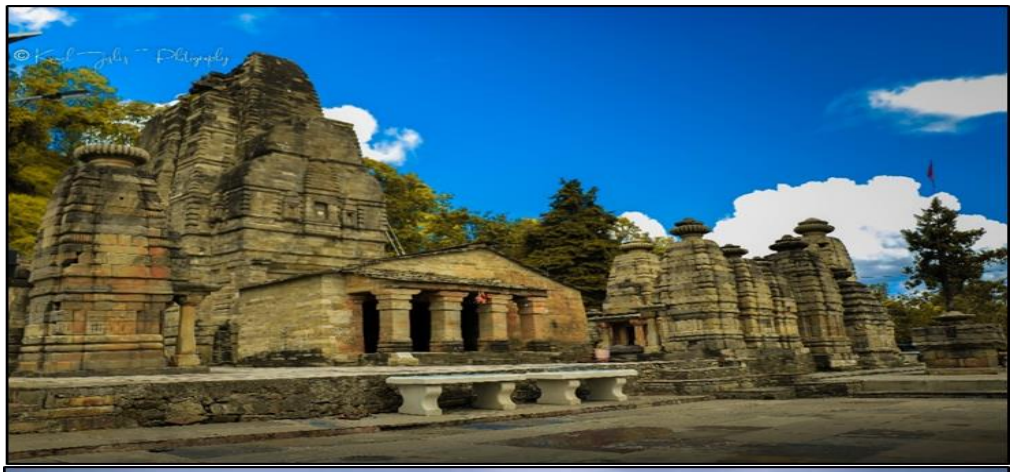
DRAFT

DISTRICT ENVIRONMENTAL PLAN

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

ALMORA



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&

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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 District Environmental Plan 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 District Magistrate. The said order also directs that Department of Environment in respective States should collect district plans to prepare State Environment Plan, 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 (MoEF&CC) shall prepare a National Environmental Plan, under the supervision of Secretary, MoEF&CC 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 Govt of Uttarakhand were included under district plan. These 14 areas were regarding compliance to rules for: solid waste including legacy waste, bio-medical waste, construction & demolition waste, hazardous waste, e-waste, polluter stretches, non-attainment cities, industrial clusters, status of sewage treatment plants (STPs) and re-use of treated water, 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 SPCB.

Implementation of the environment plan based on fundamental indicators will do noticeably more to ensure that these objectives are achieved and our compliance obligations are met. It will also allow environmental opportunities associated with our activities to be further explored and undertaken. Environmental plan describes how action might impact the natural environment in which it occurs and set out clear commitments how those impacts will be avoided, minimized, and managed so that they are environmentally acceptable. We hope this document will act as an easy reference for various stakeholders interested in progression of sustainable development planning for the Almora district. Moreover, it will help develop a comprehensive understanding of environmental planning process, which has gone into development of the area over the period. Finally, it briefly touches upon the imminent need for bringing in mountain perspective in developmental planning for the district.

Date: October 01, 2021

Principal Investigator, Co Principal Investigators & Project staff

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The present 'District Environment Plan' has been an outcome due to coordinated efforts put together by different stakeholders from top to bottom in the State as well as in the district. At the outset, we thank Chief Secretary, Uttarakhand Government; Secretary, Forest Department, Secretary, Ministry of Environment, Forest and climate change (MoEFCC), Government of India, Principal Secretary/Chairman, UKPCB, Dehradun and Member Secretary, Uttarakhand Pollution Control Board (UKPCB). We also thank the Director, G.B. Pant National Institute of Himalayan Environment (GBPNIHE), Kosi-Katarmal, Almora for providing necessary facilities, instrumental support and encouragement. We are also thankful to Chairman & District Magistrate (DM), Almora, Shri Nitin Singh Bhadauria, previous District Magistrate, Almora, Shri Mahatim Yadav, District Forest Officer (DFO) Member Secretary, for their time to time valuable inputs in the formulation of district environment plan. We acknowledge all the support received from different departments including DM office, UKPCB, NagarPalika Parishad, Forest Department, Health Department, Jal Sansthan, Irrigation Department, Mining Department, and Regional Transport Officer (RTO)for providing the information in a very satisfactory manner. The guidance and support from MoEF & CC and Government of Uttarakhand remained a constant source of inspiration at stages of this work. we thank and acknowledge all officers/staff who could directly or indirectly contribute their valuable inputs in completing the work. We also extend our thanks to all the colleagues who made this work a memorable and worthwhile experience.

Lastly but not least, our especial thanks go to Uttarakhand Pollution Control Board (UKPCB), Government of Uttarakhand, for financial support (Letter No. UKPCB/HO/Gen.183-431/2020/2156-415, dated 05/08/2020) to conduct the study in the 13 districts as well as the state of Uttarakhand.

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ABBREVIATIONS

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

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

NGOs	-Non-Governmental Organizations
NGT	-National Green Tribunal
NH	-National Highway
NITI	-National Institution for Transforming India
NMHS	-National Mission of Himalayan Studies
NP	-Nagar Panchayat
NPP	-Nagar Palika Parishad
NTFPs	-Non-Timber Forest Products
ODF	-Open Defecation Free
OSHA	- Occupational Safety and Health Administrations
PAT	-Perform, Achieve &Trade
PCC	-Pollution Control Committee
PHCs	-Primary Health Centre
PIBO	-Producer, Importer and Brand Owner
PM	-Particulate Matter
PPP	-Polluter Pays Principle
PWD	-Public Works Department
QPD	-Quintal Per Day
RBMs	-Riverbed Minerals
ROHS	-Restriction of Hazardous Substances
RSM	-Rural Sanitary Marts
SBM-G	-Swachh Bharat Mission Gramin
SDGs	-Sustainable Developmental Goals
SIDCUL	-State Industrial Development Corporation of Uttarakhand Limited
SLWM	-Solid and Liquid Waste Management
SPCB	-State Pollution Control Board
STP	-Sewage Treatment Plant
TPD	-Tonne Per Day
TSDF	-Treatment Storage and Disposal Facilities
UKPCB	-Uttarakhand Pollution Control Board
ULBs	-Urban Local Bodies
UNDP	-United Nations Development Programme
UREDA	-Uttarakhand Renewable Energy Development Agency
WHO	-World Health Organization

ZED	-Zero Effect Zero Defect
ZLD	-Zero Liquid Discharge
RTO	-Regional Transport Officer
µg	-Microgram

EXECUTIVE SUMMARY

Almora district falls in the Lesser 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:*** At present, proper collection and disposal of solid waste *(both dry and wet)* is practiced in the urban centres of the district. However, there is no established mechanism for waste collection in the rural areas.
- Waste segregation at source is a major issue in all the urban local bodies of the district. Moreover, the waste recovery and disposal facilities are not robust. Due to improper segregation of municipal solid waste, the domestic hazardous and E-waste are also dumped in the landfill sites causing environmental hazards.
- ***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).*
- Due to continuous threats of epidemic, the time has come when the government should ensure to set up a common biomedical waste treatment facility (CBWTF) in the district which can also cater the demand of nearby villages and peri-urban areas.
- ***Construction and demolition waste management:*** Rapid urbanisation and development of road 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, only 15% population in Nagar Palika Almora in the district is connected with sewerage network, Sewage management in other urban local bodies needs to be established in coming years. For other urban local bodies, Faecal

Sludge and Septage Management (FSSM) services can be implemented as recommended by Government of India for achieving the safe and sustainable sanitation to the people.

- The district has low amount of industrial waste; however, two industrial units have installed effluent treatment plants which work on the principle of Zero Liquid Discharge (ZLD).
- ***Air and Noise Pollution:*** Compared to a couple of decades ago, particulate air pollution is no longer a feature of Indo-Gangetic plains alone. Events of massive forest fires are increasing and the numbers of plying vehicles are also increasing continuously. Thus, there is a need of continuous monitoring of air quality and noise levels in the district to come up with a mitigating strategy.
- ***Surface and Groundwater Management:*** As the global temperatures are rising and weather patterns are changing drastically, the water sources in the Himalayan region are severely affected. The Almora district is mainly dependent on the ground water sources and also Kosi river discharge for its water needs. Hence, proper spring shed management needs to be done for sustainable management of water sources.
- ***Mining activity:*** As of now, illegal mining is not a big issue in the district but with the rapid urbanisation, there is a possibility of exponential increase in the demand of sand and other Riverbed Minerals (RBMs). District level task force should be constituted to have a proper check on the mining activity.

The execution of this management plan in Almora 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 have been always a challenging task before the planners. The world's poor are significantly prone to natural disasters pertaining to the fact that in many cases their livelihoods are directly dependent on the natural resources. Human welfare is closely associated with the health of the environment. Around the world, 24 percent of deaths can be traced back to avoidable environmental factors (WHO, 2018). People are in direct need of clean air to breathe, freshwater to drink and suitable places to live in that are free from pollutions including toxic substances and hazards. The 2030 agenda for Sustainable Development Goals (SDGs) and its 17 Goals adopted by world leaders define a blueprint for future development trajectory to all the nations with a focus on poverty eradication, environmental sustainability, peace and harmony (Anonymous, 2018; WHO, 2018; Azash, & Thirupalu, 2017). Recently, Intergovernmental Panel on Climate Change (IPCC) released a Report on "Climate Change 2021- The Physical Science Basis" as a part of IPCC's Sixth Assessment report *(AR6)*. The facts presented in this report regarding raising a crucial red flag that global temperatures have already risen by about 1.1ºC from pre-industrial times and has warned that 1.5ºC threshold is likely to be breached before 2040 *(the stated 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, both annual and summer monsoon precipitation are projected to increase (Krishnan, et al., 2020). In regard to the Himalayan context, the area is one of the most fragile mountainous regions of the world. Hence, it is susceptible to changes in Environmental conditions and ecology (Krishnan et al., 2020). These mountains are considered to be the Water tower of South Asia, as major rivers of the Indian sub-continent originate from the Himalayan Mountains. However, the area has become a global hotspot since the past two decades in view of environmental degradation. The indirect impact has also seen in the glaciological aspect of these mountains (Eriksson, et al., 2019). Almost, 500 million people of South Asia are dependent upon the health aspect of the Himalayan ecosystem. In India, the Himalayan Mountain Chain directly serves as a national interest 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 & 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 is implemented in the ground is known by few. We need to devise a strategy to break this trade off so that a mutually beneficial situation is achieved for the environment and society (Messerli et al., 2019). Environment plan is a prerequisite to understand how the social, political and economic factors are affecting the environment considering development. Environmental planning 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, No, 2014; Thirupalu, 2017). 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 (No, 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* (No. 2014). A rather unusual situation had arisen in this case had also encroached on protracted forestland after which encroachment was subsequently regularized. 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 (Abash 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

The Uttarakhand is a hill state which is situated in the northern part of India (Fig.1 & Table 1). The state has two commissionaires; Garhwal (capital-Pauri Garhwal) and Kumaun (capital-Nainital). Garhwal has 7 districts (i.e. Chamoli, Rudraprayag, Tehri, Pauri Garhwal, Uttarakashi, Dehradun and Haridwar), while Kumaon has 6 districts (i.e. Bageshwar, Almora, Champawat, Pithoragarh, and Udham Singh Nagar) (Table 2).

Almora district falls within the Kumaon commissionary in the stateIt shares its boundary with five other districts of the state. In the east, it is bounded by Pithoragarh district, in the west it is surrounded by Pauri Garwal, wherein in the north by Chamoli district as well as the newly created district Bageshwar, while in the south it shares its boundary with Nainital district. The district is well connected with other districts of Kumaon, Garhwal, National as well as the State capital through series of National highways such as NH 309B, NH 309A, and NH109.

Almora is known as the cultural heart of Kumaon.This town is famous for rich cultural heritage, delicious cuisines and wildlife. Almora is also known for its craftsmanship in copper and many

other unique crafts. The town is located over a horse shoe saddle shaped ridge of a mountain. The old market of the town still bears the sign of its past glory with different streets. These streets were named after specific groups of craftsmen who had worked from generation to generation in developing the skills. These have been reflected in their famous products.

Almora is recognized for its mysticism and spirituality throughout the world. According to National Aeronautics and Space Administration (NASA*)*, Kasar Devi is one of such place which comes under the influence of Van Allen belt where the geo-magnetic field is high (District Survey Report, 2018). To the surprise, it is one such place amongst the three *(the other two being Machu Picchu in Peru and Stonehenge in Great Britain)* where high positive radiations can be felt. Hence, it is believed to be a perfect place for meditation. Owing to its spiritual and mystical persona, Almora shares a historic association with Swami Vivekananda, who often visited this hill town for spiritual rejuvenation and inner healing.

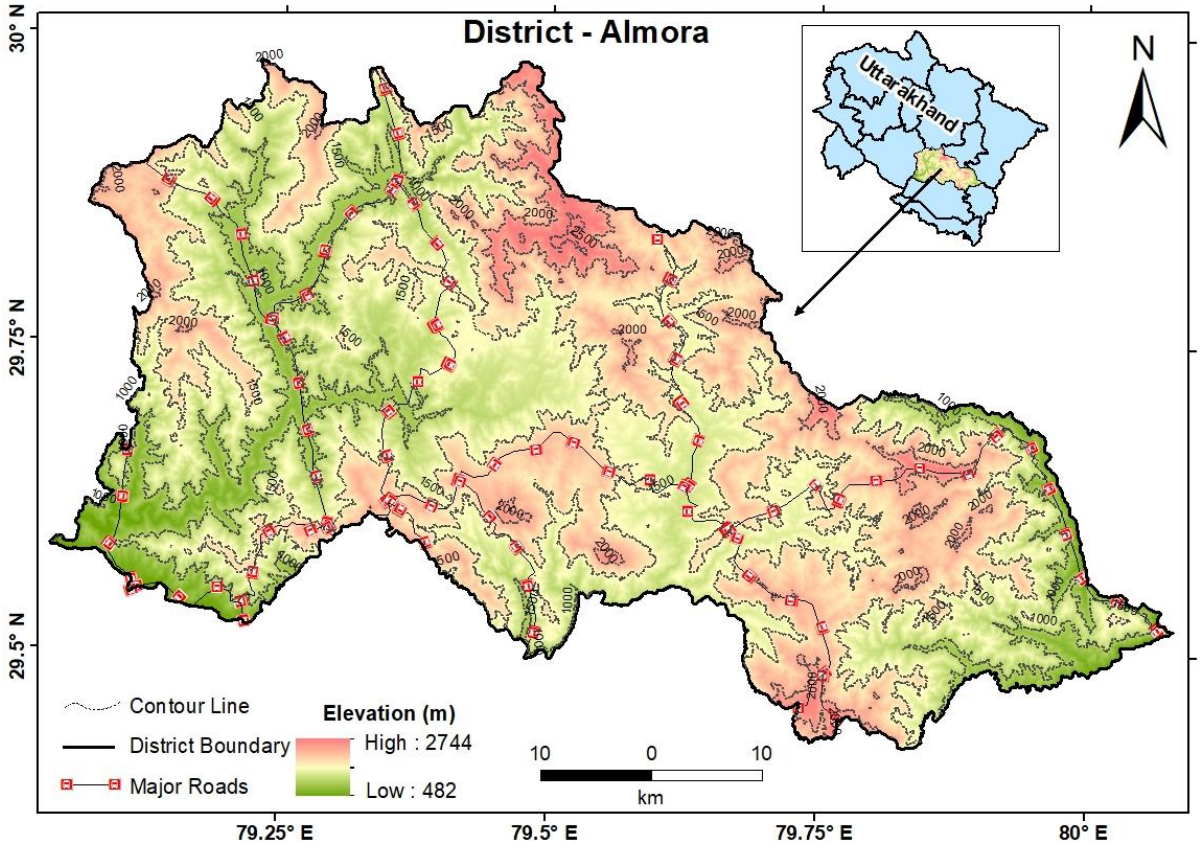


Fig. 1. Location map of Almora district in Uttarakhand

Table 1. District at a glance

Latitude	$20^0$8'N - $29^0$8'N
Longitude	$71^0$1'E - $81^0$5'E
Geographical Area (km^2)	3144
Average elevation (metre) of district headquarters	1646
Population Data (2011 Census)	
Total Population (number)	622506
Male Population (number)	291081
Female Population (number)	331425
Population density/km^{-2}	198
Population growth rate (%)	-1.28
Overall Literacy rate (%)	80.47
Male literacy (%)	92.86
Female literacy (%)	69.93
Sex Ratio	1139
Urbanised area (%)	10
Rural area (%)	90

(*Source*: District Census Handbook, 2011)

Table 2. Administrative divisions

Tehsils	09
Blocks	11
Nyay Panchayats	95
Village Panchayats	1164
Total census villages	2289
Municipal councils	02
Nagar panchayats	02
Cantonment boards	02

(Source: District statistical report, 2018)

Topography

The entire region falls within one physiographic unit, i.e., the Lesser Himalaya (Table 3). On an average, the area reflects a rough terrain, which is drained by numerous small and large perennial streams (Table 4). High mountains, ridges and deep river valleys are the common topographic features of this district.

Table 3. Altitudinal zones in Almora District

Ranges	Major Peaks	Elevation (m)
Eastern Himalayan Range	Jageshwar	2326
	Banari devi	2065
	Kasar devi	1985
	Sitlakhet	1690
Western Himalayan Range	Syahi devi	2190
	Chaubatiya	2082
	Ranikhet	1890

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

Table 4. Major river systems in Almora District

River System	Origin	Tributaries
Kosi River System	Bhakot Range near Kasauni	Suyal
Western Ramganga System	Dudhatoli range in Chamoli District	Gagas
		Kanchan Khad
		Basola Gad

(Source: District Survey Report, Almora, 2021)

Climate

The day-to-day weather pattern of Almora district is characterized by relatively high temperatures and evenly distributed precipitation throughout the year. Major seasonal changes are same as it is in the northern India having summers from March to June, monsoon from July to September and winters from December to February. Summers are usually to some extent moist compared to winters, with much of the rainfall coming from convectional thunderstorm activity, Indian summer monsoon and enhanced warm-season in some regions. January is usually the coldest month with the mean temperature of about 10ºC. Cold waves following the western disturbances often lead to the temperature conditions below freezing point (Attri & Tyagi, 2010).

Rainfall

The Almora district receives an average rainfall of about 1000 millimetre. Rainfall predominantly occurs in the rainy season pertaining to the fact that 75% of the annual rainfall occurs during June to September. July is usually the wettest month, which accounts for about 70% of the total annual rainfall. Winter precipitation takes place usually from the frontal cyclones along the Polar front (District Survey Reports, Almora, 2018).

Forest

The Almora has recorded forest cover of 1,719 km^2 which is 54.64% of its geographical area. The forest cover under different forest sub-type was highest in the district, moderate forest cover (837 km^2), open forest (683 km^2), and lowest in very dense forest (199 km^2), (Table 5) (FSI 2019). We observed that increase in forest area in Almora, 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

Flora and Fauna

Flora

The vegetation of the district has a variety of rich flora and fauna. In Almora 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 (Kala, 2008). The soil varies from place to place and is directly related to the factors prevalent in a particular locality. The rock type also plays an important role in the quality of soil and luxurious growth of the plants in many locations. The soil texture ranges from sandy loam to clayey loam.

Table 5. Forest Cover in Almora district

Particular	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Changes 2017 -2019 assessment
Forest Area of Almora District (km^2)	3144	199	837	683	1,719	1.14

(Sources: FSI Report,2019)

Plants have played a key role in a day-to-day life support system of human beings from times immemorial. The use of plant species of the Himalaya as medicine has been known for a long time and about 1748 medicinal plants are reported from the Indian Himalaya (Samant *et al.*, 1998). Besides, the plants protect our environment; these plants provide food and other life supporting commodities. These plants are very important for survival of human beings and other organisms. Tropical forests are major reservoirs of plant diversity. Those forests inhabit a large number of trees, shrubs, herbs, climbers, faunal wealth and a wealth of non-timber forest products

(NTFPs) including medicinal and wild edible plants and help in maintenance of a nature sustainability. The flora of this region may be classified into tropical, Himalayan sub-tropical and sub-alpine and alpine vegetation. The alpine and sub-alpine zones are considered to be the most natural house of the largest number of medicinal plants.

Fauna

Almora district is a natural sanctuary for leopard (*Panthera pardus*), Langur (*Semnopithecus entellus*), Monkey (*Macaca* spp.), kakar (*Muntiacus muntjak*), goral (*Naemorhedus goral*) etc., whereas the high altitude zones abound Himalayan black bear (*Euarctos americanus*), kakar (*Muntiacus*), Ghoral (*Nemorhaedus goral*), etc. The Almora district is also a home to the Binsar wildlife sanctuary which hosts remarkable variety of birds such as Grey Francolin (*Francolinus pondicerianus*), Black Drongo (*Dicrurus macrocercus*), and Spotted Dove (*Streptopelia chinensis*), possessing a bunch of magnificent colourful patterns.

Groundwater

Groundwater is the primary source of water supply in the district for drinking as well as agricultural purpose. Underground water is in the major part of the district that occurs as localized, disconnected aquifer bodies under favourable geo-hydrological conditions. Rainfall is the principal source of groundwater replenishment. The aquifer occurs in a localised manner within Ramgarh, Almora and parts of Shivalik group (CGWB, 2020).

Culture and Traditions

Almora is known as the cultural centre of Kumaun. The district has a rich and fascinating customs. An individual can find an amalgamation of spirituality and religion in their local music and dance which moreover portrays the daily life of the people. Embraced with pre-colonial legacy, Almora is filled with divine aura of ancient shrines owing to the fact that area is known as for the town of temples. The plethora of sacred places includes world famous shrines such as Jageshwar group of temples, Katarmal Sun temple, Nanda Devi Temple, Kasar Devi temple, Chitai Golu Devta temple and many more.

ENVIRONMENTAL CONCERNS IN ALMORA DISTRICT

An average of 60.8% of the total water schemes in Almora district are found to be dependent on rivulets, or springs (naulas), or seasonal streams (Gadheras). These rivulets are largely dependent on the base flow generated by the springs and other groundwater sources, especially during critical dry months and lean season. The number of functional springs in Almora region has gone down from 360 to 60 in the past 100 years, making it a serious concern for the locals (District

Survey Report, 2018). Due to developmental activities, deforestation and changing rainfall pattern, the perennial River Kosi, a lifeline of Almora district is on the verge of becoming a seasonal river. Water conservation efforts made for Kosi rejuvenation by district authorities includes digging of infiltration holes, trenches, etc. to create more than 74 million litres of water conserving capacity. Besides, the community and other organisations like research institutes, and Universities were also involved. In a coordinated manner, this effort of rejuvenation turned into a movement and it created awareness among stakeholders about sustainable practices, environmental friendly activities and importance of rainwater harvesting conservation structures in the district.

The construction work in the hill areas has been an expensive proposition like in Almora district. The development of sites for building construction in the hill districts involves cutting of the hill surface which incurs relatively higher costs compared to plain region, Further, removal of the debris due to excavation of rocks and its disposal has been a cause of concern. These disposal sites normally remain away from the town and thus involves high transportation costs. Moreover, there is a tendency of the people in the hilly areas to reside in the closest possible proximity of the centre of a town. These remain mainly the part of central business district (CBD) of a town wherein all urban activities and facilities exist but congestion remains high. This phenomenon, in turn, has resulted in the creation of haphazard clusters of houses around the town centre. These unplanned land use and mismanaged construction activities are therefore among the primary causes of degradation of physical and socio-economic environment.

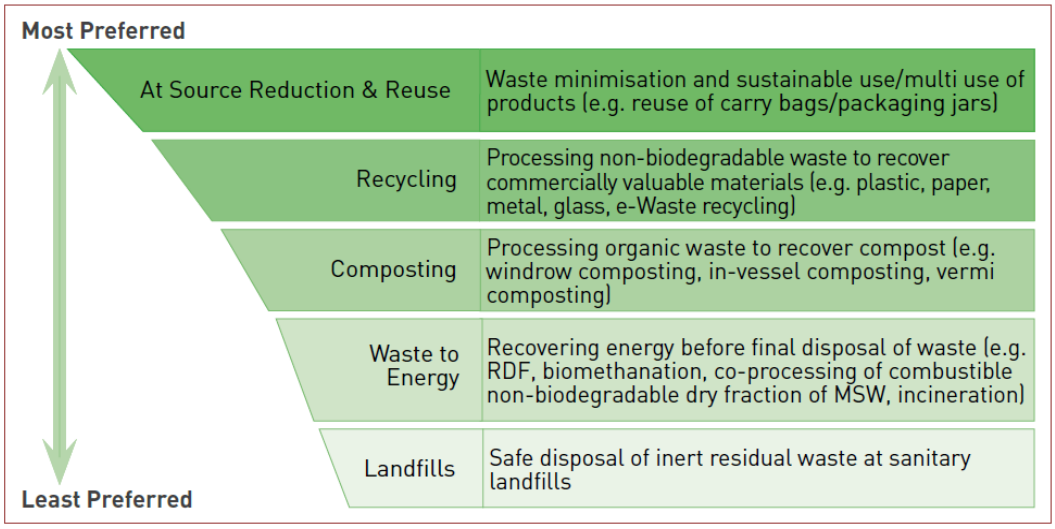
DATA AND IMPACT ANALYSIS

SOLID WASTE MANAGEMENT

Ministry of Environment, Forest and Climate Change (MoEF&CC) defines Municipal Solid Waste (MSW) as commercial and residential waste generated from a municipal area in either solid or semi-solid form excluding hazardous waste (Industrial), but including treated bio-medical waste. Predominantly, about 0.17 kg of MSW is generated per capita per day in small towns compared to about 0.67 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 while maximizing resource recovery and efficiency. 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

Fig. 3. Area specific waste collection and transportation in NPP Ranikhet

Solid Waste Management in Almora District

Waste management is still in its early stage in most of the ULBs of Almora district. Total solid waste generation is varying according to population density and urbanization in each ULB (Table 6). Waste management operations are carried out in each district which includes segregation at source, door to door collection, sweeping, waste transport, waste disposal etc. (Table 7) for which infrastructure has been developed pertaining to financial conditions (Table 8). Based on composition of waste, different methods are adopted for waste recovery, recycling etc. Some of the ULBs are making third party interventions to achieve effective waste disposal (Table 9).

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**	**Unsegregated waste (C&D, DHW etc.)**	**Total**
Nagar Palika Parishad Almora	39627	13	05	03	2.2	10.2
Nagar Palika Parishad Ranikhet	5100	07	01	03	Not estimated	04
Cantt. Board Almora	1391	02	0.25	0.16	Not estimated	0.41
Cantt.Board Ranikhet	18,886	07	3.6	2.4	01	07
Nagar Panchayat Dwarahat	2749	04	0.8	0.6	0.1	1.5

Nagar Panchayat Bhikiyasain	3275	04	0.8	1.2	Not estimated	2.0
Nagar Panchayat Chaukhutiya	*Quantification of waste could not be possible as NPP Chaukhutiya is a newly formed ULB, wherein solid waste management operations are yet to begin. Although DPR has been prepared and is sent for approval.*					

(Source: District Administration, 2021)

Table 7. Waste Management operations

Waste management operations	**Outcome**		
Segregation at source	***100% source segregation***	***Partial source segregation***	***No source segregation***
	None	NPP Ranikhet NP Dwarahat NP Bhikiyasain Cantt Ranikhet Cantt Almora	NPP Almora
Door to Door Collection	***100% Door to Door Collection***	***No door to door collection***	
	NPP Ranikhet NP Dwarahat NP Bhikiyasain Cantt Ranikhet Cantt Almora	NPP Almora *(Secondary dustbins are available for waste collection)*	
Sweeping	All the ULBs in the district are accomplishing 100% sweeping by manual method.		
Transport of Segregated waste	*ULB*	*Segregated waste Transport*	
	NPP Almora	Combined waste transport	
	NPP Ranikhet	Partially	
	NP Dwarahat	Partially	
	NP Bhikiyasain	Partially	
	Cantt Ranikhet	Partially	
	Cantt Almora	Partially	
Material Recovery Facility (MRF) operation	• NP Almora and Cantt Ranikhet have functional MRFs which also cater the waste management of Cantt. Almora and NP Ranikhet, respectively. • NP Bhikiyasain has recently started waste management operations through material recovery facility.		
Involvement of Non-Governmental Organizations (NGOs) / private agencies	Almost every ULB in the district is working with some private firm for Solid waste management.		
Authorization and issuance of identity cards to waste pickers / Sanitation workers	*ULB*	*Numbers*	
	NPP Almora	175	
	NPP Ranikhet	10	
	NP Dwarahat	15	
	NP Bhikiyasain	10	
	Cantt Ranikhet	98	
	Cantt Almora	29	
Linkage with Treatment Storage and Disposal Facilities (TSDF) / Bio-Medical Waste Treatment Facility (CBMWTF)	No ULB in the district have linkage with the treatment storage and disposal facility.		

(Source: District Administration, 2021)

Table 8. Existing infrastructure for waste management

Name of ULB	**Inventory of infrastructure involved in waste management operation**					
	Waste collection trolleys	**Mini collection trucks tractors / others**	**Composting units / Onsite composting facilities**	**Material Recovery facility (MRF) (Available / Not Available)**	**Landfills (open dumping / Trenching Ground / Sanitary landfills)**	**Remarks**
NPP Almora	20	10	38	Available	Dumping in Trenching Ground	• Decentralized composting facility is available at 36 locations. Moreover, 2 composting machines are also installed at MRF. • Remediation of legacy waste is under process. It is expected to finish in one year.
NPP Ranikhet	-	1	-	*Available*[a]	Open dumping	• NPP Ranikhet is a newly formed ULB, therefore it has inadequate infrastructure to carry out waste management operations.
NP Dwarahat	14	3	8	Available	Open dumping	• DPR is approved for establishment of MRF. • Two composting pits in every ward of the ULB are available for on-site composting.
NP Bhikiyasain	4	2	8	Available	Open dumping	• Recently started waste management operations through MRF.
Cantt. Ranikhet	12	4	55[b]	Available	Dumping in Trenching Ground	• Out of 4 trucks and trolleys, 2 are bulk waste trucks. • All of the composting units are of aerobic type with one of them uses vermicomposting for decomposition.
Cantt. Almora	16	1	5	*Available*[a]	No open dumping is noticed	• Cantt Almora was awarded all India 2nd Rank*(among all cantonments)* in 2019 for their illustrious work under Swachh Bharat Mission.

[a]*NPP Almora and Cantt. Ranikhet have functional MRFs which are also performing waste management operations for Cantt. Almora and NPP Ranikhet.*

[b]*52 composting pits in residential areas. 3 Composting pits within bulk waste generators.*

Table 9. Methods of waste 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 old dump site**
NPP Almora	• There are two composting units installed at MRF for wet waste processing each of 1QPD capacity. • 36 composting pits are available in different wards of the ULB.	Dry waste is processed at centralised MRF where it is segregated into 18 categories. Items such as plastic, tin, cardboard etc. are compacted by a compacting unit) and are sold to various recyclers. *Since 2019, ULB has earned Rs. 5 lakh by selling its waste.*	NPP Almora has around 50 tonnes legacy waste whose remediation is under process.
NPP Ranikhet	• NP Ranikhet redirects their waste *(both dry and waste)* to the MRF at Cantt. Ranikhet for processing.		No old dump site within ULB.
NP Dwarahat	• 8 operational composting pits *(2 each in a ward)* for wet waste management.	Dry waste is openly dumped.	Not initiated
NP Bhikiyasain	• 8 composting pits operational for wet waste management. • 1 composting machine is also available.	• Dry waste is segregated at newly established MRF. But the facility is yet to start compacting operations. • Plastic waste is segregated and sold to KP Enviro Tech Pvt. Ltd., Moradabad, Uttar Pradesh	Not initiated
Cantt. Ranikhet	• 3 composting units present at MRF out of which 2 are aerobic type and 1 is for vermicomposting. Other than that, 52 composting pits are operational in different wards.	• Dry waste is segregated manually at MRF and sold to the recyclers at Ranibagh *(Nainital)* • Leftover waste is dumped in the trenching ground.	Not Initiated
Cantt. Almora	• 5 Composting pits are operational for wet waste processing.	Cantt. Almora transfers its dry waste to the MRF at NP Almora for further processing.	No old dump sites are present.

(Source: District Administration, 2021)

Gap identification and Proposed policies for effective waste management in Almora district

Improper Segregation of waste at source and open dumping are some of the common gaps identified in each ULB of Almora district. No door-to-door collection of waste in Almora Nagar palika has been a cause of concern. (Table 10). However, some policies have been proposed by each ULB to refurbish their waste management operations, which includes technological interventions as well. (Table 11).

Table 10. Gap identification in waste management

Name of ULB	Shortcomings	Remarks
NPP Almora	*No source segregation of solid waste*	Waste is transported to the waste recovery facility (MRF) in Almora. There, it is segregated into 18 different categories.
	No door to door collection	Door to Door waste collection is not yet initiated due to lack of negotiation between Nagar Palika and private waste management firm. However secondary bins are provided for waste collection.
	No segregated waste transport	Combined waste transportation *(dry and wet waste)* is done in Almora and is taken to recovery facility for further course of action.
	Open dumping of waste in peri-urban areas	Peri-urban areas in the vicinity of the town have become safe haven for open dumping of waste.
NPP Ranikhet	*Partial source segregation of waste*	Waste is transported to waste recovery facility *(MRF)* at Cantt. Board Ranikhet under some signatory.
	Partially segregated waste transport	Combined waste transportation *(dry and wet waste)* after on-site composting of some percentage of wet waste is done. This is taken to recovery facility at Cantt. Board Ranikhet for further course of action.
	Minimal involvement of NGO / private firm for waste management operations.	Nagar Palika Parihsad claims self-sufficiency in handling the daily waste management operations.
	Lack of Waste collection Trolleys and On-site / Off-site composting facilities (for wet waste)	Minimal waste management infrastructure is present in the ULB.
	Open dumping of waste	Lack of onsite composting facility and material recovery facility has exaggerated the issue.
NP Dwarahat	*Partial source segregation of waste*	Lack of awareness is one of the main reason behind partial source segregation,
	Partially segregated waste transport	Source segregation is the prerequisite for completely segregated waste transport.
	Non-availability of any waste recovery / recycling facility	DPR has been approved for improving waste management operations in the ULB.
	Open dumping of dry waste	Lack of further treatment of waste and linkage with any recovery facility has made other waste management operations redundant in the town.
	Remediation of dumping sites (legacy waste).	At present, no framework is in operation to reclaim the old dumpsites.
NP Bhikiyasain	*Partial source segregation of waste*	Waste is transported to material recovery facility *(MRF)* where further segregation takes place.
	Partially segregated waste transport	Transport of segregated waste is taking place in about 50% households. For the remaining waste, combined waste transport is performed.
	Open dumping of waste	Peri-urban areas in the vicinity of the town has become safe for open dumping of waste
	Remediation of dumping sites (legacy waste).	At present, no framework is designed to reclaim the old dump sites.
Cantt. Board Almora	*Partial source segregation of waste*	Waste is transported to material recovery facility *(MRF)* at Almora under some signatory
	Partially segregated waste transport	Combined waste transportation *(dry and wet waste)* is done in Cantt. Almora which is taken to recovery facility for further

		course of action.
Cantt. Board Ranikhet	*Partial source segregation of waste*	Waste is transported to material recovery facility *(MRF)* at Cantt. board Ranikhet.
	Partially segregated waste transport	Combined waste transportation *(dry and wet waste)* after on-site composting of some percentage of wet waste is done and is taken to recovery facility for further course of action.
	Remediation of dumping sites (legacy waste).	No framework is designed for a course of action to reclaim the old dump sites.

Table 11. Proposed policies and budget requirement as suggested by different stakeholders in the district

ULB	Proposed policy	Current status and budget requirement
NPP Almora	Revamping waste segregation and disposal by identifying secondary waste collection spots	• 53 secondary collection points have been identified and are currently used for waste collection. • Furthermore, some of the open dustbins have been replaced by underground bins. *Proposed budget for maximum coverage of the same is estimated to be about* rupees *2.01 crore*.
	Reducing cost of Transportation	• ULB has proposed setting up of Mini MRFs *(estimated capacity of about 5 QPD)* at selected wards to reduce the associated transport cost. *Evaluated cost for* the same is about rupees 5 lakh. • Furthermore, instalment of a new MRF facility of 2 TPD is in planning stage.
	Remediation of legacy waste	• Remediation of about 50 tonne legacy waste is under process. *Expected time interval for the same is about one year.*
NPP Ranikhet	Establishment of Solid waste management infrastructure	• Ranikhet is newly formed ULB. Hence, it is assisted by Cantt. board for waste management operations. • A DPR to establish MRF and transfer of land for trenching ground has been sent for approval. *Estimated cost for the same would be about* rupees *1.5 Crore. The project is expected to be completed within 2 years***.**
NP Dwarahat	Revamping Solid waste management	• DPR has been approved for establishment of material recovery facility (MRF). • Scientific disposal of waste is expected to commence by 2023. *An amount of* rupees *83 lakhs is approved for the same.*
	Third party involvement in waste management operations	4 women self-help groups (SHGs) are currently involved in solid waste management.
NP Bhikiyasain	• Procurement of Compactor and other equipments. • Transfer of Land from forest department for setting up a Trenching ground.	• Bhikyasain is a newly formed ULB. Hence, a plan of action for enacting waste management operations are under process.
Cantt. Board Almora	No policy is yet defined for future course of action.	**N.A.**
Cantt. board Ranikhet	No policy is yet defined for future course of action.	**N.A.**

(Source: District Administration, 2021)

Vegetation suitable for rehabilitation of dumping sites

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

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

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

Projected population and waste generation in almora district

Projecting waste quantities in a near future is as difficult as predicting changes in waste composition for a locality or town. However, storage methods, salvaging activities, exposure to

the weather, handling methods and decomposition, all have their effects on changes in waste bulk density. As a general rule. The lower is the level of economic development, the greater will be a change between waste generation and disposal.

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

- Arithmetic increase method has been 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 per capita waste generation is assumed. *(MoF, 2009).*
- Analysis includes population and waste generation estimations only for Urban local bodies and does not include peri-urban and rural areas.

Table 13. Projected population and waste generation

ULB	**Projected Population**			**Projected Waste Generation (MTPD)**		
	2021	**2031**	**2041**	**2021**	**2031**	**2041**
Almora NP	49,070	58,513	67,956	10.2	13.99	18.36
Ranikhet NP	6,834	8,568	10,302	4	5.77	7.84
Bhikiyasain	3,486	3,697	3,908	2	2.44	2.91
Chaukhutiya	4,688	4,912	5,136	1.9	2.29	2.71
Dwarahat	2,406	2,063	1,720	1.5	1.48	1.39
Ranikhet CB	18,717	18,548	18,379	7	7.98	8.94
	578	-235	-1048	0.41	-0.19	-0.97
Total				**27.01**	**33.76**	**41.18**

Table 14. Projected decadal change in waste generation

Name of ULB	**Rate of growth % (2021-2031)**	**Rate of growth % (2031-2041)**
Almora NP	3.71	3.12
Ranikhet NP	4.42	3.58
Bhikiyasain	2.20	1.93
Chaukhutiya	2.05	1.83
Dwarahat	-0.13	-0.61
Ranikhet CB	1.40	1.20

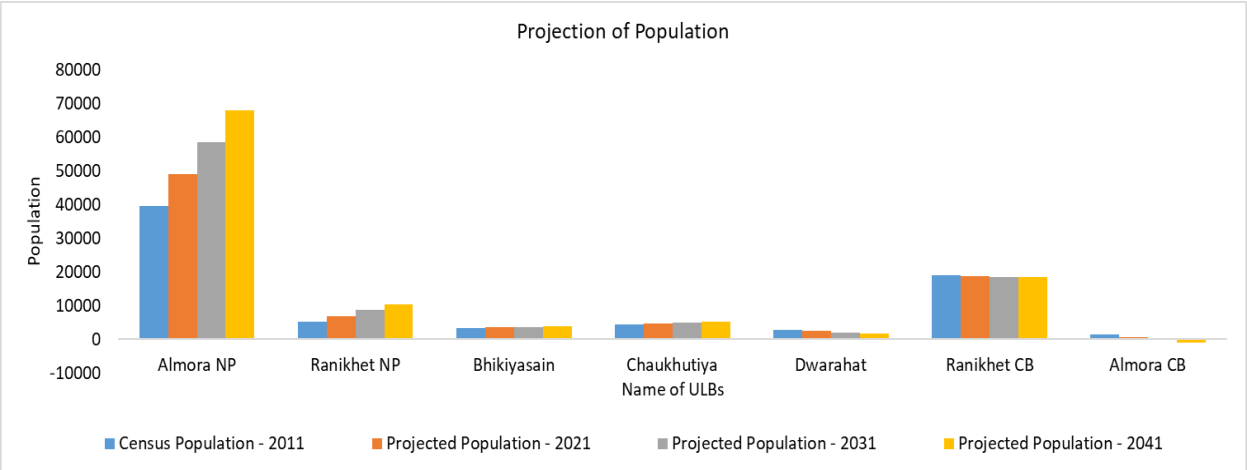


Fig. 4. Graphical representation of projected population

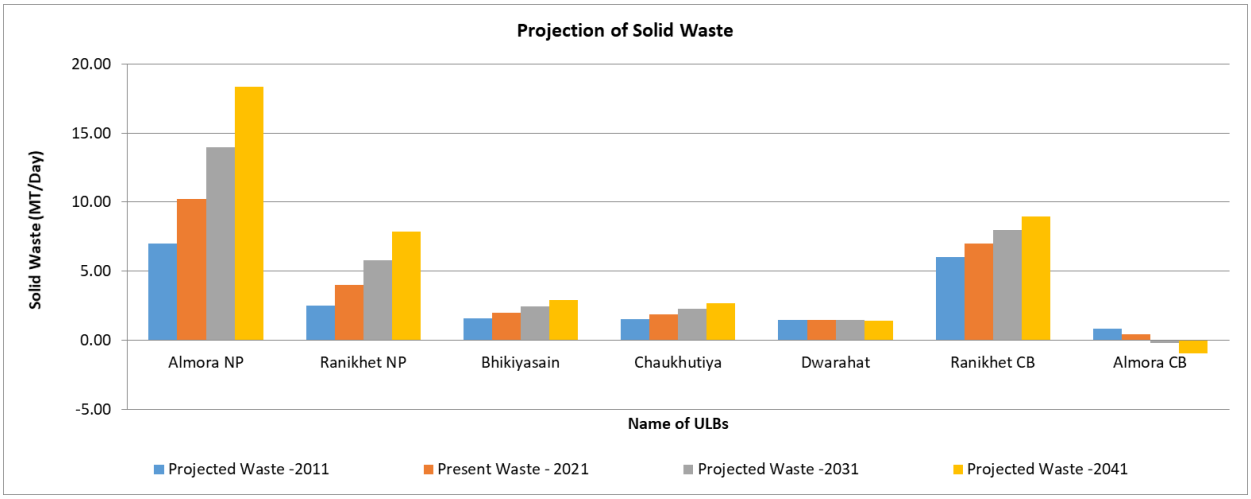


Fig. 5. Projected solid waste Generation

Inferences drawn from the projection of waste

- Solid waste generation in the district is expected to increase by almost 5-12 MTPD in the coming decades.
- The amount of solid waste generation is projected to increase by 2 to 4% in the next two decades.
- Almora district is considered as a special case where negative population growth rate has been observed in some of its ULBs. Perpetual migration might be the reason for this unusual trend.
- Negative population growth rate in Cantonment board Almora can be attributed to outmigration of natives.

- With the urban sprawling in the hill town, the physical characteristics and composition of waste will also change. The quantity of wet waste may decrease; however, there would be increase in e-waste, hazardous waste generation, plastic waste, etc.

Rural solid waste management

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As per reported by 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 (Anonymous, 2016). With the objective of achieving Open Defecation Free (ODF) plus status and to improve 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, because of its less generation rate as compared to urban areas.

Current status of Rural Waste Management in India

Rural waste has distinct characteristics as compared to urban waste in terms of composition and its types. Here, majority of the waste belongs to biodegradable category. In view of management, the rural areas are yet to formalise their solid waste management operations, hence it cannot be easily quantified.

- 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.

BIO-MEDICAL WASTE (BMW) 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 Uttarkhand 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.2).

(Source: CPCB, 2019)

Fig. 6. Segregation of biomedical waste as per BMW rules, 2016 (Source: (CPCB, 2019)

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 Almora 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 Almora district

Sufficient government and private healthcare facilities are available in Almora 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 disposal of biomedical waste. However, some of the district level healthcare facilities have established linkage with a Common Biomedical waste treatment facility (CBMWTF) (Table 15)

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

S. No.	Parameter	Outcome	
1.	Health-care facilities (HCFs) in the district.	***Facility***	***Numbers***
		Bedded HCFs	131
		Non-bedded HCFs	255
2.	Miscellaneous Health-care facilities in the district.	***Facility***	***Numbers***
		Clinic	13
		Veterinary Hospitals	35
		Pathology Labs	32
		Dental Clinics	14
		Blood Banks	01
		Bio-research labs	01
3.	Number of healthcare facilities authorised by SPCB/PCC	386	
4.	Linkage with Common Bio-medical Waste Treatment Facility (CBMWTF)	At present, there is no common biomedical waste treatment facility in the district. However, few hospitals have established linkage with *Global Environment Solutions, a CBMWTF at Gadarpur, Udham Singh Nagar*.	
5.	Capacity of Common Bio-medical	100 kg/hr (incinerator)	

	Waste Treatment Facility (CBMWTF)	
6.	Number of HCFs linked to CBWTF	At present, only 10 HCFs in the district have linkage with CBWTF *Global environment solutions Gadarpur, Udham Singh Nagar*.

(Source: District Administration, 2021)

Disposal of Bio-Medical Waste in the District

- Usually deep burial method is preferred for disposal of bio-medical waste. For that purpose, 349 hospitals have dedicated deep burial pits. Few hospitals have linkage with Common Bio-medical Waste Treatment Facility (CBMWTF).
- On an average, almost 35 kg of waste is sent to CBWTF in Udham Singh Nagar per day. There was an increment to almost 150 kg/day *(almost 4 four times the normal)* from the onset of Covid pandemic.

Current Status and Proposed policies for Biomedical waste management in Almora district

District healthcare facilities are still lacking segregation and tracking of the generated waste (Table 16). Further, as the quantity of biomedical waste is expected to see a surge in the future, the district administration is planning to set up a captive incinerator facility in Almora medical college at an estimated cost of 10 crores rupees.

Table 16. Current status of Biomedical waste management

S. No.	Action areas	Outcomes
1.	Authorisation of health care facilities by SPCB	At present, 386 HCFs are authorised in the district by State Pollution Control Board.
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	Only few HCFs segregate their biomedical waste properly with full compliance to BMW rules.
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 the biomedical waste.
5.	District level monitoring committee	Established under the chairmanship of District Magistrate.

(Source: District Administration, 2021)

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. 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). C&D waste mainly consists of concrete, bricks, excavated earth, sanitary ware, glass, steel, plastic, etc.

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

Type of Debris	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

(Source: District Administration, 2020)

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

Present infrastructure within the state

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

C&D Waste Management in Almora 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, with rapid urbanization, construction activities will rise, hence some strategy is required for scientific management of C&D waste. This may include establishment of dumping sites, framing of byelaws 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 collection of C&D waste is not initiated. However, its 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 disposal sites / Dumping zones	Only NPP Almora *(two dumping zones)* and Cantt Ranikhet *(one dumping zone)* have established dumping zones.
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. Gaps Identified in the management of C&D waste

S. No.	Observed shortcomings	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 / disposal sites / dumping zones	The dumping zones are established by NPP Almora and Cantt. Board Ranikhet. There is a provision of penalty for breaching the norms in these ULBs. Other ULBs are relatively smaller, so whatever waste generates, it is used in filling the plinth of the buildings and other low-lying areas.
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. As of now, 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 strategy for C&D waste management	Due to 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 distorts the river profile.

C&D Waste Management in Rural Areas

In the rural areas of Almora district, construction work is observed to be limited. Therefore, minimal 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 either in filling the plinth and trenches or many times used in the low-lying areas. Stones obtained from the hill slopes are used in masonry work. There is an issue of improper dumping of muck dumping along the river banks or seasonal streams (*khads*) or construction of roads. These issues need to be addressed within a strategy for managing construction and demolition waste.

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

- 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)	% of total waste
Land-fillable	2.13	24.29
Incinerable	0.40	4.52
Recyclable	2.07	23.59
Utilizable	4.18	47.60

(Source: CPCB, 2020)

Hazardous Waste Management in Almora District Quantity of hazardous waste generated in the district is very less. This pertains to lower segregation of waste in the households, government offices and commercial establishments. However, some industries generating hazardous waste have been inventoried (Table 22). No linkage with any treatment, storage and disposal facility(TSDF) is established as of now (Table 23).

Table 22. Inventory of Hazardous waste in Almora district

S. No.	Parameter	Present status			
1.	Quantity of hazardous waste generated in the district (MT/Annum)	**Incinerable**	**Landfill able**	**Recyclable/Reusable**	**Total**
		0	0	0.641	0.641
2.	Number of hazardous waste generating industries in the district	**05** • *Co-operative Drug Factory* • *Indian Medicines Pharmaceutical Corporation Ltd.* • *Om Metal Powder Industries* • *Orion Metal Powder Pvt. Ltd.* • *V. K. Himalayan Herbal Lab*			

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 sent to TSDFs available outside the district.
2.	Linkage with common TSDF	Currently, Almora district has linkage with two TSDFs namely: • K. Nandini Refineries Pilibhit, Uttar Pradesh • Bharat Oil & Waste Management Ltd., Roorkee, Uttarakhand
3.	Number of ULBs linked with common TSDFs	No ULB in the district is linked with common TSDFs
4.	Contaminated sites / probable contaminated sites within the district	According to state pollution control board, there are no contaminated sites within the district.
5.	Regulation of industries & facilities generating hazardous waste	Industries generating hazardous waste are strictly regulated by state pollution control board (SPCB).

ELECTRONIC WASTE MANAGEMENT

The Discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication technology (ICT), home appliances, audio and video products and all of their peripherals are known as Electronic waste (E-waste). 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	**Percentage Contribution (%)**
Computer devices	70
Telecom sector	12
Medical equipment	7
Electric equipment	8
Others	3

(Source: ASSOCHAM, 2020)

Worldwide Scenario

- 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
- In 2016, India generated 2 million metric tons (MMT) of e-waste. The transported e-waste in India from developed countries has further complicated the issue of management of e-waste.
- India discarded approximately 1.85 million tonnes (MT) of e-waste in 2016 which is about 12% of the global e-waste production.
- India has emerged as fifth largest electronic waste producer in world. City-wise, Mumbai tops the list in producing electronic waste, followed by New Delhi, Bangalore and Chennai.
- The government offices, public and private sector companies generate nearly 75% of e-waste, with the contribution of individual household to be only 16%.

E-waste Management in Almora district

The quantification of e-waste is not yet initiated in the district. However, the administration has managed linkage with authorised recyclers to channelize the e-waste. (Table 25). Primary segregation of e-waste is still a distant dream due to lack of awareness and e-waste collection centres (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 (MT) *(As per State pollution control board)*	Uttarakhand	*16260*
		Almora	*Not Estimated*
2.	Toll-free number in the district for the citizens to deposit e-waste	Not yet initiated in the district.	
3.	Collection centre established by ULBs in the district	At present, there are no collection centres established by any of the ULBs or the district administration.	
4.	Number of authorized e-waste Recyclers / dismantlers in the state	Currently, five authorized recyclers/dismantlers are available in the district namely: • *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 ULB in the district has 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 offices.
6.	Control over illegal trading or processing of e-waste in the district	Controlled

Table 26. Gap identification in e-waste management

S. No.	Gaps identified	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 is not being sent for recycling. There is no facility in the district to deposit or to collect e-waste. • As there is no facility of toll free number to deposit or to collect e-waste in the district. So all the e-waste generated from the residential areas is mixed with municipal solid waste and thus could not be 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 linkages with recyclers / dismantlers.

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.

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. 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 (No.)	71
Total Sewage Generation(MLD)	627
Installed Capacity (MLD)	448.18
Operational Treatment Capacity (MLD)	345
Actual Utilization (MLD)	187 *(*i.e. *42% of installed capacity, 54% of operational capacity)*
80 % of the state's total sewage treatment plant capacity caters to Dehradun, Rishikesh and Haridwar in the plain areas.	

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

Current Scenario Related to STPs in Almora District

At present, only one sewage treatment plant with moving bed biofilm reactor (MBBR) treatment technology is operational in Almora district, i.e., in Bukh, Almora municipality (Table 28). Rest of the districts still rely on conventional septic tank and soak pit method for sewage disposal.

Table 28. Inventory of sewage management *(STP Almora)*

Name of ULB	**Population**	**Quantity of Sewage generated (MLD)**	**Sewage Disposal**	
			Treated at STP (MLD)	***Untreated/partially treated (***MLD***)***
NPP Almora	80000 *(40000 + 100% avg. floating population)*	8.64	2 i.e. Total Available Capacity of STP	6.64

(Source: District Administration, 2021)

Sewer network in Almora Nagar Palika Parishad

About one third of the town in connected to piped sewer network. Rest of the wards are either partially connected or they rely on conventional methods for sewage management. (Table 29).

Table 29. Adequacy of sewerage network in Almora town

Name of ULB	**Action areas**	**Outcomes**	
NPP Almora	Coverage area of sewerage network	Total number of wards	13
		Wards totally connected with sewerage network	03
		Wards partially connected to sewerage network.	02
		Wards with no sewerage connection	08
	Percentage of population covered under sewerage network	15 % (accounts to almost 1100 households)	
	Additional treatment capacity required (MLD)	6.65 approx. to cater 100% population	

(Source: District Administration, 2021)

Sewage management in Almora district

Only Almora nagar palika and Dwarahat nagar panchayat are managing their sewage scientifically. Rest of the ULBs rely on conventional treatment methods. (Table 30). Some policies have been proposed to increase the sewer line coverage in Almora Nagar Palika. (Table 31).

Table 30. Current standpoint regarding sewage management in the district

Name of ULB	Present state of affairs
NPP Almora	• Almora sewage network is planned under four zones by Payjal Nigam. Out of which, Zone 1 is already completed and has been serving almost 1100 households (nearly 15% of the total population). • Sewage Treatment plant is thoroughly monitored by State Pollution Control Board. Random sampling of the treated waste water is performed regularly ensuing to Hon'ble NGT norms. Chemical dosing is done if sample under testing is found undesirable. • Uttarakhand state pollution control board and Jal Sansthan are the departments responsible for ensuring compliance to provision under statues related to Sewage Treatment Plants Management.
NP Dwarahat	Indigenous treatment technique is followed by Dwarahat ULB in which septic tanks are regularly emptied. The collected sludge is then transported to the digestion tank (developed by DRDO) which has the capacity to treat almost 20,000 liters *of waste water*
Other ULBs	Rest of the districts use the conventional treatment method of Septic Tank + Soak Pit for sewage disposal.

(Source: District Administration, 2021)

Table 31. Proposed policies and budget requirement put forward by different stakeholders in the district

Name of ULB	Type of Septage Management	Stakeholders responsible	Proposed Action Plan	Instruments and Budget Requirement
NPP Almora	Both on-site and off-site management	Jal Sansthan and State Pollution Control Board (SPCB)	• Almora Sewerage Network has been divided into 4 parts. Out of which, one is already operational and sewer line for Zone 2-A has been laid. It will potentially cover almost 15000 individuals. This is likely to be completed by 2023. • Furthermore, on-site Septage management (FSSM) is being planned by the respective department.The details has been sent to higher authority for approval.	• Septage receiving station. • Septage co-treatment is expected to start in 2021-22 which would require almost rupees 20 lakh. • Completion of Zone 2-A would require a budget of almost 30 crores and is expected to be functional by 2023.

(Source: District Administration, 2021)

Table 32. Adequacy of expenditure

ULB	Current operating Expenses	Anticipated future Capital Requirement	Adequacy
Almora Town	24 Lakhs/Annum	30 Crores	Not adequate

Liquid waste management in rural areas

Since the water supply for domestic purpose in rural areas has improved considerably over the years, the quantity of wastewater disposed of has also increased. Hence, effective wastewater management system needs to be introduced in rural areas to mitigate the problem of contamination in larger areas of rural environment. Untreated wastewater is discharged directly into the nearby areas and water bodies. This leads to contamination of surface as well as sub-surface water, having negative effects on human health and surrounding environmental components.

Current facts about Rural Waste Water Management in India

- United Nations Sustainable Development Goal 6 focuses on access to clean water and sanitation to all. The initiative in achieving this goal is to sensitize communities regarding hygiene and sanitation.
- With ever increasing population and sprawling urban environment, wastewater management has become a serious issue. Rural India with old or without any infrastructure has reached to a tipping point.
- India has highest number of people with no access to clean drinking water. Even with abundance of water availability in certain places, there could not be access to safe, constant supply of drinking water.

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 33)

Table 33. 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	Providing 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	Such complexes comprise of appropriated number of toilet seats, bathing cubicles, etc. This is possible only where there is a lack of space in the village for construction of household toilets.
Financial Assistance	Under Swachh Bharat Mission - Gramin	Up to Rs.12000 is provided to below poverty line (BPL) households and identified *Above Poverty Line* (APL) households for construction of one unit of IHHL It is not the cost of the toilet but an incentive amount.
Menstrual Health Management	Under Swachh Bharat Mission - Gramin	• It aims at making behavioural change in women and adolescence girls to use a clean menstrual management material to absorb or collect blood. It can be changed in privacy as often as necessary for the duration of the menstruation period. • Having access to facilities to dispose of used menstrual management materials.

(Source: District Administration, 2021)

INDUSTRIAL WASTE WATER MANAGEMENT (ETP/CETP)

Effluent Treatment Plant (ETP) is a process design for treating the industrial wastewater for its reuse or safe disposal into the land. The effluent treatment plants are used for the removal of high amount of organic compounds, debris, dirt, grit, pollution, toxic, non-toxic materials and polymers, etc. from industrial effluent. The ETP plants use evaporation and drying methods, and other auxiliary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment.

Effluent is generated in many manufacturing industries like textile, pharmaceuticals and chemicals, tanneries, etc. Contaminated water cannot be released without treatment as it contains toxic and non-toxic chemicals. Releasing it may cause contamination of the existing pure water and will affect adversely the environment. As a result, ETP's are installed in manufacturing industries.

So far, industrial policy is focused mainly on sustained growth in productivity, optimal utilisation of human capital and flexibility in adjusting to markets.

Common Effluent Treatment Plant

The concept of common effluent treatment plant has been accepted as a solution for collecting, conveying, treating and disposing of the effluents from the industrial states. The CETP concept helps small and medium scale industries to dispose of their effluents which otherwise may not be so economic to them in disposing of as a single unit. Therefore, CETP is an option which not only protects environment but also divides the investment and operational cost.

CETP can be changed to combined effluent treatment plant when it collects sewage from surrounding localities and treat it with industrial wastewater. The advantages of such systems are as follows:

- Dilution to toxic constituents and dissolved inorganic solids from the industrial wastewater.
- Better control over the process due to continuous seeding of microorganisms from sewage.
- Providing sufficient nutrients (N, P) from sewage.
- Reduced operating cost while adding chemicals.

Table 34. State Scenario of Common Effluent Treatment Plants

Total CETPs in Uttarakhand	At present, there are three CETPs operational in the state in following industrial areas: • IIE SIDCUL, Pantnagar • CETP Sitarganj • SIDCUL Haridwar
Total Design Capacity (MLD)	13
Members Units/Industrial units	920

(Source: ENVIS, 2016)

Industrial Waste Management in Almora District

The industries available in Almora district were found to be 29; wherein only two industries were identified discharging wastewater (Table 35). None of the industry was found violating the environment standards (Table 36).

Table 35. Inventory of industries and waste water generation

S. No.	Parameter	Present Status
1.	Total number of industries in the district	Twenty nine (29)
2.	Number of industries discharging waste water in the district	Two (2)
3.	Prominent industries in the district generating the liquid effluent	Dairy and Pharma industrial units in the district discharge liquid effluent.
4.	Captive effluent treatment facilities in the district.	At present, there are two captive effluent treatment plants operational in Almora district in following industrial units: • *Almora Dugdh Utpadak Sahkari Sangh Ltd. Almora* • *Indian Medicines Pharmaceutical Corporation Ltd. Mohan, Almora*
5.	Total quantity of industrial wastewater generated (in MLD) in the district	No data available[a]
6.	Quantity of treated waste water discharged into water bodies in the district	Nil[b]

[a]*Majority of the industries claim to be working on the principle of zero liquid discharge model.*
[b]*All the waste is almost claimed to be reused.*

Table 36. Status of compliance by industries

S. No.	Action Areas	Outcomes
1.	Number of industries meeting effluent standards	02
2.	Number of industries not meeting standards	Nil
3.	Number of complaints received in last three months	No complaint received in last three months regarding breeching of industrial norms.
4.	Complaints redress system (Is there any complaint redressing system based on mobile app / online portal available?)	No online portal of the state pollution control board is available for the purpose of complaint redressal. All the complaints are registered in offline mode at its regional office level in the State Pollution Control Board.

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's population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Due to overuse of groundwater, the water table is decreasing with rapid rate and it will be precarious 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 hydrological process, when water (rain, snow-melt etc.) moves downward from surface to groundwater. Mostly groundwater recharge happens 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 source 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, etc.,) are encouraged nowadays to save groundwater.

Table 37. Water resources in Almora district

S. No.	Water Resource	Number	Name and Length / Area in the District		
1.	Rivers	6	***Name***		***Length (km)***
			West Ramganga		96.57
			Gagas		42.03
			Panar		14.80
			Suryal		77.14
			Saryu		14.00
2.	Perennial streams	2	***Name***		***Length (km)***
			Kosi		50.72
			Saryu		14.00
			West Ramganga		7.14
3.	Lakes / Ponds	3	***Name***	***Altitude(m)***	***Area (ha)***
			Rani Jheel	1786	0.40
			Bhalu Dam	1821	1.13
			Tadag tal	1209	50.49

(Source: District Administration, 2021)

Table 38. Pollution control measures for existing water resource

S. No.	Parameter	Current Status
1.	Open defecation in Rivers / Nala / Khad	Fully controlled
2.	Dumping solid waste on River banks	Fully controlled
3.	Control measures for idol immersion	Measures are taken from time to time
4.	Disposal of untreated sewage in Rivers	Sewage is not directly discharged into water bodies
5.	Monitoring of Action Plans for rejuvenation of rivers	Monitored
6.	Campaigns by NGOs/District level for a protection of water quality	Four campaigns were organised last year to sensitize people about water quality and conversation.

(Source: District Administration, 2021)

Table 39. Information of groundwater in Almora district

S. No.	Parameter	Current Status
1.	Estimated numbers of bore-wells / hand pumps	1321
2.	Groundwater polluted area in the district	None
3.	Adequacy of groundwater availability	Not adequate
4.	Disposal of untreated sewage in Rivers	Sewage is not directly discharged into water bodies
5.	Access to surface water and groundwater quality data at DM office	Data is available

(Source: District Administration, 2021)

Current status of Water Resource Management

Present state of affairs

- Common water sources used for water supply schemes in Almora district are as follows:
  1. *Deep Tubewells*
  2. *Infiltration wells*
  3. *Rivers*
  4. *Rivulets / Naulas / Gadheras*
  5. *Treated surface water*
  6. *Khadins / Nadins / Tankas / Ponds*
- On average, 60.8% of the total water supply schemes in Almora district are dependent on rivulets /naulas /gadheras. Water is largely contributed by the springs during dry season.
- Awareness activities are organized on quarterly basis to bring awareness amongst people about the declining standards of water quality as well as over-exploitation of naulas and Dharas.
- No information is currently available on the annual change of ground water level in the district.

Table 40. Practices proposed by stakeholders for water resource management

Current Practice		**Department Responsible**
Management of groundwater through indigenous techniques such as constructing Chal-khal. Each of these Chal-khal provides approximately 150kL of fresh water.		Jal Sansthan / Jal Nigam / Forest department
Construction of Chal-Khal in recent years		Jal Sansthan / Jal Nigam/Forest department
Year	*Number*	
2017-2018	10	
2018-2019	27	
2019-2020	25	
2020-2021	19	

(Source: District Administration, 2021)

Artificial recharge of groundwater

Water security specifically in the spring-shed river system is highly vulnerable to seasonal changes in the spring hydrology. Most of the people residing in the rural and urban places in the district largely depend on this system for drinking water and other needs. The undulating topography and diverse micro climatic conditions pose difficulty in the efficient distribution of natural water resources.

Table 41. Scope of artificial recharge in Almora district

District	Area (km^2)	Area identified for artificial recharge (AR) (km^2)	Volume of unsaturated zone (MCM)	Available sub-surface space for AR (MCM)	Water required for artificial recharge (MCM)	Surplus available for recharge (MCM)
Almora	3689.00	922.00	1845.00	277.00	368.00	2307.00

The major part of the district is hilly which is characterised with small valleys through which the entire runoff system passes through. Major amount of the rainfall is lost as surface runoff. Apart from these small rivers, nalas also act as carriers for a base flow and spring water. In spite of a good amount of rainfall, there is an acute shortage of water especially during summer. The state government is working for rainwater harvesting in the state and are having many projects to solve this issue.

Table 42. Artificial recharge and RTRWH sstructures constructed in Almora district under catchment area conservation Program (CACMP)

District	Number of structures					Total cost (Rs lakhs)					Total cost (Rs lakhs)
	CD	CK	RTRWH	PT	CT	CD	CK	RTRWH	PT	CT	
Almora	133	30	486	43	150	0.4	0.9	170.1	0.86	0.15	172.41

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

Table 43. Artificial recharge and its estimated cost in Almora district

District	Structures proposed					Unit cost Estimate (in lakhs)					Total cost (in lakhs)					Total cost (in lakhs)
	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	
Almora	1168	275	110	275	550	0.5	0.3	0.07	0.15	0.015	584	82.5	7.7	41.25	8.25	723.7

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

AIR AND NOISE POLLUTION MANAGEMENT

Air Pollution Management

Ambient air in its natural form consists of nearly 99.9% of nitrogen, oxygen, water vapor, carbon dioxide, etc. Some other gases like helium, argon, methane, etc. also surround the earth and form its atmosphere. Any undesirable change in the natural composition of ambient air is called air pollution. The undesirable substances may be solid, liquid, or gaseous forms. Presence of pollutants in an extra concentration for a reasonable duration may have risks to human health, animals and plants. According to Global Air Report 2020, air pollution has now become the biggest health risk in India. Most of the cities from the Indo-Gangetic Plain in our country have been facing the problem of air pollution which is causing breathing discomforts, allergies and other diseases in the human beings. To tackle the ambient air pollution in the cities, Government of India has taken many steps; one of them is 'National Clean Air Program (NCAP) 2019'. Under this programme, 122 cities in the country are identified as non-attainment cities which included three cities from Uttarakhand *(Dehradun, Rishikesh* and *Kashipur).* These are the cities that have crossed the National Ambient Air Quality Standards (NAAQS) continuously for five years. The 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 considering 2017 as the base year for the comparison of pollutants.

Table 44. National ambient air quality standards in India

Pollutants	**Time weighted average**	**Concentration in Ambient Air**	
		Industrial, residential, rural and other areas	Ecologically sensitive area (notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM_{10} $\mu g/m^3$	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ $\mu g/m^3$	Annual* 24 hours**	40 60	40 60
Ozone (O_3), $\mu g/m^3$	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),	8 hours*	02	02

mg/m^3	1 hour**	04	04
Ammonia (NH_3), $\mu g/m^3$	Annual* 24 hours**	100 400	100 400
Benzene (C_6H_6), $\mu g/m^3$	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 scenario of air pollution in Almora district

As the monitoring of ambient air quality is not yet started in the district, so the present scenario regarding the status of air quality is very difficult to ascertain (Table 45). With the increase in number of forest fire events and number of vehicles in the district, the problem of air pollution is gradually increasing (Table 46). However, some control measures have been adopted for control of industrial air pollution, vehicular pollution etc. (Table 47). Therefore, this aspect needs to be addressed on priority in coming future.

Table 45. Air quality monitoring and data accessibility in Almora district

Action Area	Outcome
Number of automatic air quality monitoring stations	Yet to be installed
Number of manual air quality monitoring stations	Yet to be installed (Mobile monitoring devices are used occasionally)
Availability of air quality monitoring data	Adequate readings are not taken to obtain necessary information about prevalent air quality standards.

Table 46. Identification of air pollution sources in Almora district

Action area	Outcomes
Number of non-attainment cities	No city in the district is classified as non-attainment city according to National Clean Air Program (NCAP).

Prominent sources of air pollution	Unprecedented forest fires, vehicular pollution, open waste burning, etc. are the major reasons for air pollution in the district.

Table 47. Control measures for industrial / non-industrial air pollution

Action Areas	Outcome
Control of industrial air pollution	Yes. State Pollution Control Board is closely monitoring the industrial units in the district.
Control of non-industrial air pollution	
(a) Control open burning of waste	Although open burning of waste is not allowed, yet its practice is common in the district. Awareness regarding segregation, inefficient waste collection and transportation system could the primary reasons.
(b) Control of forest fires	Forest department is trying its best to control forest fires, but its result on ground would take some more time. Every year, hectares of forests are damaged due to forest fires.
(c) Control of vehicular pollution	15 PUC centres are available in Almora district.
District level action plan for air pollution	At present, no such action plan has been prepared.
Awareness on air quality	A general perception is that air pollution is not a big issue in the hilly region. So local citizens are not well aware of the problem regarding increasing level of air pollutants in the district especially in the urban centres of the district.
Development of air pollution complaint redressal system	Not initiated

(Source: District Administration, 2021)

Gap Identification and Proposed policies to combat air pollution in Almora District

In recent years, the main reason for increasing air pollution levels are unprecedented forest fires, soaring vehicular traffic etc. The lack of air quality monitoring to assess the damage is compounding the problem (Table 48). However, some issues are being worked upon through different policies such as installing air quality monitoring device, generation of electricity through pine needle etc.

Table 48. Gap identification

Sr. No.	Area of Concern	Remarks

1.	Forest Fires	• Lack of staff • Different departments are involved to resolve the issue. Hence, lack of coordination and responsibility sharing have been observed. • Sloppy terrain makes it difficult for fire tenders to reach high altitudinal areas. • Migration from villages to urban towns and change in living standards have exaggerated the situation. • Lack of inspection in forest areas under Van Panchayat and Civil Forest
2.	Vehicular Pollution	Air pollution monitoring station is not available in the town; hence much of the pollution goes unnoticed.

Table 49. Proposed policies and budget requirement put forward by stakeholders in the District

Proposed policies	**Responsible agencies**	**Action plan and Budget requirement**
Installation of air quality monitoring station at Almora	State Pollution Control Board	State pollution control board is planning to install air quality monitoring systems in all the district headquarters. Under this project, there is a proposal of establishing an air quality monitoring station in Almora at an estimated cost of rupees 5 lakhs.
Electricity generation through pine needle	Forest Department *Uttarakhand Renewable energy development Agency* (UREDA*)*	Two plants having generation capacity of 25 KW each have been installed and are currently in working mode.
Provision of fund to Van Panchayat for control of forest fires	Forest Department	Ensuring public participation in tackling forest fires, each Van Panchayat is being paid rupee 1 lakh.

(Source: District Administration, 2021)

Ambient air quality monitoring at Katarmal (1225 m), Almora: An initiative by GBPNIHE

The pace of urbanisation in hill locations of the Indian Himalaya has been increasing continuously. This has caused anthropogenic pressure in hill towns and spots, and there is an adverse effect on the Himalayan climate and glaciers. The air quality monitoring station for obtaining a background value by GBPNIHE at Katarmal was set up in July 2019.

Particulate Pollution

- The study on particulate pollutants exhibited mean concentration *(24 hourly values)* of the pollutants from April 2019 to July 2021.

- PM_{10} was found to be 59.7±34 µg m^{-3}, $PM_{2.5}$ 53.6±75 µg m^{-3} and PM_1 10.3±18 µg m^{-3}. Diurnal variation of black carbon (BC), a heat absorbing aerosol, showed highest concentration in the morning and evening hours. Black carbon concentration was observed to be maximum 2833±294 ng m^{-3} in December 2020; while minimum was 106±40.5 ng m^{-3} in July 2021.BC showed 20% increase from 2019 to 2021.
- Particulate matter and black carbon indicated low concentration during lockdown period in 2020 and 2021. Particulate matter generated from sources like forest fire, vehicular emissions, and open waste burning lead to the formation of secondary aerosols (Fig. 6). These emissions would exacerbate climate warming in coming future, which may increase the incidences of wildfires, radiative imbalance, torrent rains and severe droughts, etc.

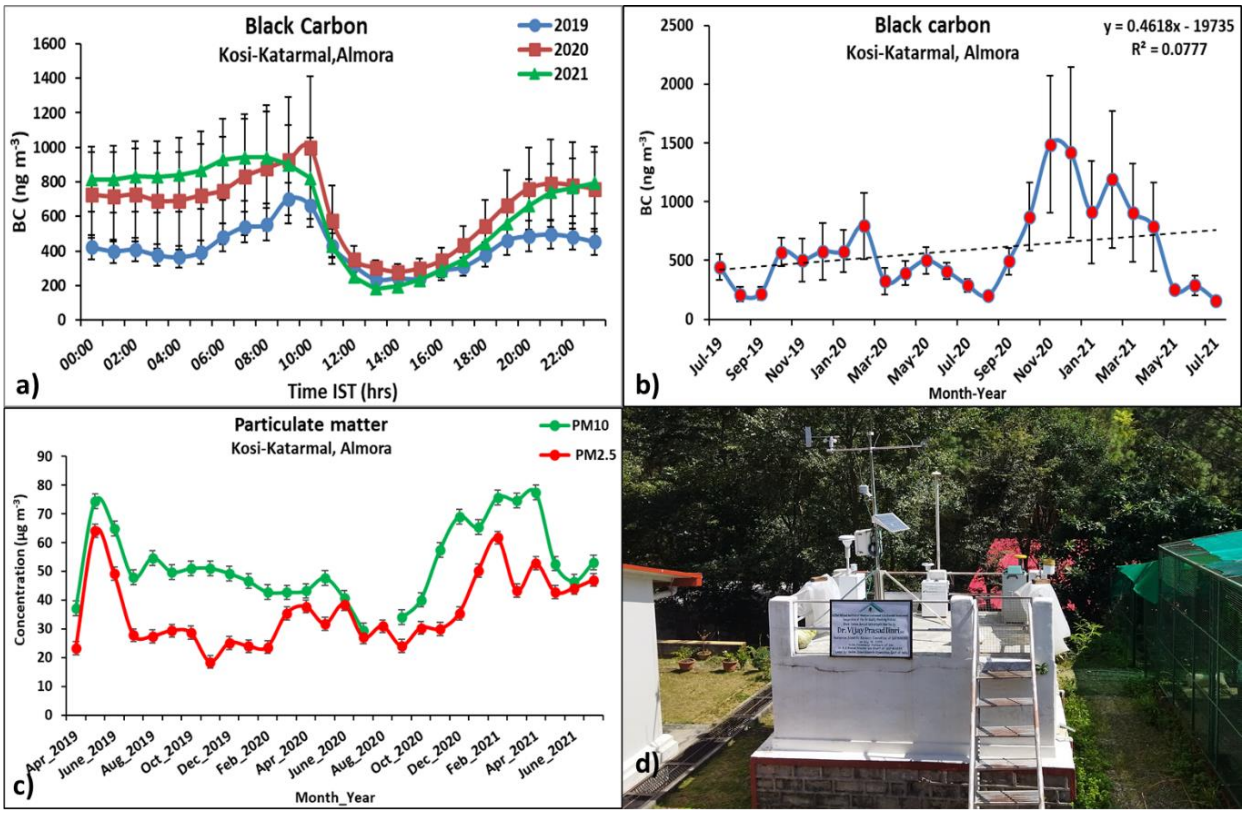


Fig. 7. Air quality monitoring set up: An initiative by GBPNIHE, Almora: (a) diurnal variations in black carbon, (b) monthly variations in black carbon, (c) monthly variations in particulate matter ($PM_{2.5}$, PM_{10}), and (d) air quality monitoring set-up

Noise Pollution and its Management

Noise pollution may be defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to WHO, sound levels less than 70 dB are not damaging to living organisms and exposure of noise level beyond 85 dB constantly for more than 8 hrs. may be hazardous and leads to loss of hearing. Although noise pollution is not a big issue in the district but proper monitoring is required to maintain noise level within the desirable limits. (Table 50)

Table 50. 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)

- Day time shall mean from 6.00 a.m. to 10.00 p.m.
- Night time shall mean from 10.00 p.m. to 6.00 a.m.
- 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.
- 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 related to human hearing.
- "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 energy mean of the noise level over a specified period.

Noise Pollution in Almora 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 51).

Table 51. Current status related to noise pollution management in Almora district

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 SPCB related to noise pollution during past one year	No complaint received *(either by SPCB or District Administration)* in past one year.
3.	Implementation of ambient noise standards in residential and silence zones.	Local police is responsible for implementation of the ambient noise level standards
4.	Silence zones in the district	At present, there is only one silence zone declared in the district, i.e., The collectorate office, Almora
5.	Setting up of sign boards	Sign boards in the silent zones are installed along highways by the Public Works Department (PWD).

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.

Mining activities in Almora district.

River sand mining and In-situ sand mining are prevalent in the district. Illegal mining activities haven't been noticed yet in the district as per state pollution control board record (Table 52). Current mining activities claims adherence to the environment norms(Table 53).Moreover no pollution related complaints have been registered for past one year.

Table 52. Current standpoints regarding mining activities prevalent in the district

Total area of district (km^2)	3082
Area covered under mining (km^2)	0.05172
Type of mining activity	River sand mining
Sand mining activity in the district	Sand mining operations are widespread in the river bed
Area affected by illegal sand mining in the district	None
Number of mining licenses given by the district authority	10

(Source: Mining Department Almora, 2021)

Table 53. Compliance to Environmental Standards

Mining areas meeting Environmental Clearance Conditions	10
Mining areas meeting consent conditions of UKPCB	10
Mining operations suspended for violations to environmental norms	nil
Pollution related complaints against mining operations during past one year	nil

(Source: Mining Department Almora, 2021)

REJUVENATION OF WATER BODIES

Most of India's major water resources *(underground waterways, lakes, rivers and reservoirs)* depends on monsoon rains to replenish/recover them. Nearly 600 million Indians faced high to extreme water stress and about 2 lakh people dies 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.High amount of water extraction and mismanagement of water resources are causing drought and sudden flood in several part of our country. Rejuvenation of waterbodies also play a vital role to improve the water quality and storage of surface run off water. For these reasons we need to store, manage and rejuvenate the existing waterbodies. We can use several government policies/Schemes like Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), 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).*

Water Resources in Almora district

Almora district has quite a reasonable number of water reservoirs and has taken rejuvenation initiatives of two water bodies (i.e. Kosi and Kunjgad) (Table 53). These initiatives are taken by the district administration with the support of other organizations like Forest department, SSJ Almora Campus, GBPNIHE-Katarmal, Almora, etc.

Table 54. Inventory of water bodies in Almora district

Total number of water bodies	643[a]	
Water bodies rejuvenated	2	
Details of water bodies rejuvenated	***Name***	***Area rejuvenated (in km^2)***
	Kosi	463
	Kunjgad	98

[a] *Includes natural and artificial water bodies*

(Source: District Administration Almora, 2001)

Kosi Rejuvenation Project

River Kosi is the "lifeline of Almora". It stretches for 75 km from its origin till Quarab and spreads in a watershed area of 452 km^2. The river plays an important role in ecological and

economic wellbeing of the region. The local communities also depend largely on this river to fulfil their water requirement and to draw their sustenance. As many as 350 villages in and around Almora depend of River Kosi for their drinking water, sanitation and other usages. Unlike other rivers in the district, Kosi is a non-glacial river. Therefore, this river's life depends on the water recharge in its huge catchment area. The River Kosi feeds 33 major irrigation canals, hundreds of small irrigation canals and 16 lift schemes.

The river has experienced a steep decline in its flow *(around 20 times decrease)* in the past two decades. The survival of the district without alike rivers may become critical in coming future if adequate and timely attention is not paid to recharge other similar water bodies in the district. It is because of these reasons that the district administration launched the Kosi and Kunjgaad rejuvenation projects to revive the flow of the river as well as to convey a message for other users to act accordingly.

Different techniques were used for the revival the flow of the Kosi river which included tree plantation, infrastructure development etc. (Table 54)

Table 55. Techniques used and progress made so far for Kosi rejuvenation

Method used	Remark
Tree Plantation	Between 2018 to 2021, tree plantation was encouraged in the watershed of River Kosi
Infiltration Holes	About 1.84 crores holes were dug
Bio-check Dams	About 2010 Check dams were constructed
Infiltration Trenches	About 11.9 lakh trenches were dug
Dry Stone Check Dams	About 152 dry stone check dams were constructed
Ponds	About 325 artificial ponds were constructed

Community Participation for Kosi Rejuvenation

- Community mobilisation activities were planned in partnership with the Panchayat Raj Institutions. Specific orientation workshops were organised to familiarise the people with the activities to be taken up for rejuvenation activities.
- NGOs, namely, Syahi Devi Vikas Samiti at Sheetalakhet worked in collaboration with district administration for increasing community ownership of the programme.
- School children and local communities were actively encouraged for tree plantation activities, where planted saplings were adopted by them.

Benefits and achievements accrued from Kosi Rejuvenation

- As much as 74 million litres of groundwater is recharged through the rejuvenation programme.
- Almost 2960 hectares of additional irrigational potential is created.
- 24 lakh plants were seeded with more than 90% survival rate.
- Kosi rejuvenation is identified as a project of national importance by National Mission of Himalayan Studies (NMHS).
- As a successful project, it has won several accolades including the "National Water Award 2018" by Government of India.
- The Kosi project was awarded for the *"maximum number of tree plantations in an hour"* categories which stood to be 1,67,000.
- It was also adjudged the best project for 'CM excellence Award' in Uttarakhand (2018-2019)

PLASTIC WASTE MANAGEMENT

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

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

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

Plastic Waste Management Amendment Rules, 2021

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

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

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

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

Plastic waste status in Almora district

Increasing plastic waste day by day in Almora district is one of the challenging environmental problem. Its generation ranged from 0.05 MT/day to 2.0 MT/day in Cantonment Board, Almora to Nagar Palika Parishad, Almora, respectively (Table 55). The major compositions of plastic waste were polythene bags including ruptured ones, wrappers of milk products, mineral water bottles, toffee wrappers, etc.

Table 56. Inventory of plastic waste generation in Almora district

Name of Urban Local Body	Population (2011 Census)	Number of wards	Estimated quantity of plastic waste generated (MT/ day)
Nagar Palika Parishad Almora	39627	13	2.0
Nagar Palika Parishad, Ranikhet	5100	07	0.3
Cantonment Board (Cantt), Almora	1391	02	0.05
Cantonment Board, Ranikhet	18886	07	1.0
Nagar Panchayat Dwarahat	2749	04	0.1
Nagar Panchayat, Bhikiyasain	3275	04	0.6
Nagar Panchayat, Chaukhutiya	*Chaukhutiya is a newly formed ULB and is yet to initiate solid waste management operations*		

(Source: District Administration Almora, 2021)

Plastic Waste management in Almora district

Waste management operations are carried out in each district which includes segregation at source, door to door collection, sweeping, waste transport, waste disposal etc. (Table 56) Infrastructure has been developed for plastic waste management pertaining to financial conditions (Table 57). Some ULBs have established linkage with vendors for recycling of plastic waste.

Table 57. Plastic waste management operations in Almora district

<table>
<tr><th>Waste management operations</th><th colspan="3">Outcome</th></tr>
<tr><td rowspan="6">Segregation at source</td><td>100% source segregation</td><td>Partial source segregation</td><td>No source segregation</td></tr>
<tr><td rowspan="5">None</td><td>NPP Dwarahat</td><td rowspan="5">NPP Almora</td></tr>
<tr><td>NPP Bhikyasain</td></tr>
<tr><td>NP Ranikhet</td></tr>
<tr><td>Cantt Ranikhet</td></tr>
<tr><td>Cantt Almora</td></tr>
<tr><td rowspan="6">Door to Door Collection</td><td colspan="2">100% Door to Door Collection</td><td>No door to door collection</td></tr>
<tr><td colspan="2">NPP Bhikyasain</td><td rowspan="5">NPP Almora (Secondary dustbins are available for waste disposal)</td></tr>
<tr><td colspan="2">NPP Dwarahat</td></tr>
<tr><td colspan="2">NP Ranikhet</td></tr>
<tr><td colspan="2">Cantt Ranikhet</td></tr>
<tr><td colspan="2">Cantt Almora</td></tr>
<tr><td>Sweeping</td><td colspan="3">All the ULBs in the district are accomplishing 100% sweeping by manual method.</td></tr>
<tr><td rowspan="6">Transport of Segregated waste</td><td colspan="2">ULB</td><td>Segregated waste Transport</td></tr>
<tr><td colspan="2">NPP Almora</td><td>Combined waste transport</td></tr>
<tr><td colspan="2">NPP Ranikhet</td><td>Partially</td></tr>
<tr><td colspan="2">NP Dwarahat</td><td>Partially</td></tr>
<tr><td colspan="2">NP Bhikiyasain</td><td>Partially</td></tr>
<tr><td colspan="2">Cantt Ranikhet</td><td>Partially</td></tr>
<tr><td colspan="2">Cantt Almora</td><td>Partially</td></tr>
<tr><td>Material Recovery Facility (MRF)</td><td colspan="3">• NP Almora and Cantt Ranikhet have functional MRFs which also cater the waste management of Cantt. Almora and NP Ranikhet, respectively.
• NP Bhikiyasain has recently started waste management operations. They have individual waste recovery facility.</td></tr>
<tr><td>Involvement of Non-Governmental Organizations (NGOs) / private agencies</td><td colspan="3">Almost every ULB in the district is working with some private firm for Solid waste management.</td></tr>
<tr><td rowspan="7">Authorization and issuance of identity cards to waste pickers / Sanitation workers</td><td colspan="2">ULB</td><td>Numbers</td></tr>
<tr><td colspan="2">NPP Almora</td><td>175</td></tr>
<tr><td colspan="2">NPP Ranikhet</td><td>10</td></tr>
<tr><td colspan="2">NP Dwarahat</td><td>15</td></tr>
<tr><td colspan="2">NP Bhikiyasain</td><td>10</td></tr>
<tr><td colspan="2">Cantt Ranikhet</td><td>98</td></tr>
<tr><td colspan="2">Cantt Almora</td><td>29</td></tr>
<tr><td>Linkage with Treatment Storage and Disposal Facilities (TSDF) / Bio-Medical Waste Treatment Facility (CBMWTF)</td><td colspan="3">No ULB in the district have linkage with the treatment storage and disposal facility.</td></tr>
</table>

Table 58. Existing infrastructure facility for plastic waste management

Name of ULB	**Inventory of infrastructural services to deal with plastic waste**				
	Plastic waste collection centres	**Availability of Plastic compactors**	**Linkage with plastic waste recyclers**	**Material recovery facility (Available / Not Available)**	**Remarks**
NPP Almora	53[a]	1[d]	1	Available	• Secondary collection points are established. • Vendors are available at Rudrapur for compaction of plastic waste, which is then recycled.
NPP Ranikhet	30[a]	1	1	Available[b]	• Secondary collection points are established. • Plastic waste is recycled in one of its facility at Ranibagh
NP Dwarahat	4	1	In process	Not Available	• Secondary collection points are established. Moreover, all 350 shops are allocated separate dustbins. • Aiming to make Dwarahat, a zero dustbin town.
NP Bhikiyasain	55[a]	Under process of purchasing	1	Available	• Secondary collection points are established. • Plastic waste is transferred to KPS Enviro Tech Pvt. Ltd., Moradabad for recycling.
Cantt. Ranikhet	45[a]	1	1	Available	• Secondary collection points are established. • Plastic waste is recycled in one of its facility at Ranibagh
Cantt. Almora	54[a]	1	1	Available[c]	Vendors are available in Rudrapur for compacted plastic waste, which is then recycled.

[a]*Waste Collection points (secondary collection) are established at different locations.*
[b]*Waste transferred to MRF at Cantt Ranikhet*
[c]*Waste transferred to MRF Almora.*
[d]*Approximately 500 kg per day plastic waste is compacted*

PROJECTED POPULATION AND PLASTIC WASTE GENERATION IN ALMORA DISTRICT

Plastic waste in India has increased steadily over the past 50 years. It is expected to double again 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 has been taken for population forecast. Decadal population and subsequent waste forecasts done based on following presumptions:

- According to arithmetic increase method, the decadal population projection showed the rate of change in population in due time. 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 consumption is discarded as waste (CPCB, 2013).
- 16 % yearly growth in per capita plastic waste consumption has been taken keeping in mind the changing waste paradigm and floating population. *(Centre for Science and Environment,2019)*
- This analysis included population and waste generation estimations only for urban local bodies and did not include peri-urban and rural areas.

Table 59. Projected population and estimated plastic waste generation in Almora district

ULB	Projected Population			Projected Waste Generation (MTPD)		
	2021	2031	2041	2021	2031	2041
Almora NP	49070	58513	67956	2.0	6.20	11.63
Ranikhet NP	6834	8568	10302	0.3	0.98	1.90
Bhikiyasain	3486	3697	3908	0.6	1.65	2.83
Chaukhutiya	4688	4912	5136	0.14	0.38	0.64
Dwarahat	2406	2063	1720	0.1	0.22	0.30
Ranikhet CB	18717	18548	18379	1.0	2.58	4.12
Almora CB	578	-235	-1048	0.05	-0.05	0.38
Total	**85779**	**96301**	**106353**	**4.19**	**11.96**	**21.8**

Table 60. Decadal increase in waste generation

Name of ULB	Rate of growth % (2021-2031)	Rate of growth % (2031-2041)
Almora NP	21.00	8.75
Ranikhet NP	22.67	9.38
Bhikiyasain	17.50	7.15
Chaukhutiya	17.14	6.84
Dwarahat	12.00	3.63
Ranikhet CB	15.80	5.96

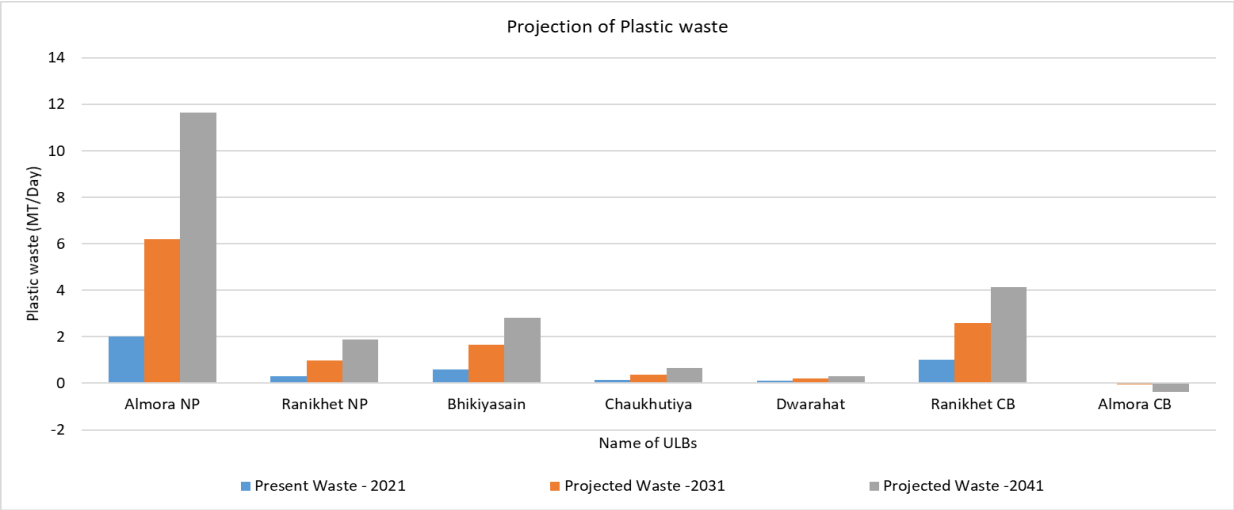


Fig. 8. Graphical representation of projected Plastic waste

Inferences drawn from the projection of waste

- Plastic waste generation in the district is expected to increase by almost 12-22 MTPD in the coming decades.
- Unprecedented growth in plastic waste is observed in the district. Recent amendments in plastic waste management rules might decrease the growth rate in coming decade.

ASSESSMENT OF URBAN LOCAL BODIES IN ALMORA 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. 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 61. Assessment of urban local bodies in Almora district

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

E-waste collection and linkage with recyclers	**2**	0	0	0	0	0	0
General Information							
Innovation and use of indigenous techniques	**2**	1	1	1	0	0	0
Enforcement of bye-laws and waste Management Rules, 2016	**2**	2	1	1	1	2	1
Total	**30**	**18**	**19**	**16**	**16**	**20**	**19**

Table 62. Final assessment of urban local bodies in Almora district

Rank	Name of ULB	Score (out of 30)	Score Percentage (%)
1.	Cantt Ranikhet	20	66.66
2.	NPP Ranikhet	19	63.33
3	Cantt Almora	19	63.33
4.	NPP Almora	18	60.00
5.	NP Dwarahat	16	53.33
6.	NP Bhikyasain	16	53.33

Observations from data assessment

- Overall, Cantonment board Ranikhet is performing well with better waste management operations as compared to other Urban Local Bodies.
- Nagar Panchayat Bhikysain, Dwarahat, Nagar Palika Ranikhet and Cantonment Board Almora are performing better waste collection operations but disposal of waste still needs adequate scientific attention.
- Nagar Palika Parishad Almora is performing outstanding in terms of waste disposal and recovery operations. However, this ULB has to focus more on waste collection specifically door to door to avoid the ever-increasing monkey menace problems in the town.
- Almost all the ULBs still need adequate attention for source segregation of waste. Regular Information, Education, and Communication (IEC) activities and awareness programs are necessary to sensitize people about the importance of segregating the waste at source.

ACTION PLAN

- Based on the data analysis and gap identification, an action plan is devised to minimize adverse impact on the environment considering development.
- A holistic action plan is provided keeping in mind the present state of affairs and environmental changes that may occur in years to come.
- Qualitative and quantitative approach is pursued to formulate a long term and short term action plan for different thematic.
- Action plan is provided keeping in mind the financial constraints of urban local bodies and various other departments.
- Departments responsible for ensuring compliance have been mentioned with reference to each action point to integrate the efforts and activities of each department in pursuit of common purpose.

Action Plan for Solid Waste Management

Almora district is currently in an intermediate phase of waste management operations where it is shifting from a mass consumption society to Sound material cycle society *(Sustainable society)*. The action plan focuses on the basic point, which forms the prerequisite for effective waste management. Each action point is in compliance with the guidelines of Solid Waste Management Rules, 2016. It is expected that the district would be able to scientifically manage their waste in a decadal timeline. The current action points must be addressed in a timeframe of 5-10 years considering the financial constraints.

Focus Areas

- *Segregation at source*
- *Home composting*
- *Scientific recovery and disposal of waste*

Table 63. Action plan for solid waste management

Action area	Concerning ULB	Strategy/ Approach	Stakeholder responsible	Purpose
Primary segregation (segregation at source)	All ULBs	• Separate storage bins. • Regular awareness campaigns. • Incentivizing wards having 100% source segregation. • Man power management. • Behaviour change communication techniques. • Promoting home composting for wet waste.	• Nagar Palika/Nagar Panchayat • Residents and NGOs	• Higher recovery of recyclables. • Better handling of waste. • Efficient Energy recovery.
Door to Door Collection	NPP Almora	• Training waste pickers. • Providing equipment, infrastructure and management support.	Nagar Palika	• 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	• By Optimizing Waste Management Infrastructure	Nagar Palika/ Nagar Panchayat	Man power optimization

		(Collection trucks, trolleys).		
Characterisation of waste	All ULBs	• By periodically checking and measuring the waste volume to establish the baseline for the waste generation. • Waste volumes should also consider seasonal variations and should be temporal in nature.	Nagar Palika / Nagar Panchayat	To keep an accurate estimate of waste generation.
Landfill mining	All ULBs	• Converting bio-waste from landfill site into compost while plastic, glass etc., can be used for recycling.	Nagar Palika/ Nagar Panchayat	• To mitigate environmental impact of waste. (methane emission) • Resource Recovery of excavated waste. • To mitigate the garbage slide
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 based waste management programs	All ULBs	• Cleanliness drive campaigns throughout the district • Information, Education and Communication (IEC) activities in Educational institutions. • Inter-personal communication (IPC):	District administration	• Social and Behavioural Change Communication • To provide training necessary to establish effective waste management

		School children and sanitation workers to spread awareness amongst people regarding waste management.		operations.
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.
Scientific recovery and disposal of waste	• NP Dwarahat • NP Bhikyasain • NP Chaukhutiya	• Establishing a waste recovery facility • construction of sanitary landfill. • Linkage with authorised recyclers and centralized treatment facilities.	Nagar Panchayat, District administration	To eliminate the risk of waste seeping underground (Leachate) within the landfill. To reduce the risk of health hazards. Reduction of Historical waste.

Wet Waste Management through composting – A study by GBPNIHE

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

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

Microbial Bio-composting at Municipal level

A site was selected to construct an open below earth surface MBC pit (size 3x1x1 m) (Kuniyal and Thakur, 2013-14). Its roof top was covered with multi-layered ultraviolet (UV) resistant polyethylene sheet *(rainfall areas)* and UV treated fibre sheet *(Snowfall areas).* It was required to

turn up the waste in an interval of 15 days for sufficient aeration. It was noticed that 500 kg of waste produced almost 167 kg compost (almost 1/3rd). Moreover, yield per hectare of garlic from the compost produced also showed desirable results.

Fig. 9. Structure and design of microbial composting pit

Phytoremediation as a mitigation measure *(for treatment of solid waste)*

Natural or planted vegetation on 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 64. Phytoremediation as a mitigation measures

Botanical name	Local and Name	Altitude (m)	Life form	Assimilating capacity	References
Lemna minor L.	Duck Weed	up to 1500	Herb	Absorb all the dissolved gases and substances, including the heavy metals, from the wastewater	Azeez and Sabbar, 2012

Helianthus annus L.	Sunflower	up to 2600	Herb	Sunflower is reported to absorb radionuclides from soil and decontaminate it.	Paliwal et al, 2014
Morus alba L.	Mulberry	300-3300	Tree	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	Dineva, 2017
Ricinus communis L.	Castor	up to 2000	Tree	Uptake of Cd & DDT from soil	Rissato et al, 2015
Canna indica L.	Canna	1800-2000		Used for removal of ammonical nitrogen from wastewater	Barya et al, 2020
Cassia fistula L.	Amaltas	100-1470	Tree	Absorbs Arsenic and Fluoride from wastewater	Janta et al, 2016
Nerium indicum Mill.	Kaner	Upto 800	Tree	Absorbs chromium from wastewater	Vazquez et al, 2016
Brassica juncea (L.) Czern.	Sarson	1000-2600	Herb	Absorbs Zinc from Soil	Rathore et al, 2019

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 Almora 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 65. Proposed policies for rural waste management

Current Policy	Sponsoring agency	Remarks
Decentralized Waste Management	Under SBM-G *(Swachh Bharat Mission-Gramin)*	Decentralized systems such as household compost and biogas plants shall be encouraged.
Community Sanitary Complex (CSCs)	Under SBM-G *(Swachh Bharat Mission- Gramin)*	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).*
Cluster Approach to Solid Waste Management	Rurban Mission of Ministry of Rural Development	It aims at developing infrastructure and livelihood opportunities in cluster of Gram panchayats that demonstrate economic growth potentials.
Community Participation through *Information, Education and Communication* (IEC) 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 management

With the onset of the pandemic, it has become clear that a proper healthcare system is need of the hour. It also provides the opportunity to improve biomedical waste management in the district. Moreover, during outbreaks such as covid-19, materials or substances which carry infection (fomites) acts as key vehicle for the transmission of the disease. Streamlining the bio-medical waste may help in reducing the infection and its transmission. This action plan provides holistic approach, which includes governance, infrastructure, training and immunization, services etc. to tackle the unprecedented growth in biomedical waste. Immediate action is required in some of the areas such as segregation and tracking of the waste generated etc. while other action points must be executed in due course of time (Table 65).

Focus Areas

- *Pre segregation of waste*
- *Tracking of bio-medical waste*
- *Linkage of major HCFs with* CBMWTF.

Table 66. Action plan for Bio-medical waste management

Action Areas	Purpose	Stakeholders
Governance		
Authorisation of all HCFs (Allopathic, AYUSH etc.) by Uttarakhand state Pollution control board (UKPCB).	To ensure compliance with the Biomedical waste management rules 2016.	Uttarakhand state Pollution control board (UKPCB)
Periodic inspection of HCFs (Health-care Facilities) 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 District level hospitals and Community Health Centres (CHCs) with Common Biomedical waste treatment facility (CBWTF).	To ensure proper disposal of Biomedical waste as specified under Biomedical waste management rules, 2016.	Health Department
Infrastructure		
Construction and maintenance of Biomedical waste collection shed at district level HCFs and CHCs.	To ensure scientific handling and 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 scientific disposal of liquid effluent generated in the HCFs.	Health Department
Training and Immunisation		
State level and District level orientation programs for healthcare workers to sensitize them about effective Biomedical waste management.	To ensure proper handling and segregation of biomedical waste in HCFs	Health department

• Setting up of Biomedical Waste Database at State level (specifically for primary health-care facilities) • Training on biomedical waste management information system (BMWMIS) to all data entry operators and pharmacists.	To keep records of biomedical waste generated in every HCF of the district (especially in PHCs at rural areas).	Health department
Immunisation *(Tetanus and complete doses of Hepatitis-B)* of all hospital staff involved in Biomedical waste management.	To avoid any kind of infection while handling Biomedical waste.	Health department
Services		
Establishing bins and bags at each generation points in HCFs with IEC posters displayed.	• To ensure segregation at each generation point and avoid mixing with MSW. • To spread awareness amongst the people related to Bio-medical 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 waste 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 HCFs (Health-care facilities) on website.	To make the information open source and ensure transparency.	Health Department and Uttarakhand state Pollution control board (UKPCB)

Action plan for C&D waste management

Increase in C&D waste generation is expected in decades to come due to rapid urbanization and modernising infrastructure. Hence, some basic facilities

Focus Areas

- *Establishment of dunping zones*
- *Framing of bye-laws*

need to be developed to manage its growth. The action plan provides below (Table 66) provide a sustainable approach for the management of the C&D waste in compliance with the latest C&D waste management rules 2016.

Table 67. 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.	• Notifying dumping zones as executed by NPP Almora & Cantt Ranikhet. • Establishment of dumping zone such that it also caters for C&D waste of Peri-urban areas and nearby villages. • Illegal dumping practices must be discouraged by charging 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.	Providing vegetation cover to control soil erosion, gully formation, consolidation of dump top and side surfaces.	• All ULBs, DPRO and PWD	Dump Slope stabilization and erosion control

Action Plan for Hazardous waste management

Hazardous waste can be a potential threat to human health and environment. This makes it necessary to manage hazardous waste to minimize its

Focus Areas

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

harmful impact. At present in Almora district, hazardous waste is not handled in a scientific way. This action plan provides some key areas in which the district needs to work to achieve effective hazardous waste management complying with latest hazardous waste management rules, 2016.

Table 68. 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 and 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 domestic hazardous waste	• By organizing district level workshops to sensitize the sanitation workers regarding hazardous waste management. • By adopting standard operating procedure for all the sanitation jobs related to hazardous waste handling.	State government and District Administration	• To ensure proper segregation of domestic hazardous waste from municipal solid waste. • To ensure disposal of materials in a safe, efficient and environmental friendly manner. • To minimize exposure to unhealthy waste by adhering to safety guidelines proposed by Occupational Safety and Health administration (OSHA).

IT enabled systems for inventorization of the hazardous waste m	State pollution control board should inventorize 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 Management

Due to lack of basic waste management operations for E-waste, its quantity cannot be determined in the district. This may be due to lack of awareness amongst the people regarding E-waste as well as lack of concern by district administration. E-waste needs to be streamlined in the current waste management operation, moreover a detailed framework must be developed for its management. This action plan discusses key areas where intervention is needed to achieve effective waste management in compliance with E-waste management rules, 2016.Some of the action needs to be addressed immediately such as establishment of collection centre etc. while others can be initiated with the due course of time. (Table 68)

Focus Areas

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

Table 69. 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	• 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 must be issued to them.	District administration and ULBs	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	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 RoHS (Restriction of Hazardous Substances) 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

Scientific and technological interventions in wastewater management are lacking in most of the ULBs of Almora district. Except two, all other ULBs rely on conventional treatment of wastewater which has become obsolete and leads to environment degradation. However, some policies are promulgated in the district to revamp the liquid waste management in Almora district. This action plan focusses on addressing concerns of each ULB pertaining to the policies and design sanctioned by the respective administration. (Table 69).

Focus Areas

- *Decentralized waste water management*
- *Phytoremediation for natural treatment*

Table 70. Action plan for waste water management (STPs)

Action Point	Concerning ULB	Strategy/Approach/Current status	Stakeholder Responsible	Purpose
Upgradation of sewer network	NPP Almora	• Almora Sewerage network is planned under 4 zones by payjal nigam, under which zone 1 is already operational. • Sewer lines are already laid under Zone2-A which will cover almost 15000 capita.	Jal Sansthan	Increase household coverage of sewer network in Almora town.
Additional STP requirement	NPP Almora	Proposal has been sent for Zone-2 STP and approval is awaited.	Jal Sansthan	Increase the percentage of population covered under Sewage management. (Currently only 15% population is covered under sewerage network).
Continuous Effluent Monitoring station	NPP Almora	Self-monitoring mechanism in the form of Online Continuous effluent monitoring system.	• Jal Sansthan • State Pollution control board	Ensure that the STP meet out the prescribed standards as per Environment Protection Act, 1986.
Decentralized waste water management under Atal mission for Rejuvenation and Urban transformation (AMRUT) by	All ULBs	• 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	• Ministry of Housing and Urban development, Government of India. • State Government	• Promoting community-planned and managed faecal sludge and septage management for group of

Faecal Sludge and Septage Management system (FSSM)		planning. • Capacity building and training on FSSM (at city level) to build their personnel capacities and organizational systems for delivery of sanitation services.		households. • Rehabilitation of old sewerage system. • To augment limited treatment capacity. • Recycling and reuse of waste water for beneficial purposes.
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 etc.)	Ministry of Housing and Urban Development ,Government of India	• Citywide sanitation sector development. • Awareness generation and behaviour change in field of Sanitation. • Sanitation and safe disposal of waste.

Action Plan for Industrial waste water management

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

Table 71. Action plan for industrial waste water management

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

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

Water Resources and Groundwater management requires an integrated approach from different departments such as the District administration, Panchayati Raj, Jal Sansthan, Jal Nigam, Payjal Nigam, Forest Department etc. Each department is expected to work in tandem with each other to achieve effective management of resources, be it land or water. The action plan focuses on the areas, which form the prerequisite for effective water resource management. Each action point is in compliance with the guidelines under Water (prevention and control of pollution act, 1974), (Amendment) Rules 2021 of water resource management act, 1986. The current action points must be addressed in a timeframe of 5-10 year considering the financial constraints. (Table 71, Table 72)

Focus Areas

- *Mapping of water scarce areas*
- *Encouraging the use of organic fertilizers*
- *Crop diversification*

Table 72. Action Plan for 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 73. 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 resulting from land runoff, precipitation, drainage, seepage etc.)	• Controlling soil erosion by planting more trees and covering bare soil with vegetation. • Constructing wetlands.	• Non-point source pollution is a leading cause of deteriorating water quality as when the runoff moves, it picks up and carries away natural and human-made pollutants finally depositing them in lakes, rivers and groundwater.
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

As the anthropogenic activities in the district are mainly responsible for increased levels of pollutants in the region, so the participation of various institutions along with the local community is desired. The first and the foremost thing is establishing air quality monitoring station in the district. The action plan provided below deals with all the aspects, which are necessary to solve the issue (Table 73).

Focus Areas

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

Table 74. 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 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 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. • Proper inspection of civil forests and forests under van panchayats by training the personnel engaged in the maintenance of these forests. • Development of mixed forest by planting indigenous broadleaf plants which maintains moisture in the soil and reduce the chances	Government of Uttarakhand and District Forest Department	To reduce harmful emissions due to massive forest fires in the district.

	of fire.		
Vehicular Traffic management	• Checking adulteration of fuel • Promoting intercity and intra-city public transportation with green fuel alternatives such e-buses e-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

Phytoremediation for air pollution in Almora district

Air pollution today is the most important aspect of environmental study as every progress by mankind has deteriorated the air quality. Artificial technologies have proved insufficient to address this problem. So a better and a natural way to combat the air pollution is plantation. However, all plants do not show the same response to a particular type of pollutant. Hence, all plants cannot remediate all kinds of air pollution. There are various parameters on which plant species are selected for plantation viz. dust accumulating potential, carbon sequestering potential etc. Each of these parameters should be well analyzed before selecting any plant species for plantation (Table 75).

Table 75. Some suitable plant species for air pollution management

Botanical name	Local Name	Altitude	Assimilating capacity	References
Chenopodium murale L	Bathua	1000-2200	Remove volatile hydrocarbons	Awadhi et al, 2012
Brassica oleracea L.	Sarso	1000-2000	Uptake Cd, Sn, Zn and Pb from air particulate through leaves	Gawronski, et al, 2017
Brassica spp.	Kali Sarso	800-2200	Absorb So_2 and No_2 from	Gawronski,

			polluted air	et al, 2017
Vicia faba L.	Broad bean	900-1400	Remove volatile hydrocarbons	Ali et al, 2015
Zea mays L.	Corn	500-1800	Remove phenolic compounds	Sandhu et al, 2007

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 75).

Table 76. 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 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 for Mining activity management plan

Although the cases of illegal mining practices are not yet registered by the state pollution control board and other concerned authorities in the district, precautionary measures are necessary keeping in mind the future aspects. Further, it is also necessary to be aware of the cases of illegal mining, which remains unregistered so far. The action plan provided below mainly emphasize on areas, which includes monitoring of the mining operation by using the latest technologies as per the sustainable sand mining guidelines 2016 (Table 76).

Focus Areas

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

Table 77. 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. • Satellite based remote sensing to provide near real time monitoring of mining areas.	District administration	To mitigate and stop adverse environmental impacts and economic losses.
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

Almora district administration has already undertaken the task of rejuvenating two rivers using various methods. Aim is to revive the flow of the rivers and to restore their ecology. This action plan provides a holistic approach, which includes scientific interventions as well as convergence activities (Table 77).

Table 78. Action plan for rejuvenation of waterbodies

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. 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 78).

Focus Areas

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

Table 79. 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 as done by NP Dwarahat. • 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 for dry and wet	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 district) • To ensure optimum utilisation of manpower • To ensure compliance with plastic waste

	waste to ensure utilisation of manpower. • ULBs can establish linkage with the NGOs working in this field for effective waste collection in the urban areas.		management rules 2016
Linkage of ULBs & other collection centres with recyclers/ cement plants / public Works Department	• NP Dwarahat, NP Chaukhutiya should establish linkage with any recyclers. • Plastic waste can be used in road construction. For this, ULBs should coordinate with the construction agencies.	All ULBs, District Panchayati raj Officer (DPRO),	• 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	• Cleanliness drive campaigns throughout the district • Information, Education and Communication (IEC) activities in Educational institutions. • Inter-personal communication (IPC): School children and Sanitation workers to spread awareness amongst people regarding waste management.	District Administration	• Social and behavioural change communication
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.

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