HEAD OFFICE
Uttarakhand Pollution Control Board
"Gauradevi Paryavaran Bhawan"
46B, IT Park, Sahastradhara Road, Dehradun
E-mail : msukpcb@yahoo.com, Phone No.-0135-2607092

Letter No.: UKPCB/HO/Gen-183-655/2023/528 **Date: 24.07.2023**

E-MAIL

To,

The Registrar General,
Hon'ble National Green Tribunal
Principal Bench,
New Delhi
Email: judicial-ngt@gov.in

Sub.: Status Report in the matter of O.A. 51 of 2023 titled as "In re : News item published in The Tribune dated 16.01.2023 titled "Joshimath disaster a warning for Mussoorie" - reg.

Ref.: Letter ref no. 140129/2023 dated 22.07.2023 of Principal Secretary, Environment Conservation and Climate Change, Govt. of Uttarakhand.

Sir,

Kindly refer to order dated 31.01.2023 passed by the Hon'ble National Green Tribunal the matter of **O.A. 51 of 2023 titled as "In re : News item published in The Tribune dated 16.01.2023 titled "Joshimath disaster a warning for Mussoorie".** In this regard letter dated 22.07.2023 of Principal Secretary, Environment Conservation and Climate Change, Govt. of Uttarakhand may also be referred.

This is to submit that under approval of Chairperson of Joint Committee / Chief Secretary, Government of Uttarakhand, please find enclosed herewith **"Status Report - Carrying Capacity of Mussoorie"** on behalf Joint Committee, in the aforesaid matter.

You are requested to kindly place the "Status Report - Carrying Capacity of Mussoorie" along with Annexures-1 to 4 and authority letter, before the Hon'ble NGT for kind consideration, please.

Sincerely Yours',

(S.K. Pattnaik)
Member Secretary

Encl.: Status Report with Annexures (1-4) & Authority letter.

Copy to:

1. Shri Kaushal Pati Gautam, AAG, State of Uttarakhand, UKPCB for information and necessary action, please.
2. Shri Mukesh Verma, Advocate of UKPCB for information and necessary action, please.

Member Secretary

प्रेषक,

रमेश कुमार सुधांशु,
प्रमुख सचिव,
उत्तराखण्ड शासन।

सेवा में,

सदस्य सचिव,
उत्तराखण्ड प्रदूषण नियंत्रण बोर्ड,
देहरादून।

पर्या॰संरक्षण एवं जलवायु परिवर्तन अनु॰ देहरादूनः दिनांकः 22 जुलाई, 2023

विषयः— मा॰राष्ट्रीय हरित प्राधिकरण, नई दिल्ली में योजित मूल आवेदन संख्या—51/2023 **Suo Moto in Re: News item published in the news paper the tribunal, dated 16-01-2023 entitled "Joshimath Disaster a Warning for Mussoorie"** के सम्बन्ध में।

महोदय,

उपर्युक्त विषयक अपने पत्र संख्या—यूकेपीसीबी/एच.ओ./सा0—183—655/2023/509, दिनांक 19.07.2023 का कृपया संदर्भ ग्रहण करने का कष्ट करें, जिसके माध्यम से Status Report – Carrying Capacity of Mussoorie तैयार कर, मा0 प्राधिकरण में दाखिल किये जाने हेतु शासन के अनुमोदनार्थ उपलब्ध करायी गई है।

2— अतः उक्त के सम्बन्ध में मुझे यह कहने का निदेश हुआ है कि अध्यक्ष, संयुक्त समिति/मुख्य सचिव, उत्तराखण्ड शासन द्वारा अनुमोदित Status Report on "Carrying Capacity of Mussoorie" को मा0 राष्ट्रीय हरित प्राधिकरण में मा0 प्राधिकरण द्वारा निर्गत आदेशानुसार समयबद्ध रूप से दाखिल किये जाने एवं प्रकरण में प्रभावी पैरवी हेतु आपको अधिकृत किया जाता है।

कृपया तदनुसार अग्रेत्तर आवश्यक कार्यवाही करने का कष्ट करें।

संलग्नकः—यथोक्त।

भवदीय,

Signed by Ramesh Kumar Sudhanshu
Date: 22-07-2023 11:41:36

(रमेश कुमार सुधांशु)
प्रमुख सचिव।

संख्या एवं दिनांक–तदैव।

प्रतिलिपि:– National Green Tribunal, Faridkot House, Copernicus Marg, New Delhi **(judicial-ngt@gov.in)** को मूल आवेदन संख्या–51/2023 में दिनांक 31.01.2023 को पारित आदेश के क्रम में सूचनार्थ।

आज्ञा से,

(रमेश कुमार सुधांशु)
प्रमुख सचिव।

Status Report

CARRYING CAPACITY OF MUSSOORIE

In Compliance of order Dated 31.01.2023 passed by the Hon'ble National Green Tribunal

(In the Matter) of O.A. No.51 of 2023

JULY 2023

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EXECUTIVE SUMMARY

The western Himalayas, home to Mussoorie as a prominent hill station in Uttarakhand, are globally recognized for their breath-taking beauty and diverse ecosystems. Towering mountains, lush forests, alpine meadows, and meandering rivers define this region, with Mussoorie nestled in the Garhwal Himalayas, offering picturesque landscapes and a pleasant climate. However, the environment and ecology of this area are delicate and vulnerable, supporting a wide range of plant and animal species, including endangered and endemic ones. The region's forests play a critical role in maintaining ecological balance, regulating water cycles, and providing habitats for wildlife. The rivers and streams originating from the Himalayas serve as vital water sources for both human and downstream ecosystems.

Unplanned urbanization driven by haphazard construction and infrastructure development poses significant risks, including building collapses and disasters during heavy rainfall and earthquakes. Although construction has been banned in Mussoorie's "freeze zone" areas since 1996, recent extension options require careful monitoring by the Mussoorie-Dehradun Development Authority (MDDA). The high influx of tourists exacerbates issues such as unregulated construction, excessive waste generation, sanitation and sewage problems, water scarcity, congested roads, traffic congestion, and vehicular pollution.

Ongoing investigations by the MDDA address reported cases of land encroachment. While no direct scientific evidence links Mussoorie's challenges to the Joshimath disaster, comprehensive studies on land subsidence in hilly terrains are essential, considering environmental and socio-economic factors. Conducting thorough investigations necessitates sufficient time, financial resources, and manpower to accurately assess Mussoorie's current situation.

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Understanding the concept of carrying capacity is crucial in policymaking and sustainable development for fragile areas like Mussoorie. *Carrying capacity refers to the maximum number of individuals an ecosystem or specific area can sustainably support without degrading natural resources or causing significant environmental damage*. It assists in determining optimal population size, infrastructure development, resource allocation, and conservation measures required to ensure long-term environmental sustainability and the well-being of local communities. Establishing limits on the number of tourists ensures the area can support visitors without compromising its natural resources and ecological balance.

The challenge may be addressed by incorporating preventive measures such as restoration programs, construction of toe walls and deflection terms to prevent erosion and stream undercutting, stabilization of slopes through retaining walls, and responsible quarrying practices should be implemented. Comprehensive landslide hazard zonation and management mapping are necessary to identify areas requiring structural mitigation, biotechnical measures, and soil conservation initiatives as part of disaster management efforts.

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1. INTRODUCTION

1.1. Background

Hon'ble National Green Tribunal, Principal Bench, New Delhi in O.A. No. 51 of 2023 – news item published in the Tribune dated 16.01.2023 titled "Joshimath disaster a warning for Mussoorie". In its hearing dated 31.01.2023 made observations in the order which is being reproduced as below:

1. *"Proceedings have been initiated in the present matter suomotu in view of captioned media report to the effect that recently Joshimath disaster has taken place which has led to displacement of number of inhabitants and damage to properties. There is reported sinking of earth surface due to displacement of sub surface material. This is on account of excessive unplanned constructions beyond carrying capacity. This is also warning for Mussoorie where unplanned constructions have taken place and are still taking place. It's carrying capacity was studied by the Lal Bahadur Shastri National Academy of Administration (LBSNAA) in 2001 which suggested that no further constructions are viable. Mussoorie Dehradun Development Authority (MDDA) has failed to go by the said study and take preventive and remedial measures. Proponents of development such as Uttarakhand Hotels and Restaurant Association do not want any control on developmental activities. The area has enormous reservoirs of ice and snow. On account of unplanned human settlements, natural ecology and recharge of aquifers are affected. Over concretization leads to landslides. Proposed tunnel below Mussoorie is dangerous. So is proposed ropeway from Dehradun to Mussoorie. Ropeway and tunnel have damaged Joshimath. Traffic congestion adds to the burden on the mountain's road. Excessive building activities are beyond the capacity of Mussoorie".*

Further, the above order also issued direction as reproduced below:

9. *"In above background, study of carrying capacity of eco-sensitive areas in Himalayan regions in holistic manner appears to be imperative for protection of environment. Without undermining need for study in all eco sensitive areas as already directed, we direct specific study for Mussoorie in the light of apprehensions expressed in above media report. Such study may cover as to how much constructions can be allowed and with what safeguards, what safeguards be used for existing buildings and all other relevant and associated aspects including vehicular traffic, sanitation management, maintaining ecological integrity in terms of soil stability and flora/fauna. For this purpose, we constitute a nine-member joint Committee to be headed by Chief Secretary, Uttarakhand. Other members will be Wadia Institute of Himalayan Geology Dehradun, Govind Ballabh Pant National Institute of Himalaya and Environment, National Institute of Hydrology (NIH), Roorkee, Prof. J.S Rawat, Kumaon University, Almora, Space Application Centre, Ahmadabad National Institute of Rock Mechanics, Bangalore, CPCB and ACS Environment, Uttarakhand who will act as nodal agency for coordination and compliance. ACS, Environment will provide for travel and logistics for members to the extent necessary. Meetings may be held online or offline as may be necessary except for visit to the site. The Committee may suggest remedial measures to prevent environmental damage in the light of carrying capacity, hydro-geology studies, geo-morphological studies and also covering other allied and incidental issues. The Committee will be at liberty to take assistance from any other expert/institution. The Committee may meet within two weeks and complete its studies within two months. It may furnish its report by email at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF on or before April 30, 2023. The Committee will be free to interact with the stakeholders including the inhabitants/members of civil societies. The Committee may also consider the*

concerns in the media report. It will be open to the Chief Secretary, Uttarakhand to take preventive and remedial measures found necessary in the light of the media report otherwise".

As per the above Hon'ble NGT order dated 31.01.2023, the committee has been assigned following task:

- Specific study for Mussoorie to suggest extend of construction in the study area, safeguards for existing buildings, vehicular traffic, waste management, and maintaining ecological integrity.
- Suggest remedial measures to prevent environmental damage in the light of carrying capacity, hydrogeological studies, and geomorphological studies and also covering other allied and incidental issues (i.e., waste management, sanitation, biodiversity conservation and pollution abetment).

1.2. Committee proceedings

In compliance of Hon'ble NGT order dated 31.01.2023, the State Government, Uttarakhand has constituted a committee headed by Chief Secretary, Uttarakhand on dated 10.02.2023. The first meeting of the committee held on 13.02.2023 and mandate given to the committee by Hon'ble NGT was discussed and deliberated in detail to ascertain the course of action in preparing the study report. A copy of the minutes of the meeting is being annexed (**Annexure – 1**). Subsequently, second meeting of the committee was held on dated 12.04.2023 as a follow-up meeting to examine work done so far in the matter and further discussed and deliberated towards preparing the requisite study report. The opinion of the expert members of the committee has been recorded and minutes of the said meeting is annexed (**Annexure – 2**). Member Secretary, UKPCB was assigned the task of Nodal Officer to coordinate with all

members of the committee, and obtain information / data / opinion from the committee members. G.B. Pant National Institute of Himalayan Environment has been assigned the task to work as Nodal Organization for compilation of data and preparation of study report.

1.3. Carrying Capacity Study Mussoorie – 2001

The Hon'ble Supreme Court of India in the matter writ petition no. 8209 and 8821 of 1983 titled as 'Rural litigation and entitlement Kendra & Ors. Versus State of Uttar Pradesh and Collector of Dehradun considered the matter of limestone quarrying in Mussoorie located in Doon Valley area. The Doon Valley area is bounded of North by Mussoorie ridge, in the North-East by lesser Himalayan ranges, on the South-West by Shivalik ranges, river Ganga in the South-East, and river Yamuna in the North-West. Hon'ble Supreme Court after detailed ecological consideration, ordered for closure of limestone mining operation forthwith in Mussoorie. Further then Ministry of Environment and Forests (MoEF) had declared the Doon Valley area as Environmentally Sensitive Area under provision of Environment (Protection) Act 1986 and accordingly effected Doon Valley Notification Feb 1989. This notification-imposed site specific and activity specific restrictions in the Doon Valley area including complete Ban on Red Category industries and No mining operation in Doon Valley area without permission of Central Government. The Supreme Court Monitoring Committee (SCMC) was constituted by MoEF, GoI to oversee the environmental concerns in Doon Valley as per Hon'ble Supreme Court Order and issues connected with compliance of Doon Valley Notification 1989. SCMC carried out the monitoring of reclamation of degraded mine area carried out by eco-task force. The SCMC is still functional and monitoring the environmental issues in Doon Valley area including Mussoorie.

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The carrying capacity of Mussoorie was first conducted by Ramachandran et al. (2001) and was sponsored by the SCMC, specifically to establish benchmarks on important parameters and pressure on infrastructure. The study was conducted in the light of water supply, sewage system, waste management, civic services, infrastructure, tourist inflow, population pressure, etc. Further, the carrying capacity assessed ground situation in relation to water and power supply, waste disposal, housing, hotel rooms, availability of hospital beds for tourists etc.

The study had considered about the existing permanent population and their livelihood demands vis- a-vis temporary influx of population especially during peak tourist season. A copy of the study report is being produced along with this report as (**Annexure– 3)**. This study report published by LBSNAA Mussoorie in 2001 was further updated with revised and updated data/information during 2011 by Secretary SCMC. A copy of the report is being annexed as (**Annexure –4)**.

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2. GENERAL PROFILE

2.1. About the study area

Mussoorie is a hill station/town near Dehradun city nestled in the lap of Western Himalayas in Uttarakhand. It is about 35km from the state capital of Dehradun and 290 km north of the national capital of New Delhi. The hill station is in the foothills of the Garhwal Himalayan range falls under the seismic zone IV (Rautela et al., 2015). The adjoining town of Landour, which includes a military cantonment, is considered a part of "greater Mussoorie", as are the townships of Barlowganj and Jharipani. Mussoorie is located at an average altitude of 2,005 m asl. In its northeast direction, are the Himalayan snow ranges, and to the south, the Doon Valley and Shiwalik ranges. Mussoorie popularly known as the Queen of the Hills, has a fairly typical subtropical highland climate for the mid-altitude Himalaya. Summers are warm and very wet, with July and August averaging approximately 660 mm of rain per month due to topographical and geological lift of the extremely moist monsoonal air. The pre-monsoon seasons in April and May is warm and generally dry and clear, giving way to heavy rainfall from mid-June, while the post-monsoon season is also dry and clear but substantially cooler. In winter, rainfall is a little more frequent than in the pre-and post-monsoon seasons, and the general weather is cool and partly cloudy. Mussoorie usually receives a few spells of snowfall in December, January and February, although the number of snowy days has come down in recent years due to a combination of local climatic factors and also process of global warming.

2.2. Demographic profile

Mussoorie is a Nagar Palika Parishad town, with a population of 30,118 according to the 2011 Census. Its demographic profile reveals that there are 16,623 males and 13,495 females. The town is divided into 11 wards, and elections are held every 5 years. The population of children aged 0-6 is 2,673, which accounts for 8.88% of the total population. The female sex ratio in Mussoorie is 812, lower than the state average of 963, while the child sex ratio stands at 918, higher than the state average of 890. The literacy rate in Mussoorie is 89.69%, significantly higher than the state average of 78.82%. The male literacy rate is 94.41%, and the female literacy rate is 83.80%. Looking ahead, the population of Mussoorie is projected to increase by 23% by 2037 and 52% by 2052, with a corresponding increase of 16% to 33% in the permanent population.

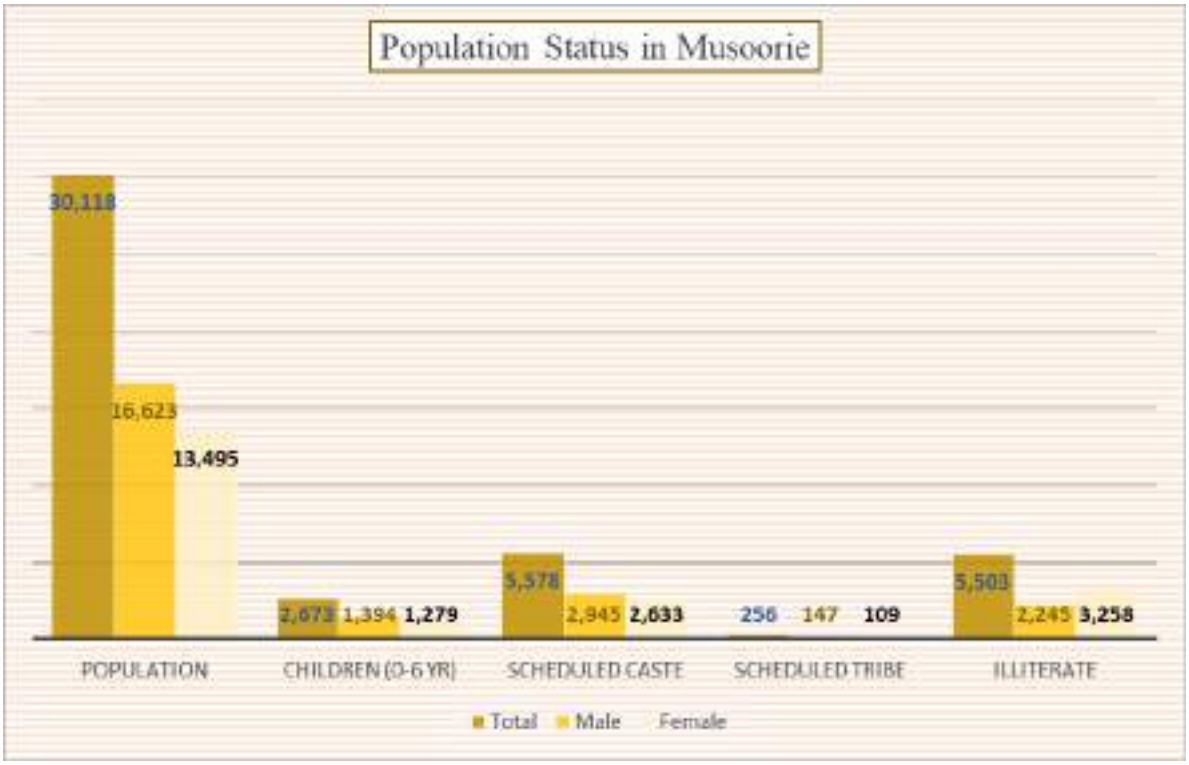

Chart 1: Population Status of the *Mussoorie Nagar Palika Parishad* (2011

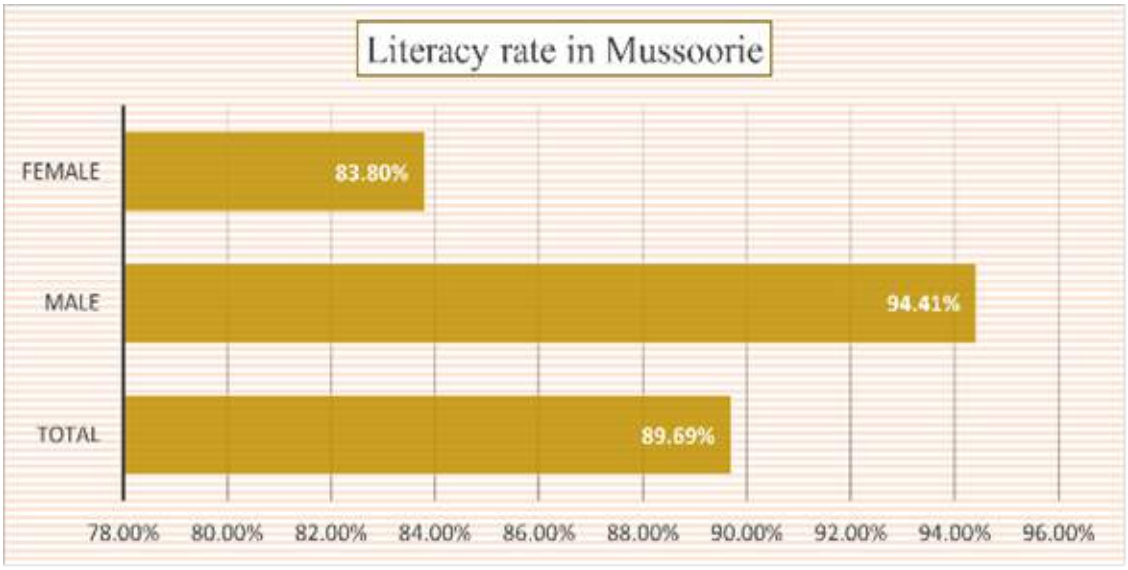

Chart 2 : Literacy Rate of the *Mussoorie Nagar Palika Parishad* (2011

Chart 3 : Ward-Wise Population of the *Mussoorie Nagar Palika Parishad* (2011

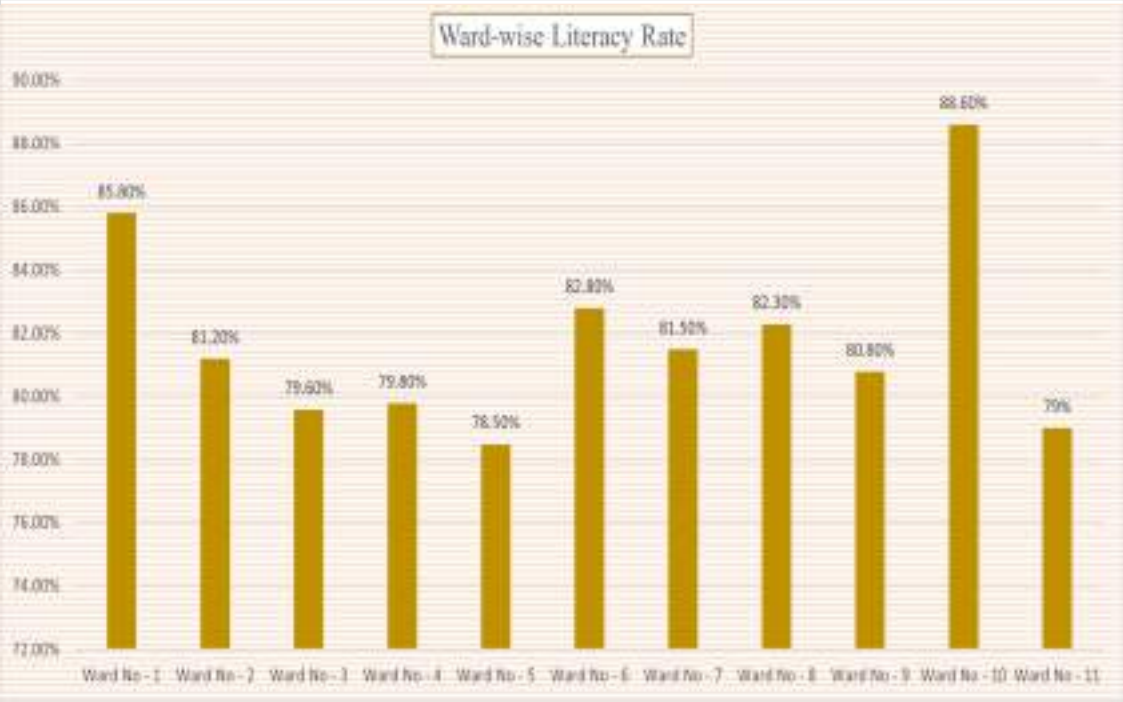

Chart 4: Ward-Wise Literacy Rate of the *Mussoorie Nagar Palika Parishad* (2011 Census)

2.3. Tourist Inflation

Mussoorie is presently the most popular destination amongst domestic tourists, being a key adventurous and aesthetic tourist destination of the state Uttarakhand. The town also attracts substantial number of foreign tourists. The various locations, especially Mall Road and Kempty fall have more regional appeal as they attract many tourists during the season from different part of the country. The annual domestic and foreign tourist traffic and percentage change from 2000 to 2021 in Mussoorie is given in the table below. The number of tourist influx has gradually increased between 2000 to 2019 but during last two-year 2020 and 2021 a reverse trend was observed may be due to Covid-19 in this region. It was estimated that about 255% tourist have been increased between 2000 to 2019 after 20 years (Table 1). These in turn speak volume about the high tourism potential that Mussoorie natural landscape is bestowed with. The tourist traffic flow in Mussoorie as provided in table reveals that the

tourist traffic to the area has grown steadily over the years with major growth taking place during 2000 to 2019 period. The growth in the number of tourist arrivals in the town indicates its increasing popularity and also the scope of promoting adventure tourism (trekking & mountaineering) and leisure tourism in the region. In 2022, total of 1173789 tourists arrived in Mussoorie with maximum influx in the months of May-June and November-December (Table 2).

TABLE 1: TOTAL NUMBERS OF TOURISTS ARRIVED IN MUSSOORIE DURING LAST TWO DECADES

Year	Indian	Foreigner	Total
2000	847191	3555	850746
2001	888870	3068	891938
2002	988481	2863	991344
2003	1024752	2986	1027738
2004	1024985	2683	1027668
2005	1044245	3547	1047792
2006	1050527	5309	1055836
2007	1075898	5424	1081322
2008	1086411	5545	1091956
2009	1096698	5869	1102567
2010	1098870	5926	1104796
2011	1114305	5982	1120287
2012	1199306	5985	1205291
2013	1070925	5050	1075975
2014	1391355	5347	1396702
2015	2764773	4499	2769272
2016	2790511	4613	2795124
2017	2794108	1865	2795973
2018	2870475	1550	2872025
2019	3022774	1065	3023839
2020	1016090	247	1016337
2021	1229528	280	1229808

Source: Uttarakhandtourism.gov.in

TABLE 2: DETAILS OF TOURIST INFLUX IN THE YEAR OF 2022

S. no.	Month	National	Foreigner	Total
1	January 2022	71218	11	71229
2	February 2022	60014	23	60037
3	March 2022	51438	45	51483
4	April 2022	68000	128	68128
5	May 2022	127000	160	127160
6	June 2022	175650	108	175758
7	July 2022	95000	102	95102
8	August 2022	96200	79	96279
9	September 2022	96603	94	96697
10	October 2022	95208	17	95378
11	November 2022	105206	166	105372
12	December 2022	130250	916	131166
Total		1171787	2002	1173789

The hill-stations like Mussoorie, Nainital, *etc.* were setup and saw an unprecedented increase in the human footprint. Considering the past tourist influx in Mussoorie, the number of visitors increased from 1,58,000 in 1958 to 3,06,000 in 1966 and 7,20,000 in 1981 (Joshi, 1990). As per study and observation of Sundriyal et al. (2018) the installation of modern tourist related facilities and infra-structure has led to the aesthetic degradation of the landscape. Tourist facility development is often disorderly and scattered. The observations indicated the aggravation of traffic congestion, atmospheric pollution, undisposed solid waste, water scarcity and infrastructure unavailability as the prevalent issues, especially during the peak tourist months. The impact of tourism on Mussoorie environment depicted in Figure 1.

The reported tourist influx data indicates an increasing trend in tourism activities in Mussoorie. The atmospheric pollution in Mussoorie during peak tourist season months can, therefore, is considered a result of elevated levels of vehicular inflow (Sundriyal *et al.*, 2018). The peak season also witnessed water scarcity. The tourist influx data (Tourist Information Centre, Dehradun) for the

study period exhibited elevated solid waste generation during the peak months when lakhs of tourists visit this hill-town and dump their waste ubiquitously (Sundriyal *et al*., 2018). During other months, the MSW generation decreased with a corresponding decrease in the number of tourists visiting the town (Sundriyal *et al*., 2018).

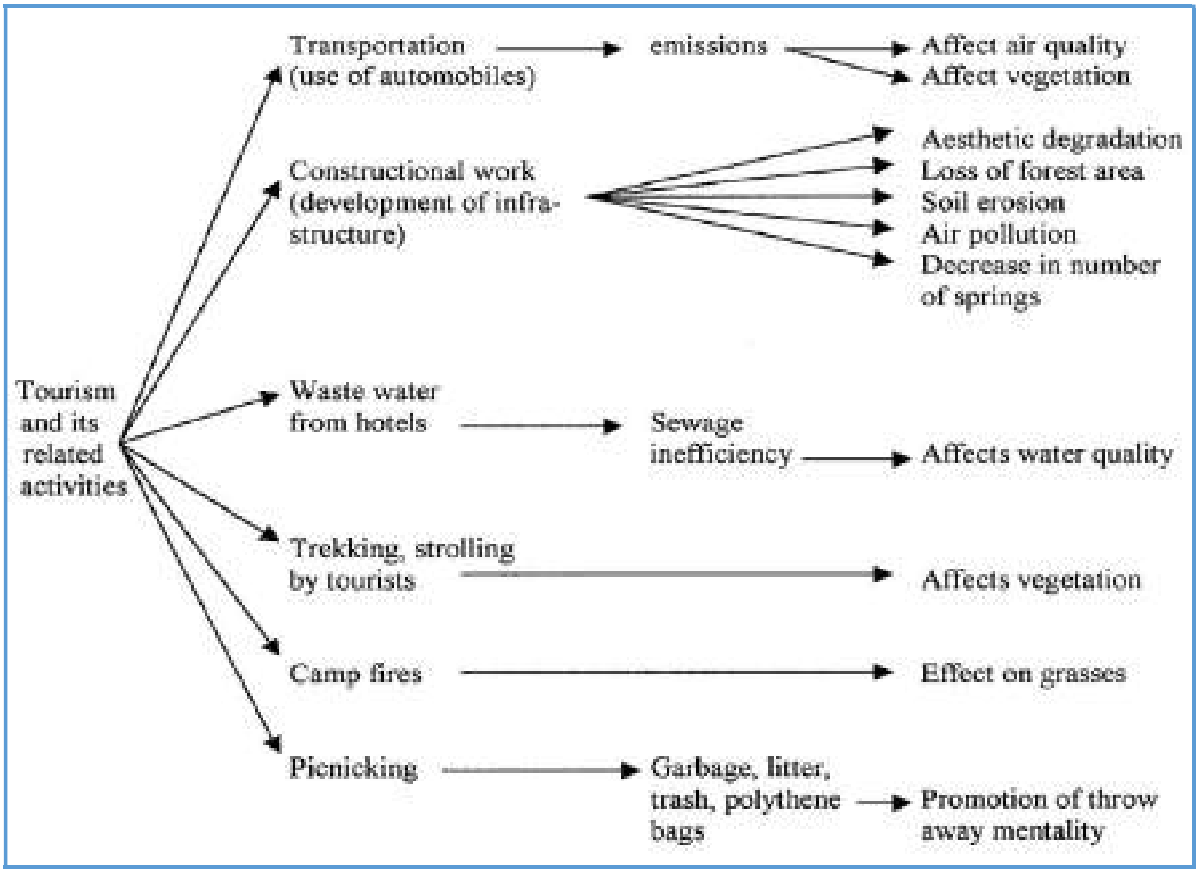

FIGURE 1: NETWORK SHOWING THE IMPACT OF TOURIST ACTIVITIES ON THE ENVIRONMENT OF THE MUSSOORIE HILLS (SOURCE: MADAN AND RAWAT 2000)

2.4. Vehicular Traffic & Parking

The popularity of Mussoorie as a tourist destination has resulted in a significant increase in vehicular traffic within the town. This surge in vehicles has led to recurring traffic congestion, particularly during peak tourist seasons.

Over the years, the road network has expanded from 219.10 kilometres in 1990 to 585.31 kilometres as of May 2023.

The Mussoorie Nagar Palika Parishad has reported that there are approximately 1,240 parking spaces available at various locations in Mussoorie. The Uttarakhand Tourism Development Board manages a parking area at the Mussoorie-Kincraig road junction with a capacity for 200 vehicles, aiming to maintain optimal traffic flow, summarized in Table 3. These efforts to manage parking spaces are essential to address the challenges posed by increased vehicular movement and ensure smoother traffic flow in Mussoorie.

TABLE 3: PARKING SPACE AVAILABILITY IN VARIOUS AREAS OF MUSSOORIE

Department	Location	No. of vehicles
Nagar Palika Parishad	Landaur (Bucharkhana)	100
Nagar Palika Parishad	Landaur near Clock Tower	40
Nagar Palika Parishad	Along Company Garden Stand	100
Nagar Palika Parishad	Bakery Hill	50
MDDA	Library Bus Stand	100
MDDA	Town Hall	100
Tourism Deptt	Kigncrag	200
Private Parking	Kempty Bus Stand	300
Private Parking	Picture palace	150
Private Parking	Vikas Hotel	100
	Total	**1240**

2.5. Built Environment

Mussoorie has witnessed significant urbanization and population growth, reflecting the broader trend in Uttarakhand. The urban population of Mussoorie has increased from 3,106 in 1881 to 18,241 in 1981, and further rose to 30,118 in 2011. The population density has also surged from 98 per square kilometre in 1901 to 511 per square kilometre in 2011. During the peak tourist season, particularly in the summer months of May, June, and July, the population density can reach as high as 1,000 per square kilometre. The demographic composition of Mussoorie is diverse, with the town currently governed by a municipal board consisting of 11 wards. The built environment of Mussoorie varies, with some wards having densely packed buildings with up to four floors, while wards 8, 9, and 10 feature high-rise apartments with eight stories. This indicates the dynamic and evolving nature of Mussoorie's urban landscape.

2.5.1. Hotels and Resorts

Mussoorie a famous hill station has a total of 303 hotels (6759 rooms, 15128 beds), 201 homestay (984 rooms, 2018 beds) and 06 *Dharamshala / Gurudwara* (144 rooms, 324 beds) with a total of 7887 rooms and 17470 bedding capacity (summarized in Table 4). The State government is promoting the homestay arrangement with different schemes and subsidiary with mandates for boosting the rural economy, sustaining the ecology by minimizing migration, and conserving local culture and tradition with eco-friendly approaches.

To promote tourism, hills slopes have been cut down for erecting new commercial establishments such as hotels & restaurants. A total of 18 new construction and 419 reconstruction and renovation activities have been done with the approval of central government, with accelerated construction after 2015 (Table 20).

TABLE 4: DETAILS OF ACCOMMODATION FACILITY AVAILABLE IN MUSSOORIE

Category	Total number	Number of rooms	Number of beds
Hotels	303	6759	15128
Homestay	201	984	2018
Dharamshala / Gurudwara	06	144	324
Total	**510**	**7887**	**17470**

There are 18 health care facility / hospitals in the region (12 private) and (06 Government) having a total of 63 bedding capacity.

2.5.2. Schools and Colleges

A total of 35 schools and colleges are existing in Mussoorie area and total of 7476 students are studying, the details are provided in the Table 5below.

TABLE 5: DETAILS OF SCHOOL AND COLLEGES IN MUSSOORIE

S.No.	Name of School / College	Type (boarding / day scholar)	Number of students
1.	Snatan dharma Sanskrit Vidyalaya	Boarding / Day	35
2.	Divya Bharti school	Day School	42
3.	Hebron elementary	Day School	210
4.	Hill Bird school	Day School	215
5.	The Mussoorie Girls and Boys	Day School	326
6.	Manav Bharti school	Day School	203
7.	St. Clares school	Day School	505
8.	C.J.M. Waverley	Boarding/Day	603
9.	Kendriya Vidyalaya	Day School	736
10.	M.P. S	Boarding/Day	258
11.	PS. Makreti	Day School	9

12.	PS. Jharipani	Day School	67
13.	PS. Barloganj	Day School	22
14.	PS. Woodstock	Day School	27
15.	PS. Landhour Cantt	Day School	16
16.	PS. Landhour no.1	Day School	13
17.	PS. Kulri	Day School	64
18.	PS. Kitabghar	Day School	25
19.	PS. Charliville	Day School	37
20.	PS. Dudhli	Day School	0
21.	PS. Nalapani	Day School	21
22.	PS. Hussainganj	Day School	12
23.	UPS. Barlowganj	Day School	16
24.	UPS. Kulri boys	Day School	17
25.	UPS. Kulri Girls	Day School	14
26.	UPS. Kitabghar	Day School	22
27.	UPS. Dudhli	Day School	0
28.	MUSSOORIE GIRLS	Day School	180
29.	SNATAN DHARM I.C	Day School	163
30.	RAMA DEVI	Day School	60
31.	Mussoorie international school	Boarding/Day	353
32.	Mahatma Yogeshwar Vidya Mandir	Day School	795
33.	Wyen berg Allen	Day School	925
34.	Tibetan homes foundation	Boarding/Day	817
35.	ST. GEORGE COLLEGE	Boarding/Day Scholar	668

3. GEOLOGICAL PROFILE

Mussoorie town area is situated on a complex geographic environment in the proximity of the Main Boundary Thrust composed of highly fractured, shattered and sheared structurally weak rocks, i.e., mainly limestone and dolomite limestone, Geomorphologically, the Mussoorie Hill terrain is made of **i)** tectonic landforms such as steep scraps, strike valleys, incised terraces, waterfalls, old landslides (e.g. discernible along Bansigad-Hathipaon Road) and active landslides (e.g. discernible along the Highways), rock falls (e.g. discernible in Radha Bhawan Estate and Butcher Khana area) and debris flow; **ii)** fluvial landforms such as V-shaped valleys, tiny alluvial terraces, fans and cones; and **iii)** pluvial landforms such as hollows, convex slopes (aquifers surface recharge zones), concave slopes (aquifer discharge zones) and colluvial cones/fans, Limestone is soluble with water, therefore, geomorphic processes like the chemical weathering and chemical erosion both are very active in the Mussoorie Hills area which accelerates the geomorphic processes of mass wasting, i.e. creeping (*e.g.* discernible near Dhobighat road on the uphill side of Henson Field near Woodstock school and in the Company Garden area).

3.1. Physiographic profile

The study location is in the Lesser Himalaya and is situated geologically to the north of the Main Boundary Thrust (MBT). The Chandpur Formation, Nagthat Formation, Blaini Formation, Krol Formation, Infra-krol Formation, and Tal Formation are made up of its rocks. The Blaini Formation, which consists of conglomerate, siltstone, greywacke, slate, and sandstone, is overlain by the Nagthat Formation's quartzite and slate. The Blaini Formation itself is overlain by the Chandpur Formation, which primarily consists of highly sheared phyllite, slates, siltstone, and greywacke. However, the rocks from the Krol and

Tal formations make up the majority of the study area. Limestone, dolomitic limestone, and dolomite are the principal rock types found in the Krol Formation. The foliation of krol limestone is inherent. Upper Tal and Lower Tal are further divided into the Tal Formation. Chert Component, Argillaceous Member, Arenaceous Member, and Calcareous Member are the four unique members that make up the Lower Tal, whereas quartzite Member is the member that makes up the Upper Tal. The hill slopes in the majority of the research area are covered with thick Quaternary deposits that represent ancient landslides. According to the channel cuts, the thickness of these deposits varies greatly.

The study conducted by Bharti et al., (2020) used Worldclim datasets (*http://www.worldclim.org/)* to understand the current trends and future projections of the climatic variables (annual mean temperature, maximum temperature of the warmest month, annual precipitation, precipitation during the wettest quarter, and precipitation in the driest quarter) for Mussoorie; by considering the period 1960–2000 as a current climatic conditions and the future conditions were downscaled global climate model data from CMIP5.As temperatures rise, people and animals need more water to maintain their health and thrive. Increased water demand can be expected due to the rise in temperature. Table 6 also show different variables of precipitation to understand the effects of climate change. Annual precipitation is expected to increase from 2,003–2,728 mm to 2,063–2,859 mm in Mussoorie. The variability in precipitation holds great importance for seasonal water consumption.

TABLE 6: PROJECTED CLIMATIC VARIABILITY (SOURCE: BHARTI ET AL., 2020)

Variable	Current Trends	RCP 4.5 (2050)
Annual mean Temperature (^{0}C)	13.1 – 20.7	15.3 – 22.8
Maximum Temperature of the	23.6 – 34.6	25.9 - 36.9

warmest month (^{0}C)		
Annual Precipitation	2003 – 2728	2063 – 2859
Precipitation in wettest quarter (mm)	1412 – 2184	1490 – 2316
Precipitation in driest quarter (mm)	111 - 123	97 - 110

3.2. Geo-hydrology

Mussoorie is located in the Lesser Himalayas and geologically to the north of the Main Boundary Thrust (MBT). The Chandpur Formation, Nagthat Formation, Blaini Formation, Krol Formation, Infra-Krol Formation, and Tal Formation are made up of its rocks. The Blaini Formation, which consists of conglomerate, siltstone, greywacke, slate, and sandstone, is overlain by the Nagthat Formation's quartzite and slate. The Blaini Formation itself is overlain by the Chandpur Formation, which primarily consists of highly sheared phyllite, slates, siltstone, and greywacke. However, the rocks from the Krol and Tal formations comprise most of the study area. Limestone, dolomitic limestone, and dolomite are the principal rock types in the Krol Formation. The foliation of krol limestone is inherent. Upper Tal and Lower Tal are further divided into the Tal Formation. Chert Component, Argillaceous Member, Arenaceous Member, and Calcareous Member are the four unique members that make up the Lower Tal, whereas quartzite Member is the member that makes up the Upper Tal. The hill slopes in most of the research area are covered with thick Quaternary deposits representing ancient landslides. According to the channel cuts, the thickness of these deposits varies greatly.

3.3. Lithology

The spatial arrangement of different litho units and the overlaying Quaternary deposits, as well as the existence of structural features, such as folds, faults, joints, fractures, etc., all have a significant impact on slope instability in a given area. Geologically, the study area constitutes the rocks of the Blaini Formation (conglomerate, siltstone, greywacke, slate, and sandstone), Krol Formation (limestone, dolomitic limestone, and dolomite), and the Tal Formation and is located in the Lesser Himalaya. Krol Formation is the dominant formation in the area of study. Tal Formation into Lower Tal with four distinct members, namely Chert Member, Argillaceous Member, Arenaceous Member, and Calcareous Member, whereas the Upper Tal is represented by Quartzite Member (Figure 2). In general, the rocks are fractured and jointed. Most of the slopes constitute the fractured and weathered rock-mass with thin veneer of sediments, and the development of soil on the slopes is not visible. It has been observed that the general slope in the area varies from 0° to > 76° and has been classified into seven classes each having an interval of 12°. The greater part i.e. ~ 38% of the study area is occupied by slope interval 38°–50°, whereas ~ 62% of the landslide covered area are located on the slopes having gradient between 25°–50°. Slope aspect is an important terrain parameter that affects the slope stability as different slope aspects receive different solar irradiance and orographic precipitation, thus affecting differential weathering and hence the varying distribution of landslides in different slope aspects is expected. Therefore, the area has been classified into nine different aspects classes viz. north (5.24%), northeast (10.94%), east (10.51%), southeast (11.09%), south (18.05%), southwest (18.46%), west (12.57%), northwest (8.67%) and north (4.47%) and around 86% of the landslide covered area are located on the slopes facing towards south, southeast, east and northeast. About 44% of the study area falls under very high, high and moderate landslide

susceptible zones and approximately 56% in the low and very low landslide susceptible zones. Dominant part of the area falling under high and moderate landslide susceptible zones lies in the area covered by highly fractured Krol limestone exhibiting slope ranging between 65 and 77°. High and very high landslide susceptible zones are located in the vicinity of the Main Central Thrust (MCT).

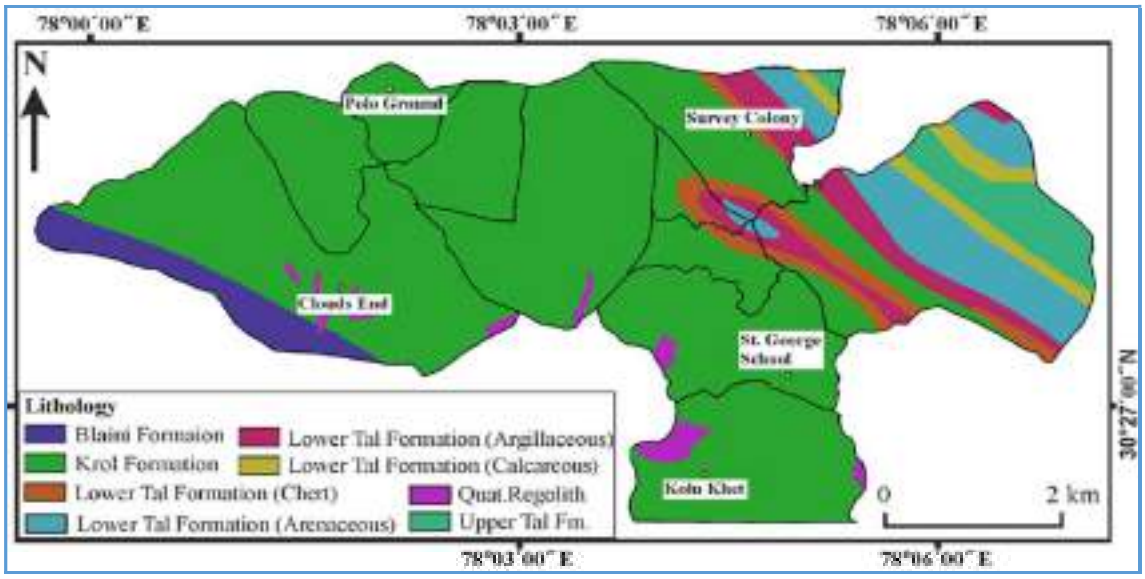

FIGURE 2: LITHOLOGICAL FORMATION OF MUSSOORIE REGION (SOURCE: RAM ET AL., 2020)

TABLE 7: LITHOSTRATIGRAPHIC SUCCESSION AROUND MUSSOORIE

Group/Formation	Lithology
Jaunsar Group	Phyllite.
Tal Formation	Coarse grained, white quartzite and pebbly quartzite, calcareous purple sandy shale, micaceous sandy siltstone, black and grey coloured banned shale, grey to black shale, chert with phosphorite and silty shale.
Krol Formation	Thicky bedded grey dolomite with thick beds od shale. Contains nodules and thin lenticular beds of black chert, grey to dark grey dolomitic limestone with thin shale and pockets of gypsum and calcite and calcareous ferruginous shale interbedded with argillaceous limestone.

Mussoorie region has been classified into five landslide susceptibility classes indicating demarcated very high, high, moderate, low, and very low landslide susceptibility zones. It has been noted that 2.31% of the area falls in the very high susceptibility zone,12.94% in the high susceptible zone, 28.65% in the moderate susceptibility, *24.01% in the low susceptibility, and 32.39% in very low susceptible zones. It has been observed that the high and very high landslide susceptibility zones are manly concentrated in the E–W trending central part and also on the southern and western parts of the study area, whereas the northern and eastern parts fall in the low hazard zone. Further, the settlement places, like Bhatta fall, George Everest, Kempty fall, and Barrlowganj, lie under high-hazard zones (Figure 3). Any expansion of construction activities may be disastrous in these zones (Ram *et al*., 2020)

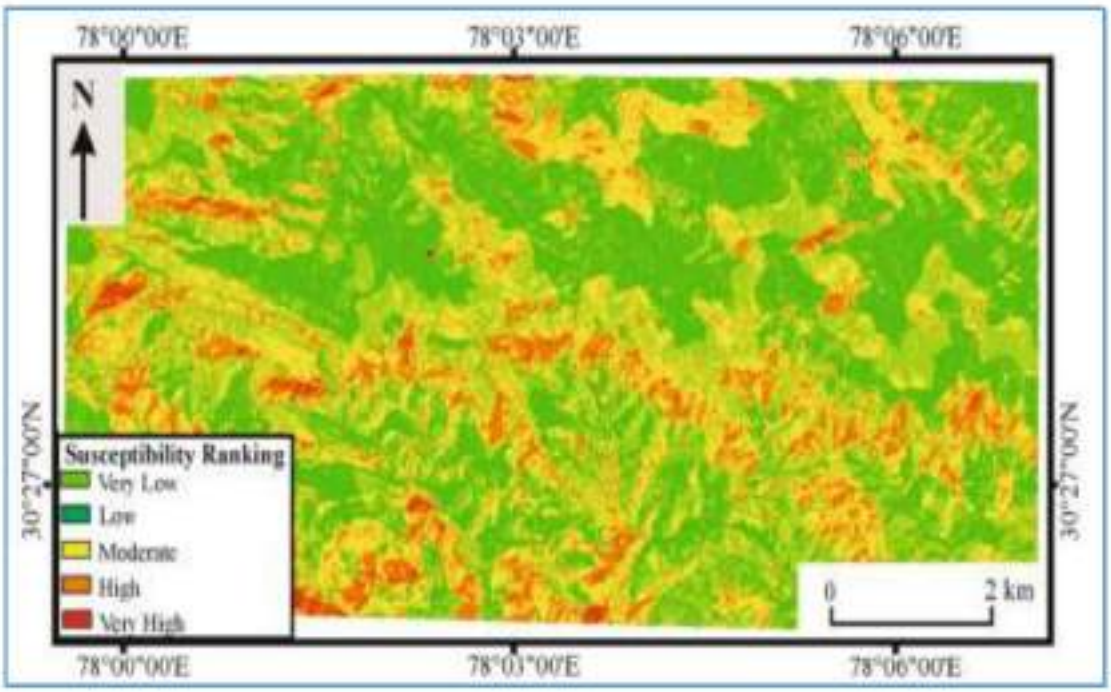

FIGURE 3: LANDSLIDE SUSCEPTIBLE MAP OF THE STUDY AREA. (SOURCE: RAM ET AL., 2020)

3.4. Geo-morphology

Geomorphological processes or changes in the morphology of the ground are regularly recorded by prior maps, satellite symbolism, and study reports of past landslides. These are likewise now and then archived in the records of watchful perceptions assumed control after some time by the administration and neighbourhood population. Geography has an imperative bearing on the geomorphic advancement of a region, especially on the slopes. The zone around Mussoorie is observed to be dismembered by a few edges, and the ground heights differ somewhere in the range of 900 and 2290 meters above mean ocean level (msl). Lal Tibba, with a stature of 2290 meters above msl, is the most astounding purpose of the territory, while the second most astounding point, Gun Hill, has an elevation of 2024 meters above msl. Organization Garden and Mussoorie Lake separately have risen 1870 and 1880 meters above msl. Groundwater exploration in the Western Doon valley (Mussoorie range in the north with 1800–2800 m elevation and in the south by frontal Siwalik range with ~800 m average elevation) has been carried out to delineate the groundwater potential and groundwater quality zones suitable for domestic purposes based on the integrated use of Remote Sensing and Geographical Information Systems (GIS).

3.5. Landslide in relation to slope

A study conducted by Panikkar and Subramanyam (1996) in Dehradun and Mussoorie enlisted the triggering factors causing the landslide, i.e., invariably rainfall and/or seismicity. Most of the landslides in the area occur after heavy rains, which serve to saturate the materials, increasing their effective weight. Moreover, it can cause the weakening of materials like clay which swell up when moist. Regarding seismicity, the Himalayas is known to be an active

seismic zone. The ground motion during an earthquake can trigger off large-scale landslides in the area. Their study in Dehradun and Mussoorie shows that all the landslides occur on south-facing slopes, which may be attributed to the microclimatology and greater anthropogenic activities here. The removal of toe support by the stream undercutting is the most frequently observed cause of sliding in the area, where 85% of the landslides occur within a distance of 200 m from the streams.

Further, 11.91% of the landslides occur in non-forested areas, indicating the effect of vegetation on the initiation of slope instability. Road cutting also causes minor landslides, although they have not had a dominant influence in the case of major landslides. Overall, rainfall and seismicity form the dominant triggering factors for landslides in the area. The statistical bivariate analysis study conducted by Ram et al. (2020) for the preparation of landslide susceptibility analysis for Mussoorie and the surrounding area indicates that the landslide in the area is controlled mainly by lithology, curvature, slope, slope aspect, and land use/land cover. This is also evidenced due to the weak, fractured, and weathered rock strata in the area that may lead to landslide due to changes in any geo-environmental factor in the area like change in the geometry of slope due to construction activity in the area or excessive rainfall conditions in the area (Ram et al., 2020). One of the similar observations by Sambhu et al. (1996), who conducted a study of landslides in Mussoorie regions, highlighted that road cutting and improper embankments have been considered to cause minor landslides; and causes of major or large landslides are monsoon, rainfall and seismic activities around the area.

A study of one such major landslide event in Mussoorie (the landslide of Surbhi Resort in Mussoorie) is reported here. According to Gupta and Ahmed (2007), natural and manmade induced factors are responsible for the occurrence of the landslide of Surbhi Resort in Mussoorie. However, the main triggering

factors were the incessant rainfall, the seepage from the upslope region, and the poor slope stability of rock mass around the landslide zone. They further concluded that the presence of highly jointed, fractured and weathered carbonate rock mass along with steep slope and high-water percolation into slopes, creates ideal conditions for slope instability in the area. The high rainfall combined with effluent discharge from the upslope region saturated the slope of the entire hills, thereby increasing the pore water pressure and decreasing the strength of these materials constituting the slope. This study also provided landslide inventory (Table 8) and a spatial distribution map of landslides in different wards (Figure 4).

TABLE 8: WARD-WISE MAPS OF LANDSLIDE INVENTORY OF THE MUSSOORIE

S. No.	Name of the Ward	Area (km^2)	No. of Landslide	Landslide density
1	Jharipani	1.89	2	1.057
2	Barloganj	1.60	2	1.251
3	Jalki	3.66	5	1.366
4	Landaur	1.51	1	0.663
5	Nagar Palika Parisad	0.50	1	2.016
6	Arya Samaj	0.31	0	0
7	Kachhari	2.4	3	1.251
8	Library	0.88	2	2.283
9	Indra Colony	0.49	1	2.037
10	Happy Valley	0.90	2	2.217
11	Bhadraj	4.01	6	1.496

Important – It may please be noted that landslide is a dynamic process, and it changes with time. The data presented above represents the distribution of

landslides as mapped in Aug 2019. The boundary of each municipality ward was obtained from the Mussoorie Nagar Palika.

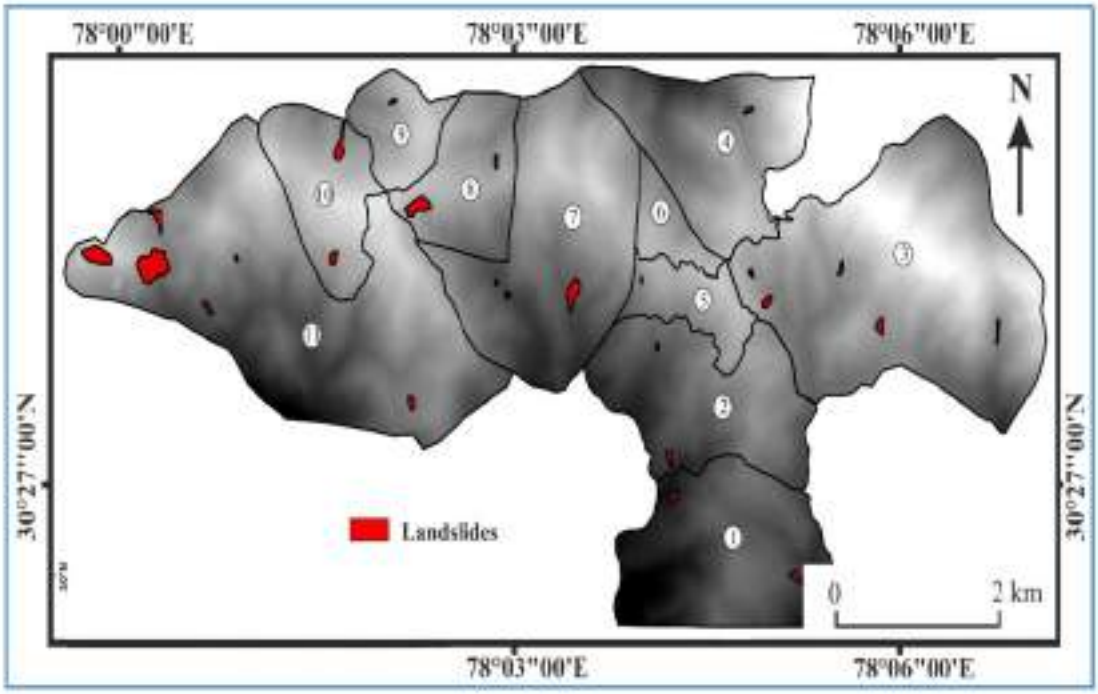

FIGURE 4: SPATIAL DISTRIBUTION OF LANDSLIDES (AS MAPPED IN AUG 2019)

4. NATURAL RESOURCE PROFILE

4.1. Forests

Mussoorie is a part of lower Himalayan region, also called 'Queen of the Hills' lies latitude 30°27' N and longitude 78°15'E with an altitude ranging from 1800 to 2300 meters. The region is enriched with various topographical features along with varied flora and fauna. This region is a fascinating hill station blessed with splendid landscapes with high peaks, waterfalls, vegetation, etc. attracting many tourists (Sundriyal et al., 2018). The area covered by forest in Mussoorie region is shown below Figure 5:

FIGURE 5: FOREST AREAS OF MUSSOORIE

4.1.1. Area of management

The classification of Mussoorie area based on type of management is as follows:

i. Reserve Forest Area

These areas are under the control of Mussoorie Forest Division, i.e. Rikholi and Motidhar forest Block. The Blockwise areaof Rikholi RF is 852 hectares, Motidhar RF is 1835.70 hectares, and Chamasari RF is 1837.66 hectares.

ii. Protected Forest Area

The Mussoorie wildlife sanctuarycreatedin1993 forms a part of the PA which is also popularly known as Binog wildlife sanctuary. It is located between latitude 28°59'40" to 31°28'05" North and longitude 70°49' to80°59'50"East which covers an area of 1081.97 hectares.

iii. Other Municipal Area Including Private Estates

These areas comprise of 3545 hectares (approx.) of Nagar Palika area that includes 276 private forest estates with varying individual areas from 0.2 to 360 hectares. These areas are generally composed of the forests, existing building, compounds, roads, orchards, agricultural land etc. Some of the private estates also have a large part of their forests adjoining the Binog sanctuary with thick banj forest, fresh water springs making them an ideal bird habitat.

iv. Landour Cantt Area

These are the areas that are managed by the cantonment authorities themselves with a total area of 280.50 hectares out of which 169.5 hectares is the forest area and the remaining 121.0hectares is covered by building and compounds.

v. Gram Samaj Area

These are the village community areas that are managed by the people of the villages to fulfil their basic requirements of fodder and fuel wood.

vi. Areas under the Cultivation:

These are mostly in the shape of 'chaks' bounded by the reserve forest and are owned by the villagers of the nearby village.

4.1.2. Forest Classification

The vertical range of Mussoorie is considerably varying from 900-2300 meters, thus exhibiting region from subtropical to temperate. The vegetation found at elevations exceeding 1500 meters corresponds to the lower oak zone, characterized as a moist temperate forest by Champion's classification of Indian Forest types. The vegetation of temperate forests region may be classified as follows:

1. Broad leaved sclerophyllous forests:
   a. *Quercus leucotrichophora* forests (1400-2300 meters)
   b. *Quercus floribunda* forests (2100-2200meters)
2. Grasslands
3. Scrub forests
4. Coniferous edaphic climax forests
   a. *Pinus roxburghii* forests
   b. Cedrus deodara forests

The area is mainly covered by oak mixed forest and conifer oak mixed forest. The dominant treespecies are *Quercus leucotrichophora, Quercus glauca,*

Quercus floribunda, Quercus semecarpifora, Lyonia ovaliflia, Rhododendron arboreum, Myrica esculenta, Cedrus deodara, Cornus capitata etc.The species richness in terms of vascular plants as well as non-vascular plants is highest on-stream banks and moist areas. For an instance the pteridophytes and bryophytes species richness is maximum on moist sites. Moreover, the Mussoorie Wildlife Sanctuary also serves as a biological hot spot on account of the presence of species of high conservation values such as *Acer oblongum*, Acer *caesium*, *Calanthe davidii*,*etc*. The Kempty falls- a major tourist attraction of Mussoorie originates within this sanctuary and plays a crucial role in maintaining a good water flow in the lean summer months.

4.2. Biological resources

The Mussoorie area is surrounded mainly by Banj Oak forests and Chir forest that occupy about 70% of total forest area. The main species Oak (*Quercus leucortichophora*) has Burans (*Rhodobendron arboreum*) and Anyar (*Lyonia obalifolia*) as principal associates. Moru (*Quercus floribanda*) and Banj (*Quercus glauca*) are found at higher elevations. Banj Oak is the climax species found in moist sheltered valleys on Northern aspect with no shrub undergrowth. The southern slopes are generally poor in vegetation cover and generally contain sporadic flora. Chir Pine forest (*Pinus roxburghii*) is generally found in the lower altitude whereas Deodar and Kail forest is present in higher altitudes.

4.2.1. Flora

A total of 1331 species of vascular plants (Raizada and Saxena, 1978) have been documented from Mussoorie region. Among these, angiosperms are 1214 distributed in 645 genera and 130 families; gymnosperms are 5 in 4 genera & 1 family and ferns are 107 in 51 genera and 23 families (Singh et al., 2021). Gramineae is the most dominant family of vascular plants followed by

Fabaceae, Asteraceae, Orchidaceae, Lamiaceae and Rosaceae. It has been observed that for Mussoorie region, the richness (S) and diversity (H') decreases with increasing elevation, i.e., 46 and 1.29 respectively below 2000m, 20 and 1.05 respectively in 2000-2500m, 24 and 1.01 respectively in 2500-3000m elevation. Lower altitude zone (<2000m) represented tropical moist forest with dominance of Shorea robusta, Quercus leucotrichophora, Terminalia chebula, while moist temperate forest present in 2000-3000m elevation zone with dominance of Rhododendron arboretum, Quercus floribunda, Q. leucotrichophora, Q. semicarpifolia, Abies pindrow (Sharma et al., 2017). Some threatened plant species including Acer caesium, Dioscorea deltoidea, Acer oblongum, Berginia ciliata, Valeriana jatamansi are also documented in the said region. (Kumar et al., 2012; Srivastav et al., 2015)

The Binog wildlife sanctuary records around a total of 335 species of vascular plants belonging to 237 genera and 102 families. Of these, 300 species are Angiosperms (86 families and 211 genera), 4 Gymnosperms and 31 Pteridophytes. As per growth form this Protected Area has 186 herbs, 71 shrubs, 19 climbers and 58 tree species. The foremost families of angiosperms are Asteraceae (19 genera, 32 species), followed by Fabaceae (14 genera, 22 species), Lamiaceae (12 genera, 22 species), Rosaceae (11 genera, 18 species) and Poaceae (13 genera, 15 species)(Kumar et al., 2012). Furthermore, in Dhanaulti region around 112 species of angiosperms belonging to 96 genera and 47 families is recorded out of which Poaceae (17 sp. & 16 gen.), Rosaceae (13 sp. & 9 gen.) and Asteraceae (8 sp. & 8 gen.) are dominant families and Rubus (4), Euonymus and Smilax (3) are dominant genus. (Srivastav et al., 2015)

4.2.2. Fauna

Mussoorie is known for its diverse range of fauna, including species like Jungle Cat, Leopard, Leopard Cat, Fishing Cat, Himalayan Goat, Serow,

Barking Deer, Flying Squirrel, Himalayan Jackal, Common Langur, Wild Boar, Mongoose, Monkey, and Porcupine.

4.2.2.1. Mammals

The diversity in the vegetation in the area supports a good number of mammalian fauna which includes Himalayan goat, Leopard, Barking Deer, Himalayan black bear, Northern plains gray langur, Yellow throated marten, Indian crested porcupine to name a few.

4.2.2.2. Avifauna

This region forms an ideal habitat of the rare species of various avifauna and is home to several species of residential and migratory birds' species. Some of the important avi-fauna present are Himalayan griffon, Crested Serpent eagle pheasant, Long-tailed broadbill, Kalij pheasant, Black partridge, cheer pheasant Rock dove, Green Bee eater, Himalayan cuckoo, Night jar, Jungle crow, Himalayan Golden eagle, Brahminy kite, Rufous sibia, Eurasian jay, etc. The endangered bird Himalayan Bater (The Mountain Quail) was seen in Mussoorie Wildlife Sanctuary long ago and might be spotted again in this region. Binog Wildlife Sanctuary is one of few such protected areas in the Western Himalayas at the altitude 1500-2200 m that is probably the westernmost (globally) breeding locations for the Long-tailed broadbill (Psarisomus dalhousiae) the only bird in the genus Psarisomus.

4.2.2.3. Herpetofauna

The region has rich assemblage of reptiles and amphibians with few species endemic to Western Himalayan region. The key herpetofaunal habitat features the area of perennial stream habitats. The systematic study of herpetofauna has only been done in Mussoorie Wildlife sanctuary that records**14 species of herpetofauna** belonging to 12 genera and 8 families.

Among them amphibians are represented by five species and reptiles are represented by nine species including five species of snakes and four species of lizards. The amphibians such as Little Torrent Frog, Large Torrent Frog, Himalayan Paa Frog, Himalayan Pit Viper, Mackinnon's wolf snake, Kumaon Mountain lizard, Himalayan Keelback are also found. Interestingly for the first time the live encounter of specimen of Black-bellied coral snake (*Sinomicrurus nigriventer*) from Bhadraj block of the P.A. confirms distribution record of the species only from Mussoorie and Nainital regions of Uttarakhand (Kumar *et al*, 2021). Also, the record of rare Himalayan wolf snake (*Lycodon mackinnoni*) one of the rarest species endemic to Western Himalayas from its type one topotypic specimen after a long gap of 112 years close to the sanctuary indicates importance of the area.

4.3. Forest Fire Risk

Forest fires pose a significant threat to the biodiversity of Mussoorie.

A study conducted in the Raipur Range of Mussoorie Forest Division identified fire-sensitive regions and analysed the factors contributing to forest fires, presented in figure 6.

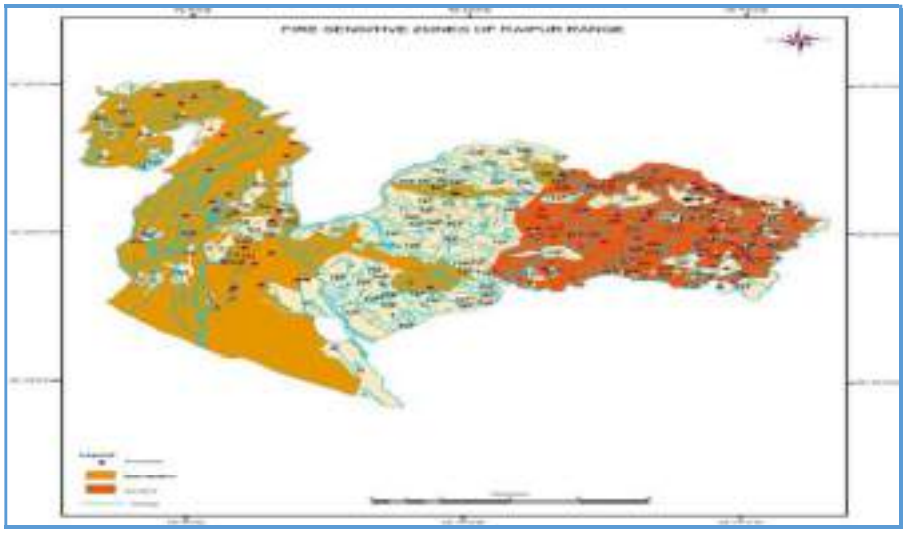

FIGURE 6: FIRE RISK ZONE MAP OF RAIPUR RANGE (VERMA ET AL., 2013)

South-western aspects with higher altitudes and medium-density forests during dry months of May and June were found to be highly prone to fire.

The forests of Mussoorie harbour a diverse array of plant and animal species, contributing to the region's ecological significance. Conservation efforts, including fire management strategies, are crucial for the preservation of this valuable biological resource.

4.3. Water resources

Mussoorie faces challenges in its water resources. With outdated infrastructure and projected future water shortages, efforts are being made through schemes like Yamuna water supply and new reservoir proposals to secure a sustainable water supply for residents and tourists. In Mussoorie, the Uttarakhand Peyjal Nigam looks after the planning and implementation of water and sewerage projects; whereas, the Uttarakhand Jal Sansthan is responsible for most repair and maintenance work (Singh, 2015). For meeting its drinking water demands, the population of Mussoorie is solely reliant on the water discharged by the nearby springs and spring-fed streams. According to Madan and Rawat (2000), a historical review and conservative estimate shows a drastic reduction in the number of its water resources from 120 (most of these have now either dried up or water discharge from them has become insignificant) to 20. of the 20 available water resources (springs and brooklets), 6 are gravity-fed and 14 require pumping water to their respective pumping stations. The Mussoorie Drinking Water Scheme covers an area of 64.25 Km^2 (Sundriyal et al., 2018).

As per Bharti et al., (2020), in Mussoorie, the municipality taps 20 spring sources to generate 9 million litres per day (MLD) of water, transported by gravity and pumping systems. There is a 98 km-wide network of distribution pipelines, with 4,065 domestic and 1,206 commercial tap connections, covering

approximately 90% of Mussoorie's area. The corresponding water requirement is higher in peak tourist seasons (May and June) and scarcity of water during the peak tourist months is, therefore, a regular problem in these destinations (Sundriyal et al., 2018). However, in reality, the town is always bursting with tourists and thus the water requirement exceeds the water availability. The situation has engraved in light of the fact that the town is facing the issue of continuously depleting water sources i.e., springs and brooklets (Sundriyal et al., 2018). The water supply infrastructure however is extremely old, most of the pumping schemes were established in the early 1900s during the British rule, with the exception of the Dhobighat pump which is fairly recent

4.3.1. Rainfall and Climate

Mussoorie receives an annual rainfall greater than 2000mm, with most of it occurring during the monsoon season. This indicates a relatively abundant water supply, at least during the rainy months.

4.3.2. Water Shortage Concerns

The town's infrastructure is described as being stuck in the colonial era, heavily dependent on the groundwork established by the British. This suggests that the water supply and management systems may not have kept pace with modern requirements and challenges. A study conducted in 1998 highlighted the issue of future water shortage in Mussoorie unless measures to augment the water supply are planned and implemented. This implies that the current water supply may not be sufficient to meet the growing demands of the population and tourism.

4.3.3. Water Demand Projection

The projected water demand (@ 135 lpcd) as per the information and data provided by Drinking Water Department based on realistic assessment is as per the below mentioned Table 9 -

TABLE 9: PROJECTED WATER DEMAND (AS PER THE INFORMATION RECEIVED FROM PROGRAM DIRECTOR, STATE PROGRAM MANAGEMENT GROUP, NAMAMI GANGE, UTTARAKHAND)

Year	Projected Population	Total water demand (MLD)
2022	93520	15.78
2037	115413	19.48
2052	142036	23.97

4.3.4. Existing Water Supply

The current water supply for Mussoorie Nagar Palika (Municipal Corporation) is sourced from 6 pumping stations and 6 gravity sources, providing 7.69 Million Litres per Day (MLD) of water. However, it is mentioned that the water demand exceeds the supply, indicating a potential water deficit.

TABLE 10: MUSSOORIE'S CURRENT WATER SUPPLY

Current supply of water							
#		**Year of establishment**		**Name of source**	**Water Supplied (MLD)**	**Type of source**	**Type of Supply**
A	**Pumping Scheme**						
1	Murray Pumping Scheme	1908	1	Khanaultry	0.648	Spring	Pumping
			2	Undercliff	0.155	Spring	Pumping
			3	Bansi	0.288	Spring	Pumping
			4	Kandighat Upper	0.288	Brooklet	Pumping
			5	Kandighat	0.691	Brooklet	Pumping

				Lower			
			6	Rikhauli Gad	0.360	Brooklet	Pumping
			7	Kandighat Stream	0.360	Brooklet	Pumping
2	Mackinnon Pumping Scheme	1913	8	Newby	0.115	Spring	Pumping
			9	John Mackinnon	0.216	Spring	Pumping
			10	ChalmerKhud	0.115	Spring	Pumping
3	Bhilaru Pumping Scheme	1925	11	Bhilaru	1.296	Spring	Pumping
4	Jincy Pumping Scheme	1972	12	Jincy	2.419	Spring	Pumping
5	Kolti Pumping Scheme	1971	13	Koltikhala	0.864	Brooklet	Pumping
6	Dhobighat Pumping Scheme	2003	14	Dhobighat	0.763	Brooklet	Pumping
B	**Gravity Scheme**						
1			15	Company Khud	0.086	Spring	Gravity
2			16	Brookland	0.129	Spring	Gravity
3			17	Nalapani	0.036	Spring	Gravity
4			18	Pargakhala	0.158	Spring	Gravity
5			19	Douglas date	0.129	Spring	Gravity
6			20	Sentipani	0.072	Spring	Gravity
	Total Pumping Gravity				**9.188**		**Gravity**
C	**Buranskhanda Rural Pumping Scheme**						
1			1	Ghatidhar	0.036	Spring	Pumping
2			2	Ghuggupal Brooklet	0.216	Brooklet	Pumping

(Source: Jal Sansthan Records)

4.3.5. Yamuna Water Supply Scheme

To address the water shortage, Mussoorie is receiving water from the Yamuna water supply scheme. In June 2023, 2.5 MLD of water was received, and it is projected to increase to 6.60 MLD by September 2023. The scheme's future projections estimate the supply to reach 11.75 MLD by 2037 and 17.62 MLD by 2052 (Table 11).

TABLE 11: FUTURE REQUIREMENT VS AVAILABILITY OF WATER DEMAND

Year	Required (MLD)	Availability (MLD)	Difference (MLD)
2022	15.78	7.69	8.09
2033	16.12	7.69+11.79=19.48	Excess 3.36
2037	19.48	7.69+11.79=19.48	Nil
2052	23.97	7.69+17.62=25.31	Excess 1.34

4.3.6. Proposed Storage Reservoirs

To address the future water requirements, the information mentions that many new proposals for storage reservoirs are in progress. This suggests that efforts are being made to enhance the water storage and supply infrastructure in Mussoorie. Details of existing water storage infrastructure are as given below in Table 12.

TABLE12: PROPOSED AND EXISTING STORAGE RESERVOIRS

S. No.	Location	New proposed CWR (Cap in KL)	Existing CWR (Cap in KL)
1	Vincent hill		227 KL 1 No.
2	Vincent hill		227 KL 1 No.
3	Vincent hill		908 KL 1 No.
4	Library savoy		380 KL 1 No.
5	Mount Rose		500 KL 1 No.
6	Gun hill no. 1		136 KL 1 No.

7	Gun hill no. 2		926 KL 1 No.
8	Gun hill no. 3		9080 KL 1 No.
9	Gun hill no. 4		2270 KL 1 No.
10	Gun hill no. 5		4540 KL 1 No.
11	Landhour survey 4	200 KL 1 No.	45 KL 1 No.
12	Landhourcantt		90 KL 1 No.
13	Depot RCC	300 KL 1 No.	45 KL 1 No.
14	Depot Landour		745 KL 1 No.
15	Wyn Berg Allen		54 KL 1 No.
16	Radha Bhawan	4000 KL 1 No.	4000 KL 1 No.
17	The Oks Nabha		400 KL 1 No.
18	Barloganj steel tank		50 KL 1 No.
19	Cloud end (Tibri top)		45 KL 1 No.
20	George everest	100 KL 1 No.	

It is evident that Mussoorie faces challenges related to water supply and increasing demand. The projected increase in water demand underscores the need for effective planning and implementation of measures to augment the water supply. The reliance on colonial-era infrastructure may pose additional challenges in meeting the growing demands. The introduction of the Yamuna water supply scheme is a step towards addressing the shortage, but it may not be sufficient in the long run. The ongoing proposals for storage reservoirs indicate recognition of the issue and efforts to develop new infrastructure. However, it remains crucial to ensure sustainable water management practices and explore additional solutions to secure an adequate and reliable water supply for Mussoorie's current and future needs.

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5. WASTE MANAGEMENT PROFILE

5.1. Solid Waste Management

It was estimated that the total solid waste dry, wet and others generated from household and commercial establishment like Shops, Govt/Non-Govt. establishments etc. in Mussoorie town is **15 Metric Tons Per Day (MTPD)** during high footfall season while during non-tourist season it is **12 Metric Tons Per Day (MTPD)**. Whereas plastic waste from municipality of Mussoorie is accounted **3.5 MTPD**. Segregation of waste at source is done about **70%** whereas Door to Door collection of solid waste is carried out about **95%**. The total of around **150** waste pickers/sanitation workers is engaged in collection and segregation of the waste from different sources. Nagar Palika Mussoorie is also among the best performers in the district. Nagar Palika Mussoorie has employed indigenous technique for waste management. Household are equipped with **QR Code** and daily solid waste collection being monitored by this system. Implementation of **Digital Deposit Refund System** is under process. It has also propagated the concept of circular economy. Plastic is segregated from the dry waste after secondary segregation at MRF centre. After compaction by plastic compactors, it is either sold to local rag pickers or is channelized to authorized recycler. Dustbins have been provided in major tourist location to prevent littering of plastic waste. A bio-methanation plant of **10 Tonne** capacity is under construction for disposal of bio-degradable waste. **75%** work of bio-methanation plant has been completed. The plant will be functional by **October 2023**.

5.2. Liquid Waste Management

In the town of Mussoorie, there are a total of 65,741 meters of sewer lines available with a capacity of 7.32 MLD (Million Liters per Day). There are 10,813 meters of sewer lines currently under construction, with a capacity of 3.25 MLD. The waste water generation of Mussoorie is around 8.15 MLD and the present sewage treatment capacity is 7.32 MLD with available 65741m sewer lines. The details of the sewage plants are summarized in Table 13. Further, six new STP of 3.25 MLD are under construction. After completion of the proposal, the total capacity will be increased to 10.57 MLD.

TABLE13: DETAILS OF MUSSOORIE SEWAGE PLANTS

S. No.	Zone	Completed		Ongoing	
		Sewer line (length m)	STP (MLD)	Sewer line (length m)	STP (MLD)
1	Kulri	3264.00	0.90	296.00	-
2	Landour North	590.00	0.80	0.00	-
3	Happy valley	5066.00	1.20	1593.00	-
4	Bhattafall	31737.00	3.12	5000.20	-
5	Landour South	7949.00	1.30	57.00	-
6	Library-Bhilaru	10087.00	-	2327.00	1.10
7	Dhobighat	1132.00	-	0.00	0.05
8	Camel back	1136.00	-	496.00	0.70
9	Company garden	3645.00	-	0.00	0.70
10	Arachadia	1135.00	-	1044.00	0.70
	Total	**65741.00**	**7.32**	**10813.20**	**3.25**

Mussoorie has established several sewage treatment plants (STPs) in different areas, while some are still in progress. The Uttarakhand Pollution Control Board monitors the performance of these STPs on a monthly basis, ensuring compliance with the Environment (Protection) Rules 1998.

TABLE 14: CHARACTERISTICS OF SEWAGE TREATMENT PLANTS (JANUARY TO MAY, 2023) (OPERATED BY UTTARAKHAND JAL SANSTHAN)

S. No.	Name of the STPs (With Capacity)		Sampling Point						
			Inlet of STP			Outlet of STP			
		Month	pH	BOD (mg/l)	TSS (mg/l)	pH	BOD (mg/l)	TSS (mg/l)	Fecal Coliform (MPN / 100 ml)
1	Landour (S), Mussoorie (1.3 MLD)	Jan	6.62	165	157	7.47	8.8	09	430
		Feb	6.75	170	163	7.60	8.4	08	94
		Mar	6.81	175	170	7.65	8.8	09	110
		Apr	STP found non-operational as plant was under maintenance work. (Date of Inspection: 01-04-2023)						
		May	7.20	180	178	7.70	9.2	10	350
2	Bhatta Fall, Mussoorie (3.12 MLD)	Jan	6.53	155	150	7.01	9.2	10	94
		Feb	6.60	150	144	7.23	8.8	09	49
		Mar	7.30	155	148	8.50	8.4	08	84
		Apr	7.20	160	156	8.10	9.2	10	94
		May	6.90	165	163	7.14	9.6	11	170
3	Landour (N), Mussoorie (0.8 MLD)	Jan	6.96	175	166	7.52	9.2	09	120
		Feb	6.81	170	165	7.41	9.6	10	84
		Mar	7.02	175	168	7.80	8.8	09	94
		Apr	7.10	180	175	7.40	8.4	09	84
		May	7.14	185	181	8.30	8.8	10	540
4	Happy Valley, Mussoorie (1.2 MLD)	Jan	6.84	170	160	7.25	8.8	10	110
		Feb	6.92	175	167	7.36	8.4	09	94
		Mar	8.30	185	179	8.75	9.2	10	70
		Apr	STP found non-operational at the time of inspection. (Date of Inspection: 01-04-2023)						
		May	7.05	195	199	7.80	10	13	16×10^2
5	Kurli Bazaar, Mussoorie (0.9 MLD)	Jan	6.71	175	167	7.51	10.0	10	84
		Feb	6.63	180	173	7.67	9.2	09	79
		Mar	6.90	190	185	8.60	9.6	10	94
		Apr	6.95	195	189	7.80	8.8	09	79
		May	6.70	200	196	7.09	9.2	10	110
	Sewage Treatment final effluent standards (As Notified by MoEF&CC)					**6.5-9.0**	**30**	**<100**	**<1000**

The water quality characteristics, including pH, Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and Fecal coliform, are regularly monitored at the inlet and outlet of the STPs. Based on the analysis, the pH, BOD, and TSS levels were found to be within the prescribed discharge limits, its characteristics are highlighted in Table 14. However, during May 2023, it was reported that the Fecal coliform levels at Happy Valley, Mussoorie, exceeded the permissible limit. This indicates a potential issue with the treatment process or the sewage input in that particular area. Further investigation and corrective measures may be required to address this concern.

5.3. Bio-Medical Waste Management

The data indicates that most healthcare facilities, both government and private, utilize the Common Biomedical Waste Treatment Facility (CBWTF) for the disposal of biomedical waste. This aligns with the Biomedical Waste Management Rules 2016, which emphasize the importance of proper treatment and disposal of biomedical waste to prevent environmental and public health risks. Biomedical waste is produced in varying quantities across the facilities. Notably, Lal Bahadur Shastri National Academy of Administration and The Dental Care generate a minimal amount of waste, while Jaunpur Pathology Laboratory produces a relatively higher quantity. Two government facilities, S.C. Bhatta and S.C. Malsi, opt for deep burial as their disposal mechanism. Deep burial involves burying the biomedical waste in designated areas, complying with specific regulations.

TABLE 15: DETAILS OF HEALTHCARE FACILITIES IN MUSSOORIE

S. No.	Name of the Health Care Facilities	Types (Govt / Pvt)	Number of beds	Biomedical waste (kg / day)	Disposal mechanism
1.	Govt. St.Marry Hospital, Camal Back Road Mussorrie, Dehradun	GOV	12	2	CBWTF

2.	Lal BhahadurShashtri National Academy of Administration, Mussoorrie, Dehradun	GOV	0	0.267	CBWTF
3.	Landour Community Hospital, Mussoorie, Dehradun	GOV	35	2.7	CBWTF
4.	Oral Health resort, Kulri, Mussoorie, Dehradun	PVT	0	0.015	CBWTF
5.	Jaunpur pathology laboratary, Kempty, Mussoorie, Taluka, Dehradun	PVT	0	0.563	CBWTF
6.	S.C. Bhatta, Mussoorie, Barloganj, Dehradun	GOV	0	0.1	Deep Burial
7.	S.C. Malsi, Mussoorie, Dehradun	GOV	0	0.1	Deep Burial
8.	Uniyal Homeopathic Clinic, Tilak road, Mussoorie, Dehradun	PVT	0	0	NIL
9.	Grunanak Charitable Dispensary, Sai ghandhiniwas, Kulri, Mussoorie	PVT	0	0	NIL
10.	Galmei Dental Clinic, Picture Palace, Tilak, Mussoorie	PVT	0	0	NIL
11.	State Veterinary Hospital, Mussoorie	GOV	0	0	
12.	Sai Clinic, Tilak Road, Picture palace, Mussoorie, Dehradun	PVT	0	0	NIL
13.	The Board of The Woodstock School and Teacher's Training College, Tehri Road, Landour, Mussoorie	PVT	12	0.25	CBWTF
14.	The Dental Care, Near hotel Himalayan club, Mussoori, Dehradun	PVT	0	0.125	CBWTF
15.	Homoeopathic Chiktsa Kendra, Near MDDA Parking, Landour Road, Mussoorie	PVT	0	0	NIL
16.	Uniyal Homeopathic Clinic, Picture palace, Mussoriee	PVT	0	0	NIL
17.	Sanon Clinic, Lonsite, Kulri, Mussoorie	PVT	0	1	CBWTF
18.	Govt. Ayurvedic Hospital, Mussoorie, Dehradun	GOV	4	0.1	Deep Burial

The data reflects a general adherence to the Biomedical Waste Management Rules in Mussoorie, with most facilities utilizing the CBWTF for the appropriate management of biomedical waste. The details of the available data are summarized in Table 15. This approach ensures the safe handling, treatment, and disposal of waste, minimizing potential hazards to human health and the environment. The presence of deep burial as an alternative method suggests that some facilities may have specific waste disposal needs or arrangements, compliant with the rules.

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6. LAND USE AND LAND COVER

6.1. Land Use Changes in Mussoorie

The comparison of land use done in 1998 in study of Carrying Capacity by LBSNAA and study conducted by Uttarakhand Space Application Center (USAC) in 2011 reveals that the land under forests which had reduced by 4.38 sq. Km. (from 79% in 1990 to 72% in 1997) between 1990 and 1997, and has increased by 0.121 sq. Km. between 1997 and 2009 (Table 16, Figure 7-12).

The density of forest has also improved between 1997 and 2009 due to afforestation activity funded by the Supreme Court Monitoring Committee as a result of cess imposed on mining. This is basically due to the clarification and directions of the Hon'ble Supreme Court mentioning that the F.C. Act, 1980 will apply not only to notified and recorded forests but also to the forests by dictionary meaning irrespective of the ownership. The implication of the direction is that for forest areas, approval for non-forest use has to be obtained from the Govt. of India.

TABLE 16: CHANGE IN LANDUSE IN MUSSOORIE (1990-97 AND 2009)

Landuse Categories	Area (Sq.Km.) 1990	Area (Sq. Km.) 1997	Area (Sq.Km.) 2009	Change in sq. km. between 1990 and 1997	Change in Sq. Km. between 1997-2009
1	**2**	**3**	**4**	**5 (3-2)**	**6 (4-3)**
Dense Forest	29.32	23.31	26.042	-6.01	**2.732**
Medium /Moderately Dense Forest	11.08	18.28	14.680	7.20	**-3.600**
Open Forest/Scrub	11.62	6.05	7.039	-5.57	**0.989**
Sub-Total Forest	52.02 (79.04)	47.64 (72.39)	47.761 (72.57)	- 4.38 (- 6.65)	**0.121 (0.18)**

Agriculture	2.51 (3.81)	3.57 (5.43)	3.896 (5.92)	1.06 (1.62)	**0.326 (0.49)**
Built-up Area	6.74 (10.24)	11.06 (16.81)	11.114 (16.90)	4.32 (6.57)	**0.054 (0.09)**
Waste/Barren Land	4.55 (6.91)	2.44 (3.70)	2.799 (4.25)	-2.11 (-3.20)	**0.359 (0.55)**
Unclassified	0.00	1.10 (1.67)	0	1.10 (1.67)	**-1.10 -(1.67)**
Water Bodies	N.A.	N.A.	0.240 (0.36)	N.A.	**0.240**
Grand Total	**65.81**	**65.81**	**65.81**		

The figures for 1990 and 1997 are based on the 1998 study by LBSNAA and for 2009 as per study of Uttarakhand Space Application Centre (USAC). The figures in parentheses are percentage of total area (65.81 sq. Km.) under various land uses. It is noteworthy that in Mussoorie construction activity was continuing at a very fast pace despite the fact that there are – 276 estates notified as private forests. This activity has reduced drastically after 1997, as a result of the Writ Petition 749/1995 filed by SCMC against MDDA & Others and 202/1995 filed by Godaverman against Union of India and Others and judgments of the Hon'ble Supreme Court dated 29.11.1996 and 12.12.1996 clarifying that the Forest (Conservation) Act, 1980 applies to the forests notified by the State Government and also to the forests by Dictionary meaning (irrespective of the ownership) and as such permission for non-forestry use of forest land will have to be obtained from the competent authority i.e. the Ministry of Environment and Forests, Govt. of India, New Delhi.

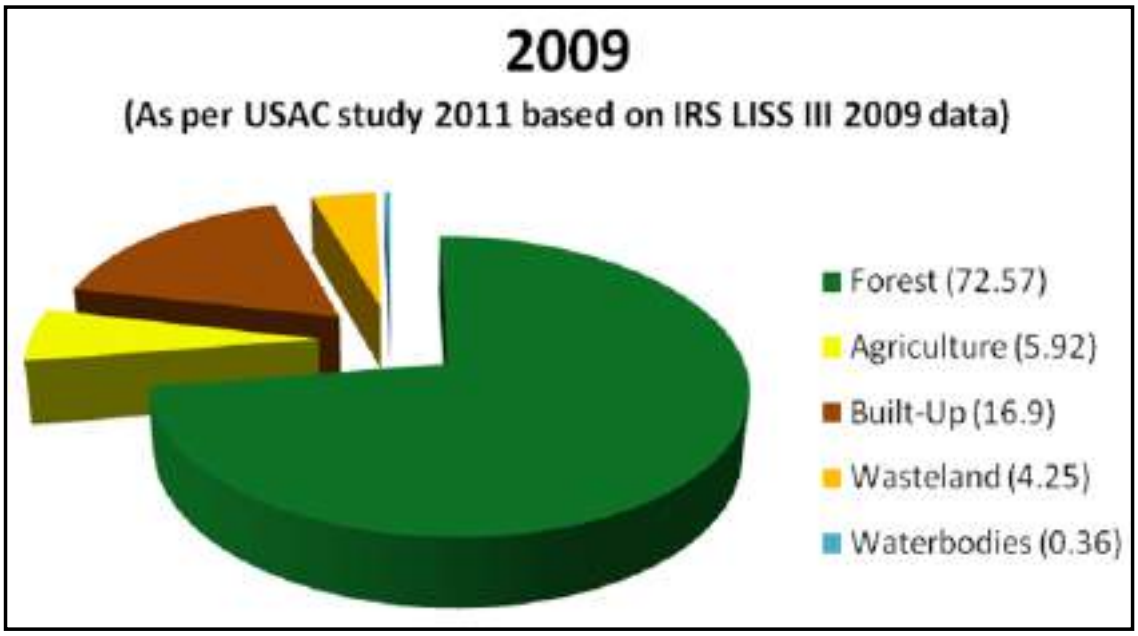

FIGURE 7: LANDUSE DATA IN MUSSOORIE (2009).

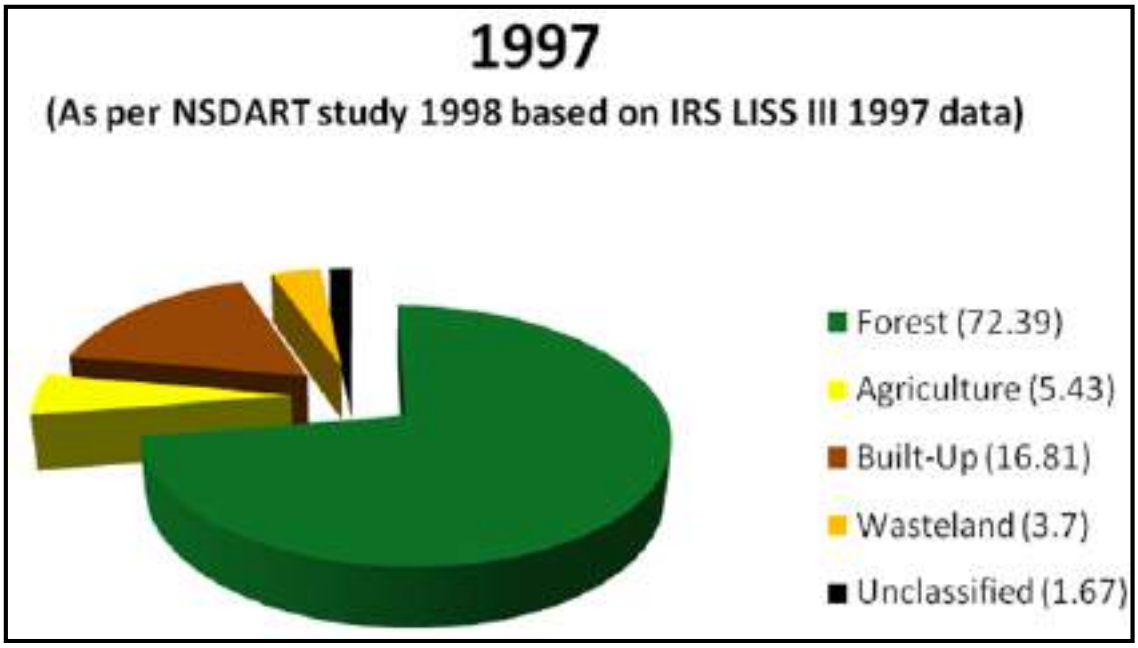

FIGURE 8: LANDUSE DATA IN MUSSOORIE (1997)

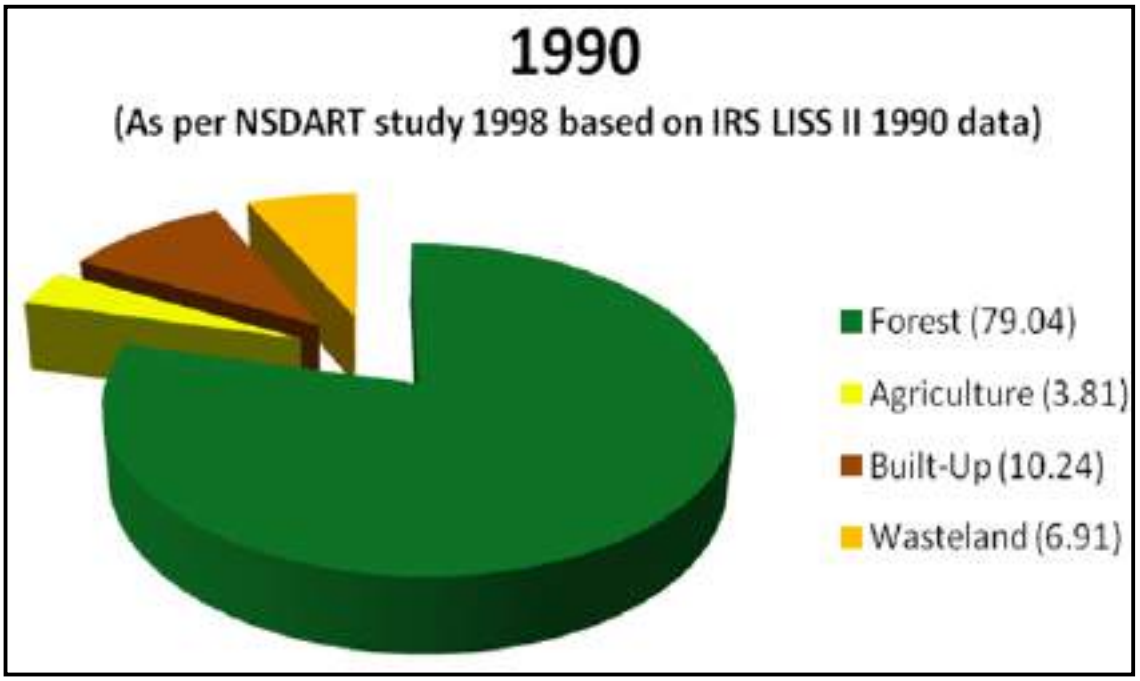

FIGURE 9: LANDUSE DATA IN MUSSOORIE (1990)

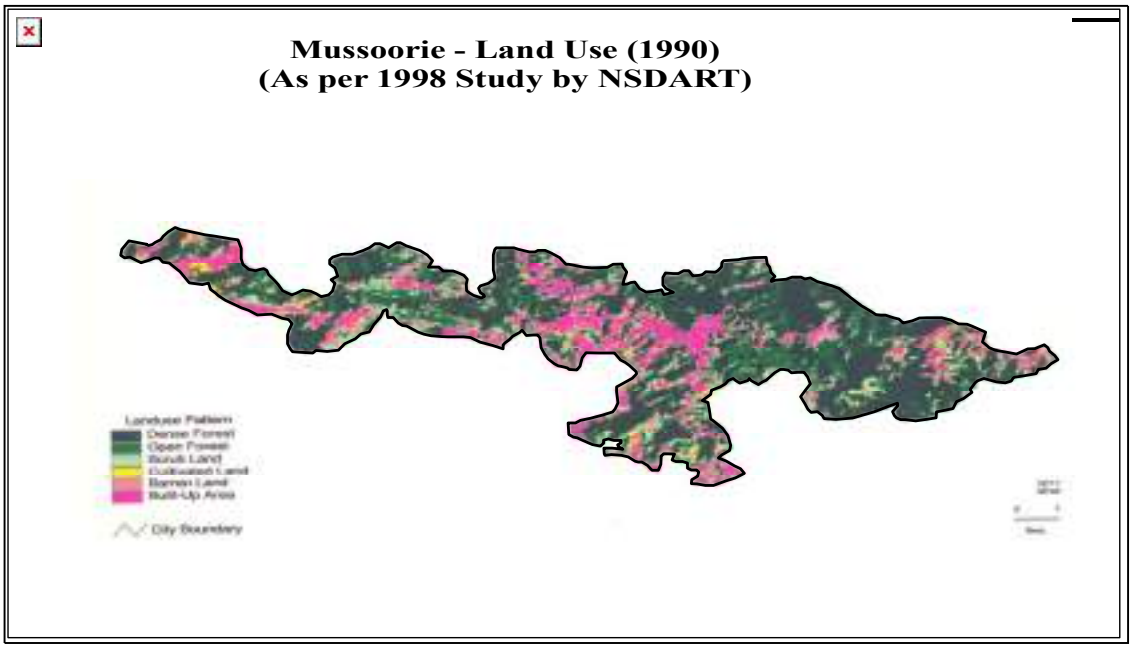

FIGURE 10: LANDUSE MAP IN MUSSOORIE (1990)

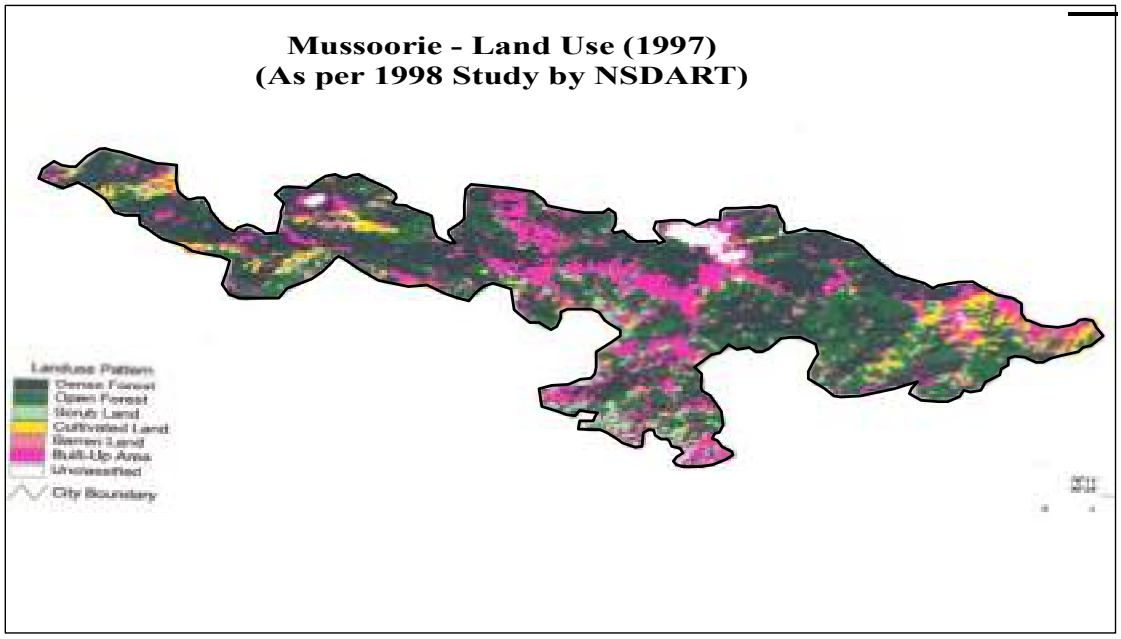

FIGURE 11: LANDUSE MAP IN MUSSOORIE (1997)

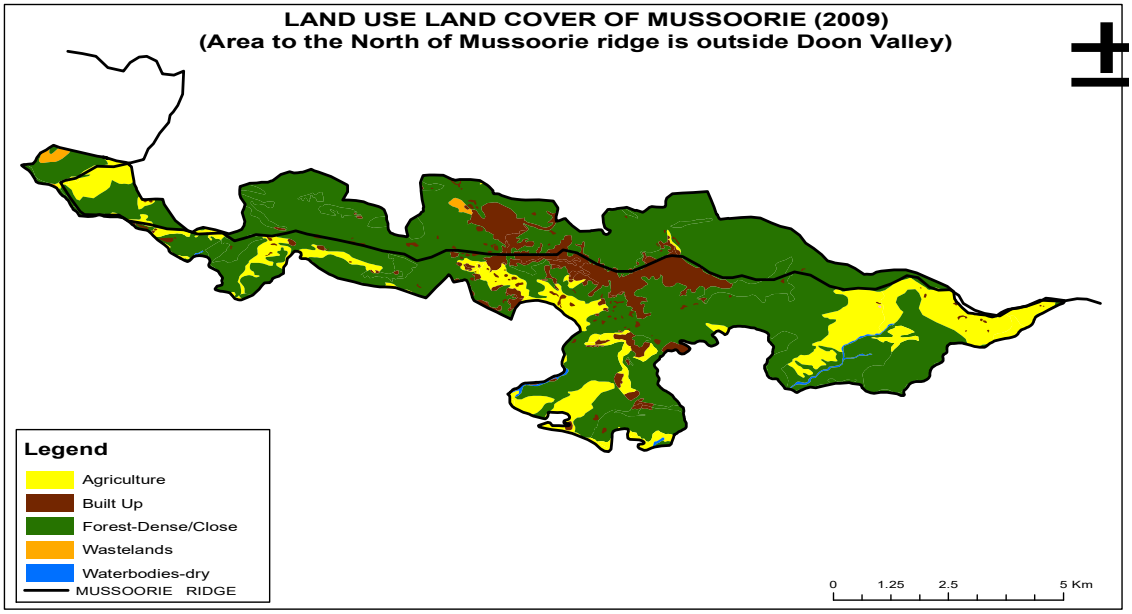

FIGURE 12: LANDUSE MAP IN MUSSOORIE (2009)

6.2. Impact of Slope on Land Use

The table below which is reproduction 1998 study gives the area and percentage of land in Mussoorie by slope categories from which it would be seen that about 79% of the area falls in slope category of 30 degree and more and only about 13 sq. kms. has less than 30-degree slope and that too in small patches. Out of this, 11 sq. kms. is already under the built-up area and therefore, hardly 2 sq. km. is available for safe construction. The use of land with more than 30-degree slope for urban development would be at a great risk and consequently the bye-laws of MDDA have banned construction in areas with more than 30-degree. The position in 2011 continues to be the same as in 1998 study since the constructions between 1997 and 2011 are by and large renovation or reconstruction of existing buildings (Table 17).

TABLE 17: AREA AND PERCENTAGE OF LAND IN MUSSOORIE BY SLOPE CATEGORIES

Degree of Slope	Area in Square Kilometers	Percent Area to Total Area
Below 10	5.54	**8.42**
10-20	3.65	**5.55**
20-30	4.23	**6.43**
30-50	10.43	**15.84**
50-90	41.96	**63.76**
Total	**65.81**	**100.00**

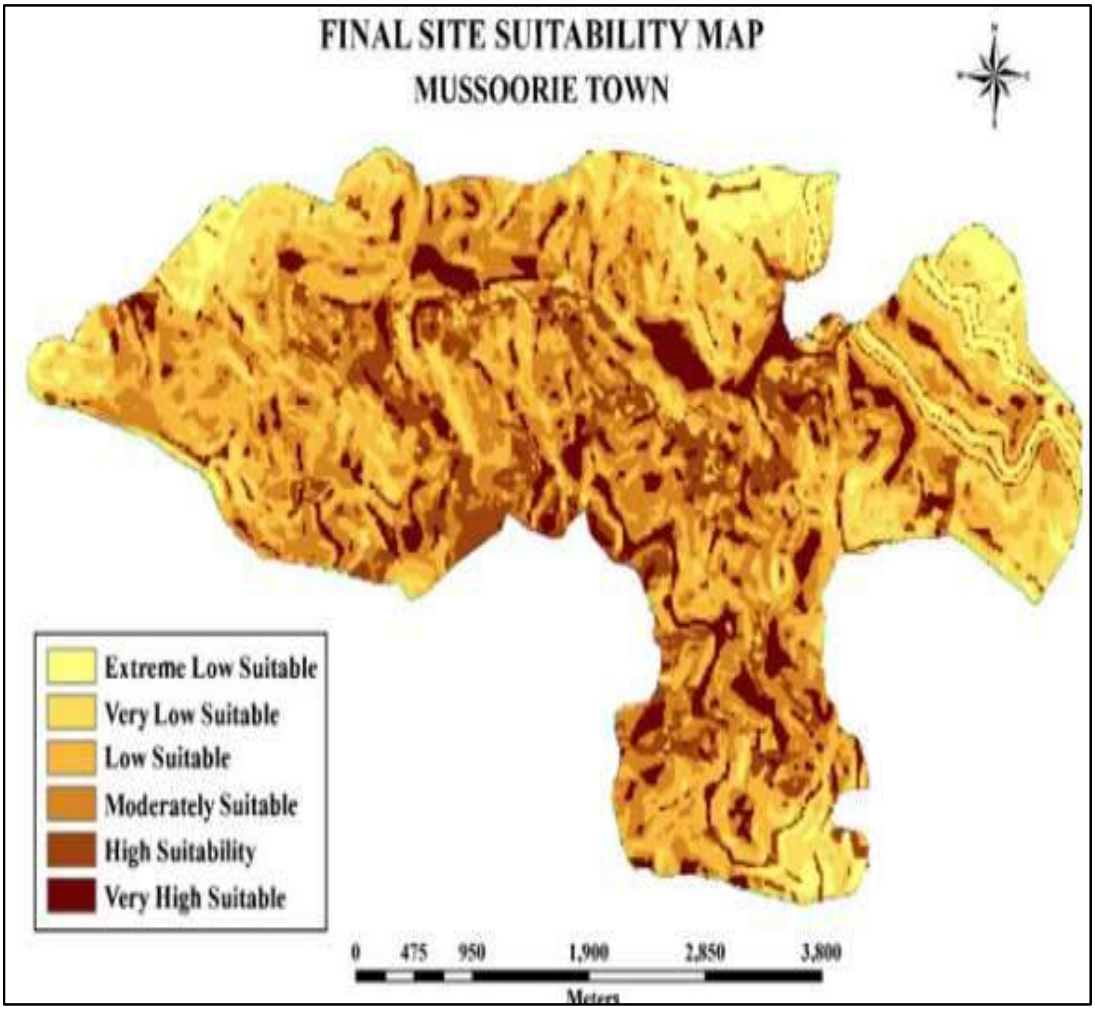

FIGURE 13: FINAL SITE SUITABILITY MAP (SOURCE: KUMAR AND SHAIKH, 2013)

6.3. Suitability for Urban Development

Studies using GIS and multicriteria evaluation techniques have identified suitable sites for urban development in Mussoorie based on factors such as slope, road proximity, land use/land cover, land values, and geological formation. Expansion of construction activities should be avoided, and proper drainage and sewage systems need to be implemented by the Mussoorie Dehradun Development Authority (MDDA), show in figure 13.

The Mussoorie town lies in Seismic Zone-IV but the buildings have constructed mostly on more than 40-degree slope and at many places even on vertical scraps also. Secondly, despite of the Uttarakhand Building By-Laws and Regulation-2001 (Amendment 2016) some of the buildings height on such fragile hill is more than 12m (i.e., more than permissible limit). Such buildings need to be red mark through GIS technology for special safeguard measures and in future the local administration should strictly implement the Building Height Law for sustainable development of the town.

As it is evident by above few points that the Queen of Hills, viz., Mussoorie lies on a steep hill composed of weak and soluble rocks and where the natural hydrological systems have been disrupted alarmingly causing socio-economic disruptions and environmental degradation. On the other hand, the town is steadily and indiscriminately sprawling imposing intolerable load on the fragile hill. For the sustenance of the Mussoorie, town a Master Plan is needed immediately before allowing further construction works and the sub-surface excavation should be completely avoided in such a weak and fragile hill. If sub-surface excavation needed absolutely, appropriate technology should be adopted and slope instability should be insured.

6.4. Land Use and Land Cover Change

Kumar and Shaikh (2013) conducted study by using the Geographic Information System (GIS) and multicriteria evaluation (MCE) technique for selection of suitable sites for urban development in Mussoorie municipal area, Dehradun district, Uttarakhand. Criteria using five parameters, i.e., slope, road proximity, land use/land cover, land values and geological formation were used to prepare the final site suitability map (presented in figure 13). The final site suitability map reveals that the study area was divided into six different suitable

categories. The area under extreme low, very low, low, moderate, high and very high lands stand at 1.13 km^2, 5.60 km^2, 1.94 km^2, 3.27 km^2, 4.97 km^2 and 1.98 km^2 respectively. Approximately 46 % of the total area falls under low, very low and extremely low suitable areas. Only 36.79 % of land falls under high and very high suitable categories. Any expansion of construction, renovation etc. activities in the area should be avoided and MDDA (Mussoorie Dehradun Development Authority) should ensure proper drainage and sewage activities.

Thapa and Bahuguna (2021) conducted study to detect the land encroachment or area of change; rate of change and monitoring spatio-temporal variation in LULC change between 1989- 2020 using change detection technique, supervised maximum likelihood classification, and Overall accuracy & Kappa Coefficient (K) was applied as an accuracy assessment tool. The result also found that among all LULC class, the most significant LULC conversion took place from agricultural land to built-up areas followed by open/scrubland and vegetation/forest cover. This analysis provides the essential long-term Geospatial information related to LULC change for making optimum decision-making process and sustainable land-use planning in the Pachhua Dun, including Dehradun & Mussoorie urban agglomeration.

Peethambaran et al., (2019) analysed and compared the predictive performance of two entirely different AI techniques, fuzzy expert system (FES), a bivariate statistical technique, and extreme learning machine (ELM), a multivariate statistical technique for GIS based landslide susceptibility zonation (LSZ) in the Mussoorie Township area (figure 14). Thematic layers of relevant causative factors and landslide inventory were prepared for the study area through field survey, remote sensing, and GIS. The resultant landslide susceptibility maps (LSM) of the study area, LSM-I of FES and LSM-II of ELM were critically evaluated and compared with the aid of landslide inventory of the study area.

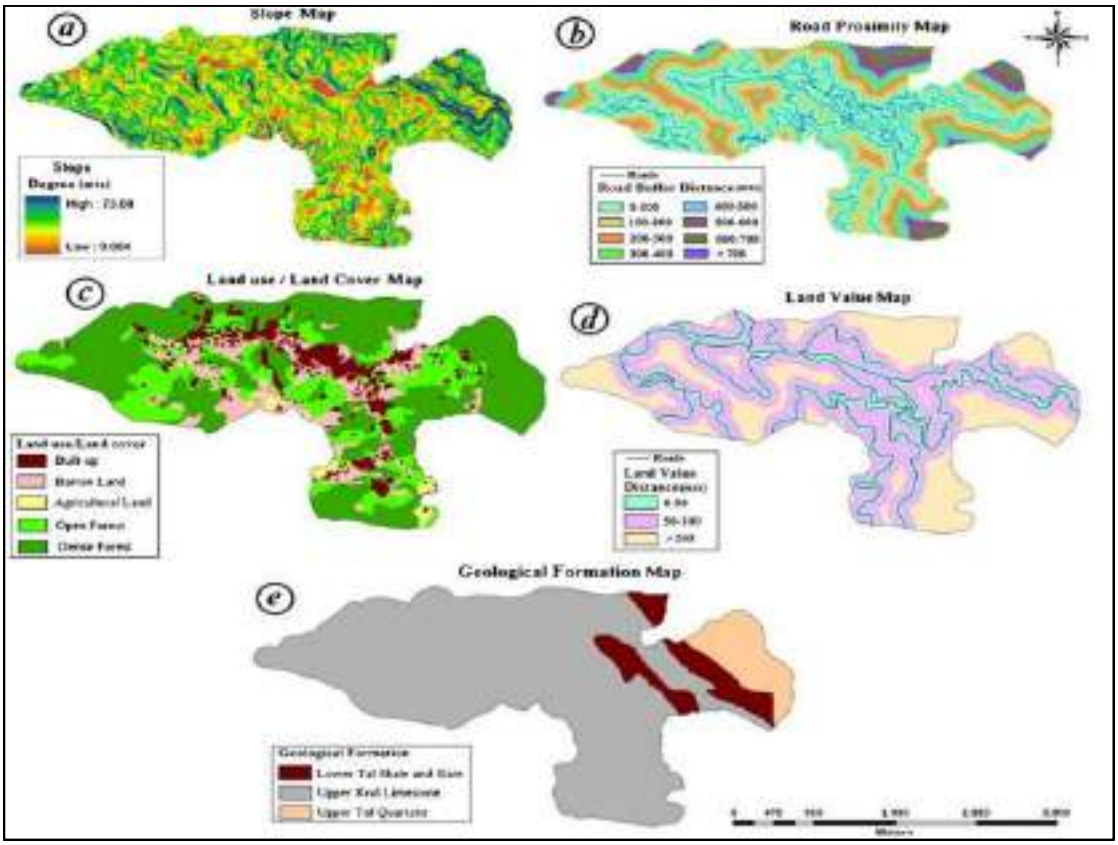

FIGURE 14: (A) SLOPE (B) ROAD PROXIMITY (C) LAND USE/LAND COVER (D) LAND VALUES (E) GEOLOGICAL FORMATION (SOURCE: KUMAR AND SHAIKH, 2013)

6.5. Built environment and safe guard to existing built structure

Nowadays, protection, conservation and improvement of environment are major issues or problems in arising in the tourism fed hill station of Mussoorie. The term environment includes of both physical and biological/ecological environment. While, physical environment includes issues relating to land, water and air, biological environment includes issues relating to plants, animals and other organisms. The major factors which contribute to environmental worsening in the area is anthropogenic disturbance in the form of tourism,

construction, over– exploitation of natural resources, disruption of natural ecological balances, destruction of a multitude of animal and plant species for economic reasons. Several research endeavours have also indicated the aggravation of traffic congestion, atmospheric pollution, undisposed solid waste, water scarcity and infrastructure unavailability as the prevalent issues, especially during the peak tourist months. The Land subsidence in a local scale is a natural phenomenon and may not pose a great threat; whereas the regional/large area, land subsidence could be an alarming situation for the settlement in the particular areas. However, the causes of the land subsidence (local or regional scale) can be both Natural as well as anthropogenic. No land subsidence studied has been carried out in the Mussoorie in the past; and the study related to landslides, drying of water resources or water supply & demand management, climate projection, tourist related impacts are conducted individually, synchronization (if any) of which to the land subsidence needs further detailed study. For wise management, sustainable development and planning (i.e., both short and long term) of natural and human resources, and for implementation and monitoring various anthropogenic and technogenic activities on environmentally fragile, ecologically sensitive and highly susceptible for climate change impacts, hill like the Mussoorie Hill -it is high time to develop the following large-scale maps using geospatial technologies & generate and document datasets for respective analysis and planning.

1. Large scale (RF 1:10,000) Geomorphic Map of the Mussoorie town and its environs which could depict spatial distribution of the following geomorphic landforms of different genetics:
   1.1 *Fluvial landforms* (i.e., ephemeral, intermittent and perennial rivers, river terraces, alluvial cones, alluvial fans, recent flood plains etc.);
   1.2 *Tectonic landforms* (i.e., fault scarps, fault aprons (dead), fault aprons (active), multitier terrace scarps, waterfall etc); and

1.3 *Pluvial landforms* (i.e., convex hill slopes, concave hill slopes, hollows, colluvial cons, colluvial fans etc).

2. Large scale map of geomorphic processes of the Mussoorie town area and its environs which could depict spatial distribution of the following geomorphic process:
   2.1 Earth creeping sites/zones;
   2.2 Slumping site/zones;
   2.3 Rock fall site/zones; and
   2.4 Debris flow site/zones.
3. For good urban governance and for smart city development, it is need of the hour to penetrate application of geospatial technologies at the grassroot level, i.e., Municipal and Ward Level using high resolution remote sensing data at Cadastral Scale (as per the models/maps provided by Rawat et al., 2021):
   i. for allotting unique polygon ID to each building of the town area;
   ii. for Creating an index map for the town area, building print, with their unique ID at suitable scale
   iii. for integrating the information of a) the Municipal register regarding each building information, b) the Jal Sansthan register regarding water tax, and c) the Power Department regarding related to electric bill of each house
   iv. for developing 3D maps of buildings to monitor building heights and area
   v. to monitor regularly in land-use/land cover existing pattern and its dynamics
   vi. for mapping of the linear features, i.e., all footpaths, streets and roads
   vii. for mapping all the ephemeral, intermittent and perennial water sources, i.e., natural springs, streams and rivers;

viii. for identification of recharge zones of dwindling and depleting water resources, i.e., springs and rivers; and

ix. for developing micro-plans for rejuvenation of dead and dying water resources of the Mussoorie Hills for the sustenance of the Town, as water is life.

In addition, it is high-time to develop, generate and document detailed information datasets and analysis on the following areas in order to carry out planning and management of the hill station:

i. Latest census information documenting population structure, demography, mortality & infancy rate.
ii. Ecological status, diversity and distribution of flora, fauna, vegetation cover, disturbances (i.e., forest fire), utilization patterns, etc.
iii. Detailed geological-geotechnical examination on 1:2000 or 1:5000 scale to assess the idea of instability before identifying and planning suitable relief measures.
iv. Vulnerability assessment of the area around Mussoorie at meso & micro (1:0000/5000) landslides hazard zonation mapping.
v. The relationship between landslide & rainfall intensity and its duration to understand the correlation between these two variables.
vi. Continuous monitoring of the landslide in the area to avoid any further destruction to buildings and to check the movement of slope.

Proper seepage or drainage system should be provided to rock slope, movement of slope should be monitored on regional basis.

6.6. Geospatial Technologies for Planning

Geospatial technologies play a vital role in the management and planning of Mussoorie. Large-scale maps depicting geomorphic landforms, processes, and urban features should be developed using high-resolution remote sensing

data. Integration of various datasets and detailed information on population, ecology, geology, and landslides are essential for effective decision-making and urban governance.

6.7. Monitoring and Safeguarding Structures

Continuous monitoring of landslides, drainage systems, and slope movements is necessary to protect existing structures in Mussoorie. Geological and geotechnical examinations, vulnerability assessments, and understanding the relationship between landslides and rainfall intensity are crucial for implementing appropriate mitigation measures. By addressing these aspects and conducting holistic studies, Mussoorie can progress towards sustainable development, manage it's carrying capacity, mitigate natural calamities, and preserve biodiversity for a safer future.

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7. CARRYING CAPACITY OF MUSSOORIE

7.1. Housing and Tourism

The housing requirement is of two types, one for the permanent residents and other for the tourists. As far as the requirement for permanent residents is concerned, there appears no problem except ensuring adequate basic amenities (sufficient water supply, clean environment, etc.). With respect to the availability of accommodation for tourists, there are around 510 hotels / homestay / *Dharamshala / Gurudwara,* which are altogether provide around 17470 bedding capacity. In which, the homestay alone contributes 11.55% of total accommodation and generating livelihood opportunity to the local resident. Therefore, the accommodation is safely available for 17470 tourists for night stay in the Mussoorie area.

7.2. Transportation

Transport is an important sector to assess the carrying capacity of a particular area. Mussoorie area comprises of 585.31 km road length (and 5.95 m width) connectivity. In 1990, the road length recorded with 219.10 and increased to 301.73 in 2000 (82.63 km length per decade). The decadal capacity has been increased to 113.99 Km in the year 2000 and 2010, and 136.28 km in 2010 and 2020. Around 11 km new road has been built every year (1990-till date) for proper transportation facility. The present public vehicle parking facility is around 1240 vehicles, except the parking facility of hotels, resorts, etc. In view of carrying capacity of the town, around 1240 can be safely permitted for public parking and in hotels / resorts as per the availability of parking space. In order to avoid traffic congestion and traffic load in Mussoorie, especially during peak tourist season, NHAI has been assigned the work of construction of highway two lanes tunnel beneath the Mussoorie town and

hence traffic going to Chakrata and Holy Shrine Yamunotri will be diverted. The feasibility study of the project is currently underway, considering a set of criteria, such as, traffic, geological conditions, hydrological condition, construction density of alignment, aquifer and sub-surface flow studies etc.

7.3. Land Use

The forest area of Mussoorie is 47.761 sq. km. land under forests which had reduced by 4.38 sq. km. (from 79% in 1990 to 72% in 1997) between 1990 and 1997, and has increased by 0.121 sq. km. between 1997 and 2009. The built area is also increased 6.57 sq. km during 1990-1997 and 0.09 in 1997-2009. The density of forest has also increased between 1997 and 2009 due to intensive afforestation activities. In Mussoorie, as per the study of Ramachandran et al. (2001) and Kumar and Shaikh (2013) around 13 sq. km. is suitable for construction of building in view of having less than 30-degree slope. Out of 13 sq. Km, around 11 sq. kms. are already having the buildings and the remaining 02 sq. km area is available for safe construction. The land in Mussoorie fall in seismic zone IV and hence State Government has already restricted the construction activities in the region. The construction is being permitted by MDDA in notified and un-notified areas in Mussoorie as per the by-law of the authority. No fresh construction is being carried out in notified estate except cases of renovation of existing buildings constructed prior to 1980. State Government has notified Freeze Zone with regard to un-notified estate where construction of residential building is being allowed as per by-law of MDDA. It is worthwhile to note that since creation of State of Uttarakhand total maps sanctioned by MDDA is 237 indicating bare minimum construction and renovation works having carried out in Mussoorie. Moreover, studies as

mentioned in preceding paras have established the fact that construction activities in Mussoorie has reduced drastically since after 1997. It is required that earthquake resistant buildings can be constructed as per the guidelines of MDDA. For existing built structures, massive awareness drive for popularizing the retrofitting measures to improve the seismic response should be made in view of safety measures / norms.

7.4. Water Supply

Keeping in view of population of tourists as well as local people, the present water demand is around 15.78 MLD as against water supply of 10.19 MLD as per the communication received from Uttarakhand Peyjal Nigam. The water deficit of Mussoorie is 5.59 MLD. Further, a total of 6.60 MLD water will be available from the Yamuna water supply scheme by September 2023. The water supply by Yamuna water supply scheme is projected to provide 11.75 MLD by 2037 and 17.62 MLD by 2052 as described in the above paras. Hence the projected water demand as per requirement of permanent resident and tourist influx will be met from the water supply by Drinking Water Department. Mussoorie received annual precipitation of around 1822 mm. Therefore, the potential of rooftop rain water harvesting in order to meet the deficit of water demand is highly recommended.

7.5. Waste Management

For waste management, the Mussoorie area generates around 15 Metric Tonne Per Day (MTPD) during high footfall season while during non-tourist season it is 12 Metric Tonne Per Day (MTPD). A total of 150 waste pickers/sanitation workers are engaged in collection and segregation of the waste from different sources. This segregation and management can be achieved at local levels of source of waste generation such as homes, hotels,

schools, hospitals, restaurants, dharamshalas, *etc*. A bio-methanation plant of 10-ton capacity is under construction for disposals of bio-degradable waste.

7.6. Sewage Treatment

The waste water generation of Mussoorie is around 8.15 MLD and the present sewage treatment capacity is 7.32 MLD with available 65741m sewer lines. Further, six new STP of 3.25 MLD are under construction. After completion of the proposal, the total capacity will be increased to 10.57 MLD. The performance of Sewage Treatment Plant (STPs) is being monitored by Uttarakhand Pollution Control Board on monthly basis, as per prescribed standards under the Environment (Protection) Rules 1998 (as amended). Water quality characteristics of pH, Biological Oxygen Demand (BOD), Total Suspended Solids (TSS) and Fecal Coliform (FC) are monitored in the inlet as well as outlet of STPs. As per the detailed analysis, the pH, BOD and TSS were found within the prescribed discharge norms.

7.7. Healthcare Facilities

A total of 18 health care facility / hospitals recorded in Mussoorie (12 private and 06 Government) having 63 bedding capacity. The WHO standard is 3 beds per 1000 population. So, the available health facility would be for 21,000 population only. Therefore, the healthcare facility should be augmented and the capacity of hospital beds should be increased according to WHO standard. Total biomedical waste generated from healthcare facility is about 7.22 Kg / day, which is being treated and disposed through Common Biomedical Waste Treatment Facility located at Mandavar, Bagawanpur, Haridwar. However presently the healthcare requirements of tourist influx including emergency

service is being provided by nearest Multispeciality hospitals and other HCFs located in Dehradun which is adjacent to Mussoorie.

Note: The above observations are based on collection of data from various sources (organizations, institutions, Govt. departments, etc.). Considering the eco-fragile nature of Mussoorie area, the further developmental activities can only be conducted with proper scientific assessment / study on geography, geomorphology and stability of the landscape. High resolution geospatial database of Mussoorie needs to created using high spatial resolution satellite data and drone based (LiDAR and broadband) imaging in order to assess 3-dimensional loading of structures on the topography of the area. It would be worthwhile considering the detailed sector wise study to assess the resources such as land, water, forest cover, road capacity to meet the demand of population growth and section-wise planning for sustainable management.

The monitoring related to above stated parameters of carrying capacity is being carried out by SCMC from time to time by seeking information from concerned departments, taking review meeting and field visits.

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8. PREVENTIVE AND REMEDIAL MEASURES

Mussoorie is presently the most popular destination amongst tourists, being a key adventurous and aesthetic tourist destination of the state Uttarakhand. The hill station is in the foothills of the Garhwal Himalayan range falls under the seismic zone IV. For better planning and management of available resources, the following preventive and remedial measures are needed to be undertaken:

1. For tunnel and major civil structures projects like hotel, hospital etc. it is suggested that detailed engineering geological and geotechnical investigations should be done as per BIS Codes and construction permission should only be granted after clearance of the report from the State/Centre appointed Statutory Body.
2. The MDDA should develop a GIS based Decision Support System (DSS) for the use of the decision makers, planners, managers and administrators, by putting all the data/information (i.e. geological, geomorphological, hydrological, environmental and developed infrastructures) of the Mussoorie Town area in an integrated high resolution (i.e., 1:10,000) common geospatial web-based platform, viz., geoportal.
3. Proper examination of existing building and it may be necessary to strengthen the retrofitting of structures to prevent them from sliding or collapsing. This could involve underpinning or adding reinforcement to the foundations. Technical auditing of multi-story buildings (≥3) by experts on annual or biennial basis can be conducted at MDDA level to know about the health of the building.
4. When repairing roads or building structures, it was recommended that the boulders not be removed by digging or blasting the hillsides. In landslide prone areas, stones and boulders should not be removed from the bottom of the hill because this would remove toe support, increasing the likelihood of

landslides. It is necessary to fill in any cracks that have appeared on the slopes.

5. Provision of effective drainage system should be ensured. Due to the lack of proper surface draining system, the rainwater of most of the buildings is being infiltrated into the ground which generates sub-surface flow and accelerates the process of land creeping resulting in damage to buildings and other properties causing economic and environmental disruptions. For safeguarding the buildings and environmental conservation, it is necessary to ensure that the rainwater of each building roof is being drained out properly into the nearest natural drainage line.

6. Phytoremediation of degraded slopes can be initiated, that can help to anchor the soil and prevent erosion. Broad leaved native trees can be promoted for stabilizing slopes, especially in the landslide prone areas.

7. Water availability concerning to current demand in summer and winter months should be maintained and proper supply system to be ensured. Recharge / rejuvenation of natural springs should be explored with scientific intervention. Natural spring in the region should be monitored and re-charge activities (proper plantation) can be initiated on proper scientific basis. Springs (act as natural piezometers) are good indicators for any change in the groundwater in the mountainous area. Therefore, there is an urgent need to inventories all springs located in the vicinity/periphery of Mussoorie towns. Their periodic monitoring may be a good tool for detecting any natural calamities events in advance in the mountainous regions.

8. Spring-shed rejuvenation and management activities can be initiated on proper scientific basis for safeguarding and augmentation of the discharge of the springs and subsequently the local streams fed by springs. Since

most of the water supply schemes of Mussoorie town are from the local springs/brooklet, incentive-based mechanism (IBM) can be adopted for effective protection and preservation of the springs/brooklet. Beside that recharge zones shall also increase soil moisture content which will help in enriching biodiversity through natural regeneration of trees, shrubs and grasses, etc. and shall increase both flora and fauna in the forest. On the other hand, due to increase in soil moisture content on forest land the incidences of forest fire, which are causing irreparable loss to environment and the entire ecosystem will be controlled as a result of this mitigation measure.

9. Roof top Rain water harvesting can be promoted to meet the deficit water demand, at least in the peak tourist period.

10. Open rain water seepage must be stopped through the construction of a pucca drainage system. Water should not be allowed to accumulate in any depression; instead, drains should be built to transport it to safe areas.

11. Proper sewerage network and appropriate treatment facilities should be ensured. The sewage water should not be allowed to percolate or connect with natural ground water. Feasibility of reuse of treated water for secondary uses can be explored.

12. Construction of new buildings are already restricted. Further, the new /additional construction related extension should be properly monitored. All the building foundations should be mapped by a competent engineering geologist to know about the safe bearing capacity of the foundation and treatment of cut slope. In consultation with the designer, type of foundation (footing, strip, raft) and height of building can be finalized. Then only after this, the map can be submitted to MDDA for approval.

13. The regulations related to waste management should be strictly followed. Dumping sites around water bodies should be strictly restricted to prevent pollution threats on the important sources of drinking water of the city. QR code based Digital Direct Refund System should be implemented for management of plastic waste. IEC activities to be promoted amongst visiting tourist towards solid waste and plastic waste management.
14. Strict measures should be made to promote the usage of biodegradable materials and ban on use of Single Use Plastics (SUPs) items should be strictly enforced.
15. Local people should be involved in the Environmental Conservation programs and awareness/training on landslides, mountain risks, etc. to be initiated.
16. Registration of tourists should be done according to carrying capacity of the area, especially the available parking space, guest room availability, etc. Tourist can be charged for visiting the Mussoorie area and the payment can be utilized for managing waste and cleanliness.
17. New construction can be allowed for land owners/local inhabitants as per plan and by-laws of building construction of MDDA and carrying capacity with a specific control on height of the building, slope percentage, drainage and control construction in freeze zone.
18. At present, the preparation of Master Plan of Mussoorie is in progress. The mitigation and preventive measures can be incorporated in the Master Plan for sustainable development.
19. For the smooth traffic management and to avoid traffic congestion the total number of permissible vehicles may not be exceeded beyond the capacity of parking facility provided by Nagar Palika, Mussoorie, Tourism Department, MDDA, Hotels, Dhramshalas, Gurudwaras etc. The road side

parking may be allowed subject to free-flow of traffic as managed by the local police.

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Annexure-1

Minutes of the Meeting held on 13.02.2023 under the Chairmanship of Chief Secretary, GoUK at Uttarakhand Secretariat with respect to the matter of Compliance of Hon'ble National Green Tribunal Principal Bench, New Delhi, order dated 31.01.2023, in O.A. No. 51/2023.

Following participants were present in the meeting :-

1. Sh. R.K. Sudhanshu, Principal Secretary Forest & Environment, Government of Uttarakhand.
2. Sh. M.C. Ghildiyal, IFS (Rtd), Secretary, SCMC, Dehradun.
3. Sh. S.P. Subudhi, Director, Environment Conservation & Climate Change Directorate, Dehradun.
4. Sh. S.K. Pattnaik, Member Secretary, UKPCB, Dehradun.
5. Sh. Dharm Singh Meena, Addl. Secretary (Forest & Environment), Government of Uttarakhand.
6. Dr.Vikram Gupta, Scientist F, Wadia Institute of Himalayan Ecology, Dehradun/Committee Member.
7. Sh. Chandan Singh, Chief Environment Officer, UKPCB, Dehradun.

Following committee members were connected virtually:-

1. Prof. J.S. Rawat, Kumaon University, Almora.
2. Dr. H.S. Venkatesh, Director, National Institute of Rock Mechanics, Bengaluru.
3. Dr. Prashant Gargava, Member Secretary, Central Pollution Control Board, Delhi.
4. Dr. K. Chandra Sekar, Center Head, G.B.Pant National Institute of Himalayan and Environment, Almora.
5. Dr. S.S. Rawat, Scientist-E, National Institute of Hydrology, Roorkeee.

With the permission of the Chairman of the Committee, Principal Secretary (Forest & Environment) welcomed all the members and gave brief background of the Hon'ble NGT order, dated 31.01.2023 in O.A. No. 51/2023. He informed that Hon'ble NGT has directed for a specific Carrying capacity study for Mussoorie. This study should cover as how much construction can be allowed in Mussoorie and what safeguards are to be used for existing building's and for other aspects as traffic, sanitation, management and maintaining ecological integrity in terms of soil stability and flora/fauna. The study will assess the carrying capacity of Mussoorie & systematic plan as envisaged in the order. As Mussoorie comes under the Doon Valley Notification area, notified by the MoEF&CC in 1989. In order to monitor the activities under this area an expert committee was constituted by the Hon. Supreme Court in 1989. Hence, the Secretary, Hon'ble Supreme Court Monitoring Committee (SCMC) was requested to give an overview on the past and present status of the area, changes, studies conducted and actions taken up, so far.

2. Secretary, SCMC, Mr. M.C. Ghildiyal made a detailed presentation on the background, need of constitution of SCMC and highlighted the details of population growth, land use change pattern and water supply sanitation needs in last three decades. He informed that carrying capacity study of the Mussoorie was already done in 1998 and in 2011. Though, he emphasized for the further study on carrying capacity covering all the aspects. He informed that phenomenal changes have been occurred in Forest area, Agriculture, Built-up area in these years. The study on change in land use in Mussoorie shows that 72.57% of the area in Mussoorie comes under forests and attracts the provisions of Forest (Conservation) Act,

1980. The land under agriculture however has reduced on the account of building construction. The population growth, increase in tourist in-flow has resulted in increased demand for water supply and requirement of sewage system and waste management. After having presentation done, Chairman of the committee ingeminated that Hon'ble NGT has also ordered to carry out detailed study on construction in Mussoorie. Hence, he invited comments/suggestions of other committee members, too.

3. Dr. Vikram Gupta, Scientist 'F', Wadia Institute of Himalayan Geology, Dehradun informed that they have carried out a carrying capacity study for Shimla in H.P. and also conducted study for Nainital and Mussoorie last year and informed that the findings of the study show that geological conditions are very weak in Mussoorie and Nainital, the later being more sensitive geologically. He also informed that lime stone in Mussoorie is very weak, there are micro cracks and don't have strength, so construction should be completely banned. The Erratic Rainfall Pattern is in short time and intensity is heavy. It was requested by the Chairman that the details of the previous study be shared which will help in further planning and a brief presentation may also be made before the committee in the next meeting.

4. Dr. Prashant Gargava, Member Secretary, Central Pollution Control Board felt the need for study of Hydrology, hydro-morphology and carrying capacity of Mussoorie and accordingly suggested remedial measures. He also suggested that first compilation of available studies on different aspects can be carried out and secondly appropriate agency can be engaged for study further. He also emphasized the study to be carried out for current status and emphasis on population, municipal solid waste, water requirement and vehicular movement in study area should be given. He suggested that action plan has to be submitted to Hon'ble NGT to adopt better technology and waste management.

5. Prof. J.S. Rawat, Kumaon University pointed out that Mussoorie town is situated on a complex geographic environment in the proximity of the main boundary thrust composed of highly fractured, shattered and sheared structurally weak rocks, i.e. mainly limestone and dolomitic limestone. In Mussoorie there are springs and tributaries which flow from North to South and these are rain-fed which are gradually drying. Therefore, enough water conservation measures have to be made. Geo-morphologically, the chemical weathering and chemical erosion both are very active in Mussoorie hill area which accelerates the geomorphic process of mass wasting, i.e. creeping. Creeping results horizontal and vertical cracks in the area. The entire area is environmentally fragile. He suggested that the cutting of trees should be prohibited and height of buildings should be monitored and rejuvenation of the springs shall be carried out. He said that there is an urgent need for mapping of surface recharge zones of all the springs/streams of Mussoorie hills using GIS and Remote Sensing technologies.

6. Dr. H.S. Venkatesh, Director, National Institute of Rock Mechanics (NIRM), informed the chair that Dr. A.K. Naithani, Head of Engineering & Geology will participate in the forthcoming activities of the Committee.

7. After due discussion and deliberation in the matter, the following decision has been taken by the Chairman/Chief Secretary, GoUK :-

i. G.B. Pant National Institute of Himalayan Environment (GBPNIHE), Almora will act as a "**Nodal Institute**" for this study. Hence, all the studies available with the respective members and institutes, shall be be shared with GBPNIHE, Almora. Dr. K. Chandra Sekar, Center Head (GBPNIHE), Almora will lead the study and

compile the various studies available on different aspects wrt Mussoorie. on Relevant reports on geology, tourism, pollution, drainage, sewage, environmental sustainability, carrying capacity etc. shall also be taken into account and different gaps should analyzed. After that compiled report will be shared with all the committee members for further suggestions/comments.

ii. All committee member will share their/Nodal Officers mobile no. and e-mail addressess to Dr. K. Chandra Sekar, Center Head (GBPNIHE), Almora to whom all available study/present data be communicated.

iii. Member Secretary, UKPCB will formulate a What'sApp group with all team members and officials to coordinate and plan away with submission of ideas/suggestions & proposals. Member Secretary, UKPCB will also work as **nodal authority** in this matter to organize regular meetings and coordinate with committee members/institutes and Hon'ble NGT.

iv. A specific designated cell could be engaged in UKPCB for collection and compilation of information/data and preparation of report as decided by the committee.

v. Chairman instructed that related departments namely- MDDA, Urban Development, Drinking Water, Forests, Transport, Housing, Disaster and USEC shall also be called in next subsequent meetings.

vi. Next meeting shall be organized in next two weeks.

At the end of the meeting chairman thanks all the participants.

Signed by Vijay Kumar Yadav
Date: 17-02-2023 16:58:26

(V.K Yadav)
Secretary

GOVERNEMENT OF UTTARAKHAND
ENVIRONMENT PROTECTION & CLIMATE CHANGE SECTION
No.- /XXXVIII-1-2023
DEHRADUN: DATED: FEBRUARY, 2023

Copy:- For information and necessary action.

1. Senior Personal Private Secretary-Chief Secretary, Uttarakhand.
2. Personal Secretary-Sh. R.K. Sudhanshu, Principal Secretary Forest & Environment, Government of Uttarakhand.
3. Sh. M.C. Ghildiyal, Secretary, SCMC, Dehradun.
4. Dr. H.S. Venkatesh, Director, National Institute of Rock Mechanics, Bengaluru.
5. Director, Space Application Centre, Ahmadabad.
6. Prof. J.S. Rawat, Kumaon University, Almora.
7. Dr. Prashant Gargava, Member Secretary, Central Pollution Control Board, Delhi.
8. Dr. Vikram Gupta, Scientist F, Wadia Institute of Himalayan Ecology, Dehradun.
9. Dr. K. Chandra Sekar, Center Head, G.B.Pant National Institute of Himalayan and Environment, Srinagar/Almora.
10. Dr. S.S. Rawat, Scientist-E, National Institutue of Hydrology, Roorkee.
11. Sh. S.K. Pattnaik, Member Secretary, UKPCB, Dehradun.
12. Director, Environment Conservation and Climate Change, Directorate, Dehradun.

By Order,

I/100458/2023

(Dharm Singh Meena)
Addl. Secretary

Annexure-2

Minutes of the Meeting held on dated 12.04.2023 under the Chairmanship of Chief Secretary, GoUK at Uttarakhand Secretariat in compliance of order passed on 31.01.2023 by the Hon'ble NGT in the matter of O.A. No. 51/2023 Suo Moto in Re: News Items published in the newspaper the Tribune, dated 16.01.2023 entitled "Joshimath Disaster a warning for Mussoorie".

The II[nd] meeting of the Committee under the Chairmanship of Chief Secretary, Government of Uttarakhand organized on 12.04.2023. Following participants were present in the meeting:-

1. Sh. R.K. Sudhanshu, Principal Secretary, Forest & Environment, Government of Uttarakhand.
2. Dr. Ranjit Sinha, Secretary, Disaster Department. Government of Uttarakhand.
3. Sh. K.M. Rao, PCCF (Environment), Uttarakhand.
4. Sh. Dharm Singh Meena, Additional Secretary, Environment Department, Government of Uttarakhand.
5. Sh. Uday Raj Singh, AS/MD, Jal Nigam, Uttarakhand.
6. Sh. S.K. Pattnaik, Member Secretary, UKPCB, Uttarakhand.
7. Dr. Chandra Sekar, Center Head, G.B. Pant National Institute of Himalayan Environment, Srinagar (Garhwal).
8. Sh. Ramji S Sharma, AMD (F&R), Uttarakhand.
9. Sh. Sunil Sharma, RTO, Dehradun.
10. Mirs. Shallu Thind, Senior Planner, TCPD, Uttarakhand.
11. Dr. Priyadarshi Upadhayay, Scientist, USAC, Dehradun.
12. Dr. Sushma Gajrola, Scientist, USAC, Uttarakhand.
13. Sh. B.D. tiwari, V.C. MDDA, Dehradun.
14. Sh. Rhandan Singh, Chief Environment Officer, UKPCB, Dehradun.
15. Sh. Maneesh Semwal, SE (Appraisal), Uttarakhand.
16. Sh. Surjeet kumar, SB, Payjal Nigam, Uttarakhand.
17. Swapnemita, Scientist, Uttarakhand.
18. Sh. Akshay Kumar, Environment Specialist, Uttarakhand.

Following Committee member were connected virtually:

1. Prof. J.S. Rawat, Kumaon University, Almora.
2. Dr. C.P. Singh, Scientist/Engineer-SF, SAC, ISRO, Ahmedabad.
3. Dr. Vikram Gupta, Scientist-F, Wadia Institute of Himalayan Geology, Dehradun.
4. Dr. S.S. Rawat, Scientist-E, National Institute of Hydrology, Roorkee.
5. Dr. Rajender Patil, Scientist, CPCB, RD-Lucknow.

The Chairman welcomed all the participants present physically as well as virtually in the meeting. With permission the Chairman of the Committee, the Principal Secretary, Forest & Environment, GoUK briefed the background of order dated 31.01.2023 passed by the Hon'ble NGT in the matter of O.A. NO. 51/2023. He also updated about the decision taken in I[st] meeting of the

Committee held on 13.02.2023 and compliances thereof. During the I[st] meeting it was decided that G.B. Pant National Institute of Himalayan Environment (GBP-NIHE) will act as "Nodal Institute" for the study to be undertaken in compliance of order of the Hon'ble NGT and all the studies/information available with the respective members and institute shall be shared with GBP-NIHE. Dr. Chandra Sekar, Center Head, GBP-NIHE, Srinagar will lead the study and compile the various studies available on different aspects w.r.t. Mussoorie.

2. In continuation of I[st] meeting, Dr. Chandra Sekar compiled available information and information shared by other members of the Committee related to Mussoorie and presented before the Committee. Presentation was covering population profile, tourism and its impact on the development of Mussoorie hills, solid waste management, floristic and faunastic bio-diversity, fire risk zonation, water supply and demand, climatic characteristics, groundwater prospects and quality, geology, landslide inventory, site suitability map, land use change etc. Dr. Chandra Sekar also identified gaps along with domain experts/institutes in order to assess carrying capacity of Mussoorie.

3. During the course of presentation it is informed that compiled information is based on available literature in public domain and information shared by Committee members. Chief Secretary remarked that updated information regarding water supply and demand, sewerage infrastructure along with existing and proposed sewage treatment capacity, infrastructure development, proposed master plan etc. is available with line departments. Despite of seriousness of matter, such data is not included in presentation. Chief Secretary expressed anguish over non-inclusion of updated information of line departments in compilation work.

4. Prof. J.S. Rawat, Kumaon University, Almora emphasized on requirement of large scale geomorphic mapping of the Mussoorie town area for guiding the development of technogenic activities i.e. further construction of buildings, roads, drainage lines and sub-surface engineering works such as construction of tunnel etc. Large scale (1:10000) geomorphic maps should depict - i) geomorphic landforms of different genetics (i.e. tectonic, fluvial and pluvial), and ii) geomorphic process (i.e., creeping site/zones, slumping site/zones, active rock falls and debris flow zones etc.) is prerequisite to resolve the problem under reference. An Integrated Common GIS platform may be created. Carrying Capacity of the Mussoorie by the Ramachandran may be studied.

5. Dr. Vikram Gupta, Wadia Institute of Himalayan Geology, Dehradun pointed that number of vehicles during peak time and normal period, water supply & gap, status of sewerage network and sewage treatment capacity, door to door garbage collection mechanism, registered hotel and their bed capacity, construction permitted, parking capacity & road length & width need to be included in the report.

6. Dr. S.S. Rawat also emphasized that water supply and demand of the area, capacity of pumping and spring inventory would also need to assess in carrying

capacity of the area.

7. Dr. Ranjeet Sinha, Secretary, Disaster Management informed that data regarding sewage management, water supply and demand, drainage etc. is available with department. Poor drainage pattern may cause landslides in the area.

8. Shri Keshav Rao, PCCF stated that use of bio-indicators may be useful for ascertain status of some environmental variables. Present of Oak and Deodar trees are good indicators of ground water in the area.

9. Dr. C.P. Singh, Scientist, Satellite Application Centre, Ahmedabad commented that the ecological fragility & environmental sustainability of Mussoorie also needs to be assessed in the larger framework of carrying capacity. Air Environment Carrying Capacity (AECC), Water Environment Carrying Capacity (WECC), Noise Carrying Capacity (NCC), Habitat Quality Index (HQI), Land Stress Index (LSI) are also important aspects along with tourism carrying capacity (TCC). Aerosol Optical Depth (AOD), PM2.5 and GHGs data if being monitored by CPCB/SPCB must be utilized for this purpose. Forest fire history from 2002 onward available from satellite cab be generated and analysed. Mussoorie boundary (shape file) may be arranged to all for contributing spatial layers available with SAC.

10. Principal Secretary, Forest & Environment stated that the Hon'ble NGT categorically directed the Committee to suggest remedial measures to prevent environmental damage in the light of carrying capacity, hydro-geology studies, geo-morphological studies and also covering other allied and incidental issues. Therefore, based on existing information and available data, the Committee may suggest remedial measures and accordingly status report may be filed before the Hon'ble NGT. As stated by the Dr. Chandra Sekar, GBP-NIHE, the detail study to ascertain carrying capacity would require at least one year time, therefore, application for seeking one year time may be filed before the Hon'ble NGT.

11. After due discussions and deliberations in the matter, the following decisions were taken for further action:

1. Under Doon Valley Notification, 1989 a n Empowered committee has been constituted by the Hon. Supreme Court in which Mr. M.C. Ghildiyal is the one of the members, this committee has regularly been conducting relevant studies and monitoring almost all the activities in the doon valley, including Mussoorie. Hence, it is pertinent to consult this committee to suggest remedial measures for the missing links, accordingly.
   Action: Nodal Officer (MS UK PCB)
2. Detail of new construction in Mussoorie along with brief account of master plan proposed for Mussoorie area, along with water and drainage plan.

   Action: VC, MDDA
3. Detail of sewerage network, existing sewage treatment & proposed capacity, water supply and demand gap and target for fulfilment of gap and drainage system of the Mussoorie. **Action:**

Department of Drinking Water

4. Details of Tourist influx and availability of hotel, beds, water for tourists; vehicular load and parking capacity along with present status of traffic management in Mussoorie. **Action: Tourism Department/Nagar Palika Parisad, Mussoorie**
5. All the concerned departments shall provide information to the Sh. S. K. Pattnaik, Member Secretary, Uttarakhand Pollution Control Board (nodal officer) for further necessary action at the earliest.

   Action: UKPCB / GBP-NIHE
6. Based on information received from concerned departments and available literature including carrying capacity related studies undertaken in the past, status report would be prepared. Status report should be included necessary preventive and remedial measures to prevent environmental degradation.

   Action: GBP-NIHE
7. MS UK PCB will deploy suitable staff or JRF/SRF, if necessary and get the report be prepared, as soon as possible. A preliminary report be filed before the Hon. NGT, with in 15 days and appropriate timeframe will be solicited for the detailed report.

   Action: MS, UKPCB

The meeting ended with thanks to and from the Chair.

Signed by Ramesh Kumar Sudhanshu
Date: 20-04-2023 16:22:47
(Ramesh Kumar Sudhanshu)
Principal Secretary.

GOVERNMENT OF UTTARAKHAND
ENVIRONMENT PROTECTION & CLIMATE CHANGE SECTION
No.I/116056/2023/XXXVIII-1-2023 (E-47348)
Dehradun: Dated: 20 April, 2023

Copy to : For kind Information & Necessary Action, please :

1. Senior Principal Personal Private Secretary-Chief Secretary, Uttarakhand.
2. Private Secretary-Sh. R.K. Sudhanshu, Principal Secretary Forest & Environment, Government of Uttarakhand.
3. Principal Secretary/Secretary, MDDA, Disaster, Drinking Water, Tourism & Urban Department, Government of Uttarakhand.
4. Sh. M.C. Ghildiyal, Secretary, SCMC, Dehradun.
5. Dr. H.S. Venkatesh, Director, National Institute of Rock Mechanics, Bengaluru.
6. Director, Space Application Centre, Ahmadabad.
7. Prof. J.S. Rawat, Kumaon University, Almora.
8. Dr. Prashant Gargava, Member Secretary, Central Pollution Control Board,

Delhi.

9. Dr. Vikram Gupta, Scientist F, Wadia Institute of Himalayan Ecology, Dehradun.
10. Dr. K. Chandra Sekar, Center Head, G.B. Pant National Institute of Himalayan and Environment, Srinagar/Almora.
11. Dr. S.S. Rawat, Scientist-E, National Institute of Hydrology, Roorkee.
12. Sh. S.K. Pattnaik, Member Secretary, UKPCB, Dehradun.
13. Director, Environment Conservation and Climate Change, Directorate, Dehradun.
14. Sh. K.M. Rao, PCCF (Environment), Uttarakhand.
15. AS/MD, Jal Nigam, Uttarakhand.
16. AMD (F&R), Uttarakhand.
17. RTO, Dehradun.
18. Senior Planner, TCPD, Uttarakhand.
19. Scientist, USAC, Dehradun.
20. Scientist, USAC, Uttarakhand.
21. V.C. MDDA, Dehradun.
22. State Project Management Group, Namami Gange, Uttarakhand
23. Guard File.

By Order,

Signed by Dharm Singh Meena
Date: 21-04-2023 14:48:07

(Dharm Singh Meena)
Additional Secretary.

CARRYING CAPACITY OF MUSSOORIE

H. Ramachandran
Nira Ramachandran *et. al*

Published for

Supreme Court Monitoring Committee,
Dehradun-248006

Carrying Capacity, within a given resource base, is the maximum rate of resource consumption and waste discharge that can be sustained indefinitely. It is a quantitative concept, involving parameters such as population (including both permanent and seasonal) and its future projection, landuse, water supply, living accommodation for population, public health services, waste disposal, education, electricity, transport, communication and so on, the optimum requirements to be projected for a reasonable quality of living level. It is, however, the resource in least supply, which provides the critical limit of Carrying Capacity and hence, of Growth.

This study has adopted a participatory approach, identifying the residents' and various interest groups' perception and prioritization of problems.

A study of Carrying Capacity so far as any hill station in India is concerned has perhaps been attempted for the first time for Mussoorie, in this book. It is hoped that it will be useful for planners, civic authorities, administrators and governments, and will stimulate similar studies and, hopefully, some action.

---

y the Director of the Institute of Applied
Executive Director of the National Society
stration, Research and Training, Mussoorie.
Lal Bahadur Shastri National Academy of
School of Economics and the Institute for
e. He has a number of books and papers in
nt to his credit.

Committee was constituted by the Hon'ble
ement of 30.8.1988 in a Public Interest
ronment issues in Doon Valley.

CARRYING CAPACITY OF MUSSOORIE

DR. H. RAMACHANDRAN
DR. NIRA RAMACHANDRAN *et al.*

Published for

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Preface

The urban centres in hill areas have in recent times attracted investments mainly in the construction sector. Much of this happens to be of speculative and commercial nature. This has obviously marginalised the resident population, particularly, with reference to land markets. Some of these towns also attract large numbers of tourists, who put additional pressure on urban infrastructure. At the same time, the tourists also happen to generate employment for the resident population and the city earns a substantial income. Both the economic and environmental costs of creating infrastructure are high. There is, therefore, the crucial question of carrying capacity and sustainability of the growth of urban centres in hill regions.

The study on Carrying Capacity was sponsored by the Supreme Court Monitoring Committee in April 1997, specifically to establish benchmarks on important parameters and pressure on infrastructure.

The study team included Dr. H. Ramachandran, Dr. Nira Ramachandran, Shri Padam Vir Singh, Ms. Seema Joshi, Shri A.W. Khan, Ms. Saloni Goal, Shri R.K. Bharadwaj and Ms. Madhuri Negi. A number of people have helped in the process of the study. We would like to specifically acknowledge assistance from Shri Jot Singh, Chairman, Municipal Council, Mussoorie, elected representatives of the Council, various departments of the Municipality, school authorities, officials of the government and other organizations, residents—particularly those who attended the meetings and gave their suggestions, the members of the Hotel Owners' Association, the National Remote Sensing Agency, the Indian Institute of Remote Sensing, and the officials of the MDDA.

Shri B. S. Baswan, Director, LBSNAA and Dr. V.K. Agnihotri, Joint Director, LBSNAA have been constantly monitoring the progress of the study, which helped the completion of the study within the stipulated time.

A draft report was circulated in April 1998 and the results of the study were presented and discussed in an open session in May 1998. All officials and non-officials who had taken part in the initial participatory meetings were invited and over forty participants attended the open session. This Revised Version of the report incorporates the suggestions and modifications proposed in the meeting.

Mussoorie
July 1998

Dr. H. Ramachandran
Dr. Nira Ramachandran *et al.*
National Society for Promotion of
Development Administration,
Research and Training,
LBSNAA

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Objectives, Methodology and Data Base

1.1 Background

Located at an altitude of about 2,000 meters in the lower Himalayan ranges of Dehradun district, the hill resort of Mussooric covers an area of 67.75 square kilometres (Figures 1A and 1B). The Census of India (1991) records a resident population of 29,629 in the Mussoorie Urban Agglomeration (U.A.), which includes the Municipality and the Cantonment area.

Many believe that this is an underestimate since enumeration was done in the month of February (Sunrise of March 1 as the reference moment) when a significant proportion of the city population that normally moves down to the plains during the winter had not returned. Besides, often the population figures quoted ignore a substantial number of children studying in the boarding schools of the city, and the population in the Tibetan settlements, etc. While the Census figures suggest a fluctuating, but sedate growth of population of the city, the tourist inflow has been rising far more rapidly over the years, wherein during the summers the floating population can be as high as twice the permanent population. Public resource allocation for city infrastructure development generally takes into account the number of permanent population. Like all resort towns, the seasonal influx of tourists overloads an already overburdened city infrastructure of Mussoorie. As the mainstay of the town is the tourist industry, any plan for sustaining the town, must, of necessity, provide built-in the demand for tourist facility of which real estate factor is a component. Such a plan must also

project future demands of tourism and lay down guidelines for encouraging this industry while sustaining the resource base and environment. It is also to be noted that there is a circular causation between tourism and the environment–unrestrained flow of tourists beyond the city's capacity, with the concomitant strain on the infrastructure and the environment—which results in a deteriorating environment and a reduction in the tourist flow. The available information base is rather weak, even with reference to such basic data as population figures.

Other than a few government and quasi-government organisations and a number of schools, which together have over 6,000 boarders, the main economic base of Mussoorie is the tourist sector. Consequently, the service sector is the mainstay of the city. Precisely because of this, this small town with limited developable land base–owing to its hill terrain–records about 140 hotels, *dharamshalas* and guest houses which together have a bed capacity for accommodating nearly 10,000 people.

The development of the city comes under the jurisdiction of the Mussoorie-Dehradun Development Authority (MDDA) which was created through a Government Notification (No.225/XI-5-84-19(1)-DA.84, dated October 29 1984, in exercise of the powers under section 3 of the Uttar Pradesh Urban Planning and Development Act, 1973) with a view to developing the area in a planned manner. The Development by-laws of the MDDA 1985, apply to development activities and existing buildings within the development area of the MDDA. All development and re-development permits are thus to be obtained from the MDDA. Permission is necessary to erect, re-erect, demolish, and make any material change or alteration in a building or part thereof within the development area. However, no permission is required for the following alterations–provision or closure of a window or a door or ventilator not opening towards other's property, providing inter-communication doors, providing partitions, gardening, white- washing, painting, re-tiling, plastering, re-flooring and construction of sun-shades. Similarly, no permits are required for carrying out works by departments of the Central or State Government or any local body for the purpose of inspection, repairing or renewing any sewers,

mains, pipes, cables or other apparatus.

The increase in the built-up area of the city has been phenomenal, as we will see later (Chapter 4), between 1990 and 1997, and the shrinking of forest cover is also striking. Meanwhile a Monitoring Committee was constituted by the Honourable Supreme Court of India with reference to Doon Valley development.

The Honourable Supreme Court in their interim order delivered on July 10, 1996, on a writ by the Supreme Court Monitoring Committee versus MDDA, stated that constructions which have not begun at site and have not proceeded beyond the plinth level shall not be permitted to be started till the stand of the State of Uttar Pradesh and the Union of India on the applicability or otherwise of the provisions of the Forest Conservation Act, 1980, and the rules made thereunder is made clear. The Honourable Court subsequently clarified on December 15, 1997, that the order dated July 10, 1996, is not to be construed as permitting the continuance of construction which had proceeded beyond the plinth level on the date of the order. In the order dated November 29, 1996, the direction given to the Central Government was to consider the cases for grant of *ex post facto* approval. This needs to be read along with the other orders made by the court in these proceedings as well as in another matter (writ petition (C) No. 202 of 1995–T.N. Godavarman *Vs.* Union of India & Ors. SCALE 1996(9) 269).

It is in this background that a study was proposed and funded by the Supreme Court Monitoring Committee to assess the environmental status of Mussoorie in the larger context of urban and non-urban land use, and the carrying capacity of urban infrastructure.

1.2 Objectives of the Study

The specific objectives of the study may be stated as follows:

(a) to bring out the current rate of conversion of open space to built-up space and to review the current procedures and rules relating to city land use;

14

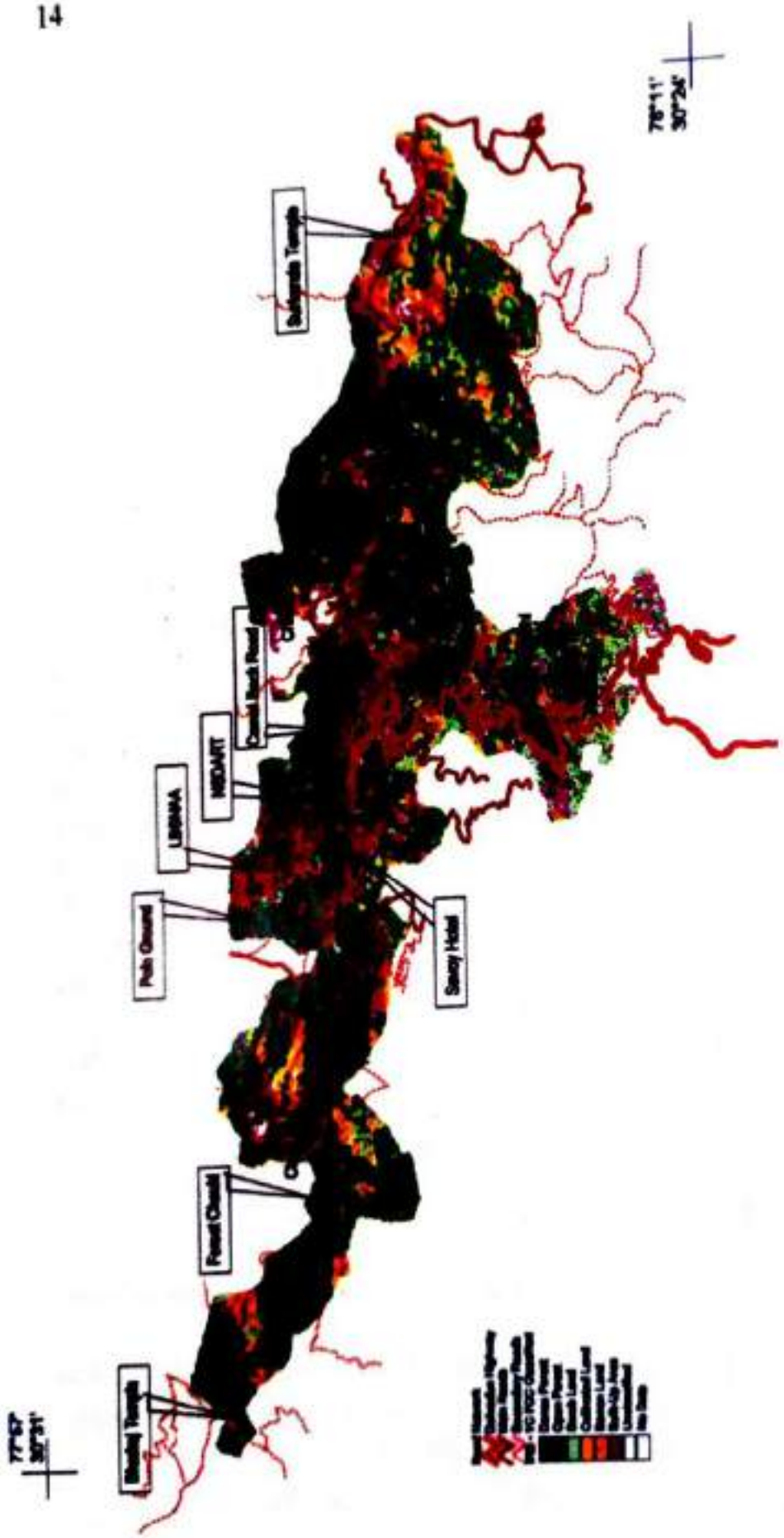

Fig. 1A : Mussoorie–Space Relations

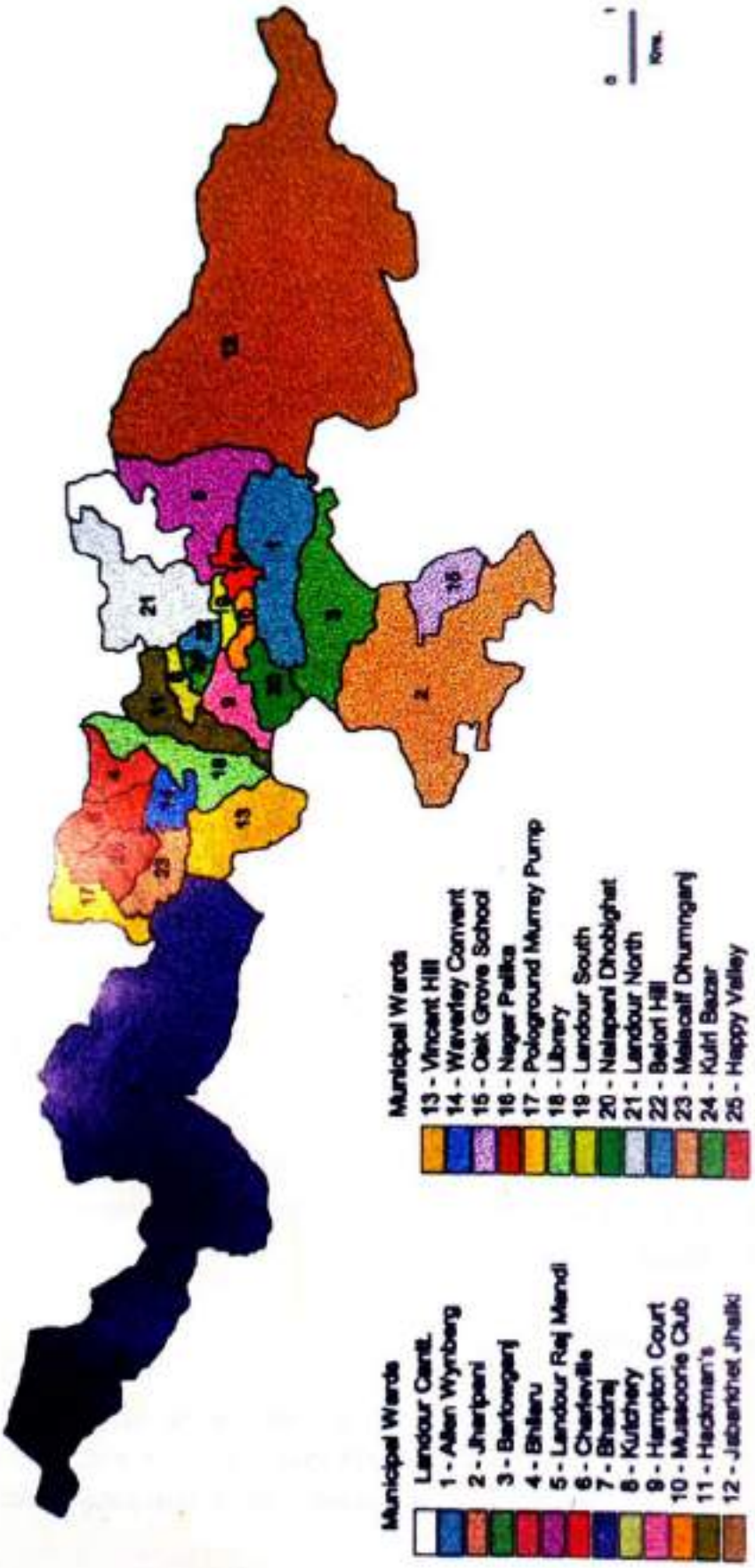

Fig. 1B : Mussoorie–Municipal Wards

(b) to prepare a detailed land use map including vertical spread and intensity of land use in areas with different slopes;
(c) to bring out the problems as perceived by different segments of residents;
(d) to analyse the ways in which these problems need to be tackled as perceived by various segments of the resident population;
(e) to undertake quantitative analysis of primary data of variables relating to the problems identified in (c) above;
(f) to develop indicators for monitoring carrying capacity and estimating the carrying capacity of the Mussoorie U.A. with special reference to available infrastructure; and
(g) to identify and define benchmarks of various indicators to monitor the carrying capacity of the Mussoorie hills.

The study was originally proposed in two phases. This report, based on the work relating to the first phase, was to address the following objectives:

(i) preparing a detailed land use map;
(ii) preparing a set of map overlays based on building regulations, zoning norms and slope stability;
(iii) preparation of a detailed map identifying hazard-prone zones;
(iv) estimating carrying capacity of the Mussoorie U. A. with particular reference to available urban infrastructure;
(v) establishing benchmarks for water and air pollution at selected points in the city;
(vi) estimating demand for water and power; and
(vii) detailing of people's perceptions on environmental problems based on a household survey.

1.3 Methodology

The key role players in the city include the residents, the local government agencies, schools and other government as well as quasi-government organisations, hotel owners, real estate and other

businessmen. Since a study of this nature is geared ultimately to lead to action, it is necessary to make it as participatory as possible. As a result, emphasis was laid on group meetings with various interest groups such as the elected representatives, officials of the government and quasi-government organisations, members of the Hotel Owners' Association and groups of residents in each ward of the city. These meetings concentrated on prioritisation of problems and possible solutions to the problems identified.

Two kinds of schedules–one concentrating on the residents' backgrounds along with their responses relating to civic services and infrastructure (Appendix 1) and the other on waste management and garbage disposal (Appendix 2)—were canvassed among sample residents and institutions including hotels. The former questionnaire was canvassed at the venue of group meetings in each ward (a total of 311 respondents–for details see Appendix 3) whereas the latter was canvassed at the randomly drawn sample households (225 samples). The questionnaire dealing with civic services and infrastructure was also canvassed at other meetings with interest groups such as elected representatives of the City Board (17 respondents), hotel owners (18 respondents) and officials of the government and quasi-government organisations (19 respondents). While the questionnaire dealing with waste management and garbage disposal has been used to estimate the quantum of waste generated, etc., the questionnaire on civic services and infrastructure was basically used to understand the perception of problems by groups of residents and interest groups. Data has been gathered from various sources such as the Census of India, City Board, MDDA, the Divisional Forest Office, UPESB, Jal Nigam, Indian Institute of Petroleum (Dehradun), Regional Transport Office (Dehradun), and Landour Cantonment Board (Mussoorie). It must, however, be noted that often, these secondary data are not in a form in which they could be used for the purpose at hand. As a result, a number of estimates had to be made. The procedures used for estimating various parameters are explained at appropriate places in the report. Data has also been generated from various topographical maps and IRS LISS 3 FCC imageries (for 1990 and 1997). The maps have been digitised and the imagery geo-referenced and analysed

on a GIS platform, for the purpose of studying land use, slope and overlays of maps.

1.4 An Introduction to City Administration and Finances

Consequent upon the 74th Constitutional Amendment (1992), and the Uttar Pradesh *Nagar Palika* Act, elections to the Mussoorie Municipal Board were held in 1997. The Municipality is divided into 25 wards (Figure 1A). Each ward is represented in the Municipal Board by one elected representative, besides the Chairman who is directly elected by the voters in the city. On an average then, each elected representative in the city represents about 1,500 residents. The tenure of the previous elected body of the Mussoorie Municipal Board came to an end on January 18, 1994, and subsequently for three years from 1994 to March 1997, an administrator managed the city.

The Municipal Board meets once every month. The major items discussed in these meetings deal with people's problems, problems of maintenance of services in their jurisdiction and the budget. The Board has created five sub-committees from among their members–property taxation committee, garden committee, health committee, public works committee and finance committee. These committees make the budget proposals and the proposals are scrutinised by the finance committee and then approved by the Municipal Board.

Three key functionaries – the Executive Officer, the Health Officer and the Municipal Engineer – who come from various provincial services provide administrative support to the Municipal Board. They are supported by a number of Assistant Engineers/ SDOs, Sanitary Inspectors and other junior-level officials. Some of the other basic infrastructure such as drinking water, power, education, telephone, etc., are outside the Municipal Board's jurisdiction and come under various state level institutions such as *Jal Sansthan*, State Electricity Board, the Department of Basic Education etc.

The annual revenue and receipts of the Municipal Board are given in Tables 1.1 and 1.2. The total income of the Municipality

during 1996-97 was about Rs. 2.67 crores (excluding opening balance), of which locally generated revenue was about 45 per cent, the remaining coming in as grant-in-aid and subsidy from the state government. Between 1993-94 and 1996-97 the proportion of grant-in-aid and subsidy from the state government to the total income has been fluctuating — 51 per cent, 40 per cent, 39 per cent and 57 per cent. The per capita annual Municipal expenditure works out to Rs. 753 if we take the permanent population of the Municipality, which comes down to Rs.623 if we include the floating population.

1.5 Organisation of the Report

The report is organised in five chapters, the first chapter setting the background, the objectives, the approach and the information base used in the study. The second chapter deals with the analysis of residents' perception of problems relating to urban infrastructure and services. This forms the basis of the third chapter, which deals with the quantitative assessment of population pressure on infrastructure including projections for the next 25 years. The fourth chapter deals with an analysis of land use with particular reference to expansion of built-up area over time in relation to the degree of slope of the land and attempts to work out the percentage of built-up area in different categories of slope. The concluding remarks are included in the fifth chapter.

After the completion of the study, the draft report was presented at an open session to which were invited all officials and non-officials who had taken part in the initial participatory meetings. Over 40 participants attended the open session where the findings of the study were discussed and reviewed in the context of local knowledge and experience and various suggestions were put forth. This revised version of the report incorporates the suggestions and the modifications proposed in the meetings.

Table 1.1: Mussoorie Municipality–Annual Account (Income)

S.NO.	HEADS OF INCOME	1993-94	1994-95	1995-96	1996-97
1.	By Balance in hand at close of last year	10,66,074	22,27,450	17,59,628	14,31,337
2.	Taxes on the annual value of building and land	21,17,759	35,51,955	36,95,764	50,31,511
3.	Conservancy Taxes	10,10,426	15,78,844	19,55,154	12,33,733
4.	Other taxes–(Animals, Pounds, Vehicles–Slaughter and Show taxes)	16,626	26,478	20,739	12,97,152
5.	Revenue derived from Municipal Property and Powers apart from taxation (Rents of lands, houses)	38,73,354	31,31,879	46,11,868	46,63,498
6.	Total fee recovered–(Tramways, Registration, Copying, Licence & Miscellaneous)	1,99,068	1,75,814	1,62,809	1,84,629
7.	Interest on Investments	91,339	1,19,371	—	1,66,986
8.	Total Help and Grants	1,00,86,229	72,74,440	81,63,300	1,19,70,650
9.	Miscellaneous Taxes	21,06,570	21,36,869	21,38,268	22,31,928
	Total Income of year excluding opening balance	1,95,01,371	179,95,650	2,07,47,902	2,67,80,087
	Other advances and deposits	25,314	40,405	3,775	6,765
	Grand Total (including opening balance)	2,05,92,759	2,02,63,505	2,25,11,305	2,82,18,189

Table 1.2: Mussoorie Municipality - Annual Account (Expenditure)

S.NO.	HEADS OF EXPENDITURE	1993-94	1994-95	1995-96	1996-97
1.	General Administration & Collection Charges	13,17,549	14,92,492	19,84,371	19,11,957
2.	Collection Charges	20,49,442	21,60,753	23,71,905	25,43,509
3.	Public Safety	1,65,640	2,57,973	4,37,139	3,67,536
4.	Public Health Convenience				
a.	Drainage	-	-	23,628	-
b	Conservancy	2,84,314	51,08,165	55,58,974	64,46,516
c	Health & Hospital (Vaccinations etc.)	75,88,82	7,76,007	8,64,676	3,55,080
d	Others	46,69,101	2,77,628	4,59,928	-
5.	Horticulture & Gardening	3,87,213	3,21,098	3,44,091	4,60,430
6.	Public work (Establishments, Buildings, roads, Stores)	31,84,564	24,44,178	39,96,655	4,930,615
7.	Other Expenditure	26,73,138	24,83,918	30,97,028	31,14,644
8.	Public Institution	1,30,000	00,88,320	1,00,000	75,000
9.	Other Miscellaneous	26,52,105	30,21,184	17,31,564	29,92,439
	Total Expenditure	1,82,71,948	1,84,31,716	2,09,46,339	2,39,33,806
	Extraordinary & Debt	93,361	72,161	1,33,637	98,073
	Balance	22,27,450	17,59,628	14,31,337	41,86,310
	Grand Total	2,05,92,759	2,02,63,505	2,25,11,305	2,82,18,189

2

Problems and Public Interventions: An Analysis of Residents' Perception

2.1 Introduction

While facts and figures continue to be the basis of planning for the future, the participation of people in the planning process is increasingly becoming crucial. This change is also manifested in the process of decentralisation, strengthened by the 73rd and 74th constitutional amendments that address the issues relating to empowerment of the people at the grassroots level. In order to capture this slice of reality– of people's perceptions of problems and public interventions–firstly, a group meeting with the elected representatives of the City Board was held which was followed by the members responding to the questionnaire on civic services and infrastructure. Secondly, similar meetings were organised with a cross-section of people in each of the city wards. The residents who attended these meetings also responded to the questionnaire. Thirdly, questionnaires were canvassed among the members of the Hotel Owners' Association and representatives of government and quasi-government organisations and meetings with them were also organised. This section of the report brings out the results of the analysis of this information.

2.2 Residents' Perception of Problems Relating to City Infrastructure

The two top ranking common problems identified by all interest

groups are unplanned construction resulting in housing shortage for the local population and traffic/parking problems and the ensuing congestion (Table 2.1). While unemployment is identified both by the residents and their representatives as the third major problem, it does not understandably, find a place in the ranking of other interest groups. Among other problems commonly identified is poor infrastructure, including water and power supply. Lack of education and health facilities also emerge in the list of local population and partly in the list of their representatives.

Table 2.1: Prioritisation of Problems by Various Interest Groups

Problems	Rank Residents	Rank Elected Representatives	Rank Officials from Govt. Organisations	Rank Hotel Owner's Assoc.
Unplanned Construction and Housing Shortage	1	1	1	1
Traffic Congestion Parking	2	2	2	4
Inadequate Water Supply	5	3	3	6
Poor Sanitation Facility	6	7	4	5
Poor Infrastructure	4	5	5	3
Unemployment	3	4	–	–
Lack of Educational Facilities	7	6	–	–
Lack of Health Facility	8	–	7	–
Deforestation/ Forest Laws	–	–	6	2

In this background, a detailed analysis of the residents' perception of problems and possible interventions may be taken up. About 95 per cent of the sample residents found the infrastructure facility in the city inadequate (Table 2.2). This perception differs marginally with the income and educational level of the respondents,

wherein a lesser proportion of residents with low income and low levels of education find city infrastructure inadequate than residents with higher levels of income and education.

Table 2.2: Distribution of Residents' Response to Adequacy of Infrastructure by Educational and Income Levels

Education Level of Respondents	Adequate		Inadequate		Total Numbers
	Number	Percent	Number	Percent	
Educational level					
Illiterate	1	16.67	5	83.33	6
Class 1–5	2	11.76	15	88.24	17
Class 6–12	7	5.47	121	94.53	128
Higher Education	7	4.61	145	95.39	152
All Respondents	17	5.61	286	94.39	303
Income Level					
Low	8	7.92	93	92.08	101
Medium	6	3.90	148	96.10	154
High	3	6.25	45	93.75	48
All Respondents	17	5.61	286	94.39	303

This high degree of inadequacy of infrastructure, in general, is more or less uniformly found across all types of services, be it civic facilities such as waste disposal, street lighting or others such as supply of potable water, power or provision of education and health services. In practically all cases, perceived inadequacy is associated with income level and educational attainment of the respondents– wherein respondents with higher income and higher level of educational achievement tend to find infrastructure in the city inadequate in relation to those with lower income and low level of

educational achievement. In this background, the analysis of adequacy of various facilities has not been stratified according to the background of the respondents. Similar studies of perception of residents in other cities do not indicate this to be a high magnitude of perceived inadequacy of city infrastructure.[1]

Water and Power Supply

The Jal Sansthan and the Uttar Pradesh State Electricity Board undertake the supply of water and power. The Municipal Board has little role in this. All sections of the residents perceived the quantity of water supplied as inadequate (Table 2.3). It is not, however, clear as to why the quality of water is perceived to be adverse. Information available from the Pollution Control Board finds that the pollution of water in and around Mussoorie is well within permissible limits with reference to all major parameters. With the city experiencing power cuts, particularly during winter of

Table 2.3: Distribution of Residents' Perception of Adequacy of Water and Power Supply

Service	Adequate/ Not adverse		Inadequate/ Adverse	
	Number	Percent	Number	Percent
Water supply	27	8.91	276	91.09
Quality of Water	57	18.81	246	81.19
Public Water Facility	39	12.87	264	87.13
Supply of Electricity	50	16.50	253	83.50
Service of the Electricity Department	38	12.54	265	87.46
Manpower in Electricity Department	250	84.18	47	15.82
Impact of power cut	265	87.46	38	12.54

[1] Ramachandran, H (1985), Living Conditions in Bangalore–An Analysis of Residents' Perception, *Ekistics*.

about 4 to 6 hours per day, it is natural that a large proportion of the residents finds the power supply to be inadequate. The services of the electricity department are also rated poor, while the manpower with the electricity department is perceived to be adequate. It should also be noted that the power cuts do not seem to affect productivity, largely because there is very little industrial activity and much of the city economy is based on the service sector.

Civic Services

Among the civic services, availability of street lighting, rain shelters and the number of *safai karamcharis* are found to be adequate by a majority of the residents (Table 2.4). A degree of class bias both in the provision of some of these services and the expectations of the various strata of society is indicated, wherein about 30 to 50 per cent of the poorer strata find street lighting inadequate, whereas the corresponding proportion from richer segments is between 16 and 21 per cent. The residents, irrespective of class, do not seem to be very dissatisfied with the effectiveness of *safai karamacharis*. It should, however, be realised that unlike large

Table 2.4: Distribution of Residents' Response to Adequacy of Civic Services

Civic Service	Adequate/ Not adverse		Inadequate/ Adverse	
	Number	Percent	Number	Percent
Street lighting	227	74.92	76	25.08
Rain Shelters	207	68.32	96	31.68
Public Bins	39	12.87	264	87.13
Safai Karamchari	207	68.32	96	31.68
Incineration Facility	50	16.50	253	83.50
Public Urinals	34	11.22	269	87.78
Cleanliness in Public Urinals	16	5.28	287	94.72
Stray dogs/monkey menace	45	14.85	258	85.15
Regulations for Pets	51	16.83	252	83.17
Veterinary Facilities	39	12.87	264	87.13

cities of the plains, there is very little class-based segregation in the residential land use of Mussoorie. All other civic services, such as availability of public bins, incineration facility, availability of public urinals and their cleanliness, veterinary facilities etc. are perceived to be inadequate by a large proportion of residents.

Transport and Congestion

Though transport, parking and traffic-related problems reach their peak during the tourist season, these problems are found to be serious by a large proportion of the residents throughout the year (Table 2.5). A large part of the transport requirement of the residents is in the context of access to places outside Mussoorie and not so much for movement within the city. However, the problems in both contexts are accentuated during the tourist season. As a consequence, a large proportion of the residents, particularly, during the peak tourist season perceives problems such as lack of bus and taxi facility, traffic management, crowding and congestion. The quality of roads and their maintenance is found to be inadequate by over 70 per cent of the residents. At the same time, since a

Table 2.5: Distribution of Residents' Response to Adequacy of Transport Services

Transport Facility	Adequate/ Not adverse		Inadequate/ Adverse	
	Number	Percent	Number	Percent
Over-crowding in Bus Stands	157	51.82	146	48.18
Bus/Taxi Facility	29	9.57	274	90.43
Traffic Management	35	11.55	268	88.45
Parking Space	22	7.26	281	92.74
Crowding in Mall (peak)	218	71.95	85	28.05
Road Congestion (peak)	25	8.25	278	91.75
Road Network	80	26.40	223	73.60
Road Maintenance	34	11.22	269	88.78

significant proportion of the earnings are from tourists, many of the residents do not perceive crowding in the city commercial area during the peak season, to be a problem. For the same reason crowding in the bus stands is also perceived as adverse only by less than half of the sample respondents. Here again, there are class differences in perception – a larger proportion (53 to 67 per cent) of the poorer sections of the residents (who are dependent on public transport to a larger extent) find bus stands overcrowded as compared to the richer sections (37 per cent to 45 per cent).

Education and Health Facilities

Inadequacy in basic social infrastructure such as educational and health facilities is also perceived by a large proportion of the residents (Table 2.6). More than three fourths of the respondents rate capacity in the city schools as inadequate, in a city that houses excellent schooling facility. That there is a lack of affordable schools is clear, particularly when we consider that less than 30 per cent of the respondents feel that there is overcrowding in schools in the city. Similarly, over 85 per cent of the respondents perceive health facilities, both regular and specialised, are inadequate.

Table 2.6: Distribution of Residents' Response to Adequacy of Education and Health Facility

Social Infrastructure	Adequate/ Not adverse		Inadequate/ Adverse	
	Number	Percent	Number	Percent
Intake Capacity of Schools	71	23.43	232	76.57
Crowding in Schools	86	28.38	217	71.62
Hospital Facility	45	14.85	258	85.15
Specialised Medical Facility	51	16.83	252	83.17

Land Development and Housing

One of the most vociferously expressed problems relates to the shortage of housing for the resident population and the nature and

implementation of the building by-laws. This has been expressed emphatically in all the participatory meetings held in various city wards as well as with the interest groups and evidenced by the response to the questionnaire (Table 2.7). Almost 90 per cent of the respondents perceive that the role of the development agency, MDDA, has been negative and has encouraged speculative and absentee housing development, pushed up the land values and marginalised the residents' requirements. The impact is also perceived to be adverse on city aesthetics and a contributory factor to congestion. A significant proportion of the residents has also noted the lack of entertainment and sports facilities.

Table 2.7: Distribution of Residents' Response to City Development and Housing

Development Issue	Not adverse		Adverse	
	Number	Percent	Number	Percent
Development Planning	31	10.23	272	89.77
Construction-related Congestion	64	21.12	239	78.88
Construction-related City Aesthetics	57	18.81	246	81.19
Implementation of Building by-laws	93	30.69	210	69.31
Entertainment Facility	30	9.90	273	90.10
Accessibility to Picnic Spots	85	28.05	218	71.95
Sports Facility	16	5.28	287	94.72

Note: Figures in brackets denote percentages.

Pollution and Landslides

The difference in air pollution during the tourist season and off-season is perceived to be significant. Close to 90 per cent of the respondents believe that the city air is not polluted during the off season as against about 80 per cent of the respondents who believe that the air is polluted during the tourist season (Table 2.8). It should be noted that much of the air pollution in the city is through emission from automobiles that reaches a very high density during the tourist season. This dimension is also associated with noise pollution. Land

degradation resulting in landslides—specifically along the most frequently used Dehradun-Mussoorie road, is found to be frequent by about 95 per cent of the respondents.

Table 2.8: Distribution of Residents' Perception of Pollution

Nature of Pollution	Not adverse		Adverse	
	Number	Percent	Number	Percent
Air Pollution	267	88.12	36	11.88
Air Pollution (Peak Season)	58	19.14	245	80.86
Noise Pollution	255	84.16	48	15.84
Noise Pollution (Peak Season)	29	9.57	274	90.43
Landslides (Dehradun-Mussoorie Road)	11	5.05	207	94.95

Perceived Indicative Solutions

For the problems prioritised (see Table 2.1), various interest groups also indicated a broad approach to the solution. These are summarised in Table 2.9.

2.3 Intra-City Disparity in Infrastructure and Services

Given the variations in the location of different city wards *vis-a-vis* elevation, slope and the city centre, the nature of problems perceived differ from ward to ward. These differences have been documented through ward-wise meetings as well as the analysis of the residents' response to questionnaires that were canvassed. The two top ranking problems identified by residents of the wards as well as what may be termed as 'problem wards' are highlighted here.

Eight of the 25 city wards indicate problems relating to housing and land-development as the first major problem (Figures 2 and 3) of Mussoorie. Such wards are mainly located in what may be termed as the city centre, which appears to be already densely built-up. Four of the city wards, particularly those in the outlying areas rate

mains, pipes, cables or other apparatus.

The increase in the built-up area of the city has been phenomenal, as we will see later (Chapter 4), between 1990 and 1997, and the shrinking of forest cover is also striking. Meanwhile a Monitoring Committee was constituted by the Honourable Supreme Court of India with reference to Doon Valley development.

The Honourable Supreme Court in their interim order delivered on July 10, 1996, on a writ by the Supreme Court Monitoring Committee versus MDDA, stated that constructions which have not begun at site and have not proceeded beyond the plinth level shall not be permitted to be started till the stand of the State of Uttar Pradesh and the Union of India on the applicability or otherwise of the provisions of the Forest Conservation Act, 1980, and the rules made thereunder is made clear. The Honourable Court subsequently clarified on December 15, 1997, that the order dated July 10, 1996, is not to be construed as permitting the continuance of construction which had proceeded beyond the plinth level on the date of the order. In the order dated November 29, 1996, the direction given to the Central Government was to consider the cases for grant of *ex post facto* approval. This needs to be read along with the other orders made by the court in these proceedings as well as in another matter (writ petition (C) No. 202 of 1995–T.N. Godavarman *Vs.* Union of India & Ors. SCALE 1996(9) 269).

It is in this background that a study was proposed and funded by the Supreme Court Monitoring Committee to assess the environmental status of Mussoorie in the larger context of urban and non-urban land use, and the carrying capacity of urban infrastructure.

1.2 Objectives of the Study

The specific objectives of the study may be stated as follows:

(a) to bring out the current rate of conversion of open space to built-up space and to review the current procedures and rules relating to city land use;

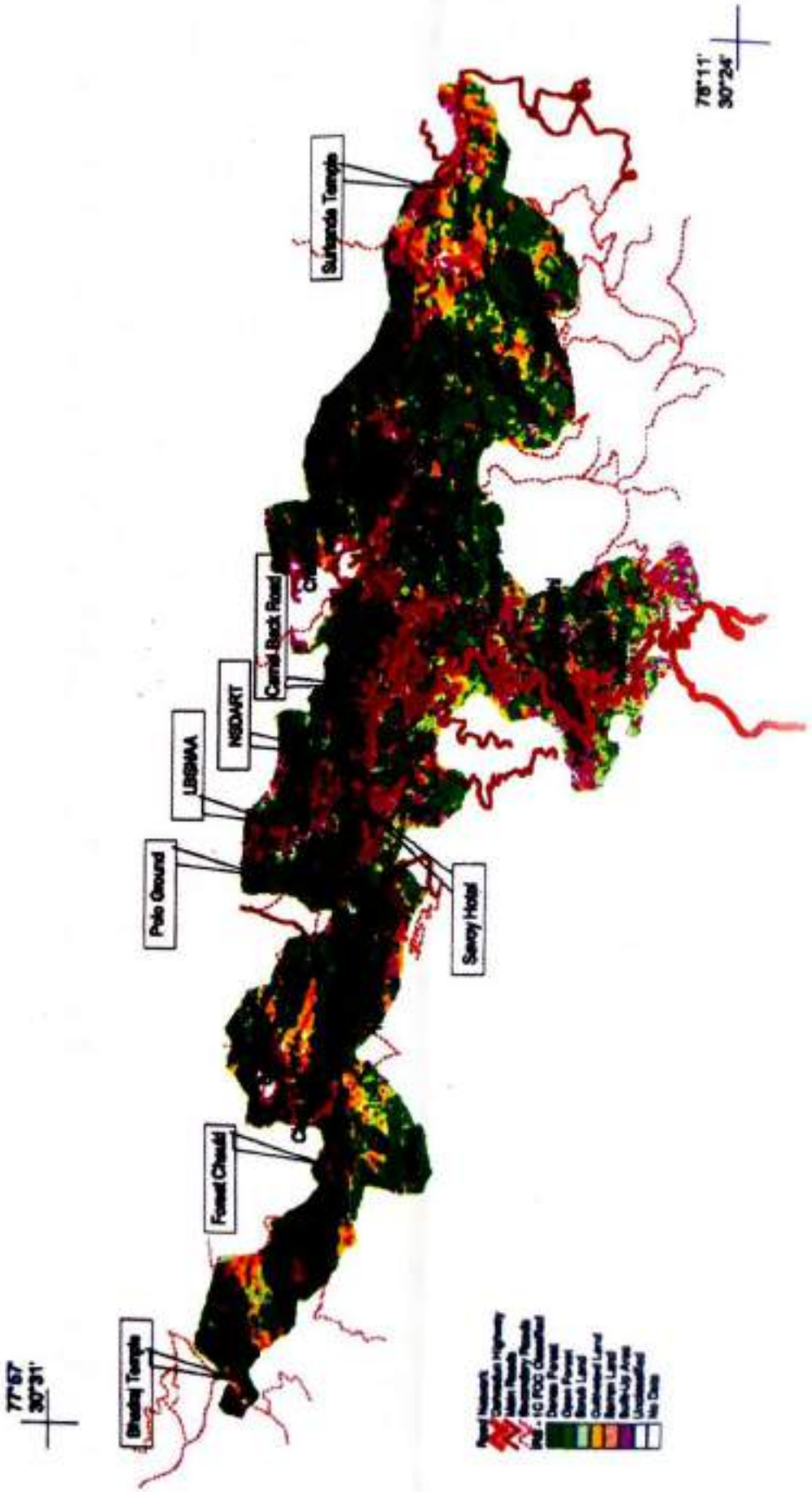

Fig. 1A : Mussoorie–Space Relations

Fig. 1B : Mussoorie–Municipal Wards

(b) to prepare a detailed land use map including vertical spread and intensity of land use in areas with different slopes;
(c) to bring out the problems as perceived by different segments of residents;
(d) to analyse the ways in which these problems need to be tackled as perceived by various segments of the resident population;
(e) to undertake quantitative analysis of primary data of variables relating to the problems identified in (c) above;
(f) to develop indicators for monitoring carrying capacity and estimating the carrying capacity of the Mussoorie U.A. with special reference to available infrastructure; and
(g) to identify and define benchmarks of various indicators to monitor the carrying capacity of the Mussoorie hills.

The study was originally proposed in two phases. This report, based on the work relating to the first phase, was to address the following objectives:

(i) preparing a detailed land use map;
(ii) preparing a set of map overlays based on building regulations, zoning norms and slope stability;
(iii) preparation of a detailed map identifying hazard-prone zones;
(iv) estimating carrying capacity of the Mussoorie U. A. with particular reference to available urban infrastructure;
(v) establishing benchmarks for water and air pollution at selected points in the city;
(vi) estimating demand for water and power; and
(vii) detailing of people's perceptions on environmental problems based on a household survey.

1.3 Methodology

The key role players in the city include the residents, the local government agencies, schools and other government as well as quasi-government organisations, hotel owners, real estate and other

3

On Measuring Carrying Capacity of Mussoorie

3.1 Estimating the City Population

The carrying capacity of an urban eco-system as a whole or part thereof is, essentially, a function of its population among other things. The first problem involved in estimating the carrying capacity of the Mussoorie U.A. was the paucity of reliable population data. The last census conducted in 1991, as well as the previous one conducted in the winter of 1981, seemed to have considerably underestimated the population as indicated in Chapter I. Census population figures for 1981 and 1991 are given in Table 3.1.

However, a survey conducted by the Mussoorie Water Supply and Sewerage Board in 1983 placed the estimated population at 31,500 with an estimated floating population of 20,200. It appears that while the census figures were underestimates, those of the Water Supply and Sewerage Board were overestimates. This necessitated a different approach to an estimation of the current (1997) population on the basis of which projections could be made. The various segments of the population of the Mussoorie U.A. have been estimated as follows.

Table 3.1: Census Population of Municipal Board and Cantonment

	1991	1981
Mussoorie U.A.	29,629	18,233
Landour Cantonment	2,907	1,910
Mussoorie (M.B.)	26,722	16,323

Population of the Municipal Board Area

The voters list for the City Board election (updated in 1995) was acquired. The number of voters registered was 17,770 i.e. equivalent to the 18 plus population. As age-wise population break-up was not available for the Mussoorie U.A., the age-wise population data for a similar hill urban area (Shimla district, Himachal Pradesh) was therefore, obtained. The proportion of population in the 18 years plus age group was 55 per cent. Taking 17,770 as equivalent to 55 per cent of the population, the total population of area under the jurisdiction of the Mussoorie Municipal Board was estimated at 31,218.

Population of the Cantonment Area

Census figures place the population of Landour Cantonment at 2,907 in 1991. The Landour Cantonment Board has confirmed these figures. The Board indicated an annual increase of approximately 5 persons. On this basis, the population was extrapolated as given in Table 3.2. The Landour Cantonment Board further notified us of a decrease of 150 persons with the closing of the PPCL Corporation during 1997. Thus, the 1997 population estimate works out to 2,787.

Table 3.2 : Population Estimates for Landour Cantonment Area

Year	Population
1991	2907
1992	2912
1993	2917
1994	2922
1995	2927
1996	2932
1997	[2937 (-150)] = 2787

Tibetan Population

As the Tibetan population of Mussoorie does not figure in the voters' list, the number of Tibetans registered with the Local Intelligence Office, Police Department, Dehradun, was obtained. The Tibetan population above 16 years of age was given as 656. To this figure, we added the number of Tibetan children studying as day scholars in the two schools for Tibetans in Mussoorie i.e. (1) Central School for Tibetans 170 and (2) Tibetan Homes School 33. The total Tibetan population was thus placed at 656 + 203 = 859.

Boarders in Tibetan Schools

The total number of boarders in the two Tibetan schools is as follows: (1) Central School for Tibetans had 493 children and (b) Tibetan Homes School had 1,268 children. The total Tibetan population was thus placed at 1,761. Boarders in Tibetan schools were assessed separately as their vacation timings are different from the public schools and would have an impact on the month-wise population estimates made later.

Boarders in Public Schools

A survey of all 16 boarding schools in Mussoorie was carried out in order to ascertain the number of children residing in them. The number of boarders in Mussoorie in 1997 was 6,028. As the number of boarding schools in the 1983 survey was also 16, it is assumed that the total number of children in boarding schools would remain around the same figure i.e. 6,028 for the period under study. It is not feasible to project the number of new boarding schools that may be established in the future.

Total permanent population estimates for 1997

Final population estimates for 1997 were arrived at in a disaggregated manner—for the winter months and for the rest of the year. As a fairly substantial proportion of the residents of Mussoorie move down to the plains during the winter months i.e., December, January

and February, it was felt that separate population estimates should be made for the three winter months and for the remainder of the year. The steps involved in this are:

1. The 1981 Census (which was conducted during winter) places the population of Mussoorie at 18,241. The 1991 Census figures are 29,629 which works out to a growth rate of 6.2 per cent per annum between 1981 and 1991. Based on this growth rate, the Census figures for 1981 were projected to 1983 as follows:

Population of Mussoorie U.A.	
1981	18,241
1982	18,241 + 1,131 = 19,372
1983	19,372 + 1,201 = 20,573

2. The projected population figures for 1983 were then compared with the survey figures for 1983 Water Supply and Sewerage Board to estimate the proportion of residents who stay in the U.A. throughout the winter. The survey of 1983 (in season) estimated the population at 31,398 and that projected on the basis of the Census during winter worked out to 20,573. Thus the proportion of winter population to population during the rest of the year is 65 per cent. Thus the total resident population is placed at 23,486 (i.e. 65 per cent of 36,132 in 1997).
3. Following from the above calculations, the population estimates for the winter months (1997) are detailed below: December and February: Resident population (22,662) + Boarders in Tibetan Schools (1,761) = 24,423
   January: Resident population (22,662) + Boarders in SOS children's village (1,268) = 23,930.
4. The estimates of in-season population are as follows:

Total residents	34,864
Boarders in public schools	4,267
Tibetan boarders	1,761
Total	40,892

5. The population in winter and the rest of the year (1997) is thus estimated to be:

December	24,423
January	23,930
February	24,423
Other Months	40,892

3.2 Population Projections

Based on the population estimates for 1997, an attempt has been made to project the population for the next 24 years i.e., to the year 2021. This was done with a view to estimating the carrying capacity of Mussoorie with reference to essential elements of the infrastructure such as water supply, waste disposal, availability of beds for tourists, etc. Population projections have been made at five-year intervals from 1997 to 2021.

Estimating the population growth rate

Census data for the population of the Mussoorie U.A. was collected for a period of 90 years i.e., for the census years beginning from 1901 at ten-year intervals to 1991. The figures were plotted on a graph and trend lines were fitted—both linear and logarithmic (Figure 4). The major difficulty in projecting the population of Mussoorie arises from the fact that during the period of nearly a century under consideration there have been several sharp dips or falls in population (Table 3.3), and the decadal growth rate has been fluctuating correspondingly.

Based on the linear trend line—best fitting the population distribution over the period 1901-1991— the expected population for the year 1997 was 24,737. On the basis of our own population estimates for 1997 detailed above, the winter population varies between 24,737 and 25,247 which closely approximates the forecast based on the linear trend line. However, to estimate the growth rate of the population several calculations were made, before adopting what seemed to be the most realistic figure.

Table 3.3 : Mussoorie Urban Agglomeration—Population Growth (1901-91)

Name	Population and Growth Rate									
	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991
Mussoorie U.A.	6461	8052	9702	6116	7172	8550	11238	20389	18233	29629
		(24.62)	(24.49)	(-36.96)	(17.27)	(19.21)	(31.44)	(81.43)	(-10.57)	(62.50)
(i) Landour Cantonment	1720	1500	1405	1150	1206	1417	1389	2351	1910	2907
		(-12.79)	(-6.33)	(-18.15)	(4.87)	(17.50)	(-1.98)	(69.26)	(-18.76)	(52.20)
(ii) Mussoorie M.B.	4741	6552	8297	4966	5966	7133	9849	18038	16323	26722
		(38.20)	(26.63)	(-40.15)	(20.14)	(19.56)	(38.08)	(83.15)	(-9.51)	(63.71)

Note: Figures in parentheses indicate per cent decadal growth.

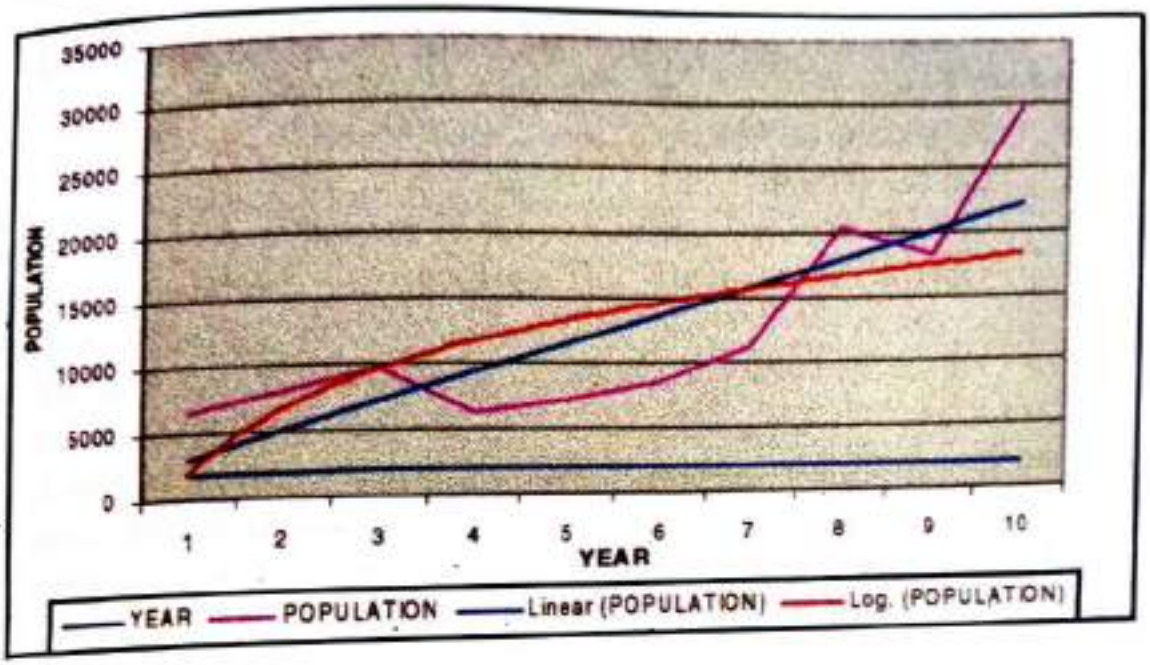

Fig. 4: Mussoorie—Population Growth (1901-1991)

Method I: The growth rate of Mussoorie U.A. between Census 1981 and Census 1991 was calculated as follows:

$$\frac{Pop._{91}\ (29,629) - Pop._{81}\ (18,233)}{Pop._{81}\ (18,233)} \times 100$$

= 62.50 per cent (or 6.25% per annum)

Method II: The growth rate based on the linear trend line is as follows:

Population 2001 = 25,263
Population 1997 = 24,737
Growth rate for 4 years = 2.13 per cent
Growth rate per year = 0.53 per cent

Method III: The growth rate based on Survey (1983) and per estimate (1997).

Population (1997) = 34,864 (Mussoorie U.A.)
Survey (1983) = 25,456 (Mussoorie U.A.)

Growth rate for 14 years = 36.96
Growth rate per year = 2.6 per cent

Method IV: The growth rate based on Survey (1983) and 1991 Census

Population (1991) = 29,629
Survey (1983) = 25,456
Growth rate for 8 years = 16.39 per cent
Growth rate per year= 2.05 per cent

Of the four different growth rates, growth rate I i.e. 6.25 per cent is unrealistically high while that based on the linear trend is too low (probably because of the fact that the Census had been conducted in winter during the some census periods and accounts for only winter residents). Thus, growth rates III and IV were selected and two separate scenarios were generated:

Scenario I: based on a growth rate of 2.05 per cent per annum.
Scenario II: based on a growth rate of 2.60 per cent per annum

Estimating the growth rate of Tourists. In order to project the number of tourists visiting Mussoorie over the next 25 years, data on the number of tourists, both Indian and foreign—entering Mussoorie every month for the years 1990 to 1996 was collected from the Department of Tourism, Government of Uttar Pradesh (see Appendix 4). The growth rate of the number of tourists visiting Mussoorie was then calculated as follows:

$$\frac{\text{Number of tourists (1996)} - \text{Number of tourists (1990)}}{\text{Number of Tourists (1990)}}$$

which gives an annual growth rate of 0.6 per cent.

The number of tourists expected to visit the Mussoorie U at five-yearly intervals was then calculated on an annual grow rate of 0.6 per cent. Thus, the projection of various segments o Mussoorie population is given in Table 3.4.

Table 3.4 : Population Projections for Mussoorie U.A. 1997-2021

Year	Permanent Population Scenario I Annual Growth Rate 2.05%	Permanent Population Scenario II Annual Growth Rate : 2.6%	Tourists Annual Growth Rate 0.6 percent	Boarders in Residential Schools
1997	34864	34864	1427514	6028
2001	37723	38490	1461774	6028
2006	41590	43494	1505627	6028
2011	45853	49148	1550796	6028
2016	50553	55537	1597320	6028
2021	55735	62757	1645240	6028

3.3 Estimating the Population Pressure

Once the population projections for the different segments of population i.e. permanent population, boarders in residential schools and tourists were made, the next step involved estimating the population pressure on the town. As Mussoorie, being a tourist town, shows sharp seasonal fluctuations in population, it was decided to estimate population pressure on a monthly basis. This would also aid in estimating requirements of water, waste disposal, hotel beds, etc., on a month to month basis.

For each of the selected years, population projections were made on the basis of the two growth rates selected—2.05 per cent per annum for Scenario I and 2.6 per cent per annum for Scenario II.

Permanent Population Estimates

Based on the projected permanent population figure for any particular year, the total in-season permanent population was derived by adding to the permanent population the total boarders in residential schools. Off-season in Mussoorie coincides with the winter months of December, January and February. The method of estimating the permanent population for these three months is as follows:

For December and February

Resident population (65 per cent of the permanent population + all boarders in Tibetan schools), e.g. for January 1997:
Resident population = 65 per cent of 34,864
= 22,662 + 1,761 = 24,423

For January

Resident population (65 per cent of the permanent population + boarders in SOS children's village who stay in Mussoorie throughout the year.
Resident population = 65 per cent of the 34,864
= 22,662 + 1,268 = 23,930

Estimates of Tourist Pressure

Based on the average month-wise arrival of tourists from 1990 to 1996, the proportion of tourists arriving in any one month of the year to the total tourists arriving annually was calculated (Table 3.5).

The projected figures for the years 1997, 2001, 2006, 2011, 2016 and 2021 were then split proportionately into tourist arrivals per month. As the average tourist spends three days in Mussoorie in May and June and two days in the other months, tourist arrivals per month were converted into the number of tourist days. The final figure of tourist pressure was obtained by dividing the number of tourist days per month by the number of days in the month to obtain the number of tourists per day in that particular month as illustrated below:

e.g., To estimate tourist pressure for January 1997

1. Total tourist arrivals in January = 45,758
2. Tourist days @ 2 per tourist = 91,516
3. Tourists per day = 91,516/31
= 2,952.

Final Estimates of Population Pressure

To obtain the final estimates of population pressure per month, the permanent population for each month was added to the tourists, per day in the month (See Appendix 5).

Table 3.5: Tourists In-flow to Mussoorie (1990-96)

Year	Average Indian Tourists (1990-96)	Average Foreign Tourists (1990-96)	Average All Tourists (1990-96)	All Tourists as per cent of previous Column Total
January	360372	50	51532	3.6
February	456536	76	65295	4.6
March	638536	143	91362	6.4
April	863634	145	123521	8.7
May	977264	161	163038	11.5
June	1755263	140	281017	19.8
July	1323500	165	274081	19.3
August	475000	144	79310	5.6
September	409000	166	68332	4.8
October	500000	128	83461	5.9
November	437000	102	72935	5.1
December	407000	75	67908	4.8

3.4 Carrying Capacity with Reference to Basic Needs

This section attempts to estimate the carrying capacity of the Mussoorie U.A. with respect to basic needs such as water, power, waste disposal, availability of hospital beds, housing, hotel beds for tourists, etc. The methodology followed here is simple one — that of projecting month-wise demands for each amenity as a function of the per capita requirement and the population projected for that month. As the current supply of the amenity is known, anticipating shortfalls in supply in the future becomes simple.

Table 3.6: Projected Water Demand @ 150 lpcd (Scenario - I)

Months	1997	2001	2006	2011	2016	2021
January	4086750	4373450	4769700	5201100	5675550	6197550
February	4366950	4662600	5061150	5488800	5953050	6509250
March	**7017900**	**7018050**	**8075250**	**8742600**	**9476400**	**10283400**
April	**7375800**	**7834350**	**8452650**	**9131400**	**9876750**	**10695750**
May	**8516850**	**8945700**	**9656100**	**10371000**	**11153700**	**12010950**
June	**10373550**	**10904100**	**11614350**	**12388050**	**13231200**	**14150850**
July	**8800050**	**9292800**	**9954750**	**10678650**	**11470500**	**12337350**
August	6907350	7330500	8003700	8622600	9352800	10156050
September	6819000	7264350	7864950	8526450	9253800	10054200
October	6948900	7397250	8002350	8667600	9399150	10203750
November	6861750	7308150	7910550	8573100	9301800	10103550
December	4326600	4621200	5018550	5455050	5934900	6462600

Current supply is 70,00,000 lpcd.

Note : Bold figures indicate demand in excess of current supply.

Current carrying capacity = **46,666.** lpcd

Table 3.7: Projected Water Demand @ 150 lped (Scenario - II)

Month	1997	2001	2006	2011	2016	2021
January	4086750	4452150	4955400	5522400	6161550	6882150
February	4366950	4737300	5246850	5810100	6439050	7193850
March	**7017900**	**7583100**	**8360850**	**9236850**	**1022400**	**11336700**
April	**7375800**	**7949400**	**8738250**	**9625650**	**10624350**	**11749050**
May	**8516850**	**9060750**	**9941700**	**10865250**	**11901300**	**13064250**
June	**10373550**	**11019150**	**11904450**	**12882300**	**13978800**	**15204150**
July	**8800050**	**9407850**	**10240350**	**11172900**	**12218100**	**13390650**
August	**6907350**	**7445550**	**8244300**	**9116850**	**10100400**	**11209350**
September	**6819000**	**7379400**	**8150550**	**9020700**	**10001400**	**11107500**
October	**6948900**	**7512300**	**8287950**	**9161900**	**10146750**	**11257050**
November	6861750	7423200	8196150	9067350	10049400	11156850
December	4326600	4695900	5204250	5776350	6420900	7147200

Current Supply is 70,00,000 lped.

Note: Bold figures indicate demand in excess of supply.

Current carrying capacity = **46,666**. lped

Projected Demand for Water

Water requirements for the U.A. have been worked out on the basis of 150 lpcd (litres per capita per day as given by the office of the Executive Engineer, Uttar Pradesh *Jal Nigam*, Dehradun). Tables 3.6 and 3.7 give the month-wise break-up of water requirement under the two scenarios. The total available supply as of 1997 is 7 million litres per day. As can be seen from Table 3.6, even at present (1997) the available water supply is sufficient only for the three winter months of December, January and February. By June the demand for water is already 1.5 times the available supply. Under Scenario I (Table 3.6), the situation with respect to monthly demand for water remains the same with sufficient water supply being available from December to February even in the year 2021. However, the peak demand for water in the month of June i.e., 141.5 million litres is more than twice the city's carrying capacity. In fact, for all nine months of the year from March to November water demand exceeds the city's supply by about 1.5 times.

Coming to Scenario II (Table 3.7), it is clear that while the existing water supply remains adequate for the period December to February till 2016, by the year 2021, water demand in December and February exceeds the available supply and the supply in January is just barely adequate to meet the demand generated. The peak demand in June will be about twice the current supply. For details of the water supply system in Mussoorie, see Chapter 5.

Current Carrying Capacity with Reference to Water Supply

The current supply of water in Mussoorie is about 70 lakh litres per day. Based on a daily per capita requirement of 150 lpcd, the carrying capacity of the Mussoorie U.A. is estimated as below:

Available water supply:	70,00,000 litres per day
Demand per capita:	150 litres per day
Carrying Capacity:	46,666 persons.

Table 3.8: Estimates of Waste Generation in Mussoorie (Scenario I)

Months	1997			2001			2006		
	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total
January	8375	1326	9701	9026	1358	10384	9905	1399	1304
February	8548	1876	10424	9198	1921	11119	10078	1979	12057
March	14312	1958	16270	15313	2414	17727	16666	2487	19153
April	14312	3312	17624	15313	3391	18704	16666	3493	20159
May	14312	6355	20667	15313	6355	21668	16666	6702	23368
June	14312	11306	25618	15313	11577	26890	16666	11924	28590
July	14312	7110	21422	15313	7280	22593	16666	7499	24165
August	14312	2063	16375	15313	2028	17341	16666	2176	18842
September	14312	1827	16139	15313	1871	17184	16666	1926	18592
October	14312	2174	16486	15313	2226	17539	16666	2292	18958
November	14312	1941	16253	15313	1988	17301	16666	2048	18714
December	8548	1768	10316	9198	1810	11008	10078	1865	11943

@ 400 gms/capita/day (for tourists) and 350 gms/capita/day (for permanent population).

Table 3.8: *(Contd).....*

Months	2011			2016			2021		
	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total
January	10875	1441	12316	11944	1484	13428	13124	1528	14652
February	11048	2011	13059	12117	2027	14144	13296	2162	15458
March	18158	2561	20719	19803	2638	22441	21617	2717	24334
April	18158	3598	21756	19803	3706	23509	21617	3817	25434
May	18158	6904	25062	19803	7111	26914	21617	7324	28941
June	18158	12282	30440	19803	12651	32454	21617	13030	34647
July	18158	7724	25882	19803	7956	27759	21617	8194	29811
August	18158	2241	20399	19803	2308	22111	21617	2378	23995
September	18158	1985	20143	19803	2044	21847	21617	2106	23723
October	18158	2361	20519	19803	2432	22235	21617	2505	24122
November	18158	2109	20267	19803	2172	21975	21617	2238	23855
December	11048	1921	12969	12117	1978	14095	13296	2038	15334

Table 3.9: Estimates of Waste Generation in Mussoorie (Scenario II)

Months	1997			2001			2006		
	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total
January	8375	1326	9701	9200	1358	10558	10339	1399	11738
February	8548	1876	10424	9373	1921	11294	10511	1979	12490
March	14312	1958	16270	15581	2414	17995	17333	2487	19820
April	14312	3312	17624	15581	3391	18972	17333	3493	20826
May	14312	6355	20667	15581	6355	21936	17333	6702	24035
June	14312	11306	25618	15581	11577	27158	17333	11924	29257
July	14312	7110	21422	15581	7280	22861	17333	7499	24832
August	14312	2063	16375	15581	2048	17629	17333	2176	19509
September	14312	1827	16139	15581	1871	17452	17333	1926	19259
October	14312	2174	16486	15581	2226	17801	17333	2292	19625
November	14312	1941	16253	15581	1988	17569	17333	2048	19381
December	8548	1768	10316	9373	1811	11184	10511	1865	12376

@ 400 gms/capita/day (for tourists) and 350 gms/capita/day (for permanent population).

Table 3.9: *(Contd)..*

Months	2011			2016			2021		
	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total	Permanent Population @ 350 gm/ cap. (kg.)	Tourists per day @ 400 gm/cap (kg)	Total
January	11625	1441	13066	13078	1484	14562	14721	1528	16249
February	11797	2011	13808	13251	2027	15278	14894	2162	17056
March	19312	2561	21873	21548	2638	24186	24075	2717	26792
April	19312	3598	22910	21548	3706	25254	24075	3817	27892
May	19312	6904	26216	21548	7111	28659	24075	7324	31399
June	19312	12282	31594	21548	12651	34199	24075	13030	37105
July	19312	7724	27036	21548	7956	29504	24075	8194	32269
August	19312	2241	21553	21548	2308	23856	24075	2378	26453
September	19312	1985	21297	21548	2044	23592	24075	2106	26181
October	19312	2361	21673	21548	2432	23980	24075	2505	26580
November	19312	2109	21421	21548	2172	23720	24075	2238	26313
December	11797	1921	13718	13251	1978	15229	14894	2038	16932

Projected Needs for Waste Disposal

The waste generated in the Mussoorie U.A. was estimated separately for the local population and the tourists. The rates selected were 350 gms. of waste per capita per day for residents and 400 gms. per capita per day for tourists. These estimates were based on trials conducted in Mussoorie during May, 1997. (For details see Annexure 2.)

Tables 3.8 and 3.9 show the month-wise generation of waste by the resident population and by the tourists visiting the U.A. In 1997 itself, the Municipality had to cope with a daily waste disposal ranging between 9.7 tonnes in January to 26 tonnes in the peak season (June). By the year 2021, this daily disposal load will be minimum 15 tonnes, and in the peak season it will touch nearly 35 tonnes under Scenario I. If higher growth rates are assumed (Scenario II), the lowest waste load would be 16 tonnes and the highest over 37 tonnes. The city utilises a single dumping site which could become a health risk, with the chances of polluting the Bhilaru Stream which is an important water source for the area.

Projected Demand for Beds in Hotels

As the economy of the Mussoorie U.A. is almost wholly dependent on the tourist trade, it becomes crucial to assess the availability of residential accommodation for tourists. This assessment is normally made on the basis of number of beds available. The Department of Tourism, Mussoorie provided figures on the of beds available in the 140 registered hotels, both government and private, as 8,028. However, as a large number of tourists visiting Mussoorie are from the lower middle and middle income groups, it is necessary to include other places which offer accommodation on a cheaper basis such as *Gurudwaras* and *Dharamshalas*. Accordingly, all eight Dharamshalas listed in the tourist information brochure were visited and information collected on the accommodation available. It is estimated that 1,598 beds are available in these institutions for tourists. All the institutions verified that available beds are full during the season i.e. May and June.

A third group providing hospitality to tourists in Mussoorie is the holiday homes of various public sector undertakings and private firms, and paying guesthouses run by private individuals. A survey of these revealed an additional availability of 218 beds. The total estimated availability of beds for tourists in Mussoorie is given in Table 3.10.

Table 3.10: Beds Available for Tourists in Mussoorie

1. Beds in 140 registered hotels	8,028
2. Beds in 8 Gurudwaras, Dharamshalas, Musafirkhanas and Temples	1,598
3. Beds in holiday homes and paying guest houses	218
Total Beds Available	**9,844**

Table 3.11 shows the daily arrival of tourists in Mussoorie in each month. It is obvious that during the season, i.e., in the months of April, May and June the number of incoming tourists is much greater than the accommodation available in the city. Thus, while in May and July, only 62 per cent and 55 per cent of the arriving

Table 3.11: Tourist Flow Per Day - Estimates (Mussoorie)

Month	1997	2001	2006	2011	2016	2021
January	3315	3395	3497	3602	3710	3821
February	4690	4803	4947	5027	5067	5406
March	5894	6036	6217	6403	6595	6793
April	8280	8478	8733	8995	9264	9542
May	**15887**	**15887**	**16756**	**17259**	**17777**	**18310**
June	**28265**	**28943**	**29811**	**30706**	**31627**	**32576**
July	**17775**	**18201**	**18747**	**19310**	**19889**	**20486**
August	5157	5119	5440	5603	5771	5944
September	4568	4678	4815	4962	5111	5265
October	5434	5564	5731	5903	6080	6262
November	4853	4970	5119	5273	5431	5594
December	4421	4527	4663	4802	4946	5095

Note: **Figures in bold indicate that the number of tourists exceeds the available accommodation. Current Carrying Capacity for overnight tourists is 9,844.**

tourists can be accommodated, in June, 65 per cent have to return the same day because of lack of accommodation. Thus, while the city bears the burden of providing water and other facilities to these incoming tourists, and faces the regular traffic jams, resulting emission of pollutants, and the responsibility of disposing of the waste generated, it still loses out on the income which would accrue to the town if the tourists spent the night. This would also, perhaps, reduce the constant traffic jams as the day tourists rush to get back to Dehradun before nightfall. On the other hand, there is a considerable excess capacity during several months in the year.

By the year 2016, this shortfall in tourist accommodation would reach a level where only 31 per cent of the incoming tourists can be accommodated in the peak month of June. By 2021, 70 per cent of the tourists arriving in Mussoorie in June would be forced to return to Dehradun or to proceed beyond Mussoorie in search of accommodation. The vast potential in the tourist trade opens up several possibilities—that of increasing the capacity of existing hotels, granting licenses to new hotels which has to be viewed in the context of excess capacity during off-season, or boosting the development of alternative locations like Dhanaulti or Chakrata. This would also necessitate augmenting access to such alternative centres.

Current carrying capacity with reference to tourism

As the total number of beds for tourists in all hotels, guest houses and *dharamshalas* in the town amounts to 9,844, the current carrying capacity of the town with reference to overnight tourists is 9,844.

Projected Demand for Hospital Beds

Town planning norms in India place the requirement of hospitals at one general hospital per 50,000 population. As Mussoorie has three hospitals[1] with capacities ranging from 30 to 53 beds, it was

[1] The Northern Railway Hospital at Jhari Pani has a 58-bed facility. However, it caters to railway personnel only and has thus been excluded from the carrying capacity estimates.

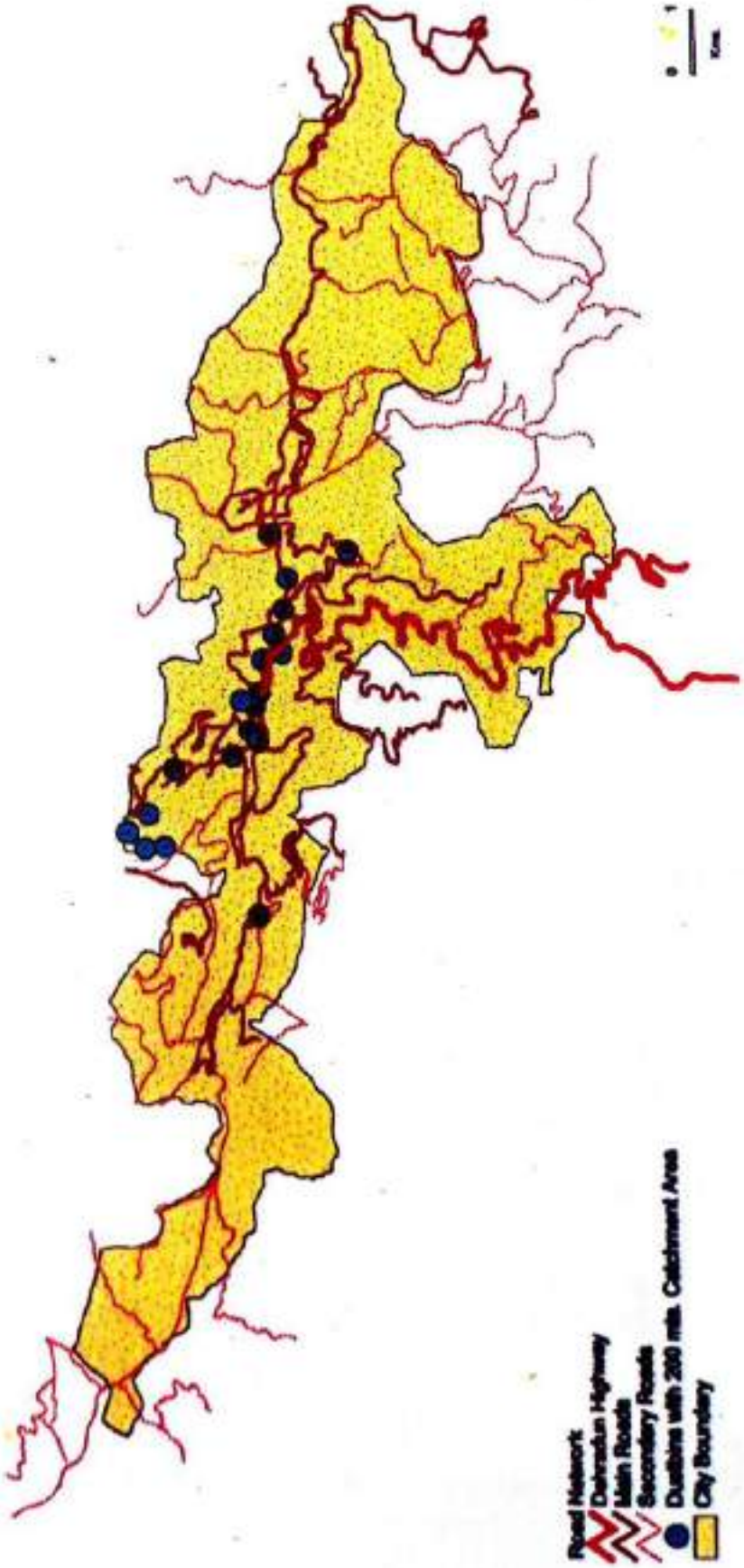

Fig. 5: Mussoorie—Spatial Distribution of Dustbins

decided that a more appropriate measure would be the availability of hospital beds against basic requirements. In order to estimate the requirement for hospital beds, one of the largest general hospitals in Dehradun i.e. the Doon Hospital with a capacity of 232 beds was selected. At the rate of one general hospital for 50,000 persons specified by the MDDA as well as Indian town planning norms, the requirement for hospital beds works out to one bed for a population of 215 persons. Thus it was decided to adopt the norm of one hospital bed per 200 persons, as the basis of working out the carrying capacity of Mussoorie with reference to health facilities. The number of hospital beds available in Mussoorie in 1997 is detailed in Table 3.12.

Table 3.12: Availability of Hospital Beds in Mussoorie (1997)

Sl.No.	Name of Hospital	Number of Beds
1.	St. Mary's Hospital, Mussoorie	53
2.	Civil Hospital, Mussoorie	30
3.	Community Hospital, Landour	50
4.	Private Nursing Homes	20
	Total (Beds)	**153**

Projected requirements for hospital beds even under Scenario I (Table 3.13) reveal a shortage of beds from March to November. In fact, even as per 1997 estimates the shortfall in hospital beds in the peak month of June is as much as 193. The pattern remains the same over the next 20 years, though the shortfall in the peak season increases sharply to 319 beds implying that the peak demand for hospital beds is over 200 per cent of the supply. By the year 2021, the requirement for hospital beds exceeds the availability throughout the year.

Under Scenario II (Table 3.14) with the higher population growth rate of 2.6 per cent, the shortfall in hospital bed begins as early as 2001 with sufficient beds being available only in the month

Table 3.13: Requirement of Hospital Beds (Scenario I)[2]

	1997	2001	2006	2011	2016	2021
January	136	146	**159**	**173**	**189**	**207**
February	146	**155**	**169**	**183**	**198**	**217**
March	**234**	**234**	**269**	**291**	**316**	**343**
April	**246**	**261**	**282**	**304**	**329**	**356**
May	**284**	**298**	**322**	**346**	**372**	400
June	**346**	**363**	**287**	**413**	**441**	**472**
July	**293**	**310**	**332**	**356**	**382**	411
August	**230**	**244**	**267**	**287**	**312**	**338**
September	**227**	**242**	**262**	**284**	**308**	335
October	**232**	**247**	**267**	**289**	**313**	**340**
November	**229**	**244**	**264**	**286**	**310**	**337**
December	144	**154**	**167**	**182**	**198**	**215**

Note: Figures in bold indicate that the estimated demand for hospital beds exceeds the current supply. Availability of Hospital Beds - 153. Current Carrying Capacity—30,600 persons.

Table 3.14: Requirement of Hospital Beds (Scenario II)

Months	1997	2001	2006	2011	2016	2021
January	136	148	**165**	**184**	**205**	229
February	146	**158**	**175**	**194**	**215**	**240**
March	**234**	**253**	**279**	**308**	**341**	378
April	**246**	**265**	**291**	**321**	**354**	**392**
May	**284**	**302**	**331**	**362**	**397**	435
June	**346**	**367**	**397**	**429**	**466**	**507**
July	**293**	**314**	**341**	**372**	**407**	446
August	**230**	**248**	**275**	**304**	**337**	**374**
September	**227**	**246**	**272**	**301**	**333**	370
October	**232**	**250**	**276**	**305**	**338**	**375**
November	**229**	**247**	**273**	**302**	**335**	372
December	144	**156**	**173**	**192**	**214**	**238**

Note: Figures in bold indicate that the estimated demand for hospital beds exceeds the current supply. Availability of Hospital Beds - 153. Current Carrying Capacity-30,600 persons.

[2] While the large boarding schools do have infirmary beds, these cannot be equated to specialised hospital beds, but must be treated at par with home nursing facilities.

of January. From the year 2006, the number of beds available is insufficient throughout the year. By 2021, the peak requirement in the months of May, June and July is such that available supply meets only 32 per cent to 38 per cent of the requirement.

Power-Capacity and Consumption

The power supply to Mussoorie is basically via *Purkul Gaon* power station through two feeder lines. The transformers in the power stations have a capacity to supply 14 MVA. In addition, in case of grid failure, there is a standby captive hydel plant at Galogi with a capacity to generate and supply 600 kVA. The maximum load during the peak season is 2,591 KW and during the off-season it is 2,058 KW. The corresponding average loads are 1,372 KW and 1,067 KW.

The average consumption during 1991 was 1.94 KW/hr. and by 1997 it rose to 3.47 KW/hr. The growth in electrical connections and power consumption during the 1990's in the city is given in Table 3.15. The average per consumer load is estimated to be 1.01 KW.

Table 3.15: Growth in Number of Electricity Connection and Consumption in Mussoorie

Year	Number of Domestic Connections	Number of Commercial Connections	Consumption (in million units per month)
1991	2983	1304	1.4
1992	3200	1369	1.5
1993	3294	1377	1.7
1994	3392	1401	1.9
1995	3522	1419	2.0
1996	3662	1442	2.2
1997	3912	1483	2.5

4

The Limits to City Expansion: The Use of Land in the Mussoorie Hills

4.1 Introduction

As has been noted earlier the Mussoorie U.A. is located on a ridge and the terrain is extremely rugged, as a result of which the land available for urban development is limited. The U.A. spans an area of about 65.81 square kilometres.[1] In this chapter we analyse: (a) the area under various slope categories, (b) the extent of land under broad land use categories, (c) the distribution of use of land under various categories of slope and (d) change in the pattern of land use between 1990 and 1997.

Cartographic data used in this analysis include:

- Municipal Ward Boundary Map
- Topographical sheets No. 53 F/15 and 53 J/3
- IRS-1B LISS 2 and IRS 1C LISS 3 False Colour Composites of April 1990 and February 1997 with 36.25 meters and 23.5 meters resolution respectively for land use trend
- Aerial Photographs from Survey of India for the year 1984-85 in the scale of 1:12000
- City Map in the scale of 1 cm : 200 meters for the year 1997 provided by Town Planning Department

[1] It may be noted that the extent of area (derived here on the basis of imagery) is short by about 2 square kilometers when compared to the area of Mussoorie given in the Census.

- Guide Maps, Tourist Maps for other general information and comparisons

For preparation of various maps, source maps were digitised using GIS ARC/Info. Land use analysis was undertaken using image-processing software ERDAS-Imagine, Slope Analysis etc. was done with ARC/Info, ARCVIEW-Spatial Analyst and TIN modules.

For the land use map, IRS FCC was rectified using topographical sheets and classified using both Unsupervised and Supervised techniques for optimum results, and outputs were verified with IIRS, Dehradun Forestry Branch and local field information. For various land use categories, tree vegetation constituting more than 40 per cent crown density was categorised as dense forests, 20 per cent to 30 per cent was considered as medium/open forests and below 20 per cent crown density was categorised as scrub/ shrub land. Other categories of land use are built-up area, agricultural land and barren land. Since Mussoorie does not have any major perennial streams, water bodies were not introduced as a separate category but are merged with barren land. Land-use maps for 1990 and 1997 are shown in Figs. 6A and 6B.

For calculating slope, a grid of 500m by 500m was superimposed on a contour map with 100m interval. This was digitised and the Spatial Analyst Module was used to calculate and map the degree of slope in each grid. The method identifies maximum rate of change in the altitude, derives slope from the surface and measures degree (or per cent) of slope.

Classified data for both the years were transferred on to a ward-wise base map in order to derive the land use pattern of each city-ward. The slope map was draped over the land use map to understand the relationship between land use and slope. This analysis was done for both 1990 and 1997.

4.2 Distribution of Slope

Of the total area of about 66 square kilometres, of the Mussoorie U.A. more than three-fourths has a slope of 30 degrees or more (Table 4.1). It is necessary to emphasise that 100 meter contour

Fig. 5A : Mussoorie—Landuse (1990)

Fig. 6B : Mussoorie—Landuse (1997)

interval is not suitable for an urban study. However, the broad lay of the land and area that should not be converted to urban development does emerge from the analysis. Only about 10 square kilometres of the city has less than 20 degrees of slope. Large contiguous areas record over 50 degrees of slopes (see Figure 7). Gently sloping land occurs in smaller parcels. In the south, north and west of the city edge and beyond the city limits we find gently sloping land.

Table 4.1: Area and Percentage of Land in Mussoorie by Slope Categories

Degree of Slope	Area (in Sq. kms)	Percent Area to Total Area
Below 10	5.54	8.42
10-20	3.65	5.55
20-30	4.23	6.43
30-50	10.43	15.84
50-90	41.96	63.76
Total	65.81	100.00

4.3 The use of Land (1990 and 1997)

A little more than 79 per cent of the land was under forests of various kinds—dense, medium, open and scrub in 1990 (Table 4.2). This proportion has come down to about 72 per cent by 1997. About 6 square kilometres of dense forest-land have become medium/open forest land during this period. Scrub-land has also reduced by about 5 square kilometres. Built-up area (including roads) and land under agriculture have increased during this period.

A visual comparison of this changing land use can be made by a study of Figures 8, 9 and 10 which map out the changes in proportion of built-up area, dense forest and open forest. Most of the city wards show significant increase in the proportion of built-up area. The built-up area that came up between 1990 and 1997 is shown as an inset in Figure 8.[5] The reduction in the proportion of

[5] Since the 1990 imagery had a resolution of 36.25 meters, the land use classification of 1997 imagery took into account only those features which could have been interpreted at a resolution of 36.25 meters.

area under dense forest is however, confined to fewer city wards. Significant reduction is noticeable in Bhadraj, Jabharkhet Jhalki, Jhari Pani, Barlowganj, Hampton Court, Landour South and Nalapani Dhobhighat. It is also worth noting that a few wards have also shown an increase in the proportion of dense forest (Fig.9) such as Bhilaru, Library, Waverley Convent and Allen Wynburg, owing perhaps to plantation activity. In the case of medium and open forest there are city wards which show substantial increase owing largely to a declassification from dense to open forest e.g. Jabharkhet Jhalki, Nalapani Dhobhighat, Polo-ground and Happy valley. On the other hand, there has also been a reduction in the open forest in wards such as Landour North, Beloni hill and Kutchery.

4.4 Land use in Relation to Slope

Of the total area under study, over 79 per cent has more than 30 degree slope and, therefore, can be used for urban development only at great risk (Table 4.1). It is clear from the table that if we take only that area which has less than 30 degree slope for construction activity, then we have only 13.42 square kilometres that is available for conversion to built-up area. Table 4.2 shows that the city already records about 11 square kilometres as built-up area. This does not, however, mean that some 2,400 hectares of land is available for further development.

The land with less than 30 degree slope is distributed in several pockets and also contains forest area. Out of the 13.42 square kilometres, as much as 8.73 square kilometres were forests — dense, medium and open — in 1997 (Table 4.3). What is also important to note is that an area of 8.04 square kilometres in areas with a slope of over 30 degrees were already built-up by 1997 (Figure 8). Corresponding built-up area in 1990 was only 6.74 square kilometres. It is possible, however, to argue that the slope analysis is based on a scale larger than that suitable for the purpose of urban development.

A significant proportion of land under dense forest in 1990 has changed into medium or open forest by 1997 (Table 4.3) as indicated by a negative value of 6 percentage points in the former

Fig. 7 : Mussoorie—Slope Analysis

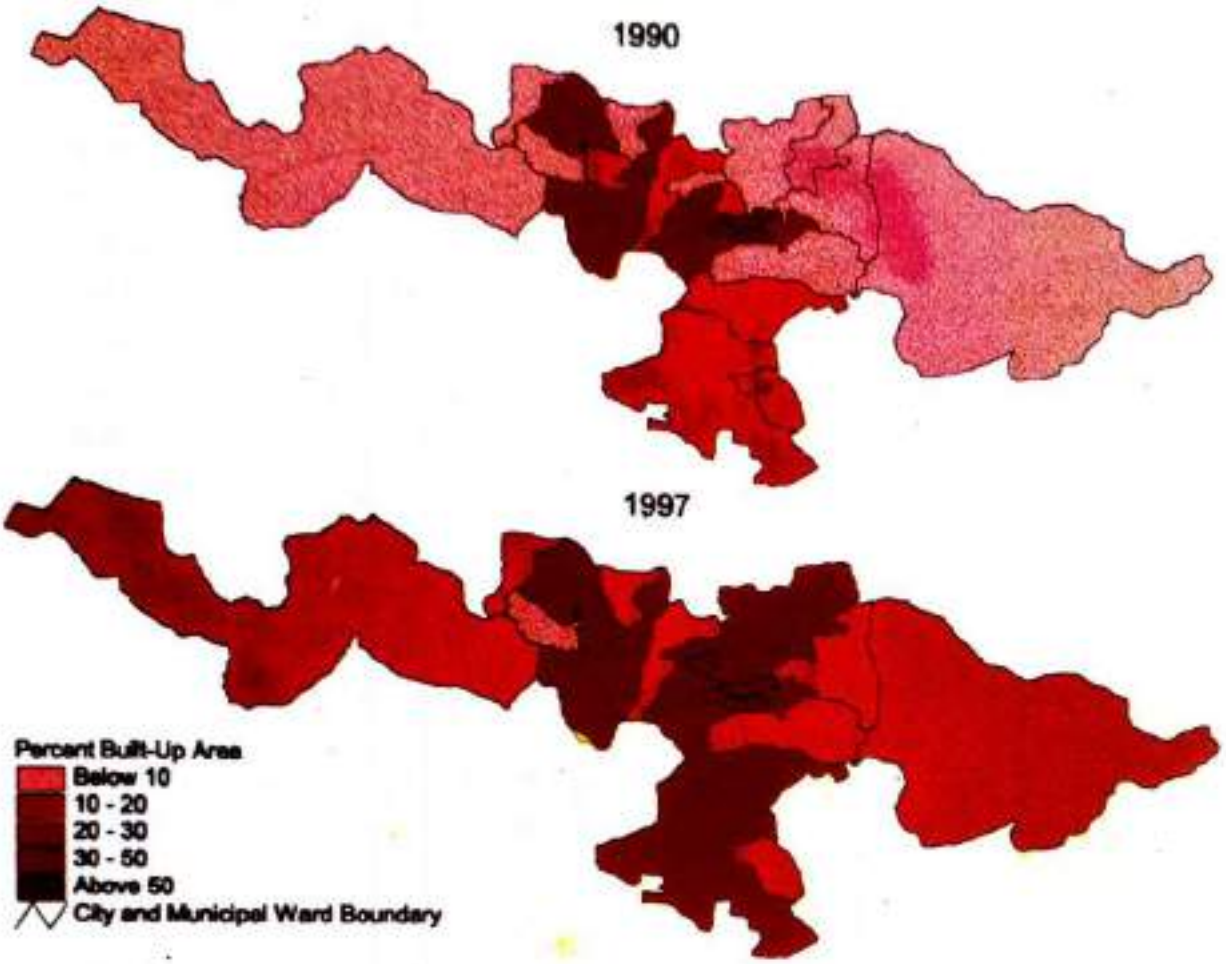

Fig. 8A: Mussoorie—Percent Built-Up Area

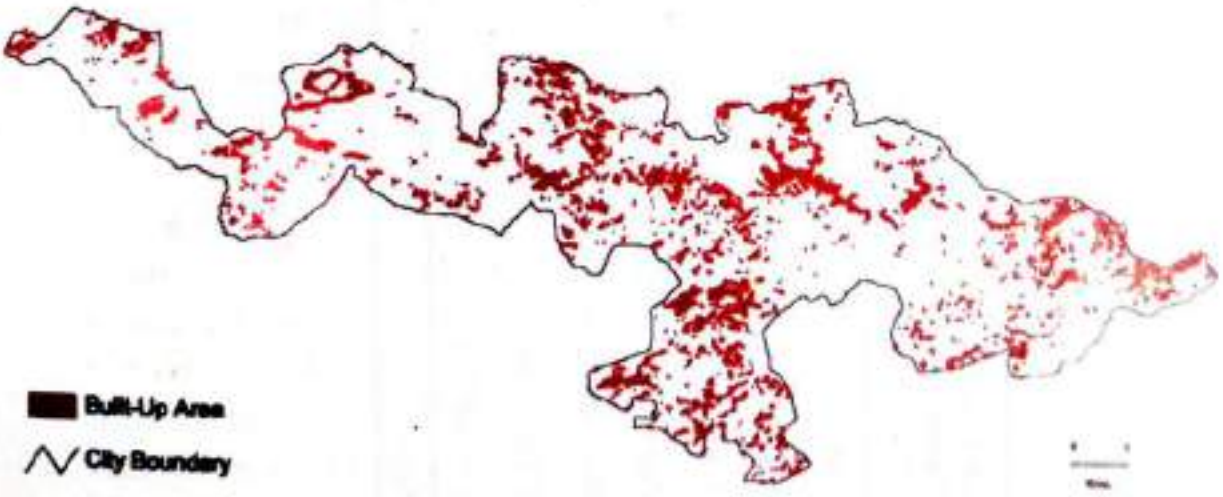

Fig. 8B : Mussoorie—Built-Up Area (Additions between 1990-1997)

Table 4.2: Change in Landuse in Mussoorie (1990-97)

Land use Categories	Area (sq.km.) 1990	Area (sq. km.) 1997	Percent Area 1990	Percent Area 1997	Change in Sq. Kms.	Change Percentage Points
Dense Forest	29.32	23.31	44.55	35.42	-6.00	-9.12
Medium Forest	11.08	18.28	16.84	27.78	7.20	10.94
Scrub/Shrub Land	11.62	6.05	17.66	9.20	-5.57	-8.46
Agricultural Land	2.51	3.57	3.81	5.43	1.07	1.62
Built-up Area	6.74	11.06	10.24	16.81	4.32	6.57
Barren Land	4.55	2.41	6.90	3.66	-2.14	-3.24
Unclassified	0.00	1.10	0.00	1.70	1.10	1.70
Total	65.82	65.78	100.00	100.00	0.00	0.00

and a positive value of over 7 percentage points in the latter. The built-up area during this period rose substantially by over 4 square kilometres.

The built-up area constituted just over 10 per cent of the city area in 1990 and increased to 16.8 per cent by 1997. However, with increasing slope, generally the proportion of built-up area does come down and forest area does record an increase (Table 4.4, see also Figures 11). In each slope-class, the largest proportion of area is under forest of various types. Understandably, the proportion of built-up area is low in areas with a slope exceeding 50 degrees and it occupies small patches of habitation. Land with slope between 30 to 50 degrees also records substantial proportion of built-up area. Areas not utilised for construction and located in the slope category of less than 30 degrees (Figure 12) would require further analysis regarding their ownership and other attributes.

If we look at each land use category, the highest proportion of land in each is found in areas with over 50 degrees of slope, since such area accounts for over 76 per cent of the city. Over 50 per cent of the built-up area is found in land with more than 50 degree slope.

Given this picture, if any land is to be converted to built-up area one needs to seek parcels of land in areas classified under 30 degree of slope and lying barren which amounts to just about 1.24 square kilometres in 1997. Analysis at a more micro scale may reveal small parcels of land with lower degrees of slope than indicated in this study.

Another way of analysing the pattern of conversion of land is to create a matrix which tells us how much of each category of land in the base year was converted and to what use it was put over a time span (1990 to 1997 in this study). Such a matrix is given in Table 4.5. A study of this table reveals that: (a) of about 34 square kilometres of area under dense forest in 1990, only 15.5 remained as dense forest in 1997. Part of it was reduced to the status of open forest (9.08 square kilometres) and about 4.52 square kilometres were converted as built-up area, (b) of about 11 square kilometres that were originally classified as open forest a little over

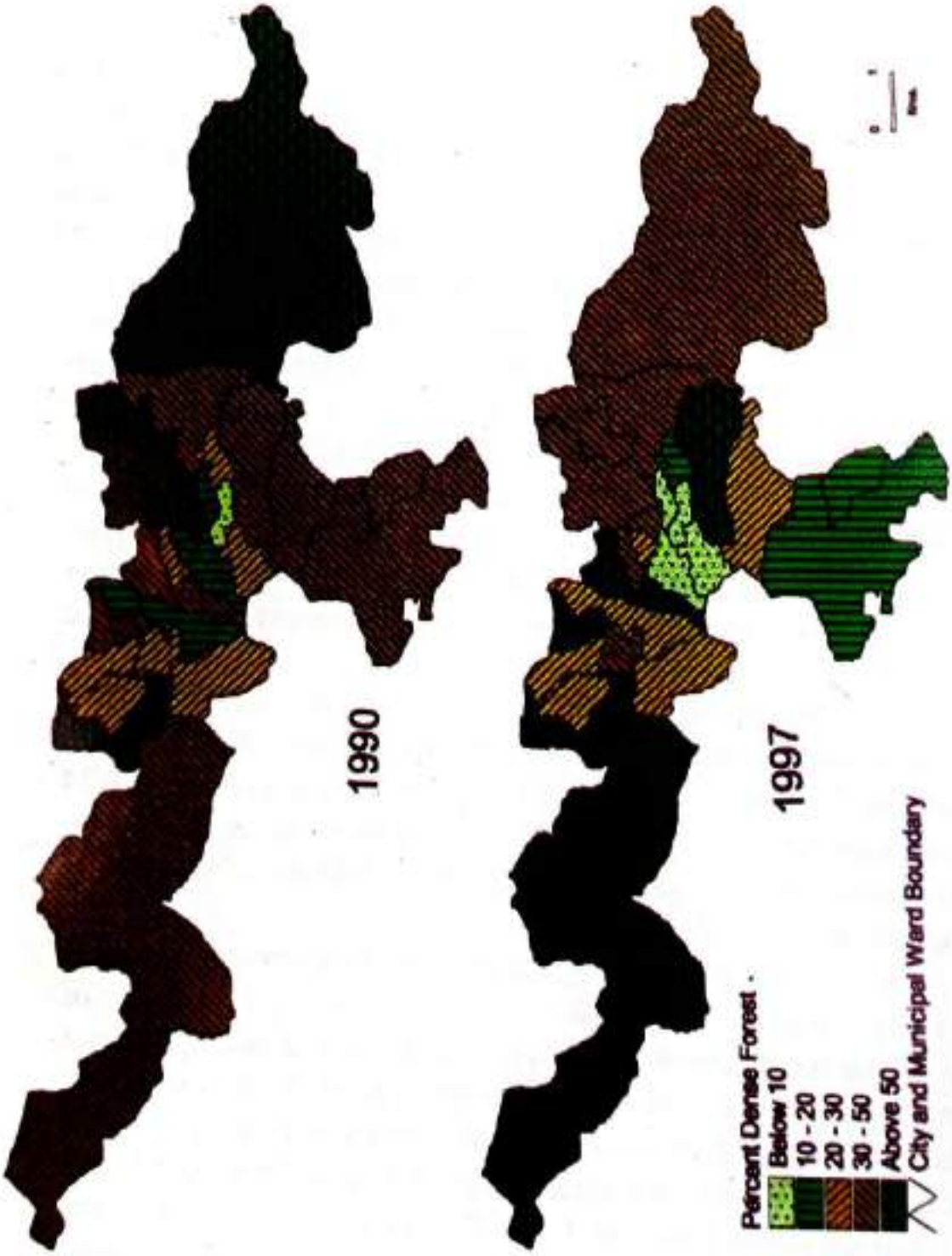

Fig. 9 : Mussorie—Per cent Area Under Dense Forest

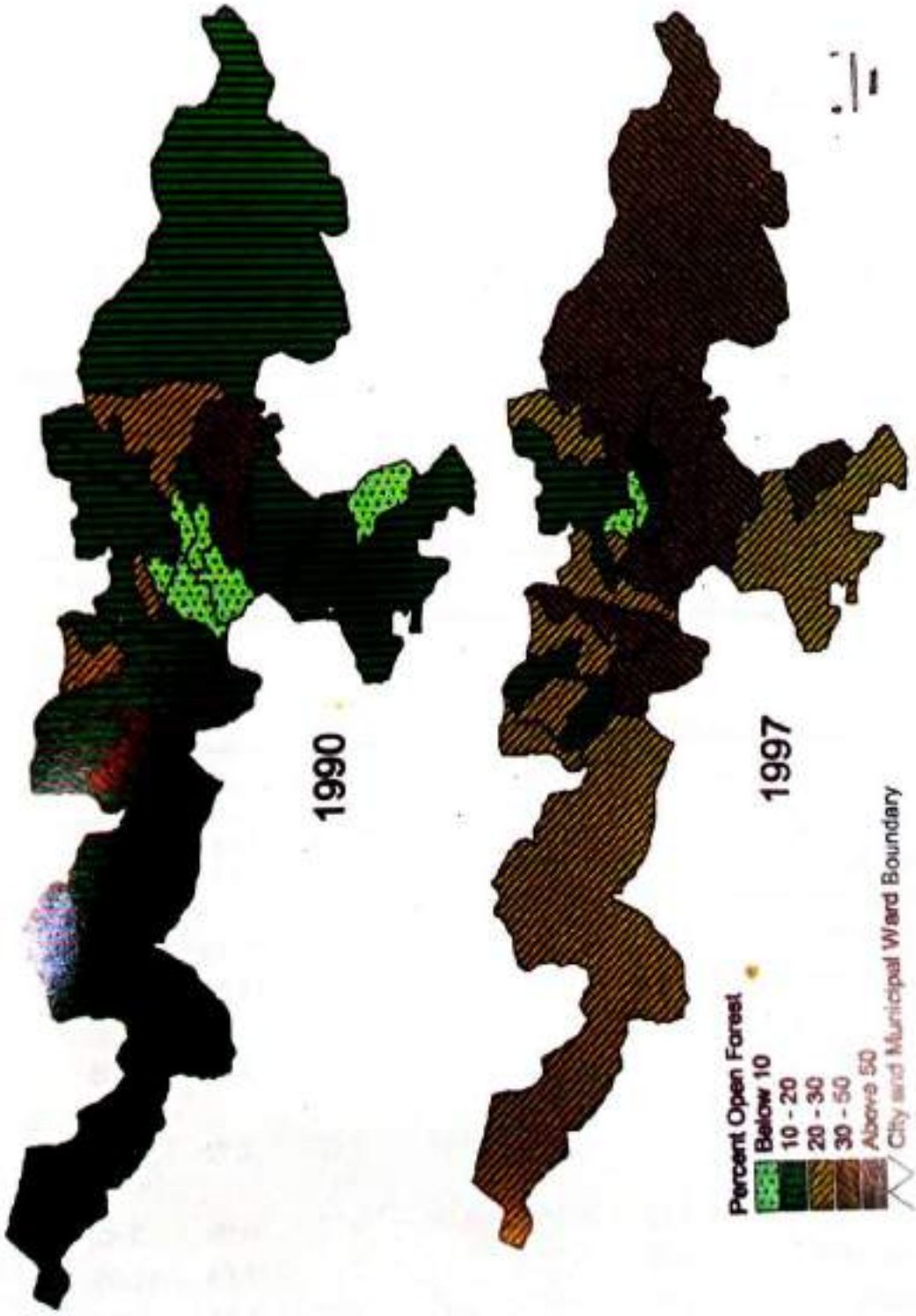

Fig. 10 : Mussoorie—Per cent Area Under Open Forest

Table 4.3: Use of Land in Mussoorie by Area under Various Categories of Slopes, 1990.

(in square kilometres)

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	2.41	1.58	1402	3.90	20.03	29.32
Medium/Open Forest	1.67	0.35	0.54	1.73	6.79	11.08
Scrub/Shrub Land	0.61	0.72	0.82	1.23	8.24	11.62
Agricultural Land	0.14	0.14	0.23	0.50	1.50	2.51
Barren Land	0.37	0.34	0.47	0.97	2.40	4.55
Built-up Area	0.34	0.53	0.77	2.10	2.99	6.74
Unclassified	0.00	0.00	0.00	0.00	0.00	0.00
Total	5.54	3.65	4.23	10.43	41.95	65.81

In Sq. Km. - 1997

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	1.40	0.91	1.35	3.51	16.15	
Medium/Open Forest	1.39	0.88	1.01	3.02	11.98	
Scrub/Shrub Land	0.76	0.48	0.55	1.08	3.18	
Agricultural Land	0.18	0.11	0.14	0.42	2.72	
Barren Land	0.58	0.56	0.10	0.22	0.96	2.42
Built-up Area	1.23	0.72	1.07	2.11	5.93	11.06
Unclassified	0.00	0.00	0.00	0.07	1.03	1.10
Total	5.54	3.65	4.23	10.43	41.96	65.81

Table 4.3 *(contd.)*

In Sq. km. Total change

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	-1.02	-0.67	-0.05	-0.39	-3.88	-6.01
Medium/Open Forest	-0.28	0.53	0.47	1.29	5.19	7.20
Scrub/Shrub Land	0.15	-0.24	-0.27	-0.15	-5.06	-5.57
Agricultural Land	0.04	-0.03	-0.09	-0.08	1.22	1.06
Barren Land	0.21	0.22	-0.37	-0.75	-1.44	-2.13
Built-up Area	0.89	0.19	0.30	-0.01	2.94	4.33
Unclassified	0.00	0.00	0.00	0.07	1.03	1.10
Total	0.00	0.00	0.00	0.00	0.00	0.00

5 square kilometres appear to have become densely forested and (c) a large part of the built-up area seems to have been obtained from densely forested area. These figures are approximate, largely because of the resolution of imagery used for the two periods of time and must not be taken as exact values.

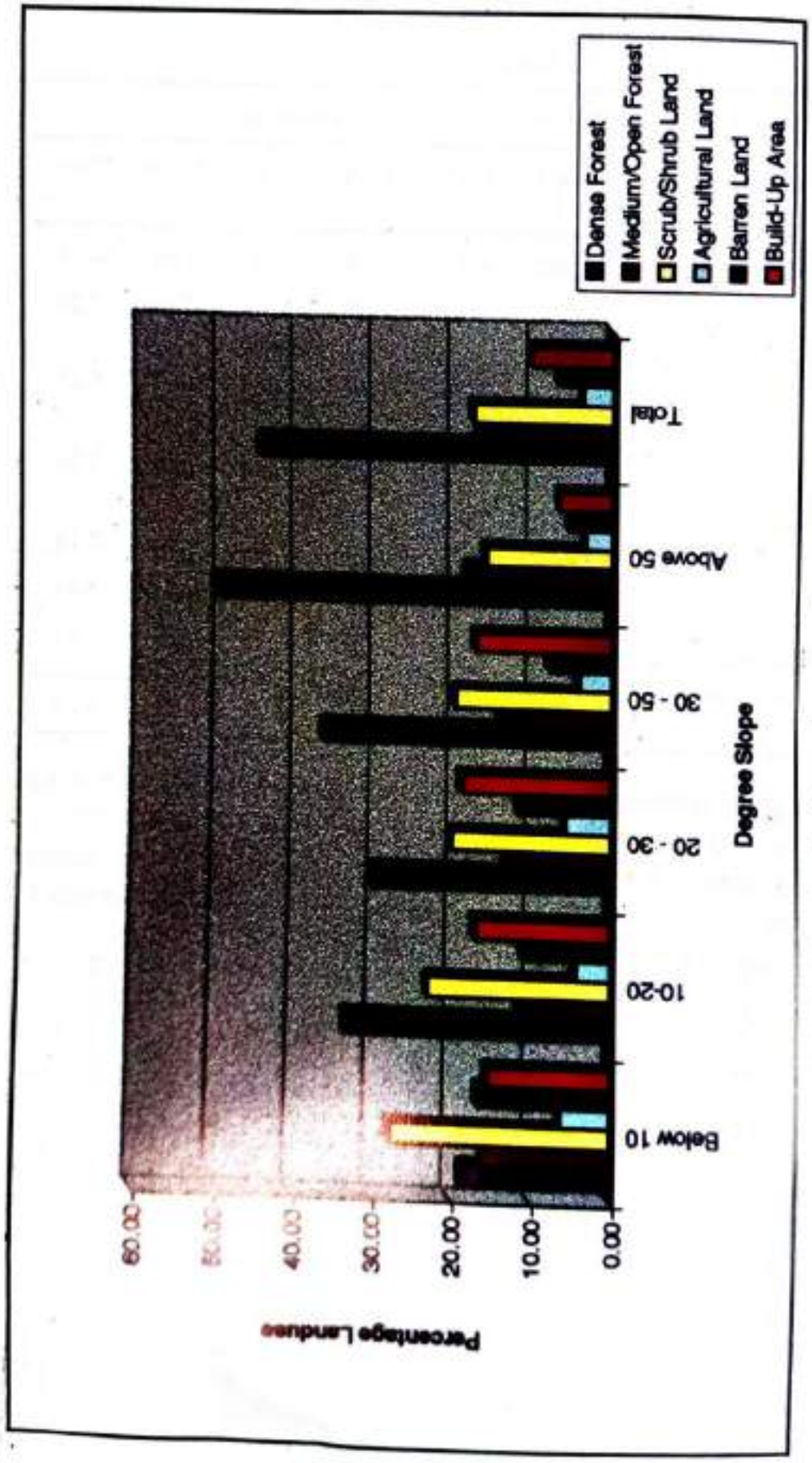

Fig. III.1 : Percentage Landuse under various slope classes, 1990.

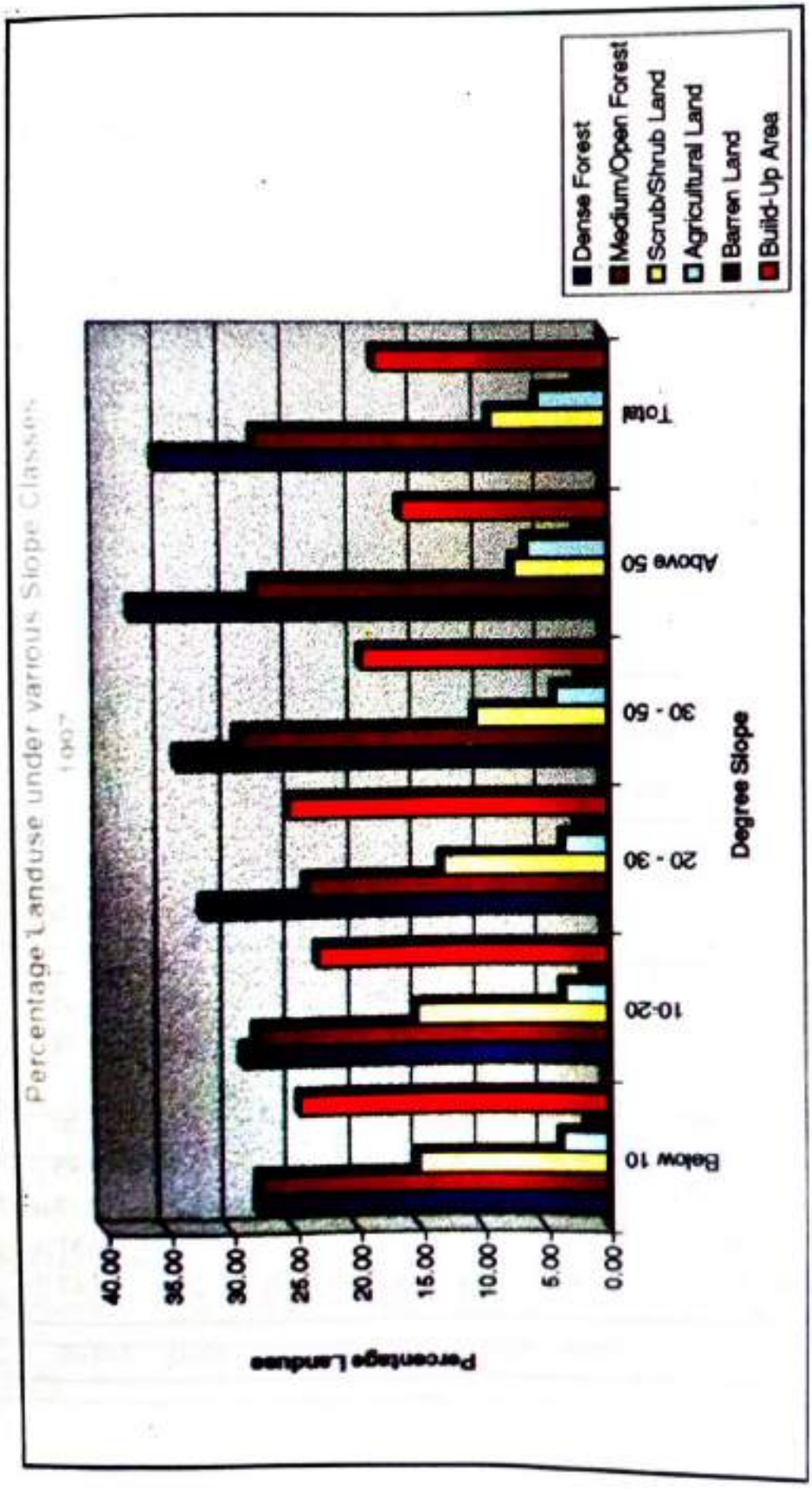

Fig. 11B : Percentage Landuse under various slope classes, 1997.

Table 4.4: Use of Land in Mussoorie—Per cent Area under Various Land use Categories by Degree of Slope

(Percentage Area to Total of the Slope - 1990)

Land Use Categories	Degree of Slope					
	Below 10	10-20	20-30	30-50	Above 50	Total
Dense Forest	43.53	43.14	33.10	37.37	47.74	44.55
Medium/Open Forest	30.16	9.64	12.77	16.61	16.17	16.84
Scrub/Shrub Land	11.01	19.58	19.39	11.84	19.65	17.66
Agricultural Land	2.48	3.75	5.49	4.75	3.58	3.81
Barren Land	6.63	9.30	11.14	9.26	5.73	6.91
Built-up Area	6.19	14.62	18.11	20.17	7.13	10.24
Unclassified	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

(Percentage Area to Total of the Slope - 1997)

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	25.20	24.87	31.99	33.62	38.49	35.4
Medium/Open Forest	25.17	24.06	23.92	28.95	28.55	27.7
Scrub/Shrub Land	13.69	13.08	13.10	10.39	7.58	9.2
Agricultural Land	3.24	2.95	3.40	4.02	6.49	5.4
Barren Land	10.48	15.22	2.35	2.08	2.29	3.67
Built-up Area	22.22	19.82	25.25	20.24	14.14	16.81
Unclassified	0.00	0.00	0.00	0.71	2.46	1.67
Total	100.00	100.00	100.00	100.00	100.00	100.00

Table 4.4: *(Contd.)*

(Percentage Area to Total Landuse Category—1990)

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	8.22	5.38	4.78	13.29	68.33	100.00
Medium/Open Forest	15.08	3.17	4.88	15.63	61.25	100.00
Scrub/Shrub Land	5.25	6.16	7.06	10.62	70.91	100.00
Agricultural Land	5.48	5.48	9.29	19.76	60.00	100.00
Barren Land	8.08	7.48	10.37	21.23	52.83	100.00
Built-up Area	5.09	7.93	11.38	31.21	44.40	100.00
Unclassified	0.00	0.00	0.00	0.00	0.00	0.00
Total	8.42	45755	6.43	15.84	63.75	100.00

(Percentage Area to Total Landuse Category—1997)

Land Use Categories	Degree of Slope					
	Below 10	10-20	20 -30	30-50	Above 50	Total
Dense Forest	5.99	3.90	5.81	15.04	69.27	100.00
Medium/Open Forest	7.63	4.81	5.54	16.51	65.52	100.00
Scrub/Shrub Land	12.53	7.89	9.16	17.89	52.53	100.00
Agricultural Land	5.03	3.02	4.02	11.73	76.21	100.00
Barren Land	24.05	23.02	4.11	8.99	39.82	100.00
Built-up Area	11.13	6.55	9.65	19.07	53.60	100.00
Unclassified	0.00	0.00	0.00	6.71	93.89	100.00
Total	8.42	5.55	6.43	15.85	63.76	100.00

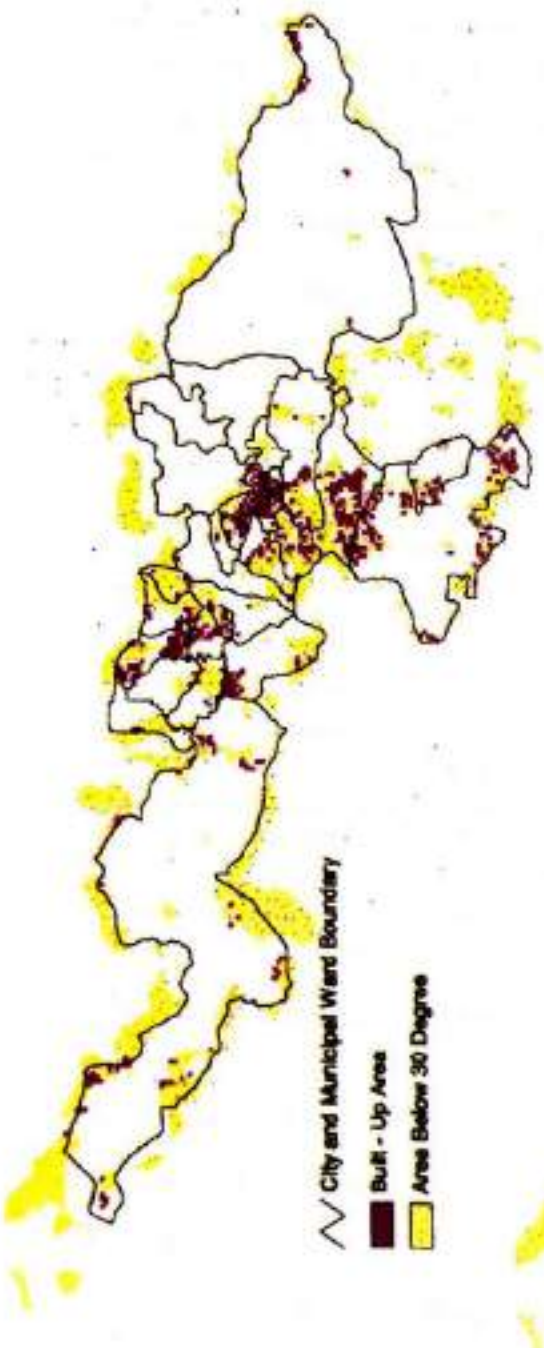

Fig. 12A: Mussoorie—The Use of Land: Area Below 30 Degree Slope
Built-up Area

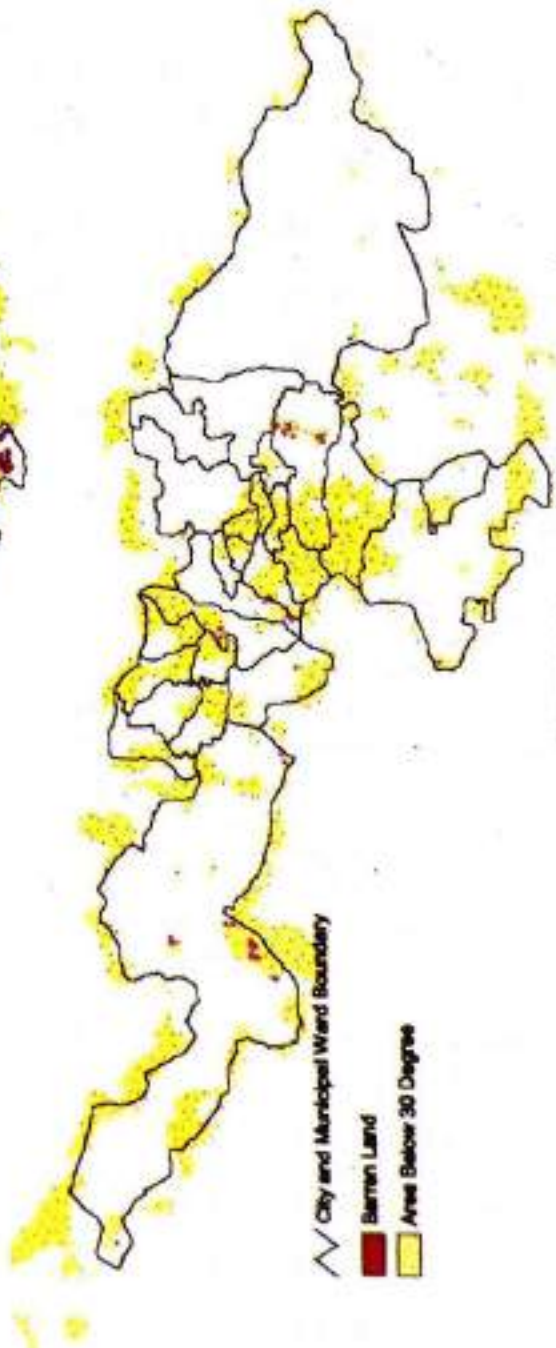

Fig. 12B: Mussoorie—The Use of Land: Barren Land

Fig. 12C: Mussoorie—The Use of Land: Cultivated Area

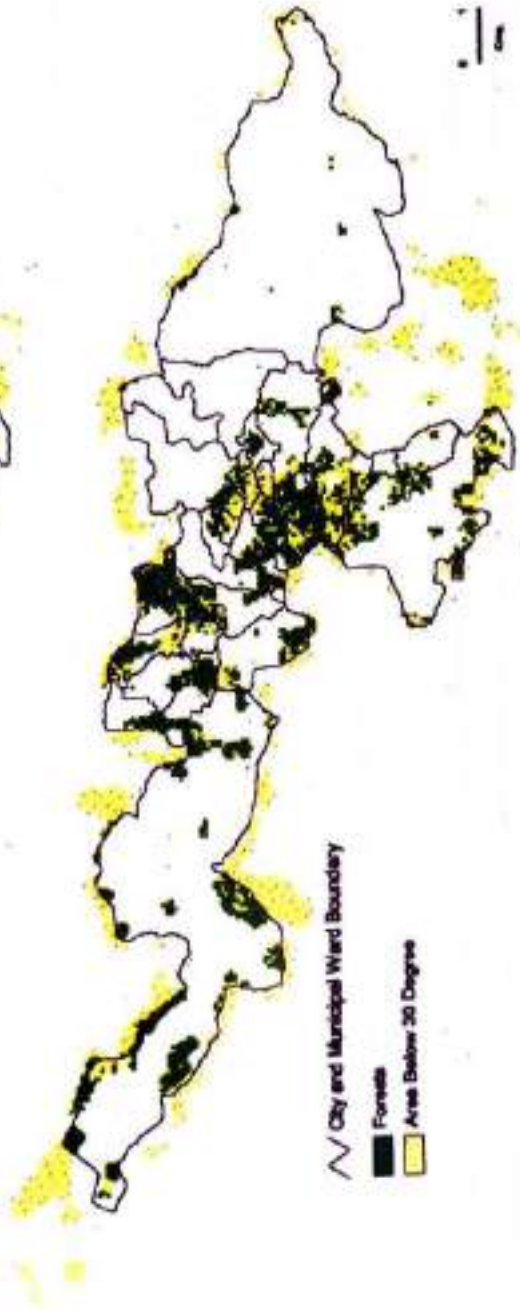

Fig. 12D: Mussoorie—The Use of Land: Land Forests

Table 4.5: Mussoorie Land Conversion Matrix - 1990—97

(in square kilometres)

1997 \ 1990	Dense Forest	Medium/ Open Forest	Scrub/Shrub Land	Cultivated Land	Barren Land	Built-up Area	Unclassified	Total
Dense Forest	15.55	9.08	2.59	1.18	0.25	4.52	0.72	33.89
Medium/ Open Forest	5.41	3.72	0.48	0.23	0.28	1.02	0.22	11.36
Scrub/Shrub Land	2.00	4.37	2.22	0.70	0.42	2.11	0.09	11.91
Agricultural Land	0.24	0.69	0.55	0.38	0.02	0.57	0.02	2.47
Barren Land	0.11	0.42	0.21	0.21	1.24	0.28	0.00	2.46
Built-up Area	0.00	0.00	0.00	0.87	0.19	2.54	0.05	3.65
Total	23.31	18.28	6.05	3.57	2.40	11.04	1.10	65.75

5

Concluding Observations

The preceding analysis may be treated at one level as a micro study involving residents, their representatives in the Municipal Board and other interest groups. At another level, it is more generalised, since study of the physical aspects involved using map and imagery information and maps on a scale and resolution that is, perhaps, inadequate for the micro urban context. However, on the basis of the analysis we may come to some tentative conclusions.

- Firstly, the city residents are aware of the developments and deterioration of living conditions over time and have been able to rank the city's problems as they perceive them. The participatory approach resulted in identification of major concerns:

  - Inadequate land base of the city for residential requirements of the permanent population in the background of rapid expansion of built-up area in the nineties, largely for commercial purposes and speculative land holding.
  - The dilemma of the need to protect and strengthen the tourist industry while minimising negative impacts of such growth manifested in pressure on services and city infrastructure including water, sanitation, land for housing, power, transportation and congestion.
  - The overriding role of development agencies that tend to de-empower elected representatives at the grassroots, dated regulations and bye-laws that govern city development, the insensitive manner of implementation of regulations,

and lack of a development plan for the city, are important factors that emerge clearly from the preceding analysis. One of the immediate requirements is to involve the elected members of the City Board in urban development decisions.

- The participatory processes adopted in this study brings out clearly that it is difficult to convince a substantial section of the resident population, that the city has grown beyond the threshold of sustainability when on many considerations—most of all the national/public interest considerations and commercial considerations–they see the city expanding, yet they find it difficult to get permission to even repair their ageing shelters, or to put up an additional room to house the expanding family. The position of technocrats and planners is even more untenable, when we find that permission for construction is often denied since most part of the city is classified as forest, without defining what constitutes a forest. One of the responsibilities of the Development Authority is to increase the level of awareness of the residents with reference to current status regarding permissions and approvals required for repair and maintenance of old structures.

- Secondly, the study has shown poor and grossly inadequate database on which development activities are planned. It has been argued earlier in this study that there is a need to include temporal considerations in estimating even such basic parameters as population of the city. Often resource allocations are based on per-capita basis and in cities like Mussoorie it becomes necessary to estimate tourist population, which in several months of the year far exceeds the resident population.

- Thirdly, based on standard norms and requirements it has been pointed out that:

- The requirement of water far exceeds the availability even at present for nine months of the year, the three months of adequate water supply being in those winter months when a third of the resident population is out of Mussoorie. The projections also show that by the year 2016 current water supply will be inadequate even during the winter months.
- Estimates of waste generation (based on trials conducted separately for resident and tourist population) indicate the vast difference in the waste generated between the peak season and the lean season—with the former recording three times that of the latter. The increase during the next two decades is estimated to be one and half times the present. The fact, that tests conducted show that the water quality in and around Mussoorie is within the pollution limits prescribed has been noted. However, with a single dumping ground whose location poses a major threat of polluting one of the important sources of drinking water of the city, waste management remains a problem to be attended to on a priority basis.
- The demand for tourist accommodation is again to be seen in the context of temporal dimension. The supply exceeds the demand by two times during nine months in a year and is likely to be so even in the next quarter of a century, while substantially short during the peak season. The answer obviously, is not in creating/augmenting capacities in hotels; the problem begs a more innovative solution.
- Medical facilities expressed in terms of availability of hospital beds indicate a shortfall even at present during the peak season and it is expected to be so throughout the year in the next two decades at the current level of supply. As noted earlier, availability of land will be the limiting factor in expansion of land dependent infrastructure.
- The capacity for distribution of electric power could be adequate with a small investment in erecting additional sub-stations and transformers, but the captive power supply is extremely limited and the bulk of the demand is met

through feeder lines. The residents have witnessed 4 to 8 hours of load shedding during winter, when demand for energy for heating is acute. This doubtless results in the use of other sources of energy including firewood from city forests.

- Fourthly, the analysis has shown that practically no land that is barren and located on gentle slopes is available for future development. About 4,300 hectares of land was used for construction in a period of about eight years between 1990 and 1997. The total built area up to 1990 was 6,740 hectares. Such rapid expansion owing to commercial pressure has tended to keep the resident population outside the land market.

- Fifthly, a substantial proportion of land with high degree of slope has been put to urban uses particularly during the previous eight years. That the construction cannot expand is clear, but a solution is needed for the housing demands of the resident population. Although most sections of the resident population believe that the Development Agencies must be kept out of the city limits, it can achieve very little in so far as urban development within the city limits is concerned in the background of the burden of rapid expansion that left the city bereft of any further scope of expansion.

ANNEXURES

ANNEXURE - I

Water Supply and Sewerage System in Mussoorie

Sources of Water

Owing to its mountainous terrain, sources of water for Mussoorie are limited to mountain streams, brooklets and rainwater, and do not include ground water. Water available from the first two sources has to be lifted over heights most of the time. Water supply, therefore, is dependent on uninterrupted and steady supply of electricity. Water available from harvesting rainwater is not completely clean and, therefore, has limited use.

Ironically, water availability is least when it is needed most. This is true for every place but in the case of Mussoorie it has unique characteristics. During summer months demand for water goes up not only because of rising temperatures but also because of increased population load of tourists. At the same time, frequency of rains and discharge of streams fall. Electricity supply becomes more erratic and power cuts more frequent.

At present water for Mussoorie is being drawn from 17 sources, 14 of which are springs and three are brooklets. Of the 17 sources, water has to be pumped up from 12 and from the remaining sources, gravity is used to carry water to the residents. Water discharge of 12 sources, from which water is carried up by pumping is 6,021 litres per minute (lmp), or 8.67 million litres per day (mlpd). Water discharge of the remaining five sources is 360 litres per minute (lmp), or 0.52 million litres per day (mlpd). Total water discharge is 6,381 lmp or 9.19 mlpd. Details of sources of water and demand as projected by *Jalsansthan* are given in Tables 1, 2 and 3. Rain,

Table 1: Garhwal Jal Sansthan :
Mussoorie Water Supply Scheme/Total Water availability

Sl. No.	Name of Water Source	Nature of Source		Discharge of source (lpm*)		System of W/S	
		Spring	Brook	Spring	Brook	Pumping	Gravity
1.	Murrey Pump						
(i)	Khanlty	spring	—	450	—	pumping	—
(ii)	Under Cliff	spring	—	108	—	do	—
(iii)	Bansi or Lyndale	spring	—	280	—	do	—
2.	Khandighat (old)	—	Brooklet	—	336	do	—
(i)	Khandighat 30 H.P. Lower	spring No. 8	—	225	—	do	—
(ii)	Khandighat, New 25 H.P.						
3.	John Mackinon						
(i)	New-Bee	spring	—	50	—	do	—
(ii)	John Mackhinon	spring	—	155	—	do	—
(iii)	Chamber khud	spring	—	32	—	do	—
4.	Bhilaru Pump						
(i)	Bhilaru upper spring, 100 BHP	spring	—	1700	—	do	—
5.	Jinsy Pump						
(i)	Jinsy stage-2	spring	—	400	—	do	—
(ii)	Jinsy stage-1	—	Brooklet	—	1680	do	—
6.	Kolty Khala						
(i)	Kolty Khala	—	Brooklet	—	605	do	—
7.	Gravity Source						
(i)	Company Khud	spring	—	40	—	—	gravity
(ii)	Brook Land	spring	—	90	—	—	do
(iii)	Nalapani	spring	—	30	—	—	do
(iv)	Pargakhala	spring	—	110	—	—	do
(v)	Duglusdail	spring	—	90	—	—	do
	Total	**14 Nos.**	**3 Nos.**	**3760**	**2621**	**12 Nos.**	**5 Nos.**

Note: Total Water availability = 3760+2621 = 6381 lpm.
* lpm (litres per minute)

which is frequent in hills, is another source of water. Most of it either seeps into the ground or runs off down the slope. Some amount is, however, harvested using traditional practices. Houses in Mussoorie have sloping roofs. Rain water falling on the roof slides down into an open pipe fixed at the base of the roof. This pipe is tilted to one side. Water falling into it thus flows to that side and into a tank placed on the ground directly below this end of the pipe. The tank is placed either on the surface or is underground. Water can be stored in these tanks for long periods, to be used as and when needed.

Jal Sansthan, Mussoorie, has water storage capacity of 16 m.l. (million litres) in balancing reservoirs at Gunhill. At times when there is a surplus, excess water is pumped into these storage tanks to be used during days of peak demand.

Supply of Water

Jal Sansthan, Mussoorie, pumps up 6.5 to 7 mlpd (million litres per day) of water from water sources like springs and brooklets in and around Mussoorie. In addition to this, about 0.51 mlpd water is available, which is collected and supplied using gravity and for which no pumping is required. The latter is made available to supply to areas that are at a lower altitude than the water sources. They are Barlowganj, Jharipani, Bhatta, Kolhukhet and Bala Hissar. These areas receive water 24 hours of the day.

The remaining parts of Mussoorie are supplied water by pumping, since they lie at a higher altitude than the water sources. Here water supply is rationed daily: two hours each in the morning and evening. During summers, supply is sometimes increased to 2.5 hours in the morning, depending on availability. Water supply using pumps depends directly on electricity supply and the supply voltage. Power cuts of three to four hours result in a drop in the supply by 1-2 mlpd. During summer months, when demand is highest, electricity supply is most erratic. *Jal Sansthan* has taken some measures to counter the effect of low voltage supply, by increasing the pumping stages in one pipeline from 9 to 10 pumps.

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Table 2: Demand for Water of Permanent Population of Mussoorie[6]

	Peak Load	Average Load
Permanent Population	40,000	34,000
Water demand (mlpd @ 175 lpcd)	7	5.95
Water demand (mlpd @ 120 lpcd)	4.8	4.08

Table 3: Demand for Water of Total Population of Mussoorie[7]

	Peak Load	Average Load
Total Population	100,000	80,000
Water demand (mlpd @ 175 lpcd)	17.50	14.00
Water demand (mlpd @ 120 lpcd)	12.00	9.60

Water stored in balancing reservoirs at Gunhill is used to meet shortfalls in water supply during the summer months. Besides the storage capacity of *Jal Sansthan*, individual hotels, resorts, cottages, houses, etc. have their private storage capacity to tide over times of low supply and high demand. No data regarding this capacity is available. It is estimated, however, that the only 5-star Hotel in Mussoorie, Jaypee Resorts has a storage capacity of nearly 0.5 m.l., and the Lal Bahadur Shastri National Academy of Administration nearly 0.2 m.l.

[6] The population figure of 34,000 is the figure considered by Jal Sansthan, Mussoorie, in estimation of the water demand in Mussoorie. The permanent population figure of 40,000 for MSR, made available by City Board, Mussoorie, however appears to be more realistic. Water supply on the basis of 175 litres per capita per day (lpcd) consumption is considered adequate by the *Jal Sansthan* to enable a person to wash clothes and bathe twice in the day. Water supply based on 120 lpcd consumption level is considered by the *Jal Sansthan* as the minimum consumption level. During peak tourist season, Jal Sansthan tries to maintain water supply at least at this level.

[7] During the peak tourist season, population in Mussoorie touches 1 lakh, comprising tourists and residents of Mussoorie. The peak population load of 1 lakh is confined to weekends, during weekdays the load is less. The average load thus works out to be 80,000. Maximum and minimum water consuption levels of 175 lpcd and 120 lpcd are considered.

Proposed and Ongoing Works

Works Completed

Two storage tanks with a capacity of 4 ml each, at Radha Bhawan and Craig Top are expected to be handed over to *Jal Sansthan* by March 1998. This will increase water storage capacity by 8 ml.

Works in Progress

Work on a new pumping scheme to lift 1 mlpd of water from Dhobhighat to Library, started in 1997. It is expected to be completed by 1999-2000.

Works Proposed

Aglad Water Pumping Scheme to pump 12 mlpd water from Aglad River. The scheme which was estimated to cost Rs. 7 crores in 1984 was shelved, partly because of opposition from farmers drawing water from the river for farming purposes. In 1998 it is estimated to cost upto Rs. 20 crores.

The Sewerage System

The sewerage system in Mussoorie was designed by the British and installed in 1934. The system was planned for 50 years, i.e. till the year 1984. The total length of sewer lines is approximately 21 kilometres and there are 1,100 manhole chambers. There are eight sewerage zones, and a total of 4,225 sewer seats, as on September 1997. Sewer collected in each zone is stabilised in a septic tank and soak pit, located at the terminus of sewer lines in that zone. Sewer lines are made of Cast Iron Socket and Spigot (CISNS) pipes; and pipe diameters are 100 mm, 150 mm, 200 mm.

Mussoorie's hilly terrain offers some advantages to the system. Flow of sewerage through pipes is much easier due to natural gradients. Hence pipes with smaller diameters are also effective. There is no need for pumping the waste and blockages are fewer.

At the same time, Mussoorie's sewerage system suffers some disadvantages. The system is old and has exceeded its life span. The original layout map of the sewer lines does not exist any more. Some sewer lines have been disconnected from their natural outfalls and connected to other outfalls. There is no effective drainage system in Mussoorie. Thus, rain water also flows into the sewer lines. Kitchen drainage is often illegally connected to sewer lines. Kitchen waste sometimes clogs the lines. Sewer outlets of illegal constructions are joined to the sewer lines. Excess construction material like rubble, sand, etc. is sometimes dumped into sewer lines.

Quantity of Sewerage Generated

Almost 75 per cent of the total water supplied to the town reaches its sewer lines. The remaining water is lost by seepage into soil, surface runoff and evaporation. Since there is no estimate of the quantity of rain water and snow, only load on the sewer lines from water supplied by the Municipality can be estimated.

	Average	Peak
Water supply (mlpd)	7.00	9.00
Sewerage generated (mlpd) (@ 75%)	5.25	6.75

Sewerage Layout

The sewerage system in Mussoorie caters only to some parts of the town. The eight zones into which it is divided do not cover the entire town. Also, there are residential establishments within these zones that are not connected to the sewer lines. Such establishments have alternative methods of sewerage disposal like individual septic tanks and soak pits and use of the conservancy system of disposal.

For the remaining parts of the town, sewerage disposal is through a network of sewer lines terminating in septic tanks and soak pits. Sewer lines, carry sewage from houses, hotels, resorts, schools, institutions, etc. and are connected to the sewer system.

At the terminus of each zone is a stabilisation pond comprising of a septic tank and a soak pit. Sewage drains first into the septic tank. Sludge, or the solid content, settles in this tank. Overflow from the septic tank flows into the soak pit. Part of the water gets soaked here and the remaining part drains out. Some of the stabilisation ponds are made of three chambers in place of two, sewerage stabilisation then is better and water draining out from them is clearer. The water draining out from the stabilisation pond is not used further. The volume of sludge that accumulates in the septic tank is very little because the solid matter is well mashed before it reaches the septic tank due to the natural gradient available in Mussoorie. Hence, cleaning of septic tanks is required when it is almost full, i.e. once in 10 years.

Jal Sansthan, Mussoorie prepared and presented a feasibility report of the Mussoorie Sewerage Scheme in May, 1989. The proposed works were in appreciation of the increasing load on the sewerage system in Mussoorie. There was also an understanding that the system was functioning well beyond its life span.

Areas where the sewerage system does not exist are:

1. Lal Tibba Cantonment area at Mussoorie, Tehri Bus Stand, Wood Stock, Jabarkhet, Bataghat.
2. Landour behind Clock Tower via Rajpur Road, Wynberg Allen School, below Nanpara, Bala Hissar upto Chandra Bhawan, upper area at Barlowganj.
3. Below Jain Dharmshala, Landour up to Picture Palace on Landour Road.
4. Masonic Lodge Bus Stand upto King Craig main road, upper and lower areas also, upto Kolukhet.
5. Camel's Back Road, below Mount Rose up to Camel's Back Road cemetry.
6. Library Chowk to Nandatels, Library Kingcraig Road.
7. Hotel Hakmans up to Vasu Cinema on the Mall Road.
8. Spring Road and Total Circular Road, Radha Bhawan.
9. Dick Road, Harnamsingh Road upto Company Garden area below the road.

10. From Srinagar Estate onwards upto Kempty Fall Road.
11. Library to Charleville Road, just below Kempty Bus Stand.
12. Dhumanganj, Hathipaon, Sangrilla upto Cloud's End Resort.

The study was commenced in 1983 when the population of Mussoorie was estimated to be more than 30,000. The new scheme was designed for the next 50 years, i.e. until 2023. The population projection for 2023, which has been used as the design population, is 1,20,000 for permanent population and 2,00,000 for the total urban population load (including tourists load at any point of time). The scheme envisages creating nine additional sewerage zones and works include replacement and laying of new lines and manholes.

Concluding Remarks

Mussoorie has the capacity to supply 7 to 7.5 mlpd of water. Of this, 0.51 mlpd that is supplied all 24 hours to low lying areas by the use of gravity, is sufficient for those areas. The remaining water supplied by pumping depends greatly on electricity supply and supply voltage. Measures taken by the *Jal Sansthan* like increasing the number of pumping stages can only be a partial solution. During the winter season when tourist pressure is low, permanent residents including boarding school children move down to the plains and water demand per capita comes down, water supply is adequate. During winters bathing is restricted to a maximum of one time daily and washing is minimal, per capita water demand thus is in the range of 120 lpcd. For the permanent population estimate of 40,000 (as estimated by the *Jal Sansthan*), total water demand is 4.8 mlpd. This is almost 2 mlpd less than the water supply capacity of 7 mlpd. Excess water available during the winter is collected in the balancing reservoirs. Increased demand over weekends, which is experienced mostly by hotels and resorts, is met by their private storage tanks in which excess water supply during weekdays is collected. The two storage tanks at Craig Top which are ready for handing over to *Jal Sansthan* will increase the latter's reservoir capacity by 8 ml. This would be a valuable addition for summers.

The third tank at Craig Top, which is under construction, will further enhance reservoir capacity by 4 m.l. The new water pump scheme from Dhobighat to Library will increase water supply by 1 mlpd. In the light of the expected increase in population pressure in Mussoorie, implementation of the Algad Water Pumping Scheme is essential to cater to the increased load.

The Mussoorie sewerage system was designed for the period upto 1984. The system has already outlived its life by over 13 years. There are problems of leaking and damaged lines, stolen C.I. pipes and damaged septic tanks. Pipelines are laid in the open and are vulnerable to damage by falling mountain rocks. CISNS pipes are very expensive, i.e. Rs. 1,000 per meter. Hence replacement of existing lines and laying new lines would involve a large expense. The lines have to bear additional load for which no provision was made in the design. This includes illegal connection of kitchen drainage and sewer lines of illegal constructions. In the absence of a proper drainage system in Mussoorie, rain water also flows into the sewer lines. This often exceeds the capacity of the latter thereby leading to overflow of manholes during the monsoons. Though the registered number of seats is 4,225, the *Jal Sansthan* estimates the actual number to touch almost 5,000.

Disposal of construction material down the sewer lines leads to frequent blockages. Hotels often construct private septic tanks/ soak pits without prior permission and capacity calculation. Hence standard norms of construction are sometimes violated leading to problems in the future. Absence of layout plans of the sewerage system often leads to problems in repairs and maintenance. The existing system caters to only 50 per cent of the town area, leaving the remaining areas to make provisions for sewerage disposal by individual and private methods.

Table 4: Zonal Division of Sewage System in Mussoorie

Sl. No.	Name of Zone	Name of Outfall	No. of Sewer Seats	Line Diameter (Inches)	Areas Covered	Problems	Works Undertaken or in Progress
1.	Landour	Butcher Khana	407	4,6	Landour Bazar, South Road, North Road Butcher Khana from Nanpara to North Road.	Line damage, manhole repair	Petty repairs
2.	Barlowganj	Barlowganj	24	4,6	Below Jaypee Hotel gate, Barlowganj Bazar	Line damage, other repairs	None
3.	Kulri	Sarai	1,319	4,6	Hotel Shipra via Picture Palace, Mayfield, Rani Bhawan upto Sarai septic tank, Below Rockwood, Kulri Mall Road., Jafarhall, Victory House upto Hira Bhawan, Below Hotel Deep Camel's Back Road, upto Sarai	Septic tank, wall damaged, CI pipes Stolen	None
4.	Bhilaru	Bhilaru	1,019	6,8	Chaman Estate, Motilal Nehru Road, bchind Library Bazar, Hotel Oasis, Mefel Hedge, Indra Bhawan, PWD Inspection House, Ekant, via Srinagar Estate	None	4 Suspension bridges repaired
5.	Arcadia	Arcadia	220	4,5	Hotel Glenvilla, via Tar Gali, Peak View Hotel, Pushp Vatika, Dila Ram	Septic tank damaged CI pipes stolen	None

Table 4: *(Cont.)*.....

Sl. No.	Name of Zone Seats	Name of Outfall (Inches)	No. of Sewer	Line Diameter	Areas Covered or in Progress	Problems	Works Undertaken
6.	Shergarhi	Shergarhi	716	4,5,6	Kulri Mall Rd. via Hotel Samrat, Stawari Bank, Sussex House, Cliff Hall Estate, Hussain Ganj, Murad Ganj, Rialto Gate, Naj Gali, Hampton Court	Manhole damaged, minor repairs	Mahole repair in progress
7.	Happy Valley	Happy Valley	508	6	LBSNAA main gate to Happy Valley, Kempty Road upto Kali Dang	Septic tank & soak pit damaged, CI pipes	None
8.	Company Bagh	Company Bagh	12	6	Hathi Paon Road upto Company Bagh Septic tank	Septic Tank damaged, minor repairs	None

Table 5: Mussoorie Sewerage Scheme —Proposed Sewer Line in Different Zones

(Line length in meters)

Sl. No.	Zone	Existing Sewer Lines				Proposed Sewer Lines					New Sweer Lines to be Laid					Manhole		
		100 mm dia	125 mm dia	150 mm dia	200 mm dia	150 mm dia	200 mm dia	250 mm dia	300 mm dia	350 mm dia	150 mm dia	200 mm dia	250 mm dia	300 mm dia	350 mm dia	(Slab 1*1.20 deep	type, 1.50	size m
1.	Company Garden	1500	-	-	-	1500	500	-	-	-	1500	500	-	-	-			135
2.	Happy Valley	918	-	2900	-	1000	1000	1000	1500	-	-	1000	1000	1500	-			235
3.	Bhilaru	658	996	376	1400	500	1000	500	800	-	300	300	500	800	-			125
4.	Scandal Point	-	-	-	-	1000	1000	-	-	-	1000	1000	-	-	-			135
5.	Cemetry	-	-	-	-	1000	1100	-	-	-	1000	1100	-	-	-			1400
6.	Arcadia	1280	-	-	-	1000	800	-	-	-	1000	800	-	-	-			120
7.	Sarai	2147	-	724	-	2000	100	500	500	500	1500	1000	500	500	500			265
8.	Butcher Khana	504	-	1000	-	1200	800	400	700	-	700	800	400	700	-			170
9.	Cremation Ground	-	-	950	-	600	400	500	900	-	-	400	500	900	-			120
10.	Brook Land	-	-	-	-	1000	300	200	-	-	1000	300	200	-	-			100
11.	Shergarhi	1137	618	-	-	1000	500	500	500	-	500	500	500	500	-			130
12.	Barlowganj	221	-	195	-	400	200	400	-	-	300	200	400	-	-			60
13.	Kincraig	-	-	-	-	500	500	700	-	-	500	500	700	-	-			110
14.	Bhattafall	-	-	-	-	800	-	-	-	-	800	-	-	-	-			50
15.	Shishu Niketan	-	1000	-	-	500	500	700	-	-	500	500	700	-	-			110
16.	Library	-	-	-	-	500	500	500	-	-	500	500	500	-	-			100
17.	Vincent Hills	-	-	-	-	600	600	-	-	-	600	600	-	-	-			80
											11700	10000	5900	4900	500			2185 Nos.
								SAY			12000	10000	6000	5000	500			2000 Nos.

ANNEXURE-2

Waste Management in Musssoorie : A Case Study

Introduction

The purpose of this case study is to assess the waste disposal and management facilities in Mussoorie and to see if the existing population pressure has not already overstretched the limits of these facilities. The study also attempts to project the waste management scenario in the near future on the basis of existing trends and expected developments.

Mussoorie Township was planned in the days of the British. Garbage disposal systems put in place at the very beginning are continuing to deliver till date. Growing consumerism and increasing use of plastics is giving way to a 'throw-away' culture, which is aggravating the problem of effective waste disposal generating more waste with an increasing proportion of non-biodegradable garbage.

Waste generated in any township can be classified into three broad categories namely, garbage (solid waste), sewage and gaseous emissions and garbage further classified into biodegradable and non-biodegradable. With the advent of plastics and its use in packaging, a substantial portion of garbage is that which does not degrade with time, or break down into smaller and simpler constituents. This portion when introduced into the environment remains there unchanged in form, for years to come. Non-biodegradable waste (e.g. plastic, films, celluloid batteries, chemicals, glass and other synthetics), is called dry waste in common parlance. On the other hand, wet waste (e.g. paper, plant and animal products) degrades readily under favourable conditions

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of moisture and temperature. Degraded waste is good quality manure and can be mixed with soil. Thus when left on its own, dry waste does not get recycled into some useful form, whereas wet waste gets recycled into manure. Hence while the load of the latter gets reduced by decomposition, reuse and recycling into an active human ecosystem, that of the former keeps increasing and accumulating as pollutants.

Waste in Mussoorie is generated by its local resident population, visiting tourists, commercial establishments like hotels, holiday resorts, shops and hawkers, and by schools and other institutions. Part of the solid waste is discarded, by those who generate it, down the *khud* or in dirty heaps in the locality. The Municipality sweepers collect the other part in the trailer bins (put in place by the City Board). On account of the toxic emissions of burning waste, the earlier practice of incinerating the collected waste has been discontinued, following protests. Presently the trailer bins are towed to the Gari Khana site where they are tilted to allow the litter to slide down the hillside. Some of the litter slides into the Bhilaru stream, thereby contaminating a precious source of water.

Any effective method of waste management necessitates separation of the dry waste from the wet. The former can then be sold for recycling while the latter is composted to produce manure, which can be sold. Since waste of a township collected at a single place for disposal is in large quantities, segregation at that stage is much too arduous and messy, making it practically impossible. Hence, segregation to be feasible on a wide scale, has to be encouraged at the point of generation, i.e. in kitchens, home or at the restaurant. Waste discarded in bins along the street by people needs to be separated in two different bins for dry and wet waste which can then be collected separately and managed separately.

Of late concerned citizens and organisations have become active in creating awareness amongst the public and exerting pressure on authorities for better management of waste. Besides creating an understanding on the menace caused by waste, they are persuading people to separate wet from dry waste in order to make both types more manageable. They are also involved, though to a limited extent, in actual separation and recycling of dry waste.

Environmental Implications of Waste

A growing mound of waste is not only an eyesore, it is also a hazard for society. Waste is smelly and a good breeding ground for disease causing bacteria and insects like mosquitoes. In comparison to wet waste, dry waste poses greater problems. Because it does not decompose, its quantity in the environment keeps building up. In addition, plastics do not allow water to penetrate through them. Hence, as in the case of Mussoorie, polythene bags thrown down the *khud*, over time, cover the roots of trees lining the mountain slope, thereby preventing water from reaching the roots. The roots gradually die and the tree gets uprooted. Without trees and their roots to bind mountain soil, the slope becomes prone to landslides. Wet waste too does not decompose when it is tied up in polythene bags for the purpose of disposal. Its plastic packaging blocks water and air needed for its decay. Part of the waste thrown down the slope, slides down to mix into the water streams thereby polluting them.

Already there are reports of average temperatures in Mussoorie rising. Fans, hitherto unseen in Mussoorie, are becoming a regular feature. During one summer season the maximum value of temperature actually touched 39 degree celsius. Natural streams are drying up and rainfall and humidity levels are falling. Deforestation has led to more frequent landslides and just as in any town in the plains, mosquitoes are becoming a menace.

Methodology for Assessing Status of Waste Management

For a comprehensive assessment of the waste management status in Mussoorie, the need for consultation with every concerned party was appreciated. This included those that generate waste and those that are involved in its disposal. Under both categories attempts were made to include institutions and individuals, commercial and non-commercial establishments, government departments and non-governmental organisations. In order to accomplish the above, meetings were held, interviews were conducted, and a survey was

organised for collection of primary information. Over and above this, assessment also relied on general observations, study of documents and reference to publications relating to waste management in general and of Mussoorie in particular.

Notable amongst those with whom meetings were held are the *Mussoorie Nagar Palika*, Health Department, *Jal Nigam*, MDDA, Tourism Department and NGOs like AAPKA and CLEAN.

A hotel schedule was designed (Appendix 2). A sample of approximately 10 per cent of the total hotels and holiday resorts were selected and the owners/managers interviewed. The selection was made so as to account for variations in size of hotel accommodation and location. An institution schedule was also designed. Concerned personnel in a sample of schools, prominent institutions like the Lal Bahadur Shastri National Academy of Administration, Indo-Tibetan Border Police, Tibetan Homes, Dharamshalas, Horse Lines, Archaeological Survey of India, Hospitals, etc., were interviewed.

For interviewing households, a household schedule was designed. Selection of households was based on systematic random sampling method and done from the latest voters list available with the City Board. Wherever the selected voter was not accessible due to death, transfer, temporary absence or error in records, the next name was selected in place of the former. Voters that were selected and lived in very far-off areas were excluded from the survey as their impact is localised and of little consequence to the main city. In this way 226 households were interviewed.

Floating population figures were obtained from the Tourism Department where the estimate is made on the basis of the vehicles crossing the Toll Tax collection point. Average length of stay of a tourist in Mussoorie was also taken on the basis of an estimate arrived at by the Tourism Department.

For estimation of the average quantity of waste generated per capita per day by residents and tourists in Mussoorie and break-up analysis of the waste, results of a survey conducted by an NGO have been used (Appendix-6).

Quantity of Waste Generated in Mussoorie

Mussoorie's population is divided into the permanent and the floating. While the residents of the town, boarding students in schools, permanent staff in hotels and dharamshalas etc. come in the former category, tourists and temporary staff at commercial establishments that move to Mussoorie only during peak tourist seasons may be included in the latter.

Consumption patterns of these categories differ. Tourists, as compared to residents, tend to generate more waste, as concluded from the survey mentioned earlier (see Appendix 6). This is because, besides regular meals they have a tendency to buy readymade food items off the shelf for consumption. In such items, the weight of the packaging is considerable as compared to the food item itself. Also there is no reuse of the packaging. Fresh litter is generated each time. Heavy waste items like empty glass bottles are discarded by tourists in greater quantities.

Current Status of Waste Management

Responsibility for management of waste in Mussoorie falls within the purview of the elected City Board, the Health Department and the Water Works Department. This arrangement is similar to that in other cities. In Mussoorie, however, the work of NGOs, institutions and contribution of individual citizens is supplementing the work of government departments. Details of areas covered, sources of funds, facilities available and procedure followed by the City Board, concerned NGOs and public institutions are as follows:

City Board

City Board staff, by its own admission, is unable to access certain areas already enumerated. Even in the wards where they claim to provide services and from where they collect the Conservancy Tax, the Municipality sweeper either does not visit or visits irregularly. As a result households have employed private sweepers or

housewives themselves empty out the small dustbins placed outside their premises (into which the household waste is discarded), into the nearest yellow trailer bin or into a garbage heap on the road or over the hillside.

Regular posts of sweepers have been sanctioned to the City Board. This number was fixed at the time of independence when the city's population was less than 10,000. No addition to this number has been made till date despite population levels having touched 40,000. During peak tourist seasons, the Board tries to cope with the load by employing 50 more sweepers on an ad-hoc basis.

Sweepers are provided with one basket each, which they carry on their backs. If the waste collected is wet, it drips onto them as they carry it on their person. Since the yellow bins into which they are supposed to dispose their load is positioned above the level at which they have collected the waste, they are reluctant to carry the burden. Some times they choose the easier option of simply sweeping the garbage down the *khud* or into dirty heaps in the corners.

Even if segregation takes place at source, because the sweeper is carrying a single basket, he/she mixes both the dry and the wet waste in the basket rendering the former exercise useless.

Location of yellow bins is sparse. If more bins are installed, more households would have easier access to them encouraging disposal of garbage in the bins.

Separate bins (blue and green in colour) have been placed along the Mall Road in order to encourage tourists to discard wet and dry wastes separately. However, information about the use of different bins is lacking. Also the design of the bin is not handy. The lids of the covered bins are very heavy discouraging their use.

Collection of dry waste is more attractive than collecting wet waste because the former can be sold. As a result, the Municipality sweeper at times is tempted to selectively collect only the former leaving the latter where he/she finds it.

The single dumping site at Gari Khana cannot take the collective load of the entire city. Waste thrown over the hillside at this site, slides down into the Bhilaru stream contaminating a

precious source of water. Dry waste thrown down the Gari Khana hillside has become a permanent dirty feature because left on its own it does not decompose. Municipality and private sweepers, citizens and tourists alike, tend to sweep or throw waste down the *khuds*, because of a lack of awareness or concern. This has left several hillsides dirty.

All areas of Mussoorie that fall within the Municipality limits are supposed to be serviced by the City Board. Even within these limits there are areas where the Board is unable to provide services. This may be on account of difficult terrain which makes access difficult, sparse habitations making them low priority areas, limited staff, equipment and funds. These areas, as per the City Board, are: (1) Dunhill, Bullet, Pan, Chaskhet and Clouds End; (2) George Estate; (3) Hathipaon; (4) Srinagar Estate; (5) Bhilaru; (6) Makdait Village; (7) Jhalki; (8) Suwakholi; (9) Bataghat; (10) Bansagad; (11) Spring Road; and (12) Circular Road.

With a view towards keeping the city clean, the remaining areas have been divided into three wards. *Nayaks* have been appointed for the purpose of monitoring and supervision of the cleaning and disposal activities. The wards are:

1. Jharipani, Barlowganj, Masonic Lodge Landour uptill Picture Palace, Kolukhet, Bhatta Village, etc.
2. From Picture Palace until Basu Cinema and adjoining areas.
3. From Vasu Cinema through Camel's Back Road until Nirankari Bhawan, Motilal Nehru Road and adjoining areas, Lal Bahadur Shastri National Academy of Administration area, Company Bagh and adjoining areas.

A hundred and fifty one posts of sweepers are sanctioned to the City Board, the number having remained constant since the time of independence. Of these sanctioned posts, 143 are filled and the remaining are lying vacant on account of retirement or death of employees. During the peak tourist season when work - load goes up several times, 50 additional sweepers are employed on a contract basis.

The Board owns 19 trailer bins and waste trolleys with capacities of 5,000, 9,000 and 11,000 litres. Of the trailer bins, three bins are out of operation, two of which have been rendered unusable by accidents and the third is undergoing repairs. The remaining 16 trailer bins and waste trolleys are placed all over the city. Besides these, several small dustbins (some coloured green and blue to indicate whether dry or wet waste is to be thrown into them) have been placed all over the city, outside homes, shops, hotels, schools etc. and along the streets. Two tractor trolleys and two tractor trailers are owned by the Board. Along with drivers they are pressed into service for towing the trailer bins and waste trolleys full of waste, from their location, to the dumping site at Gari Khana.

The City Board collects a Conservancy Tax from the establishments where it provides services. The Municipality sweepers are divided among the conservancy staff and the Roadside staff. The former goes from house to house, hotels, schools, etc. and collect the waste from the small dustbins placed outside the premises into the basket carried by him. This load he empties into the nearest yellow trailer bin. The latter collects waste from the dustbins placed along the roads, into the basket carried by him. He also sweeps the streets, collecting the rubbish in the basket. The basket is then emptied into the nearest yellow bin. Wherever waste has been segregated into dry and wet waste at source, i.e., by those who have generated it, the sweeper is supposed to collect the two wastes separately. This is rarely done in practice because the sweeper has only one basket to collect the waste.

Earlier the designated sites were four in number where the municipality had installed incinerators (Gari Khana, below South Road Landour, South of Butcher Khana and Barlowganj). However, this practice has been discontinued, due to the environmental pollution caused by the dioxins released during burning of waste. Presently, for want of a better alternative, the entire garbage collected by the City Board staff is emptied at a single site, i.e., down the Gari Khana hillside forming a landslide of waste. That part of the waste that is biodegradable degrades in the natural course of time. The part that does not degrade, notably plastics, lies there

as a permanent feature. With rains and fresh loads of waste pouring in some of the waste slides down along the hillside into the Bhilaru stream.

In order to prevent this downslide and to provide pits where the waste can collect and compost, terraces were constructed along the Gari Khana hillside. Waste thrown from above would slide down and collect into the pits formed by the terraces and decompose there. Due to poor quality of construction the terraces have got washed away with the rains.

Non-Governmental Organiations

AAPKA or the Self-Help Environment Programme (SHEP) works in association with the Lal Bahadur Shastri National Academy of Administration. The main thrust of the organisation has been towards effective garbage management both at the individual and the community level. The organisation has tried to create awareness regarding the concept and need for waste management and the concept of separating the biodegradable portion of waste (wet waste) from the non-biodegradable portion (dry waste), and disposing the two portions independently. Attempts were also made to create awareness regarding the harmful effects of use of polythene and at the same time looking for alternatives to polythene. It has also explored alternative ways of reusing polythene bags. Wherever and whenever possible the organisation has tried to draw the attention of the authorities to areas of neglect.

AAPKA's operations, particularly awareness creation, are spread throughout the city. However, the main thrust of its activities has been along the Charleville Road until Happy Valley, along the Mall Road, through Kulri Bazaar until Picture Palace and in the Woodstock School campus.

The main source of funds for AAPKA is from the sale of dry waste. Constituents of dry waste like polythene bags, paper, glass items, tins, batteries have a ready market in Dehradun. The above amount is supplemented by fixed and voluntary contributions from households. Other voluntary contributions add to the funds.

AAPKA has organised some rag pickers under its wings. They

have been equipped with basic equipment like brooms, baskets, gumboots and sticks. Some have also been provided with pushcarts. Besides the above, it has issued Identity Cards to its rag pickers thereby allowing them easier and greater access to homes and hotels. It also provides them with medical facilities and arranges transport for them to Dehradun for selling the dry waste collected by them. Rag pickers, the working hands of this organisation, are not readily accepted by the households, hotels, etc. because of their reputation for stealing. AAPKA rag pickers often run into conflict with Municipality sweepers. Rag pickers selectively collect dry waste, which can be sold. Municipality sweepers thus feel that instead of assisting them in their work, rag pickers trespass in their areas of operation.

For the purpose of creating awareness regarding the concept and need for waste management, catchy and comprehensible slogans like "SAY NO TO PLASTICS", "DO NOT THROW AWAY PLASTIC PACKINGS OR BAGS BUT COLLECT THEM SEPARATELY", "SAVE MUSSOORIE—YOU CAN DO IT" and many others have been coined and communicated using street campaigns, talks, processions, posters, leaflets, stickers, etc. Talks have been delivered in schools and school children involved in distribution of propaganda material. Sanitation Day was organised in April 1995. Households, institutions and commercial establishments have been persuaded to segregate waste generated by them. This involves collecting non-biodegradable waste separately and making it available to the local sweeper or AAPKA rag pickers in separate bags or containers.

AAPKA rag pickers, equipped with basic training and equipment, are sent door to door to collect the separated dry waste. Wherever segregation has not been done already, and it is possible to do it, given the co-operation of the concerned people, the rag pickers are persuaded to segregate the waste themselves. The dry waste so collected is further segregated into polythene bags, glass items, paper, batteries, tin, etc. Stuffed into bags it is carried down to Dehradun for sale to the *kabaris* there. Proceeds from the sale of waste go directly to the rag picker, who has collected it. No share is retained by the organisation.

Training workshops have been conducted for developing and popularising alternative uses of disposed polythene bags and paper. This involved making bags out of discarded polythene bags and paper. This is a cheaper and less energy intensive way of reusing the above waste. Subsequent to this use, they can be sold for recycling into fresh paper and plastic. Efforts have been directed at organising a paper bag making cottage industry.

Companies like AMUL have been persuaded into sponsoring posters and advertising slogans. Others local industrial units like the U.P. Mineral Development Corporation have sponsored dustbins placed along the streets. Effective waste management strategies have been successfully operationalised at Hampton Court School and Woodstock School. All residents of the school, the staff, their resident families and the students have been sensitised and trained to discard dry and wet waste into different bins put in place for this purpose. Polythene bags have been hung in classes into which the students discard wrappings, pencil shavings etc. Dry waste is made available to the rag pickers. For the wet waste pits have been dug on the school premises. The number and size of the pits is determined by the capacity required, the availability of land and depth to which it is possible to dig without encountering any hard obstruction like rocks. Wet waste is thrown into one of the pits. In order to prevent bad smell and breeding of insects, every day or two, ash made available from the school kitchen is thrown in the pit forming a layer over the waste. Every few days, soil is also layered into the pit. When this pit is full, it is covered well with soil and left to decompose. It takes three to six months depending on the season before decomposition is complete and manure is ready. In Hampton Court school, such a system of cycling of pits is managed between seven pits, and school children help when needed. Nobody from outside the school, except the rag pickers, is involved. The school does not pay Conservancy Tax.

CLEAN (Careful Learning from the Environment and Nature) is a self-sustained programme that has directed its efforts in the Landour Raj Mandi Ward and the Cantonment by working with residents, schools and guests houses to separate dry waste from wet waste at the source.

The organisation provides service to Woodstock School, ITM and private residents in the Cantonment. During 1998 many parts of the Jabarkhet Jhalki Ward are expected to be included in an educational programme.

During 1997, 2 tonnes of plastic, primarily polythene bags and 8 tonnes of paper products were recycled through a *Kabari* in Mussoorie. In addition CLEAN provides some special services.

One manager and six trained workers form the basic staff. The staff strength increased by one by the end of 1997 and it is expected that an educational extension programme will develop. A trial cleaning programme is underway at Kempty Falls, with the hope that this will become a self-sustaining project.

CLEAN has encouraged all houses, institutions and guest houses in its area of operation to separate dry waste from wet waste. For management of the wet waste it suggested digging pits on available land in which to compost the organic material. If needed it supplies manpower for digging the pits. Some mixed waste is still thrown down *khuds*. The workers of CLEAN regularly clear the *khuds*. The success of the source separation is shown in the first quarter report for 1998 when 200 kg. less of polythene was collected. In the previous year a great deal was still coming from the *khuds*.

CLEAN workers collect and sort the dry waste before it is sent to a Mussoorie *kabari*. The waste is separated into paper, cardboard, polythene, glass items including broken glass, batteries, tins, etc. Detailed records have been kept for more than three years.

CLEAN has attracted wide interest. Representatives have participated in workshops held by the Environics Academy in Dehradun as well as a one-day workshop in Shimla. A web page is being designed for the Internet. Over 2,000 nylon and cloth carry bags as alternatives to plastic bags have been distributed. Currently CLEAN is working with the Inner Wheel Women's organisation of the Rotary Club. During the monsoon season tree planting is undertaken. Discussions are underway for the setting up of a handmade paper unit following the Solan model in Himchal Pradesh.

Waste Management by Institutions in Mussoorie

Apart from households and hotels, other institutions and establishments in Mussoorie were also surveyed to study the solid waste disposal method adopted by them. These methods ranged between self reliance to complete dependence on the Municipality. In the case of some establishments, it was observed that waste is disposed over the hillside or into open pits. This was observed to be on account of either indifference or helplessness due to absence of better alternatives. On the other hand, in some institutions, the waste management set-up was observed to be worth emulating.

Schools

Hampton Court School and Woodstock School are completely self-reliant in the management of the waste generated on their premises by the students, staff and their families. For this, those generating the waste themselves have been motivated to participate fully. The method adopted by them involves separation of dry and wet waste at the point of generation itself, i.e. in the kitchen, staff quarters and classrooms. Dry waste is made available to the rag-pickers who sell it. Wet waste is dumped into deep pits dug in the school compound. From time to time ash from the kitchen and soil is layered into the pits. When the pit is full, it is covered with soil and left to decompose. Depending on the weather, it takes three to six months for decomposition to be completed and manure to form. This manure is used in the garden in the school. In the Central School for Tibetans, segregation is partial. Waste disposal and management is undertaken by the residents of the school themselves and a few private sweepers. Some of the vegetable waste is made available to pig-breeders and some dumped into pits in the school. The rest is dumped into the yellow bin close to the school premises.

Hospitals

The Community Health Centre (CHC) in Mussoorie utilises the services of the Municipality sweeper. The hospital staff separates

out biological waste and bandages from the remaining waste but the sweeper clubs it all together and throws it into an open and untreated pit close by the quarters of some of the hospital staff. The sweeper does, however, pull out the clean polythenes from the waste which he carries away to sell. At the Veterinary Hospital, all the waste collected from the hospital by its sweepers is thrown down the Gari Khana hillside which is close to the hospital compound.

Restaurants

Restaurants employ the services of either private or municipality sweepers to remove waste from their premises. They are at best segregating waste only partially. Some are not segregating at all. The restaurants on the Mall Road do not complain of illegal dumping spots close to their premises. However, those in the Kulri Bazaar and at Picture Palace complain about them during the season. Hydraulic bins lie close to the premises of most hotels, i.e. within a distance of 100 meters. The restaurants serviced by the municipality sweeper are satisfied with his service.

Mazdoor Niwas

The residents of the Chhapan Kote Mazdoor Niwas, below the Library Bus Stand, discard their waste generated by them over the hillside. A hydraulic bin is positioned within 100 meters of the Niwas but the walk to it is uphill. No municipal sweeper visits the Niwas.

Dharamshalas

Laxmi Narayan Dharamshala is collecting the total waste generated by its residents and burning it, despite the presence of a hydraulic bin within a distance of 50 meters. The walk to the bin is, however, uphill and the dharamshala is not utilising the services of municipality sweepers. The staff in the dharamshala is indifferent towards segregating waste.

Tibetan Homes

These homes are partially segregating waste. The residents of the homes themselves burn a part of the wet waste and the municipality sweeper carries a part to the nearest yellow bin. The dry waste is carried away by the sweeper for sale. The homes complained about the presence of dirty heaps of waste near their premises.

Indo-Tibetan Border Police Academy

The academy manages the waste by pressing its own team of sweepers into service. There is complete segregation of waste with the wet portion being burned and the dry portion being burned in pits.

Survey of India, Landour

In this campus, sweepers employed by the Department who are responsible for cleaning the office area and the estate manage the waste. Staff quarters on the estate dispose their waste themselves by throwing it over the *khud*.

Horse Lines

In the Horse Line in the LBS National Academy of Administration, horse waste is collected in burrows and wheeled to a *nallah* within the Lines where it is dumped and left to dry up. Since this waste has a very high content of toxins, trees in this *nallah* have been drying up. At the horse stand on the Mall Road, the Municipality Sweeper sweeps horse waste that collects during the day into the hydraulic bin. This bin is positioned right where the horses stand. Sometimes the horses eat garbage from out of this bin itself. Some horses have been reported to die as a result. During the night, the owners of the horses used for commercial purpose tie their horses wherever they can find a place for them. They sweep horse waste that collects through the night over the hillside in the morning.

APPENDIX - I

CIVIC SERVICES AND INFRASTRUCTURE QUESTIONNAIRE

QUESTION:

1. Sl. No.

2. Name & Address

3. Educational Level
   (a) Illiterate (b) From Class IInd to Class Vth
   (c) From Class VIth to Class XIIth (d) Higher Education

4. Occupation

5. Status of the Family (Number of Family Members)

6. Income Level (Average Monthly Income of Family)
   (a) Less than Rs. 2000 (b) Between Rs. 2000 to Rs. 5000
   (c) More than Rs. 5000

Litter and Public Hygiene

To what extent do you think that the city is littered?

1. Extremely
2. Somewhat
3. Not at all

What causes the maximum litter? Prioritise 1 to 6

Plastic bags

Plastic containers
Bottles
Tins
Kitchen waste
Animal droppings

Who is more responsible for the litter?

1. Tourists
2. Local population

How effective are the safai karamcharis?

1. Very effective
2. Effective
3. Ineffective

Do you think that there are sufficient public bins for litter?
Yes No

Do you think that open hydraulic bins are disturbed by cattle and monkeys? Yes No

Do you think that sufficient hygiene condition is maintained by sellers of eatables? Yes No

Do these sellers dispose off the left-overs and empty/used disposable plates etc. in the public bins? Yes No

Is there satisfactory incineration facility for garbage?
Yes No

Do the drains get choked during the rainy season?
Yes No

Where in your locality do the drains get choked?

Where in the city is there maximum litter?

Where in your locality are public bins/hydraulic bins needed?

What is the best solution for tackling litter?

Pollution

Do you think the air is polluted during the peak season?
Yes No

Do you think that the air is polluted all round the year?
Yes No

Do you think that there is noise pollution during the peak season?
Yes No

Do you think that there is noise pollution all round the year?
Yes No

Do you think that there are effective laws for preventing air and noise pollution? Yes No

Where in the town is there maximum air pollution?

Where in the town there is maximum noise pollution?

Public Conveniences

Are there sufficient public urinals in the town?
Yes No

Are there sufficient public latrines in the town?
Yes No

Are the urinals and latrines clean? Yes No

What can be done to improve the cleanliness of urinals/latrines?

Is Mussoorie public convenience (urinals/toilets) have water facilities?
Yes No

Is there any necessity in Mussoorie to have public bathing place?
Yes No

Are there sufficient public drinking water facilities in the town?
Yes No

Are there sufficient rain shelters in the town?
Yes No

Are there sufficient benches for sitting in public places?
Yes No

Where in your locality should urinals/latrines be located?

Where in your locality should rain shelter and benches be located?

Where in your locality should public drinking water facility be provided?

Roads

Is maintenance of public roads good? Yes No

Is the road network in the town adequate? Yes No

Is the width of the roads sufficient? Yes No

Do you think that the roads get overcrowded during the season?
Yes No

Do you feel like walking on the Mall Road during peak hours of the season Yes No

Is there sufficient parking space? Yes No

Have you experienced open manhole in the road which is prone to an accident? Yes No

Where in the town is there maximum congestion?

Where in the town should roads be widened?

Where in your locality can parking space be created?

Water and Electricity

Are you satisfied with the quality of drinking water?
Yes No

Are you satisfied with the supply/availability of water during season?
Yes No

Are you satisfied with the supply/availability of water all round the year?
Yes No

Is there proper management for natural water sources maintenance in Mussoorie?
Yes No
Are you satisfied with the supply of electricity during season? Yes No

Are you satisfied with the supply of electricity all round the year?
Yes No

Do power cuts adversely affect your work and productivity? (During season or all around the year)
Yes No

If yes when?
During season
All round the year

Are you satisfied with the maintenance of the electricity department?
Yes No

Do you think that the electricity department is understaffed?
Yes No

Do you think that there are sufficient street lights in the town?
Yes No

Which is the worst lit area in your locality?

Supplies

Do you think that there is a general shortage of milk, vegetables, fruits, eggs and other essential supplies during the season?
Yes No

Do you think that the prices of such commodities become unbearable during the season? Yes No

Do you have to wait long for purchasing household items during peak hours of the season? Yes No

Where should new markets be located?

Did you observe/experience anytime that harassment and exploitation of the tourist and general public by hotel-owners/shop keepers/rickshaw pullers/photographers, during the season?
Yes No

Construction Activities & Accommodation

Do you think that the construction activities in the town are planned satisfactorily? Yes No

Do you think that construction activities in the town have caused congestion and inconvenience? Yes No

Do you think that the natural beauty and scenic views are obstructed by the construction activity in the town? Yes No

Do you think that the building laws are being implemented?
Yes No

Where in the town has there been the most unplanned growth of buildings and population?

Is it right that during season because of insufficient accommodation tourist are forced to sleep on the Mall road?

Yes No

Did you or your friends experience during season any difficulties in finding accommodation in Mussoorie? Yes No

If yes, what is the solution of this problem in your opinion?

Transport

Do you experience traffic jams? (During season or all around the year)

1. Very frequently
2. Frequently
3. Sometimes
4. Rarely

Do you think that the traffic management is effective during season?

Yes No

Do you think that the traffic management is effective all round the year?

Yes No

Do you think picnic spots like Kempty are easily accessible by bus/taxi? (During season or all around the year)

Yes No

Are there adequate public transport facilities? (During season or all around the year)

Yes No

Do you have to wait in long queues for long period for travel by public transport to and from Dehradun during season?

Yes No

Are the buses and taxis overcrowded? (During season or all around the year) Yes No

Are the bus stands overcrowded? (During season or all around the year) Yes No

Which spot in your locality experiences the maximum traffic jams? (During season or all around the year)

Entertainment

Do you think that there are sufficient entertainment facilities in the town? Yes No

Are there sufficient cultural activities in the town? Yes No

Are there sufficient sports facilities in the town? Yes No

Which new facilities should be created and where?

Would you like having a botanical garden in Mussoorie?

Which tourist places should be developed?

Health

Are there sufficient hospital facilities in the town? Yes No

Do you think there are sufficient medical specialists in town? Yes No

Which area in town is worst covered by medical facilities?

Is the food served in the hotels (restaurants) having satisfactory quality standard? Yes No

Education

Do your children get admission easily in schools? Yes No

Are schools overcrowded? Yes No

Are there sufficient buildings/rooms in schools? Yes No

Is there adequate provision for higher education in Mussoorie? Yes No

Animals

Do you think that there are too many stray dogs, cattle, pigs etc? Yes No

Are there sufficient facilities for the disposal of dead animals? Yes No

Do you think that there are satisfactory regulations for pets? Yes No

Are there sufficient veterinary facilities for animals? Yes No

Which area in town is too far from veterinary facilities?

Others

Are the facilities of cremation grounds, cemetry satisfactory? Yes No

Where do you think additional cremation and burial facilities can be created?

Do you think that the infrastructure facilities are sufficient to cater to the population of Mussoorie during the season?

Yes No

Is there any particular place for disposing the debris?

Which infrastructural facility in your opinion needs the highest priority?

How often has your journey to and from Dehradun been obstructed by landslides?

1. Very often
2. Sometimes
3. Rarely

At which locations have you experienced landslides?

In Mussoorie are there enough opportunities for employment? (professional work)

If not, in your opinion which employment (professional work) should be encouraged?

Any other observations/suggestions.

APPENDIX - II

QUESTIONNAIRE—WASTE MANAGEMENT

1. Sl. No.:

2. Name & Address:

3. Location: Top of Hill Slope Bottom of Valley

4. Education level:
   Head of H. H. Spouse
   (1: Uneducated, 2: till class 5, 3: till class 12, 4: higher)

5. Occupation:

6. Family size

7. Kitchen Expenditure

8. Income group: (Family income per year)
   Less then Rs. 10,000
   Between Rs. 10,000 and Rs. 50,000
   Between Rs. 50,000 and Rs. 1,00,000
   More than Rs. 1,00,000

9. How is disposal of waste done:
   Municipality sweeper Private sweeper
   Self

10. Is it segregated Yes No

11. If yes, is segregated waste sold Yes No

12. How far is the hydraulic bin
13. Location of hydraulic bin : Above level Below level

14. Is clearing of bin regular: Yes No
15. Is sweeper regular: Yes No

16. Is sweeper effective: Yes No

17. Is there an illegal dumping spot close to the premises
Yes No

18. Are you prepared to segregate waste into wet and dry waste?
Enthusiastic Willing
Indifferent Reluctant

19. Nature of sewerage system?
Sewerage system Soak-pit/septic tank/other

20. Any problem faced with it?

Hotel Questionnaire

1. Name :

2. Capacity :

3. Address :

4. Location : Top of Hill Slope Bottom of Valley

5. Star category :

6. How much waste :

7. How is the disposal of waste done :
   Municipality sweeper . Private sweeper Self

8. Is it segregated Yes No Partially

9. If yes, is segregated waste sold Yes No

10. How far is the hydraulic bin

11. Location of Hydraulic bin
    Above level Below level

12. Is clearing of bin regular : Yes No

13. Is sweeper regular : Yes No

14. Is sweeper effective : Yes No

15. Is there an illegal dumping spot close to the premises:
    Yes No

16. Are you prepared to segregate waste into wet and dry waste?
    Enthusiastic Willing Indifferent Reluctant

17. Nature of sewerage system?
    Sewerage system Soak-pit / septic tank/ other

18. Any problem faced with it ?

Institution Questionnaire

1. Name :

2. Capacity :

3. Address :

4. Location : Top of Hill Slope Bottom of Valley

5. How much waste :

6. How disposal of waste is done :
   Municipality sweeper Private sweeper Self

7. Is it segregated Yes No Partially

8. If yes, is segregated waste sold Yes No

9. How far is the hydraulic bin

10. Location of Hydraulic bin Above level Below level

11. Is clearing of bin regular : Yes No

12. Is sweeper regular : Yes No

13. Is sweeper effective : Yes No

14. Is there an illegal dumping spot close to the premises:
    Yes No

15. Are you prepared to segregate waste into wet and dry waste?
    Enthusiastic Willing Indifferent Reluctant

16. Nature of sewerage system?
    Sewerage system Soak-pit / septic tank/ other

17. Any problem faced with it?

APPENDIX - III

CIVIC SERVICES AND INFRASTRUCTURE

Distribution of Respondents by City Wards

Sl. No.	Ward No.	Name of the Ward	Number of Residents' responses
1.	1	Allen Wyne Burg	10
2.	2	Jharipani	15
3.	3	Barllow–gunj	15
4.	4	Bhilaru	11
5.	5	Landour–Raj Mandi	13
6.	6	Charliville	13
7.	7	Bhad–raj	14
8.	8	Kachari	11
9.	9	Hampton Court	16
10.	10	Mussoorie Club–New Bharat Hotel	11
11.	11	Hakmans & Camels Back Road	12
12.	12	Jaber-Khatt & Jhalki	15
13.	13	Vincent Hill (Gurunanak School)	13
14.	14	Waverly Convent	12
15.	15	Oak Grove School	13
16.	16	Nagar Palika Parishad	11
17.	17	Polo Ground	10
18.	18	Library	15
19.	19	Landour (South)	13
20.	20	Nala Pani Dhobhi Ghat	12
21.	21	Landour (North)	10
22.	22	Bakery Hill (Near City Board)	14
23.	23	Malacalf	10
24.	24	Kulri Bazar	12
25.	25	Happy Valley	10

Government/Quasi-Government organisations - 18
City Board Members—17, Hotliers—13.

APPENDIX - IV

TOURIST INFLOW IN MUSSOORIE

Months	1990	1991	1992	1993	1994	1995	1996
January	57372 44	50000 15	60000 36	48000 27	50000 34	45000 60	50000 132
February	66536 64	60000 49	70000 43	75000 38	70000 36	55000 166	60000 138
March	93536 53	95000 71	100000 75	100000 73	90000 135	75000 308	85000 286
April	126301	130333 50	130000 140	132000 234	120000 127	100000 231	125000 236
May	182264 75	- 124	215000 115	180000 132	160000 219	130000 226	110000 238
June	270263 125	- 130	325000 109	260000 69	280000 184	250000 256	300000 230
July	158500 105	- 138	290000 135	280000 83	295000 154	300000 267	320000 270
August	100000 140	- 111	125000 103	70000 68	60000 160	55000 -	65000 280
September	80000 114	- 175	121000 94	78000 95	5000 -	60000 180	65000 220
October	80000 174	- 115	155000 137	95000 154	15000 110	80000 -	75000 78
November	75000 51	- 63	105000 105	90000 104	35000 105	60000 153	72000 136
December	80000 29	- 28	60000 32	65000 99	40000 120	70000 -	92000 140
Total	1369772 1041	1500000 1069	1756000 1127	1473000 1176	1220000 1384	1280000 1847	1419000 2423

Note: The First row represents Indian Tourists and the second represents foreign tourists

(-) represents absence of data.

APPENDIX - V

MONTH-WISE VARIATION IN POPULATION PRESSURE -1997

Month	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	23930	51390	102780	3315	27245
February	24423	65666	131332	4690	29113
March	40892	91361	182722	5894	46786
April	40892	124194	248388	8280	49172
May	40892	164164	492492	15887	56779
June	40892	282648	847944	28265	69157
July	40892	275510	551020	17775	58667
August	40892	79941	159882	5157	46049
September	40892	68521	137042	4568	45460
October	40892	82223	164446	5434	46326
November	40892	71803	143606	4853	45745
December	25247	68521	137042	4421	28844

In Season Population	**Winter Population**
Total Residents = 34864 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 40892	<u>December and February</u> 65% of residents(22662) + Boarders in Tibetan School (1761) =24423 <u>January</u> 65% of residents (22662) + Children in SOS Children's Village (1268) = 23930

SCENARIO I

MONTH-WISE VARIATION IN POPULATION PRESSURE—2001

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	25788	52624	105248	3395	29183
February	26281	67242	134484	4803	31084
March	43751	93553	187106	6036	46787
April	43751	127174	254348	8478	52229
May	43751	164164	492492	15887	59638
June	43751	289431	868293	28943	72694
July	43751	282122	564244	18201	61952
August	43751	79339	158678	5119	48870
September	43751	70165	140330	4678	48429
October	43751	86245	172490	5564	49315
November	43751	74550	149100	4970	48721
December	26281	70165	140330	4527	30808

In Season Population	**Winter Population**
Total Residents =37723 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 **Total = 43751**	<u>December and February</u> 65% of residents(24520) + Boarders in Tibetan School (1761) =26281 <u>January</u> 65% of residents (24520) + Children in SOS Children's Village (1268) = 25788

SCENARIO I

MONTH-WISE VARIATION IN POPULATION PRESSURE—2006

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	28301	54202	108404	3497	31798
February	28794	69259	138518	4947	33741
March	47618	96360	192720	6217	53835
April	47618	130989	261978	8733	56351
May	47618	173147	519441	16756	64374
June	47618	298114	894342	29811	77429
July	47618	290586	581172	18747	66365
August	47618	84315	168630	5440	53358
September	47618	72270	144540	4815	52433
October	47618	88832	177664	5731	53349
November	47618	76787	153574	5119	52737
December	28794	72270	144540	4663	33457

In Season Population	Winter Population
Total Residents = 41590 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 47618	December and February 65% of residents (27033) + Boarders in Tibetan Schools (1761) =28794 January 65% of residents (27033) + Children in SOS Children's Village (1268) = 28301

SCENARIO I

MONTH-WISE VARIATION IN POPULATION PRESSURE -2011

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	31072	55829	111658	3602	34674
February	31565	71383	142766	5027	36592
March	51881	99251	198502	6403	58284
April	51881	134919	269838	8995	60876
May	51881	178341	535023	17259	69140
June	51881	307058	921174	30706	82587
July	51881	299304	598608	19310	71191
August	51881	86844	173688	5603	57484
September	51881	74438	148876	4962	56843
October	51881	71497	142994	5903	57784
November	51881	79091	158182	5273	57154
December	31565	74438	148876	4802	36367

In Season Population	Winter Population
Total Residents =45853 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 51881	<u>December and February</u> 65% of residents (29804) + Boarders in Tibetan Schools (1761) =31565 <u>January</u> 65% of residents (29804) + Children in SOS Children's Village (1268) = 31072

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SCENARIO I

MONTH-WISE VARIATION IN POPULATION PRESSURE—2016

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	34127	57503	115006	3710	37837
February	34620	73477	146954	5067	39687
March	56581	102228	204456	6595	63176
April	56581	138967	277934	9264	65845
May	56581	183692	551076	17777	74348
June	56581	316269	948807	31627	88208
July	56581	308283	616566	19889	76470
August	56581	89450	178900	5771	62352
September	56581	76671	153342	5111	61692
October	56581	94242	188484	6080	62661
November	56581	81463	162926	5431	62012
December	34620	76671	153342	4946	39566

In Season Population	Winter Population
Total Residents = 50553 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 56581	<u>December and February</u> 65% of residents(32859) + Boarders in Tibetan School (1761) =34620 <u>January</u> 65% of residents (32859) + Children in SOS Children's Village (1268) = 34127

SCENARIO I

MONTH-WISE VARIATION IN POPULATION PRESSURE—2021

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	37496	59229	118458	3821	41317
February	37989	75681	151362	5406	43395
March	61763	105295	210590	6793	68556
April	61763	143136	286272	9542	71305
May	61763	189203	567609	18310	80073
June	61763	325757	977271	32576	94339
July	61763	317531	635062	20486	82249
August	61763	92133	184266	5944	67707
September	61763	78971	157942	5265	67028
October	61763	97069	194138	6262	68025
November	61763	83907	167814	5594	67357
December	37989	78971	157942	5095	43084

In Season Population	Winter Population
Total Residents = 55735 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 61763	<u>December and February</u> 65% of residents (36228) + Boarders in Tibetan Schools (1761) =37989 <u>January</u> 65% of residents (36228) + Children in SOS Children's Village (1268) = 37496

SCENARIO II

MONTH-WISE VARIATION IN POPULATION PRESSURE—2001

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	26286	52624	105248	3395	29681
February	26779	67242	134484	4803	31582
March	44518	93553	187106	6036	50554
April	44518	127174	254348	8478	52996
May	44518	164164	492492	15887	60405
June	44518	289431	868293	28943	73461
July	44518	282122	564244	18201	62719
August	44518	79339	158678	5119	49637
September	44518	70165	140330	4678	49196
October	44518	86245	172490	5564	50082
November	44518	74550	149100	4970	49488
December	26779	70165	140330	4527	31306

In Season Population

Total Residents = 38490
Boarders in Public Schools=4267
Boarders in Tibetan Schools =1761

Total = 44518

Winter Population

December and February
65% of residents (25018) + Boarders in Tibetan Schools (1761) =26779

January
65% of residents (25018) + Children in SOS Children's Village (1268) = 26286

SCENARIO II

MONTH-WISE VARIATION IN POPULATION PRESSURE—2006

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	29539	54202	108404	3497	33036
February	30032	69259	138518	4947	34979
March	49522	96360	192720	6217	55739
April	49522	130989	261978	8733	58255
May	49522	173147	519441	16756	66278
June	49522	298114	894342	29811	79363
July	49522	290586	581172	18747	68269
August	49522	84315	168630	5440	54962
September	49522	72270	144540	4815	54337
October	49522	88832	177664	5731	55253
November	49522	76787	153574	5119	54641
December	30032	72270	144540	4663	34695

In Season Population	Winter Population
Total Residents = 43494 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 49522	<u>December and February</u> 65% of residents (28271) + Boarders in Tibetan Schools (1761) =30032 <u>January</u> 65% of residents (28271) + Children in SOS Children's Village (1268) = 29539

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SCENARIO II

MONTH-WISE VARIATION IN POPULATION PRESSURE—2011

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	33214	55829	111658	3602	36816
February	33707	71383	142766	5027	38734
March	55176	99251	198502	6403	61579
April	55176	134919	269838	8995	64171
May	55176	178341	535023	17259	72435
June	55176	307058	921174	30706	85882
July	55176	299304	598608	19310	74486
August	55176	86844	173688	5603	60779
September	55176	74438	148876	4962	60138
October	55176	91497	182994	5903	61076
November	55176	79091	158182	5273	60449
December	33707	74438	148876	4802	38509

In Season Population	Winter Population
Total Residents =49148 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 55176	<u>December and February</u> 65% of residents (31946) + Boarders in Tibetan Schools (1761) =33707 <u>January</u> 65% of residents (31946) + Children in SOS Children's Village (1268) = 33214

SCENARIO II

MONTH-WISE VARIATION IN POPULATION PRESSURE—2016

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	37367	57503	115006	3710	41077
February	37860	73477	146954	5067	42927
March	61565	102228	204456	6595	68160
April	61565	138967	277934	9264	70829
May	61565	183692	551076	17777	79342
June	61565	316269	948807	31627	93192
July	61565	308283	616566	19889	81454
August	61565	89450	178900	5771	67336
September	61565	76671	153342	5111	66676
October	61565	94242	188484	6080	67645
November	61565	81463	162926	5431	66996
December	37860	76671	153342	4946	42806

In Season Population	Winter Population
Total Residents = 55537 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 61565	December and February 65% of residents(36099) + Boarders in Tibetan School (1761) =37860 January 65% of residents (36099) + Children in SOS Children's Village (1268) = 37367

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SCENARIO II

MONTH-WISE VARIATION IN POPULATION PRESSURE—2021

Months	Permanent Population	Number of Tourists	Tourist Days @ 3 for May/ June2 for other months	Tourists per day	Population pressure per day
January	42060	59229	118458	3821	45881
February	42553	75681	151362	5406	47959
March	68785	105295	210590	6793	75578
April	68785	143136	286272	9542	78327
May	68785	189203	567609	18310	87095
June	68785	325757	977271	32576	101361
July	68785	317531	635062	20486	89271
August	68785	92133	184266	5944	74729
September	68785	78971	157942	5265	74050
October	68785	97069	194138	6262	75047
November	68785	93907	187814	5594	74379
December	42553	78971	157942	5095	47648

In Season Population	Winter Population
Total Residents = 62757 Boarders in Public Schools=4267 Boarders in Tibetan Schools =1761 Total = 68785	December and February 65% of residents (40792) + Boarders in Tibetan Schools (1761) =42553 January 65% of residents (40792) + Children in SOS Children's Village (1268) = 42060

APPENDIX - VI

PER CAPITA WASTE GENERATION BY PERMANENT POPULATION

In order to determine the per capita waste generation and composition of waste generated by the permanent population of Mussoorie, the following study was conducted by an independent organisation.

(1) 25 dustbins were placed at selected locations in the town each day of the one month period between 15th May to 15th June,1997.

(2) Of these, some were placed in households across the town, 5 in hotels (1 in Landour, 2 in Kulri, 1 at the Library Point and 1 on the Charleville Road).

(3) The concerned residents were requested to discard waste in these dustbins alone.

(4) Waste that collected in each of the bins was brought to a central point every day and weighed.

(5) Waste was then segregated into wet and dry portions and each weighed separately.

(6) Dry waste was then separated into broad constituents like paper, glass, polythene and PVC packaging, debris, metal etc. and each constituent weighed separately.

Results

1. Per capita waste generated by the permanent population was 350 grams per day.[8]
2. Of this 74 per cent was wet waste and 26 per cent was dry waste.

---

[8] In India, per capita waste generation lies between 0.15-0.50 Kg. per day.

3. The constituents of dry waste were in the following percentage of the total waste:

Constituent	Per cent of Total Waste
Paper	2
Glass	6
Plastic/Polythene/PVC packaging	7
Debris	4
Metal	3
Cloth	2
Wood/Bones	1
Battery Cells	1

Per Capita Waste Generation by Floating Population

1. Dustbins were placed in selected hotels across the town each day of the one month period between 15th May to 15th June,1997. Some dustbins were also placed along the main road at important locations like Rialto Cinema Hall, Library Point and Landour Chowk.
2. Waste disposed by tourists during the night was collected from the dustbins placed in the hotel rooms and weighed daily.
3. Waste generated by the tourists in the hotel during the day was estimated by subtracting the waste generated by the staff of the hotel from the total waste of the hotel.
4. Waste generated by tourists during the day outside the hotel was estimated on a daily basis—weighing the waste collected in the dustbins placed at select points on the main road.
5. Waste collected from the above locations was separated into its wet and dry components and both weighed separately.

Results

1. Per capita waste generated by the floating population in Mussoorie was estimated to be 400 grams per day.

2. Of this 70 per cent was wet waste and 30 per cent was dry waste.

Limitations of the Study

1. The survey was limited to a period of one month. Consumption and waste generation patterns during that season are being extrapolated to rest of the year.
2. In order to determine the waste generated by tourists in Mussoorie during the day outside the hotels, dustbins were placed in select locations along the Mall Road. The positioning of the dustbins was at prominent tourist points but this still left many areas uncovered.

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Dr. H. Ramachandran is currently the Director of the Institute of Applied Manpower Research and was earlier Executive Director of the National Society for Promotion of Development Administration, Research and Training, Mussoorie. Prior to this he was associated with the Lal Bahadur Shastri National Academy of Administration, Mussoorie, the Delhi School of Economics and the Institute for Social and Economic Change, Bangalore. He has a number of books and papers in the field of urban and rural development to his credit.

The Supreme Court Monitoring Committee was constituted by the Hon'ble Supreme Court of India under a judgement of 30.8.1988 in a Public Interest Litigation Case, for monitoring the environment issues in Doon Valley.

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Carrying Capacity of Mussoorie (2011)

Compiled by

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Secretary, SCMC

Supreme Court Monitoring Committee
P.O. New Forest, Dehradun - 248006

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Preface

The suggestion for carrying out land use/land cover and hydrological study of Doon Valley was mooted by Mr. D. Bandyopadhyay, Member, SCMC, in one of the meetings and later, on Mr. Hugh Gantzer's suggestion to include Mussoorie area outside Doon Valley in the proposed study, was also accepted. The study was entrusted to Uttarakhand Space Application Centre, Dehra Dun.

While the study on land use to find out the changes over a period of time by remote sensing, supported by the field inspections, was continuing, the idea of updating the **1998 study on Carrying Capacity of Mussoorie**, which encompassed issues like facilities related to health, waste management, water and power supply, accommodation for tourists and other infrastructure etc, occurred to the undersigned.

This report is compilation of the study on landuse and reports collected from various departments, and comparison of the same with the data / study compiled in 1998 study on Carrying Capacity of Mussoorie. It is in no way claimed to be the original work, and at places even the reports may have been quoted verbatim. The assumptions/yardsticks/norms adopted in 1998 Study have been adopted in this compilation also.

The following literature /reports were consulted for bringing out updated study on Carrying Capacity of Mussoorie (2011). The contribution of the authors of the following literature/reports is thankfully acknowledged.

1. Landuse Study for Mussoorie by Uttarakhand Space Application Centre (USAC) Dehra Dun
2. Seismic threat in Uttarakhand – Study by Disaster Mitigation and Management Centre, Govt. of Uttarakhand
3. Management Plan of Mussoorie Forest Division – 2011 to 2021
4. 1998 Study on Carrying Capacity of Mussoorie – by NSDART
5. Reports from various Govt. Departments of Uttarakhand
6. Report on Seismic hazard status of Dehra Dun/ Doon Valley – by Dr. A.K. Mahajan, Wadia Institute of Himalayan Geology.
7. Interim data of Census – 2011 published by the Directorate of Census, Uttarakhand.

This update on Carrying Capacity of Mussoorie is not the last word. There is lot of scope for improvement in such reports. The omissions related to data, typographical errors, etc. and suggestions from readers for improvement of the report are welcome for future guidance. The undersigned is grateful to Ms. Florence R. Pandhi for proof reading of the compilation.

(M.C. Ghildial)
Secy. SCMC

Summary of Carrying Capacity of Mussoorie
(1998 Study updated in 2011)

Mussoorie township, situated at a height of 2000 mts. above msl, is spread over an area of 65.81 sq. kms on either side of Mussoorie ridge, of which 25.48 sq. kms. (part of the watershed of Yamuna) falls outside of the Doon Valley, according to Notification of 01.02.1989. Nevertheless, for the sake of comparison of the present study with the 1998 study, this area has been included in the updated report for Mussoorie.

The major factors impacting the environment and the infrastructure are Geology, Soil and Climate, Population Pressure – both permanent and tourist which have direct bearing on housing, water and power supply, sewerage, waste management and allied infrastructural facilities, which briefly are :-

1. **Geology, Soil and Climate:**

Mussoorie, like the whole Himalayan mountain area, is very fragile and unstable. The presence of limestone in the area resulted in large scale devastation of vegetation, which was ultimately stopped under orders of the Hon'ble Supreme Court, as a result of PIL filed by RLEK. The soils, altitude and the climate are major factors affecting the vegetation. The climate varies from sub-tropical to temperate depending upon altitude, aspect and locations. While the climate of low lying areas is sub-tropical type, the higher reaches have temperate climate. The average rainfall recorded in Mussoorie for 2000 to 2008 ranges from 36 mm in October to 647 mm in July. The temperature ranges between –5°c to 32°c.

2. **Population:**

The population is one of the most important factors influencing the environment and ecology of the area. Whereas the density of the permanent population in 1901 (6461) was 98 per sq. km, it has gone up to 511 per sq. km. in 2011 (population 33651). During peak season it goes up to 1000/sq. km. The projection of population for 2021 in the 1998 study was 55735 at the growth rate 2.05% per annum (20.50% decadal growth) which, as per the present study based on census figures of 2001 and 2011 is 38621 at 14.77% growth rate.

3. **Tourist Population:**

The estimated tourist inflow for Mussoorie in 1997 for January, May and June was 3315, 15887 and 28265 respectively. The projection for 2011 as per the 1998 study in January, May and June was 3602, 17259 and 30706 which as per the present study is 3870, 22407 and 35556 respectively. The projection for 2021 as per the 1998 Study in January, May and June was 3821,18310 and 32576 respectively, against the projection worked out (as per inflow of tourists between 2001 and 2010) at 5748, 33281 and 52811 for the corresponding months.

4. **Infrastructural Facilities:**

The infrastructural facilities for permanent as well as the tourist population are far from satisfactory.

5. **Accommodation for Tourists-**

The economy of Mussoorie is wholly dependant on tourists. The number of beds available in 140 registered Hotels, Dharamshalas, Paying Guest houses etc. was 9844 in 1998, which now has marginally increased to 13523 in 186 registered hotels etc ; meaning

thereby that 8884 tourists in May, 22033 in June and 8020 in July will have to return the same day owing to lack of accommodation in 2011. This number will increase to 20298 in May, 39288 in June and 18482 in July, unless matching facilities with regard to water supply, accommodation, electricity and waste disposal etc. are created in due course.

6. Health Facilities:

The availability of hospital beds in 1998 study was 153, which has come down to 90 in 2010-2011; meaning thereby that the ratio of beds to persons which was 1 : 228 in 1998 has gone up to 1 : 444 due to increase in population on one hand and decrease in number of available beds on the other. Ideally the number of beds should be 200 in 2011 for population of 40,000 and 225 in 2021 for a projected permanent population of 45,000. The ratio of hospital beds to population in 2021 would be 1: 500 persons if the number of beds remains static. This reflects the dismal picture of health care facilities for Mussoorie even for the permanent population. The problem during the tourist season is not difficult to imagine.

7. Power Supply:

The growth of domestic and commercial electricity connections in 2010 has increased to 5159 and 1717 from 3912 and 1483 in 1997. As per information from the power department, there is no power cut in Mussoorie. The department will, however, have to take care of the power supply due to increasing population.

8. Traffic and Parking Facility:

The traffic during the tourist season increases manifold with hardly any parking facility or a pragmatic traffic plan. The issue, however, is engaging the attention of the local administration and the government, which may result in augmentation in parking facilities and the strict implementation of directions for plying of vehicles during prohibited hours.

9. Sewerage:

The sewerage system developed in 1934 by the British is almost outdated and inadequate to take the load of the present population. The same is being replaced at a cost of Rs.61.73 crores by laying about 63891 mts. of sewer lines, with 10 sewage treatment plants to take care of estimated population of 82436, 95043 and 108689 in the years 2011, 2026 and 2041 respectively. The expected date of completion is 2013.

10. Water Supply:

The requirement of water for 2011, 2026 and 2041 as per the estimate of Jal Nigam would be 13 mld., 14.7 mld. and 16.9 mld. respectively, against which the reported availability is only 9.18 mld. A water supply project worth Rs.182.28 crores for supply of 19.2 mld. water to cater for the projected population up to 2044 from Yamuna by 4 stage pumping is under examination at the level of Govt. of Uttarakhand. If the water supply is not augmented by tapping water from sources like Aglar/Yamuna rivers, the whole exercise of laying sewer lines will become futile. Therefore, the water supply and sewerage project should be implemented in such a way that they become operational simultaneously. In addition, the rain water harvesting measures which have been made mandatory while approving plans for buildings need to be strictly implemented by frequent inspections by MDDA during the construction phase.

11. Waste Management:

The estimated generation of waste in 2011 ranges between 12 to 30 tonnes during

lean (January) and peak season (June), which would go upto 18 tonnes in January and 37 tonnes in June by 2021. In addition to the local body NGOs are also engaged in waste management and disposal. The strength of sweepers has marginally gone up to 167 permanent and 60 temporary during peak season, compared to 153 and 50 respectively in 1998. This important issue continues to be negiected despite the fact that the disposal of waste in tourist towns like Mussoorie should be one of the priority sectors. The Govt. of Uttarakhand is contemplating taking up the projects under the City Sanitation Plan and Asian Development Bank (ADB) Funded Scheme.

12. Master Plan:

The Master Plan for Mussoorie could not be prepared for want of survey of forest and non-forest land, which has now been taken up by Survey of India with a budget provided by MDDA. Hopefully, after identification of forest and non-forest land, the picture of land use will be clear and the Master Plan will be prepared in the near future.

It may be mentioned that the private estates in Mussoorie are notified as private forests and hence attract provisions of the Forest Conservation Act, 1980. Therefore, the construction activity is expected to be limited, since the chance of approval for such activity on a large scale on forest land by the Govt. of India under Forest Conservation Act, 1980 is very remote. Therefore, development of adjoining areas as satellite towns by identifying non-forest land fit for habitation needs to be seriously considered.

13. Land Use:

The comparison of land use done in 1998 by NSDART with the one done by USAC in 2011 reveals that the land under forests, which had reduced by 4.38 sq. km. between 1990, has increased by 0.121 sq. kms. between 1997 and 2009. The density of forest has also improved between 1997 and 2009 due to afforestation activity funded by the Supreme Court Monitoring Committee, as a result of a cess imposed on mining. This is basically due to the clarification and direction dated 1996 of the Hon'ble Supreme Court, mentioning that the F.C. Act, 1980 will apply not only to notified and recorded forests but also to the forests by dictionary meaning irrespective of the ownership. The implication of the direction is that for forest areas, approval for non-forest use has to be obtained from the Govt. of India. In the absence of the above clarification, construction activity was at its peak between 1990-1996 in utter disregard of the provisions of the Forest Conservation Act, 1980.

As per 1998 Study, about 11 sq. kms. of land in Mussoorie falls in the built up area and only 2 sq. kms. is available for safe construction. The same position continues in 2011 also since construction between 1997 and 2011 are by and large, renovation or reconstruction of existing buildings. The land in Mussoorie falls in Zone IV of the seismic hazard map. Therefore, earthquake resistant buildings need to be constructed in future for which MDDA has already made provisions in the bye-laws. There is need to frame bye-laws for dilapidated buildings constructed prior to 1984 i.e. before MDDA was notified, allowing construction up to the existing height of the building, to encourage residents to reconstruct earthquake resistant buildings by a massive awareness drive for retrofitting measures.

14. Conclusion: Mussoorie being one of the most important tourist centres of the country needs a lot of attention with regard to basic amenities, not only for tourists but also the permanent population handling them. Tourists are the backbone of the economy and livelihood of local people and hence, issues of water supply, accommodation, waste management – both sewerage and solid waste and other infrastructural facilities need to be addressed on a priority basis.

Carrying Capacity of Mussoorie – 2011

1. Background:

Mussoorie Township, the "Queen of hills", is situated in the Lesser Himalayas or either side of the ridge running east to west at an altitude of about 2000 meters. The town is famous as a tourist destination with an advantage of good rail, road and air connectivity While the town has a number of educational institutions from the British days, the La Bahadur Shastri National Academy of Administration (LBSNAA) and Indo-Tibetan Boarde Police Academy (ITBP) are important establishments of the post independence period.

The main economic base of Mussoorie is the tourist sector with hotels, dharamshala and guest houses spread all over. The other economic activity taking place in Mussoori area resulting in environmental degradation was unregulated limestone mining whic caused unwanton destruction of greenery of these hills, till such time it was stopped as a result of Writ Petition No.8209 and 8821/1993 filed by Rural Litigation and Entitlemen Kendra (RLEK) against the State of U.P. and Others in the Hon'ble Supreme Court.

The Government of India, Ministry of Environment and Forests, in pursuance of th order of the Hon'ble Supreme Court dated 30.08.1988, constituted the Supreme Cour Monitoring Committee vide No. O.M. No.1-14015/10/83/Env. IA dated 14.09.1988 as a result of the aforesaid petitions relating to environmental degradation caused b unregulated lime stone mining in Mussoorie hills. The mandate for the Committee was t look after reafforestation, mining activities and all other aspects necessary to bring abou natural normalcy in the Doon Valley, and to ensure that mining activity is carried out i accordance with law, with appropriate safeguards from environment and ecology point c view, and also to ensure that the scree is removed from the natural streams and the flow c water is maintained. It was further clarified vide order dated 09.04.1993 by the Hon'bl Court that the purpose of the Committee was not limited to the question of mer reafforestation in the areas in which scars on the earth were left behind by relentless pursu of mining for profit, but also to monitor environmental issues in the Doon Valley.

The local body i.e. Municipal Board, Mussoorie, has the responsibility of civi administration of the town. The development part of the city, however, comes under th jurisdiction of Mussoorie Dehra Dun Development Authority (MDDA) created in 1984 fo enforcement of bye-laws with regard to existing and new constructions. The constructio activity between 1990-1997 was at its peak when compared to 1990, the forest cove reduced by 4.38 Sq.Km. by 1997 and the built up area increased by 4.32 Sq. Km. It was not case of only the fast pace of construction but also of the unplanned construction i violation of Forest Conservation Act, 1980, in notified private forest estates.

The Supreme Court Monitoring Committee (SCMC), to control haphazar constructions, filed a Writ Petition (W.P. No.749/1995) against MDDA & Others in th Hon'ble Supreme Court when the Hon'ble Court vide order dated 10.07.1996 clarified tha the private forests attract the provisions of F.C. Act, 1980 and as such for non-forestry use o the areas notified as Forests will have to be obtained from the MOEF, Govt. of India. Th land mark judgment of the Hon'ble Court put a curb on construction activity which can down drastically from 1997 onwards.

The Supreme Court Monitoring Committee in 1997 sponsored the study on Carrying Capacity of Mussoorie to assess the environmental status of Mussoorie in the larger context of urban and non-urban landuse and the carrying capacity of the urban structure. The study team comprised of Dr. H. Ramachandran & Dr. Neera Ramachandra, Shri Padamvir Singh, Ms. Seema Joshi, Shri A.W. Khan, Ms. Saloni Goyal, Shri R.K. Bharatdwaj, Ms. Madhuri Negi National Society for Promotion of Development Administration, Research and Training – LBSNAA, Mussoorie.

2. Objectives of the 1998 Study by NSDART were

(i) preparation of a detailed land use map;

(ii) preparation of a set of map over lays based on building regulations, zoning norms and slope stability;

(iii) preparation of a detailed map identifying hazard prone zones;

(iv) estimation of carrying capacity of the Mussoorie Urban Agglomeration with particular reference to available urban infrastructure;

(v) establishment of bench marks for water and air pollution at selected points in the city;

(vi) estimation of demand for water and power; and

(vii) details of people's perception on environmental problems based on a household survey;

The study done by NSDART covered the municipal limit of Mussoorie, part of which (25.48 sq. km. watershed of Yamuna) falls outside the Doon Valley Notification. Nevertheless, for the sake of comparison, the area covered by the 1998 study has been included in this updated report also adopting, by and large, the same yardstick/norms/ assumptions as in the 1998 study.

3. Perception of Residents:

The residents' perception of unplanned construction, traffic problems, and water and power supply, local health facilities, disposal of waste and consequent policy issues have already been dealt within the study of 1998 and therefore, resurvey was neither considered necessary nor it is a subject matter of the present study. The problems prioritised by the various interest groups and the suggested solutions in the study carried out by NSDART hold good today.

The major indicative solutions offered by the respondents during 1998 study conducted by NSDART are as follows :-

Table 3: Major Indicative Solutions Offered by Respondents

Problems relating to	Major indicative Solutions offered
Road congestion/ Parking	Essentially repair and maintenance, railing, expansion of parking facilities at Masonic Lodge, Library and Kings Craig, additional traffic police during peak season, construction of chuna khala road, development of 500 acre land purchased by tourism department in Jharipani, bus-connection between Jharipani and Mussoorie be improved.
Water Shortage	Expansion of storage and pumping facility, better distribution system within the city.
Power Shortage	Power cuts in hill areas should be totally stopped, modernization of Galogi power house, better maintenance of transformers.

Waste Management	Better monitoring of safai karamcharis, expansion of sewerage system shifting of dumping ground away from built up area, construction of mor public toilets, and pay toilets, awareness campaigns, provision of prope stable facility for horses/mules.
Land Development/ Housing	Removal of encroachments, construction of houses for local populatio should be permitted, the role of the MDDA should be restricted to outsid City Board limits and the development role within the city should be restore to the City Board, ban on commercial construction within and on th periphery of Mussoorie, redefining of forest area within the city limits.
Unemployment	Implementation of self-employment schemes, establishing small sca activities such as dairy, poultry, etc. and at UPSMDC complex.
Health	Augmentation of health facility including special services
Education	Establishment of affordable schools and higher education/vocation education facility.

Source: Table 2.9 of 1998 study by NSDART.

4. Factors impacting the Environment :

The major factors impacting the environment are :-

(a) Locality Factors –Geology, Soil and Climate -

Mussoorie, like the whole Himalayan mountain area, is very fragile and unstable. T detail of rocks of various geological ages from Central Crystalline to Neo Tal Group found Mussoorie is given in the following table.

Serial No.	Group	Rocks	Locations
(1)	(2)	(3)	(4)
1	Krol Group	Lime-stone, Marble, Dolomite	North and South of Mussoorie.
	(a) Tal Group	Lime-stone, Quartzite, Rocks with Phosphorite	Around Mussoorie
	(b) Infra-Crol	Shale and Slate	-do-
	(c)Blaini	Dolomite, Lime-stone, Boulder, Slate, Quartzite	North of Mussoorie
2.	Nagthat	Quartzite with Schist and Phyllite	North and South of Mussoorie
3.	Chandpur	Slate, Shale Phyllite , Quartzite	North of Aglad river

The presence of lime-stone, and hence its quarrying around Mussoorie, resulted large-scale devastation of vegetation which ultimately was stopped under the orders of t Hon'ble Supreme Court, as a result of, PIL filed by the Rural Litigation and Entitlem Kendra (RLEK).

Soils-

The soils are good indicators of the vegetation in a particular place. Four types of s namely, red loam, brown forest soil, pod sol and meadow soil are found in Mussoo Whereas red loam is without organic matter and found on slopes and ridges in dry are

brown forest soil with organic matter in sizeable proportion is found in major forest areas. Pod soil is loamy and found in pockets in shady places. Meadow soil, usually found near water streams and cool, low lying shady places, remains moist and during winter a thick matting of frost covers the soil.

Climate-

The height of Mussoorie and adjoining areas is around 2000 Mts. There are four seasons in Mussoorie namely spring - March to mid June, summer/rainy season - mid June to mid-September, Autumn - mid-September to mid December and winter- mid-December to mid-March. The climate varies from sub-tropical to temperate depending on varying altitude, aspect and the locations. While the climate is sub-tropical in lower reaches, it turns temperate in higher altitudes where snow fall during winter is quite common.

The average rainfall as recorded for Mussoorie from 2000-2008 ranges between 36 mm to 647 mm with maximum precipitation during July and August. The temperature varies from –5°c to 32°c with peak winter during December-January and summer during May-June.

5. Population –

Population pressure is the most important factor impacting the environment. The ever increasing population has a direct bearing on the increasing demand for housing, power and water supply, health facilities, sewage and sanitation etc. The permanent population of Mussoorie for the year 1901 to 2011, as also the projection for 2021 based on the annual growth rate of 14.77% (the population in 2011 is 33,651 i.e. an increase of 4,332 in 2011 over the population of 29,319 in 2001), is as follows:

Table 5.1 : Mussoorie Urban Agglomeration – permanent population & Growth Rate

Year	Population as per 1998 study.	Population as per Census Report	Growth Rate (%)
1901	6461	6461	
1911	8052	8052	24.62
1921	9702	9702	24.49
1931	6116	6116	-36.96
1941	7172	7172	17.27
1951	8550	8550	19.21
1961	11238	11238	31.44
1971	20389	20389	81.43
1981	18233	18233	-10.57
1991	29629	29629	62.50
2001	37723*	29319	-1.05
2011	45.853*	33651 (provisional)	14.77
2021	55,735*	38621**	

*The projection for 2001, 2011 and 2021 in 1998 study is based at 2.05% annual growth (10.25% Quinquennial growth) over 1991 census figure.

** The projection for 2021 in the present study is based on the census figure of 2011 at

a decadal growth rate of 14.77% for Mussoorie between 2001 and 2011.

For the purposes of calculation of population pressure, waste generation, demand f water etc. the population for Mussoorie has been adopted as 40,000 (say 34,000 + 6,0 boarders in schools). Similarly, at the decadal growth rate of 14.77%, the estimate population for 2021 would be around 45,000 (say 39,000+ 6,000 for the boarders). Th projected population pressure in 2011 and 2021 is as per the following table :-

Table – 5.2 - Projection of Population Pressure in 2011 and 2021

Month	Projected population in 2021 at 14.77% of decadal growth rate over 2011 population.	Projected Tourists days @ 3/day in May – June & 2/per day in remaining months in 2011	Projected Tourist days in 2021 at 48.53% growth rate of tourists of 2011 i.e of col.3	Population pressure /day in 2011 at 40,000 permanent population + Col.3 (Table-6.4, Col.7)	Projected population pressure/ day in 2021. (2+4) (Table-6.4 Col.8)
1	2	3	4	5	6
January	45,000	3870	5748	43,870 (34674)	50748 (41317
February	45,000	7498	11137	47,498 (36592)	56137 (4339
March	45,000	6544	9710	46,544 (58284)	54710 (6855
April	45,000	10562	15688	50,562 (60875)	60688 (7130
May	45,000	22407	33281	62,407 (69140)	78281 (8007
June	45,000	35556	52811	75,556 (82587)	97811 (9433
July	45,000	21548	32005	61,548 (71191)	77005 (8224
August	45,000	12184	18097	52,184 (57484)	63097 (6770
September	45,000	10674	15854	50,674 (56843)	60854 (6702
October	45,000	11562	17173	51,434 (57784)	62173 (6802
November	45,000	6534	9705	46,534 (57154)	54705 (6735
December	45,000	6444	9571	46,444 (36367)	54571 (4308

Figures in parentheses are based on Appendix – 5 (Scenario -1) in 1998 study t NSDART.

6. Tourists inflow to Mussoorie :

(a) There is a sharp seasonal fluctuation in population on account of tourism. T statistics for 1990-96 collected during 1998 study by NSDART are as follows:-

Table: 6.1 : Tourists in-flow to Mussoorie (1990-96)

Year	Average Indian Tourists (1990-96)	Average Foreign Tourists (1990-96)	Average All Tourists (1990-96)
January	360372	90	51532

February	456536	78	65295
March	638536	143	91362
April	863634	145	123521
May	977264	161	163038
June	1755263	140	281017
July	1323500	165	274081
August	475000	144	79310
September	409000	166	68332
October	500000	128	83461
November	437000	102	72935
December	407000	75	67908

Source: Table 3.5 of 1998 study by NSDART

(b) **Projection of Tourists' Population** : The figures/projections for various years from 1997 to 2021, based on the average of month-wise arrival of tourists from 1990-1996, as worked out in the 1998 study by NSDART, are as under:-

6.2 Tourist- flow per day – Estimates (Mussoorie)

	1997	2001	2006	2011	2016	2021
January	3315	3395	3497	3602	3710	3821
February	4690	4803	4947	5027	5067	5406
March	5894	6036	6217	6403	6595	6793
April	8280	8478	8733	8995	9264	9542
May	15887	15887	16756	17259	17777	18310
June	28265	28943	29811	30706	31627	32576
July	17775	18201	18747	19310	19889	20486
August	5157	5119	5440	5603	5771	5944
September	4568	4678	4815	4962	5111	5265
October	5434	5564	5731	5903	6080	6262
November	4853	4970	5119	5273	5431	5594
December	4421	4527	4663	4802	4946	5095

Source: Table 3.11 of 1998 study by NSDART.

(c) **Tourist inflow to Mussoorie(2001-2010)** - The details of tourist inflow between 2001-2010 as reported by the Department of Tourism (Table-6.3), as also the projection of population pressure per day based on the assumptions in 1998 study and projection for 2021 as per present study, are as per the following table :-

Table 6.3: Month and year-wise details of Tourist inflow - Mussoorie

Year/ → Month ↓	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average no. of tourists in 10 years
1	2	3	4	5	6	7	8	9	10	11	12
January	51010 107	59637 122	59675 120	59995 165	62115 130	59796 230	59990 212	60430 218	62745 236	62800 245	59998
February	96570, 140	96735 110	96840 075	96800 210	105205 170	105215 372	112110 357	112235 362	112415 382	112918 380	104960
March	96650, 357	98990 360	99105 273	99125 306	99645 235	101015 484	101126 517	110170 515	101180 518	101195 522	101429
April	159690, 294	148770 296	152015 340	156310 310	156680 434	158000 450	162970 521	163110 530	163690 548	158895 546	158432
May	226150, 333	226450 305	226530 330	232130 180	232145 345	232250 501	232750 490	230045 492	236415 494	236525 485	231535
June	332950, 265	364015 143	366300 158	345450 260	345540 324	358115 367	358250 370	359640 372	360200 370	362240 372	356570
July	314203, 288	356190 215	332015 344	332600 189	333015 347	333110 419	333120 438	333630 430	334145 438	334430 469	334005
August	175210, 264	184590 256	185315 310	185890 315	192150 309	192165 554	192190 566	192495 568	192260 569	192250 572	188874
Sept.	158590 324	158845 326	158990 223	160110 230	160100 213	160215 360	160215 368	160395 376	160400 392	160295 394	160136

October	168900 198	169110 208	170315 287	179325 183	179330 304	177335 680	179390 690	180640 712	180960 762	182210 795	177236
November	94715 310	94770 312	97110 314	97190 125	98150 467	98350 587	98498 588	98610 638	98990 845	98695 840	98010
December	95940 188	96110 208	97395 212	98710 210	99340 274	99395 305	99790 307	104978 332	101758 315	102880 326	99897
Total *Indian* *Foreign*	**1972578 3068**	**2064212 2863**	**2041605 2986**	**2043635 2683**	**2063335 3547**	**2074963 5309**	**2093399 5424**	**2106378 5545**	**2105128 5869**	**2105333 5966**	**2065757 4326**
Grand Total (Indian and foreign tourists)	**1975646**	**2057075**	**2044591**	**2046318**	**2066882**	**2080272**	**2095823**	**2111923**	**2110997**	**2111299**	**20700826**

First row represents Indian tourists and second represents foreign tourists.

Growth Rate of Tourists in 2010 compared to 1996:

$$\frac{\text{(No. of tourists in 2010) – No. of tourists (1996)}}{\text{No. of tourists (1996)}^{**}} \times 100$$

$$\frac{2111299 - 1421423}{1421423} \times 100 = 48.53\%$$

** Ref. Appendix IV – 1998 study by NSDART.

Projection of population for 2021 for Mussoorie @ 14.77% decadal growth rate would be say 45,000 (38,621 permanent population + 6,000 boarders in Schools = 44621) as per table below:-

Table – 6.4 - Projection of Population Pressure in 2021

Month	Projected population in 2021 at 14.77% of decadal growth rate over 2011 population.	Projected Tourists days @ 3/day in May– June & 2/per day in remaining months in 2011	Projected Tourist days in 2021 at 48.53% growth rate of tourists of 2011 i.e of col.3	Population pressure /day in 2011 (Ref. Table 5.2)	Projected population pressure /day in 2021. (2+4)
1	2	3	4	5	6
January	45,000	3870	5748	43870 (34674)	50748 (41317)
February	45,000	7498	11137	47498 (36592)	56137 (43395)
March	45,000	6544	9710	46544 (58284)	54710 (68556)
April	45,000	10562	15688	50562 (60876)	60688 (71305)
May	45,000	22407	33821	62407 (69140)	78281 (80073)
June	45,000	35556	52811	75556 (82587)	97811 (94339)
July	45,000	21548	32005	61548 (71191)	77005 (82249)
August	45,000	12184	18097	52184 (57484)	63097 (67707)
September	45,000	10674	15854	50674 (56843)	60854 (67028)
October	45,000	11562	17173	51434 (57784)	62173 (68025)
November	45,000	6534	9705	46534 (57154)	54705 (67357)
December	45,000	5444	9571	46444 (36367)	54571 (43084)

Figures in parentheses are based on Appendix - 5 (scenario -1) in 1998 Study by NSDART

Table: 6.5 Month and year-wise details of Tourist inflow – Mussoorie (2001- 2010

Month	Permanent Population in 2010	Average no. of tourists (1990-1996) Ref. Table 3.5 of 1998 Study	Average no. of tourists/ year 2001-2010 (Col.12 of Table 6.3	Tourist / day (col.4 divided by no. of days in the month)	Tourists days @ 3/day in May – June & 2/per day in remaining months	Population pressure /day in 2010 -11. (2 +6)	Projected population pressure in 2021 as per Table 6.4 .
1	2	3	4	5	6	7	8
January	40,000	51532	59998	1935	3870	43,870	50748 (41317)

February	40,000	65295	104960	3749	7498	47,498	56137 (43395)
March	40,000	91362	101429	3272	6544	46,544	54710 (68556)
April	40,000	123521	158432	5281	10562	50,562	60688 (71305)
May	40,000	163038	231535	7469	22407	62,407	78281 (80073)
June	40,000	261017	355570	11852	35556	75,556	97911 (94339)
July	40,000	274081	334006	10774	21548	61,548	77005 (82249)
August	40,000	79310	188874	6092	12184	52,184	63097 (67707)
September	40,000	68332	160136	5337	10674	50,674	60854 (67028)
October	40,000	83461	179236	5781	11562	51,562	62173 (68025)
November	40,000	72935	98010	3267	6534	46,534	54705 (67357)
December	40,000	67908	99897	3222	6444	46,444	54571 (43084)

Figures in (parentheses) in column 8 are projections worked out in 1998 study at 2.05% growth rate per annum by NSDART. It may be mentioned that in the 1998 study the population during winter months has been taken to be 65% of the inseason population. In the present study, permanent population figure of 40,000 has been adopted round the year for arriving at the population pressure based on the provisional census figure of 33,651 for 2011 from the Directorate of Census Uttarakhand + 6,000 boarders in the schools.

Assumptions in columns 4,5 & 6 are the same as in the study on Carrying Capacity of Mussoorie i.e. it is assumed that the average tourist spends 3 days in Mussoorie in May and June and 2 days in other months. The average tourist arrival in a month (col.4) was converted into the number of tourists per day by dividing the same with the number of days in the month (col.5) and the figure was multiplied by 2 to estimate the number of tourist days in a month (col. 6). To obtain figures of population pressure per day the permanent population for each month was added to the tourist per day in the month (Col. 2 + 6= 7).

For example for estimating tourist pressure in Jan. 2010, the figure comes to 3870 as per details below :-

1. Average No. of Tourists in 2001-2010 in Jan. - 59998
2. Tourists per day at 2 per tourist - $\frac{59998}{31} = 1935$

3. No. of Tourists' days (no. of days spent in January) - 2 x 1935 = 3870

4. Population pressure per day in January, 2010 - 40,000 + 3,870 = 43,870

7. Accommodation for Tourists :

The economy of Mussoorie is wholly dependant on tourists. As per record of the Department of Trade Tax, responsible for registration and collection of tax from hotels, there are 186 registered hotels with provision of 11,707 beds for the tourists. In addition gurudwaras, dharamshalas and paying guest houses can accommodate 1816 tourists. The table below compares the accommodation available in 1997 (1998 Study) and in 2011:-

Table 7.1: Beds available for Tourists in Mussoorie

Sl.No.	Particulars	1998 study	2011 study
1.	Beds in registered hotels	8028	11,707
2.	Beds in 8 Gurudwaras, Dharamshalas, Musafirkhanas and Temples	1598	1598
3.	Beds in holiday homes and paying guest houses	218	218
	Total Beds available	9844	13,523

The figures for 1998 under serial no.2 & 3 above have been repeated in 2011 als since there has been no recorded change in accommodation as per local informatio Thus, accommodation for only 13,523 tourists is available in Mussoorie for overnight stay.

From the Table 7.1, it would be seen that during April, May and June , the arrival tourists is much more than the available accommodation, and it is estimated that against the available accommodation, for 13523, 8,884 tourists in May, 22033 in June ar 8020 in July have to return the same day owing to lack of accommodation. By 2021, the present growth rate of tourists inflow 20,298 tourists in May, 39,288 in June and 184 in July may have to leave Mussoorie the same day, unless facilities for stay with matchir infrastructural and basic facilities of water, electricity and waste disposal are created in du course .

8. Master Plan -

The Doon Valley Notification of 01.02.1989 has provided for approval of activiti related to location, setting up of industrial units, mining, tourism, grazing and land use fro Union Ministry of Environment and Forests. In addition, the Hon'ble Supreme Court h clarified that the Forest Conservation Act, 1980, will apply not only to the recorded/notifi forests but, also, to the forests by dictionary meaning. The implication of this ruling is th any non-forestry activity, of which construction activity in Mussoorie is the most importa prior approval of Union Ministry of Environment and Forests is required under the Fore Conservation Act, 1980. The scope of construction activity in Mussoorie thus, stan restricted to a great extent since most of the land here is under notified private forest which prior approval from Union Ministry will have to be obtained.

The Master Plan for Mussoorie has not been prepared for want of survey of forest a non-forest land which will form the basic data for land use and formulation of Master Pl forest and non-forest land . The survey of forest and non-forest land has been undertak

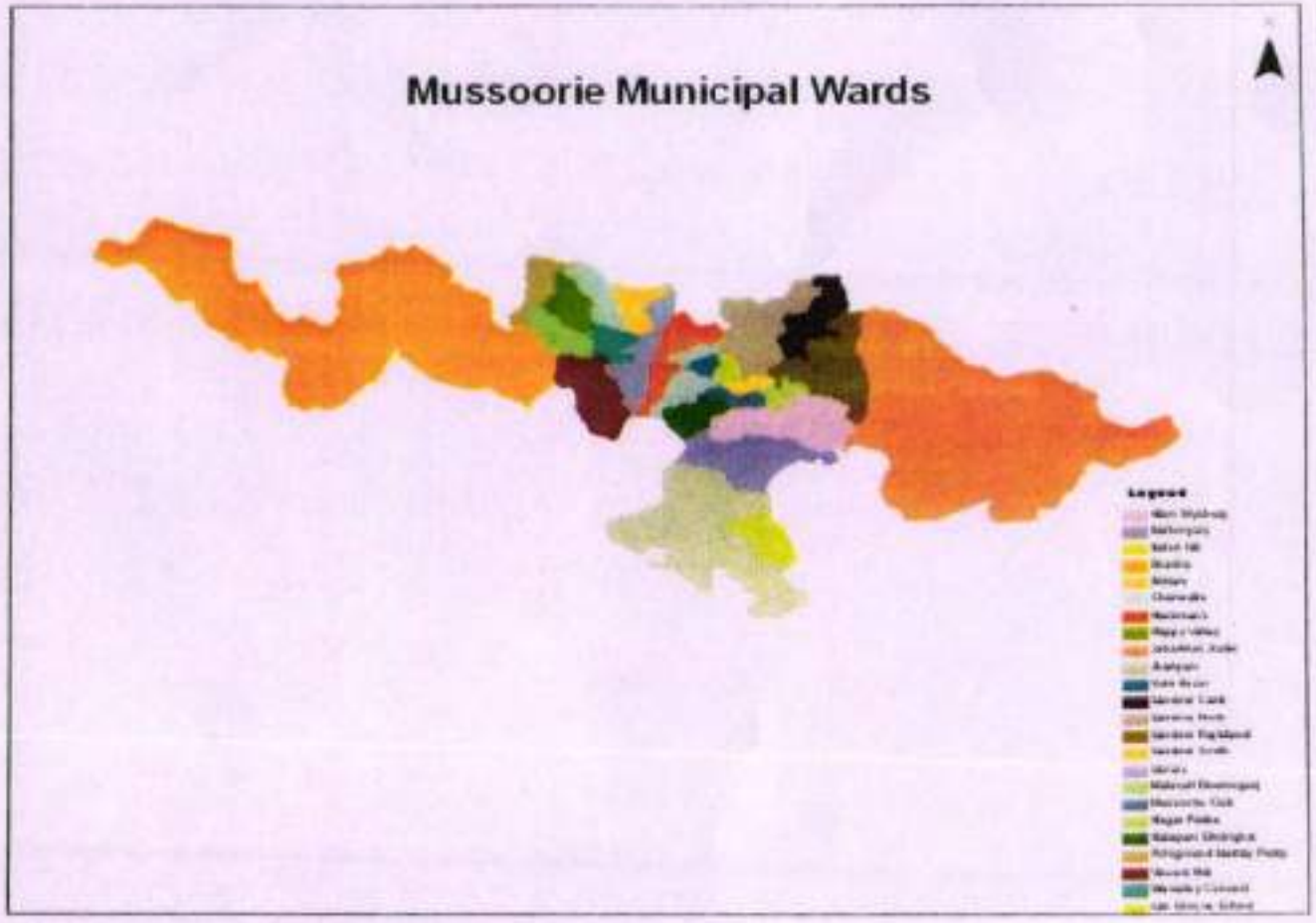
by the Survey of India with the budget provided by MDDA to identify the areas with regard to applicability of Forest Conservation Act, 1980. This exercise, once completed, will pave the way for preparation of a Master Plan, at least for the non-forest land. With regard to forest land, the Govt. of India has already issued GO No.L-UP/952/1996-FC-V of 11.02.2011 allowing construction over an area of 250 sq. mts. of built up area for residential accommodation, only subject to clearance from the Govt. of India under the Forest Conservation Act, 1980. Despite this relaxation, construction activity is expected to be limited since the chance of approval for such activity on a large scale on forest land by the Govt. of India under Forest Conservation Act, 1980 is very remote. Therefore, development of adjoining areas as satellite towns by identifying non-forest land fit for habitation needs to be seriously considered.

9. Landuse – Land Cover Changes

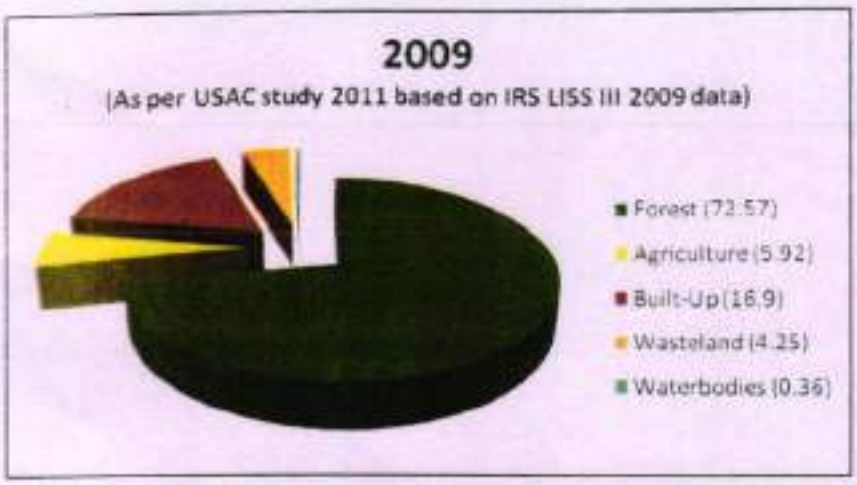
(a) The Mussoorie urban area located on either side of Mussoorie ridge has an area of about 65.81 sq. km. Since the terrain is rugged, the land available for urban development is very limited. A comparison of the land use as per the study of 1998 by NSDART and the changes over a period of time as per the study carried out by the Uttarakhand Space Application Centre (USAC) for Land Use/Land Cover and Hydrological Study of Doon Valley is given in the following table, from which it would be seen that the land under forests between 1990 and 1997 reduced by 4.38 sq. kms. (from 79% in 1990 to 72% in 1997) and has increased by 0.121 sq. kms. (0.18%) in 2009 compared to the area in 1997. The density of forest has also improved between 1997 and 2009. The tables, maps and pie charts showing the change in land use between 1990 and 2009 are as follows :-

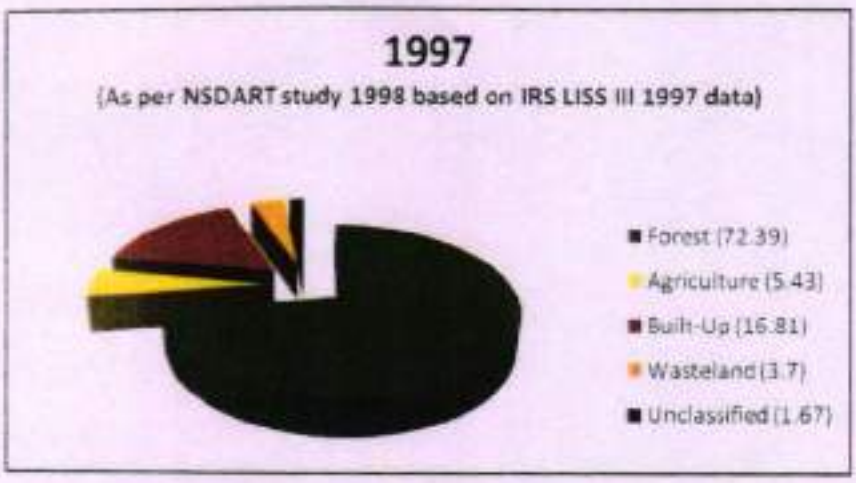
Table 9.1: Change in Landuse in Mussoorie (1990-97 and 2009)

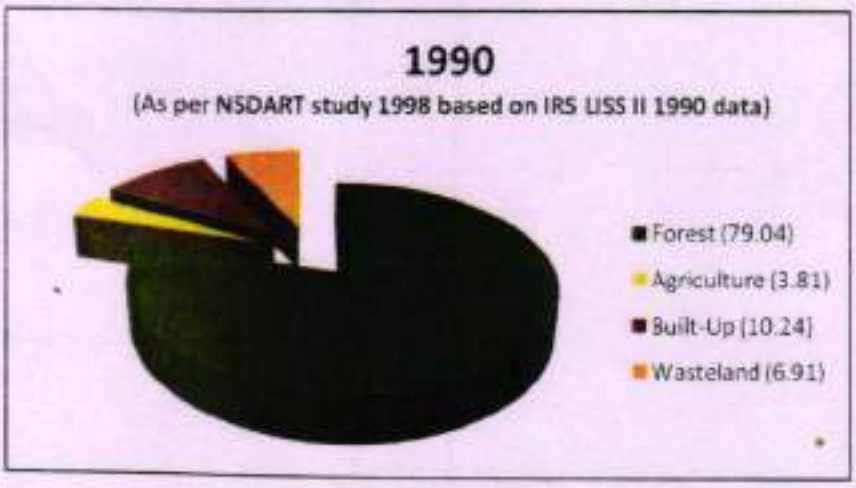
Landuse Categories	Area (Sq.Km.) 1990	Area (Sq. Km.) 1997	Area (Sq.Km.) 2009	Change sq. km .in between 1990 and 1997	Change in Sq. Km. between 1997-2009
1	2	3	4	5 (3-2)	6 (4-3)
Dense Forest	29.32	23.31	26.042	-6.01	2.732
Medium /Moderately Dense Forest	11.08	18.28	14.680	7.20	-3.600
Open Forest/Scrub	11.62	6.05	7.039	-5.57	0.989
Sub-Total Forest	52.02 (79.04)	47.64 (72.39)	47.761 (72.57)	- 4.38 (- 6.65)	0.121 (0.18)
Agriculture	2.51 (3.81)	3.57 (5.43)	3.896 (5.92)	1.06 (1.62)	0.326 (0.49)
Built-up Area	6.74 (10.24)	11.06 (16.81)	11.114 (16.90)	4.32 (6.57)	0.054 (0.09)
Waste/Barren Land	4.55 (6.91)	2.44 (3.70)	2.799 (4.25)	-2.11 (-3.20)	0.359 (0.55)
Unclassified	0.00	1.10 (1.67)	0	1.10 (1.67)	-1.10 (-1.67)
Water Bodies	N.A.	N.A.	0.240 (0.36)	N.A.	0.240
Grand Total	**65.81**	**65.81**	**65.81**		

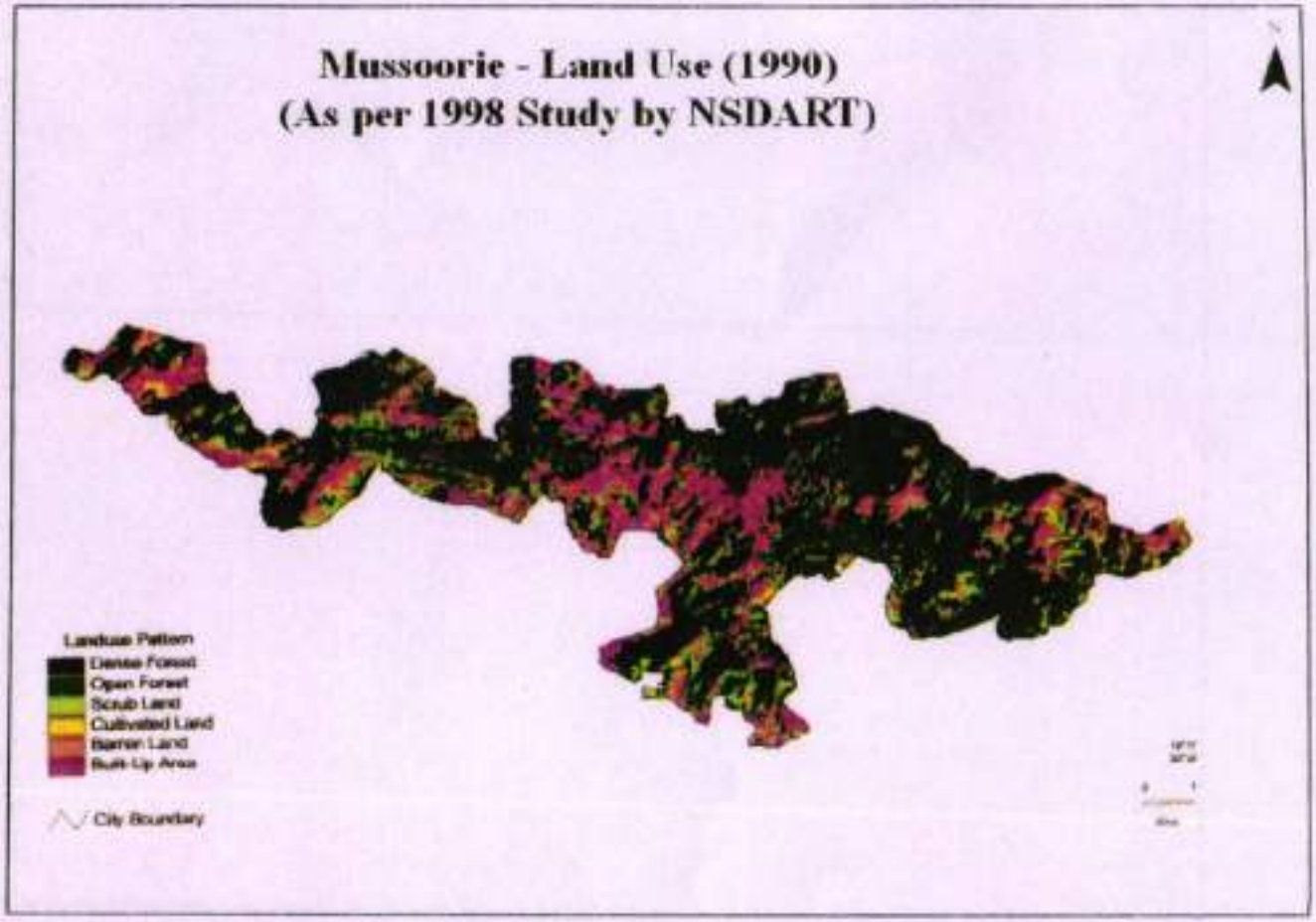

Mussoorie Municipal Wards
Legend

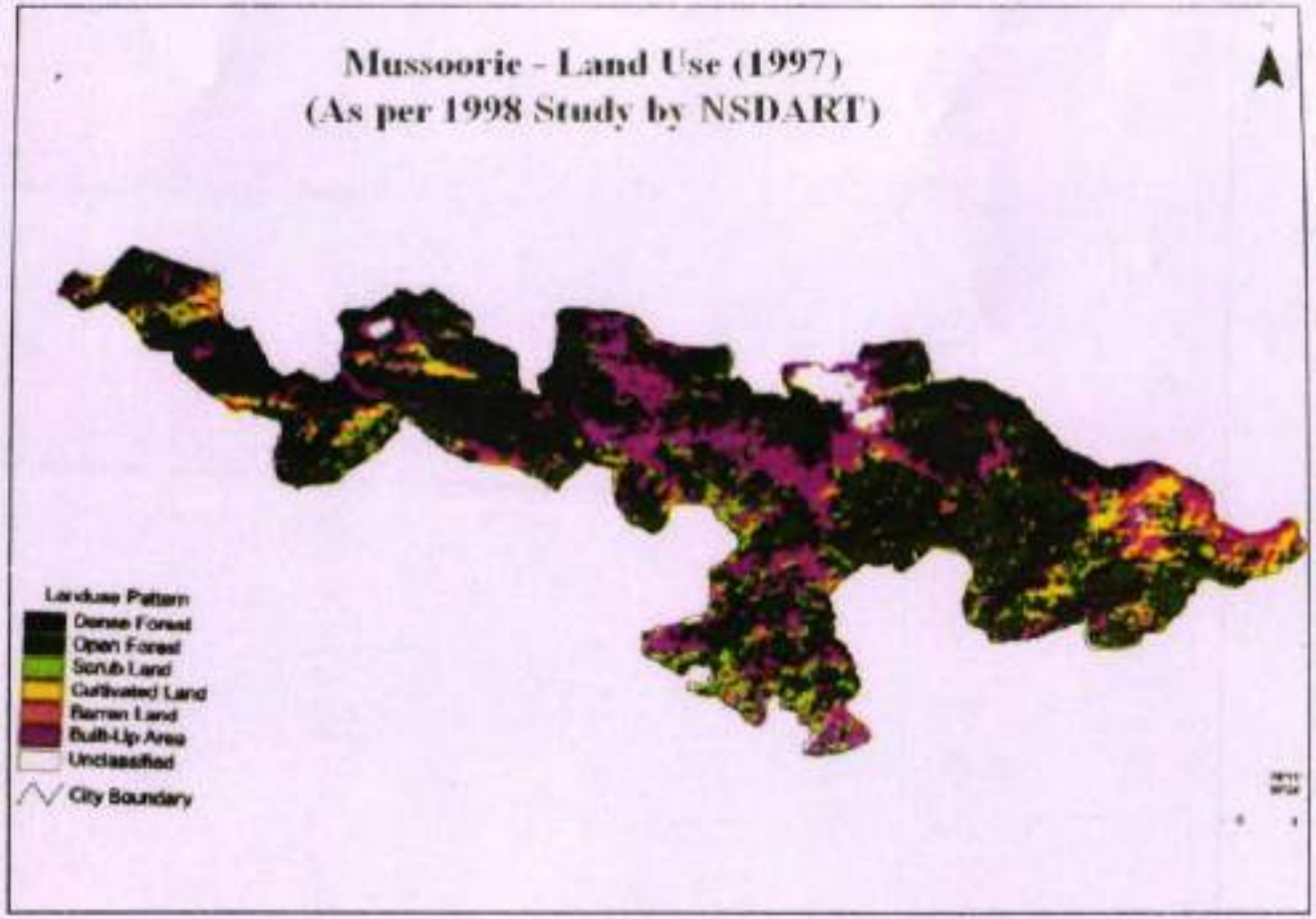
LAND USE IN MUSSOORIE IN 2009, 1997 AND 1990. THE FIGURES IN PARENTHESES INDICATE THE PERCENTAGE OF THE TOTAL LAND AREA



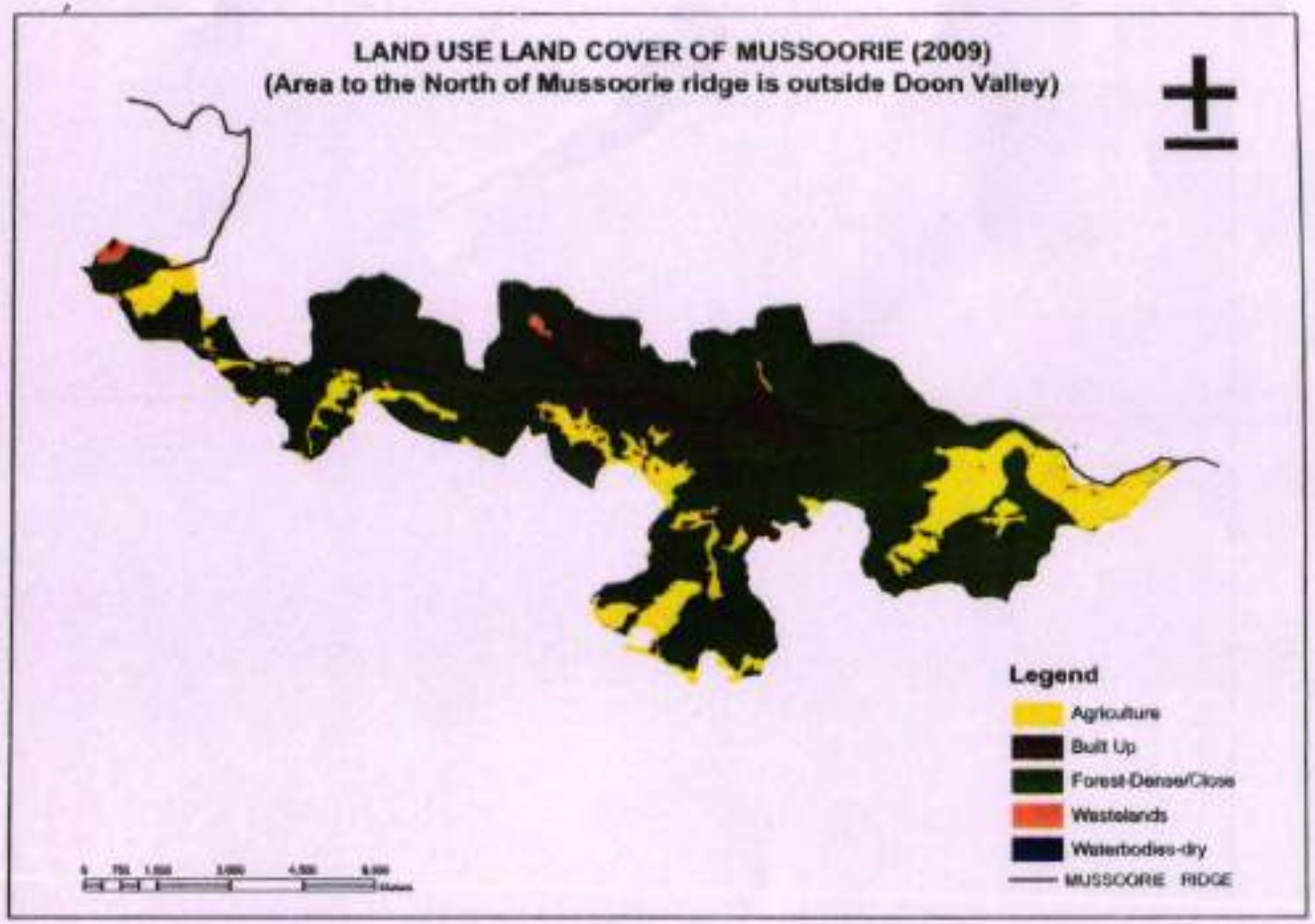


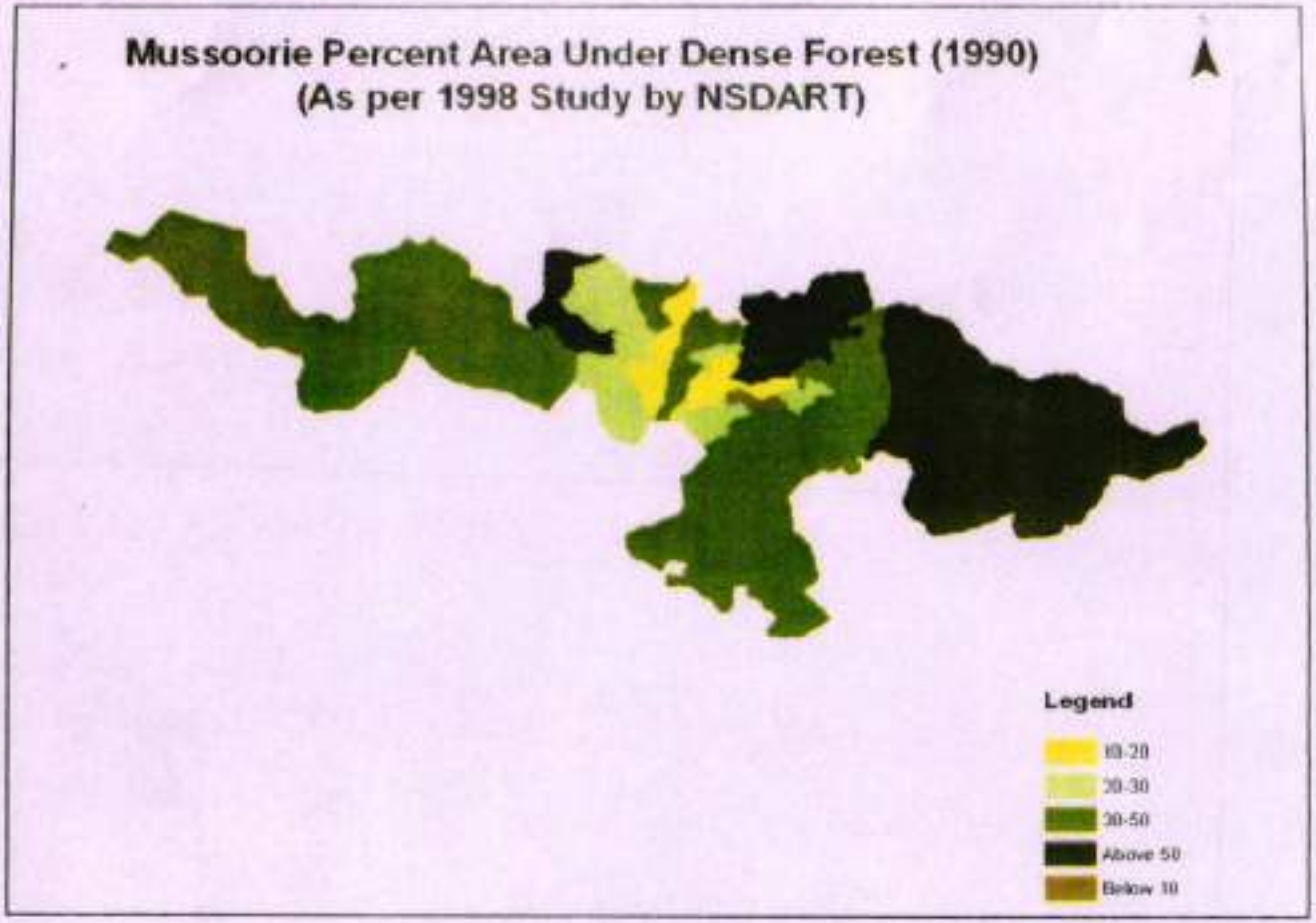



Mussoorie - Land Use (1990)
(As per 1998 Study by NSDART)
Landuse Pattern
Dense Forest
Open Forest
Scrub Land
Cultivated Land
Barren Land
Built Up Area
City Boundary

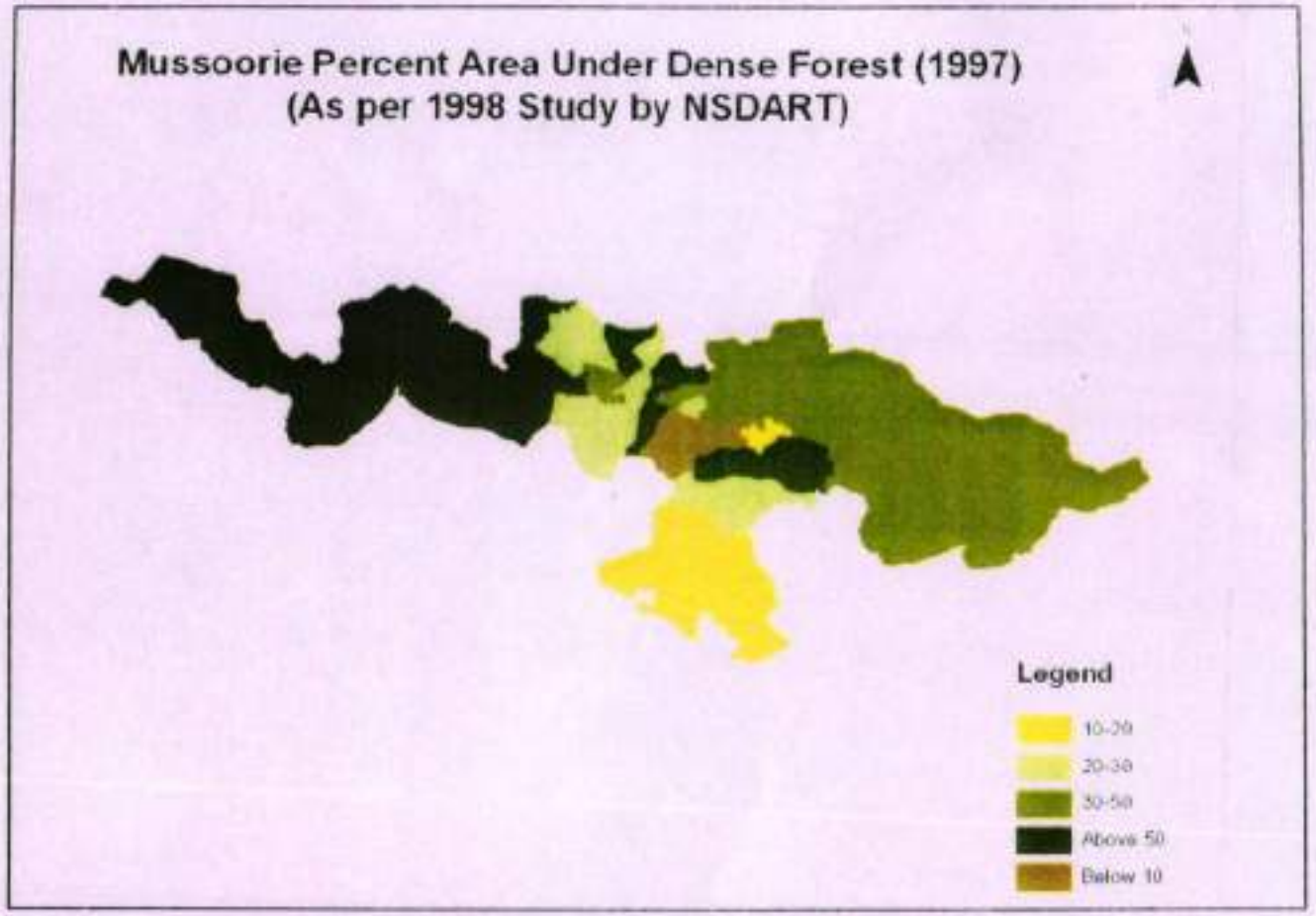

Mussoorie - Land Use (1997)
(As per 1998 Study by NSDART)
Landuse Pattern
Dense Forest
Open Forest
Scrub Land
Cultivated Land
Barren Land
Built-Up Area
Unclassified
City Boundary

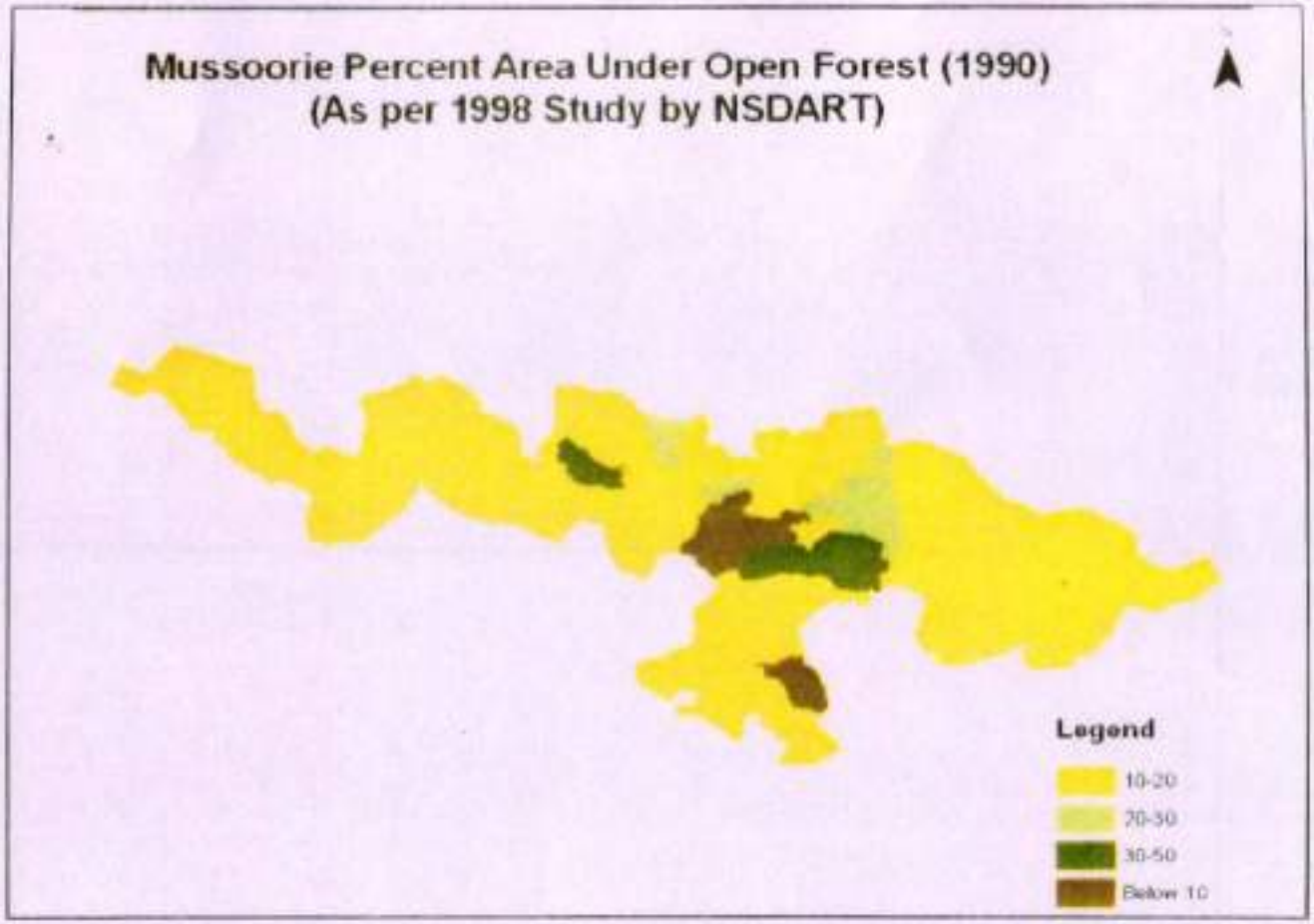
20

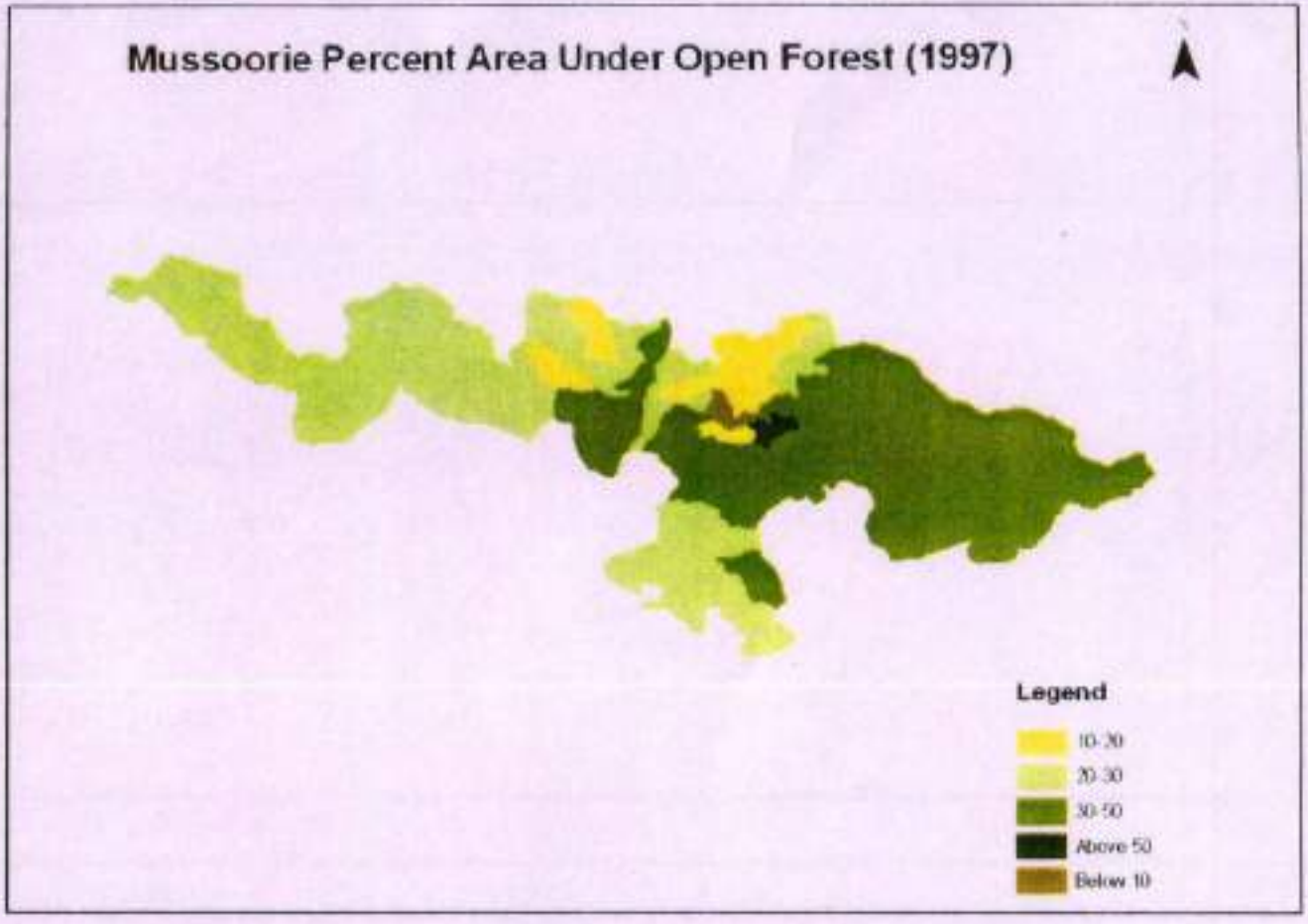

LAND USE LAND COVER OF MUSSOORIE (2009)
(Area to the North of Mussoorie ridge is outside Doon Valley)
Legend
Agriculture
Built Up
Forest-Dense/Close
Wastelands
Waterbodies-dry
MUSSOORIE RIDGE


Mussoorie Percent Area Under Dense Forest (1990)
(As per 1998 Study by NSDART)
Legend
10-20
20-30
30-50
Above 50
Below 10

22


Mussoorie Percent Area Under Dense Forest (1997)
(As per 1998 Study by NSDART)
Legend
10-20
20-30
30-50
Above 50
Below 10


Mussoorie Percent Area Under Open Forest (1990)
(As per 1998 Study by NSDART)
Legend
10-20
20-30
30-50
Below 10


Mussoorie Percent Area Under Open Forest (1997)
Legend
10-20
20-30
30-50
Above 50
Below 10

In the Table above, the figures for 1990 and 1997 are based on the 1998 study by NSDART and for 2009 as per the study of the Uttarakhand Space Application Centre (USAC). The figures in parentheses are a percentage of the total area (65.81 sq. km.) under various land uses. It is noteworthy that in Mussoorie construction activity was continuing at a very fast pace despite the fact that there are 218 estates notified as private forests. This activity has reduced drastically after 1997, as a result of the Writ Petition 749/1995 filed by SCMC against MDDA & Others; and 202/1995 filed by Godaverman against Union of India and Others; and judgments of the Hon'ble Supreme Court dated 29.11.1996 and 12.12.1996 clarifying that the Forest (Conservation) Act, 1980 applies to the forests notified by the State Government and also to the forests by dictionary meaning (irrespective of the ownership), and as such permission for non-forestry use of forest land will have to be obtained from the competent authority i.e. the Ministry of Environment and Forests, Govt. of India, New Delhi.

Landuse in relation to Slope:

The Table 9.2 below which is a reproduction of Table 4.1 of 1998 study gives the area and % of land in Mussoorie by slope categories, from which it would be seen that about 79% of the area falls in a slope category of 30 degrees and more, and only about 13 sq. kms. has less than a 30 degree slope, and that too in small patches. Out of this11 sq. kms. is already under built up area and therefore, hardly 2 sq. km. is available for safe construction. The use of land with more than a 30 degree slope for urban development would be at great risk. The position in 2011 continues to be the same as in 1998 study since constructions between 1997 and 2011 are by and large renovation or reconstruction of existing buildings.

Table 9.2 : Area and Percentage of Land in Mussoorie by Slope Categories

Degree of Slope	Area in Square Kilometers	Percent Area to Total Area
Below 10	5.54	8.42
10-20	3.65	5.55
20-30	4.23	6.43
30-50	10.43	15.84
50-90	41.96	63.76
Total	**65.81**	**100.00**

10. Eco-restoration of Mined Area -

In compliance of the orders of the Hon'ble Supreme Court to bring natural normalcy to the Doon Valley, eco-restoration of mined areas was undertaken from the funds generated as a result of cess imposed on the mines which were allowed to function by the Hon'ble Court till expiry of the lease period. The eco-restoration of mined areas around Mussoorie was done mainly by way of reforestation and soil conservation works through the Eco-task force, U.P. Forest Department and to some extent by the public schools. On completion of eco-restoration, the Ministry of Environment and Forests, Govt. of India vide Notification No.11-12/1989/Misc./FPD of 17.09.1999 constituted a committee under the

Chairmanship of Shri A.K. Wahal, ADG, ICFRE, with Dr. J.D.S. Negi, Dr. Laxmi Rawat, Scientists, Shri R.K. Singh, Asstt. Silviculturist, FRI, and Shri Dhirendra Singh, Associate Professor, IGNFA, for assessment of the progress of implementation of the greening project of mined areas in Doon Valley with regard to objectives, physical and financial performance, and overall evaluation of the project. As per the report of the committee (a) eco-restoration was partially achieved and sustained efforts to control biotic factors to enable the sites to fully recover was recommended. (b) the scree areas were established by soil binders like Dodonaea viscosa, Agave americana etc. (c) the micro-climate has significantly improved by stoppage of mining on one hand and rehabilitation measures on the other. From the table 9.1 above, it would be clear that over a period of time there has been an overall increase not only in the vegetation cover in 2009 (see sub-total of forest land) but also in the density of forest cover.

11. Micro-zonal Survey of Seismic Stress in Mussoorie :

Mussoorie falls in Zone IV of the seismic hazard map of India. There are scientific constraints in earthquake prediction and therefore, effective planning, preparedness and mitigating measures are of prime importance in the event of seismogenic disturbances. The seismic microzonation study for the Doon Valley, being done by Wadia Institute of Himalayan Geology, is continuing as part of their ongoing programme. Mussoorie town, located on hard rock, though is not prone to site amplification due to low frequency waves yet topographic effects, which have not been studied so far, can take place. The high frequency events generated from the Main Boundary Thrust (MBT) or Mohand thrust can also have its effect but, presently both these are not active and this may be due to some seismic gap or seismic quiescence (Mahajan and Others 2007 and 2008).

The survey of 3344 buildings in Mussoorie by Disaster Mitigation and Management Centre, Uttarakhand, Dehra Dun, indicates that principles of seismic safety are being ignored even in multi-storeyed buildings, and 19% of surveyed hotel buildings fall in high probability and very high probability of grade 5 and grade 4 damage. Therefore, compulsory safety audit of structures has been recommended by the centre before granting permission to operate as a public facility. For old buildings a massive awareness drive for popularising the retrofitting measures to improve the seismic response of the buildings in Mussoorie has been recommended, since replacement of these structures is neither feasible nor practical. Appropriate techno legal regime and mechanism for strict compliance to ensure that the vulnerability to earthquake is not added, has also been recommended. The practice of compounding the cases such unsafe structures, which defy standards and safety norms, need to be discontinued as a financial penalty without corrective structural measures does not guarantee the safety of a structure. The direct economic loss estimated by the centre comes to Rs.235.85 crores, which does not include losses to public facilities and infrastructure.

12. Dilapidated Buildings in Mussoorie:-

Closely connected to the issue of constructions falling in 5 & 4 damage category in Mussoorie is the issue of dilapidated buildings, which has been engaging the attention of the Supreme Court Monitoring Committee for a long time. The Hon'ble Lokayukta has also taken cognisance of the issue of the danger to life and property of inhabitants due to dilapidated buildings.

This issue was first discussed in the meeting of Supreme Court Monitoring Committee on 18.05.2004 and as a follow up in the meeting on 02.06.2004 in Delhi under the Chairmanship of Secretary, MOEF, Government of India when the following observations were made:-

Restriction on height of buildings in Mussoorie was discussed by the members. It was decided in the meeting of 02.06.2004 that relaxation granted by Government of India for extension upto 10% of the plinth area of existing buildings (constructed prior to 1980) shall be withdrawn in respect of forest lands. Further, members were also of the opinion that the State Government may also revisit their own building bye-laws and consider the same principles over the non-forest lands as well. (Action: Government of India/State Government of Uttaranchal).

The MDDA has taken a welcome decision by approving only 'earthquake resistant" building designs. The issue of *one time dispensation* for allowing reconstruction of existing buildings (not for new constructions) has not been resolved by the Govt. of Uttarakhand despite constant chasing of the issue by the Supreme Court Monitoring Committee. The facility of reconstruction if allowed will have an added advantage of construction of "earthquake resistant" buildings, since it will be one of the conditions for constructions in Dehra Dun and Mussoorie areas which are seismically very sensitive.

13. Infrastructural and Basic Facilities :

13.1 Water Supply – The 1998 Study on Carrying Capacity of Mussoorie carried out by National Society for Promotion of Development Administration, Research and Training (NSDART) for Supreme Court Monitoring Committee has already emphasised that, in future, there will be a great shortage of water unless measures for augmenting the supply are seriously planned and implemented. The following table gives the projection of water demand at 135 lpcd for the population of 2011 and 2021 (see Table – 5.1). The projections as worked out in Table 3.6 of 1998 Study by NSDART are in parentheses.

Table – 13.1 : Projected Water Demand @ 135 lpcd

Month	2011				2021			
	Permanent Population	Tourist population	Total	Demand of Water	Permanent Population	Tourist population	Total	Demand of Water
January	40,000	3870	43870	5922450 (5201100)	45,000	5748	50748	6850980 (6197550)
February	40,000	7498	47498	6412230 (5488800)	45,000	11137	56137	7578495 (6509250)
March	40,000	6544	46544	6283440 (8742600)	45,000	9710	54710	7385850 (10283400)
April	40,000	10562	50562	6825870 (9131400)	45,000	15688	60688	8192880 (10695750)
May	40,000	22407	62407	8424945 (10371000)	45,000	33281	78281	10567935 (12010950)
June	40,000	35556	75556	10200060 (12388050)	45,000	52811	97811	13204485 (14150850)

July	40,000	21548	61548	8308980 (10678650)	45,000	32005	77005	10395675 (12337350)
August	40,000	12184	52184	7044840 (8622600)	45,000	18097	63097	8518095 (10156050)
September	40,000	10674	50674	6840990 (8526450)	45,000	15854	60854	8215290 (10054200)
October	40,000	11562	51562	6960870 (8667600)	45,000	17173	62173	8393355 (10203750)
November	40,000	6534	46534	6282090 (8573100)	45,000	9705	54705	7385175 (10103550)
December	40,000	6444	46444	6269940 (5455050)	45,000	9571	54571	7367085 (6462600)

From the table above, it would be seen that whereas the projection of the 1998 study based on 150 lpcd (liters per capita per day), ranges between 5.20 mld. (million liters per day) in January and 12.38 mld. in June in 2011 and 6.19 mld. in January and 14.15 mld. in June in 2021, the requirement as per the present study at 135 lpcd it ranges between 5.92 mld. in January and 10.20 mld. in June and 6.85 mld. in January and 13.20 mld. in June for 2011 and 2021 respectively.

13.1.1 Current Supply of Water :

The source of water in Mussoorie is basically from the mountain streams. The supply is inversely proportional to the demand during the peak tourist season when during summer months, the supply goes down and the population due to tourists increases manifold. Though rain water harvesting in new constructions has been made mandatory by the MDDA, the supply, if at all, has a limited use due to poor enforcement of conditions for constructions. The water in Mussoorie has to be pumped from 12 sources, and from the remaining 5 sources the flow is through gravity as per the following table:-

Table-13.1.1 – Water Sources

Sl. No.	Name of Water Source	Nature of Source		Discharge of Source liters per minute (Imp)		System of WS *	
		Spring	Brooklet	Spring	Brooklet	Pumping	Gravity
1.	**Murrey Pump**						
(I)	Khanalty	spring	---	450 (450)	---	Pumping	---
(ii)	Under Cliff	spring	--	108 (108)	--	-do-	---
(iii)	Bansi or Lyndale	spring	--	200 (280)	--	-do-	--
2.	**Khandighat Pump**						
	Khandighat Upper	---	Brooklet	---	200 (336)	-do-	--
(I)	Khandighat 30 H.P. Lower	spring No.8	--	480 (225)	---	-do-	--
(ii)	Khandighat (Nala)			250 –			
(iii)	Rikholigad			250 –			

3	John Mackinnon Pump						
(i)	New Bee	spring	---	80 (50)	---	-do-	—
(ii)	John Mackinnon	spring	---	150 (155)		-do-	—
(iii)	Chamber khud	spring	—	80 (32)	---	-do-	—
4.	**Bhilaru**						
(i)	Bhilaru upper spring	spring	–	900 (1700)	----	-do-	-
5.	**Jinsy Pump**						
(i)	Jinsy	spring	---	NIL (400)		-do-	—
(ii)	Jinsy stage-1	---	Brooklet		1492 (1680)	-do-	—
6.	**Kolti Khala**	----	Brooklet	---	600 (605)	-do-	—
7.	**Dhobighat**			530 ----			
	Total (Spring)			3478 (3400)	2292 (2621)		
8.	**GRAVITY SOURCE**						
(i)	Company Khud	spring	---	60 (40)	---	--	Gravity
(ii)	Brook Land	spring	–	90 (90)	---	–	-do-
(iii)	Nala Pani	spring	---	25 (30)	---	---	-do-
(iv)	Pargakhala	spring	---	110 (110)	---	–	-do-
(v)	Duglusdail	spring	---	90 (90)	–	–	-do-
(vi)	Santpani	gravity		50 –			
	Total:			**425 (360)**	**2292 (2621)**		

Note: The figures in parenthesis are for 1997 (Table 3.6 – 1998 Study). Total availability of water in 1997 works out to 6381 lpm (liters per minute) and for 2011 it is 6195 lpm.

The details of supply and demand of water during the off season as per the report of the Executive Engineer, Jal Sansthan, vide letter of 14.07.2010 is as under:-

(a)	Availability of water round the year	7.76 mld.
(b)	Wastage 15% of (a) above.	1.17 mld.
(c)	Actual availability	6.59 mld.
(d)	Population that can be taken care of at 135 liters/capita/day	48,814
(e)	Demand in January (for 40,000 population)	5.4 mld.
(f)	Surplus during lean season (c-e)	1.19 mld.

During the peak season the supply of water is almost half of the demand. The only way out for reducing the gap between the demand and supply is to (a) augment the storage capacity of surplus water during lean season (b) reduce wastage of water, (c) supplement supply by rain water harvesting which has been made mandatory for new constructions and (d) most importantly tap the water from Yamuna river since the Hardy Fall project is not

feasible any more in view of the objections of local villagers who get supply from this source.

Peyjal Nigam has already formulated a scheme for tapping water from a distance of about 26 kms. from the Yamuna river near Yamuna bridge, by four stage pumping to get a supply between 12.80 mld. in 2014 to 19.28 mld. water in 2044 to cater for a projected population of about 86595 and 128342 respectively. The estimated cost of the project is Rs.182.24 crores.

In addition to supplementing the demand for water, the MDDA, in its bye-laws, has already introduced a clause making rain water harvesting mandatory while sanctioning the plans of building constructions. This provision can be implemented in the field by frequent inspections by MDDA during construction of building on non-forest land. For forest lands, the Supreme Court Monitoring Committee had recommended that the water storage tanks for rainwater harvesting will reduce water stress in Mussoorie and therefore, the same dispensation as issued vide letter F.No.11-9/98-FC of 03.01.2005 for water supply projects of Govt. be allowed on private lands in Mussoorie also, though the same attract the provisions of the F.C. Act, 1980. The recommendation however has not been accepted. Therefore the cases will be processed in the normal course under the guidelines of MOEF for diversion of forest land for non-forestry purpose.

13.2 The Sewerage System :

The sewerage system designed and installed by the British in 1934 is outdated since it was planned for 50 years i.e. upto 1984. Presently the total length of sewer lines is 21 kms. with 1100 man-hole chambers. The system is divided in 8 sewerage zones and caters for 4225 sewer seats. Thankfully, relaying of a new sewer system at a cost of Rs.6173.25 lacs has been undertaken under JNNURM/UIDSSMT for the following estimated population :-

Estimated population to be serviced:-

Year	Population	Requirement of water sewerage (mld)	Designed level (mld.)
2011	82436	11.12	13.00
2026	95043	12.03	14.70
2041	108689	14.68	16.90

The entire town has been divided into 11 zones with a proposal to relay 63890 mts. of sewer lines and construction of 10 Sewerage Treatment Plants (STPs). The target date for completion of the project is December, 2013. It may, however, be mentioned that the shortage of water (as intimated by the Executive Engineer, Peyjal Nigam) in 2011 itself is 3.81 mld. (demand 13 mld – supply 9.188 mld.), which will increase by 5.512 mld. in 2026 and 7.712 mld. by 2041 unless serious measures to augment the water supply to Mussoorie, for proper functioning of sewerage system and other purposes, are undertaken by the Govt. The implementation of a sewerage project would be futile unless augmentation of a water supply project is implemented and completed simultaneously.

The position of existing sewer lines and the sewerage project already under implementation is given in the table below:-

Table -13.2 : Mussoorie Sewerage System and Proposed Sewer Lines

Sl.No.	Zone	Existing Sewer Lines (Meters) as per 1998 Study (Table -5)				Sewer Lines (Meters) being laid under		Total
		100	125 mm (dia)	150	200	UIDSSMT Programme 150 mm	200 mm	
1.	Company Garden	1500	-	-	—	7236	-	7236
2.	Happy Valley	918	—	2900	—	5266	-	5266
3.	Bhilaru	658	996	376	1400			
4.	Dhobi Ghat	—	-	-	-	1215	-	1215
5.	Camel's back	—	-	-	-	3653	-	3653
6.	Arcadia	1290	—	—	—	1882	-	1882
7.	Sarai	2147	—	724	-			
8.	Bucharkhana	504	—	1000	-			
9.	Cremation Ground	-	-	950	-			
10.	Brookland	—	-	-	-			
11.	Shergarhi – 1 (Landaur South)	1137	618	—	-	20162	3518	23680
12.	Barlowgunj	221	-	195	-	5734	-	5734
13.	Shergarhi -2	-	-	-	-	3700	2095	5795
14.	Landaur North	-	—	-	-	877	-	877
15.	Shishu Niketan	-	1000	-	-			
16.	Library	—	-	-	-	5812	1515	7237
17.	Kulri (Landaur ad pt.)	-	-	-	-	1226	-	1226
	Total:	**8365**	**1714**	**6145**	**1400**			
	Grand Total:	**17624**				**56736**	**7128**	**63891**

13.3.Waste Management - Current Status :

Like other cities, the responsibility for management of waste in Mussoorie is that of the elected Municipal Board. However, NGOs, Institutions and individuals also supplement the work of these organisations. Despite that, the management and disposal of waste generated by local population, schools, and commercial establishments and, most importantly, by visiting tourists is far from satisfactory. The number of permanent sweepers has marginally gone up to 163 from 153, and that of temporary sweepers to 60 from 50 during the tourist season. The difficult terrain and hence the access, sparse habitation, limited staff, equipment and funds also contribute to the unsatisfactory state of affairs.

The civic amenities like water supply and garbage and sewerage disposal were planned by the British, according to the population of the town which was miniscule compared to what it is today. In fact, because of population pressure and consequent

constructions, all facilities provided for limited users have gone haywire, and waste management and disposal too is no exception.

The heaps of waste generated if not properly managed and disposed of are not only an eyesore, but become a breeding ground for mosquitoes, insects and bacteria which are the cause of various diseases. In addition, the obnoxious odour due to slow decomposition of the waste tied in polythene bags pollutes the entire atmosphere of the place. Polythene bags not only choke the drains but also prevent the percolation of water into the soil, resulting in an adverse effect on regeneration of vegetation, which is so important for the binding of soil for proper soil conservation.

The study by NSDART based on interviews of individuals, institutions, Govt. establishments, commercial organizations, NGOs, various institutes both commercial and non-commercial, has concluded that tourists as compared to the local residents, generate more waste, since besides regular meals they consume ready-made food items also packed in polythene containers of various sizes which ultimately increase the proportion of bio-degradable waste. As per the study, the per capita waste generated by the permanent population is estimated to be 0.35 kg./day (against the per capita waste generation in India between 0.15 – 0.50 kg.), in the proportion of 74% of wet and 26% of dry waste. The figures for the floating population (tourists) are 0.4 kg./day in proportion of 70% of wet waste and 30% of dry waste.

The estimates of waste generation in the present study based on the above norms adopted in 1998 Study by NSDART are as under. The projections in parentheses are as per Table -3.8 of 1998 Study carried out by NSDART:-

Table – 13.3 - Estimates of waste generation – Mussoorie

Month	2011				2021			
	Waste Generation at 0.35 kg./ capita by permanent population of 40,000	Tourist population	Waste generation at 0.4 kg./ capita by tourist population of Col.3	Total waste generation (Col. 2+4) Kg.	Waste Generation at 0.35 kg./ capita by permanent population of 45,000	Tourist population	Waste generation at 0.4 kg./ capita by tourist population of Col. 7	Total Waste genera -tion (Col.6+8) Kg.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
January	14,000	3870	1548	15,548 (12316)	15750	5748	2299	18049 (14652)
February	14,000	7498	2999	16,999 (13059)	15750	11137	4455	20205 (15458)
March	14,000	6544	2618	16,618 (20719)	15750	9710	3884	19634 (24334)
April	14,000	10562	4225	18,225 (21756)	15750	15688	6275	22025 (25434)
May	14,000	22407	8963	22,963 (25062)	15750	33281	13312	29062 (28941)

June	14,000	35556	14222	28,222 (30440)	15750	52911	21124	36874 (34647)
July	14,000	21548	8619	22, 619 (25882)	15750	32005	12802	28552 (29811)
August	14,000	12184	4874	18,874 (20759)	15750	18097	7239	22989 (23995)
September	14,000	10674	4270	18,270 (20143)	15750	15854	6342	22092 (23723)
October	14,000	11562	4574	18,574 (20519)	15750	17173	6869	22619 (24122)
November	14,000	6534	2612	16,612 (20267)	15750	9705	3882	19632 (23855)
December	14,000	6444	2578	16,578 (12969)	15750	9571	3828	19578 (15334)

The waste generated falls in three broad categories, namely, garbage (solid waste), sewage and gaseous emissions. The issue of sewerage has been dealt with in para 11 (b). So far as solid waste or the garbage is concerned, it is of two types, namely, the bio-degradable and non – biodegradable waste. Whereas the bio-degradable, or the wet waste, (e.g.) paper, plant and animal products etc.) degrades readily and can be converted into useful manner under proper conditions of moisture and temperature, the non-bio-degradable waste, or the dry-waste, consisting of plastic, films, celluloid batteries and other synthetic materials does not degrade with time and remains unchanged for many years to come. The menace of polythene bags is well-known throughout the country, though efforts to ban the use of the same are continuing. Earlier, the waste used to be incinerated in 4 sites namely, Garhi Khana, South road Landour, South of Bucher Khana and Barlowgunj where incinerators were installed, but, the practice has been discontinued due to toxic emissions of burning waste. Presently, the trailer bins placed at various places in Mussoorie are towed and emptied by sliding the waste down the Garhi Khana hill side, where down slide is prevented by providing pits and terraces to collect waste for decomposition. The terraces, however, are gradually getting washed away by rains, and serious efforts for proper management and disposal of solid waste need to be taken.

In addition to the local body i.e. Municipal Board, Mussoorie, AAPKA or the Self Help Environment Programme (SHEP), in association with LBSNAA Mussoorie, has a thrust on effective garbage management both at individual and community level.

Hampton Court and Woodstock Schools are completely self-reliant in the management of waste generated in their premises with cooperation from students, staff and their families for segregation of wet and dry waste. Whereas the dry waste is collected by rag pickers, the wet waste is converted into manure for use in the garden and schools. The hospitals, restaurants, mazdoor niwas, dharamshalas, tibetan homes, Survey of India, and horse-lines also have some management for waste disposal in varying proportion.

It is well known that the most effective method for waste management is to segregate dry and wet waste for recycling of dry waste and conversion of the wet waste into manure. The waste management with this practice can be financially viable by the sale of dry waste for recycling and wet waste as manure after composting.

The Supreme Court Monitoring Committee has been pursuing the issue of waste management in Mussoorie for a very long time and in meetings it has observed that, rather than banking on funding of Waste Management Project by ADB , JNNURM or SCMC, the Eco-tax being realised by the Municipal Board Mussoorie, should be utilised for solid waste management and disposal in Mussoorie. The Board can supplement its budget by levying 'user charges' for door to door collection waste in consultation with and the participation of the local people. The Executive Officer, Nagarpalika Parishad, vide letter of 24.10.2011, has informed that the Detailed Project Report under City Sanitation Plan has been submitted to the Directorate of Urban Development of Govt. of Uttarakhand. Principal Secretary, Urban Development,Govt. of Uttarakhand, too, has intimated that the project for waste management is likely to be funded by Asian Development Bank in Tranche - 4 between 2012-2016.

13.4. Health Care Facilities :

The 1998 Study for Mussoorie has worked out the requirement of one hospital bed for 200 persons based on the norm of a general hospital for 50,000 population. The following table would show that the number of beds in 1997 which was 153 has come down to 90 in 2010-2011:-

Table 13.4: Availability of Hospital Beds in Mussoorie

Sl.No.	Name of Hospital	Number of Beds In 1997 (Table - 3.12 of 1998 Study)	Number of Beds In 2011
1.	St. Mary's Hospital, Mussoorie	53	55*
2.	Civil Hospital, Mussoorie	30	
3.	Community Hospital, Landour	50	35
4.	Private Nursing Home	20	----
	Total (Beds)	153	90

(a) * St. Mary's and Civil Hospital, Mussoorie is under renovation as a combined hospital with a provision for 55 beds, including 5 ICU beds.

(b) Northern Railway Hospital in Jharipani has not been included since it caters for Railway personnel only.

(c) The Private Nursing Homes have reportedly been closed.

The ratio of beds to patients for a population of 35,000, which was 1 : 228 in 1997, has gone up to 1 : 444 in 2011, for a population of 40,000 by 2011 due to an increase in population on one hand and a decrease in the number of beds. By 2021, for a population of 45,000, it would go up further to 1 : 500 if the number of beds remain static. Ideally, the number of hospital beds in 2011 should be 200 for a population of 40,000, and in 2021 it should be 225 beds for a projected permanent population of 45,000. The analysis reflects a dismal picture of the health care facilities in Mussoorie, and the problem during peak requirement in the tourist season is not difficult to imagine.

13.5 Power Supply:

The power supply to Mussoorie is through the main grid with a stand-by 600 KVA Captive Power Plant at Galogi. The table below gives the details of growth in electrical connection and power consumption from 1991 to 1997 (Table - 3.15 of 1998 study by NSDART) and 2011 as per report from Electricity Department:-

Table 13.5: Number of Electricity Connection and Consumption in Mussoorie

Year	Number of Domestic Connections	Number of Commercial Connections	Consumption (in million units per month)	Remarks
1991	2983	1304	1.4	
1992	3200	1369	1.5	
1993	3294	1377	1.7	
1994	3392	1401	1.9	Table 3.15 of 1998 Study by NSDART.
1995	3522	1419	2.0	
1996	3662	1442	2.2	
1997	3912	1483	2.5	
2010	5159	1717	3.95 – 4.05 *	Report from Electricity Department.

*There is no power cut in Mussoorie as per information from the Hydel Department.

13.6 Traffic and Parking Facilities:

Transport, parking and traffic related issues have been identified as serious problems throughout the year by a large section of residents of Mussoorie, which are at its peak during the tourist season. A large part of the transport requirement of the residents is in the context of access to places outside Mussoorie and not so much for movement within the city. The quality of roads and their maintenance is found to be inadequate by over 70 percent of the residents. At the same time, since a significant proportion of the earnings are from tourists, many of the residents do not perceive crowding in the city commercial area during the peak season to be a problem. For the same reason crowding in the bus stands is also perceived as adverse only by less than half of the sample respondents. Here again, there are class differences in perception - a larger proportion (53-67 percent) of the poorer sections of the residents (who are dependent on public transport to a larger extent) find bus stands overcrowded as compared to the richer sections (37-45 percent)

Table -13.6 : Distribution of Residents' to Adequacy of Transport Services (Table 2.5 of 1998 study by NSDART)

Transport Facility	Adequate/Not Adverse		Inadequate /Adverse	
	Number	Percent	Number	Percent
Over Crowding in Bus Stands	157	51.82	146	48.18
Bus/Taxi Facility	29	9.57	274	90.43
Traffic Management	35	11.55	268	88.45

Parking Space	22	7.26	281	92.74
Crowding in Mall (peak)	218	71.95	85	28.05
Road (congestion peak)	25	8.25	278	91.75
Road Network	80	26.40	223	73.60
Road Maintenance	34	11.22	269	88.78

The traffic and parking facilities in Mussoorie are, however, being developed in addition to local bus transport in Barlowgunj, Jharipani and Mussoorie area.

14. Conclusion: Mussoorie town is one of the prime tourist locations of the country on which the livelihood of majority of local population is highly dependant. The tourists would be attracted only when basic infrastructural facilities like roads, sanitation, water supply, accommodation, health care etc. are available to them. The foregoing account would indicate that a lot needs to be done to improve such facilities to bring the town on the centre-stage of the tourism industry, which would go a long way in improving the livelihood of the local people.