegetation nearby dumping sites

No data available for the State.

9.8. Eco-sensitive zones/ Areas

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

9.9. Summary

9.10. Gap areas & Plan of Action

The tourism sector is an emergent industry having great potential for economic development of the state of Nagaland. The natural landscape and rich floral and faunal diversity provide good prospects for different types of tourism activities especially ecotourism, village tourism, adventure tourism, etc. In spite of the limitations due to scarce infrastructural and communication facilities available in the state, the tourist inflow to the state both from domestic and international has been increasing over the 10 years' period of study. There has also been a concern regarding the waste management in some tourist destinations which needs to be taken care of. As such, no data could be obtained regarding 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. From the available data, vehicular increase could not be directly linked to tourism since the data only represent the vehicles registered within the state. Data on entry/exit of tourist vehicles from outside the state to particular tourist destinations/routes would also be needed in order to determine how the growth of tourism can affect the environment and to design regulating measures to minimize the impacts.

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 purpose. Dimapur, the most populous city and gateway to the Nagaland, have higher vehicular movement. Kohima being the capital of the Nagaland also has industrial units categorized in red, orange, and green. However, there is no direct impact of tourist inflow on air quality has been studied so far. The particulate matter has been a major concern for both the cities, and due to GRAP initiatives, there has been decline in the particulate matter, and NO₂ concentration.

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

On the basis of this case study, the direct impact of tourism on the environment could not be ascertained to justify the statement "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic". For Nagaland State, it is required to conduct more studies focused specifically on assessment of the linkages between tourism growth and environmental problems like waste generation, loss of forest and biodiversity, air and water quality and other aspects.

9.11. Action plan for mitigation

1. Regulation of tourism related activities especially at ecologically fragile sites and around protected areas.

2. Strengthening of community-based tourism and developing Eco-Tourism models in several touristic cities in Nagaland with participation of local people and government departments.
3. Plantation of trees, creation and maintenance of natural parks and greenery should be made a priority in urban areas such as Dimapur and Kohima city of Nagaland.
4. Expansion of protected area network and augmenting wildlife protection.
5. Human activities and developmental projects which adversely affect forests that cover steep slopes, catchment areas of rivers, lakes and reservoirs, geologically unstable terrain and such other ecologically sensitive areas should be restricted. EIA need to be practiced for all tourism industries and development activities.
6. Skill development of local youths and promoting NGO activities and their involvements.
7. Establishment of proper waste management facilities at tourist places and strict implementation.
8. Effluent treatment plant for treatment of sewage, and wastewater.

Manipur

10.1. Introduction

10.1.1. General scenario of tourism in Manipur

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

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

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

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

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

10.1.2a. Tourist influx

According to published data, the number of tourists visiting the state has increased from 1,45,647 in 2013 (consisting of 2588 foreign visitors and 143059 domestic visitors) to 1,79,436 (consisting of 12,102 foreign and 167334 domestic tourist) in 2014. In terms of visitor influx data, a gap was detected after 2019. The yearly proportion of domestic and foreign tourists visited Manipur since 2013 to the 2019 is shown in Fig.ure-10.1.

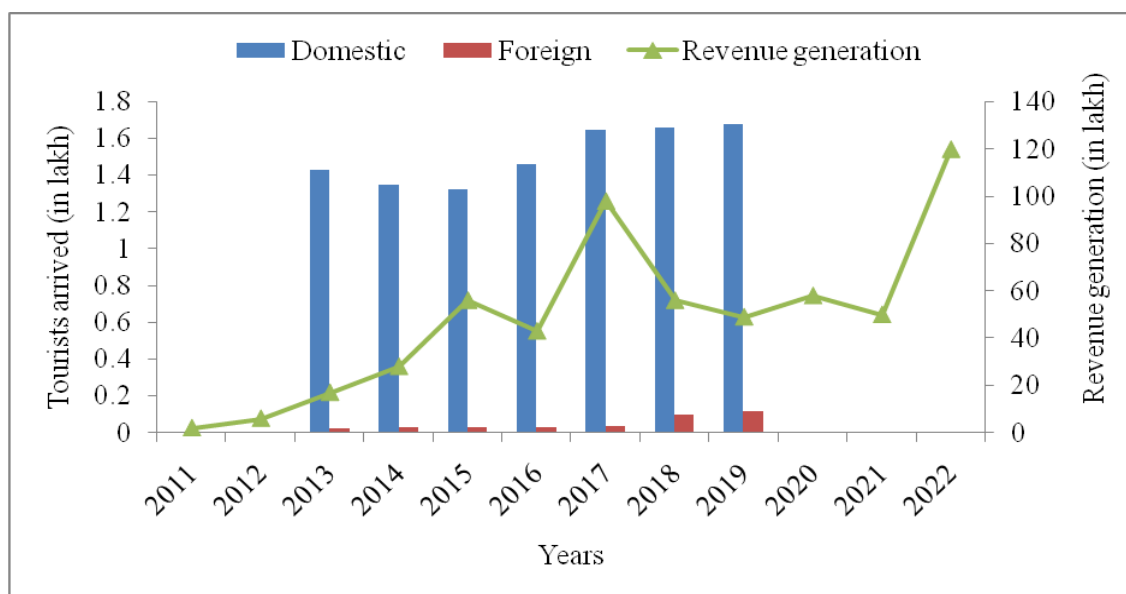


Fig.. 10.1. Tourist influx and revenue generation in Manipur state (Source: Directorate of Tourism, Government of Manipur)

Furthermore, it is evident that the rate of change in visitors influx was negative during the first years, from 2014-2015 to 2015-2016, before turning positive and peaking (13.14 %) in the year 2017-2018.

10.1.2.b. Economic growth (annual income from tourism)

As per revenue receipts, the economic services tourism from 1991 to 2022 are significantly increased in the state revenue between the year 2011 to 2022. The income from the tourism sector was INR 2 lakh in the year 2011 to INR 120 lakh in the year 2022. The year wise economic growth trend. Furthermore, the rate of change of revenue generation in the state has shown an irregular trend and it ranged between 18.37% to 200%. The rate of change was the maximum for the year 2012 and minimum during 2020. However, during the year 2018 it has declined drastically to -42.85%. Similarly, the COVID-19 pandemic also influenced a significant decrease (-13.79%) in the year 2021 (Fig.. 10.2). Based on the statistics, it can be concluded that the tourism industry is not only flourishing, but also providing ample opportunities for sustainable, environmental friendly and responsible tourism in the state.

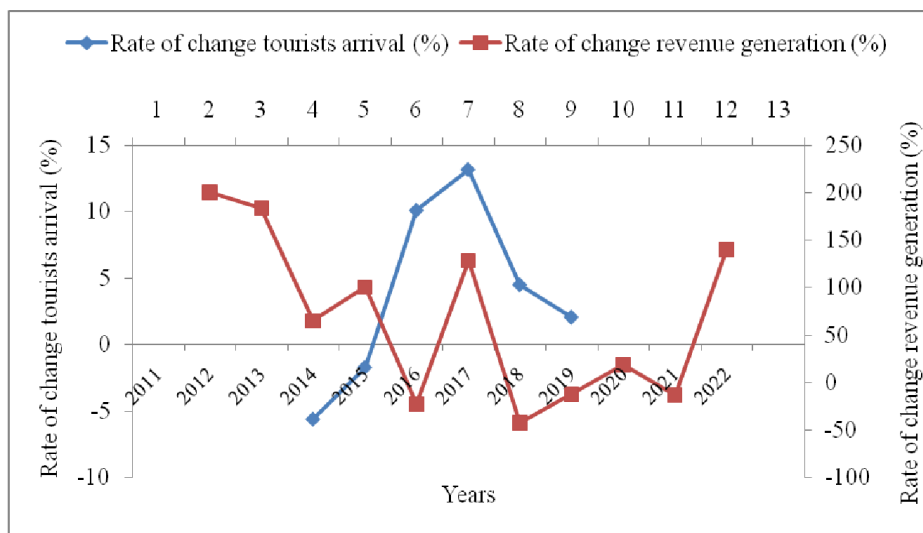


Fig.. 10.2. Rate of change in tourist arrival and revenue generation in Manipur (Source: Revenue Receipts Government of Manipur (<https://www.ceicdata.com>))

10.1.3. Number of vehicles (state / district wise)

According to Ministry of Road Transport and Highways (India), a significant increase in the vehicle numbers can be seen since the financial year 2007 to 2019. The number of vehicle registration was maximum (3,95,000) in the year 2014 and thereafter almost static trend was seen. The rate of change in vehicle registration has shown an irregular trend over the years and it ranged between 3.9 % (2012) to 37.7% (2013). However, between two successive years 2015-2016 followed by 2018 a negative rate of change was observed (Fig.. 10.3).

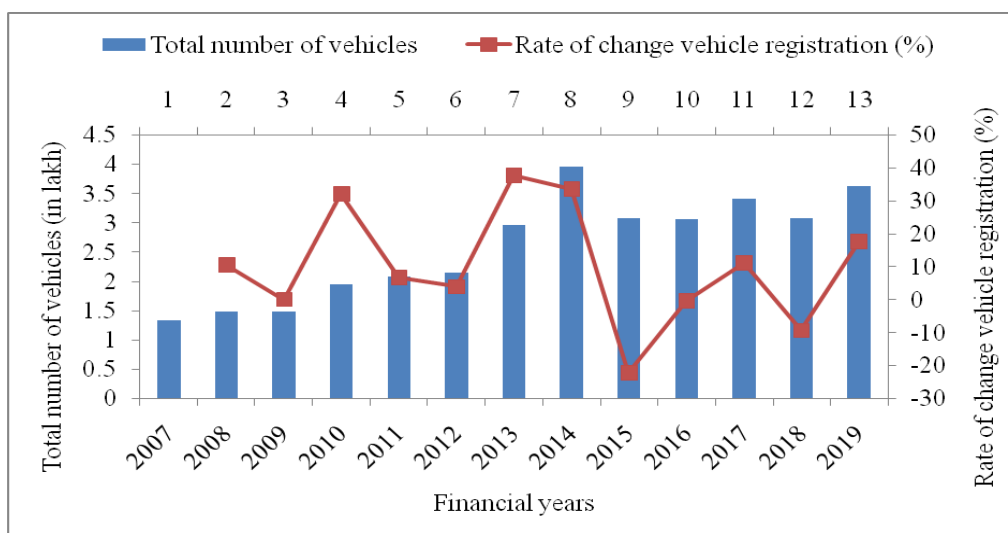


Fig.. 10.3. Total number of registered motor vehicles across Manipur from the financial year 2007 to 2019 (Source: Ministry of Road Transport and Highways (India) © Statista 2021)

10.2. Ill-effects of tourism particularly on environmental components (waste generation, air & water quality deterioration, loss of greenery & biodiversity), land/soil contamination and ground water (with some data/trends & literature review, references, etc.)

Growing tourism offers opportunity to the resident populations but also causes ill effects to the environment and to the biodiversity. In the urban centres of Manipur like Imphal, various polluting factors can be seen such as i) vehicle emission, ii) domestic solid waste, iii) excessive dust fall and, iv) unwarranted noise generation by vehicular traffic. There is also a total absence of any systematic drainage system in the Imphal city. Although Imphal has a potential to become one of the most beautiful urban centres in the country, the city presently has a very shabby and poor appearance. The urban living environment is generally dirty and the total apathy of all concerned has forced the people to accept such poor conditions as normal urban environment.

The major environment illness caused by or envisages to be caused by development of tourism sector in the state are i) enhanced vehicular emission due to increased number of vehicles ii) enhanced problems of garbage disposal generated by tourists specifically plastic bottles, disposal cups, wrappers of food items, bottles, cans, etc., and iii) disturbance of the natural settings and habitat of many indigenous, rare or endangered species of flora and fauna. It is therefore, necessary to take care of all the above aspects at the time of planning for the development of tourism sector in the state.

Among the listed tourist attractions in the Manipur state, the iconic Loktak Lake, located at Moirang town is the largest natural freshwater lake in the North-eastern region of India and plays an important role in the ecological and economic security of the region (Tuboi *et al*, 2012). This Lake is broadly divided into three zones, *viz.*, northern, central and southern zone, on the basis of vegetation type, *Phumdi* thickness, drainage network, open water area location and human activity. *Phumdi* is a

Manipuri word meaning floating mats of soil and vegetation. The lake is rich in biodiversity and has been designated as a wetland of international importance under RAMSAR convention in 1990. It has a catchment area covering 1046 sq.km has 293sq km of watershed area and 114 sq km is covered by *Phumdis*.

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

10.3. Solid waste and its management

Studies in Imphal town also indicated that the solid waste management (SWM) is not appropriate and highly unsatisfactory based on Solid Waste Management and Handling Rules, (2000). There are many shortcomings in the existing system of municipal solid waste management (MSWM). According to the report Swasth Bharat Sampann Bharat assessed on May 2022, Manipur generates a total of 178 TPD (tonnes per day) solid wastes, of which 120 TPD come from the city of Imphal alone and out of the total waste generated by the state, only 70% is collected by the civil authorities while 30% waste remains uncollected. In the absence of sanitary landfills, solid wastes get dumped in the open places, creating nuisance and unhygienic conditions. This may resulted in a high risk of contamination to different environmental compartments including soils, groundwater/surface water, and air, leading towards human health hazards (Yadav and Devi, 2016). At temporal scale, a concurrent increase in waste generation can be seen in the Imphal city (Fig.. 10.4). According to the study on urban solid waste management in Imphal, the Imphal municipality generated 48 TPD of MSW in 2001 and which increased to 72 TPD in 2011 and at present it reached to 100-120 TPD and is projected to rise about 170 tonnes/ day by 2035 (Mahongnao, 2017). Furthermore, the per capita generation of MSW also increased from 0.190 kg/day in 2001 to 0.217 kg/day in 2011 (Annepu, 2012). The city observed a decadal rate of change in MSW on an average of 50% in the year 2011 which further increased to 60.67% in 2021-2022.

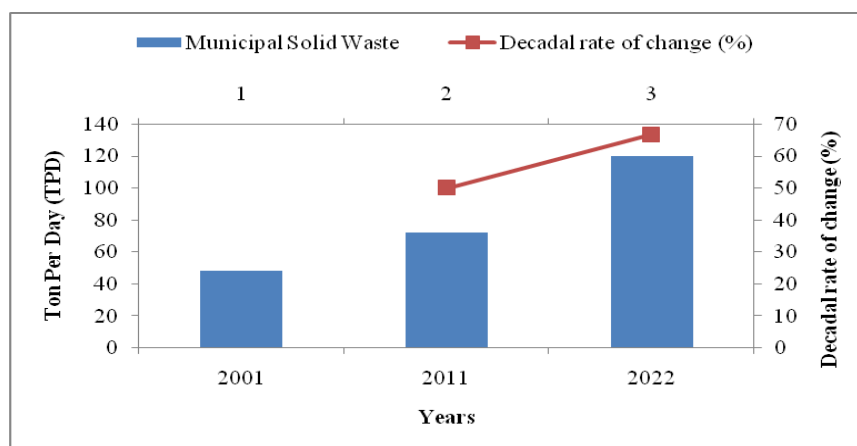


Fig.. 10.4. Decadal rate of change in municipal solid waste management in Imphal City (Source: Mahongnao, 2017)

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

10.4. Air quality and pollutants

The main source of air pollution in Manipur has been identified as auto exhaust emissions of the fast growing number of automobiles, dust-fall due to bad road management and other miscellaneous commercial earthmoving activities. The slash and burn activities in forest during February-March every year for preparation of the field for agricultural crop under Jhum practices adds huge amount of fumes and particulates into the atmosphere. The increasing trends in vehicle number in Manipur increase the problem of air and noise pollution. Two wheelers are by far dominant type in Manipur. Most of the vehicular population is found in urban areas. The number of two- wheelers registered as on 31-3-2013 was 67.88 % of the total population and personalised vehicles as on 31.3.2013 was 84.26% of the total population. It is estimated that about 8000 – 9000 vehicles per year are increasing and therefore by 2030, the vehicular population of the state would be around 4-5 lakhs (ENVIS, 2015). The level of growth in private modes of transport in comparison with public transport is a significant contributory factor for urban air pollution. Although, two wheelers are generally more fuel efficient than passenger cars they typically emit more pollutants per kilometre thereby contributing more to the particulate carbon monoxide, Sulphur dioxides and nitrogen oxide emissions. The use of a large number of

second-hand vehicles as transport is another cause of concern. In addition to this, the ambient air is further polluted by the dust from the poorly maintained road and smoke emitted from the burning solid-waste. The air quality in all the valley districts of Manipur is within the permissible limits. There are no major highly air polluting Industries in the area. The use of boilers and the existing brick kilns of seasonal operation produce emission of local influence only. The air quality in the valley is not considered bad. However, there is urgent need for putting a check on the rising and indiscriminate establishment of small industrial units within thickly populated areas and also a check on the rising trend of use of second-hand vehicles in the state (ENVIS, 2015).

The total vehicle population of Manipur as on December 2017 has increased to 367,035. Another problem is the continuous increase in construction activities. Dust from such construction clogs the air and makes breathing difficult especially for people with asthma related ailments. The routine burning waste products as a form of disposal, including plastic and polythene bags have adverse consequences for health in the urban area of the state (Sophia and Devi, 2020).

10.5. Water quality and pollutants

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

10.6. Threats to biodiversity

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

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

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

The physical composition of MSW in Imphal has a maximum content of organic waste (60.59%) followed by plastic (11.06%) and paper (7.16%). The physical composition suggests that the adoption of technologies such as compost and recycling plant is imperative in the management of MSW in Imphal municipality (Fig.. 10.5). The existing laws do not promote “3R” policy which is a key tool for effective management of MSW in the contemporary world. “3R” policy means “reduce, reuse and recycle”. Huge volume of waste can be reduced, reused and recycled to reduce the pressure on production of virgin materials (Mahongnao, 2017).

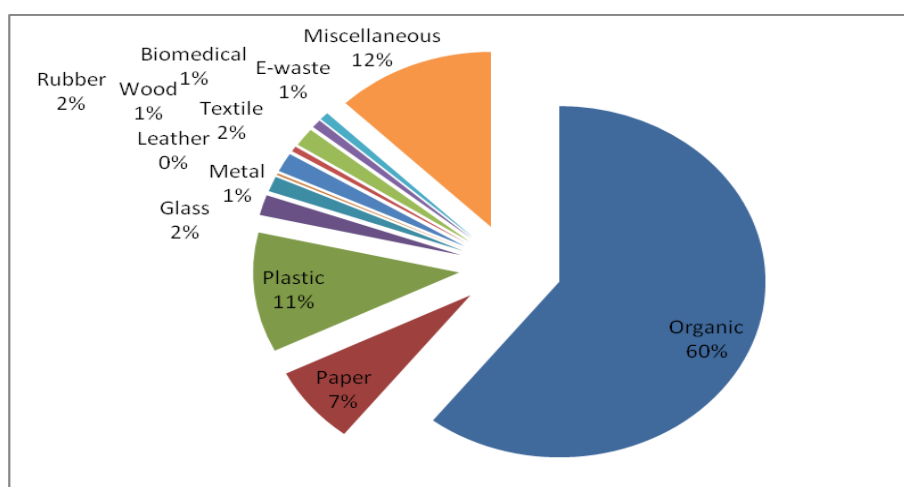


Fig.. 10.5. Physical composition of Municipal Solid Waste in Imphal city (Source: Singh and Dey, 2015)

10.7.2. Segregation / Utilization of waste:

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

10.7.3. Recycled/Reused/Unutilized / left over

10.7.3a. Waste disposal/ treatment facilities

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

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

10.8. Impact on Air quality

10.8.1. Parameter wise air quality

The assessment of the particulate pollution (PM_{2.5} and PM₁₀) in the indoor air of Manipur University campus was attempted. The results revealed variation in the spatial and temporal concentrations of air particulates within the campus. The PM_{2.5} concentrations ranged between 8.33 µg/m³ and 129.16 µg/m³ whereas, the PM₁₀ concentrations ranged between 16.54 µg/m³ to 269.88 µg/m³ (Khoiyangbam, et al 2021). The lowest concentrations of both PM_{2.5} (8.33 µg/m³) and PM₁₀ (16.54 µg/m³) was recorded in the classroom. The highest concentration of particulates was recorded in the University canteen for PM_{2.5} and in Indoor stadium for PM₁₀. In general, particulates concentrations were recorded higher in spots adjoining the National highway (No.102) and showed a declining trend with distance. Out of the 12 spots under study, the PM_{2.5} concentrations was found above the permissible levels (25 µg/m³; WHO, 2013) in 10 spots, whereas the concentrations of PM₁₀ was exceeded in 8 spots. The values of AQM in the Imphal city of Manipur during the year 2019 is depicted in Table 10.1.

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

SO₂			NO₂			PM₁₀			PM_{2.5}		
Concentration in µg/m ³			Concentration in µg/m ³			Concentration in µg/m ³			Concentration in µg/m ³		
Mini mum (24- hourl y avera ge)	Maxi mum (24- hourl y avera ge)	Ann ual Aver age	Mini mum (24- hourl y avera ge)	Maxi mum (24- hourl y avera ge)	Ann ual Aver age	Mini mum (24- hourl y avera ge)	Maxi mum (24- hourl y avera ge)	Ann ual Aver age	Mini mum (24- hourl y avera ge)	Maxi mum (24- hourl y avera ge)	Ann ual Aver age
3	18	9	5	52	21	38	180	109	37	71	56

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

10.8.2. Impact on water quality / ground water

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

10.9. Impact on Forest and Biodiversity

North eastern states endowed with rich biodiversity and Manipur is among them. According to the Forest Survey of India 2018 report, the forest cover in the state of Manipur is 16,846.90 km² which is 75.46 % of the total geographical area of the state. Manipur state shares the eastern Himalayan endemic bird area and the Indo-Burma Biodiversity Hotspot with its rich flora and fauna and diverse ecosystem which includes 4,000 species of angiosperms, 430 medicinal plants, 34 edible fungi species, 500 orchid species, 55 bamboo species. Besides, the state hosts 40 endemic rice cultivars, 160 fish species and 21 migratory aquatic birds (<https://cramanipur.wordpress.com/2020/07>). However, there are still unexplored fauna and flora species in the state and the state is facing biodiversity degeneration due to various reasons, including lack of awareness in the society, faulty practices and limitation in the scientific community.

10.10. Threatened plants

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

10.10.1. Endemic plants:

A total of 86 plants (angiosperm) recorded endemic to India found in Manipur, belonging to 56 genera and 28 families (Herb 45; Shrub 14 each; Climber 08; under shrub 2; Tree 09; Bamboo 5 (Singh et al. 2015). However, there are no reports available on the impact of tourism on Manipur's endemic plants.

10.11. Eco-sensitive zones/ Areas

The following six Eco- sensitive zones are proposed in Manipur and as per the information available in the Ministry of Environment, Forest and Climate Change (MoEFCC), GoI (accessed on 23.04.2022). The proposed proposals for Eco-sensitive zone have been finalized. These include: (i) Zeiled wildlife sanctuary, (ii) Bunning Wildlife Sanctuary, (iii) Yangoupokpi Lokchao Wildlife sanctuary, (iv) Kailam Wildlife sanctuary, (v) KeibulLamjao National Park, and (vi) Jiri-Makru Wildlife Sanctuary. A total of 1654 km² area is covered under the Eco-sensitive zone, which provide effective conservation of wildlife habitat.

10.12. Gaps and Plan of Action

Sr. No.	Gaps	Plan of Action
1	Effective management of solid waste is lacking which may hamper the state tourism in near future	<ul style="list-style-type: none">• Need to develop a mechanism for proper solid waste management through capacity building, infrastructure development, and wastes recycling to attract tourism in the state.• Involvement of local non-governmental organization for sensitization programs.• Synergize the solid waste management campaigns with the cleanliness campaign.• Initiative of buying solid waste from its residents to spread awareness on waste management can be replicated in the state.
2	Sate seems bit behind in terms	<ul style="list-style-type: none">• Research institutions need to be strengthened

	of research especially in the documentation part	and supported by the central agencies. Outer state centralized agencies can help the state to document biodiversity, culture custom and physical parameters of the state in campaign mode.
3	There are threats to the biodiversity such as forest fire, fuel wood collection, hunting bush meat, indiscriminate agro-chemical uses, and lack of awareness.	<ul style="list-style-type: none"> • Awareness regarding these issues needs to be initiated. State policies can be influenced to make strong rules and regulations to combat / minimize such incidences.

10.13. Suggested Action priorities

1. Manipur lies in the biodiversity hot spots region of the world, hosting many important, rare, and endemic species. However, hilly areas of the state are characterized by poverty and food insecurity. The important traditional knowledge associated with the flora and fauna are vanishing before being scientifically investigated. Therefore, proper documentation of this wealth of the state should be a prerequisite prior to tourism management in the state.
2. Some of the main threats to biodiversity are forest fire, fuel wood collection, hunting bush meat, indiscriminate agro chemical uses, and lack of awareness. Capacity building programs needs to be organized to sensitize the resident community towards the importance and intangible services of the biodiversity.
3. 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.
4. Proper solid waste management systems through capacity building, infrastructure development (such as engineered landfill areas; resource recovery centers, biodegradation mechanism etc), waste recycling needs to be done in order to attract tourism and its sustenance.

1.7. Summary

The fragile nature of Manipur's sensitive and environmentally diverse ecosystem is under threat as socioeconomic disparities and geopolitical turmoil deepen. The indiscriminate use of natural and biological resources has had major consequences for the state's overall ecosystem. To understand the current trend of nature and natural resource depletion in the state, an ecologically sensitive strategy is urgently needed to aid in the achievement of the state's Ecologically Sustainable Development goals. In this regard, if properly planned and performed through a participative method, ecotourism can be a very successful and beneficial approach for accomplishing such activities. Furthermore, proper solid waste management using 3R concept is must. To achieve these, skill and capacity building programs along with awareness campaigns can be practiced

Mizoram

11.1. Introduction

11.1.1. General scenario of tourism in Mizoram

Mizoram state is located between 21°56'N to 24°31'N latitude and 92°16'E to 93°26'E longitude with a geographical area of 21,081 km². It shares national boundaries with Tripura in the west, Assam and Manipur in the north and international border with Myanmar on the east and Bangladesh in the south and west respectively. The state is covered with verdant forests that teem with bamboo groves, vibrant wildlife, sheer cliffs and breathtaking waterfalls. Mizoram has many unique landmarks such as old folklores and villages with houses built on stilts. In the morning, the hills and peaks are covered under a dramatic sea of mist. In Mizoram, highlanders also called Mizos, live. They are a carefree and friendly group of people. The state has diverse festivals and dances, handicrafts, flora and animals, spectacular natural beauty, and mild climate, pristine rivers and mountains make it a colorful sight. The local peoples have delight and kind attitude are the primary drivers behind establishing some of the most alluring tourist attractions in the state (Annual Final Report of Tourism Survey for the State of Mizoram, 2014-2015).

On 18th March 1993, Mizoram declared Tourism as an 'Industry with a view to increase state revenue and boost the service providers in the sector with benefits through promotional activities on tourism (The Mizoram Responsible Tourism Policy, 2020). The State's stunning environment, biodiversity, and numerous community and government efforts to preserve its pristine condition have resulted in more market opportunities than ever before. The state government is trying to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private sector to develop tourism related infrastructure in the state without harming the existing ecology and environment in a responsible way. Special emphasis is being given particular on the development of activity-based tourism and opening up of new destinations in the countryside and lesser-known areas. Appropriate infrastructure will be developed using available resources. According to the latest data compiled by the respective associations of the tourist service providers as on 31st March 2020, there are 68 hotels in Mizoram-with a total of 505 rooms, 41 travel agencies, and 8 tour operators. There are a number of factors limiting tourism in Mizoram-including unstable flight schedules, inadequate connectivity and lack of infrastructure, poor management of heritage and adventure sites and inadequate community involvement. Development and establishment of hotels aim to service the low-end travelers that have cluttered the market and degraded Mizoram's pristine image. Further, absence of qualified tour guides and lack of awareness on tourism among the public in general and transport service providers in particular are the immediate areas where the Government should intervene.

Resolving these issues is therefore crucial and its resolution will require political will and a coordinated industry. Therefore, the Mizoram Responsible Tourism Policy outlines the way forward and urges all citizens and travelers to work together in one voice to implement the needed solutions (The Mizoram Responsible Tourism Policy, 2020). Tourism department, Government of Mizoram (GoM) has listed 164 tourist attractions/destination across 11 districts, viz., Aizawl: 38; Champhai:18; Hnahthial: 02;

Khawzawl: 09; Kolasib:11; Lawngtlai: 05; Lunglei: 17; Mamit: 26; Saitual:11; Serchhip:23 and Siaha: 04, respectively. The potential areas for the tourism in Mizoram include: Adventure and Adventure Sports Tourism, Wildlife and Eco-Tourism, Cultural Tourism, Rural Tourism-Home Stay, Nature-based Tourism, Wellness, Health & Herbal Tourism, Music Tourism, Fashion Tourism, etc.

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

11.1.2.1. Tourist influx

According to tourism department (GoM), a contentment increase in tourist influx in the state was observed upto the year 2020. During the year 2019-2020, the total number of tourist arrivals in the state was 161,677 with domestic tourist arrivals stood to be 159,534 and foreign tourist arrivals 2143. Thereafter, a significant decrease in the tourist number was observed in the year 2021 and 2022 (Fig..11.1). This sudden decrease in the tourist number can be connected to global COVID-19 pandemic outbreak. The annual growth rate of 81.04 % for domestic tourists, and 30.35 % growth rate of foreign tourist arrivals were recorded for the same period. The proportion of domestic and foreign tourist visited Mizoram since 2009 to the current year. Based on the collected literature, it is evident that rate of change in tourist influx increased from 0.22% to 80.11% during 2009-2010 to 2019-2020. However, during the period of complete lockdown due to COVID-19 pandemic in 2020-2021, the rate of change of tourist arrival was declined concurrently to -87.28%. In the successive years, i.e., 2021-2022 an increasing rate of change was observed.

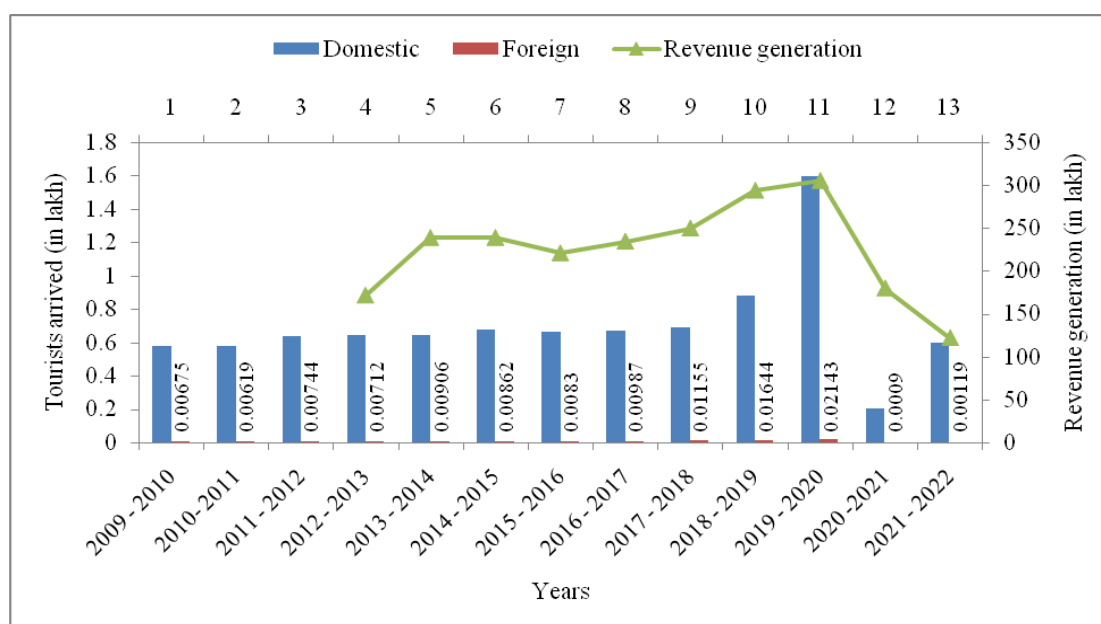


Fig.. 11.1 Tourist influx and revenue generation in Mizoram state (*Source: Tourism department, Government of Mizoram. <https://tourism.mizoram.gov.in>*)

11.2.1.2. Economic growth

The state government is attempting to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private

sector to develop tourism related infrastructure in the state without breaching the existing ecology and environment in a responsible way. Records indicate that the state has generated more than targeted revenue from the tourism upto the year 2020. Thereafter, the revenue was below the expected/targeted revenue that indicates the state has faced challenge in the tourism sector during the global pandemic of COVID-19 .Furthermore, the rate of change of revenue generation in the state ranged from 3.89% to 39.28%. The rate of change was maximum (39.28%) during 2013-2014 and minimum (3.89%) during 2019-2020. However, during the COVID-19 pandemic in the year 2020-2021, it has declined drastically to -41.11% (Fig..11.2).

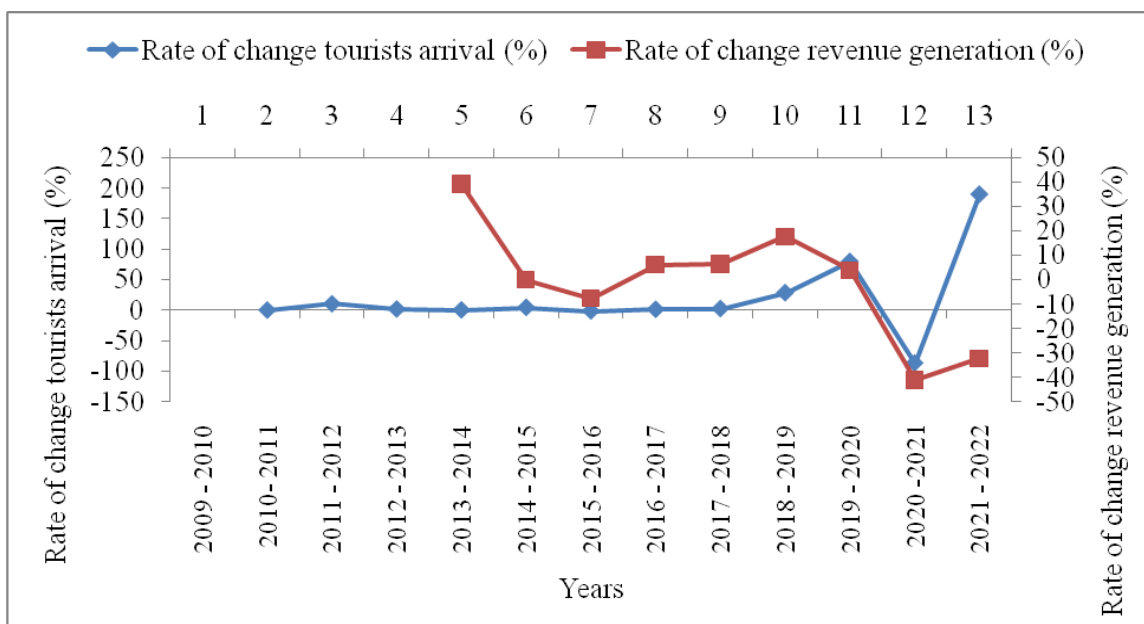


Fig.. 11.2. Rate of change in tourist arrival and revenue generation in Mizoram (*Source: Tourism department, Government of Mizoram. <https://tourism.mizoram.gov.in>*)

11.1.3. Number of vehicles (state / district wise)

The number of registered motor vehicles across Mizoram has been increased concurrently from financial year 2007 to 2021. The registered vehicles in Mizoram were sixty-one thousand approximately in the year 2007, which was increased upto 3 lakh 19 thousand in the year 2021. The annual trend of registered vehicle in Mizoram. The rate of change in vehicle registration has increased over the years and it differed 6.06% in 2009 to 18.62% in 2013 (Fig..11.3). In total 3,19,214 vehicles were registered as on March 2022 and among the nine districts of Mizoram state, maximum number (2,22,845) of vehicles were registered to Aizawl urban followed by Lunglei (27614) and minimum (5998) in Mamit district respectively (Fig.. 11.4). Interestingly, it was observed that number of tourists visiting the state dropped dramatically during the COVID-19 worldwide pandemic 2020-2021, although the number of vehicles has showed a consistent upward trend. This illustrates that the rise in the number of vehicles in the state is not solely due to tourism but also due to changes in the socio-economic conditions of the state. Although published evidences on plethora of vehicles (tourist vehicles) degrading the

environmental health of the state are not available but this plethora of vehicles is projected to have negative impact on the states air quality in populated cities.

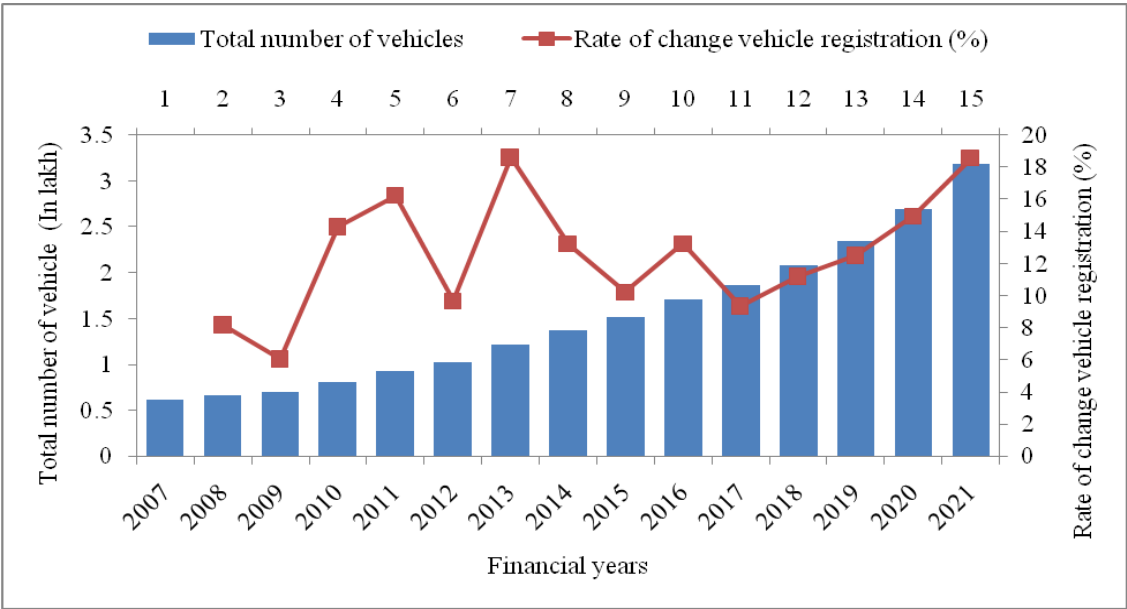


Fig.. 11.3. Total number of registered motor vehicles across Mizoram state from financial year 2007 to 2021 (Source: Department of Transport, Government of Mizoram and <https://www.statista.com/statistics/1116913/number-of-vehicles-in-mizoram-india>)

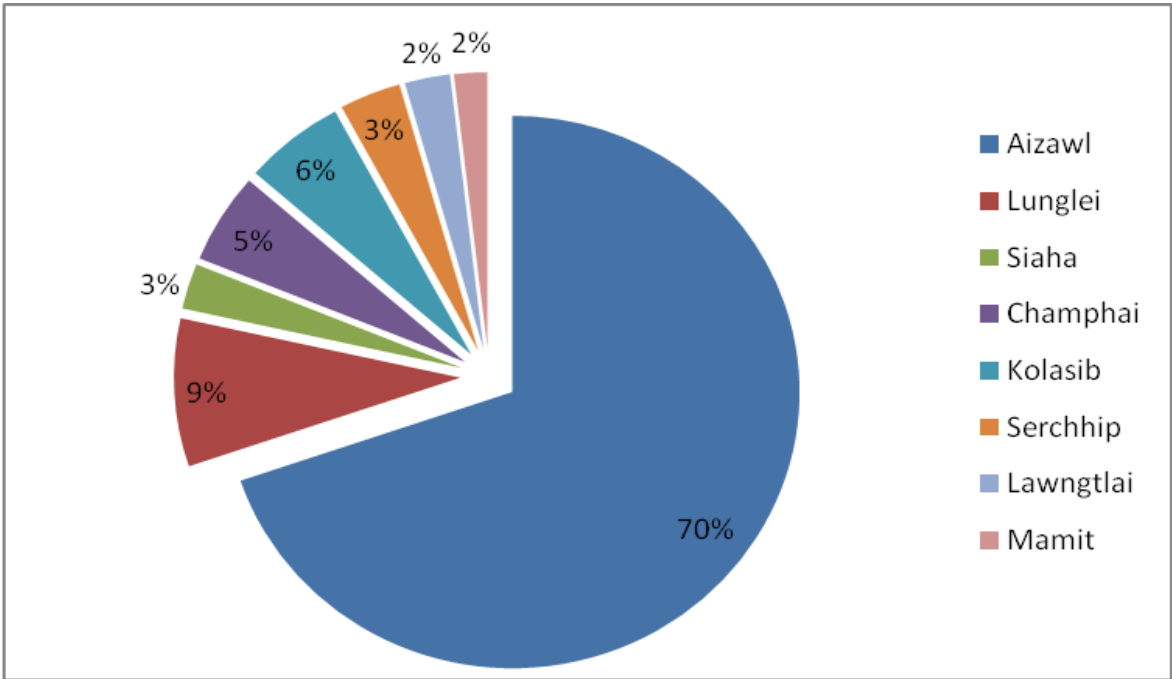


Fig.. 11.4: District wise registered vehicles in Mizoram as on 31 March 2022. (Source: Department of Transport, Government of Mizoram)

11.1.4. Ill-effects of tourism particularly on environmental components (waste generation, air & water quality deterioration, loss of greenery & biodiversity), land/soil contamination and ground water (with some data/trends & literature review, references, etc.)

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

11.1.4. Solid waste and its management

The solid waste management is among the biggest problems faced by the urban area. Compared with other urban management issues, solid waste management is given little attention (Lalneihzovi and Lalchhuanawma, 2017). In Aizawl, waste management is now looked after by the Sanitation Wing of Aizawl Municipal Corporation (AMC). Based on a survey (n=36,039 households), it is believed that 38 % of waste produced by Aizawl city is biodegradable while 39 % recyclable and remaining 23% is inert ash and debris. Out of total collected waste, 8 % goes directly to the landfill, similarly 10% of wet waste which was rejected from the composting goes to the landfill and 20% of dry waste rejected from the resource centres goes to the landfill (Lalneihzovi and Lalchhuanawma, 2017). Over the years, the amount of waste going to landfill has also been increased from 27.03 MT/day in the year 2011 to 36.94 MT/day in the year 2020. Furthermore, the decadal trend of per capita waste generation is also increasing from 470 gms/day/person in the year 2011 to 525 gms/day/person in the year 2020.

With active participation and collaboration of the local councils in arranging solid waste management system in the municipal area, majority of the households regularly dump waste in the vehicle collection points at designated place.

For families who could not participate in solid waste management system through public-private partnership (PPP) mode, the place of dumping solid waste were waste pit owned by household, stream nearby, drainage, cliff nearby the locality, and it is also occasionally burned causing air pollution.

11.1.5. Air quality and pollutants

Mizoram is one of the few states in the country where problem of air pollution is very less. If it exists, it is only in small pockets of urban areas where population density is high and those people who have adopted a modern life style. The growth and expansion of industries, automobiles and high per capita resource consumption have made the problems of pollution visible which extend to environmental domains including air, water and soil. Air quality of the state in particular is observed to be deteriorating at a fast rate due to vehicular emissions. The other major sources of air pollution in the

state include forest fires during dry winter months due to burning of slashed vegetation for Jhum cultivation. Besides, few industrial activities also pose problems of air pollution in certain areas. Air quality monitoring is conducted by Mizoram State Pollution Control Board (MSPCB) and reports regarding the annual average concentrations of SO₂, NO_x and PM₁₀ are available in the website of MSPCB, GoM since 2014 to 2017. The Air Quality Index (AQI) values recorded ranged between 17-87 for the year 2014-2017 in Mizoram and in most cases, values are falling under good category. This shows that air quality in Mizoram is mostly good or satisfactory and the people have minimal impact of air pollution in the state.

11.2. Water quality and pollutants

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

11.3. Threats to biodiversity

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

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

In Mizoram, the Aizawl Municipal Cooperation (AMC) takes cares of waste management in Aizawl district, while the Urban Development and Poverty Alleviation Department manages wastes in rest of

the census towns within the district. According to the census 2011, the population of Mizoram state was 2,93,416 and this has increased 9% (3,19,837) compared to the base year 2015 and further this increased to 10.5 % (353590) in the projected year 2020. However, the rate of increase of waste in different categories is much higher (Fig..11.5).

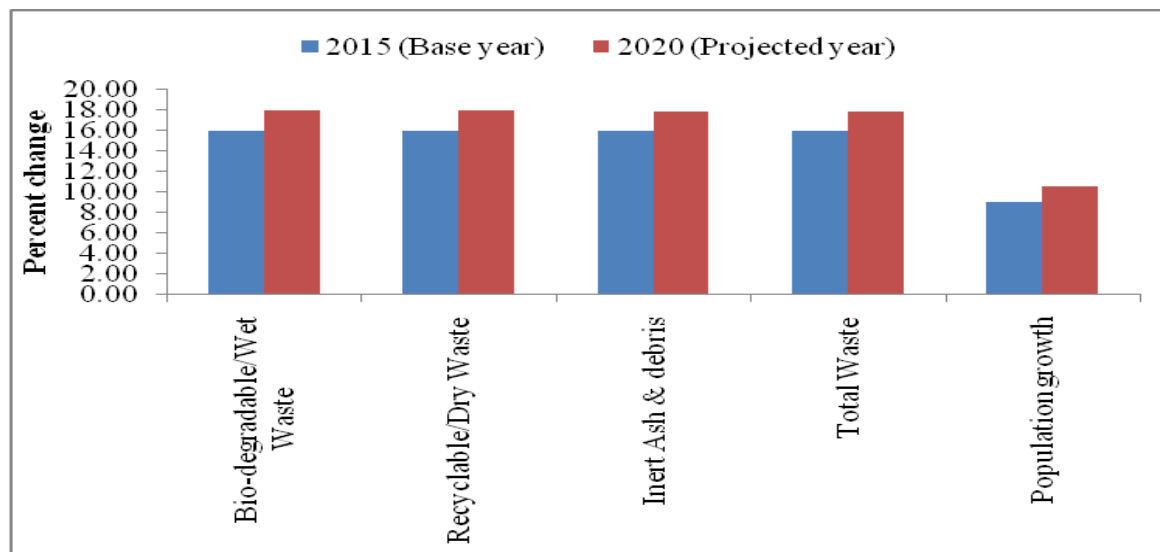


Fig. 11.5. Status of waste growth under different categories over the years w.r.t. to population growth. *Source: State Investment Project Management and Implementation Unit, Aizawl*

The waste generated in Aizawl city of Mizoram shows an increasing trend over the years. The total waste generated quantity was 137.91 MT/day (biodegradable: 52.4; recyclable: 53.78 and others: 31.72) in the year 2011. This was increased to 159.88 MT/day (biodegradable: 60.75; recyclable: 62.35 and others: 36.77) in the year 2015. While in the year 2020, it reached to 188.54 MT/day (biodegradable: 71.65; recyclable: 73.53 and others: 43.36). The available monthly solid waste data of the year 2020-2021 indicates that there is a significant hike in solid waste quantity during November to January. The sudden hike of waste can be related to the tourist influx in the city/state (Table 11.1).

Table 11.1 Quantity of waste received at Aizawl solid waste management centre (July 2020 -January, 2021)

Month	Waste Received in a day (in tonnes)			Waste Received in a week (in tonnes)			Waste Received in a Month (in tonnes)		
	Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
Jul-2020	10.36	6.56	16.92	72.54	118.42	190.96	321.23	203.22	524.45
Aug-2020	4.13	4.21	8.34	28.91	29.44	58.35	128.01	130.39	258.40
Sep-2020	4.89	3.72	8.61	34.25	26.01	60.26	151.69	115.19	266.88
Oct-2020	3.44	2.46	5.89	24.05	17.21	41.26	106.52	76.21	182.73
Nov-2020	35.26	31.04	66.29	246.80	217.25	464.05	1,057.71	931.06	1,988.77

Dec-2020	42.57	24.18	66.74	297.98	169.23	467.21	1,319.64	749.45	2,069.09
Jan-2021	42.21	24.48	66.69	295.46	171.35	466.82	1,308.49	758.85	2,067.33

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

11.4.1. Types of waste

Lalengzama and Zoramani (2018) surveyed Lunglei District of Mizoram and categorized waste in 12 categories based on the use frequency, i.e., regular, some times and never. In total, 85 households were targeted. It was observed that paper (95%), bones (93%), sanitary pads (93%), polythene (92%), etc. were among the regular disposed materials. Cloths (76%), glass (51%), etc. were common sometime disposed items and toilet waste (100%) and aluminum (96%) are among not or rarely disposed materials (Table 11.2). This indicates that the Lunglei district has proper defecation management and is an open defecation free zone.

Table 11.2. Types of waste disposed in Lunglei district of Mizoram state

Sr.No.	Particulars	Respondents (n=85)		
		Regular	Sometimes	Never
1	Aluminum	00 (00)	03 (04)	82 (96)
2	Glass	18 (21)	43 (51)	34 (40)
3	Plastic	29 (34)	38 (45)	18 (21)
4	Paper	81 (95)	04 (05)	00 (00)
5	Food waste	10 (12)	35 (41)	40 (47)
6	Toilet waste	00 (00)	00 (00)	85 (100)
7	Cloths	02 (02)	65 (76)	18 (21)
8	Parcel	45 (53)	36 (42)	04 (05)
9	Polythene	78 (92)	04 (05)	03 (04)
10	Sanitary pads	79 (93)	06 (07)	00 (00)
11	Wood/leaf	41 (48)	35 (41)	09 (11)
12	Bones	79 (93)	06 (07)	00 (00)

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

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

11.4.2. Segregation / Utilization of waste

In urban local body (ULB) Aizawl, there are 83 local councils, of which 17 census towns have implemented door-to-door waste collection, 15 census towns have implemented waste segregation and 10 census towns have implemented transportation of segregated waste (<https://greentribunal.gov.in/>) facilities. A solid wastes management centre comprising of Engineered Landfill, Composting (vermi and

mechanical compost) and Resource Recovery Centers (RRC) is in operation in Aizawl. Three more sites have also been identified within the Aizawl city. The dumpsites at Tuirial have been closed since December 2020 and remediation of the site is in progress. Other districts sites are identified in all urban/census towns. Vermi compost centres and waste resource management centre or material recovery facilities have been constructed in all towns. While engineered landfill area is proposed for two towns, viz, Lunglei and Kolasib towns, these are the most populous towns after Aizawl. Environmental clearance is being sought from State Environment Impact Assessment Authority (SEIAA), Mizoram. Under the initiatives taken by the state's UD and PA department and the AMC, cleanliness competition is being conducted every year during the month of October. The competition is made at district level, and town level and the government offices/institutions under separate category. A group of experts were constituted by the departments of UD and PA. These experts from the UD and PA department, comprise of Information and Public Relations Department, Mizoram Pollution Control Board and Central Young Mizo Association (CYMA, the largest NGO of the State) (<https://greentribunal.gov.in/>).

11.4.3. Waste disposal/ treatment facilities

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

11.4.4. Waste Processing

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

11.4.5. Recycling

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

11.5.5. Composting

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

11.5. Impact on Air quality

The Aizawl capital city of the Mizoram has the largest population among all the towns/cities in the state which is 293,416 as per 2011 census. It has four manual air monitoring stations which are in operation since 2005 to till date. There is one Continuous Ambient Air Quality Monitoring Sensor (CAAQMS) at Sikulpuikawn. Besides, Champhai (02), Kolasib (02) and Lunglei (02) also have air quality monitoring systems in different locations. The air quality-data is displayed to public using LED display board since February 2020 in Aizawl. Based on the year-round observations, the 24-hour average SO₂

concentration in all the AQMS was 2 µg/m³. Similarly, the average NO₂ concentration ranged between 5-8 µg/m³ and PM₁₀ average value ranged from 8-48 µg/m³, respectively (Table 11.4).

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

States	District	No. AAQMS stations	SO ₂			NO ₂			PM ₁₀		
			Concentration in µg/m ³			Concentration in µg/m ³			Concentration in µg/m ³		
			Mini mum (24-hourly average)	Maximum (24-hourly average)	Annual Average	Mini mum (24-hourly average)	Maximum (24-hourly average)	Annual Average	Mini mum (24-hourly average)	Maximum (24-hourly average)	Annual Average
Mizoram	Aizawl	5	2	2	2	5	21	8	10	211	48
	Champhai	2	2	2	2	5	5	5	13	37	25
	Kolasib	2	2	2	2	5	5	5	3	141	23
	Lunglei	2	2	2	2	5	5	5	3	21	8

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

11.5. Impact on water quality / ground water

(ii) *Measures/ mitigation facilities*

The important measures could be as under:

1. Purification, filtering plants, chlorination, etc. need to introduce.
2. According to Jal Jeevan Mission, department of drinking water and sanitation, Ministry of Jal Shakti, there is no community based Water Purification Plant in Mizoram.

11.6. Impact on Forest and Biodiversity

11.6.1. State wise RET categories species wise / forest cover

The recorded forest area in the state Mizoram is 5,641 km², of which 4,483 km² is reserved forest and 1,158 km² is unclassified forests. However, the forest cover in the state is 18,005.51 km² which is 85.41% of the state's geographical area. Being located in the North Eastern part of India, Mizoram is a biodiversity hotspot. It consists of 2,358 species of plants, of which 2,141 belong to Angiosperms, only six species of Gymnosperms, 200 species of mushrooms and 211 species of Pteridophytes (Singh, 1997). Similarly, orchids are very common in the state and about 251 species of orchids and 35 species of bamboos are reported from the state (Singh *et al.* 2002, Bisht *et al.* 2010). Besides, state possesses rich diversity of medicinal plants. About 500 species of the state have medicinal and ethno-botanical uses (Singh *et al.* 2002). Eight species of primates, e.g. hoolock gibbon, pig-tailed macaque, stump-

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

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

11.6.2. Endemic plants

In review of literature, a total of 51 angiosperm plants species recorded endemic to India found in Mizoram, which belong to 37 genera and 28 families (Singh *et al.* 2015).

11.7. Eco-sensitive zones/ Areas

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

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

According to the information available in the MoEFCC, GoI (accessed on 25.04.2022), a total of 8 eco-sensitive zone (two National Parks & eight Wildlife Sanctuaries) proposals were finalized. These include, (i) Khawnglung Wildlife Sanctuary, (ii) Tawi Wildlife Sanctuary, (iii) Pualreng Wildlife Sanctuary, (iv) Murlen National Park, (v) Thorangtlang Wildlife Sanctuary, (vi) Lengteng Wildlife Sanctuary, (vii) Dampa Tiger Reserve, and (viii) Tokalo Wildlife Sanctuary. In total, 717.225 km² area (5.89% of total geographical area of the state) covered under the Eco-sensitive zone and provided effective conservation of wildlife habitat.

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

and (iv) prepare in such a form and in such time in each financial year as may be prescribed, its annual report, giving full account of its activities during the previous year and submit a copy thereof to the State Government.

11.8. Gaps and Plan of Action

Sr.No.	Gaps	Plan of Action
1	Most of the monitoring and management activities / initiatives such as AQMs, SWMS, etc. are focused on capital city and/or selected locations only.	Considering Mizoram as a famous tourist destination of the North Eastern India, these monitoring and management activities need to be replicated in other tourist influx areas/districts for effective monitoring of tourism impacts in the state.
2	The state is responsive towards effective management of solid waste in urban areas but still in some parts of it throws waste to the nearby streams or practice open burning.	Awareness needs to be created and disseminated on SWM, sanitation, cleanliness through involving non-governmental organizations of the state, such as, Young Mizo Association (YMA) in a mode of house-to-house campaign, awareness campaign at schools, offices and villages.
3	Data on water quality is available for only two rivers, viz., River Tlawng (Daleshwari) and River Tuirial, 2016-2019.	In view of effective monitoring of water quality of riverine systems of the state, all the major rivers need to be monitored at least at district level.
4	Unavailability of separate data sets on tourist influx in protected areas of the state, especially through online portals of the state.	These data sets are essential to assess the impact of tourism in PAs and to estimate carrying capacity of the PAs. Therefore, a joint mechanism needs to be developed by state tourism and forest departments to monitor tourist influx in PAs.
5	Over the years, the amount of waste going to landfill has been increased from 27.03 MT/day in 2011 to 36.94 MT/day 2020. Furthermore, the decadal trend of per capita waste generation is also increased from 470 gm/day/person in the year 2011 to 525 gm/day/person in the year 2020.	Although, solid waste management centre comprising of Engineered Landfill, Composting (vermi- and mechanical compost) and Resource Recovery Centres (RRC) is in operation at Aizawl. But, their further reasonable extension is required to manage this ever increasing load of waste.

11.9. Suggested Action priorities

1. Green tax/cases may be levied on tourist vehicles similar to some other resorts.
2. The collected green tax needs to be spent on maintaining the sanctity and serenity of the tourist destinations in state. Further, it can be utilized in improving solid waste management infrastructure such as resource recovery centers, engineered landfill areas, etc.
3. Prior online registration can be made mandatory for tourists visiting the state especially in the eco-sensitive zones/areas to ensure quality tourism in the state in a sustainable manner. Some of 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.
4. 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.
5. 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.

12.0 Summary

The state government is trying to attract quality tourists and increase the stay of the tourists in the state by focusing on quality tourism, promoting sustainable tourism and encouraging the private sector to develop tourism related infrastructure in the state without breaching the existing ecology and environment in a responsible way. According to the Mizoram Responsible Tourism Policy 2020, tourism in Mizoram, however, remains constrained by unstable flight schedules, inadequate connectivity and lack of infrastructure, poor management of heritage and adventure sites and inadequate community involvement. Further, absence of qualified tour guides and lack of awareness on tourism among the public in general and transport service providers in particular are the immediate areas where the Government may intervene. Resolving these issues is therefore crucial and its resolution will require political will and a coordinated effort.

Tripura

12.1. Introduction

Tripura is the second smallest state of North-East India covering an area of 10491.69 km². Being isolated from the mainland, it suffers from overall proper economic development. The state has about 76% of the total geographical area under forest cover, out of which about 6% is under protected areas in the form of four wildlife sanctuaries namely, Sipahijala, Trishna, Gumti and Rewa. Five parallel hill ranges (Jampui, Sakbantlang, Langtarai, Atharamura and Baramura-Deotamura) clothed with forests of varying density, and ten major rivers (Langai, Juri, Deo, Manu, Dhalai, Khowai, Haora, Gumti, Muhuri and Fenny) occupying the valleys between two adjacent hill ranges, dotted with tribal hamlets, provide a perfect landscape for tourists with different preferences for recreation, enjoyment and tastes. A number of treks exist through the forests and traditionally and culturally rich hamlets, which have potential to provide a deep insight into the cultural and ecological diversity of the state. In pollution free environment, the tourists get physically invigorated, mentally rejuvenated, culturally enriched and spiritually elevated. Tourism provides the incentives to local people, entrepreneurs and governments. It is an activity, if properly managed, can give fairly sustainable economic incentives to the local people. Realizing the enormous economic, ecological, recreational and conservation potential and growing interests in tourism sector, it is important to develop and promote the activity in the state (Lal and Das, 2012).

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

Evidences collected from the literature indicated that there is a gradual increase in number of tourists arrival in Tripura state from 2008 to 2019. In a decade between 2008 to 2019, the domestic tourist influx increased about 50% in the state whereas, the foreigner tourist inflow increased 34 times (3212%) during this period (Fig.. 12.1). This trend of increasing the number of tourists in the state offers huge opportunity of tourism industry in the state and offers considerable revenue generation and creating employment for the local people. The rate of change in tourists influx continuously increased in the state which ranged between 2.24% to 30.71% in a decade. However, the tourists influx during the period of 2020-2021 was almost negligible due to Covid-19 and further complete lockdown in the country therefore, the rate of change in tourist influx in the state during this period went down drastically at -87% (Fig.. 12.2). The income generated from the tourism activity in the state during the

period of 2008-09 was Rs. 64.66 lakhs which increased about five-fold within a decade between 2008-2019 that was Rs. 345.76 lakhs (Fig.. 12.1). The rate of change in revenue generation from tourism in the state increased constantly, which ranged between 2.32% to 64.70% in a decade. However, during the period of 2020-2021 due to Covid-19 and further complete lockdown in the state and country, tourists did not arrive in the state so the income from tourism was negligible or zero (Fig..12.2). The total vehicle registered in the state during the period of 2012-2013 was 244106 and gradually increased upto 2018-2019. The rate of change in vehicle registration increased continuously in the state which ranged between 10.08% to 16.96% (Fig..12.3). The increasing numbers of vehicle suggested that there is a increasing need of transportation of the tourists and other necessary items required in the sector of tourism and development. However, the increasing numbers of vehicle may cause the concern of environmental pollution and climate change impacts in the region (see Fig. 12.3).

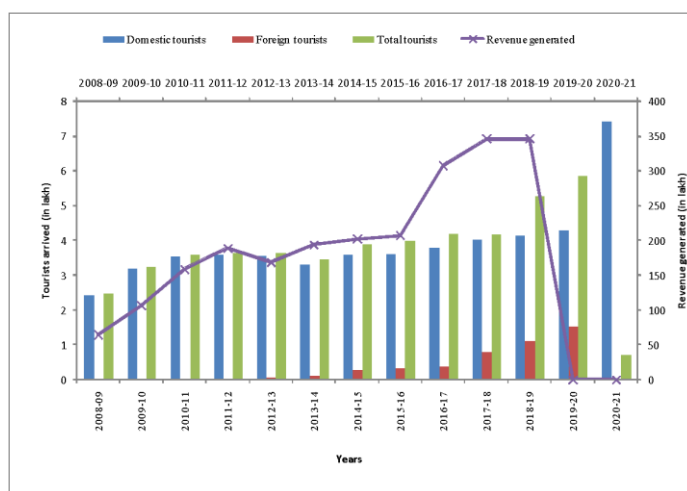


Fig. 12.1. Tourist Influx and revenue generation in Tripura state (Source: Directorate of Economics & Statistics Planning (Statistics) Department Government of Tripura, Agartala. www.destripura.nic.in)

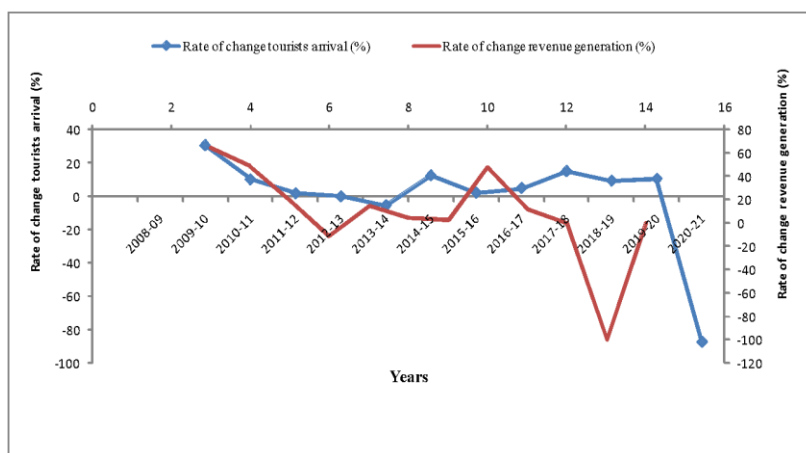


Fig. 12.2 Rate of change in tourist influx and revenue generation in Tripura (Source: Directorate of Economics & Statistics Planning (Statistics) Department Government of Tripura, Agartala. www.destripura.nic.in)

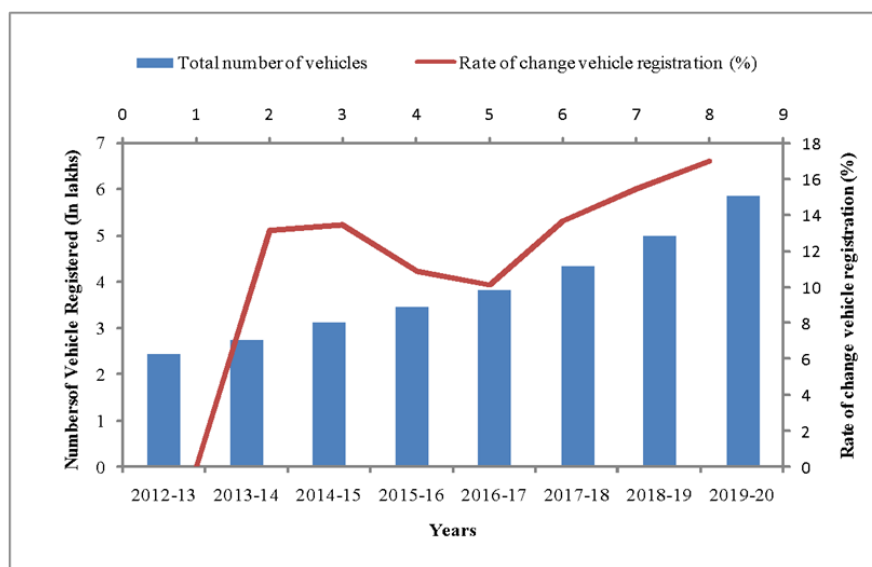


Fig. 12.3. Total vehicle registered in a decade in Tripura state (Source: Directorate of Economics & Statistics Planning (Statistics) Department Government of Tripura, Agartala. www.destripura.nic.in)

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

Based on the literature survey, it has been observed that the huge quantity of solid waste is generated, collected, treated and land filled in the state. Data indicated that the quantity of solid waste generation is steadily increasing over the years with the maximum quantity of solid waste generated (445.72 ton/day) and collected (389.46 ton/day). The waste treatment started from the year 2014 and in during 2014-2015 the total solid waste treated was 250 ton/day. Tripura state also started to dispose-off solid waste through landfill in 2015, and maximum waste was disposed through this system was 239 ton/day during the period 2018-2019. In order to dispose solid waste efficiently Hon'ble National Green Tribunal passed an Order dated 15.07.2019 in the matter of Bio Medical Waste Management Rules, 2016 vide OA No. 710-13 of 2017 in Tripura state. In this regard, Director, Science, Technology & Environment, Govt. of Tripura requested all the District Magistrates and Collectors for preparation of District Environment Plan as per the direction of the Hon'ble NGT, which may in turn be compiled for preparation of State Environment Plan. In compliance to solid waste management, Agartala Municipal Corporation has formulated Solid Waste Management Regulation- 2017, which lays down duties of waste generators, duties of manufacturers of some products, duties of industrial units, setting up of solid waste processing & treatment facilities, duties of corporation, penalties etc. In Tripura, apart from the Agartala Municipal Corporation (AMC), there are 19 Urban Local Bodies (ULBs). The generation of Municipal Solid Waste in the AMC area is about 250 metric ton per day (MTPD) and from the other 19 ULBs about 161.32 MTPD.

The Agartala Municipal Corporation has set up a Solid Waste Management (SWM) Plant with Sanitary Land Fill at Debendra Chandra Nagar with a capacity of 250 MT per day. As the total Municipal Solid Waste generated under all the above said 4 (four) Urban Local Bodies is about 250 MT per day, it has

been decided that all the above said four Urban Local Bodies shall bring their Municipal Solid Waste to the Solid Waste Management Plant at D.C. Nagar, near Agartala by using Modern Garbage Compactors. All the 4 (four) Urban Bodies in West Tripura District have been provided with Modern Garbage Compactors with 8 MT capacity to transport Municipal Solid Waste to the SWM Plant at DC Nagar. Moreover, the Solid Waste generated from the Bishalgarh MC is being disposed in the DC Nagar SWM Plant due to proximity of the SWM Plant at D.C. Nagar. The SWM Plant at DC Nagar is presently operational and generating compost out of Municipal Solid Waste. There is a sanitary land fill attached to this SWM Plant for safe disposal of remaining municipal solid waste which is non bio-degradable. Also there is a Plastic Plant and Eco-brick plant attached to this SWM Plant at DC Nagar in which all types of plastic collected and transported to this plant is converted to fine granules which are sold in the market. In West Tripura district, Municipal Solid Waste is being collected, transported and processed as per the MSW Rules, 2016. It is noted that the quantity of waste generation and its collection has not increased exponentially during the period 2013-14 to 2019-20. However, waste treatment / land filling has fluctuated during this period (Fig. 12.4).

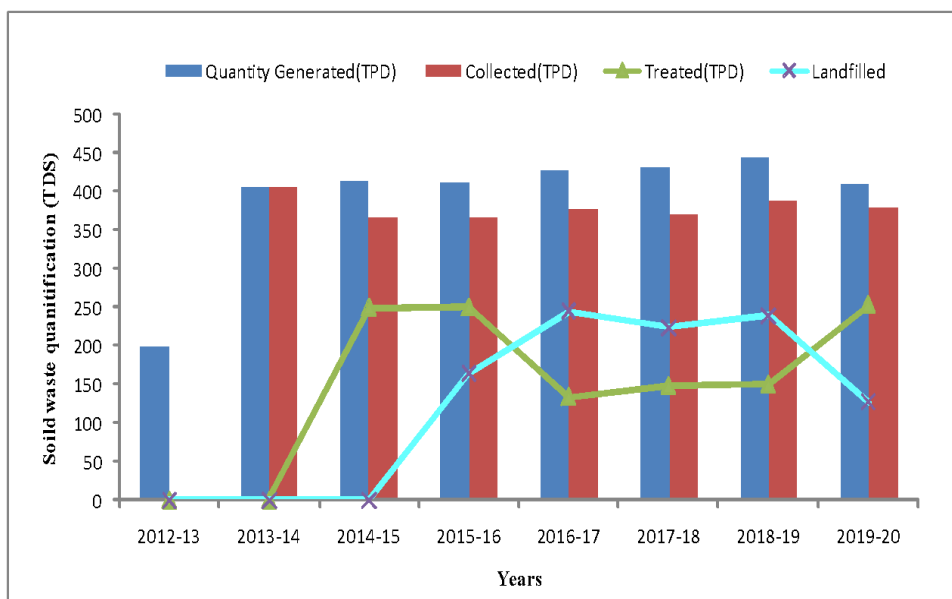


Fig.. 12.4. Solid waste generation/collection/treatment and land filled in Tripura (Source: Central Pollution Control Board) * TPD= Ton per day

12.3 Impact on Air quality

Data were collected for the period of 2017-2020 on air quality for the state of Tripura particularly from Agartala location since the only study on air quality was reported from this location. The particulate matter PM₁₀ was maximum (67µg/m³) in the year of 2020 and minimum (47µg/m³) in the year of 2017 and 2018. Similar trend was also found for PM_{2.5} that was maximum (49µg/m³) in the year of 2020 and minimum (24 µg/m³) in the year of 2018 and 2019. The maximum (21µg/m³) quantity of SO₂ was found in the year 2017 whereas, minimum quantity (4µg/m³) was calculated in the year of 2019. Data related to NO₂ were collected from the literature which indicated that the maximum (16 µg/m³) NO₂ in

the air was recorded in the year 2018 whereas, minimum ($8 \mu\text{g}/\text{m}^3$) NO_2 was quantified in the year of 2020. It is interesting to note that the quantity of NO_2 and SO_2 decreased drastically in the year of 2020 that due to Covid-19, the state did not receive tourists and vehicle movement in this year was negligible thereby the air was free from the pollutants (Fig.. 12.5). Although the range of all the air quality parameters is under permissible limit however, proper monitoring and management plan is required to maintain the air quality of the state.

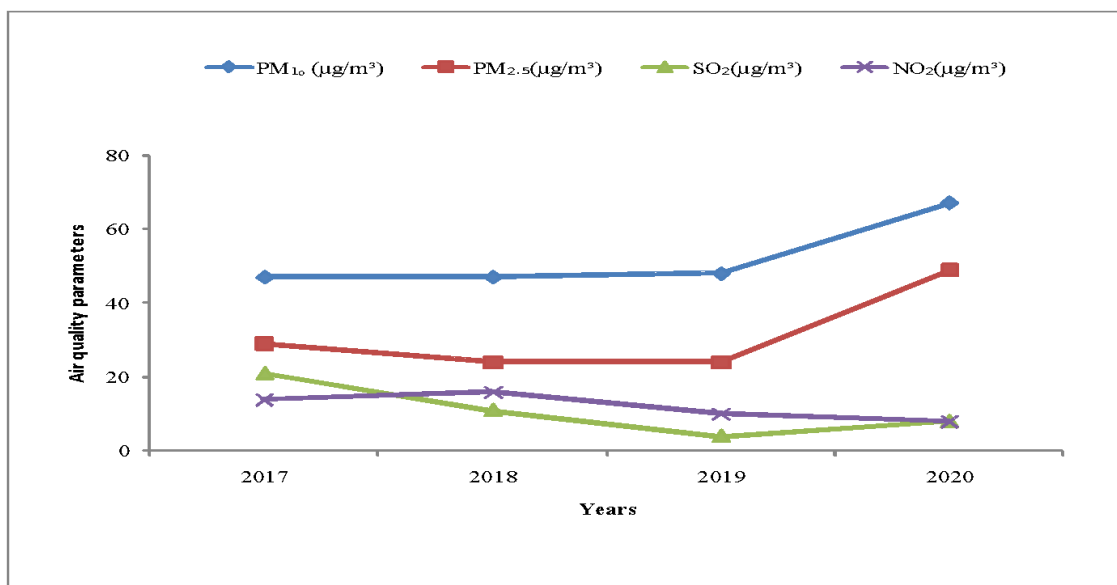


Fig.. 12.5. Impact on air quality of Tripura state (Source: Central Pollution Control Board)

12.4. Impact on water quality / ground water

Data available from secondary sources for the State of Tripura in different seasons revealed that the water quality is not so poor particularly in respect to pH, BOD, Nitrate and Fecal coliforms (Fig.. 12.6). The value of pH ranged from 5.6 to 7.7 between 2012 to 2020 which is under permissible limit. There is a slight decreasing trends of pH value from 2012 onwards. Similarly, ground water pH is 6.5-8.5, which is under permissible limit. The BOD available for 2012 and 2015 were found 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 2020. Total Fecal coliform (MPN/100ml) in ground water was recorded 2 for the entire period between 2017-2019.

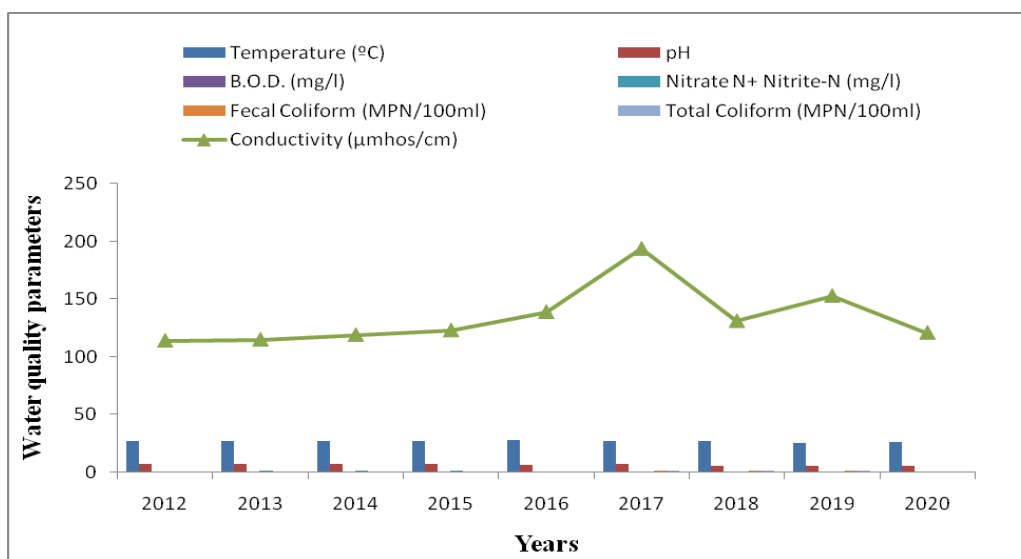


Fig.. 12.6. Impact on ground water quality in Tripura state (Source: Central Pollution Control Board)

12.6. Impact on Forest and Biodiversity

As per the ISFR (2017), based on the interpretation of IRS Resourcesat-2 LISS III satellite data for the period October 2017 to December 2017, the Forest Cover in the State is 7,725.59 sq km, which is 73.68% of the State's geographical area. In terms of forest canopy density classes, the State has 653.51 sq km under Very Dense Forest (VDF), 5,236.19 sq km under Moderately Dense Forest (MDF) and 1,835.89 sq km under Open Forest (OF). Forest Cover in the State has decreased by 0.41 sq km as compared to the previous assessment report in ISFR 2017. The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 76.06 million tonnes (278.89 million tonnes of CO₂ equivalent) which is 1.07% of total forest carbon of the country (Table 12.1). The floral diversity for a small state like Tripura appears significant from the fact the nearly 1463 of the 17,000 species or 8.6% Angiosperms (Flowering plants) known from India is recorded in Tripura (0.3% land of India). A total of 1546 species other than Bacteria, Fungi, Mosses, etc.) belonging to 862 genera and 192 families of Flora have been recorded of which 86% are widely distributed in India and adjoining countries. The Indian Wildlife (Protection) Act, 1972 amended till date include only six plant species while the Red Data Book on Indian Plants published by Botanical Survey of India contains data of more than 650 species considered rare and endangered. At least 15 of such species recorded from Tripura are known to be Rare or endangered (3). Similarly, the faunal diversity of the State is quite rich. In the aquatic system, at least 129 species of fishes are recorded belonging to 32 families, and 11 orders. The fishes of the State include 11 vulnerable species three endangered species and three rare species and 9 species endemic to India are recorded from Tripura. The state is also facing degradation and extinction of the its biodiversity due to some anthropogenic and natural drivers, as a results some of the species are at the verge of threatened category and finally extinction.

Table 12.1. Forest area of the state Tripura

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

Source: Tripura State Pollution Control Board

12.7. Eco-sensitive zones/ Areas

The state has two National Parks and four Wildlife Sanctuaries those constitute the Protected Area network of the State covering 5.76 % of its geographical area. These areas include: (1) Sipahijala Wild Life Sanctuary, (2) Tepania Eco-Park, (3) Trishna Wild Life Sanctuary, (4) Baramura Eco-Park, (5) Kalapania Nature Park, (6) Jampui Hills, and (7) Dumboor Lake. The Sepahijala Wildlife Sanctuary is located in the western part of Tripura, under Bishalgarh Subdivision of West Tripura District and about 28 km away from the capital town of Agartala. Here, the main attractions for visitors are Nature Interpretation Centre, Eco village with Tree House accommodation, high rise Watch Tower, Eco park and children joy ride, Exotic zoo animals, and Picnic spot. The Tepania Eco Park is located in Udaipur Sub-Division, 47 km from Agartala and 5 km from Udaipur. It is set amidst a charming ambience of natural beauty. This park is equipped with a rare orchid house, unique tree houses, tented accommodations, watch tower, hanging bridge, picnic block etc. The Trishna Wildlife Sanctuary is located at Joychandpur in Belonia Sub-Division, 95 km from Agartala and 15 km from Belonia. Among the four major sanctuaries in this State, Trishna is one of the attractive destinations for nature lovers. The great attraction of this sanctuary is a sizeable population of Indian Bison, commonly known as "GABA" and home to highly endangered only ape species of Indian sub-continent. The Baramura Eco Park is located in Teliamura Sub-division, 37 km from Agartala and 5 km from Teliamura. Here the tourists can avail picnic facilities, boating facilities, jungle tracking. The Kalapania Nature Park is located in Sabroom Sub-Division, 120 km from Agartala and 20 km from Sabroom. The main attraction of this park is a Nature Interpretation centre located in the middle part. The Jampui Hills is located in Kanchanpur Sub-Division of North Tripura District, 220 km from Agartala and 100 km from Dharmanagar. The luxuriant forest of jampui Hills is the premier one among the six principal hill ranges of this State. The Gumti Wildlife Sanctuary is located in Amarpur Subdivision covering an area of 389.54 km². The sanctuary boasts of a rich flora and fauna. The Dumboor Lake is the largest water body in the State, located in Gondacherra and Amarpur Subdivisions. These PAs are visited by tourists every year but there is no such information available on the impact of tourism on the forests and biodiversity of them.

12.9. Gaps and Plan of Action

S. No.	Gaps	Plan of Action
1.	Documentation on tourist influx in the protected areas including national parks and sanctuaries is completely lacking in the entire state.	An appropriate framework and action plan needs to be developed by state tourism department with collaboration of forest department at each district to collect the information on numbers of tourists arrived in protected areas.
2.	Data related to carrying capacity of the tourist destination specially protected areas/ eco-sensitive zone are mostly lacking in the state	A detail inventory needs to be made with regard to the carrying capacity of the tourists destination and protected areas to identify the potential of the areas and possible pressures on the resources. In addition, SWOT analysis of these areas is also highly required to strengthen the system.
3.	Impact of tourism on biodiversity and socio-cultural system still needs to be studied in detail.	Study of tourism activity on biodiversity and socio-cultural system both positive and negative terms is required. An appropriate code of conduct needs to be developed by state tourism department with consultation with the subject experts and local stakeholders.
4.	Initiatives on protected areas management is still lacking	A sound full proof protected areas management plan needs to be developed and executed to maintain the integrity and sustainability of the areas.
5.	Data on quantification of solid waste (degradable and non-degradable) are lacking at district level	Quantification of different kinds of solid waste at household level needs to be quantified at district level. Segregation unit of solid waste is required to be opened at district level in order to proper disposal of the waste.
6.	Data on converting degradable solid waste into compost is also lacking at district level	A composting unit needs to be made functional at district level so as the collected bio-degradable waste may be converted and recycled into bio-compost.
7.	Data on quantification of solid waste from tourist destination specially protected areas is completely lacking	A detailed inventory is required to be made in the protected area to quantify the solid waste generated by these areas. Besides, solid waste generated by the tourists/visitors needs to be collected and dumped and treated at proper

		place that needs to be made available by the State Govt.
8.	Data on water quality parameters at district level are lacking in the entire state	Few of the studies related to ground water quality parameters are carried out in metropolitan cities. This needs to be extended to places of tourist destinations to determine the impact on water quality.
9.	Initiatives on water purification specially in rural areas is lacking	There is a need to install water purification unit and pumping system in rural areas to make available potable water in this sector.
10.	Air quality data are also lacking at district level.	Data related to air quality parameters are available only for the capital of the state. Sampling on air quality is required to conduct at district level. Major towns and metropolitans at a certain interval need to assess the changing pattern of air quality and developing strategies to maintain its quality.

12.10. Action plan

At present, all the garbage thus collected from the city is disposed in open in two dump yards by way of landfill without proper processing. There is some facility for processing of garbage at Debendra Chandra Nagar Dump yard but it is not so scientific and sufficient. Hence, most of the garbage is dumped without processing. Data related to tourist visits to protected areas is yet to be documented through close monitoring and a sound management plan for conservation and management of these protected areas is highly needed. Installation of functional system equipped with advanced instrumentation for water purification and distribution to households is almost at the back foot in the entire state specially in rural areas.

Study on impact of tourists' influx on biodiversity is almost lacking in the state which is an important element for understanding the future implications of tourism and developing action plan accordingly.

Meghalaya

13.1 Introduction

Abysmal state of Municipal Solid Waste Management (MSWM) is quite apparent in all the states of India, and there can be no denial of the fact that grossly mismanaged waste littered everywhere is impacting the Himalayan environment and could create problems to human health (**Srivastava, et al.2020; Sharholy, et al. 2008**). The problem lies at every end, right from the source of waste generation to waste segregation, collection, transportation and to the very disposal of solid waste to dumping sites which could be any available sites at the steep slopes to the pristine banks of rivers in Indian Himalaya. The common practice of open dumping is seriously impacting the environment, even though the recent report by CPCB (**Annual Report on Solid Waste Management,2019-20, CPCB, Delhi**) projects an improved overall management of the MSW for India as space created due to gap in solid waste management gets filled-up due to the rise (increased from 19% in 2015-16 to 47% in 2019-20) in the solid waste treated and quantum of solid waste generated in the last five years (2015-2020).

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

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

- a) Mining activities causing severe water pollution
- b) Small stone crushing units as well as the cement industry are causing ecological imbalance
- c) Indiscriminate garbage dumping, disposal of domestic sewage, solid waste generated from the urban areas are deteriorating the environment,
- d) Air quality deterioration (PM10 levels) exceeded the NAAQS (annual average) at two stations namely, (i) Export Promotion Industrial Park (EPIP), Byrnihat, (Stn-III- Industrial area) and (ii) Umiam Industrial Estate, Ri-Bhoi District (Industrial area), and
- e) Under National Air Monitoring Programme (NAMP) monitoring network, 10 Ambient air quality-monitoring stations, and 54 stations in the State under the National Water Monitoring Programme (NWMP) covering rivers, lakes, springs/well and ambient noise level monitoring in capitol town of Shillong at three locations.

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

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

- a) Impact of Tourism on local economy in terms of income generation and employment creation was found to be positive.
- b) Audit observed that even after more than eight years of having a policy (Meghalaya Tourism Policy, 2011), no plans or targets (medium and long-term) was fixed for the Department/ DoT/ MTDC to fulfill the goals laid down in the important policy document.
- c) Infrastructure (Hotels and other amenities) created did not adhere to the important component of sustainability.
- d) Reliable dataset of tourist influx, people/households engaged in tourist sector rural tourism was found to be missing.
- e) The report mentioned that lack of medium term/ long term action plan and declining percentage of expenditure on the tourism sector, and ineffective implementation and management of tourism infrastructure projects have largely contributed to the reduction in the State's position in North Eastern states.
- f) Most importantly, it was found that no provision for solid waste management with incinerators and rain water harvesting could be physically verified in homestays/resorts which have received subsidy through Meghalaya Tourism Development and Investment Promotion Scheme, 2012 (MTDIPS).
- g) The audit report further highlights the non-compliance of CPCB/SCPCB order in installation of dustbin at Myntdu River to regulate the high pollution level in Myntdu River, Jowai Hills caused by the waste generated by tourism activity.
- h) The audit also highlighted many more shortcoming and departments may have addressed to some of the pertinent issues related to the long-term sustainability of the tourism as a driver of economic and environmental sustainability.

As per the Provision 24 (4) of the Solid Wastes Management Rules, 2016, the Central Pollution Control Board (CPCB) is required to prepare a consolidated annual report and forward it to Ministry of Environment, Forest and climate change. A rank based system is developed to categories the states and UTs based on Environmental performance using criteria's such as on waste processing, waste disposal and gap in the solid waste management. The state of Meghalaya could get only 37.5 marks

(Manipur and Mizoram scores 51 marks) due to treating only 9.64 ton/day **(8%)** out of 119.19 ton/day of collected solid waste and overall generated solid waste of 153.18 ton/day (Annual Report on Solid Waste Management (2019-20), CPCB).

13.1.1. Tourism growth in the state of Meghalaya:

According to the statistical records of the state of Meghalaya, the state has observed a substantial growth in the tourist influx, from the year 2008 to 2019 (Fig.. 13.1). With an influx of around 5.5 lakhs tourists (domestic and foreign), the state experienced a massive tourist arrival, with a growth of more than 100% (over 12 lakhs tourists) visited in the year 2019. Figure 13.1 shows the yearly statistics of the tourist influx (Source: Directorate of Tourism, Meghalaya and <https://www.ceicdata.com/en/india/resident-visits-by-states/visitor-arrivals-local-meghalaya>). Growth in domestic tourist arrival had been significant from 2016 onward and foreign tourist makes only 1% of the total tourist arrival in the state of Meghalaya. As compared to other NE states, after Assam, the state of Meghalaya was the second state witnessing the high tourist influx till 2017(nearly 10% of the total tourist influx in Northeastern states). But after the 2017, the state of Sikkim is holding the second position in terms of tourist arrival (15% of the total tourist influx in Northeastern states).

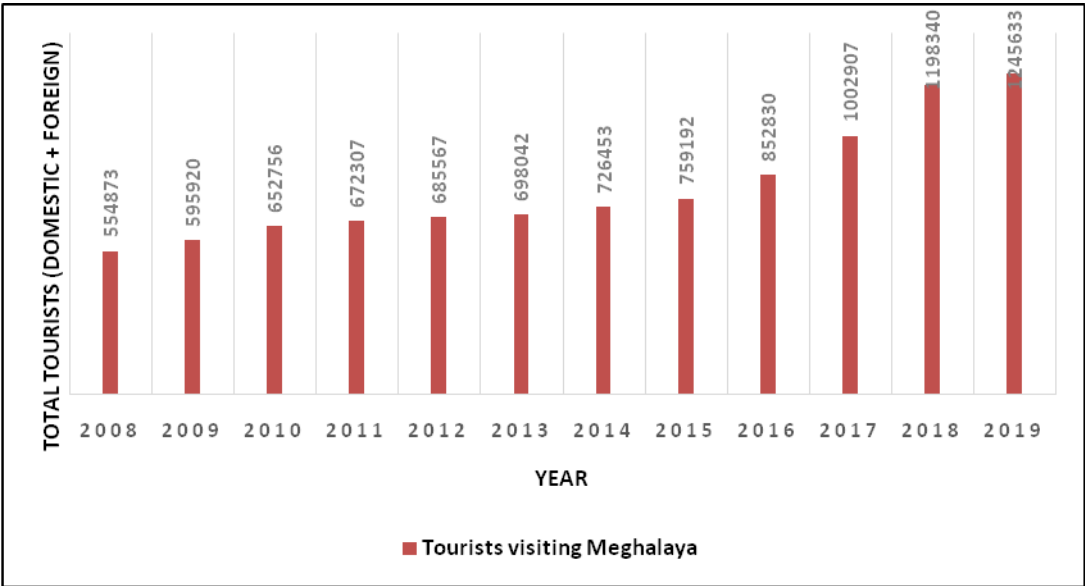


Fig.. 13.1 The graph showing the year-on-year growth of tourist influx in Meghalaya

13.1.2. Number of vehicles (state/district wise)

The total number of vehicles (government and private) registered in the state of Meghalaya from the year 2014 till 2017 is given in Fig.. 13.2.

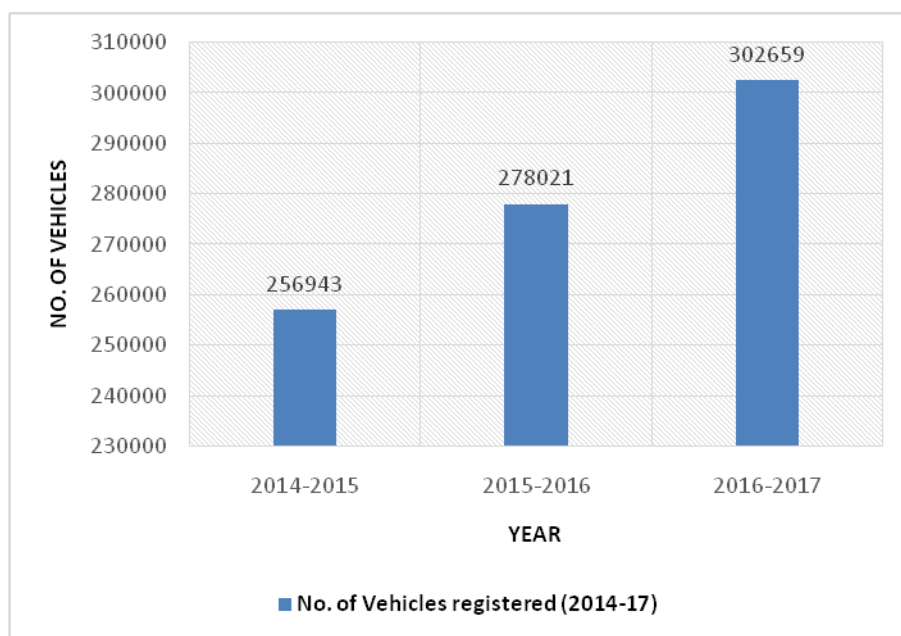


Fig.. 13.2. Number of vehicles registered in Meghalaya for the time span 2014-17.
(Source: Statistical document of Meghalaya 2019)

A substantial increase can be observed during the three time periods with vehicles on roads increasing from 2.5 lakhs in the year 2014-2015 to up to 3 lakhs in the year 2016-2017 and thus increasing by almost 18% in the state.

Table 13.1. Number of vehicles tested for the compliance to substances emission standards

Period	Type of Vehicles	Toatal no. of vehicles tested	Percentage of vehicles complying to emission standard	Percentage of vehicles non-complying to emission standards
01.04.2017 to 31.03.2018	Petrol-Driven LMV	10312	99.4%	0.6%
	Diesel-DrivenLMV	2371	98.5%	1.5%

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

High concentrations of Particulate Matter (PM₁₀) is observed at limited location (Annual Report 2018-2019, CPCB) which could be attributed to vehicular emission but as it can be observed from Table 13.1 majority of the vehicles, whether petrol driven or diesel, comply to the emission standards. Thus, indicating that vehicular pollution control measures are strictly followed in Meghalaya.

13.1.3. Assessment of waste generation/segregation and Waste disposal/ treatment facilities

An ENVIS Newsletter published in 2018 present an overall assessment of MSWM in the urban areas of Meghalaya. The state of Meghalaya is having seven urban local bodies (ULBs) namely, Shillong Municipal Board (SMB), Shillong Cantonment Board (SCB), Jowai, Tura, Williamnagar, Baghmara and Resubelpara. As per the Newsletter, 5 Municipal Boards have reported for implementation of MSW Rules (Shillong, Jowai, Tura, Resubelpara and William Nagar) and authorization was granted to 4 ULBs (Shillong, Jowai, Tura and Williamnagar). Six dumpsites are used for disposal of MSW namely Shillong, Shillong Cantonment, Jowai, Tura, Williamnagar and Resubelpara. The dumpsite of Shillong has been converted to landfill site. Ambient air, groundwater and leachate quality is being monitoring at Shillong dumpsite only. The Shillong Municipal Board collects 45TPD (Tons per Day) of Municipal Solid Waste and having an aerobic compost plant whereas the Tura Municipal Board is supported with vermin culture processing for biodegradable waste. Jowai MSW collects an average daily of 48 MT of MSW and dumps in the existing dump yard but do not have any facilities to proper management of MSW. Other two municipal areas collect less than 10MT of Solid waste and dump it in landfill site (William Nagar) and open dumping is practiced in Resubelpara and do not have waste processing facility. As far as the solid bio-medical waste is concerned which is generated from the medical facilities and should be incinerated properly through the incinerator but sadly, as reported, the incinerator installed was found non-functional and hazardous BMW disposed and burnt in the open at the dumping site that could seriously impact the environment and pose health hazards to the people.

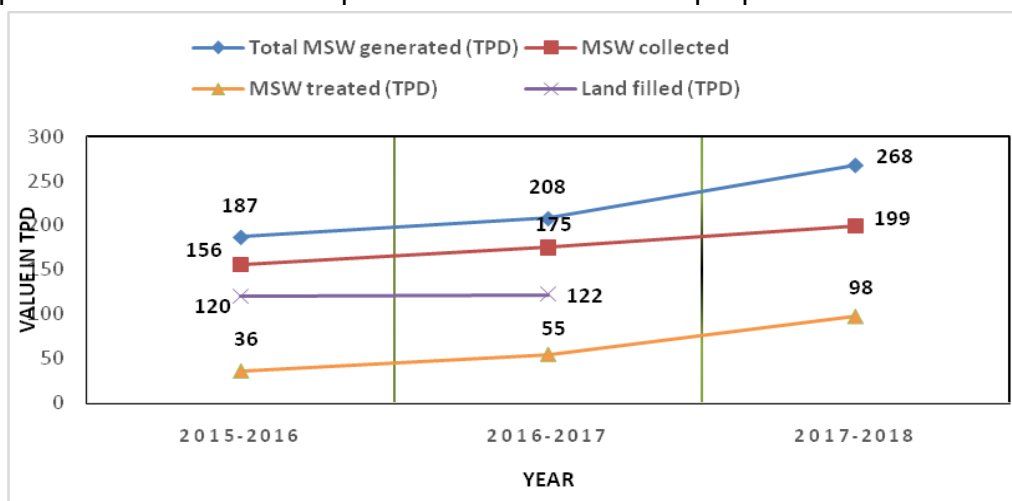


Fig.. 13.3. The assessment of the total municipal waste generated in tones per day in Meghalaya;
Source: <https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf>

The Newsletter also highlights that the dumping site affecting the overall public health at large including workers and rag pickers with its foul smell and smoke. Under the Swachh Bharat Mission a Sanitary landfill site of 170 TPD Compost Plant is created under the Shillong Municipal Broad.

Figure 13.3 highlights the total amount of municipal solid waste (MSW) generated, total MSW collected, treated and land filled per annum from the year 2015 to 2018. The data clearly show that the total amount of MSW that is generated throughout the state, only a fraction (37% in 2017-18) of the total volume collected is treated, and with each advancing year the quantities of waste generated have increased significantly. Considering for the year 2015-16, the total MSW generated was 187 TPD (tonnes per day) 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 & 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.

An inventory report (<https://nehu.ac.in/envis/files/inventory-hazardous-waste-2017.pdf>) on Hazardous Waste in Meghalaya highlights lack of a centralized hazardous waste management facility or in the neighboring State, and the units store their landfillable waste within their own premises in a concrete lined pit.

Per annum generation of hazardous waste from different dominant industrial sectors of the state is shown Figure 13.4. Zinc ash residue is the highest hazardous waste generated during the year 2016. The oil wastage and the acid residues as compared to zinc ash are quite nominal. However, the long term trend of hazardous waste generation could not be available.

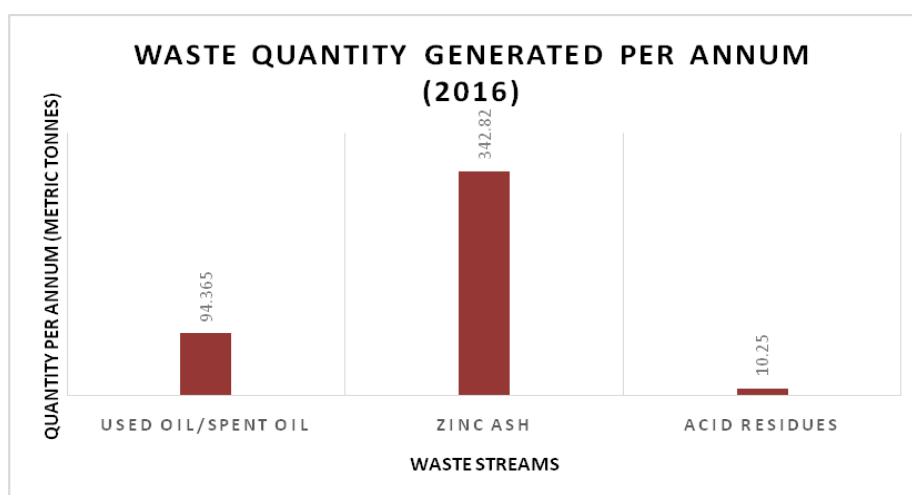


Fig.. 13.4. Hazardous waste inventory in Meghalaya

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

13.2. Impact on Air quality

The Meghalaya State Pollution Control Board monitors the air quality at ten different stations spread out in different districts. Quantities of Particulate matter (PM₁₀), Sulphur dioxide (SO₂) and Nitrogen dioxide (NO₂) released in the atmosphere is measured. The permissible limits as mentioned by the state pollution control board are mentioned as follows:

i) PM₁₀ – 60µg/m³, ii) SO₂ – 50µg/m³, and iii) NO₂– 40 µg/m³.

A graphical representation of the measured average air quality parameters of the stations for the Meghalaya state from the year 2010 to 2018. It can be observed that the year 2010 to 2014 as well as in 2016, the PM₁₀ emission had surpassed the permissible limits, with highest particulate matter of 106.78 µg/m³ emitted in the year 2010. The year 2014 emitted 62.175 µg/m³ and the year 2016 emitted 67.075µg/m³. The only years observing a dip in the values with the emission rate being below the permissible limit are 2015 and 2017 with PM₁₀ of 47.5 and 59.5 µg/m³, 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 µg/m³), while the lowest was only 2 µg/m³ recorded in the year 2014. Similarly, for NO₂, the maximum value was recorded in the year 2017 (11.27 µg/m³) and the lowest 9.025 µg/m³ 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 (Fig.. 13.5).

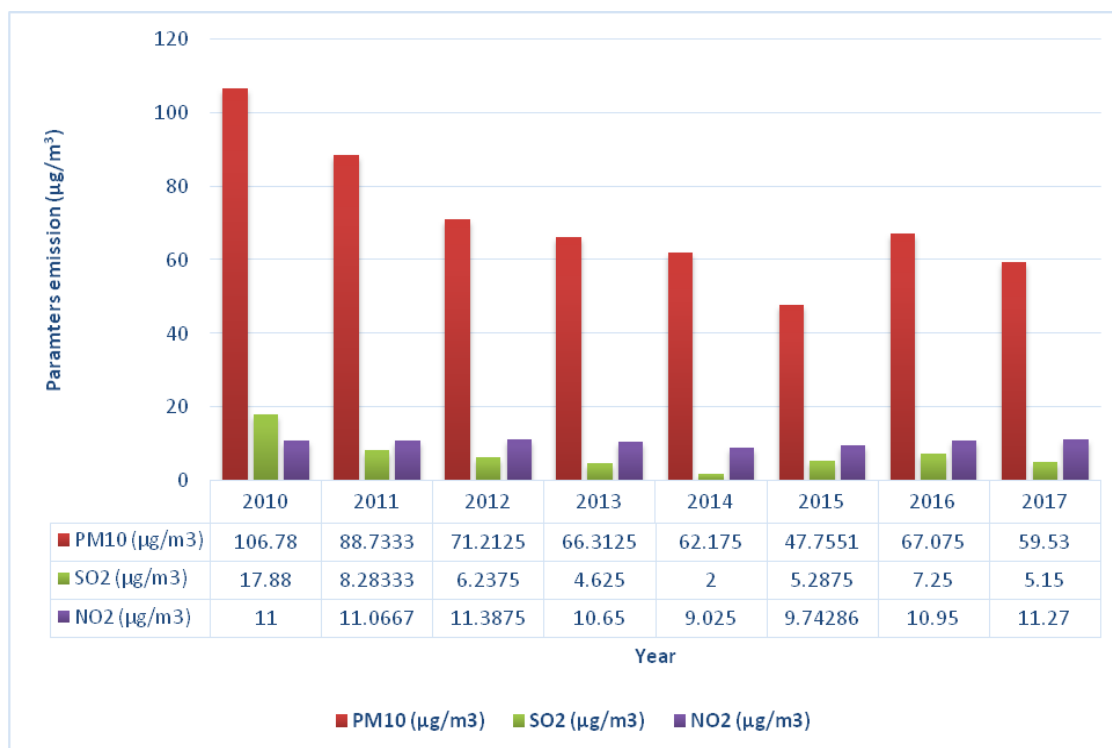


Fig.. 13.5. Average air quality parameter in Meghalaya (http://megspcb.gov.in/annual_reports.html)

13.3. Impact on surface and ground water quality

The state is endowed with several rivers and streams, which have comparatively smaller stretches but are quite important due to their water use for drinking, irrigation, industries, waste disposal etc. Surface and groundwater contamination have become a serious concern in the state in recent decades as a result of indiscriminate discharge of untreated municipal effluents, industries and mining effluents, agricultural runoff, open defecation, and dumping of solid wastes along river banks. The water quality of selected water bodies in Meghalaya is regularly monitored by the State Pollution Control Board as part of the National Water Monitoring Programme (NWMP).

Groundwater is an important freshwater resource that caters to the need of agriculture, industrial and domestic water demands. Water quality influences lives in many ways more than drinking. A total of seven ground water sources located all over the state are monitored by Meghalaya State Pollution Control Board. Monitoring stations quantifies the Iron, Fluoride concentration and Total coliform.

The permissible limits as mentioned by the Bureau of Indian Standards (IS 10500:2012) are mentioned as follows:

i) Iron – 0.3 mg/l, ii) Fluoride- 1.5 mg/l, and iii) Total Coliform: Nil/100ml

A graphical representation of the quantities of above mentioned water quality parameters in the monitored stations from the year 2010 to 2018 is shown in 13.6. There is no data recorded for iron and fluoride concentration during 2010 to 2012. The sources were affected by bacterial contamination which was probably caused by percolation of polluted surface water. As it can be observed that from 2010 to 2014 there is decrease in bacterial contamination. The concentration of Iron was recorded to be high at Ri-Bhoi district which was probably due to the geology of the area. The fluoride content at the hot spring, Jakrem (West Khasi Hills), was found to be high (more than 20 mg/l), as is typical of any hot spring. It can be stated that water quality is not alone based on the sources of pollution but also the parental rock material contributes to its quality.

As per the reports of Central Ground Water Board (CGWB) higher concentration of iron is reported in groundwater also. The presence of high iron content both in shallow and deeper aquifer is reported from some part of the Ri-Bhoi, West Khasi Hills, as well as in the East Khasi Hills districts. The comparison of iron content in shallow and deeper aquifer shows a higher concentration of iron in deeper aquifer than in shallow aquifer. Apart from iron, the other parameters are within the permissible limits. In Garo Hills, as per Ground Water Exploration, higher concentration of iron is reported in groundwater, where the depth of the well ranges from 113 to 202 m below ground level. Presence of iron in groundwater can be attributed to local geogenic causes. In Jaintia Hills, as per water quality analysis data, it was found that there is a very low pH value in most of the springs, and the iron and fluoride concentration are within permissible limit. Fluoride concentration is within permissible limit for all the districts.

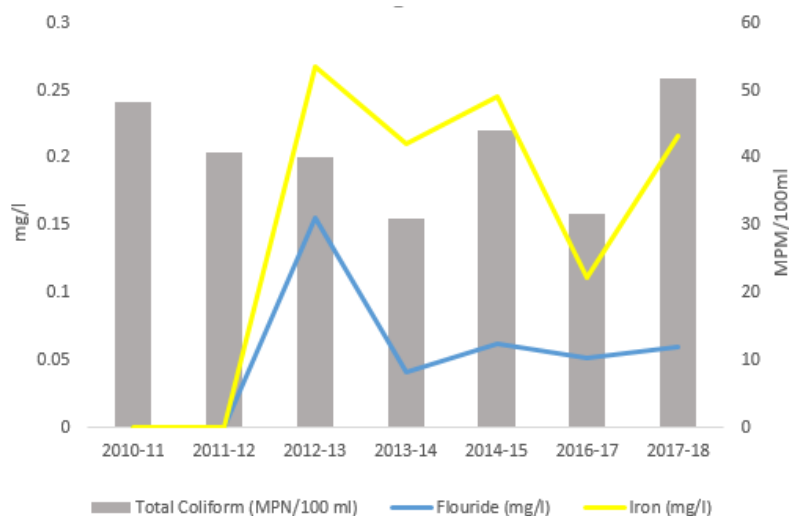


Fig.. 13.6. Groundwater Quality Monitoring 2010-18; (Source: Annual Reports: (2010-2018), Meghalaya State Pollution Control Board)

13.3.1. Surface Water Quality

The sampling stations of Meghalaya State Pollution Control Board for surface water quality monitoring are located in East Khasi Hills (17 Sampling stations), West Khasi Hills (8 Sampling stations), Ri-Bhrai (6 Sampling stations), Jaintia (8 Sampling stations) and Garo Hills (8 Sampling stations). Monitoring stations quantify BOD, Total Coliform and Ammoniacal Nitrogen. The permissible limits as mentioned by the Bureau of Indian Standards (IS 10500:2012) are mentioned as follows

- i) BOD – 5 mg/l ii) Total Coliform – Nil/ml (Shall not be detectable in any 100 ml sample)
- and iii) Ammoniacal Nitrogen – 0.5 mg/l

Graphical representation of above mentioned water quality parameters in these stations from the year 2012 to 2018 is shown in Figure 13.7. During the period 2012-18, the Bio-chemical Oxygen Demand in Ward's Lake, Umkhrah, and Umshyrpi Rivers was found to be greater than 3 mg/l. The overall coliform count in the Umkhrah and Umshyrpi rivers was found to be above 5000 mpn/100ml, which is quite alarming. The concentration of ammoniacal nitrogen in the Umkhrah and Umshyrpi rivers exceeds the permissible limit of 0.5 mg/l. These findings reveal that the predominant pollutants in the water bodies were organic and bacterial. This was primarily due to untreated waste water dumped directly from residential and business areas into the water bodies. The amount of waste collected by the two rivers, the Umkhrah and Umshyrpi, was far in excess of their capacity to absorb it, causing the water quality to deteriorate to the point where the water of these rivers is now unsafe to drink. In Nongstoin, the BOD was found to be above 3 mg/l and the total coliform count was found to be above 500 mpn/100ml. The river, which runs through the heart of the West Khasi District headquarters, has been contaminated by direct trash disposal from residential and business areas, vehicle workshops and service centers, and agricultural runoff.

In the Ri-Bhoi District the total coliform count in the water bodies was also observed to be high. The Umiam Lake received the waste that was generated in the Shillong city through the two rivers,

Umkhrah and Umshyrpi whereas the Umtrew River is subjected to pollution originating from the residential, commercial and industrial areas.

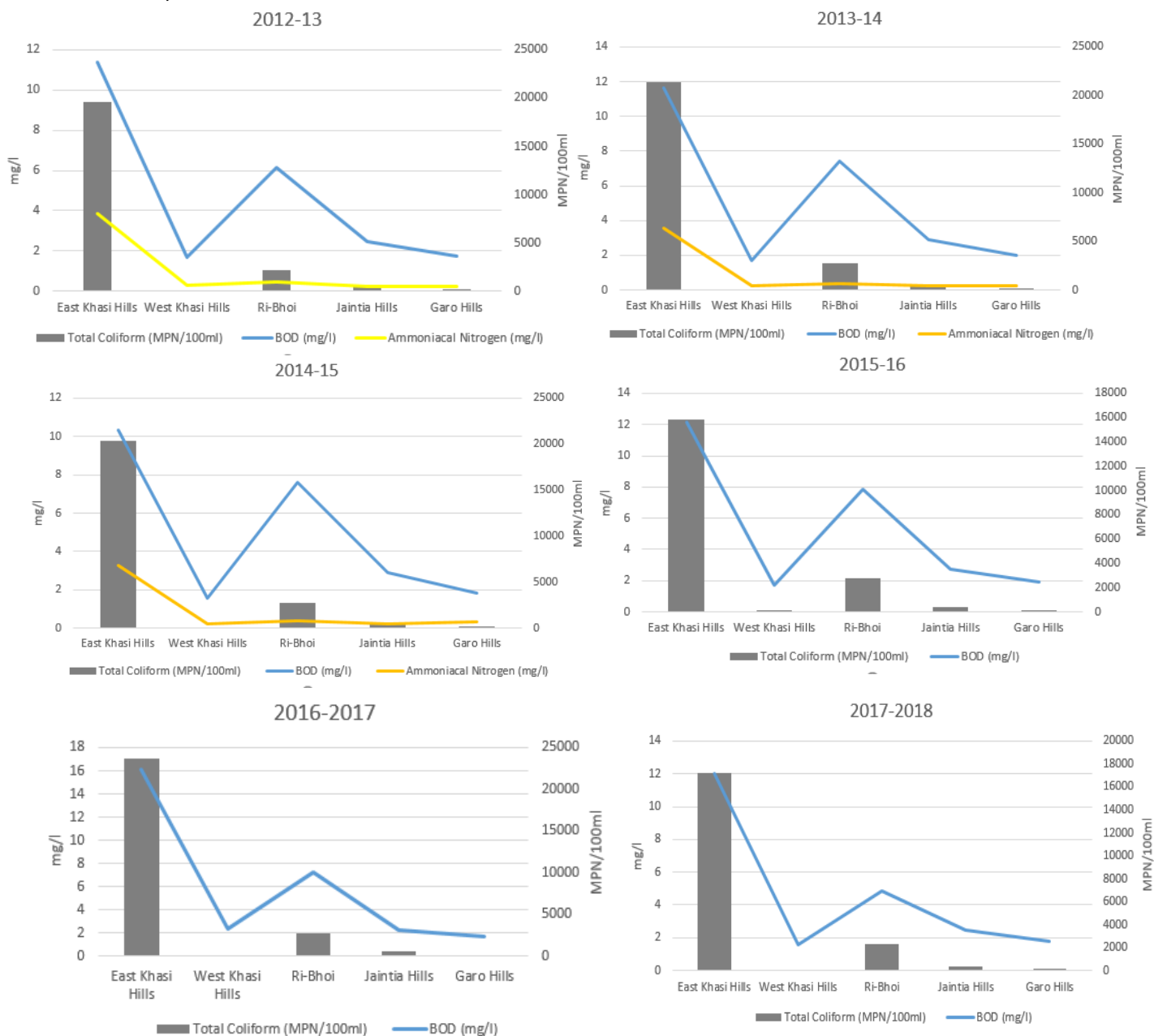


Fig.. 13.7. District wise surface water quality for 2012-2018 in Meghalaya (Source: Annual Reports (2012-2018), Meghalaya State Pollution Control Board).

13.4 Impact on Forest and Biodiversity

According to the forest reports generated by Forest Survey of India in the year 2017, the state of Meghalaya ranks 4th in the country in terms of forest cover. The forest covers an area of 17,146 square kilometers, occupying 76.44% of the total geographical area of Meghalaya. Majority of the area is covered by open and moderately dense forests, only 21% of the area falls under the non-forest

category. Out of the 17,146 km² of the total forest area, 626.55 km² of the area is under reserved forests while 12.39 km² falls under protected forests category under the East Khasi Hills, Ri-Bhoi district, and Shillong jurisdiction.

13.4.1 Groves of Meghalaya

A total of 125 sacred groves are in the state with Mawphlang sacred grove, encompassing an area of around 78 hectares, located in the East Khasi Hills district, and internationally acclaimed as an important and educational tourist center. Sacred groves also referred as 'virgin forests' which are left untouched and protected by the local inhabitants due to their cultural beliefs. According to the FSI report the sacred groves in the present times are facing threats and mainly because of the changing lifestyles of the tribal people. The threats mentioned in the report are:

1. The area under sacred groves is shrinking and few of them have been turned into degraded forests. Sacred groves in Meghalaya are now increasingly coming under threat as the tribal way of lifestyle is changing. The deterioration of sacred groves in recent times is a matter for concern.
2. Some sacred groves though protected in the past have fallen prey to encroachments and degradation. (http://www.megforest.gov.in/forest_sacredgroves.html).

13.4.2. Impacts on Forests:

Two interesting reports published by FRI and Rain Forest Research Institute, Indian Council of Forestry Research & Education, Dehradun points towards the drivers of deforestation as well as the threat to biodiversity in the biologically rich state of Meghalaya. The causes are forest cover depletion and loss of biodiversity could be shifting cultivation, wood collection, mining, population increase and settlement expansion, and fragmentation of community forests. However, the net change in the forest cover for the entire state of Meghalaya is very minimal but negative change in the most dominant class of forest, i.e. the area under moderate dense forest has decreased over a period of 2011-2017. However, none of the reports have mentioned tourism or tourism related activities impacting the forest and biodiversity.

13.5 Eco-sensitive zones

Nongkhyllem Wildlife Sanctuary and Narpuh Wildlife Sanctuary are classified as Eco-sensitive Zone and notified by the Ministry of Environment, Forest and Climate Change (MoEF& CC) in the year 2017. Nongkhyllem Wildlife Sanctuary Eco-sensitive Zone and the Reserve Forests are classified as a global bio-diversity hot spot under the Eastern Himalayan Endemic Bird Area. The Narpuh Wildlife Sanctuary Eco-sensitive Zone in East Janita Hills Jowai, Meghalaya having an area of 194.23 Sq.km. A Zonal Master Plan is prepared in consultation with all the concerned State Departments, for integrating the ecological and environmental considerations of an eco-sensitive zone. The Department of Tourism in consultation with State Departments of

Environment and Forests should prepare a Tourism Master Plan which should form a component of the Zonal Master Plan (http://www.megforest.gov.in/wildlife_zones.html).

13.6 Summary

13.6.1 Gaps & Plan of Action

- Tourism is benefitting the local economy and substantial growth is anticipated in Meghalaya in future which need proper strategies of management to safeguard the environment.
- The mining (coal and limestone query) {which recently the NGT has taken a strong action against the state Government } should have proper monitoring mechanism in terms of Air, Water(SW& GW) and Noise pollution and status of environment should be periodically reviewed after regular inspection by the concerned state authorities.
- The present impacted area due to unscientific mining should have remedial measures like filling of mine pits, channeling of acidic seepage for checking AMD contamination of water bodies and crop fields, extensive afforestation, neutralization of acidity, conservation of topsoil etc. coupled with scientific management of present day mining operations.
- Regular solid waste quantification by municipal bodies and assessment of the composition of solid waste generated is very essential to recommend different scientific measures for management of urban solid waste and its reuse. Municipal bodies should stop open dumping of solid waste and biomedical waste should be incinerated to avoid pollution in the downstream areas, and reservoirs/water bodies.
- Ground water in the area is generally good and suitable for drinking, domestic and industrial use. However, concentrations of greater than 1 mg/litre iron in ground water in some pockets have been reported. The presence of iron in drinking water should be managed through proper filtration technique.

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 once the planned approach to tourism development is adopted. Ideally, a plan should be implementable in practice. However, planners are frequently challenged by the fact that their choices “are nuanced and have to balance idealism [what ought to happen by and for society] with pragmatism [what can happen with private sector investment]”. In the IHR, ‘tourism planning research gap’ exists due to tourism often being naively and incorrectly viewed in prospective of ‘marketing and promotion’ avoiding the fact of ecological sensitiveness of the areas. Therefore, for an effective implementation of sustainable tourism, identified gaps in the IHR which require future action are suggested.

Some common suggested action for the entire IHR may include: estimation of tourist carrying capacity, promotion of green tourism, accelerate the decarbonisation of tourism operations, carbon taxes, biofuel subsidies - vehicle purchase subsidies, planning and zoning restrictions, restriction on use of vehicles in eco-sensitive areas, feed-in-tariffs for renewable energy - capital subsidies and insurance for 1st generation Carbon Dioxide Capture and Storage (CCS), establishment of proper waste segregation and management systems in tourist spots, establishment of eco friendly bio-digester toilets in high altitude trek routes, etc.

Ladakh

- *Pangong Tso lake, Nubra and Siachen Valley, Kargil, Drass*, world's highest motorable road (*Umlingla Pass*; 19,024 feet), along with some of the most popular monasteries, such as *Hemis, Alchi, Lamayuru, Shey and Thiksay etc.* are famous tourist places in Ladakh which require carrying capacity study for developing a planned infrastructure and amenities in consultation with diverse user groups.
- Protected areas (like *Hemis National Park, Changthang Cold Desert Sanctuary* and *Karakoram Sanctuary*) require vigilance and regular patrolling to reduce unwanted wildlife-tourist interaction, habitat destruction due to off-road driving, and encroachment. Simultaneously, there is a need to promote wildlife-based tourism along with periodic assessment of such activities on the natural habitat of wild flora and fauna.
- With high influx of tourists in *Chadar trek* (on frozen River 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.
- Projects like *Tsangda* should be promoted for the sustainable tourism development in the region.

Jammu & Kashmir

- Lakes like Dal, Wular, Manasbal, Nigeen, Anchar, Hokersar, Mansar, Surinsar, Sanasar, Gharana etc. are interspersed with a large number of groundwater springs. Thus, conservation and effective management of these lakes through third party monitoring need to take action on priority.
- Studies on water quality assessment of wetlands around Srinagar (i.e. Anchar, Dal, Brari Nambal, Gilsar, Khushalsar, Hokersar, etc.) are required as these have witnessed a significant reduction in the surface area and the water quality has been deteriorated since 1970's to the present period.
- Prior monitoring of carrying capacity in terms of tourist inflow of vehicles, air quality and solid waste management largely in the Kashmir region or pilgrims visiting Shri Amarnath Ji holy cave and Mata Vaishnav Devi in Jammu need to be done to ensure quality tourism in the state.
- Regular air quality monitoring at tourist spots of Jammu region (namely Patnitop, Sanasar, Mansar, Surinsar, Puthi-Basohli and pilgrims' sites, etc.) and in Kashmir Valley is required.

- Wilderness areas like National Parks and Sanctuaries in Jammu & Kashmir are used as if picnic spots for tourists. So these need to be strictly controlled to preserve biodiversity heritage.
- Proper database needs to be prepared on the impacts of the tourism activities on the wildlife and biodiversity of the state.

Himachal Pradesh

- Shimla, Kullu, Kangra, Lahual & Spiti, Chamba, Kinnaur, etc. districts are famous tourist destinations where mass tourism has been prevailing. Here, there is an ample scope for regulation in developing sustainable tourism within a carrying capacity. In view of discouraging mass tourism, there is a need to create theme-based tourism such as eco-tourism, agri-tourism, snow tourism, adventure tourism, pilgrimage tourism, culture and heritage tourism, health and wellness, etc.
- Assessment of carrying capacity of popular tourist places like Chandra tal, Pin valley, Great Himalayan National Park (GHNP), etc. would maintain the spots sustainably. Decentralization of tourists from surrounding tourist resorts to tiny spots or from overcrowded destinations could be other ways for developing responsible tourism or ecotourism. Development of new tourist sites would minimize the problem of over-crowding.
- Implementation of efficient solid waste management system need to be strengthened with upgraded technologies or methods under waste to energy recovery systems. In view of making budgetary provision for the same, green tax is being collected from the tourists upon entering into tourist spots like Shimla, Manali and Dharmshala.
- In view of minimizing air pollution, introducing clean fuel buses like electric buses need further to expand. These have already been in use at Rohtang Pass (3978m) and other different routes in Himachal Pradesh.
- NGOs need to be involved in conducting public awareness programs on waste minimization, substitution and management among different stakeholders including tourists. Also, proper signboards would go a long way in making aware the public.

Uttarakhand

- Online registration of all the upcoming tourists irrespective to ages to major sensitive and fragile tourist locations need to be done at an entry place. The purpose of tourists (adventure, wellness and health, ecotourism, wildlife tourism, etc.) may be incorporated under the online registration. There is a need for mentioning the details separately private or commercial vehicles.
- Clean fuel energy based vehicles like electric vehicles could be one of the ecofriendly options for minimising vehicular pollution in the fragile tourist spots like Nainital, Mussorrie, etc.
- Air and water quality monitoring should be done on continuous basis and waste management practices need also to be followed as per the action plan of the ESZ.
- More sewage treatment facilities (9 STPs operational in Ganga priority towns as envisaged under NamamiGange project) need to be introduced. This step would be able to save river system from the repercussions of unsustainable tourism and purification units for grey water to set up at major resorts or hotels. Further, this step may be used for landscape management and would stop the wastage of fresh water.

- The commercial vehicle drivers/owners should be trained for not allowing the tourists to throw their garbage on roads or any other open places. Ban on plastic need to be properly imposed as per guidelines in various tourist stations.

Sikkim

- There is an urgent need to consolidate all existing missions (Sikkim Tourism Mission-2015) and plans. This step together with strong participation of the different tourism stakeholders would develop a 'Policy' for sustainable Sikkim Tourism.
- Carrying capacity assessment is needed carefully 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 for the long-term appropriate use of natural and human resources.
- Research Initiative (e.g. Tsomgo Pokhri Sanrakshan Samiti) for protection and conservation of the lake, cleanliness drive at YuksumDzongri in KNP, garbage monitoring for tourist at parks, and complete ban on construction in Eco-sensitive zones have already been under process which further need to be encouraged in different ways. Its few examples are: staff training, involvement of local people and making aware, through education, and marketing tourism, etc. These steps could further minimize the impact of mass tourism.
- Wildlife depletion has to be checked and to be increased in their numbers by appropriate conservation programmes. Also, there is a need for improvement in other related infrastructure in view of maintenance of the Sikkim eco-tourism.

West Bengal, Darjeeling Hills

- As Darjeeling has been facing a problem of ill managed traffic, so it is necessary to control the number of tourists through exploring threshold value. This step would care capacity of the tourist places / eco-sensitive zones.
- There is a need of biomethanation composting for wet waste and more waste disposition centres for managing the bulk waste generated due to growth of urban population and tourist inflow in the hills.
- Continuous monitoring air quality is required for knowing the status of emissions in the hills., The study conducted by Sarkar et al. (2015) showed that there is a high concentration values of Black Carbon (BC) observed during pre-monsoon season and winter season (2010-2011). This study reflects that the direct influence of tourist activities on air quality is due to high inflow of tourists in Darjeeling and surrounding areas.
- There is a need to protect biodiversity of the national park (Singalila NP, home to the Red Pandas). Here, tourist inflow was observed more than its carrying capacity.
- Nature based tourism may have long lasting benefits only if the environmental loss are controlled. The eco-friendly planning process is required for promotion and sustainable development in tourism industry.

Assam Hills

- Complete inventory and documentation of wild flora and fauna is required. Extensive field-based research and consultation with local stakeholders for documentation of the Hills would further help documentation of biodiversity in the region.
- Community-Based Tourism (CBT), enhancing local people's involvement and participation in tourism planning and development in their areas would help in uplifting the status of tourism. It has been observed that such activities would have a positive impact on the social, economic, and environmental conditions of the tribal communities of Assam.
- Proper monitoring is required for air pollution to assess its impact on tourism.
- Waste management is another challenge that a hill is facing, proper segregation, and disposal method is needed under waste to energy initiatives.
- Expansion in the institutional capacity of local government for climate change planning will require adaptation planning, based on NDC and SDGs implementation.

Arunachal Pradesh

- Carrying capacity, management of resources, conservation of cultural and environmental asset is required in the state for sustainable tourism.
- The state's concerned department has started collection of domestic waste in major townships but its disposal/dumping is unplanned. Therefore, there is a need on designing proper infrastructure for proper waste disposal and its treatment so that the impacts on environment (water, soil, ecosystem etc.) can be minimised. Proper waste management is also directly related to the tourism sector, so a clean and safe state Arunachal Pradesh will attract more tourists.
- Arunachal Pradesh is among the states which has very rich biodiversity and this natural wealth is one of the main attractions for tourists (especially foreigners). However, the state is facing challenges like deforestation, urbanization and other developmental activities which are damaging the forest cover and biodiversity of the state. Climate change is another threat to the biodiversity of the state. Thus, it is strongly recommended to immediately adopt appropriate strategies which may help in conserving biodiversity of the state and at the same time promote future adaptation to deal with climate change impacts.
- This state is already having its 'State Eco-tourism Policy' in place. However, the tourism sector in Arunachal Pradesh could not develop at its hub as 'eco-tourism destination'. Efforts should be made to make Arunachal Pradesh as a hub for community driven eco-tourism. The people and government agencies can work together to make it a success.
- It is recommended to establish a system in state which can help the government to gather categorical information on cost-benefit (environmental and economic both) due to tourism sector only. At present, there is no any such system in place. That's why it's very difficult to assess direct impacts of tourism. Generation of reliable knowledge (scientific data) is always essential to understand the magnitude of issues, so all the concerned departments should have a well-established mechanism to regularly collect data and keep it updating regularly so that this can be used in proper studies and planning.

- Arunachal Pradesh, owning a very distinct landscape, has a very special value for the nature lover. 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 also to be promoted.

Nagaland

- Strengthening community-based tourism (e.g. Khonoma Green village, and Touphema Heritage village practice community tourism management) and developing Eco-Tourism models with participation of local people and government departments in several tourist spots in Nagaland is a need of the hour.
- Plantation of native trees, creation and maintenance of natural parks and greenery should be made a priority in urban areas such as Dimapur, Kohima city, etc. in Nagaland.
- Focus should be on expansion of protected area network and augmentation of wildlife protection.
- Waste management (sewage and solid waste) seems to be one of the major issues related to environmental pollution in Nagaland. The study elaborates that the major reason for water pollution in Dimapur city is sewage/waste water. Likewise, Kohima municipal council dumping site is a major source of water pollution. Therefore, the state government should immediately act on designing proper infrastructure to deal with alike important issues.
- In view of actions being taken and future strategies development, studies need to be conducted linking growth of tourism along with environmental problems, such as, waste generation, sewage treatment facilities and loss of forest and biodiversity.

Mizoram

- Green taxes/cases may be levied on tourist vehicles similar to some other resorts.
- The collected green tax needs to be spent on maintaining the sanctity and serenity of the tourist destinations in state. Further, it can be utilized in improving solid waste management infrastructure such as resource recovery centres, engineered landfill areas, etc.
- Prior online registration can be made mandatory for tourists visiting the state especially in the eco-sensitive zones/areas to ensure quality tourism in a sustainable manner. For example, our neighboring hill country like Royal government of Bhutan is also following this approach to promote quality tourism in the country and ensuring equitable benefit sharing to the home stay owners.

- Assessment of carrying capacity of tourist destinations, eco-sensitive zones and major cities will help a lot in managing the tourist influx and catering them in order to promote quality tourism in the state.
- Installation and/or improvement of air quality monitoring stations, solid waste management units and water quality monitoring systems at district level can be done in order to sustain the healthy ecosystem of the state.

Manipur

- Manipur lies in the biodiversity hot spots region of the world, hosting many important, rare, and endemic species. However, hilly areas of the state are characterized by poverty and food insecurity. The important traditional knowledge associated with the flora and fauna are vanishing before being scientifically investigated. Therefore, proper documentation of this wealth of the state should be a prerequisite prior to tourism management in the state.
- Some of the main threats to biodiversity are forest fire, fuel wood collection, hunting bush meat, indiscriminate agri-chemical uses, and lack of awareness. Capacity building programs need to be organized to sensitize the resident community towards the importance and intangible services of the biodiversity.
- Proper solid waste management systems through capacity building, infrastructure development (such as engineered landfill areas, resource recovery centres, biodegradation mechanism, etc.), waste recycling needs to be done in order to attract tourists and its sustenance.
- Assessment of carrying capacity of tourist destinations, eco-sensitive zones and major cities needs to be done in order to manage the tourist influx and catering them in order to promote quality tourism in the state.

Meghalaya

- Data related to tourist visits to protected areas is yet to be documented through close monitoring and a sound management plan for conservation and management of these protected areas is highly needed.
- Installation of functional system equipped with advanced instrumentation for water purification and distribution to households is almost at the back foot in the entire state especially in rural areas.
- Study on impact of tourists' influx on biodiversity is almost lacking in the state which is an important element for understanding the future implications of tourism and developing action plan accordingly.
- Some facility for processing of garbage exists (e.g. Debendra Chandra Nagar Dumpyard), but proper scientific and sufficient information about processing should be provided.

Concusion

There has been increasing concern over the sustainability of the tourism industry. Tourism in the Himalayan ecosystem is normally blamed for contributing to several environmental challenges, including carbon emissions that lead to global warming and ultimately climate change. On the other hand, tourism had been featured in at least three SDGs–SDGs 8 (Decent Work), 12 (Sustainable Consumption and Production) and 14 (Life in Water). In the Indian Himalayan Region, growth of the tourism industry is extensive in the states of West Bengal, Uttarakhand, Himachal Pradesh followed by other states. Simultaneously, adverse impacts being depicted in the IHR, include: increased waste generation, increased vehicles, increased waste disposal into rivers. These together have led to degradation of the soil, water and air quality over a period of time.

Therefore, establishment of regulated tourism practices with promotion of sustainable agendas are required for the IHR. This could be achieved through maintenance of the proper tourist capacity in every tourist place of the IHR which will in turn minimize mainly the generation of solid waste, and pollution level in the water, air and destruction of biodiversity. Some of the successful ecofriendly representative illustrations in this regard include: measures taken by the Himachal Pradesh Govt. (e.g. vehicles regulation rules on Rohtang Pass), Hon'ble High Court Uttarakhand, Nainital (maintenance of 200 tourists per day for bugyal (alpine pastures)), the Sikkim Govt. (ban in disposable plastic bags in Sikkim), etc. Further, state specific adaptation measures in this regard are described under the recommendation section of the report. These include: levying green tax/cases on tourist vehicles, renewable energy-based vehicles, proper solid waste management systems, installation of equipment's with latest technologies for air quality monitoring, strengthening community-based tourism, etc. Ultimately, establishment of responsible and sustainable tourism is a need of the hour for the Himalayan region which will have a large future impact in the socioeconomic well-being of the entire area.

On the basis of the available information, the direct impact of tourism on the persons' economic prosperity and environmental impact is therefore difficult to justify the statement, "Tourism has brought economic prosperity to the Himalayan region, but the environmental cost has been catastrophic". In some of the over-crowded and mass tourism circuits within Himachal Pradesh and Uttarakhand, some pockets might have gained economic prosperity due to tourism but this could not be true in case of every state of the IHR particularly the north-eastern states. It is therefore recommended to conduct more focused studies in terms of economic growth, environmental cost, and tourist carrying capacity to fill up these gaps in the north-eastern states in particular and other remaining states/UTs in general.

Bibliography

- Aayog, N. I. T. I.. 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) (2018).
- Action Plan for Control of Air Pollution in Non-Attainment City of Dimapur City and Conglomerates, Nagaland. *Air Quality Monitoring Committee, Nagaland* 1-14. <https://npcb.nagaland.gov.in/?p748> (2019).
- Action Plan for Municipal Solid Waste Management Himachal Pradesh, Government of Himachal Pradesh Directorate of Urban Development 6-16 (2017).
- Action Plan for Non-Attainment Towns/Cities with Respect to Air Quality Management in Kohima City, Nagaland. *Air Quality Monitoring Committee, Nagaland* 1-13. <https://npcb.nagaland.gov.in/?p735> (2019).
- Action Plan for Rejuvenation of Polluted River Stretches Priority III/IV/V in Nagaland. *River Rejuvenation Committee* 1-15. <https://npcb.nagaland.gov.in/revised-action-plan-for-rejuvenation-of-polluted-river-stretches-priority-iiiivv-in-nagaland/> (2019).
- Action Plan for Rejuvenation of River Dhansiri, Dimapur, Nagaland. *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/> (2019).
- Aienla & Sarma, T. R. 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 (2014).
- Aman Thakur, Sareeka Kumari¹, Shruti Sinai Borker, Swami Pragya Prashant, Aman Kumar and Rakshak Kumar. Solid Waste Management in Indian Himalayan Region: Current Scenario, Resource Recovery, and Way Forward for Sustainable Development Frontier in Energy Research doi: 10.3389/fenrg.2021.609229 (2021).
- Angermeier, P. L. The Natraul Imperative for Biological Conservation, *Conservation Biology* 14 (2), 373-381 (2001).
- Annepu, R. K. Sustainable solid waste management in India. *Columbia University, New York*. 2(01) 1-189 (2012).
- Annual Administration Report 2018-2019. Forest Environment Department, Government of Sikkim. <http://sikenvis.nic.in/WriteReadData/UserFiles/file/Annual%20Administrative%20Report%202018-19.pdf>. (2019).
- Annual Final Report of 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 (2015).
- Annual Report 2019-20 on 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 (2020).

- Annual Report For the year 2018-19 on Implementation of Solid Waste Management Rules (As per provision 24(4) of SWM, Rules, 1989) 1-63. https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf (2019).
- Annual Report under SWM rules 2016, Directorate of Urban Development, Government of Himachal Pradesh, 2-79 (2017-2018).
- Annual Report under SWM rules 2016, Directorate of Urban Development, Government of Himachal Pradesh, 6-85 (2018-2019).
- Annual Report under SWM rules 2016, Directorate of Urban Development, Government of Himachal Pradesh, 2-82 (2019-2020).
- Annual Report under SWM rules 2016, Directorate of Urban Development, Government of Himachal Pradesh 3-107 (2020-2021).
- Anonymous 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 (2018a).
- Anonymous 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 (2018b).
- Anonymous Gazetteer of Darjeeling District-*Government of India, West Bengal* <https://archive.org/details/dli.ministry.08794> (1980).
- Arrawatia, M. L. & Tambe, S. Biodiversity of Sikkim - Exploring and Conserving a Global Hotspot. Information and Public Relations Department, Government of Sikkim 542 (2011).
- Assessment of Noise Pollution in the State of Manipur: *Manipur Pollution Control Board* 1-32 (2007)
- Audit Report on 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>) (2019).
- Banu, S. Effects of tourism on natural environment of the hilly region of Darjeeling. *Journal of Emerging Technologies and Innovative Research* 6(1), 369-375 (2019).
- Bashir, S. & Goswami, S. Tourism induced challenges in municipal solid waste management in hill towns: Case of Pahalgam. *Procedia Environmental Sciences* 35, 77-89 (2016).
- Basu, S. R. 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> (2006).
- Bhat, B. A., Ahmad, R., Fazili, M. F., Haq, I.U. & Bhat, G. A. Threatened Fauna 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 997–1009 (2020a).
- Bhat, M. Y. & Bhatt, M. S. 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: [10.1002/app5.266](https://doi.org/10.1002/app5.266) (2019).
- Bhat, R. A., Dar, G. H., Jehangir, A., Bhat, B. A. & Yousuf, A. R. 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 (2012).

- Bhat, S. A. & Pandit, A. K. Surface Water Quality Assessment of Wular Lake, A Ramsar Site in Kashmir Himalaya, Using Discriminant Analysis and WQI. *J. Ecosyst.* 724-728 (2014).
- Bhat, S. U., Dar, S. A. & Hamid, A. A critical appraisal of the status and hydrogeochemical characteristics of freshwater springs in Kashmir Valley. *Sci. Rep.* 12, 5817 (2022).
- Bhat, S. U., Mushtaq, S., Qayoom, U. & Sabha, I. Water Quality Scenario of Kashmir Himalayan Springs—a Case Study of Baramulla District, Kashmir Valley. *Water. Air. Soil Pollut.* 231, 454 (2020).
- Bhattacharya, S., De, S., Shome, A. & Dutta, A. Socio-environmental survey of a forest hamlet proximate to Neora Valley National Park in the Eastern Himalayas, India. *Indonesian Journal of Environmental Management and Sustainability* 3(1), 1-13 (2019).
- BIS -(Bureau of Indian Standards). *Indian Standards, Drinking Water Specifications*, 2nd Revision, IS10500: 2012, 1-4 (2012).
- Bisht, L., Gupta, V., Singh, A., Gautam, A. S. & Gautam, S. Heavy metal concentration and its distribution analysis in urban road dust: A case study from most populated city of Indian state of Uttarakhand. *Spatial and Spatio-temporal Epidemiology* 40, 100470 <https://doi.org/10.1016/j.sste.2021.100470> (2022).
- Bisht, N. S., Naithani, H. B. and Garbyal, S. S. Bamboos of Mizoram. *Environment and Forest Department, Mizoram* 206 (2010).
- Central Ground Water Board (CGWB). *Ground water quality data for Different districts of H.P* <http://cgwb.gov.in/wqreports.html> (2010-2018).
- Central Pollution Control Board (<https://cpcb.nic.in/namp-data/>) 1-12. https://cpcb.nic.in/uploads/NAMP_Data_for_2011_to_2015.pdf (2015)
- Central Pollution Control Board. *National Ambient Air quality standards* 1-164. https://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf (2009)
- Chakrabarty, P. & Sadhukhan, S. K. Adventure tourism spectrum, environment and livelihood opportunities: a case study in southern Singalila trekking corridor of Indo-Nepal border. *Geo-Journal of Tourism and Geosites* 26(3), 1092–1104 (2019).
- Chatterjee, R. Municipal solid waste management in Kohima city-india. *Journal of Environmental Health Science & Engineering* 7(2), 173-180 (2010).
- Chettri, A. 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 (2019).
- Chettri, N. & Sharma, E. Assessment of natural resource use patterns: a case study along a trekking corridor of Sikkim Himalaya. *Resource, Energy Conservation* 3, 21-24 (2006).
- Chettri, N., Sharma, E., Deb, D. C. & Sundriyal, R. C. 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 (2002).
- Cole, V. & Sinclair, A.J. Measuring the Ecological Footprint of a Himalayan Tourist Center, *Mountain Research and Development* 22(2), 132-141 (2002).

- Consolidated annual review report on implementation of solid waste management rules, 2016. Annual review report: 2015-16, Central Pollution Control Board (Ministry of Environment & Forests) 10-63(2017).
- Consolidated annual review report on implementation of solid waste management rules, 2016. Annual review report: 2016-17, Central Pollution Control Board (Ministry of Environment & Forests) 1-50 (2018).
- Consolidated annual review report on implementation of solid waste management rules, 2016. Annual review report: 2017-18. Central Pollution Control Board (Ministry of Environment & Forests) 10-45 (2019).
- Consolidated annual review report on implementation of solid waste management rules, 2016. Annual review report: 2018-19, Central Pollution Control Board (Ministry of Environment & Forests) 1-56 (2020).
- Consolidated annual review report on implementation of solid waste management rules, 2016. Annual review report: 2019-20. Central Pollution Control Board (Ministry of Environment & Forests) 1-60 (2021).
- Consolidated annual review report on municipal solid wastes (management and handling) rules, 2000 annual review report: 2010-11, Central Pollution Control Board (Ministry of Environment & Forests) 19-55 (2012).
- Consolidated annual review report on municipal solid wastes (management and handling) rules, 2000 annual review report: 2011-12, Central Pollution Control Board (Ministry of Environment & Forests) 20-49 (2013).
- Consolidated annual review report on municipal solid wastes (management and handling) rules, 2000 annual review report: 2012-13, Central Pollution Control Board (Ministry of Environment & Forests) 15-39 (2014).
- Consolidated annual review report on municipal solid wastes (management and handling) rules, 2000 annual review report: 2013-14, Central Pollution Control Board (Ministry of Environment & Forests) 20-50 (2015).
- Consolidated annual review report on municipal solid wastes (management and handling) rules, 2000 annual review report: 2014-15, Central Pollution Control Board (Ministry of Environment & Forests) 22-60 (2016).
- CPCB -direction for industries *under Section 5 of the Environment (Protection) Act, 1986*, <https://cpcb.nic.in/directions-industries-authorities.1-3> (2019).
- CPCB, National Inventory on Hazardous waste generation and its Management (2017-18). *Central Pollution Control Board, MoEF& CC, GoI* 1-607 (2019).
- CPCB. *Annual Report Implementation of Solid Waste Management Rules (As per provision 24(4) of SWM Rules,16) INTRODUCTION* 1-63 (2019).
- Crawford, J.F. & Smith, P.G. Landfill technology. *Butterworths, London* 84-85 (1985).
- Dar, S. A., Bhat, S. U., Rashid, I. & Dar, S. A. Current Status of Wetlands in Srinagar City: Threats, Management Strategies, and Future Perspectives. *Front. Environ. Sci.* 7(199), 1-8 (2020).
- Das, R. & Roy, K. Tracing the concept of alternative tourism for the preservation of the ethnic socio-cultural life and environment in Darjeeling Hills. *Indian Journal of Advance Research and Innovative Ideas in Education* 2(6), 1646-1651 2016.

- DCHB report, District Census Handbook and Darjiling. Census of India, Government of India (2011) https://censusindia.gov.in/2011census/dchb/DCHB_A/19/1901_PART_A_DCHB_DARJILING.pdf (2011).
- Department of Planning, Government of Uttarakhand. *Uttarakhand Human Development Report* 17-357 (2018).
- Devi, M. K. Ecotourism in Assam: A Promising Opportunity for Development, *SAJTH* 5 (01), 179-192 (2012).
- Dimapur Municipal Council Waste assessment report. Living for environment 10-136 (2019).
- District Environment Plan – Darjeeling, West Bengal 1-34 (2021).
- Duarh, I & Milli, B. Tourism Potentially in Northeast India, International. *Journal of Science and Research* 2 (10), 1-3. (2013).
- Economic Survey Manipur. *Directorate of Economics & Statistics, Government of Manipur, Lamphelpat.* www.desmanipur.gov.in 1-301 (2020-21).
- ENVIS Centre, Ministry of Environment, Forest & Climate Change, Govt. of India (manenvvis.nic.in/Database/Air_2721.aspx?format=Print) 1-50 (2015).
- ENVIS Nagaland, *An Envis Newsletter* 1(1) 8 (2017).
- Ezung, Z. T. Rural Tourism in Nagaland, India: Exploring the Potential. *International Journal of Rural Management* 7(1&2), 133–147. DOI: 10.1177/0973005212459833 (2011).
- Foden, W. B. & Young, B. E. IUCN SSC guidelines for assessing species' vulnerability to climate change. *Cambridge, England and Gland, Switzerland: IUCN* 1-108 (2016).
- Gairola, S., Sharma, J. & Bedi, Y. S. A cross-cultural analysis of Jammu, Kashmir and Ladakh (India) medicinal plant use. *J. Ethnopharmacol.* 155, 925–986 (2014).
- Gandotra, R., Sharma, J., Hina & Andotra, P. Evaluation of water quality of river Tawi with reference to physico-chemical parameters of district Jammu (J&K), India. *Curr. World Environ.* 3(1), 55-56 (2008).
- Ghosh, D. K. & Mallick, J. K. Flora of Darjeeling Himalayas and Foothills (Angiosperms). Bishen Singh Mahendra Pal Singh, Dehra Dun 450-777 (2014).
- Gogoi, P. Tourism Sector in Assam: Its Economic Contribution and Challenges. *International Journal of Humanities & Social Science* 5(2), 214-219 (2017).
- Gogoi, R., Sherpa, N., Franklin Benjamin, J. H., Agrawala, D. K., Rai, S. K. & Dash, S. S. Flora of Sikkim - A Pictorial Guide. *Botanical Survey of India, Kolkata and Forest & Environment Department, Sikkim* 566 (2021).
- Gohel, P., Ahmed, I., Punchok, T., Rath, M., Tsephal, S., Schellenberg, T., Dorjay, T., Parkash, S. & Salma, V. Water in Liveable Leh. Report on water Supply and usage in the highest town of India. *Breman Overseas Research and Development Association, South Asia (BORDA- SA)* 10-66. (2019).
- Ground Water Information Booklet, Meghalaya Central Ground Water Board, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti Government of India 1-148. (http://cgwb.gov.in/AQM/NAQUIM_REPORT/Meghalaya/Ri/20Bhoi_report.pdf) (2017).

- Hamid, M., Khuroo, A. A., Ahmad, R., Rasheed, S., Malik, A. H. & Dar, G. H. 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 (2020).
- IBEF Report of Himachal Pradesh, 1-59. https://www.ibef.org/download/Himachal_Pradesh_271211 (2011).
- Indian Standard Drinking Water Specification, *Bureau of Indian Standards (IS 10500:2012)* 1-16 (2012).
- India State of Forest Report 2017, *Forest Survey of India, Ministry of Environment Forest and Climate change* 296-300 (2017). Bajrang Lal Meena and Nibedita Das (2012) a study on eco-tourism potential in Tripura, North-east India, *Indian streams research journal*, 1-12.
- India State of Forest Report 2021, *Forest Survey of India, Ministry of Environment Forest and Climate change* 265-272. ISBN: 978-81-950073-1-8 (2021).
- India state of forest Report Forest Survey of India, Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India 333-336 (2021).
- ISFR. India State of Forest Report-2015. Forest Survey of India. Dehradun. 252-257 (2015).
- ISFR. India State of Forest Report-2019. Forest Survey of India. Dehradun 308-313 (2017).
- ISFR. India State of Forest Report-2019. Forest Survey of India. Dehradun 284-293 (2019).
- ISFR. India State of Forest Report-2021. Forest Survey of India. Dehradun 491-500 (2021).
- ISFR. India State of Forest Report-2011. Forest Survey of India. Dehradun 236-240 (2011).
- ISFR. India State of Forest Report-2011. Forest Survey of India. Dehradun 241-246 (2011).
- ISFR. India State of Forest Report-2013. Forest Survey of India. Dehradun 208-211 (2013).
- ISFR. India State of Forest Report-2013. Forest Survey of India. Dehradun 208-211 (2013).
- ISFR. India State of Forest Report-2015. Forest Survey of India. Dehradun 258-262 (2015)
- ISFR. India State of Forest Report-2019. Forest Survey of India. Dehradun 314-317 (2017).
- ISFR. India State of Forest Report-2019. Forest Survey of India. Dehradun 294-304 (2019).
- Jana S. K. & Tamang P. Water scarcity in the hill town of Darjeeling: Effects on women's health. *International Journal of Human resource research review*. ISSN: 2320-9704. 5(7) (2017).
- Joshi, R. & Dhyani, P. P. Environmental sustainability and tourism – implications oftrend synergies of tourism in Sikkim Himalaya. *Current Science* 97 (1), 33-41(2009).
- Kannegieser, I. A Home in The Hills: Examining the socioeconomic benefits of homestay tourism on rural women and their communities in the Darjeeling District 1-45. https://digitalcollections.sit.edu/cgi/viewcontent.cgi?article=3229&context=isp_collection/ (2015).
- Khelchandra, Konthoujam. Challenges of solid waste management in Imphal.
- Khoiyangbam, R. S., Huidrom, B. & Thongam, S. Status of Air Pollution in Educational Institutes: A Case Study of Pm10 and Pm2.5 Concentrations in The Indoor Air of Manipur University Campus. *Journal of Energy Research and Environmental Technology (JERET)* 4 (1), 71-71 (2017).
- Kirch, A. Impact of Tourism and Urbanization on Water Supply and Water Quality in Manali, Northern India. *Canadian Water Resources Journal* 27(4), 383-400. DOI: 10.4296/cwrj2704383 (2002).

- Kour, G., Kothari, R., Dhar, S., Pathania, D. & Tyagi, V. V. 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 Ecol. Environ.* doi:10.1007/s40974-021-00215-4 (2021).
- Kumar, R., Parvaze, S., Huda, M. B. & Allaie, S. P. The changing water quality of lakes—a case study of Dal Lake, Kashmir Valley. *Environ. Monit. Assess.* 194, 228 (2022).
- Kumar, R., Raina, A. & Sharma, N. Dataset on water quality characteristics of a hill stream in Bhaderwah, Jammu and Kashmir. *Data Brief* 26, 104462 (2019).
- Kumari, K., Kumar, S., Rajagopal, V., Khare, A. & Kumar, R. Emission from open burning of municipal solid waste in India. *Environmental Technology (United Kingdom)* 40(17), 2201–2214. <https://doi.org/10.1080/09593330.2017.1351489> (2019).
- Kuniyal, J. C. Solid waste management in the Himalayan trails and expedition summits. *Journal of Sustainable Tourism* 13(4), 391–410. <https://doi.org/10.1080/09669580508668564> (2005).
- Kuniyal, J. C., Jain, A. P. & Shannigrahi, A. S. 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 (2003b).
- Kuniyal, J. C., Jain, A. P. & Shannigrahi, A.S. 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) [http://www.virtualmontana.org/ejournal/vol1\(1\)/tourism.htm](http://www.virtualmontana.org/ejournal/vol1(1)/tourism.htm). (2003a).
- Laishram, R. J. & Alam, W. Geochemical Assessment of Nambul River Water Quality for Domestic and Irrigation Uses, Imphal, Manipur. *Taiwan Water Conservancy* 67 (4), 23–40 (2019).
- Lalduhawma, A. & Betlu S. Indigenous knowledge of zootherapeutic use among the Biate tribe of Dima Hasao District, Assam, Northeastern India. *Journal of Ethnobiology and Ethnomedicine* 9(56), 1–15 (2013).
- Lalengzama C. & Zoramani F. Domestic Waste Disposal and Management in Lunglei District Mizoram. *Senhri Journal of Multidisciplinary Studies* 3(2), 64–80 (2018).
- Lalneihzovi & Lalchhuanawma, H. C. 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 (2017).
- Lepcha, J., Rai, Y. K. & Rai, L. K. Fambonglho Wildlife Sanctuary (Sikkim, India) and Promotion of Ecotourism: Perspectives from Ground Zero. *Int. J. of Multidisciplinary and Current research* 3, 1204–1209 (2015).
- Limbu, D. Solid waste management in the town of Darjeeling: Environmental concern. *International Journal of Humanistics and social science invention* 3(6), 22–34 (2014).
- Mahongnao, M. Urban solid waste management in Imphal, Manipur. *Jr. Of industrial pollution control* 33 (1), 696–701 (2017).
- Malik, M. I., Bhat, M. S. & Kuchay, N. A. 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 (2011).
- Mallick, J. K. Status of Red Panda *Ailurus fulgens* in Neora Valley National Park, Darjeeling District, West Bengal, India. *Small Carnivore Conservation* 43(30), 36 (2010).

- Manipur state action plan for climate change and human health. *Manipur State Action Plan* 1-27 (2013).
- Mantyka-pringle, C. S., Martin, T. G., & Rhodes, J. R. (2012). Interactions between climate and habitat loss effects on biodiversity: a systematic review and meta-analysis. *Global Change Biology* 18(4), 1239-1252.
- MEGHALAYA TOURISM POLICY – 2011, *GOVERNMENT OF MEGHALAYA, TOURISM DEPARMENT, No. Tourism.74/2009/85* (<https://tourism.gov.in/sites/default/files/2019-10/meghalaya.pdf>) 1-16 (2011).
- Meghalaya, India. *ENVIS bulletin Himalayan ecology* 24, 87-100. [https:// nehu.ac.in/ envis/ files/newsletter-vol1-issue2-March18-May18.pdf](https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf)) (2018).
- Mehta, P., Chandra Sekar, K., Bhatt, D., Tewari, A., Bisht, K., Upadhyay, S., Negi, V. S. & Soragi, B. Conservation and prioritization of threatened plants in Indian Himalayan Region. *Biodiversity and Conservation* 29(6), 1723-1745 (2020).
- Merinews. Power to people. *Darjeeling and its daily struggle for water*. (2013).
- Monthly Progress Report for the State of Mizoram for August. Mizoram State Pollution Control Board, Mizoram 13 (2021).
- Monthly Progress Report for the State of Mizoram for November. *Mizoram State Pollution Control Board, Mizoram* 15 (2020).
- Nasim, H. & Keng, T. *Directory of lakes and waterbodies of J&K state* 4-108 (2012).
- National Ambient Air Quality Status and Trends. National Ambient Air Quality Monitoring NAAQMA/45/2019-2020. *Central Pollution Control Board, MoEF&CC, Govt. of India* (www.cpcb.nic.in) 164 (2019).
- National Wildlife Action Plan. Relevant Portions of the National Wildlife Action Plan (2002-2016). Legislation, Policy, Guidelines and Strategy. (2002-2016).
- Nayak, P. & Mishra, S. K. 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 (2013).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants Volume-1. BSI, Calcutta. 1-367 (1987).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants Volume-2. BSI, Calcutta. 1-150 (1988).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants. *Botanical Survey of India, Calcutta* 1-3. <http://www.bioinformaticssikkim.gov.in/First%20List%20of%20Threatened%20Plants-L.pdf> (1990).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants. *BSI, Calcutta*. 1, 1-367 (1987).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants. *BSI, Calcutta*. 2, 1-150 (1988).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants. *BSI, Calcutta*. 3, 1-271 (1990).
- Nayar, M. P. & Sastry, A. R. K. Red Data Book of Indian Plants Volume-3. BSI, Calcutta. 1-271 (1990).
- NITI Aayog Report of Working Group II Sustainable Tourism in the Indian Himalayan Region, 1-87 (2018).
- NITI Aayog Report of Working Group II Sustainable Tourism in the Indian Himalayan Region, 100 (2018).

- Niti Aayog Report of working group II Sustainable Tourism in the Indian Himalayan Region 1-100 (2018).
- NITI Aayog, Sustainable Tourism in the Indian Himalayan Region Contributing to Sustainable Development in Indian Himalayan Region NITI Aayog 2 Sustainable Tourism in the Indian Himalayan Region. 1-12 (2018).
- Order of the National Green Tribunal regarding prohibiting use of petcoke and furnace oil as fuel (28/03/2019).
- Parray, S. Y., Koul, B. & Shah, M. P. 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) (2021).
- Peinlang, B. L. The Scope of Tourism in Meghalaya. *J Tourism Hospit.* 8(397), 2167-0269 (2019).
- Puri, K., Joshi, R. & Singh, V. Open garbage dumps near protected areas in Uttarakhand: An emerging threat to Asian Elephants in the Shivalik Elephant Reserve. *Journal of Threatened Taxa* 12(11), 16571–16575. <https://doi.org/10.11609/jott.4392.12.11.16571-16575> (2020).
- Rai, B. Microbiological quality of water of some important lakes of tourist importance in Darjeeling hills. Ph.D. Thesis, University of North Bengal. 1-202 (2017).
- Rai, R. Ecotourism potential in the Darjeeling hills: Prospects, Challenges and Possibilities. *EPRA International Journal of Multidisciplinary Research* 6(9), 228-233 (2020).
- Rawat, s. Rural Tourism and Sustainable development in Darjeeling Hills, West Bengal: Case study of Lepchajagat. *Juni Khyat* 10(5) 18-34. ISSN: 2278-4632 (2020).
- Rawal, R. S. & Dhar, U. Protected area network in Indian Himalayan region: Need for recognizing values of low profile protected areas. *CURRENT SCIENCE* **81**, 11 (2001).
- Report of The Evaluation study on Hill area development programme in Assam and West Bangal, Programme Evaluation Organization Planning Commission Government of India, New Delhipp 2-165 (2010).
- Sahoo, U. K., Singh, S. L., Lalnundanga, Lalnuntluanga, Devi, A. S. & Zothanzama, J. Climate Change Impact on Forest and its Adaptation Study in Mizoram (*Technical Report*) 44 (2018).
- Saleem, S., Kamili, A. N., Kakru, D. K., Bandh, S. A. & Ganai, B. A. Isolation, identification and seasonal distribution of bacteria in Dal Lake, Kashmir. *International journal of environmental sciences* 2(1), 185 (2011).
- Sarkar, C., Chatterjee, A., Singh, A. K., Ghosh, S. K. & Raha, S. Characterization of black carbon aerosols over Darjeeling-A high altitude Himalayan station in eastern India. *Aerosol and Air Quality Research* 15(2), 465-478 (2015).
- Sharholly, M., Ahmad, K., Mahmood, G. & Trivedi, R. C. Municipal solid waste management in Indian cities—A review. *Waste management* 28(2), 459-467 (2008).
- Sharma, A., Gupta, A. K. & Ganguly, R. 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 (2018).

- Sharma, G., Lata, R., Thakur, N. et al. Application of multivariate statistical analysis and water quality index for quality characterization of Parbati River, Northwestern Himalaya, India. *Discov. Water* 1(5). <https://doi.org/10.1007/s43832-021-00005-3> (2021).
- Sharma, I. Mammal's diversity of Ladakh (Jammu and Kashmir), India, *International Journal of Fauna and Biological Studies* 4(2), 7-12 (2017).
- Sharma, N. & Walia, Y. K. Water Quality Investigation by Physicochemical Parameters of Satluj River, Himachal Pradesh, India. *Current World Environment* 12(1), 174-180. DOI:<http://dx.doi.org/10.12944/CWE.12.1.21> (2017).
- Sharma, P., Sood, A., Sharma, S., Bisht, S., Kumar, V., Pandey, P., Gusain, M. P. & Gusain, O. P. Bacterial indicators of faecal pollution and physiochemical assessment of important North Indian lakes. *RMZ- Mater.Geoenviron* 57(1), 25-40 (2010).
- Sharma, R. P. Comparative study of past and present environment. A study in environmental degradation in the Darjeeling Hill areas. 65-66 & 72-73 (shodhganga.inflibnet.ac.in) (2012).
- Sharma, R.P. 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> (2012).
- Sharma, S. & Walia, Y. K. Water Quality Assessment of River Beas during Winter Season in Himachal Pradesh, India. *Current World Environment* 11(1), 194-203 (2016).
- Sharma, S., Wangmo, R. & Rana, S. K. *A Comprehensive Account of The Birds of Ladakh: Commentary, Notes, and Field Guide*. Walnut Publication 1-368 (2021).
- Sherpa, S. S. S. S. & Mondal, A. Carrying capacity of Singalila National Park. *International Journal of Environment, Ecology, Family and Urban Studies (IJEUFUS)* 11(2), 105-116 (2021).
- Shiteo, C. Development and Growth of Tourism in Nagaland. *South Asian Journal of Tourism and Heritage SAJTH* 10(2), 76-89 (2017).
- Singh, J. 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 (IOSR-JHSS)* 22(11), 11-17 (2017).
- Singh, N.P., Singh, K.P. & Singh, D.K. Flora of Mizoram. *Botanical Survey of India. Kolkata* 845 (2002).
- Singh, P., Karthigeyan, K., Lakshminarasimhan, P. & Dash, S. S. Endemic vascular plants of India, *Botanical Survey of India, Kolkata* 7,1-339 (2015).
- Singh, S. K. & Rao, D. N. Evaluation of Plants for Their Tolerance to Air Pollution. *Symposium on Air Pollution Control* 218-224 (1983).
- Solid waste management action plan Mokochung Municipal Council 1-20 (2019).
- Sophia, A. & Devi, M. S. Environmental Problems of Manipur. *Holistic Approach Environ.* 10(4), 124-140 (2020).
- Srivastava, V., Vaish, B., Singh, R. P. et al. An insight to municipal solid waste management of Varanasi city, India, and appraisal of vermicomposting as its efficient management approach. *Environ Monit Assess* 192, 191. <https://doi.org/10.1007/s10661-020-8135-3> (2020).
- State of Environment Report of Mizoram. Department of Environment, Forests and Climate Change, Government of Mizoram, Mizoram 1-352 (2016).
- State of Environment Report-I. Bengal Pollution Control Board 222 (2021).

- State Strategy on Solid Waste Management-Himachal Pradesh.
http://www.ud.hp.gov.in/sites/default/files/documents/H.P.%20SWM_Strategy_Final_20190601
 (2019).
- Statistical Handbook of Manipur. Directorate of Economics & Statistics, Government of Manipur, Lamphelpat. www.desmanipur.gov.in 1-277 (2017).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 22-116 (2012).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 24-143 (2013).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 35-184 (2014).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 40-359 (2017).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 1-245 (2018).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 1-220 (2019).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 1-287 (2020).
- Statistical Handbook of Nagaland, Directorate of Economics & Statistics, Government of Nagaland, Kohima 1-260 (2021).
- Sundriyal, S., Shridhar, V., Madhwal, S., Pandey, K. & Sharma, V. 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> (2018).
- Sunlu, U. 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 (2003).
- SWM. Municipal solid waste management. In *The Gazette of India* 222-445 (2016).
- Tambe, S. & Arrawatia, M. L. Climate Change initiatives in sikkim. *Climate Change in Sikkim Patterns, Impacts and Initiatives*. Information and Public Relations Department, Government of Sikkim, Gangtok 369-412 (2012).
- Tambe, S. & Rawat, G. S. An Ecological Study of Pastoralism in the Khangchendzonga National Park, West Sikkim. *The Mountain Institute – India, Sikkim* 53 (2006).
- Thadani M, Dhara V State Ranking Survey, HVS 13 (2013).
- Thakur, A., Kumari, S., Sinai Borker, S., Prashant, S. P., Kumar, A. & Kumar, R. Solid Waste Management in Indian Himalayan Region: Current Scenario, Resource Recovery, and Way Forward for Sustainable Development. In *Frontiers in Energy Research* 9(609229), 1-18. Frontiers Media S.A. <https://doi.org/10.3389/fenrg.2021.609229> (2021).
- The Mizoram Responsible Tourism Policy. Tourism Department, Government of Mizoram 1-29 (2020).
- Tourism Survey for State of Nagaland - Final Report (June 2014 - May 2015), *Ministry of Tourism, Govt. of India* 1-51 (2017).

- Tuboi, C., Irengbam, M., & Hussain, S. A. Seasonal variations in the water quality of a tropical wetland dominated by floating meadows and its implication for conservation of Ramsar wetlands. *Physics and Chemistry of the Earth, Parts A/B/C.* 103, 107-114 (2018).
- Uttarakhand tourism policy, Uttarakhand tourism policy 1-84 (2018).
- Vijay, R., Kushwaha, V. K., Chaudhury, A. S., Naik, K., Gupta, I., Kumar, R. & Wate, S. R. 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. <https://doi.org/10.1007/s12665-015-4858-9> (2016).
- Vikal, P. Multivariate analysis of drinking water quality parameters of lake Pichhola in Udaipur, India. *Biological Forum. Biological Forum- An International Journal* 1(2), 97-102 (2009).
- WHO (World Health Organisation). Guidelines for Drinking Water Quality. 4th Edition. Geneva: WHO Chronicle 38(4), 104–108(2011).
- 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. & Laurance, W. F. Habitat Fragmentation and Biodiversity Conservation: Key Findings and Future Challenges. *Landscape Ecology* 31 (2), 219-227 (2016).
- [World Bank Document](#). *Environmental & Social Policy & Procedures (ESPP)* 1-142 (2015).
- World Tourism Organization. Tourism and Biodiversity – Achieving Common Goals towards Sustainability, *ISBN: 978-92-844-1371-3*, 1-51 (2010).
- Yadav, I. S. & Devi, N. L. 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 (2016).

WEB-REFERENCES

- Conflicts on taxi routes** <https://economictimes.indiatimes.com/news/india/battle-of-routes-in-ladakh-as-taxi-drivers-from-kargil-not-allowed-to-ply-in-leh-hunger-strike-continues/articleshow/85295088.cms?from=mdr>
- <https://thekashmirwalla.com/kargil-taxi-operators-call-for-shutdown-tomorrow/>
- <https://timesofindia.indiatimes.com/city/shimla/ladakh-himachal-taxi-unions-Fig.ht-affects-tourists/articleshow/70199828.cms>
- <https://www.indiatimes.com/news/india/peace-of-leh-shattered-shocking-attack-on-a-tourist-convoy-by-local-taxi-union-caught-on-tape-243421.html>
- 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>
- 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/>

12. <https://www.greaterkashmir.com/todays-paper/state/distt-panels-to-prepare-zonal-master-plans-for-5-eco-sensitive-zones-of-jk>
13. **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>
14. Adarsh Batra Himalayan Ecotourism in Shimla. <http://www.au.edu> (2015).
15. 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)).
16. Himachal Tourism. Department of tourism and corporation HP. <https://himachaltourism.gov.in>.
17. Himachal Pradesh State Pollution Control Board .Ambient Air Quality data of different districts of Himachal Pradesh from 2010 to 2020. <https://hppcb.nic.in> (2010-20).
18. Himachal Pradesh State Pollution Control Board. Water Quality Parameters for Different districts of H.P. <https://hppcb.nic.in> (2011-20).
19. 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>.
20. (<https://www.downtoearth.org.in/blog/waste/divide-and-conquer-segregation-is-the-key-60597>)
21. <https://hpforest.nic.in/pages/display/ZjY1NHhjbnJmNjU0cw==ecosensitive-zone>
22. https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-19/learningcentre/presentations/May%202%20am/1%20-%20Memon%20-%20ISWM.pdf
23. <https://timesofindia.indiatimes.com/readersblog/environmental/indian-landfill-the-ultimate-trash-kingdom-25565/>
24. The Statesman. <https://www.thestatesman.com/cities/shimla/tourism-sector-hp-witnessed-46-per-cent-income-loss-1503030460.html>. (2021).
25. Ministry of Tourism, Govt. of India. (ON1788) and Past Issues www.ibef.org
26. Directorate of Urban Development Uttarakhand, Dehradun on the basis of Swachh Sarvekshan Based on Urban MSW action plan 2017
27. District administration, 2021
28. Forest Survey of India, Dehradun. India State of Forest Report 2021.
29. Central Pollution Control Board
30. ENVIS Sikkim: <http://sikenvis.nic.in/writereaddata/sd71.pdf>.
31. Carrying Capacity Survey Department of Tourism and Civil Aviation, Government of Sikkim (2017).
32. Anonymous <https://ejatlas.org/conflict/khangchendzonga-conservation-committee> (2017).
33. Management Plan Khangchendzonga National Park 2008-2018. MoEF, Government of Sikkim.
34. Ministry of New and Renewable Energy, Government of India (2018).
35. Kyongnosla Alpine Sanctuary <http://www.sikkimforest.gov.in/docs/IBA/sk5.pdf> (2022).
36. ENVIS Hub: Sikkim http://sikenvis.nic.in/Database/Eco-Sensitive-Zones_4136.aspx (2021).
37. Gorkhaland territorial administration. Department of tourism.
38. Tourist bureau, Darjeeling; foreigner's registration office, DIB, Darjeeling.
39. <https://www.hindustantimes.com/cities/others/assam-cabinet-approves-eco-sensitive-zone-animal-corridors-in-kaziranga-101648046044465.html>

40. <https://www.sentinelassam.com/topheadlines/eco-sensitive-zone-gets-assam-cabinet-nod-584088>
41. https://des.assam.gov.in/sites/default/files/menu/document/ecostat_medhassu_in/Statistical%20Hand%20Book%20Assam%2C%202012.pdf
42. [Report of the Evaluation Study on Hill Area Development Programme in Assam and West Bengal.pdf \(dmeo.gov.in\)](#)
43. The Telegraph, Calcutta, 28 September 2011; <https://epaper.telegraphindia.com/>
44. Assam Tourism Development Corporation Limited, 2019. <http://www.assamtourisonline.com/>
45. The times of India, 31st December 2019. <https://timesofindia.indiatimes.com/2019/12/31/archivist/year-2019,month-12,starttime-43830.cms>
46. Ministry of Tourism, Govt. of India, <https://tourism.gov.in/>
47. Central Pollution Control Board, 2019. <https://cpcb.nic.in/>
48. Statistical Handbook of Assam 2011-19. <https://des.assam.gov.in/portlets/statistical-handbook>
49. Department of Tourism, Nagaland, <https://tourism.nagaland.gov.in/> accessed on 18th April, 2022.
50. *IUCN red list*; <https://www.iucnredlist.org>, accessed on 16th April, 2022.
51. Department of environment, forest and climate change, govt. of Nagaland, <https://forest.nagaland.gov.in/> (2022).
52. Central Pollution Control Board. National Waster Quality Monitoring Programme. *Water Quality Data (Yearly)*, <https://cpcb.nic.in/nwmp-data/>.
53. <https://www.cseindia.org/imphal-municipal-corporation-imphal-manipur-8288>
54. <https://manipcb.nic.in/document/NOISE.pdf>
55. <https://www.thesangaexpress.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>
56. <https://www.cleanfuture.co.in/2018/01/10/manipur-gets-waste-management-plant/>
57. <https://www.statista.com/statistics/1116901/number-of-vehicles-in-manipur-india/>
58. <http://www.manipur tourism.gov.in/site-map/>
59. Swasth Bharat Sampann Bharat. <https://swachhindia.ndtv.com/a-village-in-manipur-is-buying-solid-waste-from-its-residents-to-spread-awareness-on-waste-management-15880/> assessed on 27th May 2022.
60. <https://www.ceicdata.com/en/india/revenue-receipts-manipur/manipur-revenue-receipts-non-tax-state-economic-services-tourism>
61. <https://www.ceicdata.com/en/india/non-resident-visits-by-states/visitor-arrivals-foreigner-mizoram>
62. <https://www.statista.com/statistics/1116913/number-of-vehicles-in-mizoram-india/>
63. <https://smartcities.data.gov.in/catalog/solid-waste-management-aizawl?>
64. <http://scstsenvis.nic.in/index4.aspx?ssslid=196&subsubsublinkid=512&langid=1&mid=1#:~:text=Habitat%20loss%2C%20hunting%20and%20over,systems%2C%20have%20caused%20this%20loss>

65. THE MEGHALAYA STATE BIODIVERSITY STRATEGY AND ACTION PLAN-2016-2026, WII
(<https://megbiodiversity.nic.in/sites/default/files/mbsap-6th-march-2017.pdf>)
66. http://www.megforest.gov.in/forest_overview.html#
67. <https://nehu.ac.in/envis/database.html>
68. <https://nehu.ac.in/envis/files/newsletter-vol1-issue2-March18-May18.pdf>
69. http://megspcb.gov.in/annual_reports.html
70. http://www.megforest.gov.in/wildlife_zones.html
71. Meghalaya State Pollution Control Board Annual Reports (2010-2018). (http://megspcb.gov.in/annual_reports.html)
72. TOURISM IN THE 2030 AGENDA <https://www.unwto.org/tourism-in-2030-agenda>.
73. (<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).
74. World Travel and Tourism Council, 2010. <http://www.wttc.org/>
