DISTRICT ENVIRONMENTAL PLAN

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

CHAMOLI

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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 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 District Magistrate. 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 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 Secretary, MoEFCC and Chairman, CPCB.

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 strategies 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 view point of sustainable development. We hope this document will act as a noble reference for various stakeholders interested in sustainable development planning for the Chamoli district. 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: Principal Investigator, Co-Project Investigators & Project staff

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ABBREVIATIONS

AMRUT	- Atal Mission for Rejuvenation and Urban Transformation
APL	- Above Poverty Line
AR6	- Sixth Assessment Report
As	- Arsenic
ASSOCHAM	- Associated Chambers of Commerce and Industry of India
BaP	- Benzo(a) Pyrene
BMWMIS	- Biomedical Waste Management Information System
BPL	- Below Poverty Line
C	- Carbon
C_6H_6	- Benzene
C&D waste	- Construction and Demolition waste
CACMP	- Catchment Area Conservation and Management Plan
CAMPA	- Compensatory Afforestation Fund Management and Planning Authority
CBMWTF	- Common Bio-Medical Waste Treatment Facility
Cd	- Cadmium
CD	- Check Dam
CETP	- Common Effluent Treatment Plant
CFL	- Compact Fluorescent Lamp
CGWB	- Central Ground Water Board
CH_4	- Methane
CHC	- Community Healthcare Centre
CK	- Chal Khal
CO	- Carbon monoxide
CO_2	- Carbon dioxide
CPCB	- Central Pollution Control Board
CPHEEO	- Central Public Health and Environmental Engineering Organization
Cr	- Chromium
CSC	- Community Sanitary Complex
CT	- Contour Trench
Cu	- Copper
DPR	- Detailed Project Report
DPRO	- District Panchayati Raj officer
EEE	- Electronics and Electrical Equipment

EEMI	- Electricals & Electronics Manufacturing in India
ENVIS	- Environmental Information System
ETP	- Effluent Treatment Plant
E-waste	- Electronic waste
F	- Fluoride
FPZ	- Flood Plain Zones
FSI	- Forest Survey of India
FSSM	- Faecal Sludge and Septage Management
GBPNIHE	- Govind Ballabh Pant National Institute of Himalayan Environment
GIS	- Geographical Information System
GPS	- Global Positioning System
HCF	- Health Care Facility
HFL	- Highest Flood Level
ICIMOD	- International Centre for Integrated Mountain Development
ICT	- Information and Communication Technology
IEC	- Information, Education and Communication
IHHL	- Individual House Hold Latrine
IPC	- Inter-Personal Communication
IPCC	- Intergovernmental Panel on Climate Change
IRAP	- Integrated Rural Accessibility Planning
ISO	- International Organization for Standardization
ISWM	- Integrated Solid Waste Management
IWRM	- Integrated Water Resources Management
MDWS	- Ministry of Drinking Water and Sanitation
MMT	- Million Metric Tons
MoEFCC	- Ministry of Environment, Forest and Climate Change
MoF	- Ministry of Finance
MoUHA	- Ministry of Urban and Housing Affairs
MRF	- Material Recovery Facility
MSW	- Municipal Solid Waste
MTPD	- Metric Ton per Day
NA	- Data Not Available/ Not Applicable
NATCOM	- National Communication
NAAQS	- National Ambient Air Quality Standards

NCAP	- National Clean Air Programme
NCEPC	- National Committee on Environment Planning and Coordination
NGO	- Non-Governmental Organization
NGT	- National Green Tribunal
NH	- National Highway
NH_3	- Ammonia
Ni	- Nickel
NITI	- National Institution for Transforming India
NO_2	- Nitrogen Dioxide
NP	- Nagar Panchayat
NPP	- Nagar Palika Parishad
NUSP	- National Urban Sanitation Policy
ODF	- Open Defecation Free
OSS	- On-Site Sanitation
O_3	- Ozone
Pb	- Lead
PCC	- Pollution Control Committee
PHC	- Primary Healthcare Centre
PM	- Particulate Matter
PT	- Percolation Tank
PUC	- Pollution under Control
PWD	- Public Works Department
QPD	- Quintal per Day
RBM	- River Bed Mineral
RoHS	- Restriction of Hazardous Substances
RSM	- Rural Sanitary Mart
RTRWH	- Rooftop Rain Water Harvesting
RWD	- Rural Works Department
SBM-G	- Swachh Bharat Mission-Gramin
SDG	- Sustainable Developmental Goals
SLWM	- Solid and Liquid Waste Management
SO_2	- Sulphur Dioxide
SPCB	- State Pollution Control Board
SSMG	- Sustainable Sand Management Guidelines

STP	- Sewage Treatment Plant
TPD	- Tons per Day
TSDF	- Treatment Storage and Disposal Facilities
UKPCB	- Uttarakhand Pollution Control Board
ULB	- Urban Local Body
UNDP	- United Nations Development Programme
WHO	- World Health Organization
µg	- Microgram

EXECUTIVE SUMMARY

Chamoli district falls in both lesser and greater Himalayan belt and is considered to be much pristine. However, the environmental degradation has been experiencing from the past few decades. While the implications of environmental and climate change are numerous and complex, economic growth and population growth are the major factors that increase anthropogenic stress due to human interference on different components of 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 a district Environment plan. Considering Almora district report as a model report, detailed deliberations were carried out to devise the action plan focusing on explicit thematic areas an under:

- ***Waste Management Operations:*** Most of the ULBs of the district are performing optimum primary segregation and door to door collection. However, management of dry waste is still an issue in the district.

  Projected population and waste estimations shows that generation of solid waste will increase manifolds in coming decades. Moreover, waste composition will also change with the development and urbanization of towns.

  Plastic waste generation in district is far less compared to other regions of the district. Huge tourist and influx during yatras season and festive events leads to increment in floating waste and littering activities. Other waste such as hazardous waste and electronic waste needs to be streamlined in current waste management operations in near future.
- ***Biomedical Waste Management:*** The current scenario has stressed on the need of proper biomedical waste treatment facilities in the district as the generation of biomedical waste is increasing exponentially *(up to four times more from pre-covid levels)*. Authorisation and certification of healthcare facilities must include regular audits to ascertain the status quo regarding biomedical waste management.

  Moreover, due to continuous threats of epidemic, the time has come when the government should take onus of setting up at least one common biomedical waste treatment facility (CBWTF) for a cluster of three to four districts.
- ***Construction and demolition waste management:*** Rapid urbanisation and development of road and rail infrastructure in the district has led to increase in the generation of construction and demolition waste. However, the district still lacks mechanism for proper

management of this waste. By laws should be framed to have a common set of guidelines for C&D waste management.

- **Waste water Management**: At present, sewage treatment facility is available in five urban local bodies of the district. However, none of these five ULBs have 100 percent coverage of the sewerage network. Rest of the ULBs are still relying on the on-site sanitation method of septic tank + soak pit. Faecal Sludge and Septage Management (FSSM) services can be implemented as recommended by Government of India to achieve safe and sustainable sanitation.
- ***Air and Noise Pollution:*** From past decades, Particulate pollution has been no longer a feature of Indo-Gangetic plains alone. Events of massive forest fires are increasing and the vehicular pollution is also soaring in mountainous regions. Some policies have been floated at departmental level to lessen the impact of forest fires. However, the need of continuous monitoring of air quality and a robust mitigation strategy cannot be understated.
- ***Surface and Groundwater Management:*** Alaknanda river system is the main drainage system in the district. Several works have been undertaken under "Namami Gange Programme" to maintain the riverine ecology and to set development goals in consonance with socio-environment needs of the district.

  Local administration and other departments are also playing their part for water resources management. Mission Mothugad is one such mission that has been undertaken to revive the flow of river Mothugad. Several recharge zone has been identified which will replenish the surface water as well as groundwater of the region. Other scientific and engineering measures are also proposed for the project accomplishment.
- ***Mining activity:*** Soapstone and River bed mineral mining activities are common the district. Although cases of illegal mining are minimal, still district level task force must be constituted to properly monitor the mining activity in the district. Moreover, mining activities must not lead to extensive degradation of river bed and must meet the consent of local people.

The execution of this management plan in Chamoli district will require the integration and co-operation of the stakeholders, viz., natives, public, private organization, local government, etc. This plan aims at reducing the risk on the 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 has always been 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 and 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 raised a crucial red flag regarding global temperatures that have already risen by about 1.1 ºC from pre-industrial times and has warned that 1.5 ºC threshold is likely to be breached before 2040 *(the stated objective of 2015 Paris Agreement, the international architecture to fight climate change, is to limit temperature increase to within 2 ºC 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 are also expected as 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 is also seen in the glaciological 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 a national interest because of working as a guard in view of defense purpose, unique ecosystem in view of permanent snow cover and incessant sources of water and biodiversity hotspots. The people in downhill slopes and in the Indo–Gangetic plains realize 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 and 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 traditional customs and traditional knowledge 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 to 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 begins 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 and Thirupalu, 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

Chamoli district falls in the lesser and Greater Himalaya Region in the Garhwal division of Uttarakhand state (Fig 1). It is the second-largest district of Uttarakhand and is also important from a strategic point of view as it shares international boundary with Tibet (China)in the north, district boundaries with Pithoragarh and Bageshwar in the east, Almora in the South, Pauri Garhwal in the southwest, Rudraprayag in the west and district Uttarkashi in the northwest. The district headquarter is situated at Gopeshwar, 10 kilometres from Chamoli town. The strategically important Rishikesh-Badrinath-Mana national highway (NH-58) passes through the district. The district will get connectivity with the rest of the country by railway network after completion of the under-construction Rishikesh-Karnaprayag railway line.

Bestowed with amazing natural beauty, Chamoli is an enchanting abode of the Gods. The district has alluring tourist destinations along with many sacred religious places. Shri Badrinath temple, one of the famous Char Dham pilgrimage sites located along the banks of the Alaknanda river is one of the most important shrines of the country. Shri Hemkunt Sahib, one of the most sacred pilgrimage sites of Sikh community is also situated in the district. Some other important places of worship in the district includes the famous lord Vishnu temple at Joshimath, Bhavisya Badri Temple, Kalpeshwar Temple, Gopinath Temple and the three of the Panch Prayags; Karnaprayag, Nandprayag, and Vishnuprayag.

The district is blessed with scenic landscapes such as eye-captivating snowy Himalayan peaks, alpine lakes and ponds such as Roopkund, waterfalls such as Vashudhara fall and Himalayan meadows (Bugyals) such as Auli, Bedni, and Gorson, etc. Chamoli established itself as *"most spectacular in its natural assets; be it the scenic beauty, valley aspects, water-edges, floristic varieties, dramatic landform or the climatic cardinalities".*

The great forest conservation movement "Chipko Movement" has its roots in the district. In 1974, under the guidance of the spiritual and Gandhian social worker Chandi Prasad Bhatt, activists from the Himalayan village of Gopeshwar formed a human chain and encircled trees to save them from being cut down .The Chipko movement of tree-huggers has grown into a worldwide phenomenon. It stirred up the existing civil society in India, which began to address the issues of tribal and marginalized people. Reni village in Uttarakhand's Chamoli district, the birthplace of Chipko movement, is a grim reminder of how things change, when Gaura Devi and 27 other women choose nature over themselves.

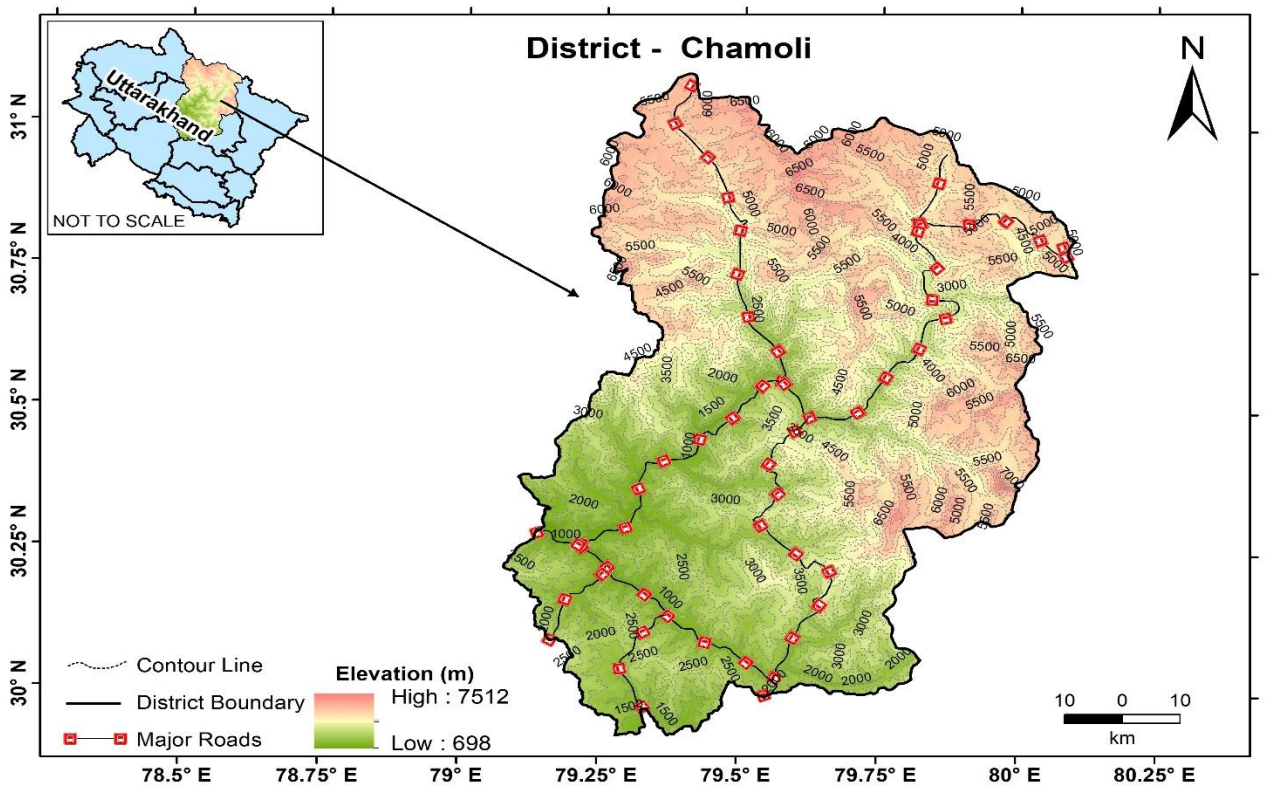


Fig. 1. Location map of Chamoli district in Uttarakhand

District at a Glance

Table 1 represents the geographical aspect, population data and administrative setup of Chamoli district.

Table 1. District at a glance

Geographical Location	
Latitude	29º 55' N to 31º 03' N
Longitude	79º 02' E to 80º 03' E
Geographical Area (km^2)	7820
Average elevation of district headquarter (m)	1550
Population Data (2011 census)	
Area (km^2)	8030
Average height above mean sea level (m)	1550
Overall Population	391605
Male Population	193991
Female Population	197614
Population density	49
Population growth rate (%)	5.74
Overall Literacy rate (%)	82.65
Male literacy (%)	93.40
Female literacy (%)	72.32
Sex Ratio	1019
Urbanised Population (%)	15.67
Rural Population (%)	84.43
Administrative Divisions	
Tehsils	12
Blocks	9
Nyay Panchayats	39
Village Panchayats	607
Total census villages	1246
Municipal councils	5
Nagar panchayats	3
Cantonment boards	1

Topography

Chamoli district comprises of high hills and mountains with very narrow valleys, deep gorges having very high gradient. The northern, northwestern, eastern and northeastern part of the district comprises Tethyan Himalaya with snow covered throughout the year. The topography is highly precipitous, consisting of series of peaks & the slopes of these peaks are covered with glaciers. These peak, are separated by the traverse deep narrow gorges of different rivers. The prevalent landforms are lateral moraines, end moraines, U-shaped glacier valleys, V-shaped fluvial valleys, river terraces and denudational structural mountains. The Lesser Himalayan range is mainly composed of highly compressed and altered rocks like granite, phyllites, quartzite etc. Some of the highest peaks of the country are located in the district (Table 2).

Table 2. Major peaks in Chamoli district

Major Peaks	Elevation (m)
Nanda Devi	7816
Kamet	7756
Chaukhamba	7138
Trishul I	7120
Dunagiri	7066
Nandakot	6861
Hathiparvat	6727
Neelkanth	6596
Mana	5545

Source: *District Survey Report, Chamoli*

The main drainage patterns are dendritic, sub-dendritic, trellis, sub-rectangular and rectangular. The major rivers are Alaknanda, Dhauli Ganga, Pindar, Nandakini etc. These rivers along with their tributaries forms the Alakananda river system. (Table 3).

Table 3. Alaknanda River Systems in Chamoli district

River System	Tributary	Confluence
The Alaknanda River System (Source- Satopanth-Bhagirat Kharak Group of glaciers)	Saraswati	Mana
	Khilarwan Ganga	Hanuman Chatti
	Dhauli Ganga	Vishnuprayag
	Nandakini	Nandprayag
	Pinder	Karnaprayag

(*Source: District Survey Report, Chamoli 2018*)

Climate

The climate varies from Sub-tropical monsoon type (mild winter, hot summer) to tropical upland type (mild winter, dry winter, short warm summer). The average maximum and minimum temperature varies between 31 ºC to –2.9ºC respectively except in the northern part of the district where the temperature dips down considerably. The northern, north-western, north-eastern and western part of the district is perennially under snow cover and the climate here is sub-arctic type. Severe winter and comparatively higher rainfall are the characteristic features of the northern part.

Rainfall

Rainfall, spatially, is highly variable depending upon the altitude. About 55 to 65% of rainfall occurs in the northern half of Central Himalayan Zone in Chamoli district. August is the rainiest month. Rainfall rapidly decreases after September and it is the least in November. About 17% of the annual precipitation occurs in winter season. The winter precipitation is in association with the passage of the western disturbances and is mostly in the form of snowfall, particularly at higher elevations. The precipitation during the pre-monsoon month is frequently associated with thunderstorms. Average annual rainfall in the district is 1230.8mm.

Groundwater

Ground water abstraction is mainly done through hand pumps with very negligible discharges. The other source of ground water in the district is in the form of springs. Large-scale ground water development is not possible in the Chamoli district since it is a hard rock area with steep slopes and low ground water potential. In this hilly district water sources are not easily accessible hence water for drinking and irrigation is a problem for the local people. Agriculture is mostly rain fed. Hence new sources need to be identified and existing sources need to be conserved and augmented.

Forests

In the district Chamoli has recorded forest cover of 2709.43 km^2 which is 33.74% of its geographical area. The forest cover under different forest sub-type was highest in the district, moderate forest cover (1580 km^2), open forest (686.43 km^2), and lowest in very dense forest (443 km^2), (Table 4) (FSI 2019). We observed that increase in forest area in Chamoli, district was due to highly out-migration. 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. Common property resources are community forests, pasturelands and water resource, which rural people use and conserve together.

Table 4. Forest Cover in Chamoli district

Particular	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Changes 2017 -2019 assessment
Forest Area Chamoli District (km^2)	8030.00	443.00	1580	686.43	2709.43	0.43

Fauna and Flora

Fauna

Chamoli District is known for its meadows of endemic alpine flowers and the variety of flora & fauna. This richly diverse area has gained importance as a region containing a diversity of alpine flora, representative of the different types of alpine shrubs & meadows. In Chamoli district, 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 and the major forest produces among these are medicinal herbs. The world-famous Valley of flower National Park, Nanda Devi Biosphere Reserve (both are

the UNESCO world heritage sites), and some part of the Kedarnath Wildlife Sanctuary which is spread over a total area of 2262.7 km^2forms the part of the district and preserves a wide variety of Himalayan flora and fauna (Table 5).

Fauna

Chamoli district, located in Garhwal Himalayas of Uttarakhand. The high altitudes (Valley of Flower Nanda Devi National Park, Mana and Niti valleys) of the district support a diverse and unique assemblage of wild flora and fauna. These valleys are situated in the heart of the Garhwal hills. In the district many wild animals such as Leopard (*Panthera pardus*), Asiatic Black bear (*Ursusthi betanus*), Indian peafowl (*Pava cristatus*), Grey Francolin (*Francolinus pondicerianus*), Black Drongo (*Dicrurus macrocercus*), Spotted Dove (*Streptopelia chinensis*), etc., (Table 5).

Table 5. Wildlife Reserves in Chamoli district

Wildlife Reserves	Altitudinal variation (m)	Type of species	Number of species
The Nanda Devi National Park	2000 to 4250	Birds	130
		Butterflies	40
		Spiders	40
		Plants	400
		Animals (Snow leopard (*Panthera uncia*), Asiatic black bear (*Ursus thibetanus*), Himalayan brown bear (*Ursus arctos*), Himalayan musk deer (*Moschus chrysogaster*), Bharal (*Pseudois nayaur*) and Himalayan tahr (*Hemitragus jemlahicus*)	
The Valley of Flowers National Park	3200 to 6675m	Flowers (*Anemone, Geranium, March marigold. Primula, Potentilla, Geum. Asters Lilium, Himalayam Blue poppy, Aconitum, Delphinium, Ranunculus, Rhododendrons)*	300
The Kedarnath Musk Deer Sanctuary	1160 to 7068m	Plant species	1100
		Mammals	23
		Birds	240
		Butterflies	147

Culture and Tradition

Residing in the mountainous region, mostly in places that are not easily accessible, the people of the district have been able to preserve their culture, folklore, folksongs *(Chanchari)* and folk dances *(The Thadiya dance, Jeetu Bhagdawal, Jagar or Ghariyali)*. Festivals play an important role in the life of people in the district, the important ones being Ram Navami, Nag Panchmi, Raksha-Bandhan, Janmashtami, Dusshera, Dipawali, Makar Sankranti, Shivratri, Holi, Bishwat Sankranti, Gaucher Mela, etc.

Nanda Devi Raj Jaat or the Himalayan Mahakumbh is a festival widely celebrated in Chamoli district in which Goddess Nanda Devi is worshiped. Devotees from both Kumaon and Garhwal region of the state along with other parts of the country participate in this sacred yatra. The festival is held for three weeks and is organised once in every twelve years in the Chamoli district. It is performed on a long route that takes almost twenty-two days to complete.

Environment Concerns in District

Chamoli district has a history of repeated natural disasters due to its geological, structural, and climatic condition. There are many instances in the recent past when these catastrophes have caused heavy losses to human life and property. These include earthquakes, landslides, floods, cloudbursts etc. The rockslide-triggered flash flood in Chamoli is one of many possible hazards in the Himalayas mountains. Mountain hazards like glacial lake outburst floods, torrential floods, debris flows, landslides, and avalanches, especially caused by the coupling of avalanches, glacier movement, snow melt, and extreme precipitation are other possible hazards common in this region. The latest Disaster struck in the District on 7 February 2021, when a massive flash flood ravaged the valleys of the Rishi Ganga, Dhauliganga, and Alaknanda rivers. The flood swept away the unfinished Tapovan Vishnugad Hydropower Project and inflicted substantial damage on the Rishi Ganga Hydropower Project. We need to understand that the impact would have been far less with more prudent development of projects in the region. Policymakers should realize that damaging today and repairing tomorrow is not an option in the Himalayan region. Occurrence of two big disasters (Kedarnath flood 2013 and Glacier burst 2021 in Joshimath), that too in a timeframe of less than a decade is an unprecedented phenomenon. Nowhere in the world has such king of events occurred within such short interval of time. There is enough data to suggest that climate change is responsible for the increasing number of severe flash floods due to glacial melt in the district.

Most of the existing hydropower projects were built in the past two to three decades, mainly starting from the downstream sections. Now, these projects are gradually moving upstream where the exposure to mountain hazards is high, the chances of multiple hazards happening in combination and occurring more frequently, and cascading effects can create compounding impacts on the system. Hydropower projects are particularly at risk because of the proximity of their infrastructure (such as diversion dams/reservoirs) to the river network where water-related hazards occur (Kumar and Katoch 2016). Many hydropower projects have been damaged by events like the Chamoli flood. For example, the Dig Tsho 1985 GLOF event in the Everest region, the 2015 earthquake, the 2014 Jure landslides, the 2013 Uttarkhand flood, and the 2016 Bhote Koshi GLOF (Nepal) damaged hydropower plants in Nepal and India (Vaidya et al. 2021). Conversely, hydropower infrastructure

also impacts the local environment, causing changes in natural flow regimes and environmental flows, alteration of aquatic ecosystems, and deterioration of water quality, among others.

One of the major concern in the district is Char Dham project. Indiscriminate blasting during road construction create crakes in soil and rocks that may enhance the possibility of flash-flood, Landslide and Cloudburst in the future. We need to develop a biodiversity management framework for Char Dham project that would be helpful to reinstate local biodiversity from adverse impacts of the project. The government is imposing a project disregarding the ecological concerns of the area. Making a road is fine, but it should be done keeping in mind its ecological implications. Else, it won't be long before another disaster hits Uttarakhand.

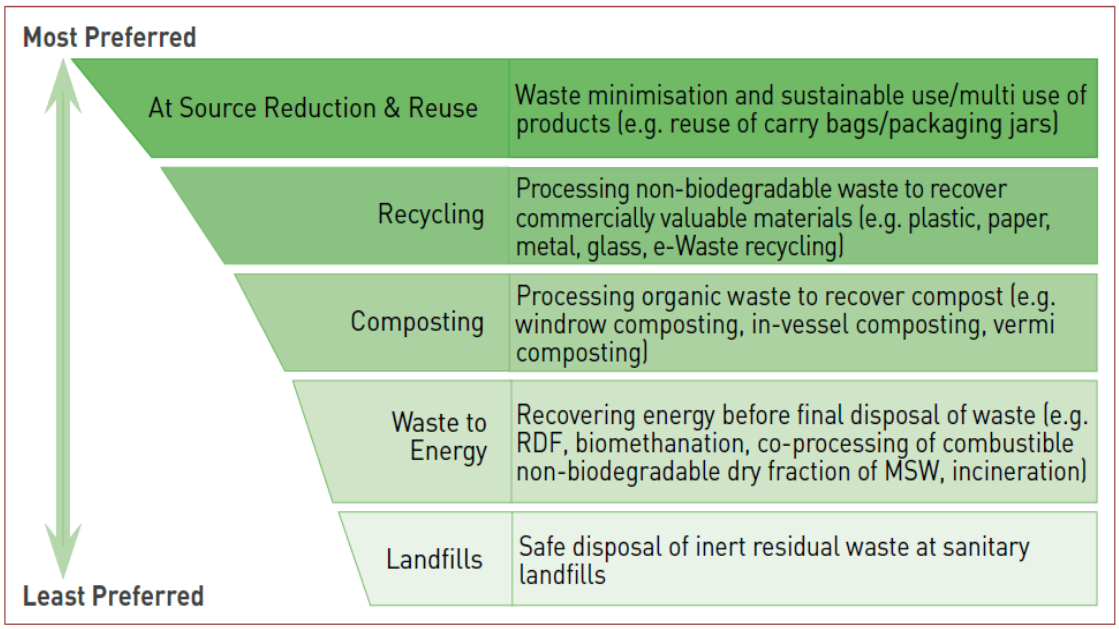
IMPACT AND DATA ANALYSIS

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 0.67 kg per capita per day in cities. More than 70% of waste in India is considered to be dumped in an unsatisfactory manner (Sharma and Jain, 2019).

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

Current status in the urban areas of the district

Waste generation in the urban areas of the district has seen a significant rise in recent times which stressed on the need for necessary infrastructure and manpower for the scientific disposal of waste. The waste generation within the district varies with the amount of tourist influx, consciousness among the masses regarding their role in waste management and enforcement of various policies of the government by the urban local bodies. Overall the waste generation is maximum in Nagar Palika Parishad, Gopeshwar (i.e. 5 MT) and minimum in Nagar Panchayat Tharali (i.e. 0.2 MT) (Table 6).

All the ULBs of the district are trying to adopt the approach of integrated solid waste management which includes various operations such as segregation, collection, transportation, disposal and recovery (Table 7). The ultimate aim is the scientific handling and disposal of waste.

Table 6. Inventory of total solid waste generation

Name of Urban Local Body	**Population *(2011 census)***	**Number of Wards`**	**Solid waste generation *(MTPD)***			
			Dry	Wet	C&D and others (Unsegregated waste)	Total
Nagar Palika Parishad Gopeshwar	21447	11	1	4	Not Estimated	5.00
Nagar Palika Parishad Gauchar	8864	07	1.20	0.80	3.0	5.00
Nagar Palika Parishad Joshimath	16709	09	0.3	0.8	Not Estimated	1.1
Nagar Palika Parishad Karanprayag	9850	07	3	1.2	Not Estimated	4.2
Nagar Panchayat Badrinath	2438	04	0.035	0.015	Not Estimated	0.5
Nagar Panchayat Gairsain	8665	07	0.1	0.2	Not Estimated	0.3
Nagar Panchayat Pokhari	5295	07	0.75	0.25	Not Estimated	1
Nagar Panchayat Thrali	4649	04	0.15	0.05	Not Estimated	0.2
Nagar Panchayat Pipalkoti	3521	04	0.5	0.8	0.2	1.5
Nagar Panchayat Nandprayag	1641	04	0.2	0.3	Not Estimated	0.5

Table 7. Waste management operations

Waste Management Operations	**Outcome**	
Segregation at source	ULB	Source Segregation (%)
	Nagar Palika Parishad Gopeshwar	75
	Nagar Palika Parishad Gauchar	75
	Nagar Palika Parishad Joshimath	90
	Nagar Palika Parishad Karanprayag	85
	Nagar Panchayat Badrinath	70
	Nagar Panchayat Gairsain	40
	Nagar Panchayat Pokhari	90
	Nagar Panchayat Tharali	85
	Nagar Panchayat Pipalkoti	85
	Nagar Panchayat Nandprayag	90
Door to Door Collection	All the ULBs except Gopeshwar, Gauchar and Joshimath have 100 percent coverage for door to door collection.	

Sweeping	All the ULBs in the district are accomplishing 100% sweeping by manual method.	
Segregated waste Transport	In all the ULBs only a part of the total waste collected is transported segregated manner and the rest of the waste is transported in combined form.	
Material Recovery Facility (MRF) operation	• No ULBs of the district has installed a material recovery facility. • Segregation of waste is done at some temporary sites in all the ULBs.	
Involvement of Non-Governmental Organizations (NGOs)/ private agencies	Only NPP Karnprayag is taking the assistance of a private firm (i.e. Green Energy Ltd.) to handle the waste management operations other ULBs are handling the waste management operations by themselves.	
Authorization and issuance of Identity cards to waste pickers/Sanitation workers	**ULB**	**Number**
	Nagar Palika Parishad Gopeshwar	91
	Nagar Palika Parishad Gauchar	28
	Nagar Palika Parishad Joshimath	61
	Nagar Palika Parishad Karanprayag	42
	Nagar Panchayat Badrinath	26
	Nagar Panchayat Gairsain	14
	Nagar Panchayat Pokhari	17
	Nagar Panchayat Tharali	14
	Nagar Panchayat Pipalkoti	16
	Nagar Panchayat Nandprayag	16
Linkage With Treatment Storage and Disposal Facilities (TSDF)/Bio-Medical Waste Treatment Facility (CBMWTF)	No ULB in the district has linkage with either the treatment storage and disposal facility or the common biomedical waste treatment facility.	

Available Infrastructure for waste management in the urban areas of the district

It has been noticed that all the municipalities of the district have more or less sufficient resources for the waste collection but somehow, they all are lacking waste segregation. None of them has a material recovery facility to segregate the collected waste into different categories. However, to ramp up the waste management operations, some financial assistance is being provided by both central and state governments. (Table 8).

Table 8. 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	Material Recovery Facility (Available/Not Available)	Landfills (open dumping/ Trenching Ground/sanitary landfills)	Remarks
Nagar Palika Parishad Gopeshwar	15	8	40	Not Available	Trenching Ground (under construction)	DPR of 1.45 Cr. has been approved by the government to set up various facilities required for the scientific disposal of waste in the ULB.
Nagar Palika Parishad Gauchar	30	6	12	Not Available	Trenching Ground	DPR. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Palika Parishad Joshimath	10	6	16	Not Available	Trenching Ground (under construction)	• Two bulk waste generators (Indo-Tibetan Border Police (ITBP) and National Thermal Power Corporation Limited (NTPC)) are notified within the ULB and both of them have on-site facilities for wet waste management. • DPR of 1.30 Cr. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Palika Parishad Karnprayag	35	2	17	Not Available	Trenching Ground	DPR of 1.45 Cr. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Panchayat Badrinath	50	5	2	Not Available	Trenching Ground (under construction)	• Material Recovery Facility is under construction in the ULBs.

						• Several other infrastructure works are also started in the Nagar Panchayat area under the Badrinath master Plan.
Nagar Panchayat Gairsain	20	3	12	Not Available	Open dumping	DPR of 1.69 Cr. is approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Panchayat Pokhari	18	3	4	Not Available	Open dumping	The DPR of 1 Cr. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Panchayat Tharali	8	2	4	Not Available	Trenching Ground (under construction)	The DPR of 1.22 Cr. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Panchayat Pipalkoti	15	3	2	Not Available	Open dumping	The DPR. of 1.42 Cr. has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.
Nagar Panchayat Nandprayag	25	2	5	Not Available	Trenching Ground (under construction)	The DPR of 94.14 lakhs has been approved by the government to set up various facilities for scientific disposal of waste in the ULB.

Methods used for the treatment of solid waste in the district

Wet waste management is quite satisfactory in all the urban local bodies of the district as all of them have composting facilities for processing the wet waste. As far as the processing of dry waste is concerned nearly all the ULBs are focusing on the recovery of useful materials to reduce the stress on the landfill sites. For this, have either established linkage with authorised recyclers or local scrap pickers (Table 9).

Table 9. Methods of treatment, disposal and recovery

Name of ULB	Wet waste management *(Centralised or on-site composting)*	Dry Waste Management *(waste to Energy/ Recycling/ incineration/ open Dumping in Trenching ground/ sanitary landfill)*	Remediation of the old dump site
Nagar Palika Parishad Gopeshwar	There are 40 composting units are available in different wards of the ULB.	• Non-biodegradable waste after segregation and compaction is sent to the recycling facilities at Haridwar and Saharanpur. • All the residual (inert) waste is dumped in the trenching ground.	No old dumpsite is present.
Nagar Palika Parishad Gauchar	12 composting units are there within the ULB for the processing of wet waste.	• Recyclable waste is sold to the local rag pickers. • The rest of the waste is dumped in the trenching ground.	No old dumpsites are present.
Nagar Palika Parishad Joshimath	There is a total of 16 composting units present in the ULB few of them either newly constructed or under construction. The rest of the facilities are utilised for making manure.	• Recyclable waste is sent to a third-party recycler. • The rest of the waste is dumped in the trenching ground.	Remediation of the old dumpsite has started in the ULB.
Nagar Palika Parishad Karanprayag	A total of 17 decentralised composting units are operational in the ULB.	• A part of the dry waste that can be recycled is sent to the recycling facility at Rishikesh. • The residual waste is dumped in the trenching ground.	Remediation of the old dumpsite has started in the ULB.
Nagar Panchayat Badrinath	Two centralised composting facilities are present in the ULB.	• NP Badrinath transports the dry waste to the MRF at NPP Joshimath for further processing.	No old dumpsites are present.
Nagar Panchayat Gairsain	There are 12 decentralised composting units are available in different wards of the ULB.	• Local rag pickers are authorised by the municipality to segregate and collect the recyclable portion of the total waste. • The rest of the waste is dumped in an open dumping site.	No old dumpsites are present.

Nagar Panchayat Pokhari	There are 4 composting units are available in different wards of the ULB.	• Nagar Panchayat has established linkage with an authorised recycler (i.e. K.K. Traders) for the recovery of a part of the waste. • The rest of the waste is dumped in the open dumping site.	No old dumpsites are present.
Nagar Panchayat Tharali	There are 4 composting units are available in different wards of the ULB.	• Dry waste is dumped in an open dumping site as of now. • No linkage has been established so far with any recyclers • Trenching ground is under construction in the ULB.	No old dumpsites are present.
Nagar Panchayat Pipalkoti	There are 2 composting units are available in different wards of the ULB.	• Dry waste is dumped in an open dumping site as of now. • No linkage has been established so far with any recyclers • Trenching ground is under construction in the ULB.	No old dumpsites are present.
Nagar Panchayat Nandprayag	There are 5 composting units are available in different wards of the ULB.	• Dry waste is dumped on All the residual and inert waste is dumped after that in a Trenching ground site. • Dry waste is out of which recyclable waste is sold to the local Rag pickers after segregation.	NP Nandprayag has an old dumpsite whose remediation is under process.

Gap Identification

Although all the urban local bodies are trying to adopt the holistic approach of integrated solid waste management but due to some reasons such as financial and geographical limitations, they are lacking in many aspects related to waste management. Almost all the ULBs are struggling to achieve the target of complete source segregation of waste. Apart from this, the unscientific disposal of waste is also a major concern (Table 10). However, they have proposed some set of actions to overcome these gaps for which either fund have been allotted to them or will be allotted soon (Table 11).

Table 10. Gap identification

Name of ULB	Observed Shortcomings	Remarks
Nagar Palika Parishad Gopeshwar	Partial Source segregation of waste	ULB has achieved 75 % source segregation so far and targeting 100% source segregation.
	Partial Coverage for door to door collection	100 % coverage has not been possible so far due to topographical limitations but the municipality is discovering ways to cover all the households.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations. ULB is doing all the waste management operations by itself.
Nagar Palika Parishad Gauchar	Partial Source segregation of waste	More than two-thirds of the households segregate their waste.
	Partial Coverage for door to door collection	ULB has covered almost 85% of households and is expecting to cover the rest of the population soon.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-involvement of NGO/private firm for waste management operations.	The municipality is managing the waste management operations by itself.
	Non-availability of any waste recovery facility	DPR has been approved for setting up a recovery facility along with other equipment required for the scientific disposal of the waste.
	No linkage with authorised waste recyclers	ULB sells their waste to local Rag pickers who are authorised by the municipal body.
Nagar Palika Parishad Joshimath	Partial Source segregation of waste	More than 90 per cent source segregation has been achieved in the ULB so far.
	Partial Coverage for door to door collection	100 % coverage has not been possible so far due to topographical limitations but the municipality is discovering ways to cover all the households.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.

Nagar Palika Parishad Karanprayag	Partial Source segregation of waste	Source segregation is done in all the 7 wards of the ULB NPP has achieved 85% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
Nagar Panchayat Badrinath	Partial Source segregation of waste	Source segregation is done in all 4 wards of the ULB. NPP has achieved 70% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
Nagar Panchayat Gairsain	Partial Source segregation of waste	Source segregation is done in all the 7 wards of the ULB. NPP has achieved 40% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations.
	Open Dumping of waste	Currently, ULB does not have any trenching ground for the disposal of residual/inert waste.
Nagar Panchayat Pokhari	Partial Source segregation of waste	Source segregation is done in all the 7 wards of the ULB. NPP. has achieved 90% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for	As of now no NGO or Private firm is serving the ULB in its waste management operations.

	waste management operations.	
	Open Dumping of waste	Currently, ULB does not have any trenching ground for the disposal of residual/inert waste.
Nagar Panchayat Thrali	Partial Source segregation of waste	Source segregation is done in all 4 wards of the ULB. NPP. has achieved 90% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations.
	Open Dumping of waste	Currently, ULB does not have any trenching ground for the disposal of residual/inert waste.
	No linkage with authorised waste recyclers	ULB sells their waste to local Rag pickers who are not authorised so far.
Nagar Panchayat Pipalkoti	Partial Source segregation of waste	Source segregation is done in all 4 wards of the ULB. NPP has achieved 90% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for waste management operations.	As of now no NGO or Private firm is serving the ULB in its waste management operations.
	Open Dumping of waste	Currently, ULB does not have any trenching ground for the disposal of residual/inert waste.
	No linkage with authorised waste recyclers	ULB sells their waste to local rag pickers who are not authorised so far.
Nagar Panchayat Nandprayag	Partial Source segregation of waste	Source segregation is done in all 4 wards of the ULB. NPP has achieved 95% source segregation so far and aiming for a target of 100% segregation at source.
	Partially segregated waste transport	Completely segregate waste transport would only be possible once the complete source segregation will be achieved.
	Non-availability of any waste recovery facility	DPR has been approved for improving waste management operations in the ULB.
	Non-involvement of NGO/private firm for	As of now no NGO or Private firm is serving the ULB in its waste management operations.

	waste management operations.	

**There is a gap identified in the waste management operations of all the ULBs of the district as no ULB. has established linkage with Treatment Storage and Disposal Facility (TSDF) and Common Biomedical Waste Treatment Facility (CBMWTF) for the disposal of domestic hazardous waste and municipal sanitary waste respectively.*

Table 11. Proposed policies and budget requirements put forward by different stakeholders in the district

ULB	Proposed Policy	Current status and Budget requirement
Nagar Palika Parishad Gopeshwar	Revamping Solid waste management	• DPR. wortha 1.45 Cr. has been approved for the ULB to improve its waste management operations. • With the use of this budgetary allocation, ULB is planning to procure waste pickers, vehicles and litter bins along with this establishment of recovery facility and construction of sanitary landfills are also planned. • ULB has already achieved the ODF+ status and now aiming to achieve ODF++ status in the upcoming years.
Nagar Palika Parishad Gauchar	Revamping Solid waste management	• DPR of 1.45 Cr. has been approved and some of the budget has been allocated to the ULB to improve its waste management operations. • The establishment of the material recovery facility and construction of sanitary landfill along with procurement of some machinery and vehicles is proposed under this budgetary allocation. • ULB is declared as bin free city in the year 2021. • ULB has already achieved the ODF+ status and now aiming to achieve ODF++ status in the upcoming years.
Nagar Palika Parishad Joshimath	Revamping Solid waste management	• DPR of 1.30 Cr. has been approved and some instalments are allocated to the ULB to improve its waste management operations. • With this budgetary allocation, Nagar Palika is aiming to achieve complete scientific disposal of municipal waste. • ULB is declared as bin free city in the year 2021. • ULB has already achieved the ODF status and now aiming for ODF+ & ODF ++ status in the upcoming years.
Nagar Palika Parishad Karanprayag	Revamping Solid waste management	• DPR of 1.45 Cr. has been approved to improve waste management operations in the ULB • Establishment of a material recovery facility is proposed under this allocation. • Three out of a total of seven wards of the ULB are declared bin free. • ULB has already achieved the status of ODF+ and now targeting the ODF++ status.
Nagar Panchayat Badrinath	Revamping Solid waste management	• DPR of rupees 1.69 Cr. has been approved and the budget has been allocated to the ULB to improve its waste management operations. • With this allocation, various works such as the development of the trenching ground etc. are proposed. • ULB is declared as bin free city in the year 2021. • ULB has already been granted the status of ODF+ and the application for ODF++ is underway.

Nagar Panchayat Gairsain	Revamping Solid waste management	• DPR of rupees 1.90 Cr. has been approved and the budget has been allocated to the ULB to improve its waste management operations. • ULB has already achieved the status of ODF and now targeting the ODF+ status.
Nagar Panchayat Pokhari	Revamping Solid waste management	• DPR of 1 Cr. has been approved and the budget has been allocated to the ULB to improve its waste management operations. • Under this allocation Nagar Panchayat has planned to procure various types of machinery such as compactor and waste collection vehicles, along with this development of a recovery facility has also been proposed. • ULB has already achieved the status of ODF+ and now targeting the ODF++ status.
Nagar Panchayat Tharali	Revamping Solid waste management	• DPR of rupees 1.22 Cr. has been approved and the budget has been allocated to the ULB to improve its waste management operations. • Under this allocation, several works have been already initiated in the ULB, such as the development of the trenching ground. • ULB has already achieved the status of ODF and now targeting the ODF+ status.
Nagar Panchayat Pipalkoti	Revamping Solid waste management	• DPR of rupees 1.42 Cr. has been approved and the budget has been allocated to the ULB to improve its waste management operations. • Under this allocation Nagar Panchayat has planned to procure various types of machinery such as compactor and waste collection vehicles, along with this development of a recovery facility has also been proposed. • ULB is declared as bin free city in June 2021. • ULB has already achieved the status of ODF+ and now targeting the ODF++ status.
Nagar Panchayat Nandprayag	Revamping Solid waste management	• DPR of rupees 94.14 lakhs has been approved and the budget has been allocated to the ULB to improve its waste management operations. • Under this allocation Nagar Panchayat has planned to procure various types of machinery such as compactor and waste collection vehicles, along with this development of a recovery facility has also been proposed • Three of the total four wards of the ULB are declared as bin free. • ULB has already achieved the status of ODF and now targeting the ODF+ status.

Vegetation suitable for rehabilitation of dumping sites

Phytoremediation, collectively referring to all plant based technologies, uses green plants to remediate contaminated sites (Sadowsky, 1999). Natural or planted vegetation on landfill sites has a key role in soil erosion control and removal of contaminants, besides imparting aesthetic value (Table 12). Moreover, it may be used in leachate treatment. Landfill vegetation often shows signs of damage commonly caused by the presence of landfill gas in the root protection zone. The aim for the reconstruction of a suitable medium for landfill re-vegetation is to provide a cover that is deep and as favourable to root growth as is necessary to achieve desired plant performance (Nagendran, et al. 2006). In this context, locally available species could be hardened and resistant in reclaiming the waste dump problem.

Table 12. Suggested vegetation for reclaiming landfill sites in the district Chamoli

Botanical Name	Local and English Name	Life form	Altitude (m)	Assimilating capacity	References
Quercus leucotrichophora A. Camus	Banj oak	Tree	1200-2400	Microbial biodegradation, binding, holding soils, and/or decreased leaching	Meenakshy et al, 1981
Bauhinia variegata L.	Kachnar	Tree	1250-1800	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	Das, 1981
Bauhinia acuminata L	Kachnar	Tree	1150-1500	conversion of Hg to volatile chemical from groundwater	Chaphekar, et al., 1980
Adina cordifolia (Roxb.) Hook. f. ex Brandis	Haldu	Tree	Upto-1500	conversion of Se and Hg to volatile chemical from groundwater	Prajapati, 2012
Berberis aristata DC.	Kingore	Shrub	1350-2000	Metals, radionuclides, hydrophobic organics	Das, 1981
Berberis asiatica Roxb. ex DC.	Kilmora	Shrub	1650-2400	Adsorb' all the dissolved gases	Das, 1981
Cynodon dactylon (L.) Persoon	Dubla, Doob	Herb	700-2500	Absorbs Arsenic and Fluoride from wastewater	Chaphekar, et al., 1980
Azolla pinnata R. Br.	Azolla	Herb	400-2200	Control the Hg, and Cd from wastewater also known as bio-fertilizer	Rai, 2008

Projected Population and Solid Waste Generation in Chamoli District

Projecting waste quantities in a near future is as difficult as predicting changes in waste composition for a locality or town. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste bulk density. Generally, lower is the level of economic development, greater will be the change between waste generation and disposal.

In the present context, population Census data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste generation projection is done based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant.
- In view of changing waste paradigm and floating population, 1.5% yearly growth in per capita waste generation is assumed.
- Analysis includes population and waste generation estimations for only urban local bodies and does not include peri-urban and rural areas (Table 13 and 14).

Table 13. Estimated Population and Waste Generation

ULB	Projected Population			Projected Waste Generation (MTPD)		
	2021	2031	2041	2021	2031	2041
Gopeshwar NPP	23061	24675	26289	5.00	6.15	7.54
Gauchar NPP	10425	11986	13547	5.00	6.61	8.59
Joshimath NPP	20214	23719	27224	1.1	1.48	1.96
Karanprayag NPP	12723	15596	18469	4.2	5.92	8.06
Badrinath NP	3194	3950	4706	0.5	0.71	0.97
Gairsain NP	11816	14967	18118	0.3	0.44	0.61
Pokhari NP	6400	7505	8610	1	1.35	1.78
Tharali NP	5341	6033	6725	0.2	0.26	0.33
Pipalkoti NP	4178	4835	5492	1.5	2.00	2.61
Nandprayag NP	1578	1515	1452	0.5	0.55	0.61
Total				**19.30**	**25.47**	**33.06**

Table 14. Decadal Change in Waste Generation

Name of ULB	Rate of growth % (2021-2031)	Rate of growth % (2031-2041)
Gopeshwar NPP	2.30	2.25
Gauchar NPP	3.22	3.00
Joshimath NPP	3.49	3.20
Karanprayag NPP	4.10	3.62
Badrinath NP	4.22	3.70
Gairsain NP	4.57	3.92
Pokhari NP	3.49	3.19
Tharali NP	2.99	2.82
Pipalkoti NP	3.31	3.06
Nandprayag NP	1.04	1.02

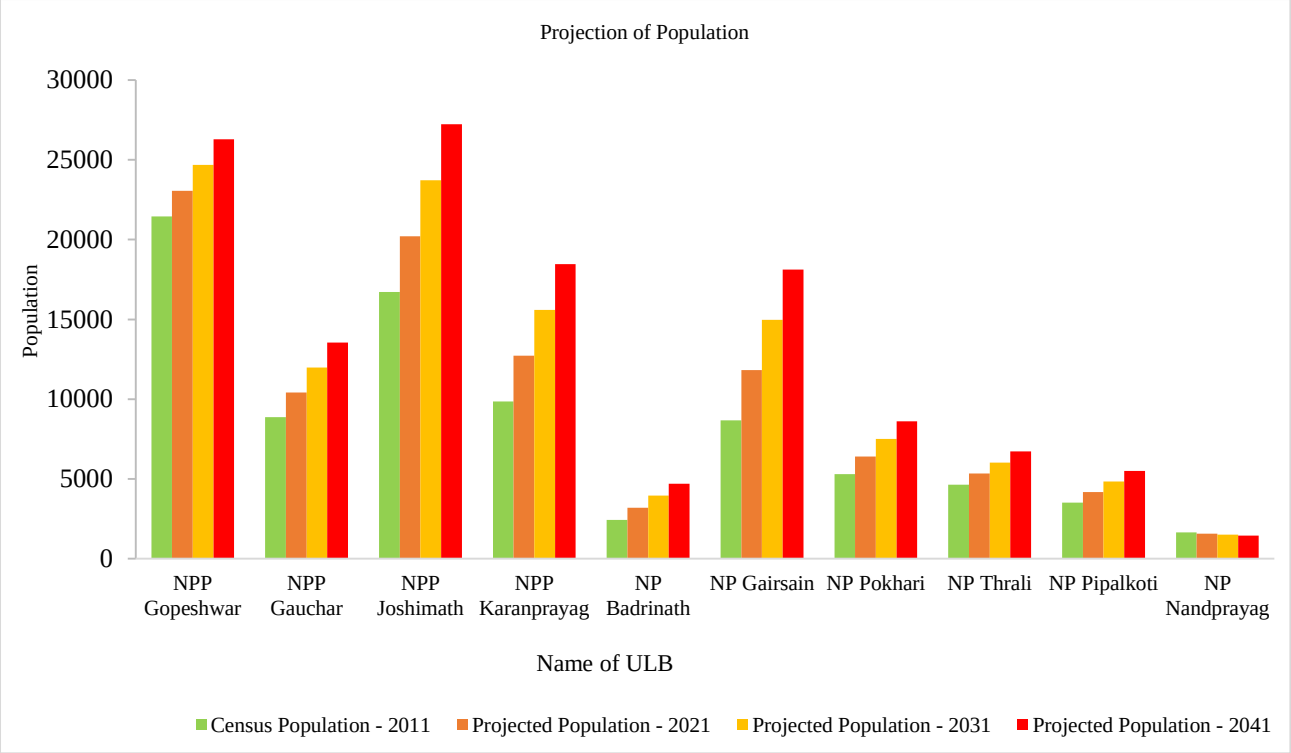


Fig. 3. Graphical representation of projected population in Chamoli district

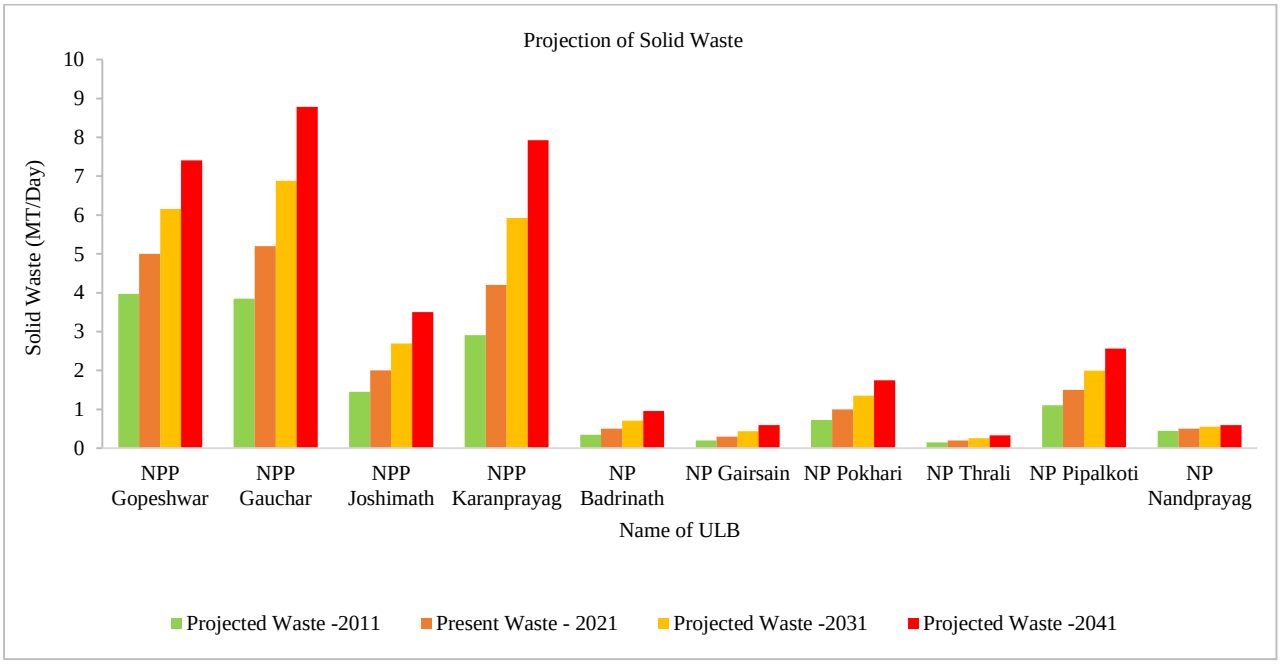


Fig. 4. Projected solid waste generation in Chamoli district

Inferences drawn after projecting the population and waste generated

- Solid waste generation in district is expected to rise by almost 5-15 MTPD in the coming decades.
- Maximum growth rate is observed in Gairsain as the population of the ULB is likely to increase rapidly. It has been declared as summer capital of the state, hence rapid development is expected in near future which will definitely change the waste paradigm.
- As all the ULBs of the district are likely to see a rise in the waste generation so all the ULBs needs a complete revamping in the infrastructure requirement for waste management.
- Special attention is required for the waste management in Badrinath keeping in mind the heavy tourist influx in the ULB.

Rural Solid Waste Management

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As reported by the 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 health care centres (CHCs), and primary health care 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. Segregation of 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). In Chamoli district, the daily biomedical waste generation increased by four times during the peak of the pandemic situation. 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.

Biomedical waste management in Chamoli district

Quite a few government and private healthcare facilities are available in the Chamoli district, which consists of bedded and non-bedded hospitals, veterinary hospitals, pathology labs, clinics etc. The district relies on the conventional method of deep burial for the disposal of biomedical waste. So far none of the district level healthcare facilities have established linkage with a Common Biomedical waste treatment facility (CBMWTF) (Table 15). Many of the healthcare facilities are either not authorised by the state pollution control board or their authorisation certificates have expired. Healthcare facilities in the district are also lagging in the barcode tracking of biomedical waste as per the Biomedical waste management rules 2016 (Table 16).

Table 15. Inventory of current healthcare infrastructure for Bio-medical waste management

S. No.	Parameter	Outcome	
1.	Health-care facilities in the district	***Facility***	***Numbers***
		Bedded HCFs	50
		Non-bedded HCFs	49
		Total	99
2.	Miscellaneous Health care Facilities in the District	***Facility***	***Numbers***
		Clinics	22
		Veterinary Hospitals	23
		Pathology Labs	02
		Dental Clinics	01
		Blood Banks	-
		Total	48
3.	Number of health care facilities authorised by SPCB/PCC	Only 6 Bedded & 12 Non-bedded health care facilities of the district are authorised by the state pollution control board (SPCB).	
4.	Linkage with Common Bio-medical Waste Treatment Facility (CBMWTF)	No Healthcare facilities of the district linkage with any of the CBMWTF.	
5.	Total Biomedical Waste (BMW) generation in the district	33.31kg/day	

6.	Daily Bio-Medical Waste (BMW) lifting by Common Bio-Medical Waste Treatment Facility (CBMWTF)	10.95 kg/day

Table 16. Current status of biomedical waste management

S. No.	Action areas	Outcomes
1.	Authorisation of health care facilities by SPCB	6 Bedded & 12 Non-bedded health care facilities of the district are authorised by the state pollution control board (SPCB).
2.	Adequacy of facilities to treat biomedical waste	At present no facility is available in the district, solely for the treatment of biomedical waste.
3.	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 biomedical waste medical waste management rules 2016.
4.	Tracking of biomedical waste *(Implementation of bar code system for tracking)*	There is no facility available in the district for the bar code tracking of biomedical waste.
5.	District level monitoring committee	Already established under the chairmanship of the District Magistrate.

Gap Identification in The Management of Biomedical Waste in the District

Chamoli district is lacking in many aspects if we compare the current status with the desired level as per biomedical waste management rules 2016. Some of them are as following:

- Very few healthcare facilities have been authorised by the state pollution control board.
- No linkage is established yet with any of the Common Bio-Medical Waste Treatment Facility (CBMWTF).
- Bar code tracking facility is not available for biomedical waste management.

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT

Construction and Demolition (C&D) waste is produced in the construction, remodelling, repair and demolition of residential / commercial buildings and other structures and pavements. C&D waste mainly consists of concrete, bricks, sanitary ware, glass, steel, plastic, etc. (Table 17). According to a general estimate, 40% of the total C&D waste originates from renovation work, while 50% from the demolition work and remaining 10% from new construction work (CPCB, 2020) (Table 18).

Implementation of 3r Principle in C&D Waste Management

Construction and demolition waste is inert in nature. It does not create chemical or biochemical pollution. Hence in view of its management, maximum emphasis should be given on 3R Principle. The concept of 3R, which refers to reduce, reuse and recycle particularly in the context of production and consumption is well known today. Waste reduction is presumed to be optimal measure for C&D waste management due to its minimal adverse impact on environment. Applicable building materials can be reused for original activity or to fulfil any other purpose. Steel, doors and windows, wood, bricks and other construction items can be easily taken out and again put to reuse without much processing. The last but not least step is to recycle the C&D waste considered fit for recycling. This is usually done by converting the waste into recycled sand and aggregates that have various construction applications. This principle can be applied to the entire life cycle of products and services – starting from design and extraction of raw materials from collection to transport, and then manufacturing, practicing scientific disposal. Hence, it is evident that application of 3R principle would help reduce the C&D waste in the construction industry.

Present State of Affairs

- According to a report by Transparency Market Research (2016), the volume of construction waste generated worldwide every year will nearly double to 2.2 billion tonnes by 2025 (CWM, 2020).
- Our country generates 150 million tonne/year C&D waste but the official recycling capacity is a meagre 6500 tonnes/day or just about 1% *(as per building material promotion council* (CWM, 2020).

Table 17. Characteristics of C&D Waste in India

Debris type	Percentage (%)
Wood	42.4
Drywall	27.3
Concrete	12.0
Brick and Other Mixed Debris	7.3

Cardboard	5.4
Metals	1.8
Asphalt	1.4
Plastic & Foam	1.4
Other packaging	0.6
Textiles	0.4

Table 18. 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

Recent 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.

C&D Waste Management in the district

Construction and demolition waste is not yet quantified in the district pertaining to the fact that its quantity is assumed to be nominal (Table 19). However, dumping zones are established along the Char-Dham national highway by the Public works department. With rapid urbanization, construction activities will rise, hence some strategy is definitely required for scientific management of C&D waste. This may include the establishment of dumping sites, framing of by-laws etc., (Table 20).

Table 19. Current Status Related to C&D Waste Generation

S. No.	Action Areas	Outcomes/Remarks
1.	Quantity of C&D waste generated *(KGPD)*	Not estimated as no collection initiated. However, the quantity is assumed to be minimal.
2.	Collection of C&D waste	None of the ULBs has initiated 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, and Border Road Organisation. Most of the dumping zones are established along the under-construction Char Dham highway project in the district. U.L.Bs 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 has linkage with any common C&D waste treatment facility.

Table 20. Gap identification

S. No.	Observed shortcoming	Outcome/Remarks
1.	Quantification of C&D waste.	As the collection of C&D waste is not initiated hence quantification of C&D waste generated in the district is not possible.
2.	Establishment of collection centre /Deposition points/Dumping Zones.	Most of the U.L.Bs has 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 waste management is not initiated by any of the ULBs within the district.
4.	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 there0foreminimal 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). State Pollution Control Board (SPCB) is responsible for tabulation of hazardous waste generating units and quantification of waste generated in respective state. Hazardous industrial wastes in India can be categorized broadly into two categories as under:

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

Present state of affairs

- Almost 9 MMT of hazardous waste was generated in India in the year 2020. Half of the hazardous waste generated was utilizable (Table 21).
- Hazardous and Other wastes (Management and Transboundary Movement) rules, 2016 govern the collection, transfer, Processing, treatment and disposal of hazardous waste.
- The rules were amended on March 2019 keeping in consideration the ease of doing business, boosting make in India initiative by simplifying the procedures, while at the same time upholding the principles of sustainable development.
- According to CPCB Report 2019-20, there are 69,308 hazardous waste generating units in India having authorized annual capacity to generate about 39.46 million MT of hazardous waste. However, about 8.78 million MT hazardous waste was generated during 2019-20, based on the annual returns submitted by such units (CPCB, 2020).

Table 21. Hazardous Waste generation in India

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

Hazardous Waste Management in Chamoli district

The quantity of hazardous waste generated in the district is very less. This pertains to lower segregation of waste in households, government offices and commercial establishments. However, the amount of industrial hazardous waste has been inventoried (Table 22). The industrial hazardous

waste generated in the district is incinerable in nature and sent to the treatment facility at Roorkee. No linkage with any treatment, storage and disposal facility (TSDF) is established as of now by any of the ULB (Table 23).

Table 22. 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
		4.347	0.00	0 .00	4.347
2.	Number of Hazardous waste generating industries in the district	30			

Table 23. 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 treatment storage and disposal facility (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.*
3.	Display board of Hazardous waste generation in front of gates of respective industries	As per state pollution control board only 02 hazardous waste generating industries in the district have installed display board in front of their gates.
4.	Number of ULBs linked with common TSDFs	No ULB in the district is linked with common TSDFs.
5.	Contaminated sites/probable contaminated sites within the district	As per state pollution control board there are no contaminated sites within the district.
6.	Regulation of industries & facilities generating Hazardous waste	Industries generating hazardous waste are strictly regulated by state pollution control board.

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). Computer devices contributes to almost two third of electronic waste in India. (Table 24). It is categorised into 21 types under two broad categories:

- Information technology and communication equipment.
- Consumer electrical and electronics

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 (EEMI, 2018).

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**.** Amendments were further made on March 2019 with the objective of channelizing the E-waste generated in the country towards dismantlers and recyclers in order to formalise the e-waste recycling sector.

Table 24. 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 of at worldwide level. In 2016, 44.7 Million Metric Tons (MMT) of e-waste was generated worldwide *(equivalent to 6.1 kg / inhabitant)*. Following the current growth rate of rising e-waste, it was estimated that by 2021, quantity has already been 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. On the other hand, there is no record of remaining e-waste. The quantity of E-waste generated worldwide is expected to grow at a rate of 3.15% (Compound annual growth rate).

Indian Scenario

- According to Central Pollution Control Board (CPCB), India generated more than 10 Lakh tonnes of e-waste in 2019-20. Against this, the e-waste dismantling capacity has not been increase from 7.82 lakh tonnes since 2017-18
- In 2018, the Ministry of Environment had told the tribunal that 95% of e-waste in India is recycled by the informal sector and scrap dealers unscientifically dispose of it by burning or dissolving it in acids.
- 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%.
- India's first e-waste clinic for segregating, processing and disposal of waste from household and commercial units has been set-up in Bhopal, Madhya Pradesh.

E-waste Management in Chamoli district

As the collection of e-waste is not initiated by any of the ULBs of the district, so presently it is not possible to quantify the e-waste (Table 25). Also, none of the ULBs has established linkage with any of the authorised electronic waste recycler/dismantler (Table 26).

Table 25. Current standpoints regarding e-waste generation and collection

S. No.	Parameter	Outcome & Remarks	
1.	Quantity of E-waste generated per annum (As per State pollution control board)	Uttarakhand (MT)	16260
		Chamoli	Not Estimated
2.	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.	
3.	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.	
4.	Number of authorized E-waste Recyclers/dismantlers in the state.	**(05)** Attero Recycling Pvt. Ltd. Raipur, Bhagwanpur Bharat Oil & Waste Management, Mukhimpur, Laksar Resource E-Waste Solution Pvt. Ltd. Bahadrabad Scarto Metal Recycle Plant, Mewar Khurd, Roorkee	

		Anmol Paryavaran Sarakshan Samiti, Daulatpur Budhwa Shahid, Banjarewala
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 26. 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 a type of waste water that is produced by a community of people in any area. It is characterized by a certain volume of flow and physical condition, along with chemical and toxic constituents and its bacteriologic properties. Around 80% of water supply flows back into the ecosystem as wastewater, which can cause major health hazard and environmental degradation, (Denchak, 2018).

According to a report of the Central Pollution Control Board (2015), India has the capacity to treat approximately 37% of its wastewater. In other words, this comes about 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD. Moreover, most of the sewage treatment plants do not function at their optimum capacity and do not conform to the standards as prescribed (Table 27).

Sewerage system with individual household latrines connected with pipelines comes only 31.7 per cent of the total urban households. More than half of the urban population in the State relies on on-site sanitation (OSS) systems like septic tanks. Septic tanks and other On-site Sanitation system covers 53.1 per cent of the total wastewater generated in the state. Treatment by sewage treatment plant is mostly limited to plain areas of district. Further, some individual households in the state discharge the waste from their toilets directly into open drains

Table 27. Current Scenario related 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)

Current Scenario RELATED TO STPS in the District

Majority of the district falls in the catchment area of the Alaknanda River and its tributaries, one of the two headstreams of the holy Ganga. Many sewerage treatment facilities are constructed in the recent times (Table 28) near the urban settlements situated along the banks of the river. Treatment plants are constructed under 'Namami Gange' mission to prevent the possible contamination of the holy river.

Table 28. Inventory of sewage treatment facilities in district

Name of ULB	Population	Total installed capacity (MLD)	Additional Capacity Required (MLD)	Description of sewage treatment plants
Nagar Palika Parishad Gopeshwar	21447	4.45	-	1.2 MLD STP (Vaitrani) 1.25 MLD STP (Pokhari Bend) 1.19 MLD STP (lisa band) 0.76 MLD STP (Near Mahindra showroom) 0.05 MLD STP (Near jhula pull)
Nagar Palika Parishad Joshimath	16709	1.08	2.70[a]	1.08 MLD STP (Pokhari) 2.70 MLD STP (Marwari)[a]
Nagar Palika Parishad Karanprayag	9850	0.35	0.97	0.05 MLD STP (Near Police chawki) 0.10 MLD STP (Near Old Bridge) 0.05 MLD STP (Subhash Nagar) 0.05 MLD STP (Near BRO Bridge) 0.10 MLD STP (Near ward no.1&3)
Nagar Panchayat Badrinath	2438	1.01	-	1 MLD STP (near temple) 0.01 MLD STP (Near suspension bridge)
Nagar Panchayat Nandprayag	1641	0.15	0.11	0.1 MLD STP (Near forest office) 0.05 MLD STP (Sangam Road)

[a] *An STP of 2.7 MLD is under construction in Joshimath.*

Adequacy of Sewerage Network in Various Urban Local Bodies of the District

None of the ULBs of the district has an adequate sewage network. All of them have partial coverage of the sewerage network in their respective ULBs (Table 29). However, to cover the rest of the population, the concerned department i.e. Payjal Nigam, Ganga division, Chamoli is planning to make DPR for further approval for concerned authority. The operation and maintenance of the existing treatment facilities for up to 15 years has been handed over to the construction agency of these facilities (Table 30).

Table 29. Adequacy of sewerage network

Action points	**Name of ULB**				
	Gopeshwar	Joshimath	Karnaprayag	Badrinath	Nandprayag
Length of the existing underground sewerage network (km)	26.23	16.44	2.36	5.39	5.52
Population covered under the existing sewerage network (%)	85	50	10	90	5
Additional length of the sewerage network required (km)	5	7.50	6	1.50	3.50

Current Standpoints Regarding Sewage Management in the District

- Currently five of the ten ULBs of the district have operational sewage treatment facilities rest of the ULBs are relying on the conventional on-site treatment facility of septic tank + soak pit.
- Among the ULBs having sewerage network, Badrinath has maximum coverage of the sewerage network (i.e. 90%), the rest of the households are not covered in Badrinath ULB is due to topographical limitations. The sewage from those households is pumped and discharged into the main sewer line.
- The proposals that are sent for Gopeshwar and Karnprayag are once rejected by the government, so new proposal need to be send to the government.
- For rest of the ULBs no proposals are still made to cover rest of the households.

Table 30. Adequacy of expenditure

ULB	Capital Expenses (In Lakhs)	Average Yearly Operating Expenses (In Lakhs)
Nagar Palika Parishad Gopeshwar	3112.84	205.2
Nagar Palika Parishad Joshimath	2620.92	148.12
Nagar Palika Parishad Karanprayag	704.56	33.64
Nagar Panchayat Badrinath	913.25	60.69
Nagar Panchayat Nandprayag	336.08	20.68

Liquid Waste Management in Rural Areas

Since the water supply for domestic purposes in rural areas has improved considerably over the years, the quantity of wastewater that is disposed of has also increased. 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. Several government policies are intact to scientifically manage liquid waste in the rural areas, to healthify the surroundings and declare them open defecation free.

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.

Practices for Rural Waste management in India

Various interventions are made under Swachh Bharat Mission (SBM-G) to mitigate the ecological and health related impacts of liquid waste in rural areas. These include infrastructure development financial compensation, awareness programs etc. targeting remotest of the villages (Table 31).

Table 31. 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 BPL (below poverty line) 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, groundwater is contaminated 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 Chamoli district

Chamoli 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 (Table 32). 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 (Table 33). 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 34).

Table 32. Water resources in the District

S. No.	Water Resource	Remarks	
1.	Rivers/Streams in the District	Alaknanda river originates from Satopanth glacier at 3641m. is the major river flowing through the district. Several rivers meets the Alaknanda river in the district.	
		River	***Confluence point with Alaknanda***
		Saraswati	Downstream of Mana Village
		Khilrawan Ganga	Badrinath
		Dhauli Ganga	Vishnuprayag
		Nandakini	Nandprayag
		Pinder	Karnprayag
2.	Lakes and ponds	***Lake***	***Elevation (m)***
		Rupkund	4536
		Hemkund	4633
		Satopanth Lake	4600
		Auli Lake (Artificial)	2909

Table 33. Pollution Control in Water Resources

S. No.	Parameter	Current Status
1.	Open Defecation in River/Nala/Khad	Fully controlled
2.	Dumping of Solid waste on River Banks	Fully controlled
3.	Control Measures for idol immersion	Measures taken
4.	Nalas/drains meeting rivers	All the major Nalas/drains have already been tapped in the recent year under the Namami Gange mission. Currently, No major contaminated drain has a direct outfall in the water bodies in the district.
5.	Disposal of Untreated Sewage in Rivers	Sewage is not directly discharged into water bodies.
6.	Monitoring of Action Plans for rejuvenation of rivers	Monitored
7.	Encroachment near flood pains	Encroachment is found in almost all the urban settlements along the river valleys.
8.	Protection of flood plains	Robust measures has not been taken so far.

Table 34. Information of Groundwater in District

S. No.	Parameter	Current Status
1.	Groundwater polluted area in the district	Not Identified
2.	Adequacy of Groundwater Availability	No studies are conducted so far by the concerning department for the assessment of the groundwater.
3.	Disposal of Untreated Sewage in Rivers	Nil
4.	Access to surface water and groundwater quality data at DM office	Available

Current standpoint regarding Water Resources Management in Chamoli

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. *Rivulets/Naulas/Gadheras*
  4. *Spring*
  5. *Streams*
  6. *Treated surface water*
- Springs (70.3%)followed by Streams (20.4%) and Rivulet / Naula / Gadhera (7.3%) are noted to be highly tapped for water schemes in Chamoli
- The Ghaat block of Chamoli district has the highest water dependency on Springs (84%).
- Awareness activities are organized quarterly to bring awareness amongst people about the declining standards of water quality as well as overexploitation of Naulas and Dharas.
- No information is currently available on the annual change of Ground water level in the district.

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. However, there is some scope of artificial recharge in the district as mentioned in (Table 35).

Table 35. Scope of Artificial recharge in Chamoli district

District	Area (km^2)	Area identified for AR (Artificial recharge) (km2)	Volume of unsaturated zone (MCM)	Available sub-surface space for AR (MCM)	Water required for artificial recharge (MCM)	Surplus available for recharge (MCM)
Chamoli	7520	1880	3760	564	750	4703

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 constructing infrastructure for artificial recharge of groundwater to mitigate acute shortage of water. The number of artificial structures constructed proposed and their estimated cost is mentioned in (Table 36 and 37).

Table 36. Artificial Recharge and RTRWH Structure constructed in Chamoli 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	
Chamoli	0	0	50	0	1000	0	0	17.5	0	1	18.5

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

Table 37. Artificial recharge and cost estimate in Chamoli

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	
Chamoli	375	275	100	250	500	0.5	0.3	0.07	0.15	0.015	187.5	82.5	7	37.5	7.5	322

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 of National Clean Air Program (NCAP) is to meet the prescribed annual average ambient air quality standards at all locations in the country in a stipulated 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 38).

Table 38. 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* 24 hours**	100 400	100 400
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.*

Current standpoint regarding air pollution in the district

As the monitoring of ambient air quality is not yet started in the district so the present condition regarding the air quality is very difficult to ascertain (Table 39). With the increase in number of forest fire events and number of vehicles in the district, the problem of air pollution is gradually increasing which needs to be addressed (Table 40). Although many steps have been taken to control the forest fires (Table 41) which is one of the major reasons behind this problem hardly any results have come out on the ground, every year hundreds of hectares of forest are destroyed by fire. This is happening due to the acute shortage of workforce in the forest department and the lack of mutual coordination among various departments (Table 42).

Table 39. 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 40. 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).*
Prominent sources of air pollution in the district	Unprecedented forest fires and vehicular pollution are major reasons for Air pollution in the district.
Control of industrial air pollution	The district has two small industrial estates and only a few small scale industries are currently operational in these industrial estates. Some of them are 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	
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.

Table 41. Control measures for industrial / non industrial air pollution

Action Areas	Outcomes
Control of vehicular pollution	03 PUC centres are available in Chamoli district.
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.
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

Table 42. Gap identification

S. No.	Area of Concern	Remarks
1.	Uncontrollable forest fires	• Lack of staff • Sloping terrain makes it difficult for fire tenders to reach high altitudinal areas. • Abrupt migration from villages and change in living habits has exaggerated the situation. • Lack of inspection in forest areas under Van panchayat and Civil Forest.
2.	Lack of monitoring to assess the effects of vehicular pollution	No Air pollution monitoring in the town, hence much of the pollution goes unnoticed.

Proposed Policies to mitigate air pollution in the district

Some initiatives have been taken by UREDA and Forest department to control air pollution, specifically forest fires in the district. Both the departments are working on different methodologies to lessen the impact of unprecedented forest fires that engulfs the forest areas of the district (Table 43).

Table 43. Proposed Policies by Stakeholders for air pollution management

Proposed policies	Responsible agencies	Action plan
Electricity Generation thorough Pine needle	• Forest Department • Uttarakhand Renewable Energy Development Agency (UREDA)	Under first phase, biomass would be prepared from under Self-employment scheme.
Preventive and Control measures to mitigate forest fires	Forest Department	To control the incidents of forest fire, various initiatives are taken by the forest department which are as follows: - **Preventive measures:** 1. Formation of fire safety committees 2. Controlled and regular combustion 3. Establishment of crew stations and deployment of fire watchers 4. Cleaning and maintenance of fire lines 5. Publicity and public awareness **Control measures:** 1. Receiving fire accident information from satellite. 2. On-spot control of fire accident by the crew. 3. Deployment of fire control staff from permanent crew stations. 4. Cutting of counter fire lines. 5. Cooperation of firefighting police, revenue, and other departments 6. Public cooperation

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 (Table 44). 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 44. 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 Chamoli 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 45).

Table 45. 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 the 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 region of the state, the scale and intensity of RBM (Riverbed Minerals) 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.

Current Standpoints Regarding Mining Activities in the district

River bed mining and Soapstone mining are prevalent in the district. Two mining sites are operational and both of them are authorised by the concerned department. However, some cases of illegal mining have been registered related to river bed mining for which penalties are charged (Table 46). Both the mining sites are meeting environment clearance conditions and assent from UKPCB (Table 47).

Table 46. Prevalent Mining Activities

Parameter	**Outcome**			
Total Area of District (km^2)	8030			
Area Covered under Mining (km^2)	0.15662			
Type of Mining Activity	***Mining activity***	***Legal\Illegal***	***Area under mining (km^2)***	***Revenue***
	River Bed Material	Legal	0.00375	829168 (*In the financial year 2020-21*)
	Soapstone	Legal	0.15287	300000 (*In the financial year 2020-21*)
Penalties charges for illegal sand mining activities	***Type of Mineral***		***Total no of cases registered***	
	River Bed Material		20	
	Soapstone		00	
Number of mining sites operational	02			
Number of sites where permission for mining is given to the district authority by the environmental ministry	02			
Action against illegal mining activities in the district (*in the financial year 2020-21*)	***Amount received from the penalties charged for illegal mining***		***Amount received from the penalties charged for illegal storage & transportation of minerals***	
	11,29,168		26,76,923	

Table 47. Compliance with environmental standards

Parameter	**Outcome**
Mining areas meeting Environmental Clearance Conditions	02
Mining areas meeting consent conditions of UKPCB	02
Mining operations were suspended for violations of environmental norms	Nil
Pollutions related complaints against Mining operations in past one year	Nil

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)*

Rejuvenation works in Chamoli district

Rainwater harvesting and augmentation works such as construction of water tank, pirul check dam and contour trench are prevalent in Chamoli district. These works are performed specifically in forest areas (Reserved forests and Civil/Forest panchayat).

Mission Mothugad

General Information

Ramganga River is a major river in the Gairsain development block of district Chamoli. It is the main tributary of Ramganga which originates from Dudhatoli which is 2800 meters above sea level. The Ramganga River, which originates in the form of a small drain, takes the form of a river only after meeting Mothugad. The total catchment area of this river is 76. 56 km^2. About 40% of the catchment area of the Mothugad River is reserved forest

Mothugad River Rejuvenation Program

In the past years, the water level of Mothugad decreased significantly which lead to existential crisis for the river. Due to timely intervention from multiple departments, Mothugad River Rejuvenation program was undertaken to revive the flow of the river. Under this, catchment area of the river has been divided into 12 recharge zones to improve the health of river and to mitigate water-related risks (Table 48).

Table 48. Identified Recharge zone and their area

Recharge zone	Area (ha)
Chorarakhal	305.9
Devdhar recharge	283.5
Dewali khal	348.3
Dudhatoli	571.9
Gairsain	262.6
Ghandiyal khal	294.6
Himwalghat Gad	383.7
Kudyabagar	430.9
Musa ka kotha	458.8
Nanda devi	470.5
Silkot	263.5
Parwari	448.7

Works to be carried out under this Project

Forestry and engineering measures are proposed to revive the flow of the river as well as to maintain the riverine ecology. These are as follows:

1. Infiltration Holes
2. Infiltration trenches
3. Biological check dams
4. Dry stone masonry checks dams
5. Afforestation
6. Chal-khal & Jalkund

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 tons per year globally *(CPCB, 2013).* India generates 15 million tons 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 producer's 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 Management Rules,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.

Current Status Regarding Plastic Waste Management in the urban areas of the district

Due to increased awareness among the natives and efficient waste management of the municipal bodies of the district, the amount of plastic waste generation is not so high. Plastic waste generation is maximum in Nagar Palika Parishad Joshimath and least in Nagar panchayat Gauchar (Table 49). Almost all the ULBs are trying to implement integrated solid waste management that includes operations from collection to recycling of the plastic waste (Table 50). Some of the ULBs are also lacking in the necessary infrastructure required for the management of plastic waste. (Table 51).

Table 49. Inventory of Plastic Waste Generation

Name of Urban Local Body	Population (2011 census)	Number of Wards	Estimated Quantity of Plastic Waste Generated (MT/Day)
Nagar Palika Parishad Gopeshwar	21447	11	0.03
Nagar Palika Parishad Gauchar	8864	7	0.015
Nagar Palika Parishad Joshimath	16709	9	0.09
Nagar Palika Parishad Karanprayag	9850	7	0.08
Nagar Panchayat Badrinath	2438	4	0.05
Nagar Panchayat Gairsain	8665	7	0.035
Nagar Panchayat Pokhari	5295	7	0.05
Nagar Panchayat Thrali	4649	4	0.07
Nagar Panchayat Pipalkoti	3521	4	0.03
Nagar Panchayat Nandprayag	1641	4	0.04

Table 50. Plastic Waste Management Operations

Waste management Operations	Outcome	
Door to Door Collection	All the ULBs except Gopeshwar, Gauchar and Joshimath have 100 percent coverage for door-to-door collection.	
Segregated Waste Collection (Single used plastic, Recyclable plastic, etc.)	***ULB***	***Segregation (%)***
	Nagar Palika Parishad Gopeshwar	75
	Nagar Palika Parishad Gauchar	*75*
	Nagar Palika Parishad Joshimath	*90*
	Nagar Palika Parishad Karanprayag	*85*
	Nagar Panchayat Badrinath	*70*
	Nagar Panchayat Gairsain	*40*
	Nagar Panchayat Pokhari	*90*
	Nagar Panchayat Thrali	*85*
	Nagar Panchayat Pipalkoti	*85*
	Nagar Panchayat Nandprayag	*90*
Material Recovery Facility (MRF) operation	No ULB in the district have a Material Recovery Facility	
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	Only Nagar Palika Parishad Karnprayag is taking the assistance of a private firm (i.e. Green Energies private limited).	
Authorization and issuance of Identity cards to Waste Pickers/Sanitation workers	***ULB***	**Numbers**
	Nagar Palika Parishad Gopeshwar	91
	Nagar Palika Parishad Gauchar	21
	Nagar Palika Parishad Joshimath	61
	Nagar Palika Parishad Karanprayag	42
	Nagar Panchayat Badrinath	26
	Nagar Panchayat Gairsain	17
	Nagar Panchayat Pokhari	14
	Nagar Panchayat Thrali	17
	Nagar Panchayat Pipalkoti	16
	Nagar Panchayat Nandprayag	16

Table 51. Present infrastructure for plastic waste management operations

Name of ULB	Inventory of infrastructure available for plastic waste management operation				
	Plastic Waste collection centres	**Availability of plastic compacter**	**Linkage with Plastic waste Recyclers**	**Material recovery Facility (Available/Not Available)**	**Remarks**
Nagar Palika Parishad Gopeshwar	10	Available	Established	Not Available	Nagar Palika has earned 15 lakhs so far by selling the waste to the recyclers.
Nagar Palika Parishad Gauchar	16[a]	Available	Established	Not Available	ULB is declared as bin free city in January 2021.
Nagar Palika Parishad Joshimath	03[b]	Available	Established	Not Available	Nagar Palika has earned 62 lakhs so far by selling the waste to the recyclers.
Nagar Palika Parishad Karanprayag	08	Available	Established	Not Available	Nagar Palika has earned 14 lakhs so far by selling the waste to the recyclers.
Nagar Panchayat Badrinath	40[a]	Not Available	Established	Not Available	ULB is declared as bin free city in April 2021.
Nagar Panchayat Gairsain	60	Available	Established	Not Available	-
Nagar Panchayat Pokhari	20	Available	Established	Not Available	Nagar Palika has earned 80,000 so far by selling the waste to the recyclers.
Nagar Panchayat Thrali	40	Not Available	Not Established	Not Available	-
Nagar Panchayat Pipalkoti	06[a]	Not Available	Not Established	Not Available	ULB is declared as bin free city in June 2021.
Nagar Panchayat Nandprayag	25	Available	Established	NA	-

[a] *Litter bin of capacity lesser than 50 liters are provided within ULB to collect plastic waste.*
[b] *Secondary storage 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. 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 Chamoli District

Plastic waste in India has increased steadily over the past 50 years. It is expected to double over the next 20 years. Its growth rate in India is considered to be the highest in the world.

Projecting waste quantities in coming future is a difficult task. It is because of its changing composition over the seasons and periods due to ever changing dietary habits, economic conditions of the people and pandemic situation like COVID-19 in the concerned region. Crop harvesting season with adequate availability of a variety of food also affect the plastic generation. Lower is the level of economic development, greater will be the change between plastic waste generation and disposal. Moreover, COVID-19 like pandemic situation also caused remarkably plastic waste generation for creating medical tools and devices. These could be syringes, insulin pens, intravenous line (IV), surgical gloves, catheters, inflatable splits, etc.

Census population data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste forecasts is done based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant.
- The per capita generation of plastic waste was estimated to be 11 kg/annum (Centre for Science and Environment, 2019).
- It is assumed that 70% of the total plastic waste consumed 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)*

This analysis included population and waste generation estimations for only urban local bodies and did not include peri-urban and rural areas (Table 52 and 53).

Table 52. Projected Population and Waste Generation

ULB	Projected Population			Present/Projected Waste Generation (MTPD)		
	2021	2031	2041	2021	2031	2041
Gopeshwar NPP	23061	24675	26289	0.03	0.08	0.23
Gauchar NPP	10425	11986	13547	0.02	0.04	0.13
Joshimath NPP	20214	23719	27224	0.09	0.27	0.82
Karanprayag NPP	12723	15596	18469	0.08	0.25	0.79
Badrinath NP	3194	3950	4706	0.05	0.16	0.50
Gairsain NP	11816	14967	18118	0.04	0.12	0.36
Pokhari NP	6400	7505	8610	0.05	0.15	0.45
Tharali NP	5341	6033	6725	0.07	0.21	0.60
Pipalkoti NP	4178	4835	5492	0.03	0.09	0.27
Nandprayag NP	1578	1515	1452	0.04	0.10	0.25
Total				**0.49**	**1.48**	**4.39**

Table 53. Decadal Change in plastic waste Generation

Name of ULB	Rate of growth % (2021-2031)	Rate of growth % (2031-2041)
Gopeshwar NPP	17.82	17.70
Gauchar NPP	19.89	19.39
Joshimath NPP	20.51	19.84
Karanprayag NPP	21.87	20.79
Badrinath NP	22.15	20.98
Gairsain NP	22.93	21.47
Pokhari NP	20.49	19.83
Tharali NP	19.37	18.98
Pipalkoti NP	20.09	19.53
Nandprayag NP	14.96	14.92

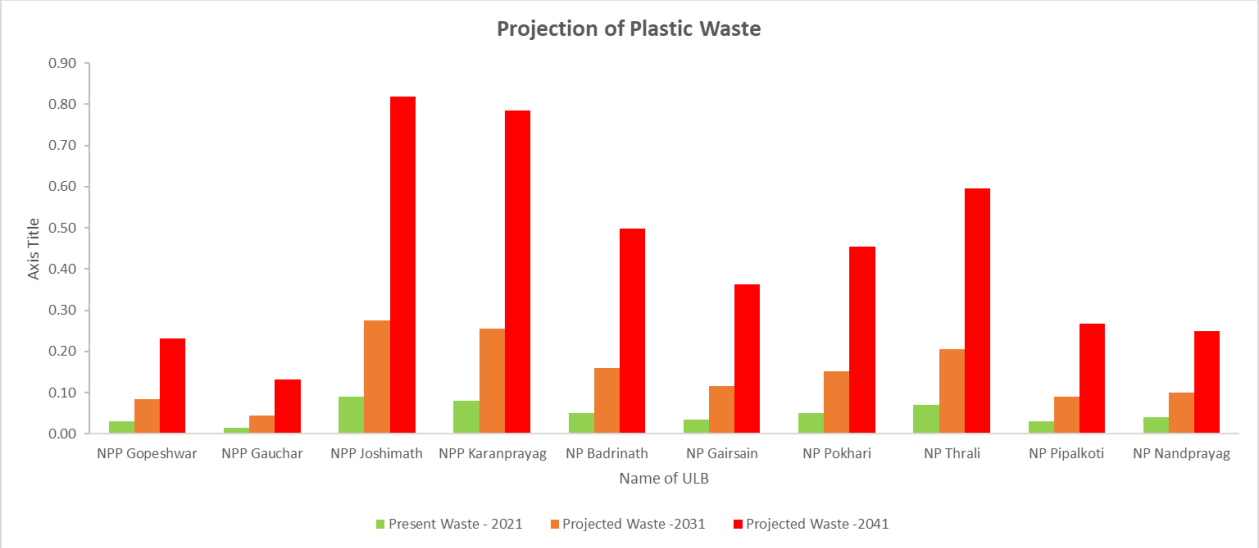


Fig. 6. Projected plastic waste generation in Chamoli district

Inferences drawn from the projected data

- Total plastic waste generation in all the urban local bodies is likely to increase by 1-5 MTPD in the coming decades.
- Maximum growth is liked to occur in Nagar Panchayat Gairsain due to sharp population growth in the ULB.
- Huge Pilgrim influx adds to the overall waste generation in the district. Plastic waste could be one of the largest contributor and will alter the waste composition.

ASSESSMENT OF URBAN LOCAL BODIES IN CHAMOLI 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 54 and 55). 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 54. Assessment of Urban local bodies in Chamoli district

Indicators	**Maximum Points**	**Urban Local Body**					
		NPP Gopeshwar	NPP Gauchar	NPP Joshimath	NPP Karnprayag	NP Badrinath	NP Gairsain
Solid Waste Management							
Segregation	**4**	3	3	3	3	3	2
Collection	**4**	3	3	3	4	4	4
Segregated Waste Transport	**4**	1	1	1	1	1	1
Wet Waste Processing	**2**	2	2	2	2	2	2
Dry Waste Processing	**4**	2	2	2	2	2	2
Disposal	**2**	1	1	1	1	1	0
Inclusion of Informal Sector	**1**	0	0	0	1	0	0
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							
E-waste Collection and Linkage with Recyclers	**2**	0	0	1	1	0	0
General Information							
Innovation and use of indigenous Techniques	**2**	0	1	1	0	1	0
Enforcement of By-laws and Waste Management Rules, 2016	**2**	2	2	2	1	2	1
Total	**30**	**14**	**15**	**16**	**16**	**16**	**12**

Continue…….

Indicators	**Maximum Points**	**Urban Local Body**			
		NN Pokhari	**NN Tharali**	**NPP Pipalkoti**	**NPP Nandprayag**
Solid Waste Management					
Segregation	**4**	3	3	3	3
Collection	**4**	4	4	4	4
Segregated Waste Transport	**4**	1	1	1	1
Wet Waste Processing	**2**	2	2	2	2
Dry Waste Processing	**4**	2	0	0	2
Disposal	**2**	0	1	1	1
Inclusion of Informal Sector	**1**	0	0	0	0
Bio-medical waste Management					
Linkage with CBWTF*(Common Bio-medical Waste Treatment and Disposal Facility)*	**1**	0	0	0	0
Hazardous Waste Management					
Linkage with TSDF (*Treatment, Storage and Disposal Facilities)*	**1**	0	0	0	0
C&D Waste management					
C&D Waste Processing	**1**	0	0	0	0
E-Waste Management					

E-waste Collection and Linkage with Recyclers	**2**	0	0	0	0
General Information					
Innovation and use of indigenous Techniques	**2**	0	0	1	0
Enforcement of By-laws and Waste Management Rules, 2016	**2**	0	2	2	1
Total	**30**	**12**	**13**	**14**	**14**

Table 55. Final Assessment of Urban Local bodies of Chamoli District

Name of ULB	Score (out of 30)	Score Percentage (%)
Nagar Palika Parishad Gopeshwar	14	46.67
Nagar Palika Parishad Gauchar	15	50
Nagar Palika Parishad Joshimath	16	53.34
Nagar Palika Parishad Karanprayag	16	53.34
Nagar Panchayat Badrinath	16	53.34
Nagar Panchayat Gairsain	12	40
Nagar Panchayat Pokhari	12	40
Nagar Panchayat Thrali	13	43.34
Nagar Panchayat Pipalkoti	14	46.67
Nagar Panchayat Nandprayag	14	46.67

Observations from data assessment

- All the ULBs are lagging behind when it comes to segregation of waste at the household level. Some ULBs such as Gopeshwar, Gauchar and Joshimath have inadequate door to door collection of the waste. However, it is quite satisfactory in other ULBs of the district.
- None of the ULB is having an operational material recovery facility for the segregation of collected waste.
- In Gairsain and Pokhari trenching ground is not available for the disposal of inert waste. Some ULBs such as Tharali and Pipalkoti have not established linkage with authorised recyclers.
- None of the Urban Local Bodies has linkage with Common Biomedical Waste Treatment Facility (CBWTF) and Treatment Storage and Disposal facility (TSDF) for the disposal of municipal sanitary waste and domestic hazardous waste respectively.
- Overall Joshimath, Karnprayag and Badrinath are performing better among all the ULBs of the district while Gairsain and Pokhari need to revamp their waste management operations.

ACTION PLAN

Action Plan for Solid Waste Management

Chamoli district is still lacking scientific management of dry waste. Unavailability of any material recovery facility has further exaggerated the issue. Most of the ULBs have their DPR approved to buy equipment's and machinery for scientific waste management operations. It is expected that the district would be able to scientifically manage its waste in a decadal timeline. The current action points must be addressed in a timeframe of 5-10 years considering the financial constraints (Table 56).

Focus Areas

- *Scientific recovery and disposal of waste.*

Table 56. Action plan for solid waste management

Action areas	Concerning ULB	Strategy/Approach	Stakeholder Responsible	Purpose
Primary Segregation (Segregation at Source)	All ULBs	• Separate Storage Bins. • Regular awareness campaigns • Man power Management. • Behavioural change Communication techniques. • Promoting Home composting for wet waste.	Nagar Palika Parishad/ Nagar Panchayat Residents and NGOs	• Higher Recovery of Recyclables. Hygienic environment for handling of waste.
Door to Door Collection	NPP Gopeshwar, NPP Gauchar, NPP Joshimath	• Training waste pickers. • Providing equipment, infrastructure and management support.	Nagar Palika Parishad	• To counter the Monkey menace in local dump sites and secondary storage bins. • To limit the open dumping of waste • To formulate Sustainable waste management model.
Segregated Waste Transport	All ULBs	• Optimizing Waste Management Infrastructure (Collection trucks, trolleys). • Man power optimization at Recovery facility.	Nagar Palika / Nagar Panchayat	• To reduce open dumping of waste. • Reduction of Historical waste. • To reduce contamination of ground water.

				Reduction of transportation charges.
Linkage with Treatment Storage and Disposal Facility (TSDF) and Common Biomedical Waste Treatment Facility (CBMWTF)	All ULBs	• Separate bins for sanitary and domestic hazardous waste. • Linkage with nearby TSDF and CBMWTF	Nagar Palika/Nagar Palika Parishad/ Nagar Panchayat	Segregation and proper disposal of Municipal sanitary waste and domestic hazardous waste.
Linkage with authorised recyclers		Either the local scrap pickers can be authorised or direct linkage could be established with any recycling unit.	Nagar Palika Parishad/ Nagar Panchayat	• To reduce open dumping of waste. To insure proper recycling of the waste.
Cluster based Approach to Solid waste management	All ULBs	• By merging schemes from Central and state government department with Rurban Mission of Ministry of Rural development	District Administration District Panchayati Raj Officer (DPRO)	• To club the villages in peri-urban areas of the town with the nearby solid waste management facility for effective waste management in rural areas. • To execute Rurban mission of Government of India.
Community participation for waste management	All ULBs	• 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	• Social and Behavioural Change Communication Cleanliness drive campaigns throughout the district

Establishment of Green Protocol	All ULBs	By encouraging Green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. To bring generation of non-biodegradable waste close to zero.

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

Natural or planted vegetation on a landfill 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 or to 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 57).

Table 57. Suggested vegetation for reclaiming landfill sites in the district Uttarakashi

Botanical Name	Local and English Name	Altitude (m)	Life form	Assimilating capacity	References
Quercus leucotrichophora A. Camus	Banj oak	1200-2400	Tree	Microbial biodegradation, binding, holding soils, and/or decreased leaching	Meenakshy et al, 1981
Bauhinia variegata L.	Kachnar	1250-1800	Tree	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	Das, 1981
Bauhinia acuminata L	Kachnar	1150-1500	Tree	conversion of Hg to volatile chemical from groundwater	Chaphekar, et al., 1980
Adina cordifolia (Roxb.) Hook. f. ex Brandis	Haldu	Upto-1500	Tree	conversion of Se and Hg to volatile chemical from groundwater	Prajapati, 2012
Berberis aristata DC.	Kingore	1350-2000	Shrub	Metals, radionuclides, hydrophobic organics	Das, 1981
Berberis asiatica Roxb. ex DC.	Kilmora	1650-2400	Shrub	Adsorb' all the dissolved gases	Das, 1981
Cynodon dactylon (L.) Persoon	Dubla, Doob	700-2500	Herb	Absorbs Arsenic and Fluoride from wastewater	Chaphekar, et al., 1980
Azolla pinnata R. Br.	Azolla	400-2200	Herb	Control the Hg, and Cd from wastewater also known as bio-fertilizer	Rai, 2008

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 Chamoli 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 58).

Table 58. 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

There is no proper system for the scientific disposal of biomedical waste in the Chamoli district. Healthcare facilities and ULBs have no linkage with any common bio-medical waste treatment facilities. Due to this, proper segregation and disposal of biomedical waste seems difficult. The district should collect biomedical waste by connecting all health-related facilities by cluster based approach. This action plan provides a holistic approach which includes governance, infrastructure, training and vaccination, services, etc. for proper management of biomedical waste in near future (Table 59).

Focus Areas

- *Pre segregation at healthcare facilities*
- *Streamlining domestic households waste in biomedical waste management*
- *Centralized collection of biomedical waste.*

Table 59. 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	To keep records of biomedical waste generated in every HCF of the district (especially in PHCs at rural areas).	Health department

(BMWMIS)) to all data entry operators and pharmacists.		
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

The amount of construction and demolition waste in the Chamoli district is currently minimal. But due to the development of Char Dham All Weather Road and Rail Project, the overall construction work is escalating. Therefore, the amount of construction and demolition waste will increase exponentially in the district. Hence it is important to make dumping zones as well as treatment facilities for construction and demolition waste management. Separate dumping zones needs to be defined by the government organization in charge of construction of road and rail projects in the district. This action plan (Table 60) provides a sustainable approach to the management of C&D waste in compliance with the latest C&D Waste Management Rules 2016.

Focus Areas

- *Establishment of dumping zones for C&D waste in ULBs and peri-urban areas*
- *Framing of by-laws*

Table 60. Action plan for C&D waste management

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Setting up of C&D waste dumping Site for local construction activities and road construction debris.	• 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)	To ensure compliance with C&D Waste Management Rules 2016.
Framing by-laws for C&D waste management.	• 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)	To ensure compliance with C&D Waste Management Rules 2016.

Management of C&D waste.	• 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)	• 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.
Plantation in old dump sites.	• 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)	• Established the slope at old dumping zones.

Action Plan for Hazardous Waste

At present, the number of industries generating hazardous waste is very less in the district, however it has been inventoried to some extent. Hazardous waste is not yet streamlined in waste management operations of Chamoli district. But its quantity may increase in future. The district also does not have any treatment, storage, and disposal facilities for the management of hazardous waste. 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 61).

Focus Areas

- *Inventorization of hazardous waste from industries and domestic households.*
- *Linkage of ULBs with TSDF*

Table 61. Action plan for hazardous waste

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Linkage of ULBs with common Treatment, Storage and Disposal Facilities (TSDF) or disposal facility	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)	To ensure segregation of domestic hazardous waste from municipal solid waste and its proper disposal.
Training of sanitation workers regarding segregation of domestic hazardous 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	To ensure segregation of domestic hazardous waste from municipal solid waste
IT enabled systems for inventorization of the hazardous waste m	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	To ensure compliance to Hazardous waste management rule 2016.

Action Plan for E-Waste

E-waste cannot be quantified in the district due to a lack of basic waste management functions. This may be due to a lack of awareness among people about e-waste as well as a lack of concern by the district administration. There is a need to streamline e-waste in the current waste management operations, besides a comprehensive framework should be developed for its management. This action plan discusses the key areas where interventions are required to achieve effective waste management in compliance with the E-Waste Management Rules, 2016 (Table 62).

Focus Areas

- *Inventorization of e-waste generated.*
- *Establishment of e-waste Collection Centres*
- *Authorization of e-waste pickers*

Table 62. Action plan for E-waste

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Establishing E-waste Collection Centres	• 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	• To ensure proper segregation of E-waste from municipal solid waste • Capacity building of stakeholders to promote effective E-waste management.
Authorization of E-Waste Pickers	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	To avoid illegal trading and processing of e-waste.
Linkage of ULBs with authorized recyclers/ Dismantlers	All the ULBs in the district should establish linkage with any of the five authorized E-waste recyclers.	All ULBs	To ensure proper recycling if possible and if not then proper disposal as per E-waste management rule 2016.
District level Awareness campaign	• 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	Promoting behavioural change in public.

Extended Producer Responsibility	• 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	• Proper Collection and Disposal of E-waste • Channelization of e-waste generated from *the "end-of-life"* products to ensure environmentally sound management

Action Plan for Waste Water Management (STPs)

Under the Namami Gange Project, several STPs have been constructed with limited capacity. Other ULBs still rely on conventional treatment of wastewater which has become obsolete and leads to environmental degradation. However, some policies have been implemented in the district to improve liquid waste management in the district. This action plan focuses on addressing the concerns of each ULB regarding the policies and designs accepted by the respective administrations (Table 63).

Focus Areas

- *Laying of sewer lines*
- *Reconnaissance survey to find out appropriate sewage management technique for a region.*

Table 63. Action plan for waste water management

Action areas	Concerning ULB	Strategy/Approach	Stakeholder Responsible
Upgradation of Sewer Network	• Gopeshwar • Joshimath • Karnprayag • Badrinath • Nandprayag	• Reconnaissance survey of rest of the ULB. • Preparation of estimation for the required sewer network to receive the financial grant from the government. • If off-site sanitation is not financially viable then septage management is also one of the possible options by upgrading the existing STPs for co-treatment.	Jal Nigam/Jal Sansthan
Continuous Effluent Monitoring station	• Gopeshwar • Joshimath • Karnprayag • Badrinath • Nandprayag	• Self-monitoring mechanism in the form of Online Continuous effluent monitoring system.	• Jal Sansthan • State Pollution control board
Decentralized waste water management under Atal mission for Rejuvenation and Urban transformation (AMRUT) by Faecal Sludge and Septage Management system (FSSM)	• Gauchar, • Gairsain • Pokhari • Tharali • Pipalkoti	• In line with National FSSM policy, each state is expected to develop and issue an FSSM implementation strategy and plan guideline. This may be integrated with overall city land use planning. • Capacity building and training on FSSM *(at City level)* to build their personnel capacities and organizational systems for delivery of sanitation services.	Ministry of Housing and Urban development Government of India

City Sanitation Plan under National Urban Sanitation policy	All ULBs	• Enhance synergy among municipal government agencies, the private sector, NGOs and others. • Increase funding from sources other than municipal government *(such as from the national and provincial governments , donor agencies, the private sector)*	Ministry of Housing and Urban Development, Government of India

Phytoremediation as a mitigation Measure *(for domestic waste water)*

With removal of some biotic and abiotic pollutants (by absorbing these pollutants), certain plants, can help in the natural treatment of domestic waste water (Table 64).

Table 64. Mitigation Measure *for domestic waste water*.

Botanical name	Local name	Remarks
Jacarnda mimosifolia	Jacarnda	Antimicrobial action against E.coli and Staph bacteria
Salix babylonica	Willow	Improve the quality of ground water by absorbing ammonical nitrogen and heavy metals
Canna spp.	Canna	Used for removal of ammonical nitrogen from sewage
Azolla pinnata	Azolla	Used for cleaning of sewage and degrades diesel fuel and absorbs mercury and cadmium
Typha domingenesis	Southern Cattail	Reduces bacteria from water and absorbs Al, Fe and Zn from Sewage.

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.

Focus Areas

- *Watershed and spring shed management*
- *Water quality monitoring and maintenance of environment flow*

Chamoli district lies in the drainage basin of numerous river, Hence, groundwater and surface water sources remains replenished throughout the year. It becomes important to maintain the riverine ecology so that water quality and discharge are maintained as per the standards. EIA assessment of hydropower projects needs to be rigorous in which ecological imperatives should be considered. This 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 65 and 66).

Table 65. Water Resources management

Action Point	Strategy/Approach	Purpose
Integrated water resources management (IWRM) at River basin level	By Considering basin/sub basin as a basic unit for planning and management.	To achieve water security for all purposes ,managing risks and to mitigate disasters
River Basin Master Plan	By analysing River Basin Characteristics	Periodic review of hydrological conditions prevailing over a basin Identification of protected areas
Mapping of water scarce areas in a 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	• To get estimate of vulnerable areas in the district.
Assessment of water Resources in various river basin	Using Modern technology and Hydrological modelling	To collect reliable data To assess water resources potential and analysing water requirements for various uses,

Public Awareness and use of Low Cost technologies	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.	For better water application efficiency
Integrated Rural area Programme (IRAP)	By bringing together all the programmes of different ministries as well as rural employment and development programme into one for effective collaboration and planning.	• For constant interactive relationships between different departments Location specific programmes can be drawn up locally under this overall programme.

Table 66. Ground water management

Action Point	**Strategy/Approach**	**Purpose**
Multidisciplinary Approach (Nexus between groundwater, agricultural policy, urban infrastructure and energy consumption)	By integrated vision and coordination amongst different departments.	For groundwater sustainability
Mapping of aquifer at micro level	By Maintaining an Aquifer information and Management system	• To quantify the available ground water resources To formulate plan appropriate to the scale of demands and aquifer characteristics.
Artificial recharge of Ground water	• 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).	• To ensure sustainability of ground water resources • To ensure the quality of recharge to prevent possible contamination
Identification of Non-point sources of Pollution (Pollution	• Controlling soil erosion by planting more trees and covering bare soil with vegetation.	• Non-point source pollution is a leading cause of deteriorating water quality as when the runoff moves, it

resulting from land runoff, precipitation, drainage, seepage, etc).	• Constructing wetlands.	picks up and carries away natural and human-made pollutants, finally depositing them in lakes, rivers and groundwater.
Mitigating Groundwater Contamination	• Reducing the use of pesticides and fertilizers. • Encouraging organic farming in the area by organising various Information, Education and Communication (IEC) campaigns.	• To ensure the ground water quality of an area. • To reduce health hazards caused due to contaminated water.

Action Plan for Air Quality Management

At present information related to air pollution in Chamoli is minimal. But it is often observed that the anthropogenic activities in the district are mainly responsible for the increasing level of pollutants in the area, the major one being forest fires. Hence the involvement of various institutions with the local community is desired. Most importantly, an air quality monitoring needs to be done in the district at least during months when forest fires are on rise. The action plan provided below deals with all the aspects, which are prerequisite to address this issue (Table 67).

Focus Areas

- *Air quality monitoring*
- *Control of forest fires*

Table 67. Action plan for air quality management

Action Areas	Strategies/Approach	Stakeholders	Purpose
Air quality monitoring	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)	To identify the hotspots within the district and further development of mitigation measures for those areas.
Solid waste collection system	• 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 DPRO District Panchayati Raj Office (DPRO)	To reduce emission of harmful gases by open burning of waste especially in urban areas.
Control over forest fires	• 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.	Government of Uttarakhand and District Forest Department	To reduce harmful emissions due to massive forest fires in the district.

	• Development of mixed forests by planting indigenous broadleaf plants which maintains moisture in the soil and reduce the chances of fire.		
Vehicular Traffic management	• 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	• To reduce emissions caused by vehicles.
District level action plan for air pollution	A district level task force with some experts can be formed for air quality management in the district.	District Administration	To improve existing air quality.
Awareness on air quality	Mass awareness can be promoted with IEC activities by involving institutions such as schools and colleges for this purpose.	District Administration	To promote awareness among the masses regarding the issue.
Complaint redressal system	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	• To sort out grievances registered by citizens

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 68).

Table 68. Action Plan for Noise pollution management

Action Areas	Strategies/Approach	Stakeholders	Purpose
Noise level monitoring	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)	To recognize the current situation of noise levels in the district and identify the hotspots

Traffic management	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	• To ensure noise level within permissible limits
Complaint redressing system	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	To sort out grievances registered by citizens
Mass Awareness	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	To promote awareness among the masses regarding the issue

ACTION PLAN MINING ACTIVITY MANAGEMENT PLAN

Focus Areas

- *Association of different departments in curbing illegal mining*
- *Advanced surveillance techniques*
- *Digitization of trading process*

River bed mining is prevalent in Chamoli district owing to the flood plains of major rivers. Environment impact assessment must be rigorous to maintain ecological balance in the site and its periphery. 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 69)

Table 69. Mining activity management plan

Action Areas	Strategies/Approach	Stakeholders	Purpose
Monitoring of mining activity	• 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	To ensure sustainable mining activity within the district.
System for online purchase and sale of Sand and other RBMs	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	To ensure compliance to Enforcement and Monitoring guidelines for Sand mining, 2020.
Identification of hotspots for illegal mining	The district task force should identify the possible hotspots for illegal mining through surveillance and patrolling.	District Administration	To have check on the mining activities in the district.
Community participation	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	• 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.

Action Plan for Rejuvenation of Waterbodies

Mission Mothugad has been undertaken in the district to revive the flow of Mothugad River. Several works have been started under the project by intervention of different departments. Some technological interventions are desired in this project to reap maximum benefit. This action plan provides a holistic approach, which includes scientific interventions as well as convergence activities for rejuvenation of water bodies (Table 70).

Table 70. 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 are influenced by rejuvenation activities carries out for Kosi river(Almora), Bhela river(Kashipur) and Heval River (Tehri 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.

Focus Areas

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

Plastic waste generation in the district is not much as compared to the urban local bodies of other district. This could be due to awareness amongst households. However, Chamoli district witness huge influx of tourist throughout the year, hence floating waste and littering needs to be streamlined in the existing waste management operations. 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 71).

Table 71. Action Plan for Plastic waste management

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Source segregation	• 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	• To ensure better efficiency in waste processing • Higher recovery of resources.
Effective Collection and segregated waste transport	• 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.	All ULBs, District Panchayati Raj Officer (DPRO), Village Panchayats	• 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

	• ULBs can establish linkage with the NGOs working in this field for effective waste collection in the urban areas.		To ensure compliance with plastic waste management rules 2016
Linkage of ULBs & other collection centres with recyclers/ cement plants / Public Works Department	• 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 agencies such as Public Works Department.	All ULBs, DPRO (District Panchayati raj Officer),	• To avoid open dumping of plastic waste. • To ensure reuse and recycle of plastic waste.
Implementation of extended producer responsibility (EPR) through producer/Brand owner	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	To reduce the workload of ULBs
Community participation for waste management	• 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	Social and Behavioural Change Communication Cleanliness drive campaigns throughout the district
Establishment of Green Protocol	By encouraging Green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.

CONCLUSION

Over the past few decades, ever growing environmental problems have invited lots of attention of the stakeholders like academicians, local government, environmental planners, social activists and judiciaries. The environmental issue has therefore raised a large scale public concern. Many actions have been taken by the Government of India and concerned Environmental Protection Agencies to protect different environmental components, ecosystem services and human health from a particular pollution and degradation threat. Despite, some of the successes achieved on the grounds, many more problems continue to remain unresolved with the new ones emerging continuously day by day. With the ever increasing native and floating population and resultant anthropogenic pressures, sometimes addressing a strategy becomes a bit difficult. However, combined and interdependence might reduce complexity of environmental systems. The present new challenges before planners and policymakers might be resolved if a scientific spirit could be maintained in management actions on a ground. Scientific research could play an important role in managing and minimising pollution loads. The scientific studies and their implementation on ground will continue to play its vital role in resolving environmental problems. The environmental problems may lead to a sectoral view of problems like pollution, health, basic sanitation, land management, and conservation and sustainable use of natural resources. Decisions based on incorrect or incomplete understanding of environmental components would not allow to achieve the targeted goals of environmental management with lower risks and cost. This report as an environment plan of the district describes a framework for acquiring an idea to manage current problems of environmental aspects such as solid waste, biomedical waste, C&D waste, e-waste, industrial waste water, plastic waste, etc. These problems need to be considered as a tool to prepare for a variety of problems in view of emerging in near future. Though there is no any optimal institutional framework for environmental and natural resource management at the district level, yet some general features of an ideal institutional system could be many. These could be as follows: (i) flexibility of a plan or a model, (ii) capacity to generate information and create awareness of the importance of environmental problems among the decision-makers at all levels, (iii) decentralized decision-making and enforcement, (iv) involvement of individuals for a clear-cut role, and consensus of stakeholders (governmental agencies, non-governmental organizations, community groups and other associations) in environmental management; and (v) a high-level political will and support . There is a need to apply from the sectoral approach to collaborate approach. This is a need of the hour to mitigate and minimise the environmental impacts in our surroundings.

Environmental planning for different environmental components need to be adhered to the principle of sustainability where science serves as a quantifiable tool. The environmental management approach needs to be holistic in nature. Decision making is an integration of science and management to get people involved and managers to act and to plan.

Fig. 7. Different activities in Chamoli District for preparation of District Environment Plan

(A & B) A consultative workshop/Seminar in the Chamoli district on preparation for District Environment Plan

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