DISTRICT ENVIRONMENTAL PLAN

(As per the Hon'ble National Green Tribunal (NGT) vide order O.A. no. 360/2018, dated 26.09.2019)

PAURI GARHWAL

G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand

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PREFACE

Hon'ble National Green Tribunal (NGT) vide order, dated 26/09/2019 in O.A. No. 360 of 2018 filed by Shree Nath Sharma vs. Union of India and others directed that Central Pollution Control Board (CPCB) shall facilitate the concerned District Magistrates in preparation of the District Environmental Plan (DEP) by placing a model plan on its website. This model plan may be adopted as per local requirements by all districts under the supervision of the concerned District Magistrate (DM). The said order also directs that the Department of Environment in respective states should collect district plans to prepare State Environment Plan (SEP), which shall be monitored by respective Chief Secretaries of the concerned State by 15/12/2019. Based on State Environmental Plans, CPCB and Ministry of Environment, Forest & Climate Change (MoEFCC) shall prepare a National Environmental Plan (NEP), under the supervision of Chairman, CPCB and Secretary, MoEFCC.

There are diverse environmental issues that address our key responsibilities to the community and its surrounding environment. As a set of target, fourteen areas by Hon'ble NGT and one more - plastic waste by Government of Uttarakhand were included under the district plan. These 14 areas were regarding compliance to rules for solid waste including legacy waste, bio-medical waste, Construction & Demolition Waste (C&D), hazardous waste, electronic waste (E-waste), polluter stretches, non-attainment cities, industrial clusters, the status of Sewage Treatment Plants (STPs) and re-use of treated water, the status of Common Effluent Treatment Plants (CETPs) / Effluent Treatment Plants (ETPs), ground water extraction / contamination and re-charge, air pollution including noise pollution, illegal sand mining, and rejuvenation of water bodies. In addition, plastic waste was also assessed based on consultative workshops with the state government including State Pollution Control Board (SPCB).

The present environmental plan describes the status quo of 15 thematic areas and sets out action plans to mitigate their impact on different environmental parameters and human health. It briefly touches upon the basic need for bringing in mountain perspective in developmental planning. Implementation of this plan based on selected indicators will resolve different environmental issues. Also, it will meet compliance of different departments within a district. It will also allow a variety of environmental opportunities associated with different activities to be further undertaken from a viewpoint of sustainable development. We hope this document will act as a noble reference for various stakeholders interested in environmental management and sustainable development planning for the district of Pauri Garhwal. Moreover, it will help to develop comprehensive understanding of the environmental planning process in view of socio-economic and financial situation of the district.

Date: July, 4 2022 Principal Investigator, Co-Project Investigators & Project staff

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AMRUT	-Atal mission for Rejuvenation and Urban Transformation
APL	-Above Poverty Line
AR	-Assessment Report
As	-Arsenic
BMWMIS	-Biomedical Waste Management Information System
BPL	-Below Poverty Line
C	-Carbon
C&D waste	-Construction and Demolition waste
CACMP	-Catchment Area Conservation Programme
CAGR	-Compound Annual Growth Rate
CANTT	-Cantonment Board
CBMWTF	-Common Bio-Medical Waste Treatment Facility
Cd	-Cadmium
CD	-Check Dam
CEMS	-Continuous Emission Monitoring System
CETP	-Common Effluent Treatment Plant
CFL	-Compact Fluorescent Lamps
CGWB	-Central Ground Water Board
CH_4	-Methane
CO	-Carbon monoxide
CO_2	-Carbon dioxide
CPCB	-Central Pollution Control Board
CPHEEO	-Central Public Health and Environmental Engineering Organisation
Cr	-Chromium
CSCs	-Community Sanitary Complex
CT	-Contour Trench
Cu	-Copper
DDT	-Di-chloro Diphenyltrichloroethane
DPR	-District Project Report
DPRO	-District Panchayati Raj Officer
E-waste	-Electronic Waste

EEE	-Electronics and Electrical Equipment
ENVIS	-Environmental Information System
ETPs	-Effluent Treatment Plants
F	-Fluoride
FPZ	-Flood Plain Zones
FSI	-Forest Survey of India
FSSM	-Faecal Sludge and Septage Management system
GBPNIHE	-G.B. Pant National Institute of Himalayan Environment
GIS	-Geographical Information System
GPS	-Global Positioning System
HCFs	-Health Care Facilities
ICT	-Information and Communication Technology
IEC	-Information, Education and Communication
IHHLs	-Individual Household Latrines
IPC	-Inter-Personal Communication
IPCC	-Intergovernmental Panel on Climate Change
IRAP	-Integrated Rural Area Programme
ISO	-International Organization for Standardization
ISWM	-Integrated Solid Waste Management
IWRM	-Integrated Water Resources Management
MBBR	-Moving Bed Biofilm Reactor
MDWS	-Ministry of Drinking Water and Sanitation
MMT	-Million Metric Tonnes
MoEF&CC	-Ministry of Environment, Forest &Climate Change
MoF	-Ministry of Finance
MoUHA	-Ministry of Urban & Housing Development
MPCC	-Medical Pollution Control Committee
MRF	-Material Recovery Facility
MSMEs	-Micro, Small &Medium Enterprises
MSW	-Municipal Solid Waste
MTPD	-Metric Tonne per Day
NA	-Not Applicable

NAAQS	-National Ambient Air Quality Standards
NACP	-National Clean Air Program
NASA	-National Aeronautics &Space Administration
NCEPC	-National Committee on Environment Planning &Co-ordination
NGOs	-Non-Governmental Organizations
NGT	-National Green Tribunal
NH	-National Highway
NITI	-National Institution for Transforming India
NMHS	-National Mission on Himalayan Studies
NP	-Nagar Panchayat
NPP	-Nagar Palika Parishad
NTFPs	-Non-Timber Forest Products
ODF	-Open Defecation Free
OSHA	-Occupational Safety and Health Administrations
PAT	-Perform, Achieve &Trade
PCC	-Pollution Control Committee
PHCs	-Primary Health Centre
PIBO	-Producer, Importer and Brand Owner
PM	-Particulate Matter
PPP	-Polluter Pays Principle
PWD	-Public Works Department
QPD	-Quintal Per Day
RBMs	-Riverbed Minerals
ROHS	-Restriction of Hazardous Substances
RSM	-Rural Sanitary Marts
SBM-G	-Swachh Bharat Mission Gramin
SDGs	-Sustainable Developmental Goals
SIDCUL	-State Industrial Development Corporation of Uttarakhand Limited
SLWM	-Solid and Liquid Waste Management
SPCB	-State Pollution Control Board
STP	-Sewage Treatment Plant
TPD	-Tonne Per Day

TSDF	-Treatment Storage and Disposal Facilities
UKPCB	-Uttarakhand Pollution Control Board
ULBs	-Urban Local Bodies
UNDP	-United Nations Development Programme
UREDA	-Uttarakhand Renewable Energy Development Agency
WHO	-World Health Organization
ZED	-Zero Effect Zero Defect
ZLD	-Zero Liquid Discharge
RTO	-Regional Transport Officer
µg	-Microgram

EXECUTIVE SUMMARY

The seven ULBs of the district of Pauri Garhwal have distinct topographic features from the plain to the hills. It is therefore a major challenge for the planners to devise a strategy that will holistically address the environmental issues such as waste management, air and water pollution, illegal mining activities, etc. Environmental and climate change issues are many and that's why these could also be complex. Economic and population growth have been the factors that need to be highlighted to explain the increasing stress imposed by human interferences on the natural environment.

In view of analysing the current status and furnishing a comprehensive plan to mitigate the environmental deterioration, GBPNIHE was assigned with the task to prepare an Environment Plan for the District of Pauri Garhwal. Detailed deliberations were carried out to devise the action plan focusing on explicit thematic areas which are as under:

- ***Waste Management Operations:***Traditional waste management in consonance with semi-automated recovery facilities has been a part of waste management in Pauri Garhwal district.
- Topography based waste management and lean waste management strategies (elimination of non-value added activities) need to be applied for effective solid waste management operations.
- Other wastes such as hazardous waste, and e-waste are not segregated, and exist as mixed waste collected from the domestic households and commercial establishments. No mechanism has been developed for their scientific handling.
- More than 100 industries are generating hazardous waste in the district which have linkage with a Treatment, Storage and Disposal Facility (TSDF) at Roorkee.These industries are strictly regulated by State Pollution Control Board.
- Plastic waste, after segregation and compaction, is being sold to local rag pickers. No ULB has established linkage with Public Relation Officers (PROs) of the producers.
- Based on our assessment, Nagar Nigam Kotdwar has better waste management operations as compared to other 7 ULBs in the district.
- ***Biomedical Waste Management:*** As of now, maximum quantity of biomedical waste is lifted to CBMWTF. Some HCFs practise deep burial method for disposal of biomedical waste. Incineration facility is also available in the district for a safe and scientific disposal of biomedical waste.

- ***Construction and Demolition Waste Management:*** Few ULBs have started collection of C&D waste in the district. Its quantity is assumed to be minimal. Dumping zones established under Char Dham highway project which are being used by some ULBs for the disposal of C&D waste.
- ***Waste water Management***: At present, 5 sewage treatment facilities are operational in the district (4 of them are at Srinagar and 1 is at Swaragashram).
- Around 20% of the area in Nagar Nigam Srinagar is connected with sewer lines. On the other hand, almost 100% of the targeted households have been connected with STP in Nagar Panchayat Swaragashram.
- Other ULBs have Septic tank for the disposal of waste water.
- ***Air and Noise Pollution:*** Compared to a couple of decades ago, particulate air pollution is no longer a feature of Indo-Gangetic plains alone.Forest Fire is also on rise in the district particularly during dry season (March to June).
- A Forest Fire Protection Management Scheme has been envisaged by the forest division. This includes protection of all forest areas from fire accidents, preventing afforestation of oak and other broad leaved forests, conservation of water and soil, etc.
- ***Surface and Groundwater Management:*** The district is rich in water resources and hosts some of the major rivers of the state. Open defecation, dumping of solid waste near river catchment and other pollution causing activities are partially controlled in the district**.**
- Bore wells are used in some ULBs for extracting groundwater for daily water needs. Nagar Nigam Kotdwar has observed maximum extraction of groundwater in recent past.
- No groundwater polluted areas have been identified in the district of Pauri Garhwal.
- ***Mining Activity:*** Owing to large flood plains, the district is rich in sand and other river bed minerals. River catchment areas in Pauri, Kotdwar and Srinagar are the major mining zones in the district. Some illegal mining activities have come into notice for which penalities were charged as per Mines and Minerals (Development and Regulation) Act, 1957.
- All legal mining sites meet the prescribed standards of environmental clearance and consent conditions of different deparments.

The execution of this management plan in the district of Pauri Garhwal will require the integration and co-operation of the stakeholders, viz., public including local communities, private organizations, local government, etc.This plan aims at reducing the risk on human health and environmental components with a target of sustainable development in the district.

INTRODUCTION

Establishing a link between environmental degradation, poverty and economic sustainability have been always a challenging task before the planners. The world's poor are significantly prone to natural disasters pertaining to the fact that in many cases their livelihoods are directly dependent on the natural resources. Human welfare is closely associated with the health of the environment. Around the world, 24 percent of deaths can be traced back to avoidable environmental factors (WHO, 2018). People are in direct need of clean air to breathe, freshwater to drink and suitable places to live in that are free from pollutions including toxic substances and hazards. The 2030 agenda for Sustainable Development Goals (SDGs) and its 17 Goals adopted by world leaders define a blueprint for future development trajectory to all the nations with a focus on poverty eradication, environmental sustainability, peace and harmony (Anonymous, 2018; WHO, 2018; Azash, & Thirupalu, 2017). Recently, Intergovernmental Panel on Climate Change (IPCC) released a report on "Climate Change 2021- The Physical Science Basis" as a part of IPCC's Sixth Assessment Report *(AR6)*.The facts presented in this report regarding raising a crucial red flag that global temperatures have already risen by about 1.1ºC from pre-industrial times and has warned that 1.5ºC threshold is likely to be breached before 2040 *(the stated objectives of 2015 Paris Agreement, the international architecture to fight climate change, is to limit temperature increase to within 2ºC from pre-industrial times)* (IPCC, 2021). For the Indian, perspective, the report says that waves and humid heat stress will be more intense and frequent in 21st century (IPCC, 2021). Changes in monsoon precipitation pattern are also expected, both annual and summer monsoon precipitation are projected to increase (Krishnan, et al., 2020). In regard to the Himalayan context, the area is one of the most fragile mountainous regions of the world. Hence, it is susceptible to changes in environmental conditions and ecology (Krishnan et al., 2020). These mountains are considered to be the '**Water Tower**' of South Asia, as major rivers of the Indian sub-continent originate from the Himalayan Mountains. However, the area has become a global hotspot since the past two decades in view of environmental degradation. The indirect impact has also seen in the glaciological Cryospheric aspect of these mountains (Eriksson, et al., 2019). Almost, 500 million people of South Asia are dependent upon the health aspect of the Himalayan ecosystem.In India, the Himalayan mountain chain directly serves as a national interest becauseit is working as a guard in view of defense purpose, unique ecosystem in view of permanent snow cover, incessant sources of water and biodiversity hotspots. The people in downhill slopes and in the Indo–Gangetic Plainsrealize its significance in many more aspects in view of sustainable development. A prerequisite for such sustainability is ecological audit in areas, which at once

would apprise about the present environmental issues and a strategy to meet the targets for the future (Sandhu & Sandhu, 2015).

Uttarakhand being a crucial chunk of the Himalayan Regime is utmost vulnerable to environmental degradations and risks. About three fourth of the state's population is rural, therefore their livelihoods are almost dependent on natural resources (Raj, 2015). The traditional customs and traditional knowledge of the local people of Uttarakhand tend to be sustainable and are in harmony with the natural ecosystem. However, these are often overlooked as sometimes reckless development of roads, infrastructure, and environmental degradation takes precedence over the traditional ecological knowledge. The recent data on SDGs indices released by NITI Aayog shows that the state is one of the top gainers with increase in overall index by 8 points. However, a lot is needed to be done in terms of the indicators related to Climate Action *(SDG, 13)*(Chopra, 2014). The tragedy of ecological governance in most parts is that it remains trapped in 'Environment-Development Binary'. In contrast, the people of Uttarakhand had in past shown with movements such as the 'Chipko Andolan (1953)', which gave an idea of human well-being sensitive to forests, mountains, and water bodies (Sarkar, 2018).

The art of establishing balance between economic development and sustainable development is known to many, but how it is implemented in the ground is known by few. We need to devise a strategy to break this trade off so that a mutually beneficial situation is achieved for the environment and society (Messerli et al., 2019). Environment plan is a prerequisite to understand how the social, political and economic factors are affecting the environment considering development. Environmental planning began in India in early 1970s after 'Human Environment Conference' at Stockholm held by United Nations which led to the formation of National Committee on Environment Planning and Co-ordination (NCEPC*)* (NATCOM, 2012). Subsequently, then the Ministry of Environment and Forest (MoEF) was formed in mid 1980s by Government of India. Realizing that the conservation of nature and its sustainability is a basic requirement for sustaining healthy life on globe. The key purpose of this plan is therefore to implement and devise programs intended to reduce pollution loads in different natural components, suggest mitigating or minimizing impacts, conserving and protecting the environment which could be considered together as a base for sustainable development (UNDP, 2015;Gaur, 2008).

FUNDAMENTAL PRINCIPLES OF ENVIRONMENT PROTECTION

(Judgments of the Hon'ble Supreme Court of India)

Sustainable Development

Hon'ble Supreme Court has recognized the principle of sustainable development as a basis for balancing ecological imperatives with development goals. In rural litigation and entitlement Kendra, *Dehradun Vs. State of U.P.*, the Supreme Court 1985 was apprised with the problem of the mining activities in the limestone quarries in Dehradun-Mussoorie area (Azash and Thirupalu, 2017; Anonymous, 2014). This was the first case of its kind in the country involving issues relating to environment and ecological balance and brought into sharp focus the conflict between development and conservation. In this case, the Supreme Court emphasized the need for reconciling development and conservation in the larger interest of the country (Anonymous, 2014; Sahu, 2014). Furthermore, it was realized that the necessary condition for achieving sustainable development is ecological security, economic efficiency and social equity (Rajaram, 2005).

Precautionary Principle

The emergence of precautionary principle marked a shift in the international environmental jurisprudence– a shift from assimilative capacity principle to precautionary principle. Basically, it is a principle which ensures that a substance or activity posing threat to the environment is prevented due to adversely affecting it, even if there is no conclusive scientific proof lining that particular substance or activity to the environment damage (Kriebel et al. 2001). In *Vellore Citizens Welfare Forum Vs. Union of India*, it was alleged that the untreated effluent being discharged by tanneries in Tamil Nadu was entering into the river, agricultural fields and was significantly polluting the water. Justice Kuldip Singh *(Known to be Green Judge)* observed that "even otherwise once these principles are accepted as a part of the Customary International Law, there would not be difficulty in accepting them as a part of domestic law (Venkat, 2012). It is almost accepted proposition of municipal law, that the rule of customary international law, which are not contrary to the municipal law shall be deemed to be incorporated in the domestic law and shall also be followed by the courts of laws of the country. According to this special principle, the burden is on the person wanting to change the status quo to show that the actions proposed will not have any adverse effect, the presumption operating in favor of environmental protection (Singh, 2000).

Polluter Pays Principle

Polluter Pays Principle (PPP) has become a popular slogan in recent times. *"If you make a mess, it's your duty to clean it up".* It should be mentioned that in environmental law, this principle doesn't refer to Fault". Instead, it favours a curative approach which is concerned with repairing ecological damage (Kriebel et al., 2001). The Hon'ble Supreme Court held that as per the Polluter Pays Principle, "once the activity carried on is hazardous or inherently dangerous, the person carrying out such activity is liable to make good the loss caused to any other person by this activity irrespective of the fact whether he took reasonable care while carrying on his activity. While applying the principle of polluter pays, the Supreme Court later expressed the view that compensation to be awarded must have some correlation not only with the magnitude and capacity of the enterprise but also with the harms caused by it (Kriebel et al., 2001).

Public Trust Doctrine

The public trust doctrine primarily rests on the principle that certain resources like air, sea water and forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The said resources being a gift of nature, they should be made freely available to everyone irrespective of the status in life. This doctrine came up 2014 for consideration in the *M.C. Mehta vs. Kamal Nath* (Anonymous,2014). Though the Supreme Court did not specifically refer to the Doctrine of Public Trust directly, in many cases they have given impact on this doctrine implicitly (Azash and Thirupalu, 2017). Traditionally, the doctrine of public trust was applied only for protection of access to the common for public benefit, now the doctrine is being applied even to prevent over-exploitation of the environmental components (Azash andThirupalu, 2017).

Public Liability Insurance

The Public Liability Insurance Act 1991 has been enacted with the objective of providing immediate relief to the victims of accidents that might occur while handling hazardous substances. The owner who has control over handling of hazardous substances is required under the act to pay specified amounts to the victims as interim relief based on "No-Fault" liability. The expression 'Handling' is defined widely to include manufacture, trade and transport of hazardous substances. *Accidents by reason of war or radioactivity are excluded from the scope of the Act (*Azash and Thirupalu, 2017). The principle of absolute liability was propounded in case of *MC Mehta vs. Union of India* with the primary question regarding the extent to which industries engaged in hazardous and inherently dangerous industries can be held liable. This principle was further reaffirmed in the Indian Council for *Enviro Legal Action vs. Union of India* in which it was held

that industries will be absolutely liable to the harm caused to villages due to pollution caused due to soil and underground water.Hence,these are bound to take remedial measure to improve the situation*(*Azash and Thirupalu, 2017).

ENVIRONMENT MANAGEMENT SYSTEM (ISO 14001:2015)

An environmental management system helps organizations identify, manage, monitor, and control their environmental issues in a holistic manner. ISO 14001 is an internationally agreed standard that sets out the requirements for an environmental management system (Da, 2015). It helps organizations to improve their environmental performance through more efficient ways of resource use and reduction of waste. Other ISO standards that look at different types of management systems such as ISO 9001 for quality management and ISO 45001 for occupational health and safety, all use a high-level of structure.This means that ISO 14001 can be integrated easily into existing ISO management systems. ISO 14001 includes the need for continual improvement of an organization system and approach to environmental concern (Da, 2015). It is suitable for organizations of all types and sizes, let they be private,or not-profit organisation or governmental. It is desirable that an organisation should consider all environmental issues relevant to its operations such as air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation and adaptation, and resource use efficiency (Ferronato and Torretta, 2019).

DISTRICT PROFILE

District of Pauri Garhwal, also known as Garhwal district is historically one of the most important cultural and social centres in Garhwal region of Uttarakhand. Administrative headquarters of the Garhwal division is also situated in Pauri. Pauri district shares boundaries with Dehradun and Haridwar in the West;Chamoli, Rudraprayag andTehri Garhwal in the North; Nainital and Almora in the East; and Bijnor (U.P.) in South. This district extends from the Bhabar tract bordering the Ganga plains to the high mountains. The ancient pilgrim routes to Badrinath and Kedarnath passes through this district. The district is well connected with all major destinations across Uttarakhand and Northern India with a series of National Highways including NH-534 and NH-309. The district is also connected via railway network in the Southern Bhabar area.

The Land of Pauri Garhwal is blessed with splendid views of snow-capped peaks of Himalayas, scenic valleys & surroundings, meandering rivers, dense forests and hospitable people with a rich culture. Diverse in topography, the district of Pauri Garhwal varies from the foothills of the ‘Bhabar’ areas of Kotdwar to the soul-lifting meadows of Dhudatoli, sprawling at an altitude of

3116 meters. The district is one of the most fascinating segments of the Himalaya stretching from the banks of Ramganga river that separates Pauri Garhwal with Almora districtto some extent after the Marchula Bridge, in the east to the banks of Ganga demarcating the western border.

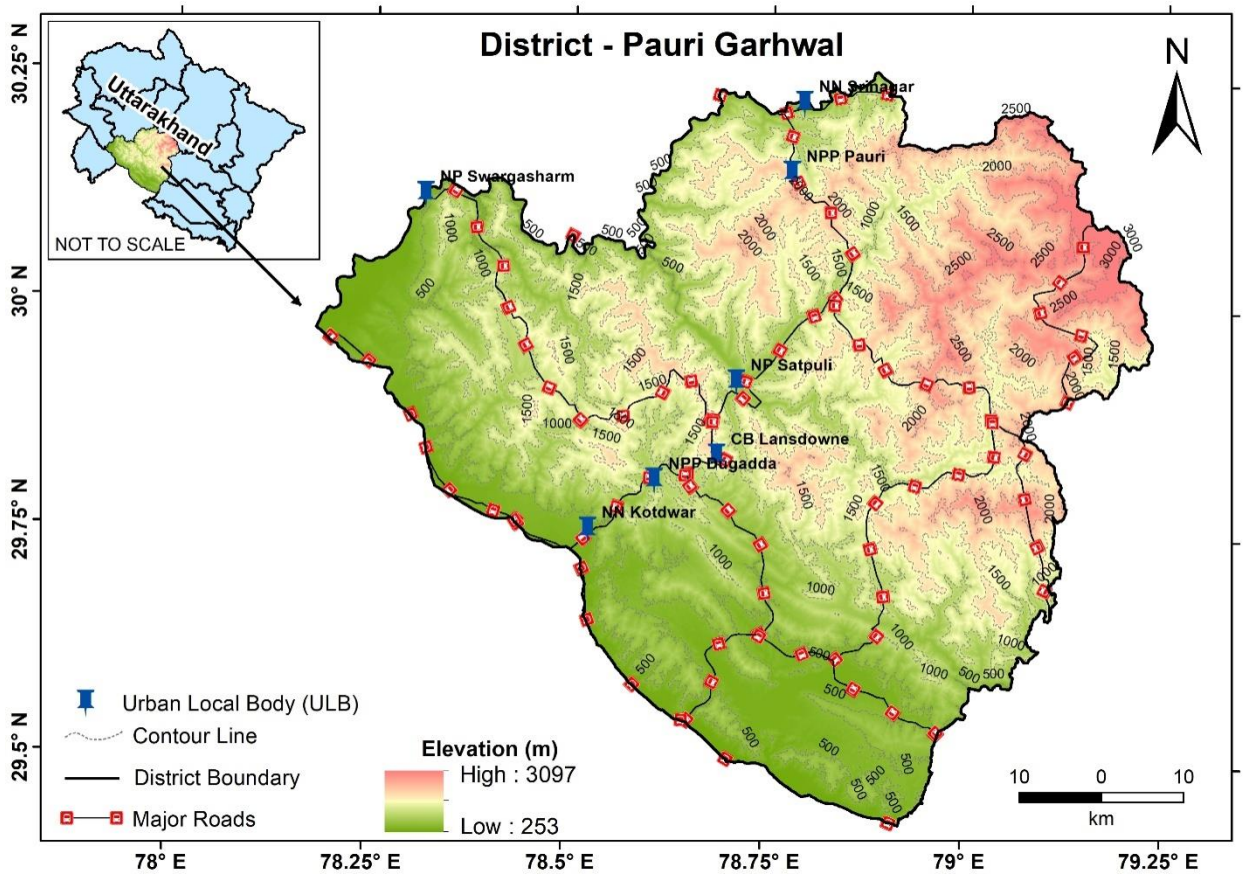


Fig. 1. Location and Salient features of Pauri Garhwal district

The foothill region of the district is very rich in terms of biodiversity which is why majority of the region is declared as a protected area. A major portion of the Corbett National Park falls within the district along with some of the portions of Rajaji National park. The district falls within Biogeographic Zone 2 (Himalaya) and Biotic Province 2B (Western Himalaya) as per the Biogeographic Classification of India. This district is part of the lesser and middle Himalaya with an altitudinal range between (200–3200 m). It has a forest cover of 64% with the area under moderate dense forest being almost 2000 km^2 followed by scrublands and open forests.

District at a glance

Table 1 represents the geographical aspect, population data and administrative set-up of Pauri Garhwal district.

Table 1. Pauri district at a Glance

Geographical Location	
Latitude	29° 45’ to 30°15’
Longitude	78° 24’ to 79° 23’ E
Geographical Area (km^2)	5329
Average elevation of district headquarter (m)	1814
Population Data (2011 census)	
Overall Population	687271
MalePopulation	326829
FemalePopulation	360442
Population density	129
Population growth rate (%)	-1.41
Literacy rate (%)	82.02
Male literacy (%)	92.71
Female literacy (%)	72.60
Sex Ratio	1103
Urbanised Population (%)	16.40
Rural Population (%)	83.60
Administrative Divisions	
Tehsils (Nos.)	09
Blocks (Nos.)	15
Nyay Panchayats (Nos.)	118
Village Panchayats (Nos.)	1212
Total census villages (Nos.)	–
Municipal councils (Nos.)	4
Nagar panchayats (Nos.)	1
Cantonment boards (Nos.)	1

Source: District census handbook, 2011

Topography

Except for the narrow strip of Bhabar, the entire region in district of Pauri Garhwal is mountainous. The highest point of the area is 3116 metres at Dudatoli and the lowest point of the area is 295 metres near Chilla. The cross profiles of the fluvial valleys show convex form with steep valley sides, interlocking spurs descending towards the main channel, hanging valleys, waterfalls and rapids and terraced agricultural fields on the gentle slopes on the valley sides. The clustering of villages is confined mainly on the gentle slopes of the ridges on the fluvial terraces (Table 2).

The Alaknanda river, one of the major tributies of Ganga, is flowing along western border of the district and separate it from the districts of Pauri Garhwal, Dehradun, Haridwar. Nayyar River is the major river system within the territory of the district and is one of the major tributies of Alaknanda. This is called Nayyar after the confluence of eastern and Western Nayyar at Satpuli. Both the Nayyars originate from the Doodhatoli range and drain their water to the south. The Eastern Nayyer takes a long semicircular course while Western Nayyar flows almost straight upto the confluence. There are many other streams which bring quite good quantum of water to drain in this river. Other important rivers of the district are western Ramganga, Malini, Khoh. Western Ramganga River originates from the Doodhatoli ranges in district Pauri Garhwal and enters into district Almora before entering into district Pauri Garhwal. The Diwal, Rewasan etc. are small rivers, which have waters only during Monsoon season.

Table 2. Major River Systems in Pauri district

River System	Origin	Tributaries
River Alaknanda System	Confluence of Satopanth Glacier and Bhagirathi Kharak Glacier, Uttarakhand	Saraswati, Dhauliganga, Nandakini, Pindar, Mandakini
River Nayyar system	Doodhatoli Ranges, Pauri Garhwal	Khatalgarh Nadi, Sindudigad, Dungrigad, Pasolgad, Dhaijyuligad, Machhigad, Pharsarigad, Syoligad
River Western Ramganga System	Doodhatoli Ranges, Pauri Garhwal	Ban, the Khoh, the Gangan, the Gagas, the Aril, the Kosi, the Haldgadi Rao and the Deoha
Other important rivers of the district are Malini, Khoh, The Diwal, Rewasan etc. Some of these riversare non-perennial by their nature and active highly during monsoon season.		

Climate

The region has a sub-temperate to temperate climate, which remains pleasant throughout the year. The maximum temperature recorded in the month of June is 45°Cat Kotdwar while in the higher reaches at Dudhatoli it only rises to 25°C. Temperature descends to a minimum of 1.3°C in January, and means monthly temperature for the region ranges from 25°C to 30°C.

Rainfall

The hilly terrain with its densely forested slopes receives adequate rainfall generally commencing from mid-June and extending till mid-September. Occasional rainfall is also recorded in winter. Average annual rainfall in the district is 2180 mm.About 90 percent of which is generally concentrated over the monsoon. The higher reaches receive some snow in winter season when temperature falls down below freezing point. Winter precipitation is derived from the western

disturbances. The precipitation in the pre and post monsoon seasons is associated with the thunderstorms.

Groundwater

The Pauri Garhwal district faces acute water scarcity during the peak summer season. Even as there is a plenty of water available in hills, but the main problem of the locality is the drinking water. in the district six highly water scarce development blocks has been identified. This problem is very prominent as a number of river channels and natural water sources have dried up. So there is a need to developed groundwater recharge infrastructure and apply all possible techniques (such as, rainwater harvesting, artificial groundwater recharge/injection wells etc.) to stop or slow down decline the water table.

Flora and Fauna

National parks are designated area marked for conservation for wildlife, especially endangered species of flora and fauna. Major portions of two of the very prominent national parks of the country falls within the district. Jim Corbett National Park (It spreads over parts of two districts, a major part of park with an area of 312.86 km^2. falls in Pauri Garhwal district and the rest 208.14 km^2 in Nainital district) and The Rajaji National Park (Spread over an area of 820.42 km^2 in Pauri Garhwal, Dehradun and Haridwar districts of Uttarakhand).The vegetation of the district has a variety of rich flora and fauna, various important species of trees, namely, Phalyat (*Qurecus glauca*), Moru (*Q. floribunda*), Banj (*Q. leucotrichophora*), *Pine (Pinus roxburghii)*, Burans (*Rhododendron arboreum*), Anyar (*Lyonia ovalifolia*), Khaphal (*Myrica esculenta*), Akhrot (*Juglans regia*), and Lodh (*Symplocos ramosissima*), etc. are found in the forests. Pauri Garhwal is a natural sanctuary for leopard (*Panthera pardus*), Langur (*Semnopithecus entellus*), Monkey (*Macaca* spp.), kakar (*Muntiacus muntjak*), goral (*Naemorhedus goral*) etc. (Table 3).

Table 3. National Parks in Pauri Garhwal district

National Park	Type of Species	Total no. of Species
Jim Corbett National Park	Trees (Sal (Shorea), Teak, Oak, Silver fir, Spruce, Cypress, Birch, and Bamboo)	110
	Mammals (Tiger, Leopard, Elephant, Chital Deer, Sambar Deer, Hogg Deer, Barking Deer, Wild Boar, Langur, Wild pig, Rhesus Monkey, Jackal, Rabbit, Yellow Throated Martin etc.)	50
	Bird (600 species of birds can be found in Corbett National Park)	600
	Reptile species (Crocodile, Gharial, King Cobra, Common Krait, Cobra, Russel Viper, Rock Python and Monitor Lizard etc.)	25
The Rajaji	Mammals (Asian Elephant, Tiger, Leopard, Himalayan black bear, Sloth	50

National Park	bear, Civet, Marten, Jackal, Hyena etc.)	
	Birds (300 species of birds can be found in this park)	300
	Migrants(Pochards, Gulls, Mallards,Teals and Shellducks etc.)	90

Forests

The Pauri Garhwal has recorded forest cover of 3,394km^2 which is 63.68% of its geographical area. The forest cover under different forest sub-type was highest in the district, moderate forest cover (574.26 km^2), open forest (1,902.03 km^2), and lowest in very dense forest (199 km^2) (Table 4) (FSI, 2019). The local people conserve forest using traditional methods which not only benefit carbon sequestration but also enable restoration and conservation of forests, meadows and biodiversity together with local socio-economic upliftment (Table 4).

Table 4. Forest Cover in Pauri Garhwal district

Particular	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Changes 2017 -2019 assessment
Forest Area of Pauri Garhwal (km^2)	5,329	574.26	1,902.03	918.70	3,394.99	0.99

Culture and Tradition

Traditional fairs and festivals are the opportunities to meet each other from the ancient times in the district. In the ancient time, when there were no such facilities of communication and transport, these traditional fairs and festivals have played an important role in social gathering and meeting with relatives.Most of the festivals of the region are based on mythological traditions. Some of the famous fairs in the district are Gindi Mela, Vaikunth Chaturdashi, Mela of Srinagar, Binsar Mela. The folk songs (Jhoda, Thadya, and Khuded), Music (Dhol & Damoun, Daur & Thali, Turri, Ransingha) and Dances(Thadiya, Chauffulla, Holi, Sarron and Chepli)of the region reflects its traditional cultural richness. As the life of the people of this district is closely associated with nature and religion, the folk activities are closely associated with these features in representation of the inherent customs and traditions of the people.

ENVIRONMENT CONCERNS IN A DISTRICT

The Major issues in the district Pauri Garhwal are changing of crop cycle due to climate change, effect on flora and fauna due to rising temperatures, cloud bursts and subsequent flash floods, landslides and Groundwater scarcity and Forest fire events.

Forest fires in the district is now becoming a common phenomenon. Forest fires generally happens due to two causes; Anthropogenic (Manmade) & Natural causes. Forest fires due to anthropogenic activities is increasing more frequently in the district for the past few decades. Out of the total forest fires incidences in Uttarakhand, 63% were intentional and remaining 37% were accidental (Tiwari et al., 1986 & 1987). A large fraction of area is affected every year due to forest fires and correspondingly a large amount of economic loss is seen in the district. Some other effects of forest fires are change in species composition, loss of micro flora and fauna, loss of seeds, loss of habitats of particular species, change in micro-climate, migration of species, soil desiccation, soil erosion resulting in landslides and invasion by exotic species.Controlled forest fires help in removing and dried litter and allow new growth to come up. However, uncontrolled forest fires, especially summer fires, cause severe damage to the forest biodiversity. Low precipitation during summer season reduces moisture level in the forest making it more susceptible to catch fire and spread quickly over large area of the forest land. It has been observed that forest fires occur mainly due to lightening but in case of Uttarakhand occurrences due to lightening is less as compared to anthropogenic occurrence.

In the Pauri district, groundwater is a major concern, asthe district faces acute water scarcity during the peak summer season.There is a plenty of water available in hills but the main problem of the locality is the drinking water. Six highly water scarce block have been identified.

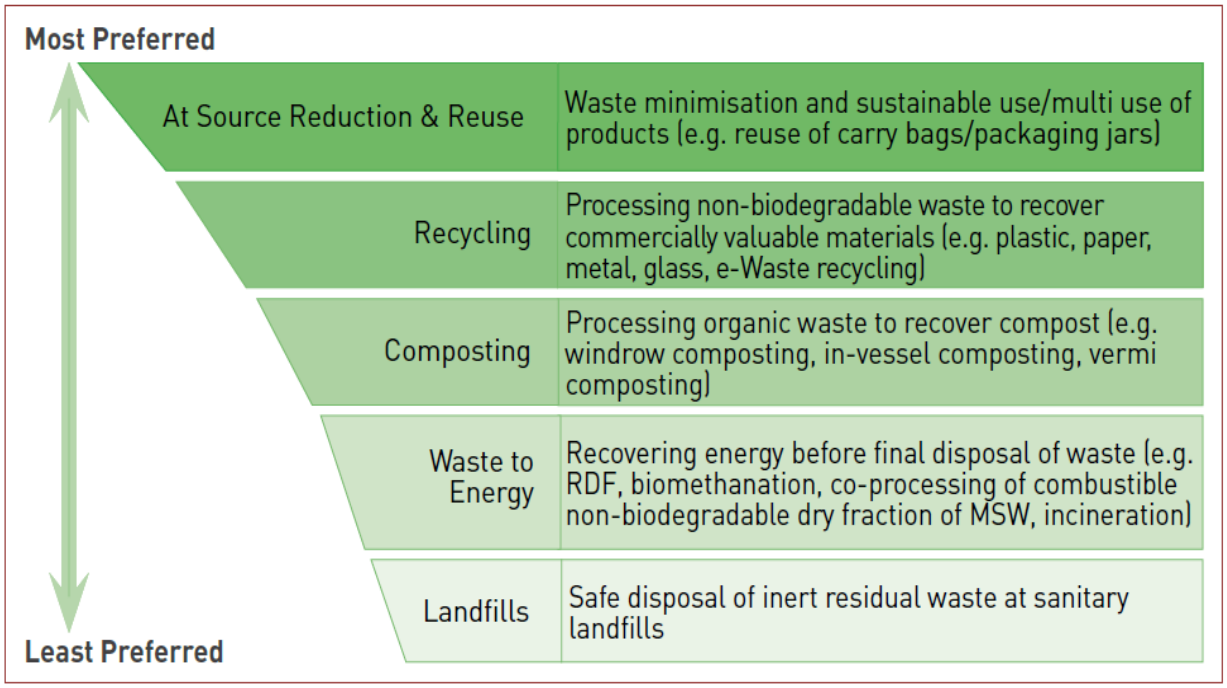
DATA AND IMPACT ANALYSIS

SOLID WASTE MANAGEMENT

Ministry of Environment, Forest and Climate Change(MoEF&CC)defines Municipal Solid Waste(MSW)as commercial and residential waste generated from a municipal area in either solid or semi-solid form excluding hazardous waste *(Industrial*), but including treated bio-medical waste. Predominantly, about *0.17 kg* of MSW is generated per capita per day in small towns compared to about *0.67kg* per capita per day in cities. More than *70%* of waste in India is believed to be dumped in an unsatisfactory manner.

Integrated Solid Waste Management (ISWM)

It is based on the waste management hierarchy, with an aim to reduce the amount of waste being disposed of while maximizing resource recovery and efficiency (Fig 2). Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of process and technologies.



(Source: MoHUA, 2016)

Fig. 2. Waste management paradigm

Solid waste management in Pauri Garhwal district

More than 80 MT solidwaste is generated per day in the district of Pauri Garhwal. Nagar Nigam Kotdwar accounts for around 3/4^{rth} of waste generated in the district (Table 5).Primary waste management operations such as source segregation ,door to door collection are optimum in the

district. Other infrastructure and services such as waste recovery facility,involvement of private agencies for waste management etc. are prevalent in most of the ULBs of the district (Table 6).

Table 5. Inventory of total solid waste generation

Name of Urban Local Body (ULB)	Population (2011 census)	Number of wards	Solid waste generation (MTPD)			
			Dry	Wet	*Other Waste	Total
Nagar Nigam (NN) Kotdwar	33035	40	25	35	Not estimated	60
Nagar Nigam (NN) Srinagar	20115	13	7.2	3.6	1.2	12
Nagar Palika Parishad (NPP) Pauri	25440	11	04	03	01	08
Nagar Palika Parishad (NPP) Dugadda	2422	04	0.126	0.080	0.010	0.216
Nagar Panchayat (NP) Swargasharm	4669	04	0.5	01	Not estimated	1.5
Nagar Panchayat (NP) Satpuli	4345	04	0.5	0.6	0.2	1.3

(Source: District administration, Pauri Garhwal, 2021)

*Other waste may include sanitary waste, domestic hazardous waste, horticulture waste etc.

Table 6. Waste management operations

Waste Management Operations	Outcome	
Segregation at source	ULB	Source Segregation (%)
	NN Kotdwar	90
	NN Srinagar	80
	NPPPauri	90
	NPP Dugadda	80
	NP Swargasharm	90
	NP Satpuli	90
Door to door collection	All the ULBs have 100% coverage for Door to Door collection.	
Sweeping	All ULBs in the district are accomplishing 100% sweeping manually.	
Segregated transport of waste (received from door to door collection)	ULB	Transportation of waste in segregated manner (%)
	NN Kotdwar	90
	NN Srinagar	80
	NPPPauri	90
	NPP Dugadda	80
	NP Swargasharm	90
	NP Satpuli	90

	Collected segregated waste is transported by twin compartment vehicles andrest (i.e. unsegregated waste) is transported in combined manner.	
Material Recovery Facility (MRF) operation	• NN Kotdwar and NN Srinagar have automated waste recovery facility. • NPP Pauri and NPP Dugadda have Semi-automated waste recovery facility. • NP Swargasharm and NP Satpuli have not any recovery facilities but they are doing secondary segregation at near to the trenching ground/ dumping zone.	
Involvement of Non-Governmental Organizations(NGOs)/ private agencies	NGOs/ private agencies	ULB
	A2V Infra Ltd.	NN Kotdwar
	Swachh Sulabh Foundation	NN Srinagar
		NP Swargasharm
	Zero Waste Pvt. Ltd.	NPP Dugadda
	Abhinandan Facility and Servicing.	NP Satpuli
Authorization and issuance of Identity cards to waste pickers/sanitation workers	ULB	Number
	NN Kotdwar	270
	NN Srinagar	116
	NPPPauri	90
	NPP Dugadda	15
	NP Swargasharm	35
	NP Satpuli	18
Direct linkage with Treatment Storage and Disposal Facilities (TSDF)/ Bio-Medical Waste Treatment Facility (CBMWTF)	Not initiated	

Availability of infrastructure for waste management

Trolleys, Mini trucks with Twin compartment are available for waste collection and transportation in the district. Wet waste is composted in both centralized and decentralized manner. Barring some, most of the ULBs are using material recovery facility to process their dry waste.After segregation,resuable dry is either picked up by local rag picker or is channelized through private agencies handling waste management operations of ULBs. Leftover waste is disposed in dumping ground (Table 7).

Table 7. Present infrastructure for waste management operations

Name of ULB	Inventory of infrastructure involved in waste management operation					
	Waste collection trolleys	**Mini collection trucks/tractors/others**	**Composting units/ on-site composting facilities**	**MRF/ (available/ not available)**	**Landfills (dumping ground/ trenching ground/sanitary landfills)**	**Remarks**
NN Kotdwar	300	15	40	Available	Dumping ground	• Two wheeler trolleys – 100 and three wheeler trolleys – 200 • Twin compartment vehicles are being used for transportation of source segregated waste.
NN Srinagar	115	11	10	Available	Dumping ground	• Contruction of SLF is under process. • Twin compartment vehicles are being used for transportation of source segregated waste.
NPP Pauri	40	10	03	Available*	Trenching Ground	Twin compartment vehicles are being used for transportation of source segregated waste.
NPP Dugadda	15	03	06	Available*	Dumping ground	
NP Swargasharm	50	18	05	Not Available	Trenching Ground	
NP Satpuli	10	04	02	Not Available	Open dumping	

* Semi Automated Recovery Facility

Table 8. Methods of treatment, disposal and recovery

Name of ULB	Wet waste management (centralised/ decentralized or on-site composting)	Dry waste management (waste to energy/ recycling/ incineration/ dumping in trenching ground/ sanitary landfill)	Remediation of the old dump site
NN Kotdwar	• Total 40 composting pits are available in the ULB. Out of these,15are decentralized composting pits which are constructed at different wards. • Rest 25 composting pits area are constructed in the dumping zone itself.	• After secondary segregation, the reusable and recyclable wasteis channelizedthrough A2V Infra Ltd. • Leftover waste is openly dumped at dumping zone.	• There is an old dumpsites with 27000 m^3 legacy waste. • A firm named Eco star Pvt Ltd. is working on the remediation of this dump site.

NN Srinagar	All the composting pits are constructed near trenching ground.	• After secondary segregation, the reusable and recyclable waste is channelized through'Swachh Sulabh Foundation'. • Leftover waste is openly dumped at dumping zone.	• There is an old dumpsites with 27000 m^3 legacy waste. • Remediation has not started yet.
NPP Pauri	03 decentralized composting pits have been constructed at different wards of the town.	• After secondary segregation, the reusable and recyclable waste is sold to the local rag pickers. • The leftover waste is dumpedin the trenching ground.	No old dumpsites are available within the ULB.
NPP Dugadda	Total 06 decentralized composting pits are constructed two wards.	• After secondary segregation, the reusable waste is channelized through'Zero Waste Pvt Ltd'. • Leftover waste is openly dumped at dumping zone.	No old dumpsites are available within the ULB.
NP Swargasharm	All the composting pits are constructed near trenching ground.	• After secondary segregation, the reusable and recyclable waste is channelized through'Swachh Sulabh Foundation'. • The leftover waste is dumpedinto the trenching ground.	No old dumpsites are available within the ULB.
NP Satpuli	02 decentralized composting pits have been constructed at different wards of the town.	• After secondary segregation, the reusable and recyclable waste is channelized through'Abhinandan Facility and Servicing' • Rest of the waste disposed into the dumping ground.	No old dumpsites are present within the ULB.

Table 9. Gap identification

Name of ULB	**Observed shortcomings**	**Remarks**
NN Kotdwar	No linkage with authorised waste recyclers	Recyclable and Reusable dry waste is sold to local rag pickers with due intervention from the ULB and private waste management firm.
NN Srinagar	Partial Source segregation	ULB achieved 80% source segregation and aimed to do 100% source segregation as soon as possible.
	No linkage with authorised waste recyclers	Recyclable and Reusable dry waste is sold to local rag pickers with due intervention from the ULB and private waste management firm.
NPP Pauri	No linkage with authorised waste recyclers	At present, the ULB is selling the Recyclable and Reusable dry waste to the local rag pickers.

	Lack of machinery in material recovery facility	Waste recovery operations are carried out in a semi-automated manner.
NPP Dugadda	Partial Source segregation	ULB achieved 80% source segregation and aimed to do complete source segregation as soon as possible.
	No linkage with authorised waste recyclers	After secondary segregation some amount of dry waste (Recyclable and Reusable) is sold to the local rag pickers with due intervention from the ULB and private waste management agency.
	Lack of machinery in material recovery facility	Waste recovery operations are carried out in a semi-automated manner.
NP Swargasharm	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	No linkage with authorised waste recyclers	After secondary segregation some amount of dry waste (Recyclable and Reusable) is sold to the local rag pickers with due intervention of the ULB and private waste management firm.
NP Satpuli	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	No linkage with authorised waste recyclers	After secondary segregation Recyclable and Reusable dry waste is sold to the local rag pickers with due intervention of the ULB and private waste management firm.
** A common gap that has been identified in the waste management operations of the district is the lack of linkage with Treatment Storage and Disposal Facility (TSDF) and Common Biomedical Waste Treatment Facility (CBMWTF) for the disposal of domestic hazardous waste ,sanitary waste and biomedical waste.		

Table 10. Proposed policies and budget requirements put forward by different stakeholders in the district

ULB	Proposed Policy	Current status and Budget requirement
NN Kotdwar	Revamping Solid Waste	• DPR of 16 Cr. has been approved by the department for further improvement in solid waste management operations. • NN Kotdwar has applied for ODF+ status.
NN Srinagar		• DPR of 7.08 Cr. has been approved by the department for purchasing waste transportation vehicles, civil work and purchasing of instrumentation for effective solid waste management in the ULB. • NN Srinagar has applied for ODF++ status.
NPP Pauri		• DPR of 4.12 Cr. has been approved by the department for purchasing waste transportation vehicles,buying machinery for material recovery facility, civil work and instrumentation for effective solid waste management.

	Management	• NPP Pauri has applied for ODF++ status.
NPP Dugadda		• The DPR of 60.87 Lakh has been approved by the department development of trenching groung, purchasing of transportation vehicles and succsion machine, buying machinery for material recovery facility. • NPP Dugadda has applied for ODF++ status.
NP Swargasharm		• NP Swargasharm are working with 'Rishikesh Cluster' for effective solid waste management in the ULB. • ULB has applied for ODF++ status.
NP Satpuli		• The DPR of 1.6 Cr. has been approved by the department establishment of segregation hall, composting pits and purchasing of instrumentation for effective solid waste management in the ULB. • NP satpuli declared as a bin-free city on march 2021 and applied for ODF++ status.

Vegetation suitable for rehabilitation of dumping sites

Besides having aesthetic value, vegetation (natural or planted) on a landfill site has an important role to play in soil formation, removal of contaminants and erosion control (Sadowsky, 1999). Moreover, vegetation may also be used in leachate treatment. Sometimes, vegetation over landfill sites may show signs of damage due to presence of landfill gas (LFG) in the root zone. In view of reconstruction of a suitable medium for landfill, afforestation, plantation, or re-vegetation might provide a capping that is deep and as favourable as to root growth to achieve desired plants' performance in getting over these degradations. In this context, locally available species could be hardened and resistant in reclaiming the waste dump problem (Table 11).

Table 11. Suggested vegetation for reclaiming landfill sites inPauri Garhwal district

Botanical Name	Local and English Name	Life form	Assimilating capacity	Altitude (m)	References
Quercus leucotrichophora A. Camus	Banj oak	Tree	Microbial biodegradation, binding, holding soils, and/or decreased leaching	1200-2400	Kumar et al.. 2021
Bauhinia variegata L.	Kachnar	Tree	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	1250-1800	Agarwal et al. 2011
Bauhinia acuminata L	Kachnar	Tree	Conversion of Hg to volatile chemical from groundwater	1150-1500	Agarwal et al. 2011
Adina cordifolia (Roxb.) Hook. f. ex Brandis	Haldu	Tree	conversion of Se and Hg to volatile chemical from groundwater	Upto-1500	Prajapati, 2012
Berberis aristata DC.	Kingore	Shrub	Metals, radionuclides,	1350-2000	Khan et al.

			hydrophobic organics		2019
Berberis asiatica Roxb. ex DC.	Kilmora	Shrub	Adsorb all the dissolved gases	1650-2400	Khan et al. 2019
Cynodon dactylon (L.) Persoon	Dubla, Doob	Herb	Absorbs Arsenic and Fluoride from wastewater	700-2500	Sekabira et al. 2011
Azolla pinnata R. Br.	Azolla	Herb	Control the Hg, and Cd from wastewater also known as bio-fertilizer	400-2200	Kumar et al. 2020

Estimated Future population and Solid Waste Generation in Pauri Garhwal District

Forecasting waste quantities in the future is as difficult as it is in predicting changes in waste composition. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste density. As a general rule, the lower the level of economic development, the greater the change between generation and disposal.

Census population data for the years 2001 and 2011 has been taken for population forecast. Decadal population and subsequent waste forecasthas been done based on the following presumptions:

- The arithmetic increase method has been used for the decadal population forecast, hence the rate of change of population with time is assumed to be constant.
- 1.5% yearly growth in per capita waste generation has been taken keeping in mind the changing waste paradigm and floating population *(MOF, 2009).*
- The analysis includes population and waste generation estimations only for Urban Local Bodies (ULBs) and does not include peri-urban and rural areas (Table 12).

Table 12. Estimated Population and Waste Generation

ULB	**Projected Population**			**Present/ Projected Solid Waste Generation (MTPD)**		
	2021	**2031**	**2041**	**2021**	**2031**	**2041**
NN Kotdwar	41123	49211	57299	60.00	82.57	110.56
NN Srinagar	20572	21029	21486	12.00	14.11	16.58
NPP Pauri	26137	26834	27531	8.00	9.45	11.14
NPP Dugadda	1846	1270	694	0.22	0.17	0.11
Total				**80.22**	**106.3**	**138.39**

Table 13. Decadal Change in Waste Generation

Name of ULB	**Rate of growth % (2021-2031)**	**Rate of growth % (2031-2041)**
NN Kotdwar	3.76	3.39
NN Srinagar	1.76	1.75
NPP Pauri	1.81	1.80
NPP Dugadda	-2.09	-3.72

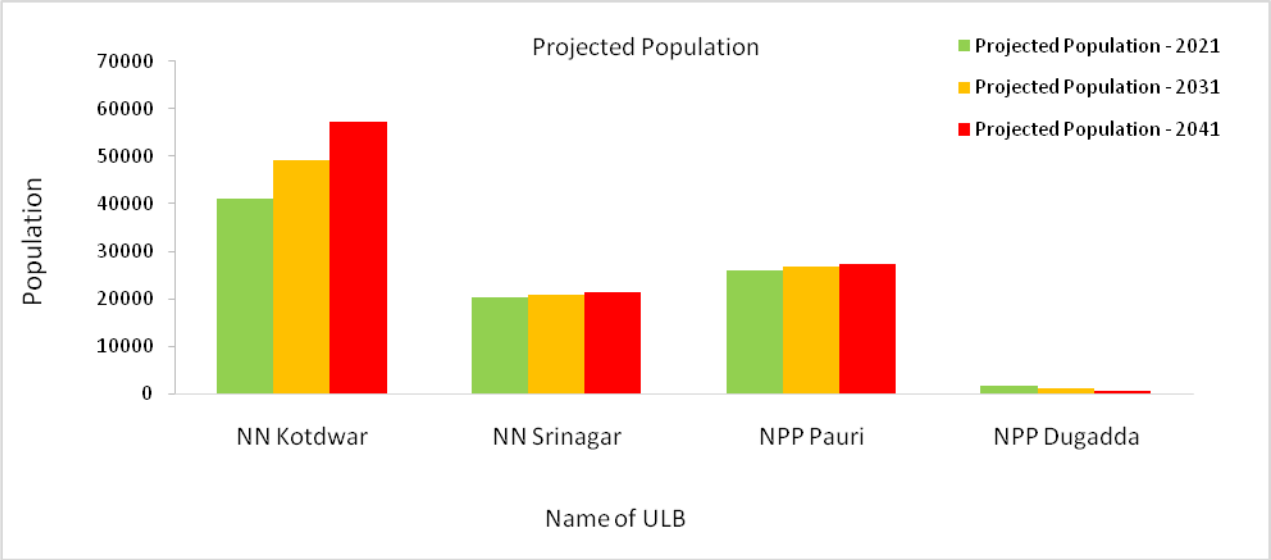


Fig. 3. Graphical representation of projected population in Pauri Garhwal district

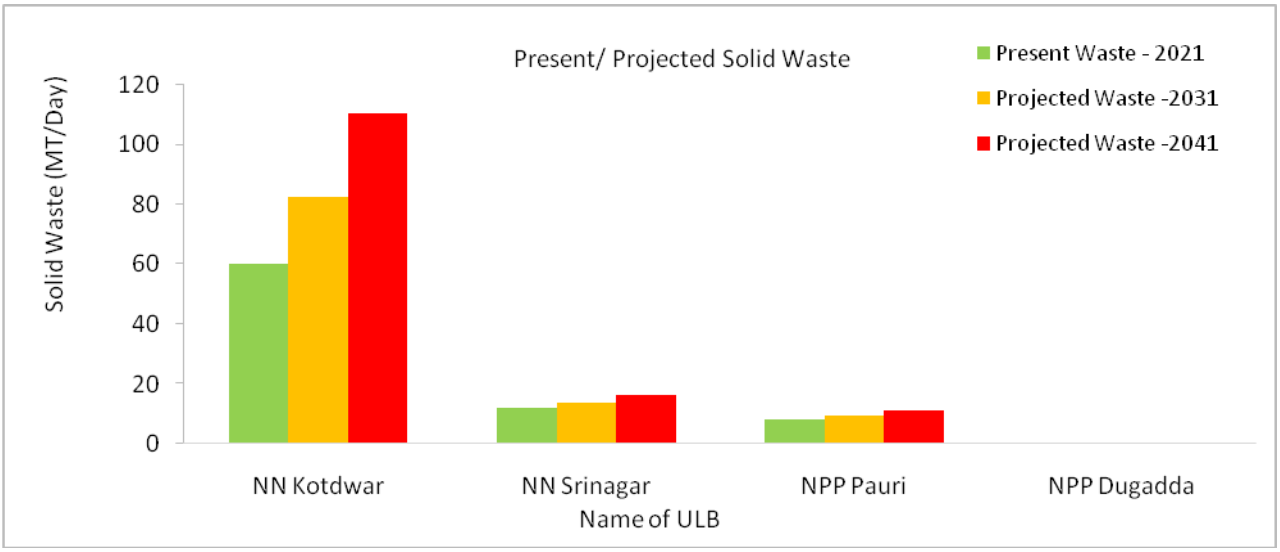


Fig. 4. Present/ projected solid waste generation in Pauri Garhwal district

Inferences drawn after projecting the population and waste generated

- Maximum growth rate is observed in NN Kotdwar in the district. Population of the ULB is likely to increase rapidly as, Kotdwar is a conjunction point in between hills and plains, which provide the pleasant weather condition with full modern facilities in present days.
- Most of the ULBs in the district are likely to see a rise in the waste so with the the special attention of NN Kotdwar and NN Srinagar,the other ULBs also needs a complete revamping in the infrastructure required for waste management.

Rural Solid Waste Management

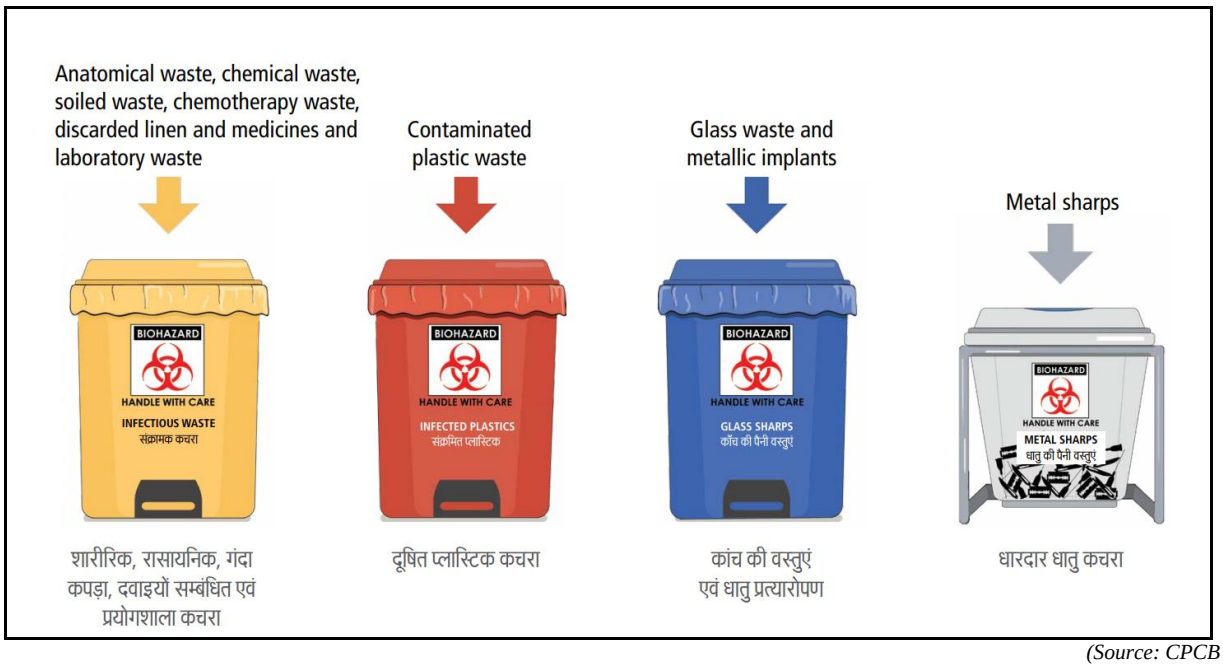
The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As reported bythe Ministry of Drinking Water and Sanitation(MDWS)about 0.3 to 0.4 million metric tonnes of solid waste is generated in rural India every day. With the objective of achieving ODF plus status and improving cleanliness, hygiene and the general quality of life in rural areas, the aspect of Solid and Liquid Waste Management(SLWM) assumes greater significance. Most of the solid waste generated in rural areas can be reused after generation because the generation rate of rural areas is much less as compared to urban areas.

Current standpoint about rural waste management in India

- According to 2011 census, 68.84% of total population in India live in rural areas which generate almost 0.3-0.4 million metric tonnes of waste per day.
- Due to lack of commercial development, rural solid waste contains only domestic waste (92.4%) as a major contributor to the total waste generation.
- Rural community produces comparatively more biodegradable waste (63.5%) compared to non-biodegradable waste (36%).
- About 78% of the rural population use open dumping as storage and collection of solid waste.

BIOMEDICAL WASTE MANAGEMENT

According to latest biomedical waste management rules (published in 2016 and amended in 2019), biomedical waste is defined as such waste that is generated during diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto or in the production or testing of biological experiments. The fact sheet of WHO states that 20% of the total waste generated by health care activities is hazardous. All the biomedical waste generated is essential to be properly collected, segregated, stored, transported, treated and disposed of in a safe manner to prevent spreading infectious diseases. The health system of Uttarakhand constitutes a large network of health care facilities based on three-tier system that comprises of district level health care facilities (District hospitals, base hospitals, etc.), Community Healthcare Centres (CHCs), and Primary Healthcare Centres (PHCs). Biomedical waste generation has shown a wide variation in Uttarakhand due to its typical physiographical conditions and changing density of population. Handling and disposal of biomedical waste is done as per BMW rules, 2016 (Fig. 5).



(Source: CPCB 2019

Fig. 5. Segregationof biomedical waste as per BMW rules, 2016

Importance of biomedical waste management in the wake of pandemic

Due to the onset of covid pandemic, biomedical waste generation increased worldwide. Similar trend was also observed in our country from 2019 to 2021. The daily biomedical waste generation increased from 619 MTPD to 800 MTPD in India (CPCB, 2021)and from 3.8 MTPD to 6.26 MTPD in Uttarakhand state (ENVIS, 2020).At present, the biomedical waste is being generated not only from the health care facilities but also from the quarantine centres, and residential areas

where patients were in a home isolation. Bio-medical waste ought to be segregated in the households as well as from the municipal solid waste. Thus, it has to be properly disposed of to get rid of the risks of infection among the workers handling the municipal solid waste in urban local bodies (Table 14).

Table 14. Inventory of current healthcare infrastructure

S. No.	Parameter	Outcome	
1.	Health care facilities in the district	***Facility***	***Numbers***
		Bedded HCFs	161
		Non-bedded HCFs	251
		Total	**412**
2.	Miscellaneous health care facilities in the district	***Facility***	***Numbers***
		Clinics	105
		Veterinary Hospitals	41
		Pathology Labs	16
		Dental Clinics	11
		Blood Banks	--
		Animal Houses	--
		Bio-Research labs	--
		Others	--
		Total	**173**
3.	Number of health care facilities authorised by SPCB/PCC	147Bedded & 209 Non-bedded health care facilities of the district areauthorised bythe state pollution control board (SPCB).	
4.	Linkage with Common Bio-medical Waste Treatment Facility (CBMWTF)	43 major Healthcare facilities of the district have well linkagewith the CBMWTF (Roorkee).	
5.	Total Biomedical Waste (BMW) generation in the district	93.52 kg/day	
6.	Daily Bio-Medical Waste (BMW) lifting by Common Bio-Medical Waste Treatment Facility (CBMWTF)	86.30kg/day	
7.	The capacity of the Common Bio-Medical Waste Treatment Facility (CBMWTF)	100kg/hr	
8.	Captive disposal facilities of Health Care Facilities (HCFs).	Deep burials Incinerator -01	
9.	Type of treatment/disposal methods used by ULBs for Biomedical waste (Excluding the waste lifted by CBMWTF).	Nil	

Table 15. Current status of biomedical waste management

S. No.	Action areas	Outcomes
1.	Adequacy of facilities to treat biomedical waste	At present no facility is available in the district, solely for the treatment of biomedical waste.
2.	Segregation of BMW as per guidelines of BMW Rules, 2016	All the healthcare facilities of the district properly segregate their biomedical waste into separate colour-coded bins as per BMW Rules, 2016.
3.	Tracking of biomedical waste(Implementation of bar code system for tracking).	This district has no such kind of facilities for tracking the bar code of biomedical waste.
4.	District level monitoring committee	Already established under the chairmanship of the District Magistrate.

Table 16. The Compliance Status of Some Major HCFsregarding Biomedical Waste management

S. No.	**Name of Hospital**	**Process of disposal of biomedical waste**	**Remark**
1	District Women's Hospital, Pauri	M.P.C.C., Roorkee, Haridwar	Waste is taken daily to MPCC Roorkee
2	Base Hospital, Kotdwar	M.P.C.C., Roorkee, Haridwar	
3	District Hospital, Pauri	Deep burial pit	Contact is being established with MPCC, Roorkee, and Haridwar.
4	Base Hospital, Srinagar	deep burial pit	
5	All other CHCs, AHCs, and Government Allopathic Hospitals	Deep burial pit	

Gap identification in the management of biomedical waste in the district

As far as the management of the biomedical waste is concerned the district is lacking in many aspects. We compare the current status with the desired level as per biomedical waste management rules 2016 and finds some gaps. Which are as following as:

- Very few HCFs have authorised by the SPCB/ PCC.
- Bar code tracking facility is not available for biomedical waste so far in the district.

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT

Construction and Demolition waste is produced in the construction, remodelling, repair and demolition of residential/commercial buildings and other structures and pavements. It is a basic thumb rule that 40% of the total C&D waste originates from renovation work, 50% from demolition work and 10% from new construction work. C&D waste mainly consists of Concrete, Bricks, Timber, and Sanitary ware, Glass, Steel, and Plastic etc.

Implementation of 3r principle in C&D waste management

The concept of 3R which refers to reduce, reuse, and recycle particularly in the context of production and consumption is well known today. It is something like using recyclable materials more than actual practice, reusing raw materials if possible and reducing the use of resources and energy. These can be applied to the entire life cycles of products and services – starting from design and extraction of raw materials to transport, manufacture, use, dismantling and disposal. The quantity of waste generated in the construction industry is quite large and much of this waste can be predicted and avoided. Hence it is evident that the application of the 3R principle will help reduce the C&D waste in the construction industry.

Present state of affairs

- The volume of construction waste generated worldwide every year will nearly double to 2.2 billion tonnes by 2025, according to a report by Transparency Market Research.
- The country generates 150 million tonne/yearof C&D waste but the official recycling capacity is a meagreof 6500 tonne/day or just about 1%(as per the building material promotion council).

Table 17. Thumb rule for estimation of C&D waste generation for India

Range	Type of construction
40-60 kg/m^2	New construction
40-50 kg/m^2	Building repair
300-500 kg/m^2	Demolition of building

Present infrastructure within the state

- Currently, no treatment facility is available in the state for processing the C&D waste.
- In the hilly districts, ample dumping zones are not established due to which waste is dumped at the riverbanks.
- As the management of C&D waste is not done in the state, so it is not possible to assess the total amount of waste generated.

Table 18. Current status related to C&D waste generation

S. No.	Action Areas	Outcomes/Remarks
1.	Quantity of C&D waste generated (kg/day)	Initiation have been taken by few ULBs to collect the C&D waste but quantity of waste is not estimated as it is assumed to be minimal C&D waste generated from the respective areas are either used by the waste generators for filling the low lying areas.If any C&D waste is aleft than that waste are used to repair the roads.
2.	Collection of C&D waste	Very few ULBs has initiated for the collection of C&D waste in the district.
3.	Establishment of deposition points/ dumping zones	Dumping zones are established in the district by various construction agencies such as NH & PMGSY divisions of state PWD. Most of the dumping zones are established alongthe under-construction Char Dham highway project in the district. ULBs are also using these dumping zones to deposit C&D waste generated within the towns.
4.	Establishment of Linkage with any C&D waste recycling facility	There is no C&D waste treatment facility in the district.Moreover; none of the ULBs hasdirect linkage with any common C&D waste treatment facility.

Table 19. Gap identification

S.No.	Observed shortcoming	Outcome/Remarks
1.	Quantification of C&D waste.	Most of the ULBs is not initiated for collection and quantification of C&D waste generated in the district.
2.	Establishment of collection centre/deposition points/ dumping zones.	Most of the ULBshas not established dedicated deposition points for C&D waste, as present they are using the dumping zones established by the construction agencies such as state PWD.
3.	Implementation of by-laws for C&D waste management.	Due to lack of awareness regarding C&D waste management, it is not properly segregated, and also the process of implementing by-laws for the C&D wastemanagement is not initiated by any of the ULBs within the district.
4.	Establishment of linkage with common C&D waste recycling facility	As the amount of C&D waste is minimal, most peoples are using their waste for filling their low land and for rest of C&D waste local authorities are using it to repair the road. No linkage have found for recycling and scientific disposal the
5.	Lack of strategies for C&D waste management.	Due to a lack of strategies for C&D waste management, dumping of C&D waste is done along the banks of rivers openly at many places in the district which is hampering the river profile.

C&D waste management in rural areas

In the rural areas of the district, construction work is very limited there of foreminimal amount of C&D waste is generated which mainly consists of the soil excavated from the foundation trenches and stones from the hill slopes. This excavated soil is reused in filling the plinth and trenches or many times used in filling the low-lying area. Stones obtained from the hill slopes are used in masonry work. There is an issue of improper dumping of muck on the river banks during the construction of roads which needs to be addressed.

HAZARDOUS WASTE MANAGEMENT

Hazardous Waste is any waste which because of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment whether alone or in contact with other wastes or substances. Tabulation of Hazardous waste generating units and quantification of wastes generated in India is done by the respective State Pollution control boards (SPCBs). Hazardous industrial wastes in India can be categorized broadly into two categories:

- Hazardous wastes generated from various industries in India.
- Hazardous industrial wastes transported to India from western Countries for re-processing and recycling.

Present state of affairs

- The collection, transfer, Processing, treatment and disposal of hazardous waste is governed by Hazardous and Other wastes (Management and Trans -boundary Movement) rules, 2016.
- According to CPCB Report 2019-20. In India, there are 69,308 hazardous waste generating units having authorized annual capacity to generate about 39.46 Million Metric Tonnes (MMT) of hazardous waste. However, during 2019-20, about 8.78 MMT hazardous waste has been generated as per the annual returns submitted by such units (Table 20).

Table 20. Hazardous Waste generation in India

Type of hazardous waste	Quantity/Year (MMT)	% of Total waste
Land-fillable	2.13	24.29%
Incinerable	0.40	4.52%
Recyclable	2.07	23.59%
Utilizable	4.18	47.60%

Table 21. Inventory of hazardous waste in the district

S. No.	Parameter	Present status			
1.	Quantity of Hazardous waste generated in the district (in MT/annum)	Incinerable	Landfillable	Recyclable/ Reusable	Total
		2.161	1.731	4.131	8.023
2.	Number of Hazardous waste generating industries in the district	110			

Table 22. Current status related to hazardous waste management

S. No.	Action Areas	Outcome and Remarks
1.	No. of captive / common Treatment Storage and Disposal Facilities (TSDF) in the district.	Currently, there is no captive or common TSDF in the district for the treatment of hazardous waste. The hazardous waste generating in the district is send to TSDFs available outside the district.
2.	Linkage with common TSDF	Currently, the hazardous waste generating industries of the district have linkage with the following Treatment storage and disposal facility. 01 (M/s Bharat Oil waste Management) at Roorkee, Haridwar, Uttarakhand.
3.	Display board of hazardous waste generation in front of gates of respective industries	As per state pollution control board only 60hazardous waste generating industries in the district have installed display board in front of their gates.
4.	Number of ULBs directly linked with common TSDFs	No ULBs in the district is directly linked with common TSDFs.
5.	Contaminated sites/probable contaminated sites within the district	As per state pollution control board there is a prpbable contaminated sites (Siggadi Industrial Area) within the district.
6.	Regulation of industries & facilities generating hazardous waste	Industries generating hazardous waste are strictly regulated by SPCB.

ELECTRONIC WASTE MANAGEMENT

The Discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication technology(ICT), home appliances, audio and video products and all of their peripherals are known as Electronic waste(E-waste). The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; in water due to recycling process *(if not carried our properly)*, through inhalation of gases during recycling, contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process.

Government of India has notified E-Waste Management Rules 2016, which are expanded to manufacturer, dealer, re-furbisher and Producer Responsibility Organization (PRO) of components, consumables, spares and parts of Electronics and Electrical Equipment (EEE) in addition to equipment as listed in Schedule I appended with the rules. Moreover, Compact Fluorescent Lamps (CFL) and other mercury containing lamps are also brought under the provisions of these Rules**.**

Table 23. Bifurcation of E-waste based on electronic appliances

Types of Waste	Contribution (%)
Computer devices	70
Telecom sector	12
Medical equipment	7
Electric equipment	8
Others	3

Worldwide Scenario

- Electronics and Electrical Equipment (EEE) are manufactured and disposed worldwide. In 2016, 44.7 Million Metric Tonnes (MMT) of e-waste was generated worldwide (equivalent to 6.1kg/inhabitant). Following the current growth rate of rising e-waste, it is estimated that by 2021, quantity has already risen to 52.2 MMT or 6.8 kg/inhabitant.
- Out of the total e-waste produced in 2016, only 20% (8.9 MT) is documented to be collected properly and recycled, while there is no record of the remaining e-waste. The quantity of e-waste generated worldwide is expected to grow at a rate of 3.15% (CAGR).

Indian Scenario

- In 2016, India generated 2 MMT of E-waste. The transported e-waste in India from developed countries has further complicated the management of e-waste.
- India discarded approximately 1.85 MMT of e-waste in 2016 which is about 12% of the global e-waste production.

- India has emerged as fifth largest Electronic waste producer in world. City-wise, Mumbai tops the list in producing electronic waste, followed by New Delhi, Bangalore and Chennai.
- The government offices, public and private sector companies generate nearly 75% of e-waste; with the contribution of individual household only being 16%.

Table 24. Current standpoints regarding e-waste generation and collection

S. No.	Parameter	Outcome & Remarks	
1.	Quantity of E-waste generated per annum *(*As per SPCB)	Uttarakhand (MT)	16260
		Pauri Garhwaldistrict	Not Estimated
2.	Number of authorized E-waste recyclers/dismantlers in the state.	**(05)** 1- Attero Recycling Pvt. Ltd. Raipur, Bhagwanpur 2- Bharat Oil & Waste Management, Mukhimpur, Laksar 3- Resource E-Waste Solution Pvt. Ltd. Bahadrabad 4- Scarto Metal Recycle Plant, Mewar Khurd, Roorkee 5- Anmol Paryavaran Sarakshan Samiti, Daulatpur Budhwa Shahid, Banjarewala	
3.	Toll-free number in the district for the citizens to deposit E-waste.	Facility of toll free number to deposit E-waste is not initiated in the district.	
4.	Collection centre established by ULBs in the district.	At present there are no collection centre established by any of the ULBs or the district administration.	
5.	Linkage with any E-waste recycling facility	No ULBs in the district have established linkage with authorised E-waste recycling facility, However district administration have linkage with the authorised E-waste recycling facility to deposit E-waste generated from the government office.	
6.	Control over illegal trading or processing of E-waste in the district.	Controlled	

Table 25. Gap identification

S. No.	Observed Shortcomings	Remarks
1.	Establishment of collection centres & Toll free number	• Ample amount of E-waste is lying idle in the government offices of the district which cannot be sent for recycling as there is no facility in the district to deposit E-waste. • As there is no facility of Toll free number to deposit E-waste in the district so all the E-waste generated from the residential areas is mixed with municipal solid waste and thus not treated properly.
2.	Segregation of E-waste by ULBs	As the quantity of E-waste generated is very less so there is no mechanism in the ULBs for segregation.
3.	Linkage of ULBs with authorised recyclers/ dismantlers	Yet to establish any linkage.

WASTE WATER MANAGEMENT AND SEWAGE TREATMENT PLANT

Domestic sewage is the type of waste water that is produced by a community of people and is characterized by volume of flow, physical condition, chemical and toxic constitute and its bacteriologic status. Around 80% of water supply flows back into the ecosystem as wastewater, this can be a critical environmental and health hazard if not treated properly.

Currently, India has the capacity to treat approximately 37% of its wastewater, or 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD according to the 2015 report of the Central Pollution Control Board. Moreover, most sewage treatment plants do not function atmaximum capacity and do not conform to the standards prescribed (Table 26).

Piped sewerage system connects only 31.7 per cent of the total urban households with individual household latrines. More than half of the urban population in the State relies on On-Site Sanitation (OSS) systems such as septic tanks (53.1 per cent) for the collection of faecal sludge and wastewater. Further, some individual households in the state discharge the waste from their toilets directly into open drains (Table 26).

Table 26. Current Scenariorelated to STPs (MLD) in Uttarakhand

Number of STPs Installed in Uttarakhand	**71**
Total Sewage Generation (MLD)	627
Installed Capacity (MLD)	448.18
Operational Treatment Capacity (MLD)	345
Actual Utilization (MLD)	187 (42% of installed capacity, 54% of Operational capacity)
80 % of the state's total sewage treatment plant capacity caters to Dehradun, Rishikesh and Haridwar (Plain areas).	

(**Source:** ENVIS Centre on Hygiene, sanitation, sewage treatment systems and technology)

Table 27. Inventory of sewage treatment facilities in district

S.No	**ULB**	**Location**	**Installed STP capacity (MLD)**	**Operational capacity (MLD)**	**Status of nalas meeting in the waterbodies**		
					Toal No. of nalas	No. of tapped nalas	No. of untapped nalas
1.	Srinagar	Daang,Bhaktiyana, Ufalda andKritinagar	3.50	1.50	--	--	--
		Srinagar Market	1.00	0.50	10	10	00
		Srikot Ganganali (Taulia Srikot)	0.050	0.50	02	02	00
		Srikot Ganganali (Junior Srikot)	0.075	0.070			
2.	Swargashram	Swargashram	3.00	2.12	20	19	01

Table 28. The Compliance Status of Sewage Treatment Facilities in the DistrictHousehold/Hotels/Dharamshala/ Ashrams/ Rafting Camps

Nagar Palika Kotdwar				
Items	Total Target	Achieved	Remaining	Remark
Total no. of Households	4030	0	4030	
Total no. of Hotels/Resorts/Guest House	180	0	180	No sewage connection and No STP.
Total no. of Ashrams/Dharamshala/ Apartments	NIL	NIL	NIL	NIL
Nagar Palika Srinagar				
Total no. of Households	6074	693	5381	• For laying of a new sewer line, a DPR of 57.5793 Lakhs has been sent to Uttarakhand Govt. under EAP for Approval by Jal Nigam Srinagar. In addition to that up-gradation of a 3.5 MLD sewer treatment plant is being done by Uttarakhand Payjal Nigam Ganga Ikai, Srinagar. • Currently, around 20% (11 KM main and branch sewer line) area of Srinagar is connected to the Sewer line.
Total no. of Hotels/Resorts/Ashrams	37	16	21	No sewer lines.
Total no. of Apartment	NIL	NIL	NIL	Connected to the sewer line.
Nagar Palika Pauri				
Total no. of Households	6127	0	6127	No sewer line.
Total no. of Hotels/Resorts/Guest House	20	0	20	
Total no. of Ashrams/Dharamshala/ Apartments	02	0	02	
Nagar Palika Dugadda				
Total no. of Households	439	0	439	No sewer line.
Total no. of Hotels/Resorts/Guest House	16	0	16	
Total no. of Ashrams/Dharamshala/ Apartments	NIL	NIL	NIL	NIL
Nagar Panchayat Satpuli				
Total no. of Households	1206	0	1206	No sewage connection and no STP
Total no. of Hotels/Resorts/Guest House	13	0	13	
Total no. of Ashrams/Dharamshala/ Apartments	1	0	1	
Nagar Panchayat Swaragashram – Jonk				

Total no. of Households	672	672	0	660 – Connected to sewer line 12 – Soak pit base
Total no. of Hotels/Resorts/ Guest House	82	82	0	All are connected to the sewer line.
Total no. of Ashrams/Dharamshala	30	30	0	
Total no. of Apartment	1	1	0	Connected to the sewer line.

Liquid Waste Management in Rural Areas

Since the water supply for domestic purposed in rural areas has improved considerably over the years, the quantity of wastewater that is disposed as also increases. Hence effective wastewater management systems need to be introduced in the rural areas to mitigate the problem of contamination in the majority of rural areas, untreated wastewater is discharged directly into the local surroundings and water bodies. This leads to contamination of surface as well as sub-surface water, having negative effects on the environment and human health.

Current standpoint about Rural Waste Water Management in India

- With Population growth and rapid industrialization, wastewater management has become a serious issue. Rural India with old or no infrastructure has reached a tipping point.
- India has the highest number of people who don't have access to clean drinking water. Even abundance of water in certain places do not guarantee access to safe, reliable, drinking water.
- United Nations Sustainable Development goal 6 focuses on access to clean water and sanitation for all. The goal of the initiative is to sensitize communities to the advantages of hygiene and sanitation.

Table 29. Policies undertaken for waste water management in rural India

Current Policy	Sponsoring agency	Remarks
Construction and Usage of Individual Household Latrines (IHHLs)	Under Swachh Bharat Mission- Gramin (SBM-G)	There are various models of toilets available based on safe sanitation technologies like Twin pit, Septic tank, Bio toilets etc.
Availability of Sanitation Material through Rural Sanitary marts (RSM), Self-help groups (SHGs)	Under Swachh Bharat Mission- Gramin (SBM-G)	To provide material, services and guidance needed for constructing different types of latrines and other sanitary facilities for clean environment,
Community Sanitary Complex (CSCs)	Under Swachh Bharat Mission- Gramin (SBM-G)	Such complexes comprise of appropriated number of toilet seats ,bathing cubicles etc.(Only where there is lack of space in the village for construction of household toilets).

Financial Assistance	Under Swachh Bharat Mission- Gramin (SBM-G)	Up to Rs.12000 is provided to below poverty line (BPL) households and identified APL (Above poverty line) households for construction of one unit of IHHL. It is not the cost of the toilet but an incentive amount.
Mensural Health Management	Under Swachh Bharat Mission- Gramin (SBM-G)	It is aimed at making behavioural change in woman and adolescence girls using a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of the menstruation period, and having access to facilities to dispose of used menstrual management materials.

GROUND WATER EXTRACTION/CONTAMINATION AND RE-CHARGE

Groundwater is found underground in the cracks and spaces in soil, sand and rock.Over 70% of the earth's surface is covered in water but of that water, just 1% is readily available for human use, out of which ,99% is stored beneath our feet as groundwater *(The Groundwater Foundation, 2021).*

Ground water extraction:

Over 80-85% of our country population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Due to overuse and leverage of high amount of groundwater water table decreasing with rapid rate and it will very harmful for mankind

Ground water contamination

Groundwater contamination occurs when man-made products (such as, gasoline, oil, road salts and chemicals) get into the groundwater and makes it unsafe and unfit for any kind of use for humans and as well as other animals *(The Groundwater Foundation, 2021*). Unfortunately, groundwater is susceptible to pollutants. Hazardous materials from the land surface can move through the soil and end up in the groundwater. For example, pesticides and fertilizers can find their way into groundwater supplies over time. Also, groundwateriscontaminated by the untreated waste from septic tanks and toxic chemicals from underground storage tanks and leaky landfills.

Groundwater Recharge

Groundwater recharge is a hydrologic process, when water (rain, snow-melt etc.) moves downward from surface to groundwater. Mostly groundwater recharged by naturally but due to high amount of groundwater extraction, water table is falling down day by day. Saving groundwater is very important for mankind as it is the major sources of drinking water and agricultural irrigation water (The Groundwater Foundation, 2021).A comparison of depth to water level of August 2019 with decadal mean of august (2009-2018) indicates that there is decline of more than 4m in the groundwater level in state of Uttarakhand (CGWB,2019-20). Therefore, some artificial methods (Rainwater harvesting, Injection wells) are applied nowadays to save groundwater.

Groundwater management in the district

Pauri Garhwal district is quite rich in terms of water resources, Alaknanda one of the two headstreams of the holy Ganga originates and flows through the district.After the commencement of the flagship ‘Namami Gange’ project, all the major towns along the river valleys are connected

through the sewerage network to prevent direct outfall of the contaminated water in the river. Also, many steps have been taken in recent years to prevent the dumping of waste and to prevent open defecation along with the river bodies.Since the widespread network of river and rivulets of the district are substantial to fulfil the needs of the regions lying adjacent to the river valleys, still, the upper reaches of the district are relying on the groundwater sources such as springs to fulfil their daily needs still the groundwater potential of the district is not estimated so far.

Table 30. Water Resources in Pauri Garhwal District

S. No.	Water Resource	Remarks			
1.	Rivers(Perennial)	Name	Total length within the district (in km)	Place of origin	Altitude at origin (m)
		Ramganga	30-40	Dhoodhatoli	2555
		East nayar	60	Dhoodhatoli	2555
		West nayar	70	Dhoodhatoli	2555
		Alaknanda	60	Vasukital	3855
		Ganga	60	Vasukital and Gau-mukh	4070
		Khoh	30	Langurgad and kalu danda	1280
		Malan	25	Balli ramdi charek	1000
		Madhu ganga	--	Tadkeshwara Hills	--
		Shrigad	--	Neelkanth	--
		Ghattugad	--	Langurgad	--
		Kolhu	--	Dungadanda Range	730
		Mandal	--	--	2157
2.	Streams (seasonal)	There are 10 seasonal streams (Jamun, Harkishan, Kidi, Ginvain, Paniyali, Sukhro, Gwalgarh, Jagdev, Sigaddi and Doom) in the district.			
3.	Lakes and ponds	Number	Total area (m^2)		
		07	5180		

Table 31. Pollution control in water resources

S. No.	Parameter	Current Status
1.	Open defecation in River/Nala/Khad	Partially controlled
2.	Dumping of solid waste on river banks	Fully controlled
3.	Control measures for idol immersion	Measure taken
4.	Nalas/Drains meeting rivers	04 nalas are meeting into the Alaknanda river.
5.	Disposal of untreated sewage in rivers	Sewage is not directly discharged into water bodies.
7.	Encroachment near flood plains	Encroachment removed within 100 meters from both sides of river Heval which is a tributary of Ganga. Presently 284 huts and 26 temporary camps have been evacuated from the river banks at NP Swargasharm- Jonk.

8.	Protection of flood plains	• At present 25 year & 100 years flood line demarked along to left bank of the river Alaknanda. Initial notification for flood plain zoning has been published by uttarakhand Secretariat and proposal has been send to Secretariat for final notification. • Presently, the work of installation of the Demarkation Pillar under the said zone has been completed. • Flood protection RCC Wall constructed Alaknanda river left bank

Table 32. Information of groundwater in the district

S. No.	Parameter	Current Status
1.	Estimated numbers of bore-wells/ hand pumps	55
2.	Groundwater polluted area in the district	Not Identified
3.	Adequacy of groundwater availability	Adequate
4.	Disposal of untreated sewage in rivers	Data not available
5.	Access to surface water and groundwater quality data at DM office	
5.	Is there any action plan available for this district	Maximum ground water extraction is from Kotdwar ULB but seeing past record their is not much change in water table. Since it may decrease due to climate we are looking towards recharging of bore well during ranning season for that in future new tubwell perposal will include this also.

Current standpoint regarding water resources management in Pauri district

Present state of affairs

- Common water sources used for water supply schemes over the district are:
  1. Deep Tubewells,
  2. Khadins / Nadins/ Tankas/ Ponds / Wells/ Ooranis,
  3. Rivers,
  4. Rivulets/ Naulas/ Gadheras,
  5. Spring
  6. Treated Surface water
  7. Streams
- Rivulets / Naulas / Gadheras(45.4%)followed by Khadins / Nadins/ Tankas/ Ponds / Wells/ Ooranis(28.7%) andSprings(15.3%) are noted to be highly tapped for water schemes in Pauri Garhwal district.
- TheRikhnikhal block has the highest water dependencyon Springs, approximately 87% of total water supply.

Artificial Recharge of Groundwater

The geographical area of the district is divided into units like high relief glaciated area, Structural hills, Denudational hills, dissected fans, River terraces and flood plains.Major part of the hilly area has a slope more than 20%, the slope of this magnitude makes the area unsuitable for groundwater development due to low groundwater potential. In this region the groundwater mainly manifests in the form of springs and occurs under unconfined conditions and the water table follows the topography (Table 33).

Table 33. Scope of Artificial recharge in Pauri Garhwal district

District	**Area (km^2)**	**Area identified for AR (Artificial recharge) (sq.km)**	**Volume of unsaturated zone (MCM)**	**Available sub-surface space for AR (MCM)**	**Water required for artificial recharge (MCM)**	**Surplus available for recharge (MCM)**
Pauri Garhwal	5230	1308	2615	392	522	3271

The major part of the district is hilly with localized small valleys through which the entire runoff passes. Major part of the rainfall is lost as surface runoff. Apart from this the small rivers, nallas also act as carriers for base flow & spring water. In spite of good rainfall there is acute shortage of water especially during the summer. The state government is working for rainwater harvesting in the state under many projects to solve this issue (Table 34 and 35).

Table 34. Artificial Recharge and RTRWH Structure constructed in Pauri Garhwal district under catchment area conservation Program (CACMP)

District	Number of structures					Total cost (in lakhs)					Total cost (in lakhs)
	CD	CK	RTRWH	PT	CT	CD	CK	RTRWH	PT	CT	
Pauri Garhwal	850	00	133	11	00	85	00	46.55	0.22	00	131.77

CT-Contour Trench, CK- Chal Khal, RTRWH- Rooftop Rain Water Harvesting, CD- Check Dam, PT- Percolation Tank, NA- Data Not Available

Table 35. Artificial recharge and cost estimate in Pauri Garhwal district

District	**Structures proposed**					**Unit cost estimate (in lakhs)**					**Total cost (in lakhs)**					**Total cost (in lakhs)**
	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	
Pauri Garhwal	325	220	150	375	750	0.5	0.3	0.07	0.15	0.015	162.5	66	10.5	56.25	11.25	306.5

CT-Contour Trench, CK- Chal Khal, RTRWH- Rooftop rainwater harvesting, CD- Check Dam, PT- Percolation Tank, NA- Data not available

AIR AND NOISE POLLUTION MANAGEMENT

Air Pollution Management

The ambient air that is the atmospheric air in its natural form consists of nearly 99.9% of Nitrogen, Oxygen, Water vapors, Carbon dioxide, and some other gases like helium, argon, methane, argon, etc. surrounds the earth and forms its atmosphere. Any undesirable change in the composition of ambient air is called air pollution. The undesirable substances can be in solid, liquid, and gaseous forms and when present in sufficient concentration for a sufficient time under certain conditions can endanger human health and welfare of plants and animals. According to state of Global Air report 2020, Air pollution has now become the biggest health risk in India. Most of the cities in our country (majority of them are from the region of Indo-Gangetic plains) are facing the problem of air pollution which has led to increase in cases of breathing discomfort and other related diseases. To tackle the problem of air pollution in our cities, Government of India has taken many steps, one of them being National Clean Air Program (NCAP) 2019. Under this programme, 122 cities in the country are identified as non-attainment cities which includes three cities from the Uttarakhand *(Dehradun, Rishikesh and Kashipur)*. These are the cities that have fallen short of the National Ambient Air Quality Standards (NAAQS) for over five years. Goal ofNational Clean Air Program(NCAP) is to meet the prescribed annual average ambient air quality standards at all locations in the country in a stipulated timeframe. The tentative national level target of 20% to 30% reduction of $PM_{2.5}$ and PM_{10} concentration by 2024 is proposed under the NCAP taking 2017 as the base year for the comparison of concentration (Table 36).

Table 36. National ambient air quality standards in India.

Pollutant	**Time weighted average**	**Concentration in Ambient Air**	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central (Government)
Sulphur Dioxide (SO2), µg/m^3	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO2), µg/m^3	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60
Ozone (O3) µg/m^3	8 hours* 1 hour**	100 180	100 180
Lead (Pb) µg/m	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH_3) µg/m^3	Annual*	100	100

	24 hours**	400	400
Benzene (C_6H_6) µg/m^3	Annual*	5	5
Benzo(a)Pyrene (BaP)-particulate phase only, ng/m^3	Annual*	1	1
Arsenic(As), ng/m^3	Annual*	6	6
Nickel (Ni), ng/m^3	Annual*	20	20

Source: National Ambient Air Quality Standards, Central Pollution Control Board Notification in the Gazette of India, Extraordinary, New Delhi, 18th November, 2009.

** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.*

*** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

Table 37. Air quality monitoring and data accessibility

Action Area	Outcomes
Number of automatic air quality monitoring stations in the district	Yet to be installed
Number of manual air quality monitoring stations in the district	Yet to be installed
Availability of air quality monitoring data	Ample readings are not taken to provide necessary information about prevalent air quality standards.

Table 38. Identification of sources of air pollution

Action area	Outcomes
Number of non-attainment cities in the district	No city in the district is classified as non-attainment city according to national clean air program (NCAP).
Identification prominent sources of air pollution in the district	Unprecedented forest fires, some small scale industries and vehicular pollution are major reasons for air pollution in the district.

Table 39. Control measures for industrial/ non industrial air pollution

Action Areas	Outcomes
Control of industrial air pollution	The district has one industrial estates and few small scale industries are currently operationalin the district. Out of these there are 12industries found to violate the air pollution norms to which the notice has been sent by the state pollution control board.
Control of non-industrial air pollution	
(a) Control open burning of waste	Open burning of waste is strictly prohibited in the urban areas of the district. However due to lack of waste management system in the rural areas waste burning is still prevalent.
(b) Control of forest fires	The forest department is trying its best to control forest fires but the result is yet to be seen on the ground. Every year hectares of forests are damaged due to forest fires.
(c) Control of vehicular pollution	08 PUC centres are available in Pauri Garhwal district.

District level action plan for air pollution	At present, no such action plan has been prepared.
Awareness on air quality	There is the mind set in the district that air pollution is not an issue in the hilly region so local citizens are not aware of the problem of increasing levels of air pollutants in the district especially in the urban centres of the district.
Development of air pollution complaint redressal system	Not Initiated

Forest Fire Protection Management Scheme in Pauri Garhwal District

About 72.26 % area of Garhwal district is forested. Most of the residents of the district are dependent on forests for their daily needs like firewood, wood, timber, fodder leaves, water, etc. For the continuous fulfillment of the needs of the people, the existing forests must be protected and their density should be increased by developing the degraded forest areas. There are incidents of forest fire every year in the district. Forest fire causes degradation of forest cover and adversely affects the water holding capacity of the soil, besides causing environmental imbalance. The highest risk of forest fire occurs between March 15 and June 15. In this sensitive period, this scheme is being proposed to keep the forest safe from fire, to keep the damage at a minimum level by taking measures for quick prevention and mitigation of forest fire, to get public participation in forest firemanagement, and for public awareness (Table 40).

Table 40. Details of Highly Sensitive and sensitive areas under Pauri Garhwal district

Sr.No	Range name	Highly Sensitive Area (ha)	Sensitive area (ha)
1.	Garhwal Forest Division, Pauri.	16863.90	**6220.10**
2.	Civil and Soyam Forest Division, Pauri.	19633.94	**47671.12**
3.	Kalagarh Forest Division, Lansdowne.	930.00	**1280.00**
4.	Land Conservation Forest Division, Ramnagar.	10208.041	**4896.49**
5.	Lansdowne Forest Division, Kotdwar.	3232.10	**3213.80**
6.	Rajaji National Park, Dehradun.	820.42	**820.42**
7.	Land Conservation Forest Division, Lansdowne.	9527.656	**2193.46**
8.	Corbett Tiger Reserve, Ramnagar.	5795.50	**0.00**
Total		**67011.557**	**66295.39**

Table 41. Causes of fire in the district

Causes of forest fire		Effects of forest fire
Due to nature	• This is due to high temperature, low humidity, wind speed and constant dryness.	• Many important plant species are destroyed. • Leads to waterlogging which reduces water seepage. • Loss of wildlife and many micro-organisms. It may lead to destruction of natural habitat and extinction of many species. • The fulfilment of the various needs of the daily use of the common man gets hampered. • Reduces subsistence agriculture which has severe consequences on the livelihood of forest communities.
Anthropogenic activities / Negligence of the general public	• From the spark emanating from the smoke of motor vehicles. • Unintended smouldering of cigarettes, bidis, and matchsticks thrown by passers-by and shepherds. • Unorganized campfires at campsite and fairs. • Unintended forest fire because of burning of dry grass in the fields after crop harvesting.	
Intentionally	• By residents to obtain new grass and clear paths. • For the purpose of hunting wild animals.	

Table 42. Division wise details of fire accidents that happened in the last 5 years

Division Name	Total no of Fire accidents in 2017-2021	Total Area (ha) affected of Fire accidents in 2017-2021
Garhwal Forest Division, Pauri	1276	3282.6
Lansdowne Forest Division, Kotdwar	188	326.1
Kalagarh Forest Division, Lansdowne	66	104.5
Rajaji National Park, Dehradun	76	191
Civil and Soyam Forest Division, Pauri.	1610	3550.24
Land Conservation Forest Division, Lansdowne.	268	406.2
Land Conservation Forest Division, Ramnagar	90	116.2
Corbett Tiger Reserve, Ramnagar.	172	79.72
Total	**3746**	**8056.56**

Table 43. Forest fire management strategy in Pauri Garhwal District

Prevention	Method	Remarks
Fire prevention measures	Publicity and public participation	• Organized public awareness program through street plays/rallies etc. • Organize seminars and training & formation of fire safety committees at village level. • Cleaning of fire lines, motorways, walkways/horse roads
Fire Fighting Measures	Detection	• Formation of village fire safety committees and appointment of fire watchers/village guards. • Establishment of fire control rooms for exchange of information.
	Control	• Establishment of master control room andcrew stations

Table 44. Gap identification

S. No.	Area of concern	Remarks
1.	Uncontrollable forest fires	• Lack of vehicles and staff to improve connectivity and effective management of forest fire. • Multiple departments are involved to resolve the issue, hence lack of coordination and responsibility sharing has been observed. • Lack of required wireless mobile facilities to send accurate information (fire location, status etc.) and establishment of robust communication between several departments. • Lack of basic medical facilities to the firefighter (forest department staff, local citizens etc.)injured during extinguishing fire.
2.	Lack of monitoring to assess the effects of small scale industries and vehicular pollution	

Noise pollution management

Regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to WHO sound levels less than 70 dB are not damaging to living organisms and exposure of noise level beyond 85 dB constantly for more than 8 hrs. may be hazardous and leads to loss of hearing.Although noise pollution is a big issue in the district but proper monitoring is required maintain noise level within the desirable limits. Following table represents the permissible noise level standards in India (Table 45).

Table 45. Permissible noise level standards

Area code	Category of area/zone	Limits in dB(A) L_{eq}*	
		Day Time	Night Time
A	Industrial Zones	75	70
B	Commercial Zones	65	55
C	Residential Zones	55	45
D	Silence Zones	50	40

Source- Noise Pollution (Regulation and Control) Rules, 2000

Note: - 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.

2. Night time shall mean from 10.00 p.m. to 6.00 a.m.

3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority

4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* dB(A) L_{eq} denotes the time weighted average of the level of sound in decibels on scale 'A' which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) L_{eq}, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

L_{eq}: It is an energy mean of the noise level over a specified period.

Noise Pollution in Pauri Garhwal district

Thus far, Noise pollution is not a major issue in the district, but installation of a monitoring station is necessary to examine the increased sound levels during festivals and other public events (Table 46).

Table 46. Current status related to noise pollution management

S. No.	Parameter	Current Status
1.	Number of noise level measuring devices available with various agencies in the district	At present no noise level monitoring device is installed in the district.
2.	Number of complaints received by state pollution control board related to noise pollution in last 1 year	No complaint either by SPCB or District Authority is received by state pollution control board in last 1 year
3.	Implementation of ambient noise standards in residential and silent zones.	Local police is responsible for the implementation of the ambient noise level standards.
4.	Silent zones in the district	No place in the district is declared as silent zones.
5.	Setting up of sign Boards	Sign boards are installed around hospitals, schools and along the highways by the concerned authorities.

ILLEGAL SAND MINING

The Mines and Minerals (Development and Regulation) Act, 1957 has empowered state governments to make rules to prevent illegal mining, transportation and storage of minerals. However, still large numbers of illegal mining cases are registered in the country and in some cases; many of the officers even lost their lives while executing their duties to curb illegal mining. Ministry of Environment, Forest & Climate Change (MoEF&CC) put forward the sustainable sand management guidelines (SSMG) 2016, which focus on the management of sand mining in India, but there is a need to revamp the existing system for effective enforcement of regulatory provisions and their monitoring. Recently, in 2020, new set of guidelines have been put forward by (MoEF&CC) in 2020, which focuses on the effective monitoring of sand mining (from the identification of sand mineral sources to its dispatch and end-use by consumers and general public) and uniform protocol for the whole country. Also, states are advised to conduct river audits and monitoring of mining activities with night vision drones and other modern surveillance equipment.

Sand being an important economic resource and the second most used mineral after water is one of the main ingredients of concrete and mortar. Besides, its economic importance, it also constitutes an important abiotic component in the aquatic ecosystem like rivers. As our country has seen robust growth in the infrastructure sector in the recent decade, the demand for sand increased by manifolds. Further, with the announcement of the national infrastructure pipeline project, the demand for sand is going to increase exponentially in near future. In recent years, Uttarakhand has also seen an increase in riverbed quarrying operations. With the establishment of the stone crusher industry especially in the southern Terai and Bhabar regions of the state, the scale and intensity of Riverbed Mining (RBM) excavation has further increased in the past few decades. Uncontrolled and illegal mining of river bed minerals like sand has led to the loss of revenue to the state, degradation of aquatic and riparian habitat (through large changes in the channel morphology) and geology of adjoining groundwater systems.

Table 47. Prevalent Mining Activities

Total area of district(km^2)	5329
Type of Mining Activity	River bedmining (mainly sand) is prevalent in the district.
Total no of sand mining sites in the district	Total 12 sand mining sites are there in the district.
Total mining areas	4,59,510 m^2
Number of mining licenses given by the district authority	12
Action against illegal mining activities in the district	--

(in the financial year 2020-21)	
Penalties charged for the illegal mining activities/ Earnings from mining royalty	So far Rs. 6.81 Cr. is collected through the penalties charged over illegal mining activities in the district.

Source: Geology and mininig unit, Pauri Garhwal

Table 48. Details of sand mining sites

S.No	Name of Lessee	Place of Mining	Area (ha)
1	Sh. Rajendra Singh Bisht, S/o Uday Singh Bisht	Village- Fatehpur Reti, Srinagar	3.127
2	Sh. Rajendra Singh Bisht, S/o Uday Singh Bisht	Village - Srikot Gangnali Srinagar	2.00
3	Sh. Indra mohan Negi, S/o Surendra Singh Negi	Village - Char, Kotdwar	4.364
4	Sh. Vijay Joshi, S/o Magatram Joshi	Village - Badkholu, Pauri	4.864
5	Sh. Thaneshwar Badola, Late B.R. Badola	Village - Bilkhet Pauri	4.013
6	Sh. Thaneshwar Badola, S/o Late B.R. Badola	Village - Naugaon Kamanda Pauri	1.651
7	Sh. Vinod Singh Negi, S/o Prem Singh Negi	Village - Chota Maroda Pauri	0.640
8	Sh. Bhrat Bhushan, S/o Jagmohan Singh	Village - Maroda Pauri	4.002
9	Smt. Neetika Chauhan W/o Trilok Singh	Village - Dhuroli Satpuli	2.272
10	Sh. Matbur Singh Negi, S/o Late Sankar Singh Negi	Village - Aamotha sera, Pauri	0.840
11	Sh. Matbur Singh Negi, S/o Late Sankar Singh Negi	Village - Kesharpur Pauri	0.500
12	M/s Van Vikas Nigham	Malan River Kotdwar	17.687
Total			**45.951**

Table 49. Compliance with environmental standards

Mining areas meeting environmental clearance conditions	12
Mining areas meeting consent conditions of UKPCB	12
Mining operations were suspended for violations of environmental norms	NA
Pollutions related complaints against mining operations in past one year	NA

REJUVENATION OF WATER BODIES

Most of India's major water resources *(underground waterways, lakes, rivers and reservoirs)* have to depend on monsoon rains to replenish/recover them. Nearly 600 million Indians faced high to extreme water stress and about 2 lakh people died every year due to inadequate access to safe water. The NITI Aayog in 2018 released the results of a study warning that India is facing its "worst water crisis" in history and that demand for potable water will outstrip supply by 2030, if concrete steps are not taken. If matters are to continue, there will be a 6% loss in the country's GDP by 2050. Due the high amount of water extraction and mismanagement of water resources are causing drought and sudden flood in several part of our country. Rejuvenation of water bodies also play a vital role to improve the water quality and storage of surface runoff water. For these reasons we must need to store, manage and rejuvenate the existing water bodies. We can use several government policies/Schemes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Atal Bhujal Mission etc. to restore and rejuvenate the water bodies. The Water Stress Index 2019 by London-based Verisk Maplecroft ranks India as the 46th highest risk country *(Verisk Maplecroft 2019)*. India is also 13th on the Aqueduct's Water Risk atlas and listed as one of the world's ***"extremely water-stressed countries"*** *(World Resources Institute 2019)*

Table 50. Present scenario in the district

The Technique Used In The District For Rejuvenation Of Water Bodies	**To rejuvenate water bodies following works are done under various schemes such as MNREGA** • *Construction of recharge pits* • *Construction of Infiltration trenches* • *Construction of chal-khals* • *Construction of Staggered contour trenches* • *Construction of Wooden Check dam* • *Construction of Check dam* • *Construction of Recharge ponds* • *Plantation drives* • *Pit digging for fodder plants* • *Earthen Works*
Plant Species Used For Rejuvenation Of Water Bodies	• Banj *(Quercus leucotrichophora)* • Bhimal *(Grewia optiva* • Kachnar *(Bahunia purpuria)* • Burans *(Rhododendron arborium)* • Utis *(Alnus nepalensis)*

Local action plan For rejuvenation of waterbodies	The district is running a water conservation and augmentation program in which the conservation of water sources, rural ponds, Chal-Khals and traditional water sources are being renovated in the gram panchayats of the district.

PLASTIC WASTE MANAGEMENT

Plastic waste is defined as the accumulation of plastic objects (e.g. Plastic bottles, bags etc.) in the environment that adversely affects the Wildlife and Humans. Its broad range of application is in packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, building materials, etc. The ongoing pandemic has caused a rapid growth in the generation of plastic waste for the medical, packaging and other services *(like PPE kit, gloves, face shield, packaged food, etc.).*

Plastic products have become an integral part in our daily life pertaining to the fact that its production has crossed 150 million tonnes per year globally *(CPCB, 2013).* India generates 15 million tonnes of plastic waste every year but only one fourth is recycled due to lack of a functioning solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women (UNDP, 2018-2024).

India is committed to take action for mitigation of pollution caused by littered Single Use Plastics. In the 4th United Nations Environment Assembly held in 2019, India has piloted a resolution on addressing single–use plastic products pollution, recognizing the urgent need for global community to focus on this very important issue. The adoption of this resolution at UNEP was a significant step.

Plastic Waste Management Amendment Rules, 2021

Keeping in view the adverse impacts of littered plastic on both terrestrial and aquatic ecosystems, the MOEF&CC has notified the Plastic Waste Management Amendment Rules,2021, which prohibits identified single use plastic items which have low utility and high littering potential by 2022.Salient features of this amendment are as follows:

- The manufacture, import, stocking, distribution, sale and use of single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022.
- In order to stop littering due to light weight plastic carry bags, with effect from 30th September, 2021, the thickness of plastic carry bags has been increase from 50 microns to 75 microns and to 125 microns with effect from 31st December,2022. This will allow reuse of plastic carry due to increase in thickness.
- The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through extended producers responsibility of the Producer, Importer and Brand Owner(PIBO). For

effective implementation of Extended Producer Responsibility, the guidelines for extended producer responsibility being brought out have been given legal force through Plastic Waste Management Amendment Rules, 2021.

- The State government and concerned Central Ministries and associated departments have also been requested to develop a comprehensive Action plan for elimination of single use plastics and effective implementation of Plastic Waste ManagementRules,2016 and its execution in a time bound manner.
- Directions under Section 5 of Environment (Protection) Act, 1986, have been issued to all state for setting up for institutional mechanism for strengthening enforcement of Plastic Waste Management rules,2016.

Table 51. Inventory of Plastic Waste Generation

Name of Urban Local Body	Population (2011 census)	Number of Wards	Estimated Quantity of Plastic Waste Generated (MT/Day)
NN Kotdwar	135000	40	5.00
NN Srinagar	20125	13	1.8
NPP Pauri	25440	11	2.0
NPP Dugadda	2422	04	0.04
NP Swargasharm	4669	04	0.02
NP Satpuli	4345	04	0.06

(Source: District administration, Pauri Garhwal,2021)

Table 52. Plastic Waste Management Operations

Waste management Operations	Outcome	
Door to Door Collection	All the ULBs have 100 percent coverage for door to door collection.	
Segregated Waste Collection (Single used plastic, Recyclable plastic, etc.)	***ULB***	***Segregation (%)***
	NN Kotdwar	90
	NN Srinagar	80
	NPPPauri	90
	NPP Dugadda	80
	NP Swargasharm	90
	NP Satpuli	90
Material Recovery Facility (MRF) operation	ULB	Type of recovery operation
	NN Kotdwar	Automated
	NN Srinagar	
	NPP Pauri	Semi-automated
	NPP Dugadda	
	NP Swargasharm and NP Satpuli have not recovery facilities but they are doing secondary segregation at near to the trenching ground/ dumping zone.	
Linkage with Public Relation Officers (PROs) of producers	No ULB in the district has linkage with Public Relation Officers (PROs) of producers.	

Involvement of Non-Governmental Organizations (NGOs)/ private agencies	NGOs/ private agencies	ULB
	A2V Infra Ltd.	NN Kotdwar
	Swachh Sulabh Foundation	NN Srinagar
		NP Swargasharm
	-	NPPPauri
	Zero Waste Pvt. Ltd.	NPP Dugadda
	Abhinandan Facility and Servicing	NP Satpuli

Authorization and issuance of identity cards to waste pickers/ sanitation workers	ULB	Number
	NN Kotdwar	270
	NN Srinagar	116
	NPPPauri	90
	NPP Dugadda	15
	NP Swargasharm	35
	NP Satpuli	18

Table 53. Present infrastructure for plastic waste management operations

Name of ULB	**Inventory of infrastructure available for plastic waste management operation**				
	No. of dustbins	**Availability of plastic compactor**	**Linkage with Plastic waste recyclers**	**MRF (Available/Not Available)**	**Remarks**
NN Kotdwar	30	Available	Not Established	Available	Nagar Nigamis earningINR 70-80 thousands/month by selling the dry waste to the local rag pickers.
NN Srinagar	32	Available	Not Established	Available	Nagar Palika is earning INR 25 thousands/month by selling the dry waste to the local rag pickers. This ULB has earned 17 lakhs from 2015 tillpresent time.
NPP Pauri	14	Available	Not Established	Available	NPP Pauri is earning INR 28 thousands/month by selling the dry waste to the local rag pickers.
NPP Dugadda	16	Available	Not Established	Available	This ULB is earning INR 20 thousands/month by selling the dry waste to the local rag pickers. This ULB has easrned INR 07 thousands/month from 2021 till present time.
NP Swargasharm	64	Not available	Not Established	Not Available	Nagar Panchayetis earningINR 15 thousands/month by selling the dry waste to the local rag pickers.
NP Satpuli	00	Not available	Not Established	Not Available	Nagar Panchayet is earning INR 06 thousands/month by selling the dry waste to the local rag pickers. This ULB declared as bin free

					city on March, 2021.

[a] *Litter bin of capacity lesser than 50 liters are provided within ULB to collect plastic waste.*
[b] *Secondarystorage bins*
[c] *Plastic waste is sold to local rag pickers which are authorized by the ULB.*

Gaps identified in the management of plastic waste in the district

Plastic waste management is also an important part of the solid waste management system. So, the shortcomings in the management of plastic waste are more or less similar as specified in section of solid waste management (Table 9). As segregation, collection, compaction and linkage with authorised recyclers are some of the necessary aspects in the management of plastic waste and all the ULBs are somehow lagging in one or more of these aspects. Also, no system is there in the rural areas of the district for the management of plastic or any other kind of waste.

Estimated Future Population and Plastic Waste Generation in Pauri Garhwal

Plastic waste in India has surged over the past 50 years and is expected to double again over the next 20 years. The growth rate of the Indian plastic industry is one of the highest in the world.

Forecasting waste quantities in the future is as difficult as it is in predicting changes in waste composition. As a general rule, the lower level of economic development, the greater the change between generation and disposal.

Census population data for the years 2001 and 2011 has been taken for population forecast (Table 55). Decadal population and subsequent waste forecasthas been done based on the following presumptions:

- The arithmetic increase method has been used for the decadal population forecast, hence the rate of change of population with time is assumed to be constant.
- The per capita consumption of plastic waste has been taken as 11kg/annum. *(Centre for Science and Environment, 2019).*
- It is considered that 70% of total plastic waste consumption is discarded as waste. *(CPCB,2013)*
- 16 % yearly growth in per capita plastic waste consumption has been taken keeping in mind the changing waste paradigm and floating population. *(Centre for Science and Environment,2019)*
- The analysis includes population and waste generation estimations only for urban local bodies and does not include peri-urban and rural areas.

Table 54. Projected Population and Waste Generation

ULB	Projected Population			Present/ Projected Plastic Waste Generation (MTPD)		
	2021	2031	2041	2021	2031	2041
NN Kotdwar	41123	49211	57299	5.000	15.56	47.10
NN Srinagar	20572	21029	21486	1.800	4.78	12.71
NPP Pauri	26137	26834	27531	2.000	5.34	14.24
NPP Dugadda	1846	1270	694	0.040	0.07	0.10

Table 55. Decadal Change in plastic waste Generation

Name of ULB	Rate of Growth % (2021-2031)	Rate of Growth % (2031-2041)
NN Kotdwar	21.11	20.27
NN Srinagar	16.58	16.57
NPP Pauri	16.69	16.68
NPP Dugadda	7.89	4.21

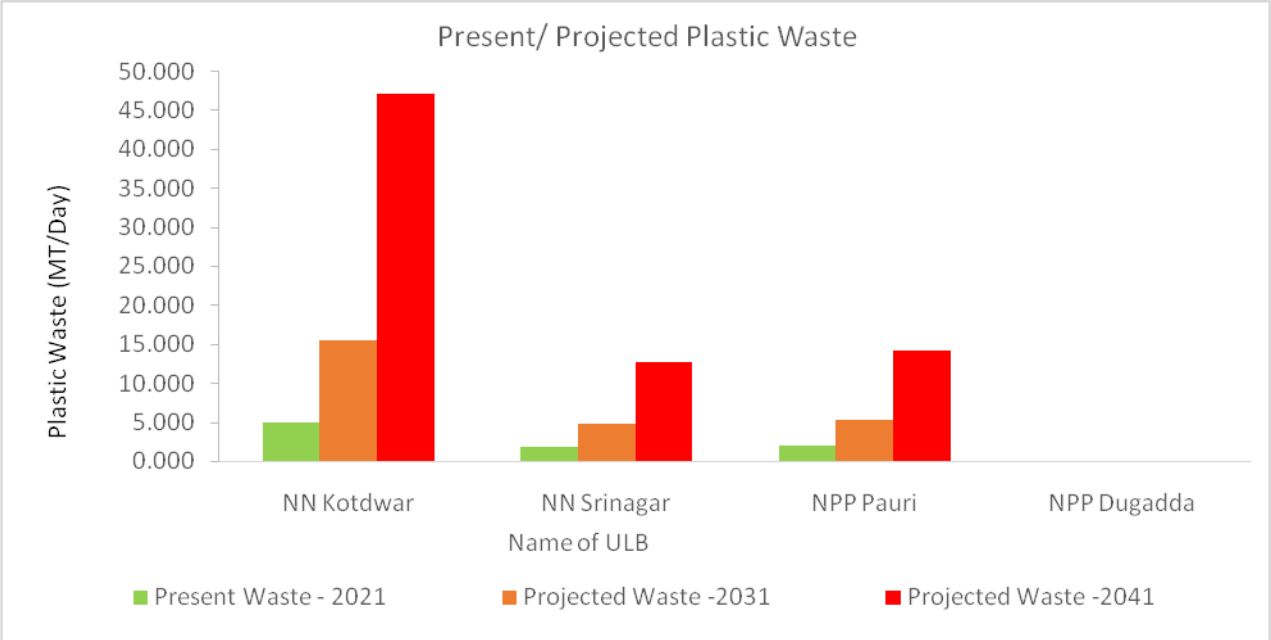


Fig. 6. Projected plastic waste generation in Pauri Garhwal district

Inferences drawn from the projected data

- Total plastic waste generation in all the urban local bodies is likely to increase by 10 to 32 metric tonnes in the upcoming decades.
- Maximum growth is supposed to occur in NN Kotdwar due to sharp population growth in the ULB.
- Overall with the increase in the economic prosperity, plastic waste is likely to increase in almost all the ULBs so all of them need to focus the management of plastic waste.

ASSESSMENT OF URBAN LOCAL BODIES IN PAURI GARHWAL DISTRICT

In order to push the Urban Local bodies to adopt effective waste management, an assessment of their waste management operations has been carried out (Table 56, Table 57). The main objective of this assessment is to let ULBs know their present status regarding various waste management operations in Solid waste management, bio-medical waste management, C&D waste management etc. Based on the adopted methodology, few inferences have been drawn to let administration know about their performance in various indicators.

Table 56. Assessment of waste management operations of urban local bodies in Pauri Garhwal district

Indicators	**Maximum Points**	**Urban Local Body**					
		NN Kotdwar	NN Srinagar	NPP Pauri	NPP Dugadda	NP Swargasharm	NP Satpuli
Solid Waste Management							
Segregation	**4**	3	3	3	3	3	3
Collection	**4**	4	4	4	4	4	4
Segregated Waste Transport	**4**	3	3	3	3	3	3
Wet Waste Processing	**2**	2	2	2	2	2	2
Dry Waste Processing	**4**	2	2	2	2	0	0
Disposal	**2**	0	0	1	0	1	0
Inclusion of Informal Sector	**1**	1	1	0	1	1	1
Bio-medical waste Management							
Linkage with CBWTF*(Common Bio-medical Waste Treatment and Disposal Facility)*	**1**	0	0	0	0	0	0
Hazardous Waste Management							
Linkage with TSDF (*Treatment, Storage and Disposal Facilities)*	**1**	0	0	0	0	0	0
C&D Waste management							
C&D Waste Processing	**1**	0	0	0	0	0	0
E-Waste Management	**2**	0	0	0	0	0	0
General Information							
Innovation and use of indigenous techniques	**2**	0	0	0	0	0	0
Enforcement of Bye-	**2**	2	2	2	2	2	2

laws and Waste Management Rules, 2016							
Total	**30**	**17**	**17**	**17**	**17**	**16**	**15**

Table 57. Final Assessment of Urban Local bodies of Chamoli District

Name of ULB	Score (out of 30)	Score Percentage (%)
NN Kotdwar	17	56.66
NN Srinagar	17	56.66
NPP Pauri	17	56.66
NPP Dugadda	17	56.66
NP Swargasharm	16	53.33
NP Satpuli	15	50

Observations from data analysis

- All the ULBs are doing pretty well in sourcesegregation (household level)and door to door collection of segregated waste.
- Except NP Swargasharm and NP Satpuli all others ULBs has their own MRF facilities to manage the dry waste.
- In NPP Pauri and NP Swargasharm have their trenching ground but for the other ULBs trenching ground is not available for the disposal of inert waste. No linkage has been established yet with the authorised recyclers by any ULBs in the district.
- None of the Urban Local Bodies has linkage with CBWTF (Common Biomedical Waste Treatment Facility) and TSDF (Treatment Storage and Disposal facility) for the disposal of municipal sanitary waste and domestic hazardous waste respectively.
- Most of the ULBs are performing near to equal as comapared to each other but the overall performance in waste management is not pretty satisfactory as all the ULBs are got average performane of 50% or near to 50% in managing the waste.

ACTION PLAN

Action Plan for Solid Waste Management

All ULBs of Pauri Garhwal district have been recognized as bin free and ODF. That brings up major challenge for the ULBs to augment their waste management operations in consonance with the bin free city concept. Dry waste management is the need of the hour for overall improvement in Solid waste management.

Focus areas

- *Waste management operations need to follow based on bin free city concept*
- *Scientific recovery techniques require for disposal of dry waste*
- *Cluster based approach for Solid waste management*

This action plan below focuses on the basic point, which forms the prerequisite for effective solid waste management. Each action point is in compliance with the guidelines of Solid Waste Management Rules, 2016.The current action points must be addressed in a timeframe of 5-10 years considering the financial constraints (Table 58).

Table 58. Action plan for solid waste management

Action areas	Concerned ULBs	Purpose	Strategy/ Approach	Stakeholders Responsible
Primary segregation (segregation at source)	All ULBs	• Increasing the recovery level of recyclable waste. • Maintaining the hygienic environment. • Reduction of capital, energy and land requirement for waste management. • Simplifying the waste management operations. • Reduction of unhealthy and hazardous practice of rag pickers searching through waste piles for saleable waste items.	• Separate Storage Bins in every households and commercial places. • Regular awareness campaigns (by using hoarding playing recordings, miking about process of waste management operations and its advantages using waste collection vehicles). • Man power management. • Behavioural change • Promoting on-site composting (home composting) for wet waste.	• Nagar Palika Parishad/ Nagar Panchayat • Residents and private agencies/ NGOs

Segregated waste transport	All ULBs	• Reduction of open dumping of waste. • Reducing the carbon footprint and greenhouse gas emissions. • Reduction of transportation charges.	• Optimizing waste management infrastructure (collection trucks, trolleys). • Man power optimization at recovery facility.	Nagar Palika/ Nagar Panchayat
Treatment Storage and Disposal Facility (TSDF) and Common Biomedical Waste Treatment Facility (CBMWTF)	All ULBs	• Segregation and proper disposal of municipal sanitary waste and domestic hazardous waste.	• Separate bins for sanitary and domestic hazardous waste. • Establishment linkage with nearby TSDF and CBMWTF.	Nagar Palika/Nagar Palika Parishad/ Nagar Panchayat
Landfill mining	All ULBs	• Reduction of historical waste. • Reducing contamination of ground water. • Mitigation of environmental impact of waste. (Methane emission) • Resource recovery of excavated waste.	• Established linkage with any private agencies, NGOs for recycling of dumped waste. • Distribution of waste freely to the local interested rag pickers. • Manually or mechanically excavation of historical waste.	Nagar Palika/Nagar Palika Parishad/ Nagar Panchayat
Authorised recyclers	All ULBs	• Reduction of open dumping of waste. • Ensuring the proper recycling of the waste.	Either the local scrap pickers can be authorised or direct linkage could be established with any recycling unit.	Nagar Palika Parishad/ Nagar Panchayat
Cluster based approach to solid waste management	All ULBs	• Clubing the villages in peri-urban areas of the town with the nearby solid waste management facility for effective waste management in rural areas. • Execution of Rurban Mission of Government of India.	• By merging schemes from Central and state government department with Rurban Mission of Ministry of Rural development	District administration District Panchayati Raj Officer (DPRO)

Community participation for waste management	All ULBs	• Social and Behavioural Change Communication • Cleanliness drive campaigns throughout the district	• Information, Education and Communication (IEC) activities in Educational institutions. • IPC (Inter-personal communication): School children and Sanitation workers to spread awareness amongst people regarding waste management.	District Administration
Establishment of Green Protocol	All ULBs	• Prevent the use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.	By encouraging green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration

Wet Waste Management through composting – A study by GBPNIHE

The role of compost, organic fertiliser derived from waste, has been overshadowed by the excessive use of pesticides and chemical fertilisers in agricultural practices. The lack of compost used in farm fields and the dependence on chemical fertilisers have had a number of negative impacts, such as deteriorating soil conditions, deficient or excess nutrients, insect outbreaks and solidified soil. However, organic waste generated in daily life can help recover soil fertility if it is used to produce compost (Kuniyal et al. 2005a &b).

Composting involves the breakdown of organic waste in the presence of microorganisms, heat and moisture. Effective microbial composting includes three types of microorganism namely bacteria, fungi and actinomycetes that act upon waste to convert it into sugars, starch and organic acids. It is a self-reliant method of composting with little or no use of technology.

Microbial Bio-composting at Municipal level

A site was selected to construct an open below earth surface MBC pit (size 3 x 1 x 1 m) (Kuniyal and Thakur, 2013-14). Its roof top was covered with multi-layered ultraviolet (U.V.) resistant polyethylene sheet *(rainfall areas)* and UV treated fibre sheet *(snowfall areas).* It was required to turn up the waste in an interval of 15 days for sufficient aeration. It was noticed that 500 kg of waste produced almost 167 kg compost (almost 1/3rd). Moreover, yield per hectare of garlic from the compost produced also showed desirable results.

Fig. 7. Structure and design of microbial composting pit

Phytoremediation as a mitigation measure (for treatment of Solid waste)

Natural or planted vegetation on alandfill has an important role in erosion control and removal of contaminants, besides imparting aesthetic value. Moreover, it may also be used in leachate treatment. Phytoremediation is a promising, plant-based technology in which the plants and their associated microbes are utilized to absorb and clean up environmental contamination through engineered constructed systems. The ultimate aim is to either remove the pollutant from the contaminated media orto alter the chemical and physical nature of the contaminant so that it eliminates the risk to human health and the environment. Several plants are being identified to be used in phytoremediation task (Table 59).

Table 59. Phytoremediation as a mitigation measures

Botanical Name	Local and English Name	Life form	Assimilating capacity	Altitude (m)	References
Quercus leucotrichophora A. Camus	Banj oak	Tree	Microbial biodegradation, binding, holding soils, and/or decreased leaching	1200-2400	Kumar et al, 2021
Bauhinia variegata L.	Kachnar	Tree	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	1250-1800	Agarwal et al. 2011
Populus nigra L.	Popular	Tree	Accumulation of Cd, Pb, As, and Ni	100-1800	Houda et al., 2016
Mangifera indica	Mango	Tree	Absorb dust particles	100-1200	Shukla, et al., 2019

Adina cordifolia (Roxb.) Hook. f. ex Brandis	Haldu	Tree	conversion of Se and Hg to volatile chemical from groundwater	Upto-1500	Prajapati, 2012
Berberis aristata DC.	Kingore	Shrub	Metals, radionuclides, hydrophobic organics	1350-2000	Khan et al., 2019
Cynodon dactylon (L.) Persoon	Dubla, Doob	Herb	Absorbs Arsenic and Fluoride from wastewater	700-2500	Sekabira et al., 2011
Azolla pinnata R. Br.	Azolla	Herb	Control the Hg, and Cd from wastewater also known as bio-fertilizer	400-2200	Kumar et al., 2020

Action Plan for rural waste management in India

The Government of India as well as state government is looking up at every Gram Panchayats (GPs) to come up with a working system to manage solid waste. At the moment there are Gram Panchayats in Tamil Nadu, Andhra Pradesh, West Bengal, Gujarat and Chhattisgarh which have created a robust and sustainable system to manage solid waste.

Presently in Pauri Garhwal district, the amount of solid waste generation from rural areas is unaccounted due to lack of waste management facilities and awareness. Some of the policies are propagated by both Central and State government to come up with an array of practicable models for solid waste management in rural areas.

Table 60. Policies undertaken for rural waste management in India

Current Policy	**Sponsoring agency**	**Remarks**
Decentralized Waste Management	Under Swachh Bharat Mission-Gramin (SBM-G)	Decentralized systems such as household compost and biogas plants shall be encouraged.
Community Sanitary Complex (CSCs)	Under Swachh Bharat Mission-Gramin (SBM-G)	Such complexes comprise an appropriate number of toilet seats, bathing cubicles etc.(Only where there is a lack of space in the village for the construction of household toilets).
Cluster Approach to Solid Waste Management	Rurban Mission of Ministry of Rural Development	It aims at developing infrastructure and livelihood opportunities in a cluster of Gram panchayats that demonstrate economic growth potentials.
Community Participation through IEC (Information, Education and Communication) Activities	National Institute of Rural Development and Panchayati Raj	All the stakeholders need to plan for a series of IEC campaigns to educate the residents on how proper segregation at the household levels eases the entire process of managing waste at subsequent stages.

Action Plan for Bio-Medical Waste

Focus Areas

- *Pre-segregation of waste before transport & disposal*
- *Tracking of bio-medical waste*
- *Linkage of major HCFs with* CBMWTF

With the onset of the pandemic, it has become clear that a proper healthcare system is need of the hour. It also provides the opportunity to improve biomedical waste management in the district. Moreover, during outbreaks such as covid-19, materials or substances which carry infection (fomites) acts as key vehicle for the transmission of the disease. Streamlining the bio-medical waste may help in reducing the infection and its transmission. This action plan provides holistic approach, which includes governance, infrastructure, training and immunization, services etc. to tackle the unprecedented growth in biomedical waste. Immediate action is required in some of the areas such as segregation and tracking of the waste generated etc. while other action points must be executed in due course of time (Table 61).

Table 61. Action plan for bio-medical waste

Action Areas	Purpose	Stakeholders
Governance		
Periodic inspection of Health-care Facilities (HCFs) by Uttarakhand state Pollution control board (UKPCB).	To ensure proper segregation of Biomedical waste as per Biomedical waste management rules, 2016.	Uttarakhand state Pollution control board
Linkage of ULBs with Common Biomedical waste treatment facility(CBWTF).	To ensure segregation of Biomedical waste from Municipal solid waste and thus its proper disposal as per Biomedical waste management rules,2016.	All ULBs
Infrastructure		
Construction and maintenance of Biomedical waste collection shed at district level HCFs and CHCs.	To ensure proper segregation of Biomedical waste into different categories as specified under Biomedical waste management rules,2016.	Health Department
Installation of effluent treatment plants in district level HCFs and CHCs.	To ensure disposal of liquid effluent generated in the HCFs.	Health Department
Training and Immunisation		
State level and District level orientation programs for healthcare workers to sensitize them about effective Biomedical waste management.	To ensure proper handling and segregation of biomedical waste in HCFs	Health department

• **Setting up of Biomedical Waste Database at State level (specifically for primary health-care facilities)** • **Training on Biomedical Waste Management Information System(BMWMIS) to all data entry operators and pharmacists.**	To keep records of biomedical waste generated in every HCF of the district (especially in PHCs at rural areas).	Health department
Immunisation (Tetanus and complete doses of Hepatitis-B) of all hospital staff involved in Biomedical waste management.	To avoid any kind of infection while handling Biomedical waste.	Health department
Services		
Establishing bins and bags at each generation points in HCFs with IEC posters displayed.	• To ensure segregation at each generation point and avoid mixing with MSW. • To spread awareness amongst the people related to Biomedical waste management.	Health department
Timely replacement of bags, BMW transfer to collection shed and then prompt lifting to biomedical waste treatment facility from the shed.	To ensure timely disposal of biomedical waste.	Health Department and Uttarakhand state Pollution control board (UKPCB).
Bar code system for tracking bags and containers and use of GPS enabled systems in transportation vehicles.	To ensure tracking of biomedical waste collection, Transportation, disposal and recycling as specified under Biomedical waste management rules,2016 .	Health Department and Uttarakhand state Pollution control board (UKPCB).
Information		
Development of an IT-enabled data management system to keep inventory of waste collection, consumables supply, training programs etc. in HCFs (including PHCs in the district)	To ensure transparency in the biomedical waste management system up to primary level.	Health Department
Display details of authorisation, treatment, annual report of all Health-care facilities(HCFs) on website.	To make the information open source and ensure transparency.	Health Department and Uttarakhand state Pollution control board (UKPCB).

Action Plan for C&D Waste Management

Increase in C&D waste generation is expected in decades to come due to rapid urbanization and modernising infrastructure. Hence, some basic facilities need to be developed to manage its growth. The action plan provides below provide a sustainable approach for the management of the C&D waste in compliance with the latest C&D waste management rules 2016 (Table 62).

Focus Areas

- *Establishment of dunping zones*
- *Framing bye-laws regarding C&D waste*

Table 62. Action plan for C&D waste management

Action Point	Purpose	Strategy / Approach	Stakeholders Responsible
Setting up of C&D waste dumping Site for local construction activities and road construction debris.	To ensure compliance with C&D Waste Management Rules 2016.	• Establishment of dumping zone such that it also caters for C&D waste of Peri-urban areas nearby villages. • Proper collection and transportation systems should be set up to aid processing. Illegal dumping practices must be discouraged due to penalties on open dumping. • Establishment of dumping zone in district road, village road.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)
Framing by-laws for C&D waste management.	To ensure compliance with C&D Waste Management Rules 2016.	• By-laws should be framed by each ULBs and DPRO as per C&D waste management rule for proper disposal of C&D waste in the district. • Provision of heavy fines should be done under these by-laws for illegal dumping of demolition waste such as excavated earth material on the banks of river or on the hill slopes.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)
Management of C&D waste.	To ensure that C&D waste comes to the recycling plants as segregated input, and the recycled products are picked up for use in construction.	• Managing C&D waste separately from municipal solid waste. • Enhancing awareness and incentivization for efficient C&D waste handling and processing.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)
Plantation in old dump sites.	Established the slope at old dumping zones.	• Plantation at old dumping zone should be done with the help of community participation to stabilize the slope over there.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)

Action Plan for Hazardous Waste

Hazardous waste can be a potential threat to human health and environment. This makes it necessary to manage hazardous waste to minimize its harmful impact. At present inPauri Garhwal district, hazardous waste is not handled in a scientific way. This action plan provides some key areas in which the district needs to work to achieve effective hazardous waste management complying with latest hazardous waste management rules, 2016 (Table 63).

Focus Areas

- *Primary segregation of hazardous waste*
- *Linkage of ULBs with TSDF*

Table 63. Action plan for hazardous waste

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Linkage of ULBs with common Treatment, Storage and Disposal Facilities (TSDF) or disposal facility	To ensure segregation of domestic hazardous waste from municipal solid waste and its proper disposal.	All the ULBs of the district should establish linkage with nearby common TSDF or disposal facility to ensure proper disposal of hazardous waste to avoid its dumping in the landfill site. One Collection facility should be setup in the district to collect domestic hazardous waste from the rural areas of the district.	All ULBs & *District Panchayati Raj officer* (DPRO*)*
Training of sanitation workers regarding segregation of domestic hazardous waste	To ensure segregation of domestic hazardous waste from municipal solid waste	Training programme should be organised at state/district level for handling and segregation of domestic hazardous waste so that sanitation workers should not catch any kind of infection during its handing and its proper segregation could be possible.	State government and District Administration
IT enabled systems for inventorization of the hazardous waste m	To ensure compliance to Hazardous waste management rule 2016.	State pollution control board should inventories the generation, collection, and disposal of both domestic and industrial hazardous waste on its website so that complete transparency is maintained in the management of hazardous waste in the district.	State pollution control board

Action Plan for E-Waste

Due to lack of basic waste management operations for E-waste, its quantity cannot be determined in the district. This may be due to lack of awareness amongst the people regarding E-waste as well as lack of concern by district administration. E-waste needs to be streamlined in the current waste management operation, moreover a detailed framework must be developed for its management. This action plan discusses key areas where intervention is needed to achieve effective waste management in compliance with E-waste management rules, 2016.Some of the action needs to be addressed immediately such as establishment of collection centre etc. while others can be initiated with the due course of time (Table 64).

Focus Areas

- *Inventorization of e-waste generated*
- *Establishment of e-waste collection centres*
- *Authorization of e-waste pickers*

Table 64. Action plan for E-waste

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Establishing E-waste Collection Centres	• To ensure proper segregation of E-waste from municipal solid waste • Capacity building of stakeholders to promote effective E-waste management.	• Collection centre should be established for all ULBs in such a way that they could also cater the collection from nearby rural areas. • A Toll Free Number must be issued for the collection of E-waste	All ULBs
Authorization of E-Waste Pickers	To avoid illegal trading and processing of e-waste.	Authorization of E-waste pickers should be done by district administration and urban local bodies. For that, Identity cards should be issued to them.	District administration and ULBs
Linkage of ULBs with authorized recyclers/ Dismantlers	To ensure proper recycling if possible and if not then proper disposal as per E-waste management rule 2016.	All the ULBs in the district should establish linkage with any of the five authorized E-waste recyclers.	All ULBs
District level Awareness campaign	Promoting behavioural change in public.	• Promoting Information, Education and Communication (IEC) activities in educational institutions (Schools, Colleges etc.) • Promoting Awareness programmes under Digital India Initiative (Initiated by Ministry of Electronics and Information Technology) about alternate methods of disposing E-waste.	District administration
Extended Producer Responsibility	• Proper Collection and Disposal of E-waste • Channelization of e-waste generated from the "end-of-life" products to ensure environmentally sound management	• Random sampling of electrical and electronic equipment's placed on market to monitor and verify the compliance of Restriction of Hazardous Substances (RoHS) provisions as per the guidelines of Central Pollution Control Board (CPCB) • "E-waste Return" Programme should be initiated to incentivize people and bring about behaviour change	State government

Action Plan for Industrial Waste Water Management

Owing to its hilly terrain Pauri Garhwal district has minimal industries. Amongst all those industries, only few of them discharge industrial waste, rest of the industries operates on Zero liquid discharge principle. However, some policy intervention is required for scientific management of industrial wastewater. This action plan focusses on the areas including real time monitoring and high quality manufacturing to achieve effective industrial wastewater management (Table 65).

Table 65. Action plan for industrial waste water management

Action Point	Purpose	Stakeholders Responsible
Installing 24/7 Continuous Emission Monitoring System(CEMS)	• Real time monitoring of emission and effluent discharge points. • To keep pollution levels in check on a real-time basis.	Uttarakhand State Pollution Control Board (UKPCB)
Guidelines for Conducting Safety Audit as per NGT	• To mitigate industrial accidents.	• Central Pollution Control Board (CPCB) • Uttarakhand State Pollution Control Board (UKPCB) Ministry of Environment, Forest and Climate Change (MoEFCC)
Capital subsidies and other forms of Financial support to install ETPs	• Ensuring sustainability of Industrial units. • To encourage a calibrated green focus.	• Directorate of Industries, Government of Uttarakhand
Energy Efficiency in Industrial Sector through Perform, Achieve and Trade (PAT) Scheme	• To reduce Specific energy consumption in energy intensive structure. • To enhance cost effectiveness of energy saving through certifications of excess savings.	• Directorate of Industries, Government of Uttarakhand • Uttarakhand State Pollution Control Board (UKPCB)
Zero Effect Zero Defect (ZED) Certification	• To achieve high quality manufacturing that's also green. • To Rate MSMEs (Micro, Small and Medium Enterprises) on quality control and certification for energy efficiency.	• Directorate of Industries, Government of Uttarakhand • Uttarakhand State Pollution Control Board (UKPCB)

Action Plan for Water Resources Management and Ground Water Extraction/Contamination

Water Resources and Groundwater management requires an integrated approach from different departments such as the District administration, Panchayati Raj, Jal Sansthan, Jal Nigam, Payjal Nigam, Forest Department etc. Each department is expected to work in tandem with each other to achieve effective management of resources, be it land or water. The action plan focuses on the areas, which form the prerequisite for effective water resource management. Each action point is in compliance with the guidelines under Water (prevention and control of pollution act, 1974), (Amendment) Rules, 2021 of water resource management act, 1986. The current action points must be addressed in a timeframe of 5-10 year considering the financial constraints (Table 66 & 67).

Focus Areas

- *Mapping of water scarce areas*
- *Encouraging the use of organic fertilizers*
- *Emphasis on crop diversification*

Table 66. Water Resources management

Action Point	Purpose	Strategy/Approach
Integrated water resources management (IWRM) at River basin level	To achieve water security for all purposes ,managing risks and to mitigate disasters	By Considering basin/sub basin as a basic unit for planning and management.
River Basin Master Plan	Periodic review of hydrological conditions prevailing over a basin Identification of protected areas	By analysing River Basin Characteristics
Mapping of water scarce areas in a district	To get estimate of vulnerable areas in the district.	• By using modern mapping tools such as Geographical Information System(GIS) and Remote sensing • By setting up an interdisciplinary framework consisting of Local institution and empowered government agency
Assessment of water Resources in various river basin	To collect reliable data To assess water resources potential and analysing water requirements for various uses,	Using Modern technology and Hydrological modelling
Public Awareness and use of Low Cost technologies	For better water application efficiency	Using field application methods such as Drip irrigation/micro sprinkler irrigation systems in water scarce areas. This can be achieved by bringing government subsidies in this area as the local people needs incentives to up bring this modern technology.
Integrated Rural area Programme(IRAP)	• For constant interactive relationships between different departments • Location specific programmes can be drawn up locally under this overall programme.	By bringing together all the programmes of different ministries as well as rural employment and development programme into one for effective collaboration and planning.

Table 67. Ground water management

Action Point	Purpose	Strategy/Approach
Multidisciplinary Approach(Nexus between groundwater,agricultural policy,urban infrastructure and energy consumption)	For groundwater sustainability	By integrated vision and coordination amongst different departments.
Mapping of aquifer at micro level	• To quantify the available ground water resources • To formulate plan appropriate to the scale of demands and aquifer characteristics.	By Maintaining an Aquifer information and Management system
Artificial recharge of Ground water	• To ensure sustainability of ground water resources • To ensure the quality of recharge to prevent possible contamination	• By demarcating groundwater recharge zones by identifying critical natural recharge areas of an aquifer and those areas that require special attention with regard to recharge of groundwater. • By using broad leaf plants to improve the moisture content in the soil and thereby increasing the groundwater level and water holding capacity of soil. • Improving the scale of work done through various schemes such as MNREGA which will help develop indigenous recharge methods (such as Chal-khal).
Identification of Non-point sources of Pollution (Pollution resulting from land runoff, precipitation, drainage, seepage etc.)	Non-point source pollution is a leading cause of deteriorating water quality as when the runoff moves ,it picks up and carries away natural and human-made pollutants finally depositing them in lakes,rivers and groundwater.	• Controlling soil erosion by planting more trees and covering bare soil with vegetation. • Constructing wetlands.
Mitigating Groundwater Contamination	• To ensure the ground water quality of an area. • To reduce health hazards caused due to contaminated water.	• Reducing the use of pesticides and fertilizers. • Encouraging Organic farming in the area by organising various Information ,Education and Communication (IEC) campaigns.

Action Plan for Air Quality Management

Focus Areas

- *Increase in Air quality monitoring stations*
- *Control of forest fires*

As the anthropogenic activities in the district are mainly responsible for increased levels of pollutants in the region, so the participation of various institutions along with the local community is desired. The first and the foremost thing is establishing air quality monitoring station in the district. The action plan provided below deals with all the aspects, which are necessary to solve the issue (Table 68).

Table 68. Action plan for air quality management

Action Areas	Purpose	Strategies/Approach	Stakeholders
Air quality monitoring	To identify the hotspots within the district and further development of mitigation measures for those areas.	Ambient air quality monitoring stations can be installed in all the urban centres and other identified areas such as construction sites after manual air quality monitoring.	Uttarakhand state pollution control board (UKPCB)
Solid waste collection system	To reduce emission of harmful gases by open burning of waste especially in urban areas.	• Door to Door collection of waste in the peri-urban areas and provision of dry waste collection from rural areas within the district. • After implementing proper collection mechanism, provision of heavy fines should be made on open burning of waste.	All ULBs and DPRODistrict Panchayati Raj Office (DPRO)
Control over forest fires	To reduce harmful emissions due to massive forest fires in the district.	• Providing the forest department adequate manpower and machinery to control forest fires. • Proper coordination between various departments involved in this operation. • Proper inspection of civil forests and forests under van panchayats by training the personnel engaged in the maintenance of these forests. • Development of mixed forests by planting indigenous broadleaf plants which maintains	Government of Uttarakhand and District Forest Department

		moisture in the soil and reduce the chances of fire.	
Vehicular Traffic management	To reduce emissions caused by vehicles.	• Checking adulteration of fuel • Promoting intercity and intra-city public transportation with green fuel alternatives such e-buses & rickshaws etc. • Paving of road shoulders especially in urban areas.	• Department of Police • Transport Department • Public works department
District level action plan for air pollution	To improve existing air quality.	A district level task force with some experts can be formed for air quality management in the district.	District Administration
Awareness on air quality	To promote awareness among the masses regarding the issue.	Mass awareness can be promoted with IEC activities by involving institutions such as schools and colleges for this purpose.	District Administration
Complaint redressal system	To sort out grievances registered by citizens	Online complaint registration and redressal system should be formed at the district level to register complaints regarding air pollution issues.	• Uttarakhand state pollution control board (UKPCB) • District administration

Action Plan for Noise Pollution management

Presently, Noise pollution is not a big issue in the district. It prevails only at festive times and public gatherings. However, actual noise level cannot be ascertained due to lack of monitoring station. This action plan focuses on key aspects that requires minimal financial interventions and maximum management (Table 69).

Table 69. Action Plan for Noise pollution management

Action Areas	Purpose	Strategies/Approach	Stakeholders
Noise level monitoring	To recognize the current situation of noise levels in the district and identify the hotspots	Noise monitoring studies need to be done in the district especially within the urban centres within the district by manual monitoring. In the areas identified as hotspots, continuous monitoring stations should be set up.	Uttarakhand state pollution control board (UKPCB)
Traffic management	To ensure noise level within permissible limits	Signboards should be placed at sensitive locations in the towns within the districts and if required silent zones should be established Green belts can be formed along the roads in the urban areas to reduce noise levels.	• District Administration • Public Works department and ULBs
Complaint redressing system	To sort out grievances registered by citizens	Online complaint registration and redressal system for noise pollution should be made which can be used by citizens, Traffic police, ULBs, and state pollution control board.	District Administration
Mass Awareness	To promote awareness among the masses regarding the issue	Mass awareness campaigns must be organized with the help of IEC activities by taking the help of institutions such as schools and colleges for this purpose	District Administration

Action Plan Mining Activity management

Although the cases of illegal mining practices are not yet registered by the state pollution control board and other concerned authorities in the district, precautionary measures are necessary keeping in mind the future aspects. Further, it is also necessary to be aware of the cases of illegal mining, which remains unregistered so far. The action plan provided below mainly emphasize on areas, which includes monitoring of the mining operation by using the latest technologies as per the sustainable sand mining guidelines 2016 (Table 70).

Focus Areas

- *Identification of mining hotspots*
- *Digitization of trading process*

Table 70. Mining activity management plan

Action Areas	Purpose	Strategies/Approach	Stakeholders
Monitoring of mining activity	To ensure sustainable mining activity within the district.	• A district-level task force should be formed to monitor mining activities and to conduct river audits and surveillance. • For the rivers marking the boundaries with other districts, a combined task force should be formed to monitor mining activity in the river.	District Administration
System for online purchase and sale of Sand and other RBMs	To ensure compliance to Enforcement and Monitoring guidelines for Sand mining, 2020.	An online system should be made at the state or district level for e-auctioning the mines to ensure transparency in the system.	State Government and District Administration
Identification of hotspots for illegal mining	To have check on the mining activities in the district.	The district task force should identify the possible hotspots for illegal mining through surveillance and patrolling.	District Administration
Community participation	• To understand local community's willingness in curbing illegal mining from the area. • To have local check on the illegal mining activities in the district.	A toll-free number must be issued for citizens in the district to register any complaint against any illegal mining practices as identified by them in their vicinity	District Administration

Action Plan for Rejuvenation of Waterbodies

Pauri Garhwal district administration has already undertaken the task of rejuvenating two rivers using various methods. Aim is to revive the flow of the rivers and to restore their ecology. This action plan provides a holistic approach, which includes scientific interventions as well as convergence activities (Table 71).

Table 71. Action Plan for Rejuvenation of water bodies

Action Point	Strategy/Approach	Purpose
River Catchment/Basin Management	Participatory and self-management institutional framework for administering the catchment with a combination of engineering, social and scientific management.	• Reducing levels of potential contaminants in raw water. • Distribution of water and prioritization of water uses under stressed conditions.
Plantation in Flood plain zones(FPZ)	Vegetation that acts as natural resistant to soil disturbances and standing water must be encouraged.	• To reduce shoreline erosion • Particular type of plants acts as natural barriers to dissipate waves and back-lying areas from flooding.
Prohibition of disposal of municipal plastic waste and Biomedical waste (specially in flood plain zones)	• Awareness and behavioural change activities. • Provisions of heavy fine for those found throwing garbage in rivers.	• To maintain ecological balance of the water body • To prevent pollution activities nearby river basin.
Spring-shed and Stream shed management	• By constructing loose boulder, check dams. • Encouraging IEC (Information, Education and Communication) activities in local institutions (schools, colleges etc.)	• To improve water resource sustainability • To enhance water discharge from springs and rivers
Convergence Activities	By making use of social media platforms.	Ensuring Community participation

**Key points for the action areas in this thematic areas influenced by rejuvenation activities for River Kosi (Almora), River Bhela (Kashipur) and River Heval (Pauri Garhwal)*

Action Plan for Plastic Waste Management

Plastic waste causes a plethora of problems when it leaks into the environment. Stranded single use plastics create visual pollution. There is evidence that the toxic chemicals added during the manufacture of plastic, transfers to animal tissue, eventually entering the human food chain. Moreover, by clogging sewers and providing breeding grounds for mosquitoes and pests, plastic bags can increase the transmission of vector-borne diseases like malaria, cholera. The current policies and legislation against use of plastic in fragile Himalayan ecosystem needs revamp as most of the policies are plain centric. However, some basic action areas like source segregation, effective collection and transport requires urgent redressal. Each action point complies with the guidelines of Plastic Waste Management rules, 2016. The current action points must be addressed in a timeframe of 5-10 years considering the financial constraints (Table 72).

Focus Areas

- *Collection centres in rural areas*
- *Formalisation of waste pickers*

Table 72. Action Plan for Plastic waste management

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Source segregation	• To ensure better efficiency in waste processing • Higher recovery of resources.	• ULBs should distribute separate bins to households, street vendors and other shopkeepers. • Distribution of separate bins to every households and shopkeepers in rural areas under Swachh Bharat Mission Gramin should be ensured. • Mass awareness programmes regarding source segregation with the inclusion of institutions such as schools and colleges.	All ULBs, District Panchayati raj Officer (DPRO), Village Panchayats
Effective Collection and segregated waste transport	• To reduce open dumping of waste • To reduce monkey menace (which is a huge issue in the urban areas of the state) • To ensure optimum utilisation of manpower • To ensure compliance with plastic waste management rules 2016	• Training waste pickers and providing them proper equipment suitable as per the topography of the area for door to door collection in urban areas. • Establishing plastic waste collection centres in rural areas where door to door collection is not possible. • Provision of separate vehicles is done for dry and wet waste to ensure utilisation of manpower. • ULBs can establish linkage with the NGOs working in this field for effective waste collection in the urban areas.	All ULBs, District Panchayati Raj Officer (DPRO), Village Panchayats
Linkage of ULBs & other collection centres with recyclers/ cement plants / Public Works Department	• To avoid open dumping of plastic waste. • To ensure reuse and recycle of plastic waste.	• Plastic waste collection centre to be started in rural areas should also be linked with recyclers. • Plastic waste can be used in road construction for this; ULBs should coordinate with the construction	All ULBs, DPRO (District Panchayati raj Officer),

		agencies such as Public Works Department.	
Implementation of extended producer responsibility (EPR) through producer/Brand owner	To reduce the workload of ULBs	ULBs can ask the manufacturers collectively or individually in line with the principle of extended producer responsibility (EPR) to provide the required finance to establish plastic waste collection centres.	All ULBs
Community participation for waste management	Social and Behavioural Change Communication Cleanliness drive campaigns throughout the district	• Information, Education and Communication (IEC) activities in Educational institutions. • Inter-personal communication (IPC): School children and Sanitation workers to spread awareness amongst people regarding waste management	District Administration
Establishment of Green Protocol	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.	By encouraging Green protocol in local schools, publicfunctions, IECcampaigns, sports events, annual temple festivals and other gatherings.	District Administration

CONCLUSION

The population density in the district of Pauri Garhwal is mainly concentrated in the towns such as Kotdwar, Srinagar and Pauri. These 3 ULBs account for more than 90% (80 out of 83.01 MTPD) of solid waste generated in the district. In addition, optimum source segregation, and door-to-door collection of waste have also been under practice t in the district. Many ULBs are using material recovery facility as a part of their waste management operations. However, linkage with authorised recyclers is still a matter of concern as it gives push to informal economy and unscientific handling of plastic waste. Formalization of waste pickers by employing them in waste recovery operations may help in near future. Distinct plain and hill topographic features of the district also demand a need of topography based waste management plan. Major HCFs in the district for disposal of biomedical waste have linkage with Common Biomedical Waste Treatment and Disposal facility (CBMWTF) at Roorkee. More than 83 kg of 93.2 kg waste generated is lifted to CBMWTF daily in the district. Leftover waste is either disposed through deep burial method or incinerated. The pandemic situation like COVID-19 caused biomedical waste generation even in domestic households. There needs some strategy for its scientific handling to avoid any major health outbreak in future. This can be done by establishing linkage between ULBs and HCFs for effective management of biomedical waste. Major chunk of Char-Dham All-weather roads traverses through the district.The construction of this highway has led to generation of C&D waste for which designated dumping zones have been established. Leftover C&D waste (after filling and reparation works) in the ULBs is disposed off in these dumping zones. Sooner or later, the district administration will require framing of guidelines for management of C&D waste. Five STPS with an installed capacity of 7.6 MLD are operational in the district. However, 4 of the 5 STPs have been constructed in Nagar Nigam Srinagar and its periphery. Rest of the ULBs still rely on Septic Tanks for the disposal of waste water. Interception and diversion works are done for tapping the Nalas which discharge in the tributaries of the River Ganga. Domestic households in Srinagar district also need to be connected with STPs through sewerage system. Scientific management in Nagar Nigam Kotdwar is a need of the hour keeping in view of its population density. Air pollution has not only a concern in the plain areas rather it has also much concern regarding background values in the upper reaches of the Himalayan region. The district has no framework or instrumentation still to deal with this issue especially in majority of the sations. Forest fires have created havoc, especially in the hilly areas of the district. The highest risk of forest fires occurs between March and June which remain mostly dry. A forest fire management strategy has been devised which includes fire preventive measures, extinguishing measures, etc.

District Pauri still needs air quality monitoring stations to acertain the particulate matter as well as gaseous pollutants. The administration shall come up with an area specific action plan to mitigate air pollution. The district is quite rich in water resources, be it river or high altitude lake. As many as 12 perennial rivers and 7 lakes drain the catchment area of the district of Pauri Garhwal. Major pollution causing activities were observed to be dumping of waste in a river side, open air defecation, disposal of untreated sewage, etc. are partially controlled.Flood lines have also been demarcated along the banks of River Alaknanda. In the plain areas, tubewells are the major source of groundwater extraction in the district.Ground water is not a major issue in the district except Kotdwar where maximum extraction has been recorded in recent years. River bed mining, specifically sand mining activities are prevalent in the district.This pertains to the fact that the flood plains of the major rivers offer enormous mining potential.Some cases of illegal mining were recorded for which penalties amounting to almost 6.80 crores were charged.Increasing urbanization will increase the demand of sand in near future.Hence, major concerns will be on maintainence of the river beds and their profile and reduction unscientific mining activities. This will require collaboration of instrumentation, local people and concerned departments.

Located partly in the Indo-Gangetic plains and in the Northern Himalaya, the district of Pauri Garhwal offers a good case study for environment planners to devise a plan suitable for this varied topography. Allocation of funds in accordance with the policy will also play a major role in bringing harmony between existing environment from plains to hills and developmental needs of the district.

Fig. 8. Consultative workshops with different stakeholders in the district Pauri for the preparation of District Environment Plan (October 27, 2020)

REFERENCES

Anonymous, (2016). Solid Waste Management in Rural Areas a Step-by-Step Guide for Gram Panchayats, A Companion to The Facilitators of Swachh Bharat Mission (Gramin), Centre for Rural Infrastructure National Institute of Rural Development & Panchayati Raj Rajendranagar, Hyderabad,

Anonymous, (2018). "Uttarakhand Vision 2030" Department of Planning Commission, Government of Uttarakhand, Institute for Human DevelopmentPlot No. 84, Functional Industrial Estate (FIE), Patparganj, Delhi- 110092.

ASSOCHAM, (2018). Electricals & Electronics Manufacturing in India (2018) NEC Technologies India Private Limited,Advant Navis Business Park, Plot No.-7, Noida, New Delhi.

Attri, S.D., & Tyagi, A. (2010). Climate profile of India. Environment Monitoring and Research Center, India Meteorology Department: New Delhi, India.

Azash, S.M.D. & Thirupalu, N. (2017). Fundamental Principles of Environmental Protection and Sustainable Development, National Conference on Marketing and Sustainable Development, Vol. 13, pp 14,

Azeez, N.M., & Sabbar, A.A. (2012). Efficiency of duckweed (Lemna minor L.) in phytotreatment of wastewater pollutants from Basrah oil refinery. Journal of Applied Phytotechnology in Environmental Sanitation, 1(4), 163-172.

CPCB (2013). Overview of Plastic Waste Management,Central Pollution Control Board,Parivesh Bhawan, East Arjun Nagar,Delhi-110032

CPCB (2019). Biomedical waste management as per biomedical waste management rules 2016, Central Pollution Control Board,Parivesh Bhawan, East Arjun Nagar,Delhi-110032.

Dineva, S. B. (2017). Leaf blade structure of Morus alba L. and resistance to industrial pollution. Journal of Applied Forest Ecology, 5, 1-8.

District Census Handbook (2011) District Census Handbook Pauri Garhwal, Census 2011, http://www.censusindia.gov.in/2011census/dchb/0507_PART_A_DCHB_Pauri Garhwal.pdf.

District Statistical Report (2018) District statistical Handbook 2018, Pauri Garhwal, District Pauri Garhwal, Uttarakhand.

Forest Survey of India (FSI, 2019) An Assessment Report on Forest Cover Status of India. Government of India: Ministry of Environment and Forest (MoEF); Forest Survey of India Dehradun, Vol-II, pp, 284-294, https://fsi.nic.in/forest-report-2019.

Gajananda, K, Kuniyal, J.C., Monin, G.A., Rao, P.S.P., Safai, P.D., Tiwari, S. and Ali, K. (2005) Trend of atmospheric aerosols over the north western Himalayan region, India, *Atmospheric Environment* 39(27): 4817-4825.

Groundwater Year Book India 2019-20 (2020) Central Ground Water Board (CGWB), Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India,

Janta, R., Chantara, S., Inta, A., Kawashima, M., & Satake, K. (2016). Levels of road traffic heavy metals in tree bark layers of Cassia fistula tree. International Journal of Environmental Science and Development, 7(5), pp 385-388.

Kuniyal, J.C. (2005a) Solid waste management techniques for the waste generated and brought down from campsites in the hill spots, trails and expedition tops, *Waste Management and Research* 23(3): 182-198

Kuniyal, J.C. (2005b) Solid waste management in the Himalayan trails and expedition summit, *Journal of Sustainable Tourism* 13(4): pp 391-410.

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

Houda, Z., Bejaoui, Z., Albouchi, A., Gupta, D. K., & Corpas, F. J. (2016). Comparative study of plant growth of two poplar tree species irrigated with treated wastewater, with particular reference to accumulation of heavy metals (Cd, Pb, As, and Ni). Environmental monitoring and assessment, 188(2), pp 1-10.

Khan, S.M., Page, S., Ahmad, H., Shaheen, H., Harper, D. (2012). Vegetation dynamicsin the Western Himalayas, diversity indices and climate change. Sci. Technol.Dev. 31 (3), 232e243.

Malik A, Kumar A, Guhathakurta P and Kisi O, (2019). "Spatial-temporal trend analysisof seasonal and annual rainfall (1966–2015) using innovative trend analysis methodwith significance test", Arabian Journal of Geosciences 12:328, https://doi.org/10.1007/s12517-019-4454-5.

Messerli, P., Murniningtyas, E., Eloundou, P., Foli, E. G., Furman, E., Glassman, A,& Ypersele, J. P. (2019). Global sustainable development report 2019: the future is now–science for achieving sustainable development (2019).

Pal, S.S., Kansal, A., Rawat, T. (2018) Bio-medical waste in Pandemic COVID 19 Uttarakhand UKPCB, ENVIS Newsletter16(2): 1-6.

Prajapati, S.K. (2012) Bio-monitoring and speciation of road dust for heavy metals using *Calotropis procera* and *Delbergia sissoo*"*Environmental Skeptics and Critics* 1(4): 61-64.

Sekabira, K., Oryem–Origa, H., Mutumba, G.B., & Basamba, T.A. (2011). Heavy metal phytoremediation by *Commelina benghalensis* (L) and *Cynodon dactylon* (L) growing in urban stream sediments.International Journal of Plant Physiology and Biochemistry, Vol. 3(8), pp. 133-142.

The Groundwater Foundation (2020) National Groundwater Association, Accessed website (17 May 2020).

Ukpebor, E.E., Ukpebor, J.E., Aigbokhan, E., Goji, I., Onojeghuo, A.O., & Okonkwo, A.C. (2010). *Delonix regia* and *Casuarina equisetifolia* as passive bio-monitors and as bioaccumulators of atmospheric trace metals. Journal of Environmental sciences, 22(7), 1073-1079.

UNDP Report, (2018-2024). Handbook on Sustainable Urban Plastic Waste Management, United Nations Development Programme (UNDP) andNITI Aayog New Delhi, pp.1-142.

Vazquez, S., Martín, A., Garcia, M., Espanol, C., & Navarro, E. (2016). Metal uptake of Nerium oleander from aerial and underground organs and its use as a biomonitoring tool for airborne metallic pollution in cities. Environmental Science and Pollution Research, 23(8), 7582-7594.

Wetlands of Uttarakhand (2012), Report jointly published by the Uttarakhand ForestDepartment and WWF India, pp 1-194,DOI:10.13140/RG.2.2.14255.02728

WHO, (2018). Delivering Quality Health Services: a global imperative for universal health coverage. World Health Organization, OECD & International Bank for Reconstruction and Development. Pp 93, ISBN 978-92-64-30030-9

Websites Used

http://www.uttarainformation.gov.in/

http://www.nird.org.in

https://in.nec.com/en_IN/pdf/

https://ueppcb.uk.gov.in/

https://fsi.nic.in/forest-report

https://www.maplecroft.com/

https://www.wri.org

https://www.newagepublishers.com

https:// garhwal.nic.in

https://www.ihdindia.org.in