Climate Centre for Cities

LAHDC LEH

The Administration of the Union Territory of Ladakh

MCL
Municipal Committee of Leh

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY
SOUTHEAST ASIA

Funded by the European Union

Leh City Climate Action Plan

Net Zero by 2047

DAI

Leh City
Climate Action Plan
Net Zero by 2047

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Message

Dr. Debolina Kundu
Director (Additional Charge)
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Urban Affairs (NIUA)

It is a privilege to present the City Climate Action Plan (CAP) for Leh, a significant step forward in our collective efforts to combat the escalating challenges posed by climate change in this unique region. I would like to express my heartfelt appreciation to the Global Covenant of Mayors for selecting Leh as part of this critical initiative, to the European Union for their generous financial support, and to the Ladakh UT Administration, including the Ladakh Autonomous Hill Development Council (LAHDC), for their unwavering commitment. Special thanks are due to the Leh Municipal Committee for their proactive engagement and to all stakeholders who contributed their time and resources.

The Leh Climate Action Plan is a vital framework aimed at building climate resilience while striving for net-zero emissions by 2047. However, while plan preparation is a crucial first step, the real challenge lies in its successful implementation. The CAP not only identifies the climate risks facing Leh but also outlines detailed mitigation and adaptation strategies, providing a clear roadmap to achieve our climate goals. This ambitious vision can only be realized with the active and sustained commitment of all stakeholders.

Leh, positioned in one of the most climate-sensitive regions in the world, is particularly vulnerable to extreme weather events, including cloudbursts and Glacial Lake Outburst Floods (GLOFs). The CAP highlights that 90% of Leh's population is at medium to high risk of floods. To tackle these vulnerabilities, the CAP proposes a comprehensive range of measures, including stormwater management, enhancing the resilience of critical infrastructure, and addressing water management challenges by reviving Leh's historically important springs, many of which have fallen into disuse due to groundwater overexploitation.

Given the unique climatic challenges in Leh, traditional afforestation is particularly difficult. To address this, context-specific alternatives have been proposed, including the establishment of renewable energy farms to leverage Leh's significant solar energy potential, which is key to achieving Net Zero by 2047. These plans align with the ClimateSmart Cities Assessment Framework (CSCAF), introduced by the Ministry of Housing and Urban Affairs (MoHUA) under the Smart Cities Mission in 2019. This framework helps ensure that city-level actions are consistent with national priorities and contribute to the Sustainable Development Goals (SDGs).

At the National Institute of Urban Affairs (NIUA), we are committed to supporting Leh and other cities across India in their climate action journeys. Our vision extends beyond this plan—our aim is to scale up Climate Action Plan preparation and implementation across cities, working with various climate alliances and leveraging our partnerships with other national and regional networks.

Furthermore, we are empowering future generations through the creation of a network of young urban professionals and engaged youth, promoting citizen-led climate actions in cities.

In conclusion, while the Leh Climate Action Plan marks a significant step forward, the true test lies in turning this vision into reality. I encourage all stakeholders to continue their dedicated efforts, and together, we can secure a sustainable and climate-resilient future for Leh.

Message

Shri Stanzin Rabgais
Executive Officer
Leh Municipal Committee

It is with great pride and gratitude that I present the City Climate Action Plan for Leh, a significant milestone in our collective efforts to address the pressing challenges of climate change. At the outset, I would like to extend my heartfelt thanks to the Global Covenant of Mayors for selecting Leh as a part of this critical initiative, the European Union for providing the necessary funding, and the National Institute of Urban Affairs (NIUA) for their dedication and expertise in developing this plan. Their support has been indispensable in bringing this ambitious project to life.

Leh, nestled between the Karakoram and Great Himalayan ranges, is one of the most vulnerable regions to climate change impacts. As we have witnessed in recent years, the growing intensity of cloudbursts, flash floods, and Glacial Lake Outburst Floods (GLOFs) pose significant risks to our community. According to the Leh Climate Action Plan, over 90% of the city's population faces medium to high flood risks, with over 16,000 people projected to be impacted by urban floods by 2047. These are stark reminders of why climate resilience is not just an option, but a necessity for the future of Leh.

The Leh Climate Action Plan envisions achieving net-zero emissions by 2047, while also building the city's resilience against extreme weather events and long-term climate change impacts. I am profoundly grateful to the UT administration of Ladakh, the Ladakh Autonomous Hill Development Council (LAHDC), and the local NGOs, business associations, and religious organizations who contributed to the development of this plan. Their invaluable input, whether through providing critical data, sharing on-the-ground experiences, or supporting the plan's goals, has been key to creating a comprehensive and actionable roadmap.

The collaborative nature of this effort is reflected in the stakeholder consultations that informed the development of the plan. As highlighted in the report, the active involvement of local communities and institutions has allowed us to incorporate both scientific insights and traditional knowledge, ensuring that the Climate Action Plan is not only data-driven but also contextually relevant.

The 2021 cloudburst, which caused widespread damage, serves as a stark reminder of the challenges we face. As the CAP outlines, it is essential that we implement both mitigation and adaptation strategies to protect our community from such events, while reducing our overall contribution to climate change.

As we move forward, I firmly believe that the Leh Climate Action Plan will serve as a guiding document, helping us transition to a more sustainable and resilient future. By reducing emissions, safeguarding our precious natural resources, and preparing our infrastructure to withstand future climate risks, we can ensure that Leh remains not just a place of natural beauty, but a thriving, resilient community.

In closing, I would once again like to thank all the stakeholders, including the residents of Leh, for their continuous support and commitment to this plan. It is through our collective efforts that we will secure a sustainable future for generations to come.

Message

Piero Roberto Remitti
Co-managing Director
Global Secretariat, Global Covenant of Mayors

It is my honor to present the Climate Action Plan for the city of Leh, a region known for its unique geographical challenges and rich cultural heritage. This document represents a crucial step forward in the city's commitment to addressing climate change impacts through locally-driven, community-led initiatives.

The resilience of Leh is truly inspiring, and this plan is a testament to the collective efforts of the municipal government. local stakeholders, and international partners.

Leh's climate journey is emblematic for regions with high altitudes and fragile ecosystems across the globe. I am confident that this Climate Action Plan will serve as a guiding light for similar communities to tackle the complex realities of climate change while safeguarding their ecological and cultural wealth.

Message

Victor R. Shinde
Head, Climate Centre for Cities
National Institute of Urban Affairs (NIUA)

It is with great pride that I introduce the City Climate Action Plan for Leh, a crucial initiative aimed at making Leh resilient to the growing threats posed by climate change, such as cloudbursts and flood risks. The plan outlines strategies to achieve net-zero emissions by 2047, emphasizing solar energy, sustainable water management, and disaster preparedness. I would like to thank the Global Covenant of Mayors, the European Union, and the Ladakh administration for their unwavering support. Now, the focus must shift toward implementing these strategies through coordinated efforts from all stakeholders

Executive Summary

Leh, the capital and largest urban center of Ladakh, is situated in the Indus Valley, covering 17.43 sqkm with a population of 30,870 according to the 2011 census. Its steep mountainous terrain and the presence of the river contribute to a linear growth trajectory. Leh's elevation ranges from 3200m to 4000m above sea level. Connectivity is limited to the Kushok Bakula Rimpochee Airport outside the municipal area and NH1 and NH3, both of which have limited operations during the winter months. The town's population is projected to increase to 64,217 by 2047, with tourism being the primary industry supporting the economy and attracting seasonal migrants.

This climate action plan looks at Leh as a climate victim, likely to be one of the worst impacted regions globally due to climate change. Aligning with the National Mission for Sustainable Habitat under the National Action Plan for Change and the ClimateSmart Cities Assessment Framework developed by the National Institute of Urban Affairs, this City Climate Action Plan looks at minimising Leh's contribution to climate change by reducing its emissions and building resilience against the predicted impacts of climate change.

Baseline

Leh is projected to experience a significant temperature increase by 2100 under two scenarios: 4.67°C under SSP 5-8.5 and 2.77°C under SSP 2-4.5. By 2050, temperatures will rise by 1.38°C and 1.09°C, respectively. Summer peak temperatures could increase by 8-10°C, while winter maximums and minimums might rise by about 5°C and 10°C. The temperature increase, particularly in late summer and winter, will impact glacier cycles and potentially reduce glaciers by 80% if the increase exceeds 6°C. Precipitation is expected to increase by 10% under SSP 2-4.5 and 30% under SSP 5-8.5, primarily after 2050. Monthly variations show a decline in summer precipitation and a rise in winter precipitation, which, being snowfall, may not immediately benefit agriculture and could increase water runoff, reducing overall water availability in Leh.

Leh's baseline emission inventory for 2021-22 shows total emissions of 143,884 MTCO2e, with a per capita rate of 3.33 MTCO2e, much higher than the national average. Stationary energy accounts for over 64%, transportation for nearly 34%, and waste for only 2% of emissions. Projections indicate a 3.5 times increase in emissions by 2047, with stationary energy's contribution rising to 74% and transportation and waste sectors decreasing to 25% and 1%, respectively.

This report focuses on two main climate risks for Leh: urban floods and water scarcity. Flood risk is projected to increase due to intensified rainfall, with 42.5% of the developed areas and over 16,000 people expected to be impacted. Over 90% of Leh's population faces medium to high flood risk, projected to impact 58,000 people by 2047. Water scarcity is also expected to become a concern due to the over-reliance on groundwater extraction. About 7% of the population and large portions of the government and industrial areas lie in low groundwater zones.

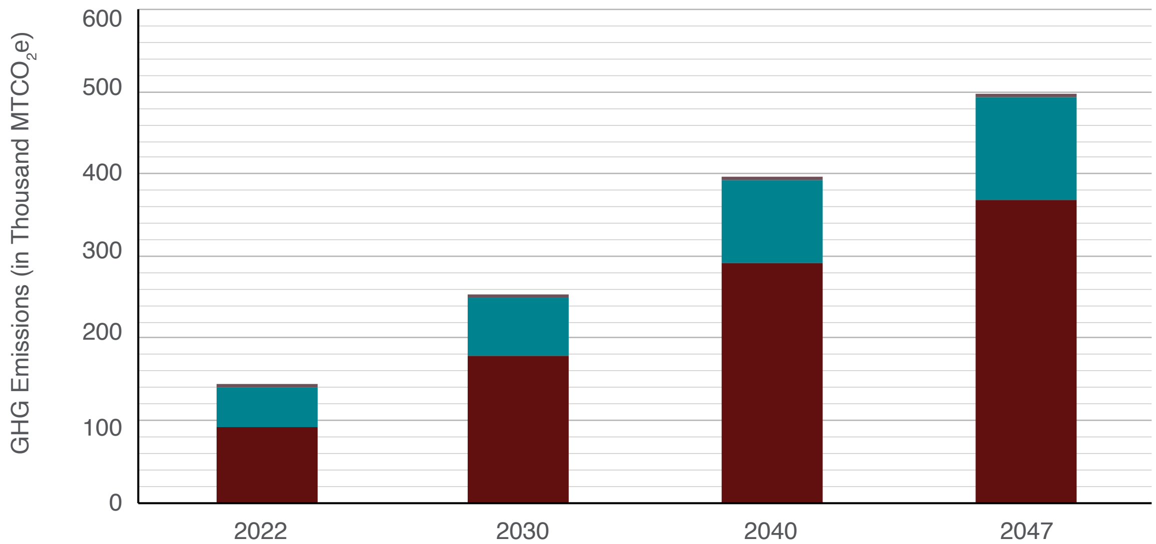


Figure 1: Projected GHG growth in Leh

Recommendations

This climate action plan establishes a dual vision of achieving a climate resilient and net zero Leh by 2047. The dual visions address the two main elements of a climate action plan - Mitigation and Adaptation. This ambitious vision has been set in consultation with the public, the public representatives and the administration. This collective aspiration reflects Leh's determination to stand as a beacon of sustainability, setting an example for communities worldwide. This vision also underscores the region's commitment to cultivating environmental responsibility and resilience within its long-term growth strategy. By embracing this forward-looking vision, Ladakh seeks to preserve its natural splendor and build a balanced, sustainable future for future generations.

The mitigation actions for Leh are divided into four groups: Planned Actions, Usage Reduction, Emission Reduction, and Carbon Sink. These aim to reduce 497,619 MTCO2e by 2047. Planned Actions are underway, while Usage Reduction focuses on cutting electricity and fuel usage through energy efficiency measures. The city plans to switch to renewables like electric vehicles and solar power to reduce emissions further. The total cost is ₹9.57 Cr, with a target cost of ₹19,248 per MTCO2e reduced, staggered over time. Usage reduction measures are more cost-effective than emission reduction measures. Key mitigation actions under the CAP are as per the graph below:

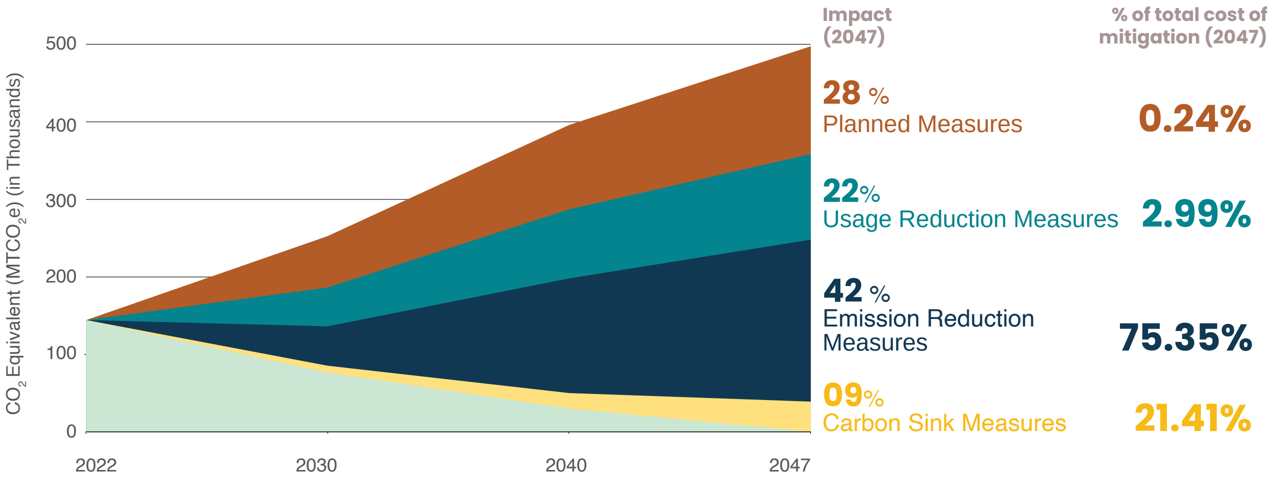
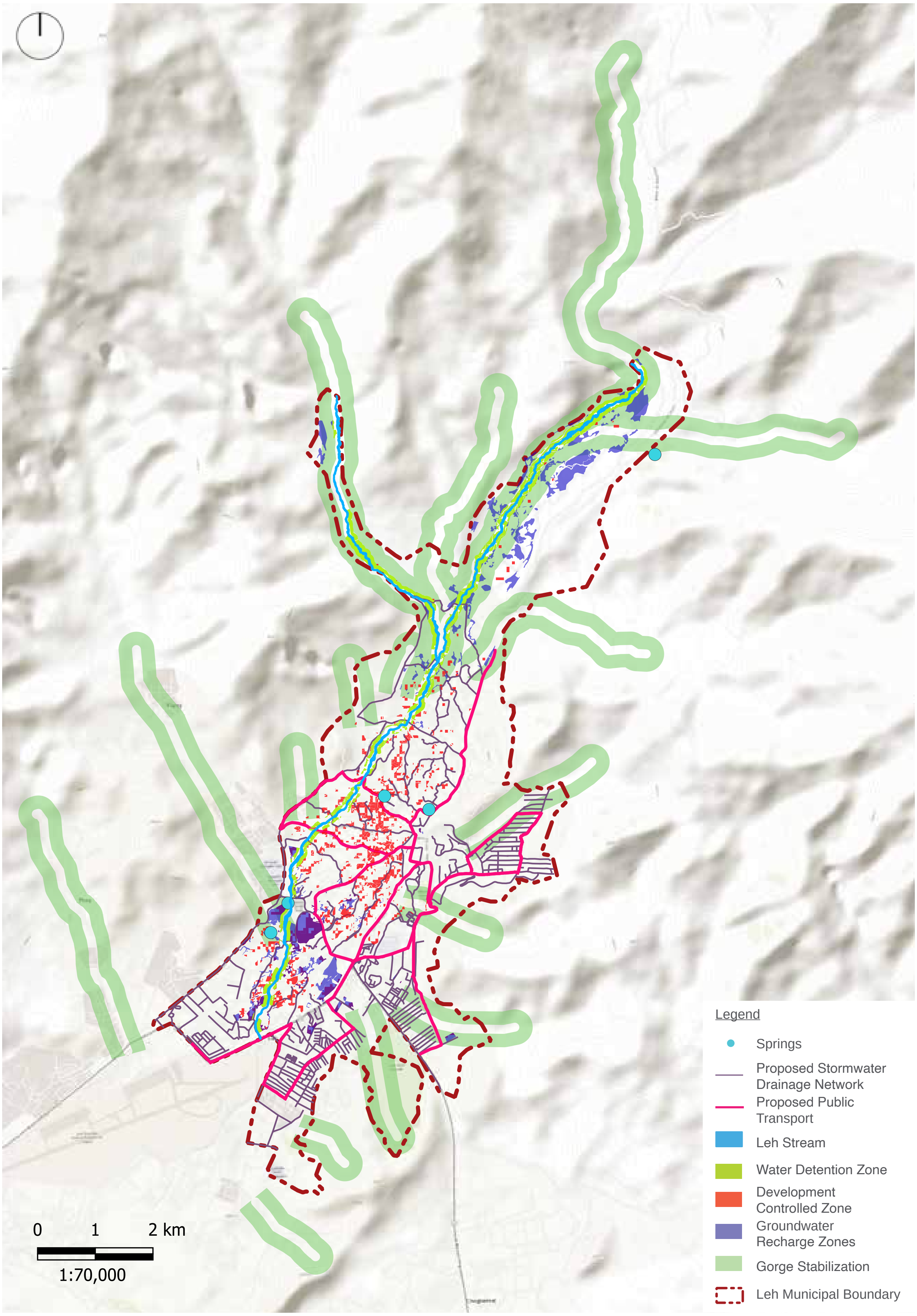


Figure 2: Categorisation of Mitigation Actions under Leh CAP

Adaptation measures are vital for Leh to confront climate change challenges effectively, especially in water management and flood resilience. This Climate Action Plan focuses on two key areas: Effective Water Management and Combatting Flash Flooding. Four objectives and fourteen actions aim to enhance Leh's resilience to climate change impacts through policies, plans, and projects for existing settlements and future developments. Key Adaptation measures proposed under the plan are as per the following table:

No.	Action	Extent	Tentative Cost*
1	Development Restricted Area Demarcated (sqkm)	2.80	NA
2	Controlled Development Area Demarcated (sqkm)	8.17	NA
3	Springs Revivals Proposed (nos)	5 / 10	₹5 Cr
4	Ground Water Recharge Zones Demarcated (sqkm)	9.8	NA
5	Hill Slope Area Stabilised (sqkm)	11.727	₹5.07 Cr
6	Storm Water Drainage Developed (km)	84.75	₹42.4 Cr
7	Flood Detention Areas Demarcated (sqkm)	0.67	NA
8	Pricing Regime for Water Supply		NA
9	Mandates for the installation of Low Flow Fixtures		₹8.94 Cr
10	Mandates for Dual piping systems in new commercial and hospitality uses		NA
11	Mandates for Borewell usage metering and pricing		NA
12	Treated Water Reuse Plan for Leh		NA

*Tentative Costs Estimated as per 2023 prices. Final costs may vary based on detailed on-ground studies and estimations. Estimations do not include costs of land acquisition



Map 1: Proposed Adaptation Interventions

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List of Abbreviations

AT&C	Aggregate Technical & Commercial losses
BAU	Business As usual
BOD	Biochemical oxygen demand
C-CUBE	Climate Centre for Cities
C&D	Construction and Demolition
CAP	Climate Action Plan
CCAP	City Climate Action Plan
CH4	Methane
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
COP	Conference of parties
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSCAF	ClimateSmart Cities Assessment Framework
DDOC	Decomposable Degradable Organic Carbon
DG sets	Diesel Generator sets
DIHAR	Defence Institute of High-Altitude Research
DPR	Detailed Project Report
DST	Department of Science & Technology
DULB	Directorate of Urban local Bodies
EV	Electric Vehicle
FOD	First Order of Decay
GBH	Girth at Breast Height
GCOM	Global Covenant of Mayors
GDP	Gross Domestic Product
GHG	Green House Gases
GLOFs	Glacial Lake Outburst Floods
HPCL	Hindustan Petroleum Corporation Limited
HVRA	Hazard, Vulnerability and Risk Assessment
I&FC	Irrigation and Flood Control
PDD	Power Development Department
IEC	Information, Education and Communication

IMD	Indian Metrological Department
IOCL	Indian Oil Corporation Limited
IPCC	Intergovernmental Panel on Climate Change
LAHDC	Ladakh Autonomous Hill Development Council
LEH MC	Leh Municipal Committee
LiFE	Lifestyle for Environment
LPG	Liquified Petroleum Gas
LREDA	Ladakh Renewable Energy Development Agency
MLD	Million Litres per day
MNRE	Ministry of Natural and Renewable Energy
MoHUA	Ministry of Housing and Urban Affairs
MW	Mega Watt
N2O	Nitrous Oxide
NAPCC	National Action Plan on Climate Change
NDC	Nationally Determined Contribution
NGO	Non-government Organization
NIUA	National Institute of Urban Affairs
NMSH	National Mission on Sustainable Habitat
NMT	Non-motorized Transport
NRW	Non-Revenue Water
PCC	Pollution Control Committee
PHE	Public Health & Engineering
PWD	Public Works Department
RDSS	Revamped Distribution Sector Scheme
RTO	Regional Transport Office
RTS	Rooftop Solar
SIDCO	Sindhu Infrastructure Development Corporation
MTCO2e	Metric Tonnes of Carbon Dioxide
UNFCCC	United Nations Framework Convention on Climate Change
UT	Union Territory

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01 Introduction

Project Background

Need for City Climate Action Plan

India's Climate Journey

CSCAF

Photo Credit: Kanchan Sinha

1.1 Project Background

The anthropogenic impacts of climate change affect 80% of the land area where more than 85% of the world's population currently reside. Almost 3.6 billion (~44%) live in areas highly susceptible to climate change. Cities, which house more than 4.2 billion people, are particularly vulnerable to these impacts where urban form and socio-economic activities can amplify vulnerabilities. Cities face intensified challenges, grappling with the urban heat island effect, increased vulnerability to floods and storms, and strained resources. The impact extends beyond physical infrastructure, affecting health, economies, and emergency response capabilities. Mitigation and adaptation measures are crucial to enhancing urban resilience and addressing the complex interplay between climate change and city life. Parallelly, cities consume 60-80% of all energy and contribute 75% of the planet's carbon emissions.

India, as per the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (IPCC, 2021), is on the brink of experiencing severe impacts of climate change. These include increased flood damage to infrastructure, heat-related human mortality, and exacerbated drought-related food and water scarcity. The country ranks second to Puerto Rico in terms of extreme weather deaths (2736 deaths) and severe economic losses (USD 13.8 billion). It is also ranked 6th among the ten most affected countries in the world as per the Global Climate Risk Index, 2016. Urban centers, which house a third of India's population and contribute to 63% of the nation's GDP, are particularly vulnerable to these climate disasters. These disasters are projected to put at least 4.5% of the GDP at risk by 2030, while extreme heat stress alone is projected to kill 15 lakh more Indians annually by 2100. Indian cities also disproportionately contribute to Greenhouse Gas (GHG) emissions. While the national average per capita emissions is around 1.8 MTCO2e eq per year, the average in urban areas can be as high as 4.79 MTCO2e eq.

In collaboration with the National Institute of Urban Affairs, the Ministry of Housing and Urban Affairs (MoHUA), the Government of India, has established the Climate Centre for Cities (C-Cube). Since its inception, C-Cube has been instrumental in coordinating an ecosystem development process to create synergy across all climate actions (both mitigation and adaptation) being undertaken by various stakeholders in Indian cities. As part of this, C-Cube, in partnership with the Global Covenant of Mayors and the European Union, has led the development of City Climate Action Plans. These plans aim to streamline climate actions undertaken by cities and align them with national and international targets and commitments.

1.2 Need for City Climate Action Plan

While India has set national-level priorities and targets to address climate change, it is crucial to translate these into actionable interventions at the local level. A city climate action plan serves this purpose by defining the city's climate visions and developing pathways for implementing mitigation and adaptation actions (policies, plans, and projects) that the city can take to reduce its GHG emissions and increase climate resilience. The plan develops emission inventories and conducts climate vulnerability assessments to identify and prioritise the actions that will need to be taken by the city.

1.3 India's Climate Journey

India's climate journey which began in 2008 has been turbo charged since 2016 when India became a signatory to the Paris climate agreement. Since then, India has taken various actions to fulfill its commitments under the NDCs. The details of these actions are below.

2008

8 Missions NAPCC

The Prime Minister's Council on Climate Change, GoI, launched the National Action Plan on Climate Change in 2008 with 8 sub-missions representing the multi-pronged, long-term, and integrated strategies to mitigate and adapt to the adverse impacts of climate change. The plan aims at fulfilling India's developmental objectives with a focus on reducing the emission intensity of its economy. Eight missions under NAPCC are as follows:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for Green India
- National Mission for Sustainable Agriculture
- National Mission for Strategic Knowledge for Climate Change

2016

Paris Agreement and India's NDC

As a signatory to the Paris Agreement, India is bound by the terms of the landmark international treaty on climate change, adopted by 196 nations at the Conference of Parties (COP) 21 in Paris. The Agreement's overarching objective is to curb global warming to well below 2°C, ideally 1.5°C, compared to pre-industrial levels. To achieve this, India submitted its intended Nationally Determined Contributions (NDC) to the UNFCCC which included eight goals, aiming at increased non-fossil fuel capacity, reducing emissions intensity, and creating additional carbon sinks by 2030

2019

ClimateSmart Cities Assessment Framework

The Ministry of Housing and Urban Affairs (MoHUA) launched CSCAF as a city-level framework to promote climate-resilient and low-carbon development across urban India under the Smart Cities Mission (SCM). The first round of the assessment evaluates 96 cities.

2020

Climate Center for Cities

MoHUA and NIUA launched C-Cube to institutionalise climate actions in Indian cities, focusing on an ecosystem development process for synergising all climate initiatives nationwide.

2020

CSCAF 2.0

The second round of the assessment expanded the evaluation to 126 cities and included cities that were not part of the Smart Cities Mission.

2021

COP26 (Net Zero 2070)

At COP26 in Glasgow, India reaffirmed its commitment to intensify climate action by presenting five key elements, referred to as 'Panchamrit'. It includes increasing non-fossil fuel capacity by 500GW, achieving 50% of energy requirements from renewable sources, reducing total projected carbon emissions by one billion tonnes, lowering the carbon intensity of the economy by 45%- all by 2030. It was an update to its climate targets through which India declared a long-term goal of achieving net-zero emissions by 2070, crucial to the environmental challenges it faces as a developing country

2022

CSCAF 3.0

The current round of CSCAF expands the assessment to 226 cities across India.

2022

National Mission on Sustainable Habitat (NMSH)

India's GHG emissions surged by 144%, from 1,311.29 $MtCO_2$ eq. in 1994 to 3,202 $MtCO_2$ eq. in 2014 (WRI CAIT). Effectively managing the carbon footprint of urban habitats and ensuring their resilience to climate change poses a challenge for India, especially with its growing urban population and an amplified demand for land. To mainstream climate change mitigation and adaptation measures into urban planning and policy frameworks, the Government of India launched NMSH in 2010 under the NAPCC. It outlines strategies for mitigating GHG emissions and building resilience in infrastructure assets and communities.

2022

LT LEDS

India launched its long-term low-emission strategy for development in COP 28. This strategy, in line with the commitments under the Paris Agreement, focused on, among other strategies, long-term sustainable urbanism by integrating climate action, mitigation strategies and climate risk adaptation within planning processes.

Mission LiFE

The government of India introduced Mission Life in COP26 to encourage and mainstream environmentally responsible behaviours in everyday life. Intending to conserve natural resources, the mission focused on channeling the efforts of individuals and communities into a global mass movement of living in harmony with nature. The mission had seven main focus areas - Saving energy, Saving water, Stopping single-use plastics, Sustainable food systems, Reducing waste, healthy lifestyles, and Reducing e-waste.

1.4 ClimateSmart Cities Assessment Framework (CSCAF)

In February 2019, the Ministry of Housing and Urban Affairs (MoHUA) launched the ClimateSmart Cities Assessment Framework (CSCAF) under the Smart Cities Mission (SCM). This pioneering city-level framework, encompassing climate-relevant parameters, including those outlined in the National Clean Air Programme, aims to promote climate-resilient and low-carbon development across urban India, aligning with the Sustainable Development Goals (SDGs) and India's Nationally Determined Contributions (NDCs) towards mitigating global climate change. CSCAF as a city-level framework encompasses five climate-relevant thematic areas and 28 progressive indicators offering a comprehensive monitoring and evaluation tool for cities to annually assess their performance.

Comprising 28 progressive indicators across five thematic areas (see figure 1), the ClimateSmart Cities Assessment Framework (CSCAF) offers a comprehensive monitoring framework for evaluating the progress made in alignment with the National Mission for Sustainable Habitat (NMSH) guidelines. CSCAF functions as a tool for cities to annually assess their performance and provides an incremental roadmap for adopting and implementing relevant climate actions. The outcomes of CSCAF are utilized to monitor progress and inform NMSH. Additionally, the framework facilitates the dissemination of context-specific best practices implemented by Indian cities and assesses the necessary skills and resources for scaling up these practices through its Secretariat at the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA).

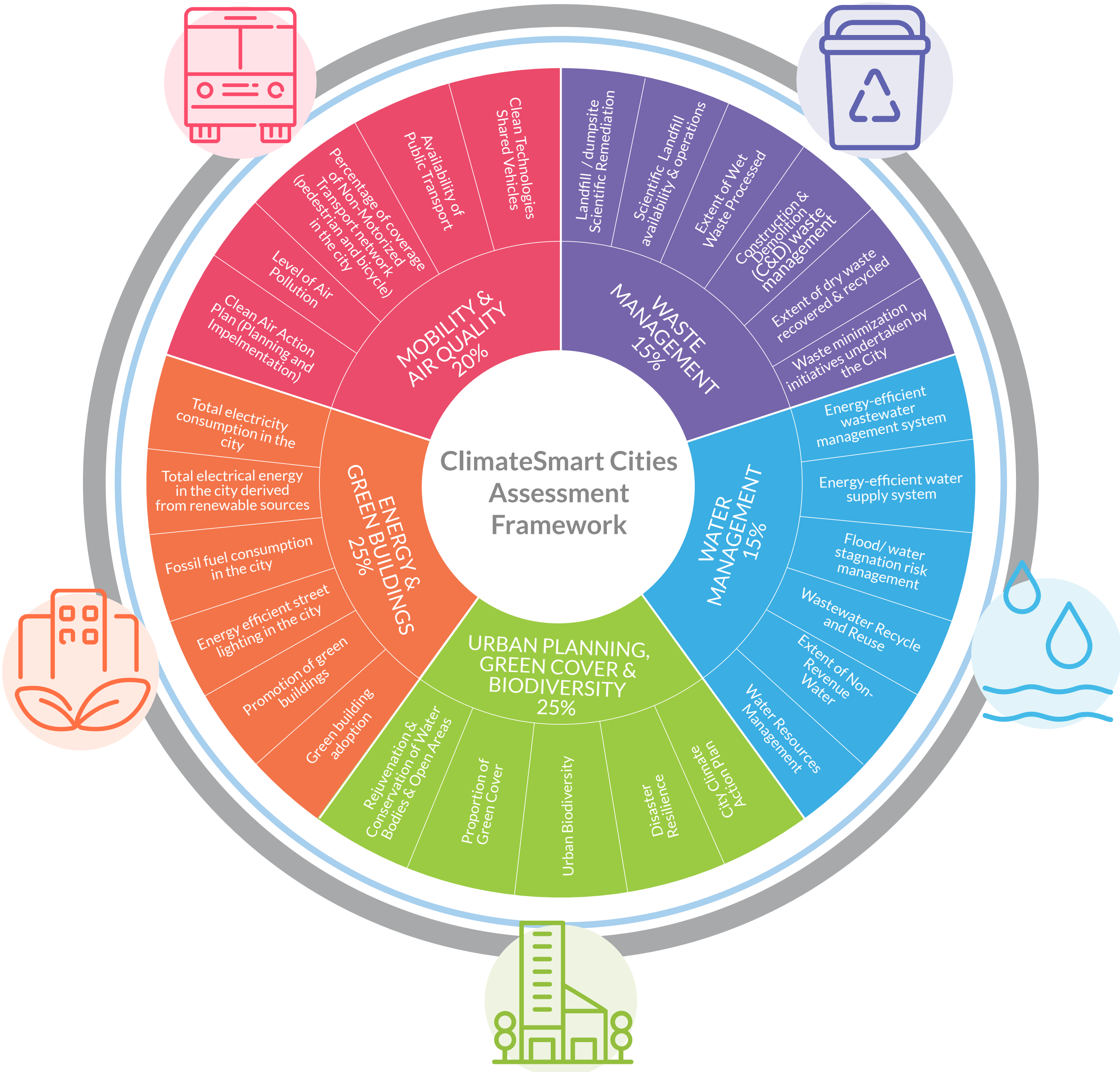


Figure 3: ClimateSmart Cities Assessment Framework

>5.5°C

Rise in Temperature by 2047

As per SSP 5-8.5 Scenario

3.5x

Increase in GHG Emissions by 2047

38%

Of the Population is Expected to be living at a high risk of flooding

02 Profile

Regional Context

City Profile

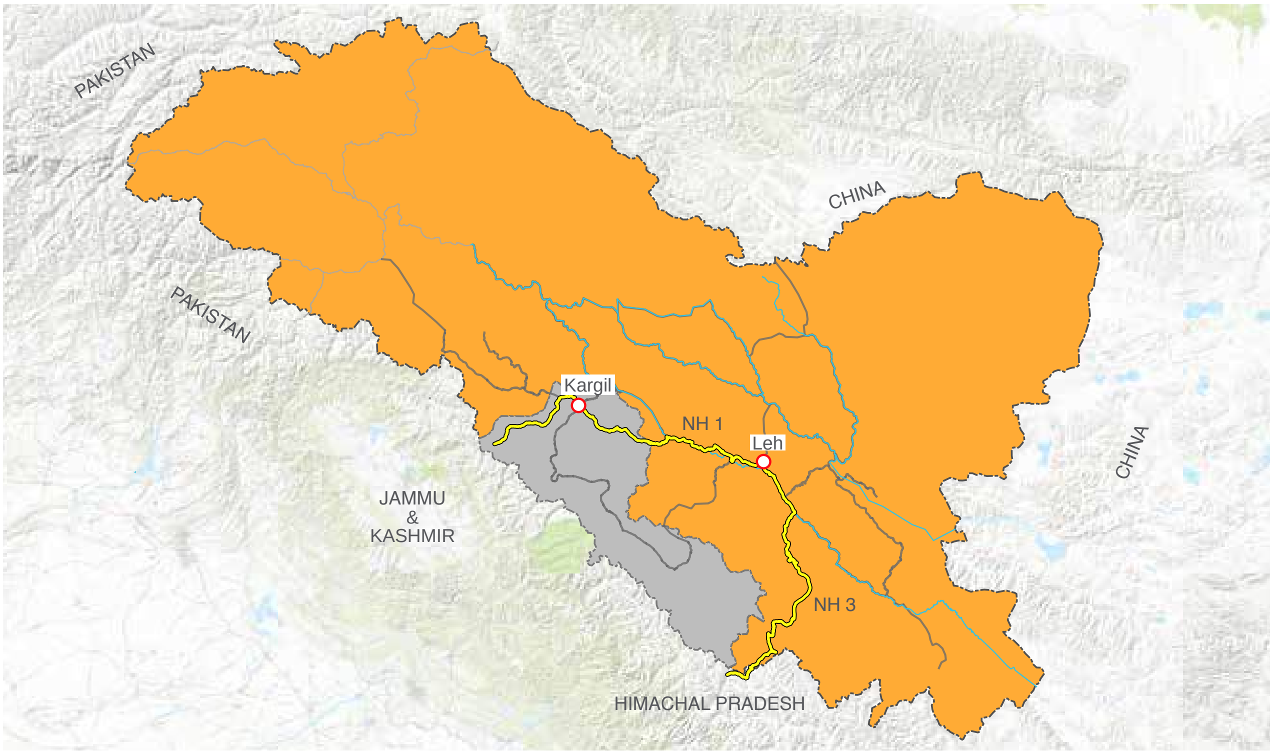
Climate Change Impact

2.1 Regional Context

Nestled between the Karakoram and Great Himalayan ranges and situated at an altitude of 3,000 meters (9,800 feet), Ladakh is one of the world's highest and most remote regions. Spanning an area of approximately 117,000 sqkm, Ladakh is, following its split from the state of Jammu and Kashmir in 2019, India's second-largest Union Territory. Ladakh is also one of the most sparsely populated regions in India, with a population of 2,74,289 per the 2011 census at an average density of about 4 persons/sqkm, significantly lower than the national average of 481 persons/sqkm. Most of this population is concentrated in and around the two main urban centers of Leh and Kargil.

The geographical location and altitude of the region result in an extremely cold and dry climate year-round. Winter temperatures in the region can drop to lows of -30°C (during January/February), while the summer highs in certain areas can go as high as 30°C, usually during July. Being on the leeward side of the Himalayan range, precipitation in the region is also meager, with an annual average of 80mm, with most of this happening in the form of snowfall during the winter months (between December and February). Consequently, most of the region's water needs are met through the Indus River and its tributary, and the Zanskar River, which is both fed through the glacial melt. The increased temperatures and the accelerated pace of glacial melt place these sources under threat. South-eastern Ladakh is home to Rupshu, an area of extensive brackish lakes situated at a uniform elevation of around 13,500 feet (4,100 meters) above sea level.

The region's sparse vegetation consists mainly of hardy shrubs, grasses, and small flowering plants that have evolved to withstand harsh conditions, including low precipitation, extreme temperature variations, and high altitudes. Vegetation is mainly found along river valleys, where water availability is relatively higher, and in sheltered areas protected from strong winds. Despite the arid landscape, Ladakh supports a surprising diversity of plant species, including several endemic and rare plant species adapted to the region's specific ecological niches. These include medicinal herbs, aromatic plants, and alpine flowers. Ladakh is also home to animal species like the elusive snow leopard, Tibetan wild ass (kiang), Himalayan marmot, and ibex. Birdlife is also abundant, with species such as the Tibetan sandgrouse, black-necked crane, and Himalayan griffon vulture. Ladakh's fragile biodiversity, however, faces threats from climate change, habitat degradation, overgrazing, and unsustainable development practices.



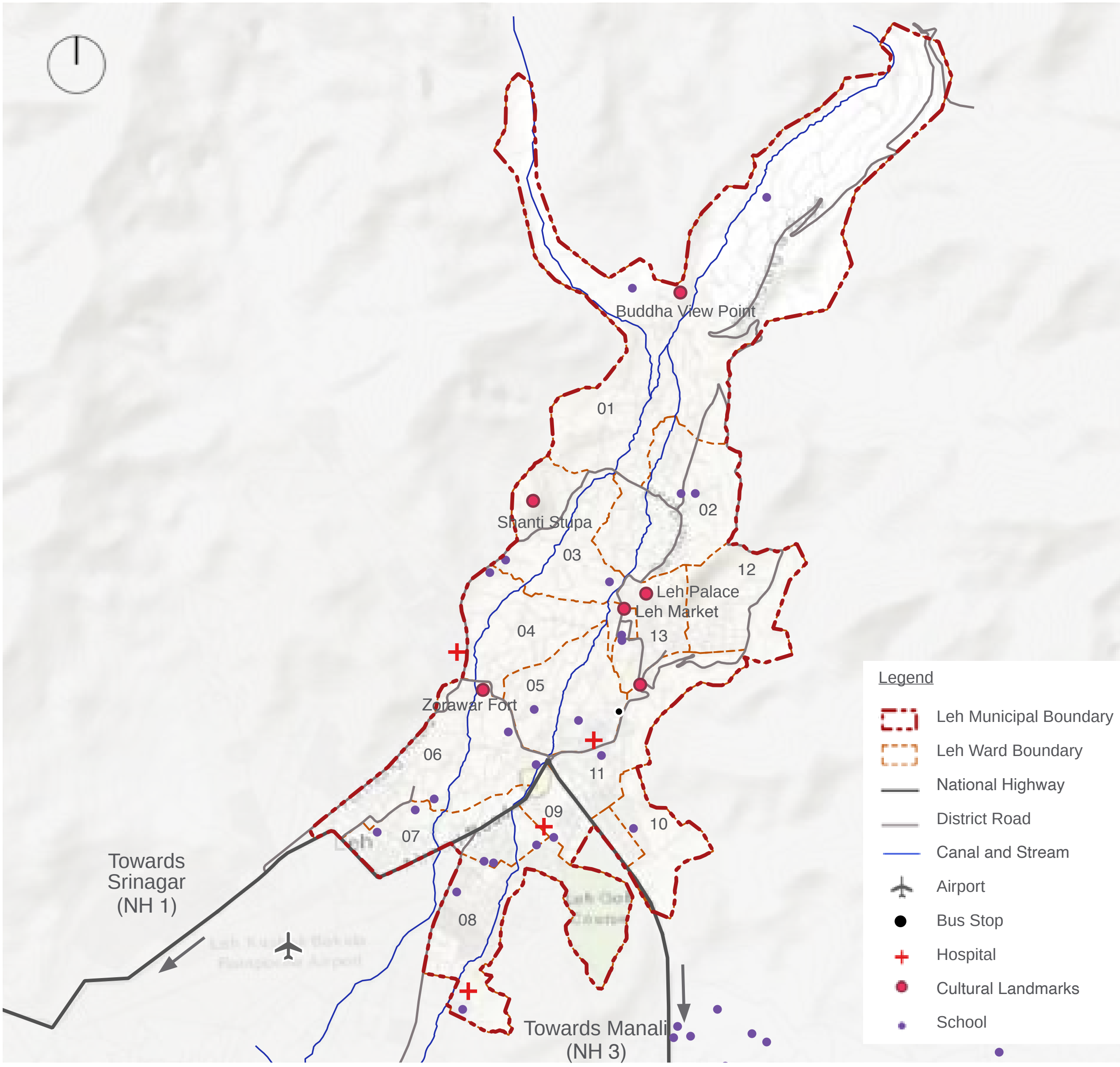
Map 2: Regional Context

2.2 City Profile

Leh is the capital and largest urban center of the Union Territory of Ladakh. The town is situated in the Indus Valley, covering an area of 17.43 sqkm and has a population of 30,870, per the 2011 census. The steep mountainous terrain around the town and the presence of the river contribute to giving Leh a linear growth trajectory. Leh also has a very undulating topography and steep inclines with elevation within the municipal area varying from 3200m to 4000m above sea level.

2.2.1 Connectivity

The only commercial airport in the union territory, Kushok Bakula Rimpochee Airport, is located just outside the boundary of the Leh. This airport has daily flights connecting Delhi, Jammu, Srinagar and Chandigarh. Ladakh is currently not connected to the rest of the country by a rail network, but plans are underway to construct the Bhanupali (Punjab) –Leh all-weather railway line. The Bhanupali-Bilaspur-Beri (63.10 km) new line project was approved by the Cabinet Committee in Economic Affairs (CCEA) in Feb 2008 at an anticipated cost of ₹6753.42 crore on a cost-sharing basis with the Government of Himachal Pradesh. NH1 (Baramulla-Srinagar-Kargil-Leh) and NH3 (Amritsar-Manali-Leh) are the principal access roads to Leh. Both these highways are closed during the winter months due to excessive snowfalls in the passes. Work is currently underway to ensure all-weather connectivity along both these highways. The work on the 14.15 km long Zoji la tunnel is expected to be completed by 2026, allowing for all-weather connectivity between Leh and Srinagar.



Map 3: City Profile

2.2.2 Urban Profile

Administratively, Leh is divided into 13 wards. The main urban centre of the town, with the main market is located in Ward 13, while Ward 1 is primarily rural in nature, with the land use being predominantly agricultural. Most of the historic settlements of Leh are encompassed within Ward 02, while Wards 03, 04, and 05 have most of the hotels and cater predominantly to tourists. The industries, which are almost exclusively MSMEs, are all located in Ward 07, while the rest of the wards are predominantly residential. New developments are mostly in Wards 09, 10, and 12, with Ward 12 catering mainly to migrant workers.

2.2.3 Demographic

Leh's 2011 population of 30,870 is projected to have increased to 42,352 in 2021. More than half of Leh's population (51.45%) live in wards 11 and 13. In contrast, ward 01, which is majorly agricultural, has a very low gross density of 1 pph. Similarly, ward 12 also has low densities due to the steep slopes and undulating terrains. Wards 03 and 04 have low gross density but relatively high residential densities as the presence of hotels/homestays in these wards has put a premium on the availability of residential land. The sex ratio within the town is very skewed, with 70% of the population being male. This is primarily due to the excessive employment-linked migration from the rural parts of the Union Territory. Leh has a literacy rate of 90% - much higher than the national average of 76.32. Based on current trends, the population of Leh is expected to increase to 64,217 by 2047 (Figure 4).

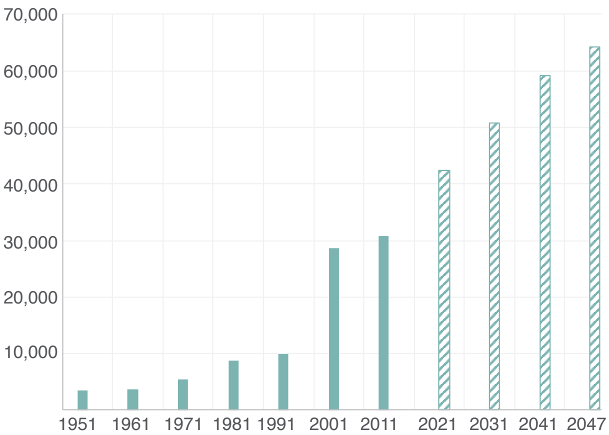
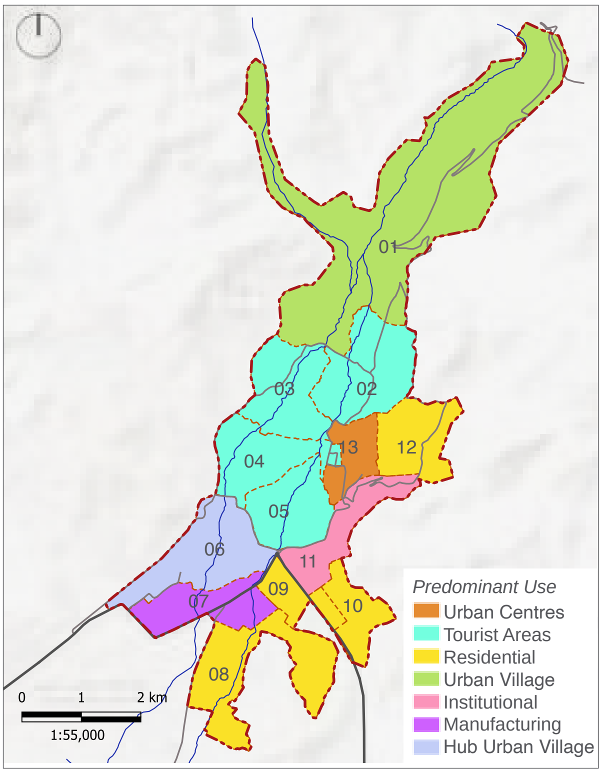


Figure 4: Population Growth in Leh

Source: Calculated as per data obtained from Census 2011

Recorded Population as per Census

Projected Population



Map 4: Urban Character

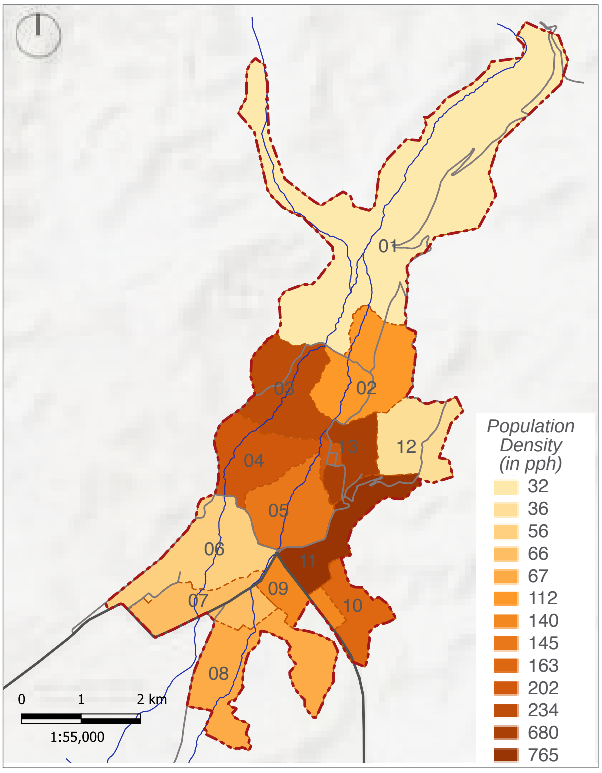
Source: Leh Vision Document

Legend

Leh Municipal Boundary — District Road

Leh Ward Boundary — Canal and Stream

National Highway



Map 5: Population Density

Source: Leh Vision Document

Legend

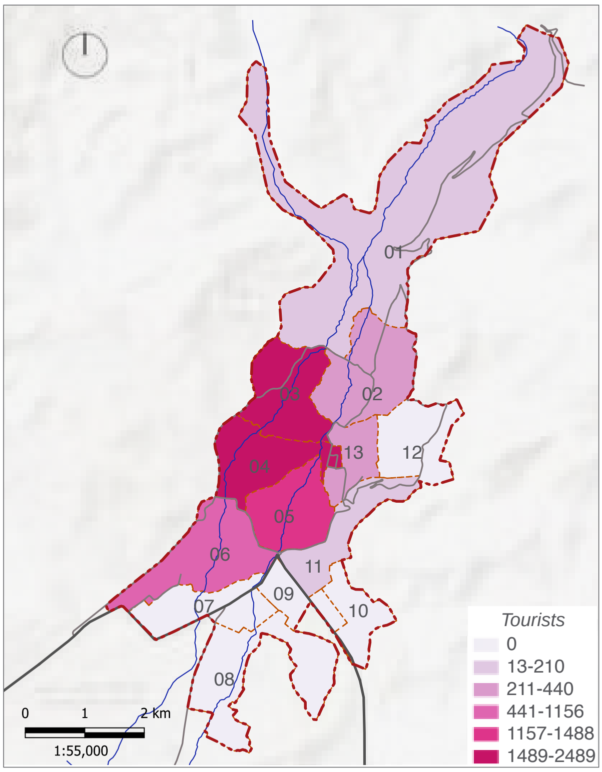
Leh Municipal Boundary — District Road

Leh Ward Boundary — Canal and Stream

National Highway

2.2.4 Economy and Tourism

Tourism is the main industry that supports the town, with more than 50% of the GDP dependent on the sector. The sector also attracts a significant portion of seasonal migrants (during the tourist season between April and September) from both the Ladakh district and the rest of India. The industry has seen a significant boom since 2010, especially with domestic tourists, with Leh receiving 5,31,996 tourists in 2018 - about 25 times the pre-2010 average (Figure 5). Consequently, more than half of the town is involved in service sector employment, with most of the rest (>40%) involved in agriculture-related employment.



Map 6: Ward-wise Tourist Distribution

Source: Leh Vision Document

Legend

Leh Municipal Boundary

Leh Ward Boundary

National Highway

District Road

Canal and Stream

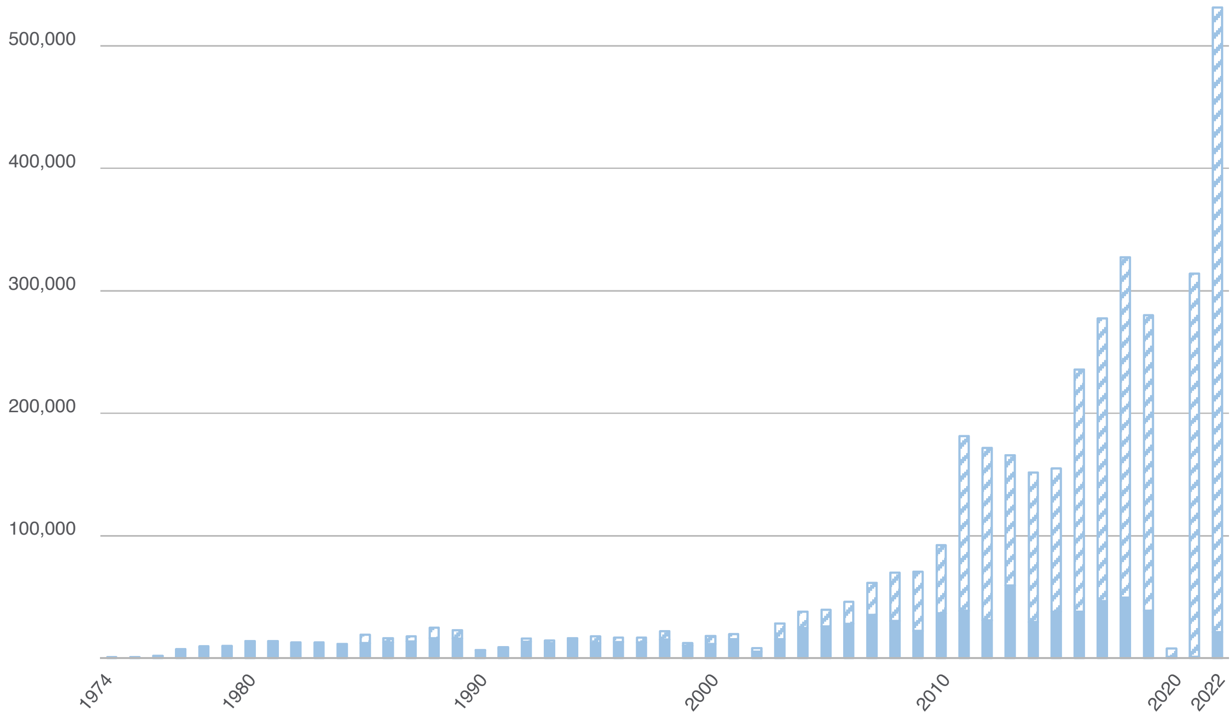


Figure 5: Growth of Tourism in Leh

Foreign Tourist Population

Domestic Tourist Population

PROFILE

2.2.5 Soil, Hydrology and Vegetation

The majority of the soils in Leh and Kargil districts are sandy to sandy loam in texture and medium to medium-high in organic matter with poor water holding capacity. The poor soil quality, combined with the cold desert climate, leads to the development of scarce but distinctive local vegetation. The loose soil and the lack of vegetation cause periodic soil erosion, further degrading the soil quality and its ability to support vegetation. The combination of these conditions leads to significant surface runoff of the already low percolation that Leh receives.

2.2.6 Climate

Like the rest of the Union territory, Leh also has a cold desert climate due to its high altitude and location on the leeward side of the Himalayan range. Winter temperatures are regularly well below freezing, with temperatures going below -20°C (Figure 6). Summer temperatures are comparatively higher and more pleasant, with averages around 20°C. The average daily highs, however, have risen by almost 2°C. However, the increase is not uniform with the summer temperatures having increased by more than 5°C in June while the winter temperatures have remained steady. This, combined with the high solar intensity, accentuates the need for cooling methods like air conditioning in the summer months, which were previously not required in the region.

Leh also has very low precipitation, with most of it (more than 50%) happening in the form of snowfall during the winter months. Barring a few years of extremely high precipitation (between 2009 and 2012), the average precipitation in Leh is around 125mm, with only ~54mm occurring as rainfall during the summer months between May and October (Figure 7).

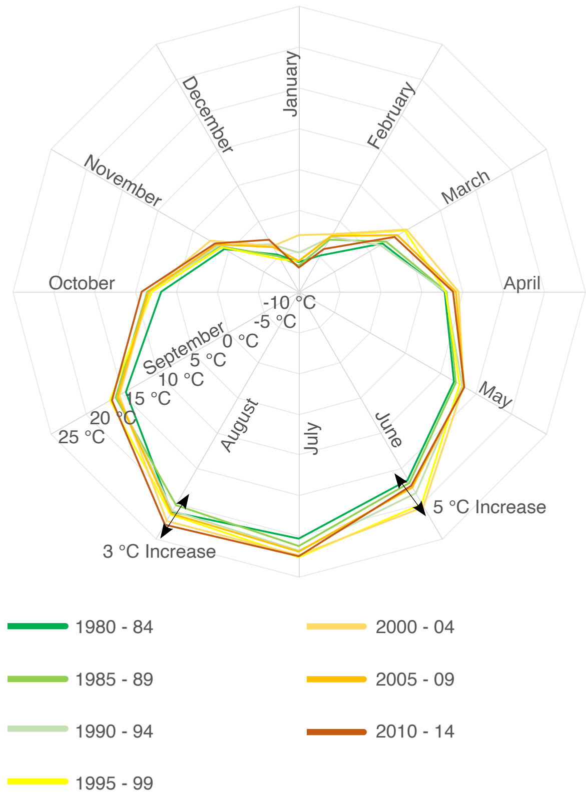


Figure 6: Temperature change in Leh 1980-2015

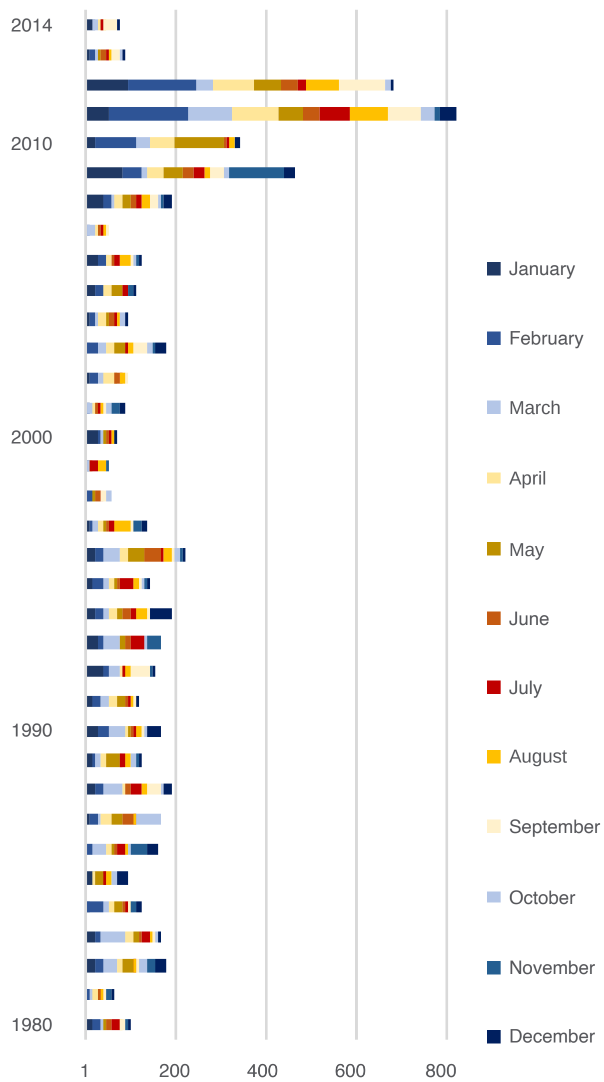


Figure 7: Rainfall Patterns in Leh 1980-2015

03 Methodology

Project Approach

Methodology for GHG inventory

Methodology for HVRA

3.1 Project Approach

This climate action plan looks at Leh as a climate victim, likely to be one of the worst impacted regions globally due to climate change. Aligning with the National Mission for Sustainable Habitat under the National Action Plan for Climate Change and the ClimateSmart Cities Assessment Framework developed by the National Institute of Urban Affairs, this City Climate Action Plan looks at minimising Leh's contribution to climate change by reducing its emissions and building resilience against the predicted impacts of climate change. The overall structure of the plan follows the four main stages as highlighted below:

Baseline Analysis	Based on the CSCAF framework, the baseline developed provides a comprehensive picture of disaster vulnerability and Green House Gas Emissions in Leh.
Future Projections	Future projections of both GHG Emissions and Climate Patterns to understand how Leh will be impacted by global weather patterns and climate change while also mapping Leh's projected contributions.
Problem Identification and Vision Setting	Discern areas where climate action is needed in Leh and establish a Vision and climate targets for the city.
Implementation Road Map	Developing structural and non-structural measures to meet the climate targets set by the city, including recommendation timelines, financial and responsibility mapping and MEL frameworks.

Through multiple rounds of stakeholder consultations, the plan incorporates the recommendations, feedback and on-ground knowledge of the residents, NGOs and government officials working in Leh. This Climate Action Plan has been developed for the Municipal area of 17.45 SqKm; however, the thrust areas and recommendations of this plan can be scaled up and expanded to include outgrowth areas of the expanded municipal area of Leh.

Hazards
Vulnerability
Risk Assessment
GHG Emissions

Data Collection & Literature Review

Extensive data, crucial for analysis and projections in the Action Plan development, was gathered from various departments and categorised into Hazards, Vulnerability, Risk Assessment, and Greenhouse Gas Emissions Inventory, utilising tabular and spatial formats to assess parameters and identify physical hotspots.

April 2023

May 2023

1st Stakeholder Consultation

The primary objective was to validate identified challenges and issues through interactive exposures, based on data collection and literature review.

June 2023

Field Survey & Data Analysis

Field visits to natural resources, followed by data analysis that involved translated collected data into city implications for climate change, overlaying timelines and hotspots on spatial maps and conducting rigorous calculations to comprehend climate change effects in different city areas within the Hazards, Vulnerability, and Risks Assessment (HVRA)

August 2023

Second Stakeholder Consultation

The goal was to collaboratively define the plan's vision, and pinpoint key focus areas with all relevant public, private and not-for-profit agencies. Recommendations were captured on maps, tables, digital forms and through focused group discussions. It helped in creating a robust inventory of contextually relevant and locally integrated solutions.

September 2023

Target Setting

Based on the 2nd stakeholder consultation, target setting was done with the support of esteemed dignitaries and officials

October 2023

Development of Recommendations

As per the estimated targets, recommendations were formulated in the shape of policies, projects and institutional frameworks

November 2023

Final Report Development

The last round of stakeholder consultations aimed to secure approval from city officials for the proposed actions outlined in the plan

December 2023

Review and Feedback

The conclusive report has been presented to the city and GCoM for review and their feedback.

Final Submission to city

3.2 Methodology for GHG inventory

A GreenHouse Gas (GHG) inventory seeks to accurately quantify and track the amount of greenhouse gases emitted (source) and removed (sink) by cities. The inventory provides a comprehensive picture of the sources of emissions, including the type and quantity of greenhouse gases emitted. This allows cities to establish baselines and identify and prioritise mitigation actions for reducing emissions in line with various national and international targets. Additionally, a uniform system of establishing GHG inventories enables centralised reporting by cities allowing for scrutinisation of actions, comparisons of efficiencies and ensuring the achievement of national/sub-national targets.

Emissions generated by various activities in cities are broadly divided into three categories based on where the emissions occur. These are as follows:

Scope 01	GHG emissions from sources located within the city boundary.
Scope 02	GHG emissions occur as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.
Scope 03	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

For this Climate Action Plan, only Scope 1 and Scope 2 emissions of activities occurring within the 17 sqkm municipal boundaries of Leh are considered. The inventory developed will account for emissions of the seven gases currently required for most national GHG inventory reporting under the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3). The development of the baseline will consider various activities categorised under Stationary Energy, Transportation and Waste as per below.

Emission Sources Considered for Leh Climate Action Plan

Sector	Emission source	Scope 01	Scope 02
Stationary Energy	Residential buildings	Scope 01	Scope 02
	Commercial buildings	Scope 01	Scope 02
	Institutional buildings	Scope 01	Scope 02
	Manufacturing industries and construction	Scope 01	Scope 02
	Energy industries	Scope 01	Scope 02
	Agriculture, forestry, and fishing activities	Scope 01	Scope 02
	Non-specified sources (Municipal services, charging stations)	Scope 01	Scope 02
	Fugitive emissions from mining, processing, storage, and transportation of coal	Scope 01	Scope 02 (not applicable)
	Fugitive emissions from oil and natural gas systems	Scope 01	Scope 02 (not applicable)
Transportation	On-road transportation – Petrol, Diesel, CNG, LPG & PNG	Scope 01	Scope 02 (not applicable)
	Railways	Scope 01	Scope 02 (not applicable)
	Water-borne transportation	Scope 01	Scope 02 (not applicable)
	Aviation	Scope 01	Scope 02 (not applicable)
	Off-road transportation	Scope 01	Scope 02 (not applicable)
Waste	Solid Waste Disposal	Scope 01	Scope 02 (not applicable)
	Biological treatment of waste	Scope 01	Scope 02 (not applicable)
	Incineration & open burning	Scope 01	Scope 02 (not applicable)
	Waste water treatment & discharge	Scope 01	Scope 02 (not applicable)

3.3 Methodology for Climate Risk Assessment

Climate risk and vulnerability assessments (CRVAs) are critical to a city's climate risk management strategy and form the basis for developing adaptation actions and climate action plans. Climate risk assessments identify the likelihood of future climate hazards and their potential impacts on cities and their communities, contributing to overall climate risk. The assessment for this Climate Action Plan focuses on the impacts of short-term risks posed by extreme weather events like heatwaves or cloud bursts and the long-term slow-impact effects of climate change. The climate risk analysis has been conducted in the following four stages:

Hazard assessment

Hazard assessment identifies the probability, intensity and timescale of critical current and future climate hazards in a city and where these hazards are prevalent / are likely to manifest (2050 and beyond where possible).

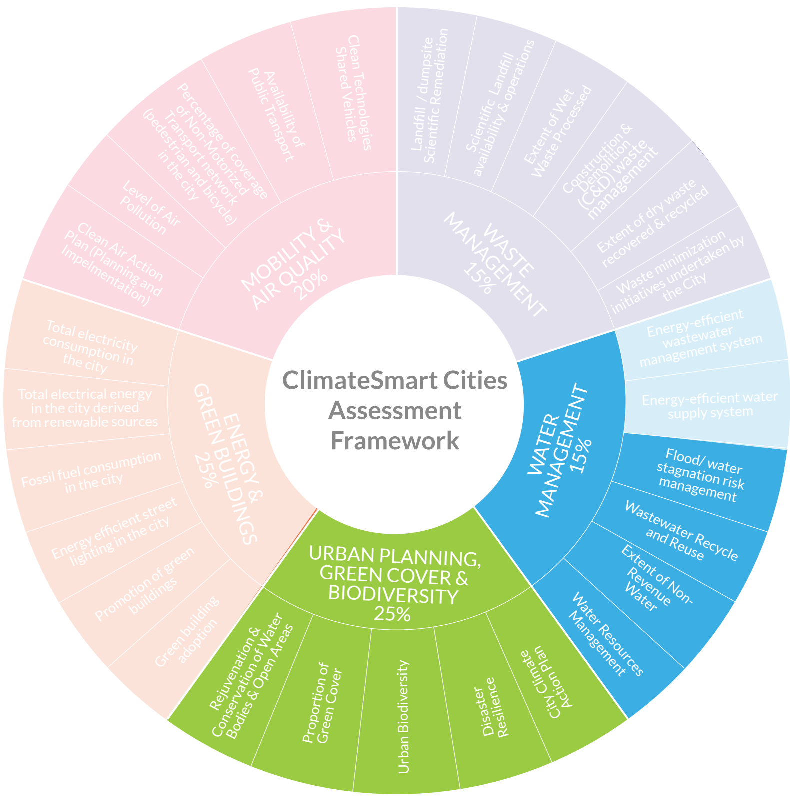
Impact assessment

Impact assessment looks at the potential impacts of those climate hazard events on people, assets, services, and the natural environment.

Risk assessment

Risk assessment determines the critical risks based on the interplay of hazards and impacts.

The CSCAF framework has been used as a baseline for this analysis; two themes and nine indicators from the framework focus on understanding the past climate and disaster risks that the city has faced. The hazards identified have been spatialised, and multi-criteria decision analysis using the Analytical Hierarchy process was used to understand current and future risks. This understanding, in combination with climate modelling, temperature, and rainfall projections, has been used to develop a comprehensive profile of future climate risks for the city.



04 Baseline

Baseline Analysis

Summary GHG Inventory

Summary HVRA

Baseline Analysis

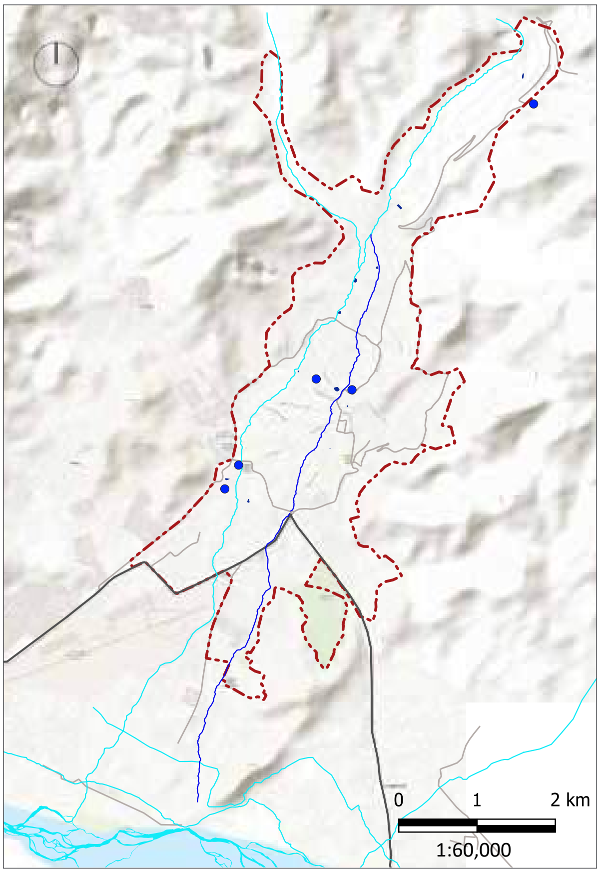
THEME 01: Urban Planning, Green Cover & Biodiversity

Rejuvenation And Conservation Of Water Bodies

Proportion of Green Cover

Urban Biodiversity

Disaster Resilience



Map 7: Waterbodies within Leh City

Source: Leh MC

Legend

Springs	District Road
Canal	Ponds
Leh Stream	Indus River
National Highway	Leh Municipal Boundary

4.1.1 : Rejuvenation & Conservation Of Water Bodies

The primary waterbody in Leh is the Leh Stream, which is fed from springwater from the upper reaches of ward 01 and glacial melt from the various peaks of the Ladakh range. The length of the stream is fairly short at 18km and drains into the Indus River shortly after exiting the municipal area of Leh. The Stream has an associated drain, which was developed to carry overflow water during times of higher-than-normal rainfall or snowmelt. Both of these waterbodies have had their carrying capacities reduced due to encroachment, particularly in the more developed wards.

Leh also has various natural springs that tap into the region's groundwater networks and have historically served as a steady source of fresh water to the residents, particularly during the winters when the surface water systems freeze due to negative temperatures. Once numbered over 17, there are currently only four active springs, with the rest being lost due to the over-exploitation of the groundwater and the apathy shown towards their management. There are also 12 small ponds within the municipal area, most of which are in various states of disuse.

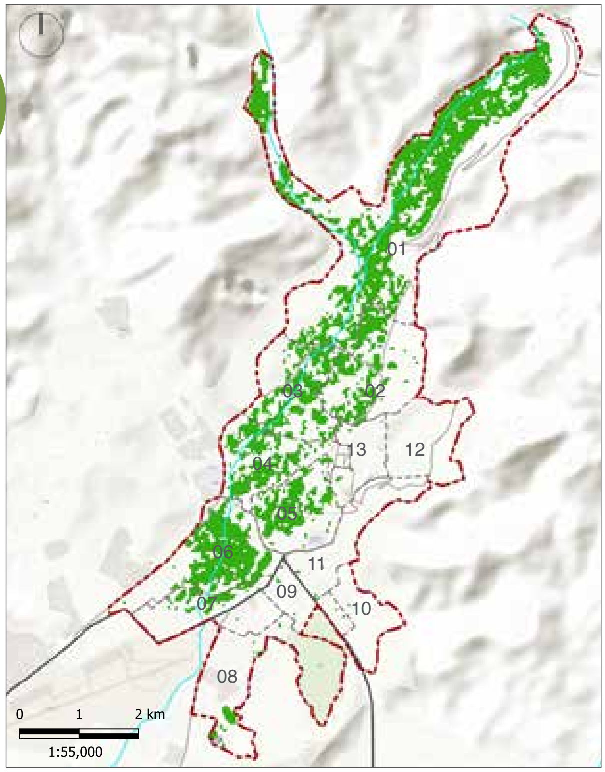
Figure 8: Karzu Zing Pond

4.1.2 : Proportion of Green Cover

Leh being the cold desert with dry summer and the extremely cold winters, the green cover in the town is very seasonal. Further, due to the poor soil quality, only a few local tree species are supported in the region. Most of the green spaces in Leh are not designated as such and are usually in the form of temporary greens like agricultural lands, and private and vacant lots. Of the 5.5 sqkm (2011) to 4.73 sqkm (2021) green spaces observed through satellite imagery, only 0.836 sqkm has been officially designated as green spaces, either as urban forest, wetland or scrub land. Most of the designated green spaces are in Ward 01(74.61%) and Ward 06 (15.04%).

Wards 01 to 05 have a large proportion of green cover observed through satellite imagery but not designated as such per the Land Use plan. These are mostly agricultural lands in ward 01, while in wards 02 to 05, they are private greens in either vacant lots or in large properties. These spaces, particularly in wards 02, 03 and 04, are under increased threat due to tourism-linked development pressures. Newer developed areas (09 to 12) do not have any notable green spaces due to the nature of development in these wards.

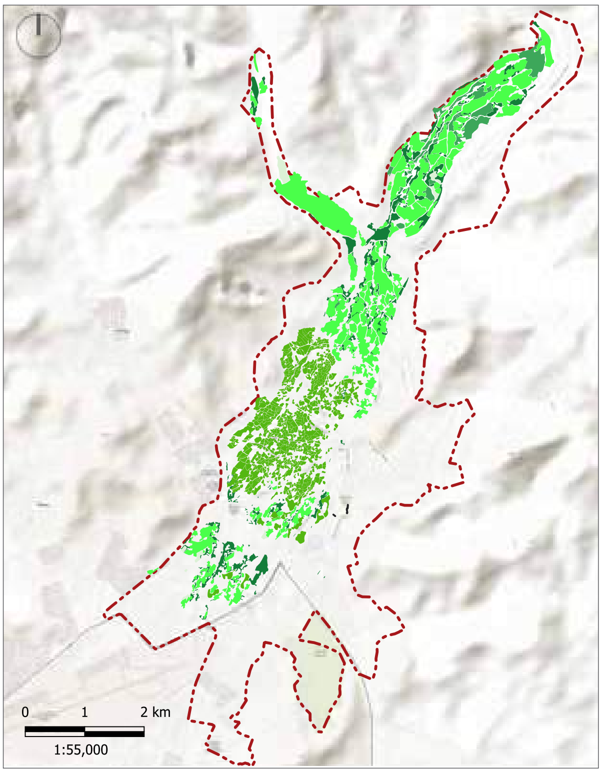
Name	Area of Forest Cover (ha)	Percentage of Ward Area
WARD 1	62.41	10.56%
WARD 2	2.67	4.75%
WARD 4	1.54	1.66%
WARD 5	3.42	6.40%
WARD 6	12.58	9.23%
WARD 7	0.84	0.74%
WARD 11	0.06	0.07%
WARD 13	0.12	0.28%



Map 8: Green cover from Satellite Imagery -2021

Legend

Stream
District Road
National Highway
Green Cover
Leh Municipal Boundary
Ward Boundary



Map 9: Green Cover demarcated in LU Plan

Source: Leh MC

Legend

Leh Municipal Boundary
Farm
Forest
Meadow
Shrub
Agriculture

BASELINE

Figure 9: Black-necked crane

Figure 10: Snow Leopard

Figure 11: Apricot Trees

4.1.3 : Urban Biodiversity

Ladakh's climate and geography have given rise to a distinct ecosystem characterised by flora and fauna uniquely evolved to suit the harsh local conditions. The region hosts over 300 species of birds, many of which are migratory and travel seasonally during the summer months to escape the heat of the Indian mainland. A few of these rare and endangered species that breed in high-altitude regions are black-necked Cranes and Bar-headed Geese, where the Black-necked crane is designated as the state bird of Ladakh. Ladakh is also home to unique mammal species, including the elusive snow leopard, the Tibetan antelope, and the Himalayan ibex. Many highly valued medicinal herbs and shrubs are also endemic to the Ladakh region. This unique and fragile ecosystem is, however, under threat of habitat loss due to developmental pressures exerted by the tourism sector.

Leh has recently established a Biodiversity Management Committee, which, in partnership with the GB Pant Institute, is preparing the People's Biodiversity Register (PBR). This is being done with the active involvement of the local community and nature enthusiasts, as per the guidance of the PBR guidelines 2013. PBR is a comprehensive database recording peoples' traditional knowledge and insight into the status, uses, history, ongoing changes and forces driving these changes on the biological diversity resources of their localities.

Types of Tree	Scientific Name
Apple tree	Malus Domestica
White Mulberry	Morus Alba
Apricot Tree	Prunus armeniaca
Himalayan Poplar	Populus Ciliata
Binsa (White Willow)	Salix Alba

Figure 12: Local Trees of Leh

4.1.4 : Disaster Resilience

The Leh District Disaster Management Plan identifies potential disasters to which Leh is vulnerable, including Cloudbursts and Flood, Glacial Lake Outburst Flood (GLOF), Earthquakes, Landslides, Road Accidents, Fire, Snow Avalanche, Drought, Stampede, Cold Wave, Chemical Hazards, and Insect Pest and Diseases. However, cloudbursts and their associated floods have been responsible for almost all the loss of life and property over the last two decades (Figure 13). The risks associated with flooding are only likely to increase with the increased pace of glacial melt, which is Leh's primary source of surface water.

To understand the risks associated with this flooding (from the multiple causes), a multi-criteria decision-making process has been employed to identify areas at risk of flooding. Six parameters, Drainage Density, Elevation, Slope, Topographical Wetness Index, Land Use Land Cover, and Normalised Difference Vegetation Index, were used to assess the flood risk (Maps in Annexure). More than half of the town area (50.32%) is at medium risk of flooding, with a further 25% being either at high or very high risk of flooding. Most of the very high risk and high risk areas are in wards 04 to 08 - 91% and 62%, respectively.

Name of Calamity	Human Lives lost	Cattle lost	House/ Hut damaged	Crop loss (Hect-are)
Flood/ Landslide	0	0	0	0
Avalanche	0	0	0	0
Fire	0	0	0	0
Cyclone	0	0	0	0
Pest Attack	0	0	0	0
Hailstorm	0	0	0	0
Drought	0	0	0	0
Earthquake	0	0	0	0
Cold Wave	0	0	0	0
Cloud Burst	**234**	**391**	**511**	**660**
Lightning	0	0	0	0
Total	234	391	511	660

Figure 13: Disaster Deaths and Damages 2000-2023

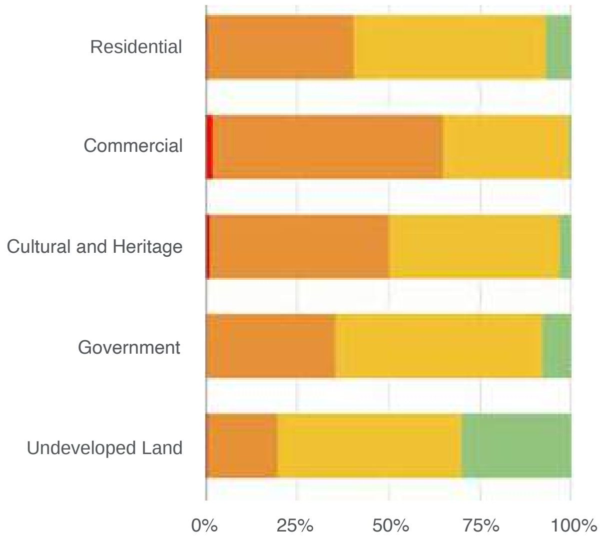


Figure 14: Landuse wise Flood Risk Profile

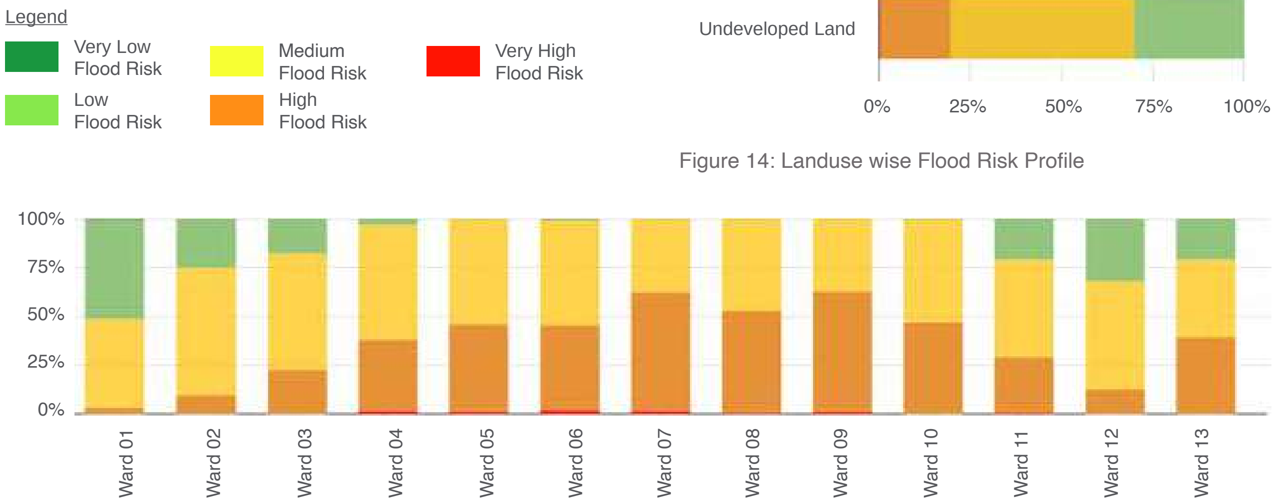
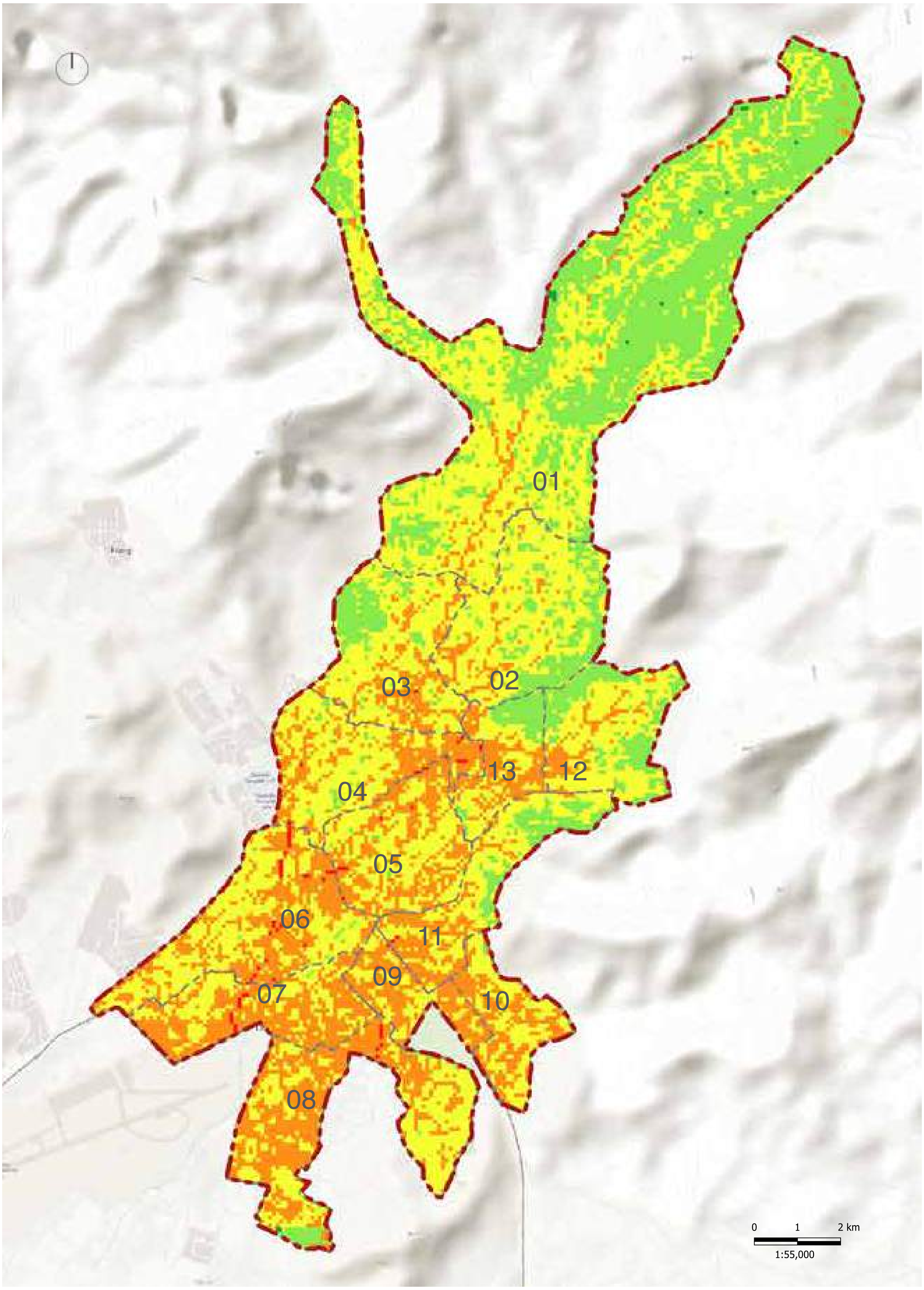


Figure 15: Ward wise Flood Risk Profile



Map 10: Flood Risk Assessment

Legend

Very Low Flood Risk
Low Flood Risk
Medium Flood Risk
High Flood Risk
Very High Flood Risk
Leh Municipal Boundary
Ward Boundary

Baseline Analysis

THEME 02: Energy & Green Buildings

Electricity Consumption

Energy Derived from Renewable Sources

Fossil Fuel Consumption

Energy Efficient Street Lighting

Promotion and Adoption of Green Buildings

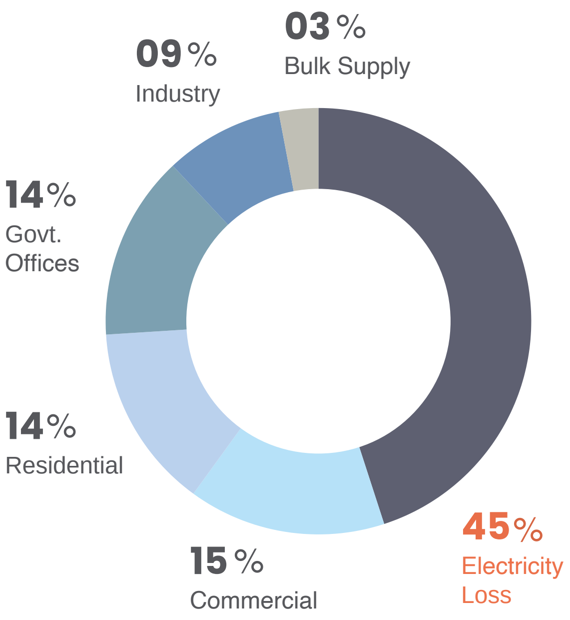


Figure 16: Electricity Consumption of city in 2021-22

4.2.1 : Electricity Consumption

Leh City consumes about 59887.48 MWh of electricity annually, with a per capita consumption level of 1,387 kWh. While this is significantly lower than the global average consumption of 3000kwh, the most significant component (45%) of this is the energy being lost due to theft or transmission losses. Government buildings and services use a large proportion (14%) of the electricity consumed, while other major users, residential, commercial and industrial users consume 14%, 15% and 9% respectively.

Given the cold climate in Leh, the winter energy consumption is much higher in most use categories. Government buildings utilise almost five times the energy used in summer during the winter months. Winter utilisation accounts for nearly 80% of the energy used by government buildings. This difference is smaller in other users, with residences using 1.4 times and commercial buildings utilising 1.2 times more energy.

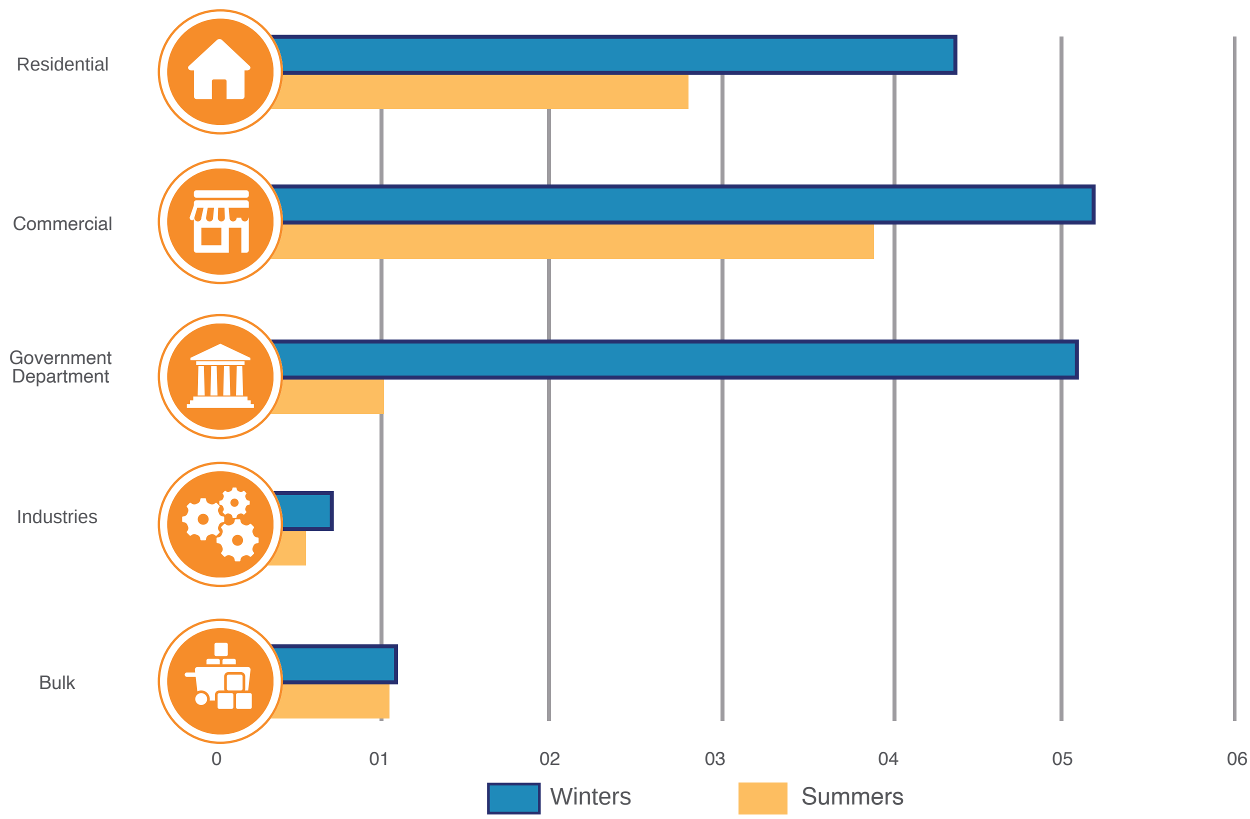


Figure 17: Seasonal electricity consumption of Leh city (kWh in millions)

4.2.2 : Energy Derived from Renewable Sources

Leh and the whole Ladakh region have a very high solar potential of 1,858 kWh/kWp with more than 300 clear and sunny days across the year. This extends to the winter months, with an average monthly potential higher than 125 kWh/kWp. The union government has sought to leverage this potential by proposing to develop India's largest solar field of 13GW in the Ladakh region. Yet, despite these advantages, Leh has not tapped into this abundant renewable energy source. Currently, only 0.8% of Leh's energy needs are met through renewables with an installed off-grid capacity of 200Kw.

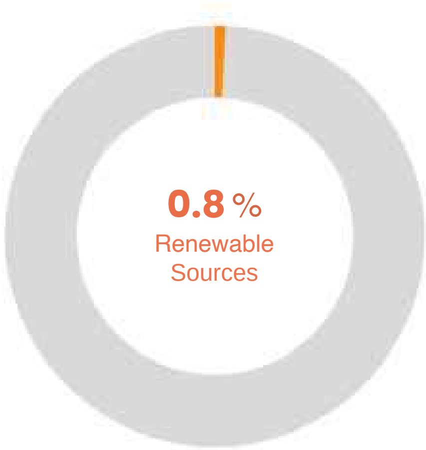


Figure 18: Electricity Generation by Source

4.2.3 : Fossil Fuel Consumption

Leh consumed 16,767Kl of Diesel, 12,391Kl of Petrol, 2,979Kl of Kerosene, and 595Kl of LPG in 2022. While the usage of petrol is primarily for vehicles, diesel is used for heating (19%), generators (33%) and for vehicles (48%). Most diesel vehicles are used for tourism purposes in Leh. The lack of winter tourism and the difficulties in using diesel vehicles in winter drastically reduce the winter utilisation of diesel in Leh. Diesel usage also accounts for 55% of the total GHG emissions from fossil fuels in the city, with petrol, kerosene and LPG contributing to 34%, 10% and 1%, respectively.

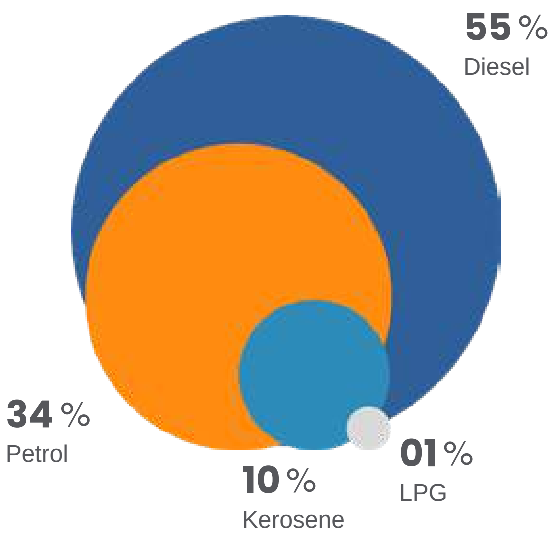


Figure 19: Share of GHG emissions from various fossil fuels consumed in 2021-22

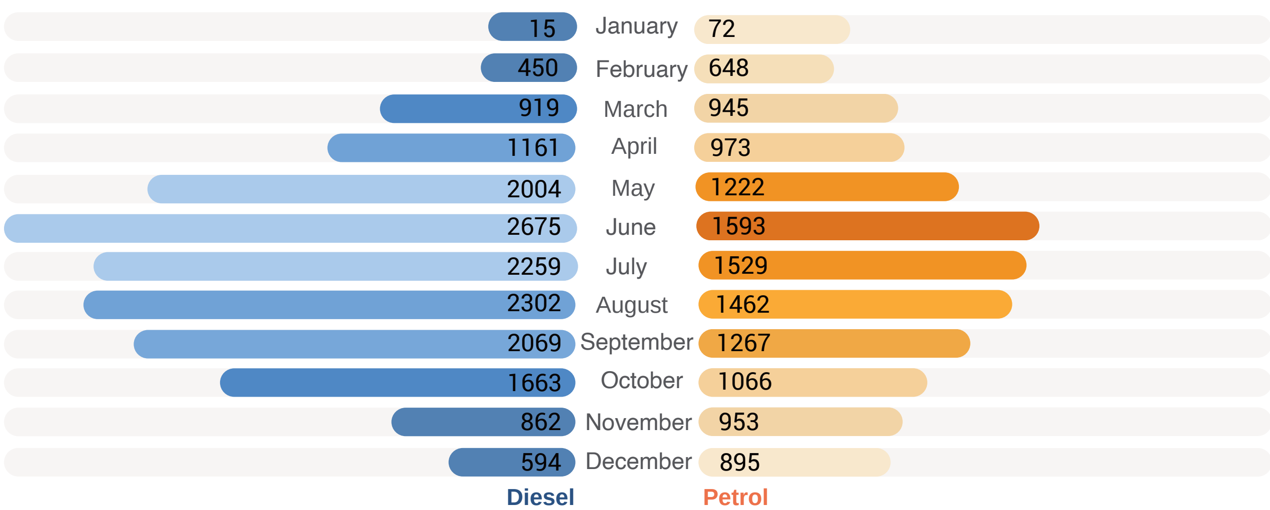
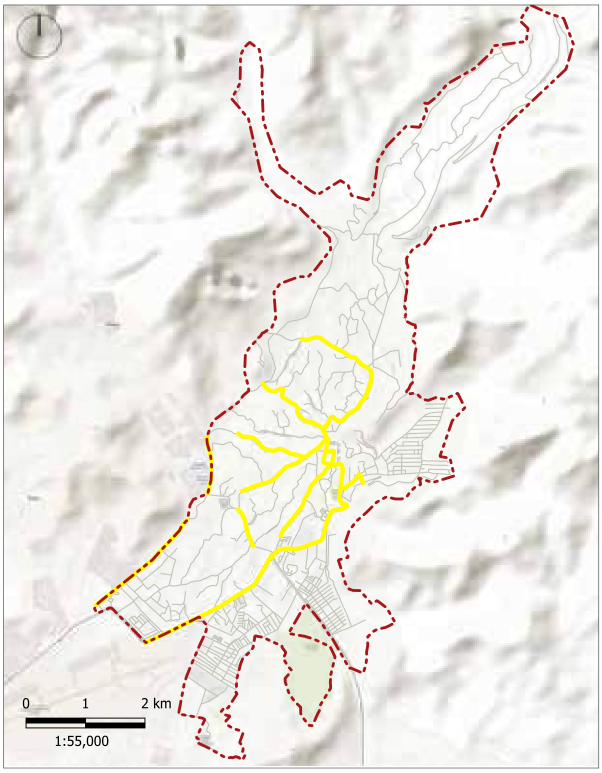


Figure 20: Monthly Variation in Fuel Consumption (Kl)



Map 11: Existing Streetlight Coverage

Source: Leh Vision Document

Legend

Roads

Streetlights

Leh Municipal Boundary

4.2.4 : Energy Efficient Street Lighting

Leh has 5373 streetlights within the municipal area, the majority of which are LED lights. However, only 6% of these streetlights are solar-powered. Streetlight coverage within the municipality is quite low, with just 14.64% of the mapped streets equipped with streetlights. This leaves 85.36% of the mapped streets, along with all unmapped secondary roads, in need of additional street lighting to effectively function as safe spaces, particularly for pedestrians and NMT users. Leh would hence require a total of 7382 street lights to be installed to achieve 100% coverage.

Figure 21: Druk Padma Karpo School (Rancho School)

4.2.5 : Promotion and Adoption of Green Buildings

Leh's unique climate poses very different requirements for green buildings compared to other parts of India. In the context of Leh, energy efficiency should focus on the promotion and adoption of buildings that are effective in trapping heat and minimising energy utilisation in winter months. This would involve utilising construction methods such as Trombe walls, building orientations, and materials such as double glazing, etc. While there has been some uptake in these techniques and technologies, particularly among the commercial units that have seen the financial benefits of energy-saving measures, there are no mandates, policies, or standards to support the wide-scale adoption of these measures.

Baseline Analysis

THEME 03: Mobility & Air Quality

Clean Technologies Vehicles

Availability of Public Transport

Coverage Of Non-Motorised Transportion

Air Pollution and Clean Air Action Plan

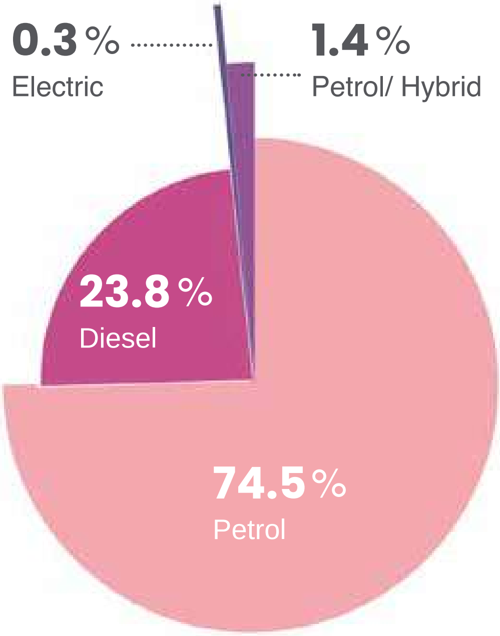


Figure 22: Registration of vehicles by type (2018-2022)

4.3.1 : Clean Technologies Vehicles

Electric vehicle adoption is in its infancy in Leh. Only 38 (0.28%) out of the 13,653 vehicles registered over the last five years (2018-22) were EVs. In 2022, Leh introduced an EV policy that offers subsidies for 101 EV vehicles yearly, much lower than the average annual registration of ~4000. For successful transitions, Leh will need to take a more proactive approach toward achieving critical mass. A significant hindrance to achieving this is the lack of confidence in the performance of EVs in Leh's mountainous terrains. The Motor Garages department has successfully conducted trials using EVs for various UT administrative functions. Leh has also undertaken trials of hydrogen-powered public buses since 2023.

4.3.2 : Availability of Public Transport

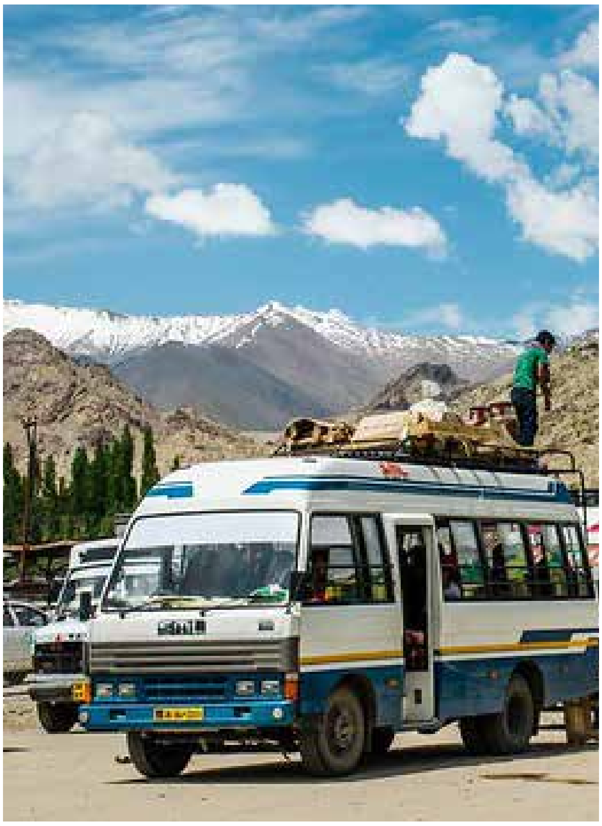
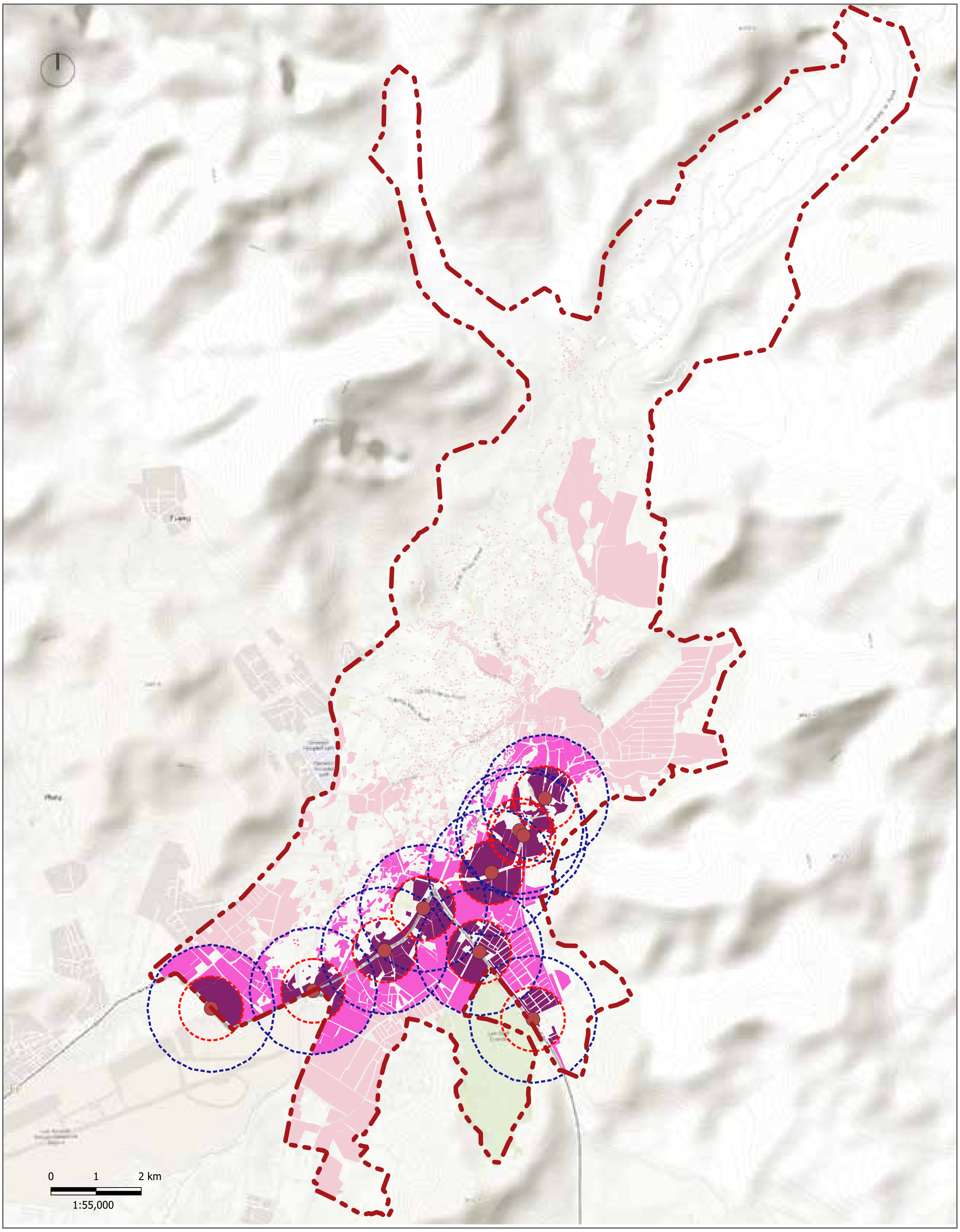


Figure 23: Sanjukta Basu

Leh has minimal public transportation availability. Its coverage only extends to 10.25%% of the residential area and 22.30% of the population. Consequently, more than 32,905 people in Leh do not have a public transit point within walking distance from their residence. Similarly, of the 518 registered hotels in Leh, only four are within walking distance of public transport routes. As a result of this poor public transport system, a mere 12% of trips within the town utilise buses as the primary mode of transportation, and Leh currently has almost 340 cars per thousand people, much higher than India's average of 59 per thousand people.

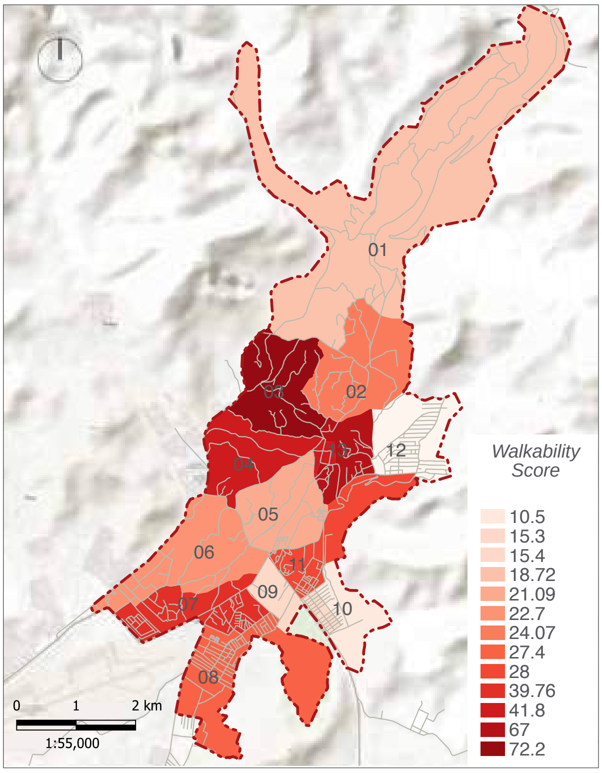
Given the nature of development in Leh, only minibuses and other similar smaller vehicles can operate, particularly in the narrower stretches in the town's center. Leh currently has 66 minibuses, and while this is above the standards required for a town of this size, these buses operate only on intra-city routes. There is a need to expand the service to within Leh town.



Map 12: Coverage of Public Transportation

Legend

- Leh Municipal Boundary
- Existing Bus Stops
- 250m Bus Stop Buffer
- 500m Bus Stop Buffer
- Developed area under 250m accessibility
- Developed area under 500m accessibility
- Developed area



Map 13: Ward Walkability Score

Source: LEDeG

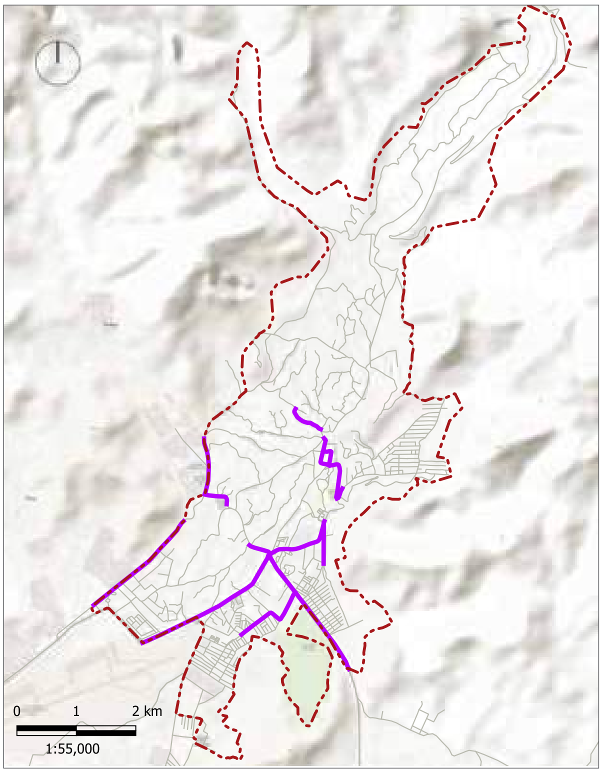
Legend

Roads

Leh Municipal Boundary

4.3.3 : Coverage of Non-Motorised Transportion

Leh town has a very low walkability score of 31. Pedestrian infrastructure is lacking across the town, with the few wards achieving a high score (like 03 and 13) only achieving it due to special pedestrian-only tourist streets like Changspa Road and the Main Market Road. Of the 129.716km of roads in Leh, only 10.93km (8.43%) have footpaths. The availability of NMT infrastructure also affects the ability to access public transport systems where they exist.



Map 14: Existing Footpath

Source: Leh Vision Document

Legend

Roads

Leh Municipal Boundary

Footpath

4.3.4 : Air Pollution and Clean Air Action Plan

Leh has only recently begun monitoring air quality data. While air quality trends and seasonal variations/spikes will be harder to gauge at this point, most measured parameters are within permissible limits. However, given the high proportion of car ownership and the extensive dependency on trucking to supply Leh with the necessities from the plains (including vegetables and grains), Leh will only be able to maintain air quality standards through a comprehensive Clean Air Action Plan, which it currently lacks.

Baseline Analysis

THEME 04: Water Management

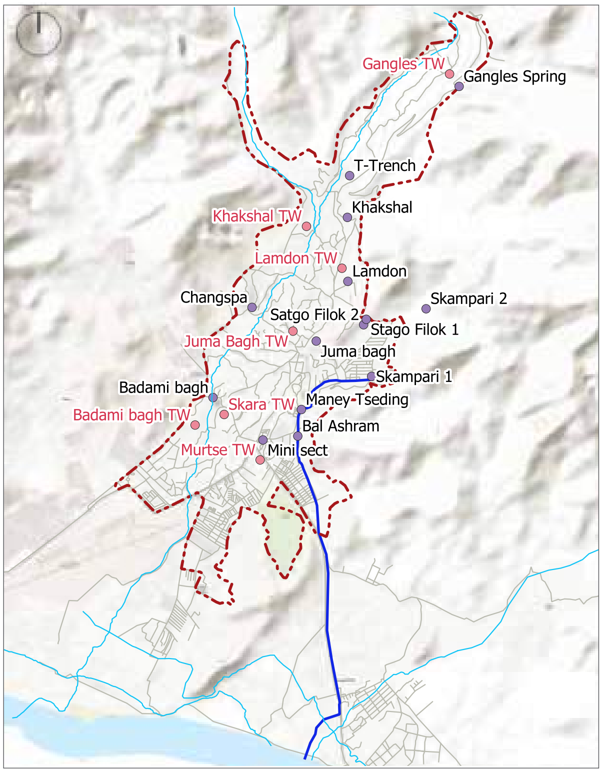
Water Resources Management

Extent of Non-Revenue Water (NRW)

Water Recycle & Reuse

Flood And Water Stagnation Risk Management

Energy Efficient Water Supply And Waste Water Management System



Map 15: Water Supply Infrastructure

Legend

- Service Resevoir
- Tubewell
- Leh Stream
- Water Supply Line
- Road Network
- Leh Municipal Boundary

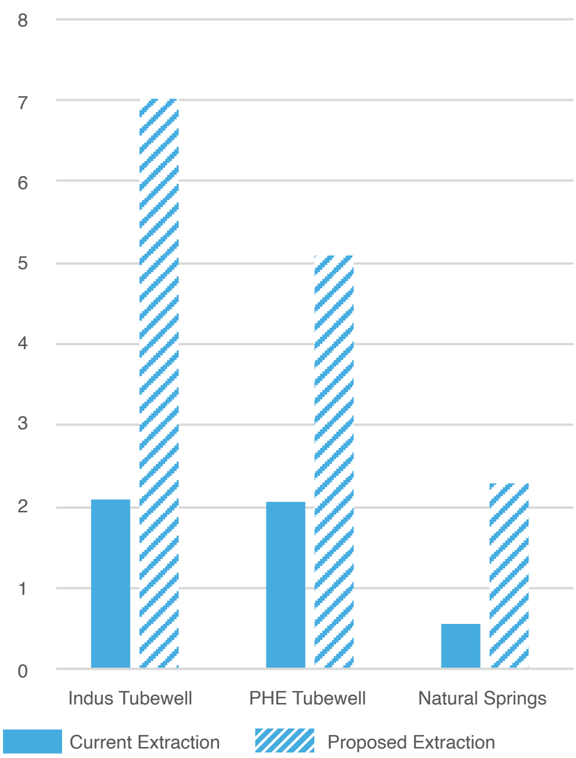


Figure 24: Water Extraction from various sources

4.4.1 : Water Resources Management

Leh currently supplies 4.53 million litres per day (MLD) extracted from three main sources - The Indus Tubewell (44.7%), Tubewells within the Municipal area operated by the PHE department (43.6%) and natural springs (11.7%). This supply, however, falls short of the daily demand of 8.8 MLD in the summer months (accounting for tourists and migrants). The supply network also covers only 56% of the town area, this shortfall is met through private borewells. The 6.7 MLD extracted from within the Leh municipal area put tremendous pressure on the groundwater table in the region, which is only recharged seasonally through glacial melt.

Leh has already proposed to develop a 24 X 7 water supply system with 100% coverage within the municipal area. The proposal, targeted for the year 2053, estimates a summer demand of 14.4 MLD and a winter demand of 6 MLD. The proposal looks to more than triple the extraction from all the aforementioned sources, adding further pressure on the already strained groundwater resources. Concurrently, the administration has also developed the Draft Ladakh Water Security Policy, Strategy & Action Plan, which sets the baseline for and proposes actions for sustainable and equitable usage of the scarce water resources in the region.

Water Source	Proposed Extraction Capacity (MLD)
Gyalung Spring	1.1
Gangles TW	0.6
T-Trench Spring	1.2
Murtsey Tubewell	0.7
Khakshal Tubewell	0.5
Tukcha Tubewell	0.6
Jumabagh Tubewell	0.5
Lamdon Tubewell	0.4
Sankar Tubewell	0.4
Badami Bagh Tubewell	0.3
Skara Tubewell	0.4
Gompa Tubewell	0.4
Indus Riverbank Tubewell	7

4.4.2 : Extent of Non-Revenue Water (NRW)

Leh's Non-Revenue Water (NRW) levels at 96.50% of the water supplied are significantly above the maximum permissible threshold of 20%. While a large portion of this can be attributed to the region's lack of water metering and pricing systems, 36% is due to transmission and destitution (T&D) losses. If T&D losses remain at similar levels after the 24x7 water supply plan implementation, Leh will face water losses of more than 5MLD (which is more than the total current supply). Leh's lack of water pricing has also led to the overutilisation of water resources. While the estimated demand (as per CHPEEO standards) is 8.8 MLD, Leh currently uses almost 10 MLD of water (estimated based on used water being discharged to STP).

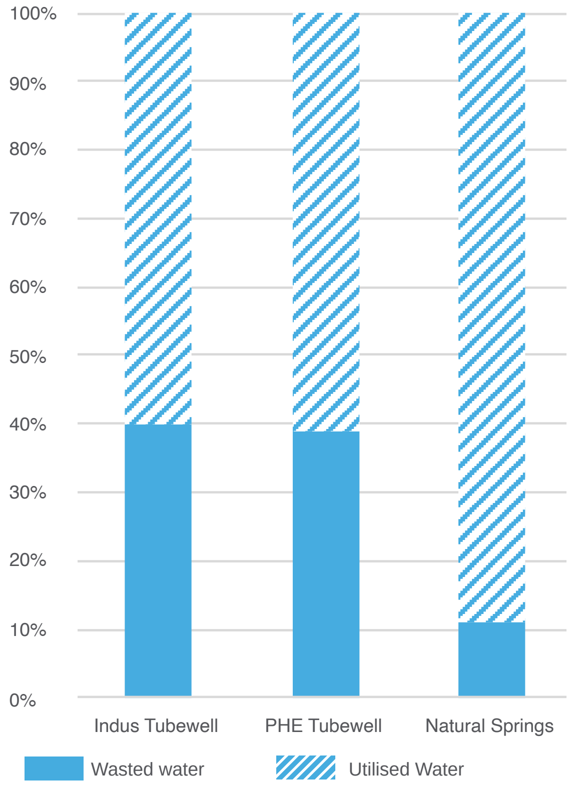
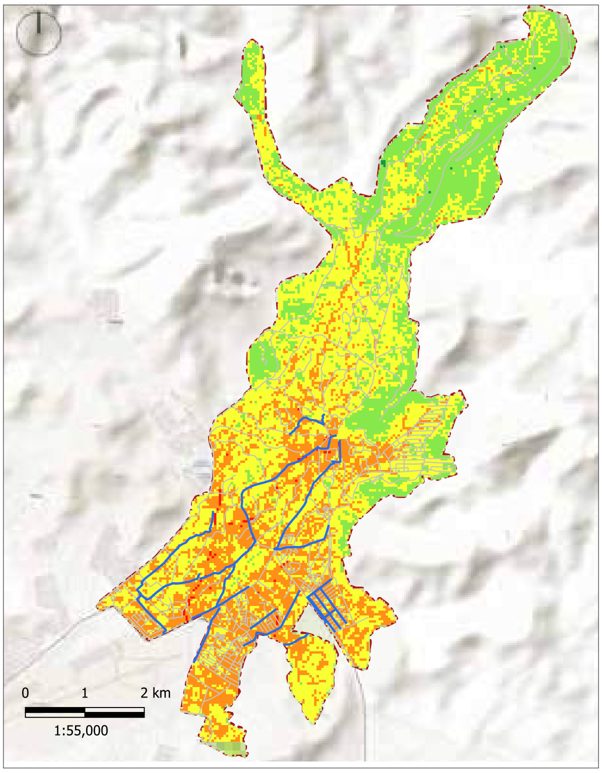


Figure 25: Percentage of water wastage from various sources

4.4.3 : Water Recycle & Reuse

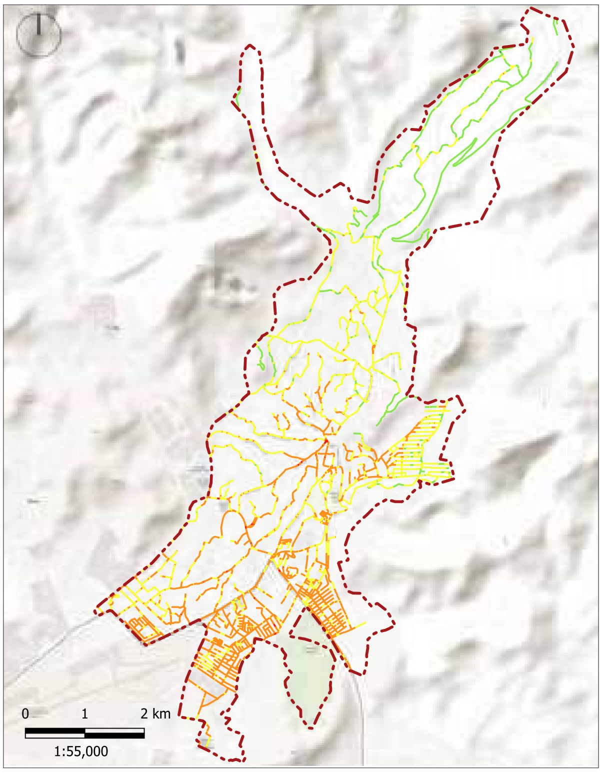
Leh currently generates 7.97 MLD of used water. However, the capacity of the current STP in Leh is only 3MLD; hence, the system is overwhelmed beyond capacity, particularly during the summer months when usage increases due to tourist activities. The overload in the STP capacity would also indicate that the treated water does not meet the required standards; however, it is impossible to determine this definitively as extensive tests of STP outflow have not been performed. Leh has recently constructed an additional STP to bridge this gap; however, this STP has yet to be operationalised. There is also a further proposal to develop an STP outside the municipal limits for a capacity of 13MLD in line with the draft masterplan at a cost of ₹123.61. Despite the paucity of freshwater in Leh, the town does not actively reuse treated water. The outflow from the STP is currently discharged into the Leh Canal, which drains into the Indus River. While there is a proposal to utilise some of the treated water for landscaping purposes within government building complexes, it is not operationalised yet and would utilise only a small portion of the treated water that would be discharged from the STPs. The current STP designs also cannot treat water beyond the levels required for most reuse functions apart from landscaping and cultivating non-consumable crops.



Map 16: Flood Risk Management

Legend

- Leh Municipal Boundary
- Road Network
- Stormwater Drainage
- Very Low Flood Risk
- Low Flood Risk
- Medium Flood Risk
- High Flood Risk
- Very High Flood Risk



Map 17: Flood Risk Profile of Roads

Legend

- Very Low Risk
- Low Risk
- Medium Risk
- High Risk
- Very High Risk
- Leh Municipal Boundary

4.4.4 : Flood And Water Stagnation Risk Management

As highlighted in 4.1.4, Leh is at high risk of cloud bursts and its associated flooding. While the terrain prevents water stagnation, considerable areas in the town are at high risk of flooding. Due to the loose nature of the soil in slopes around Leh, the floods are usually accompanied by mudslides and significant deposits of silt and sand across the town. This was most recently seen in the floods in 2023 when there were significant soil deposits in and around the main market area.

Leh has 15.89 km of stormwater drains covering 12.25% of the total roads. Of the very high and high risk regions in Leh, only 19.74% of the roads are covered by stormwater drains. The table below shows the extent of roads under various flood risk categories and the corresponding stormwater lengths.

Risk Type	Length (in km)
Very High	0.79
High	48.13
Medium	54.83
Low	19.41
Very Low	0.04

4.4.5 : Energy Efficient Water Supply And Waste Water Management System

Currently, the energy used by the water supply and wastewater system contributes only 0.2% of total electricity consumption. However, this low value is partly because a significant portion of the consumption happens outside the municipal area - like near the Indus tubewell, which supplies a significant portion of the water to Leh. Both the 24x7 water supply plan and the Draft Ladakh Water Security Policy, Strategy & Action Plan do not focus on system-level energy efficiency. In the long term, this could lead to long-term hurdles, especially with the proposed increase in water supply and sewage treatment facilities.

Baseline Analysis

THEME 05: Waste Management

Waste Minimisation Initiatives

Extent Of Dry Waste Recovered And Recycled

Extent Of Wet Waste Processed

Scientific Landfill Availability & Operations

Landfill/ Dumpsite Scientific Remediation

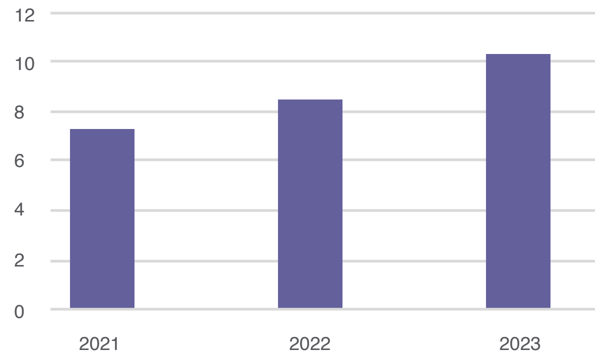


Figure 26: Daily Average Waste Generated (TPD)

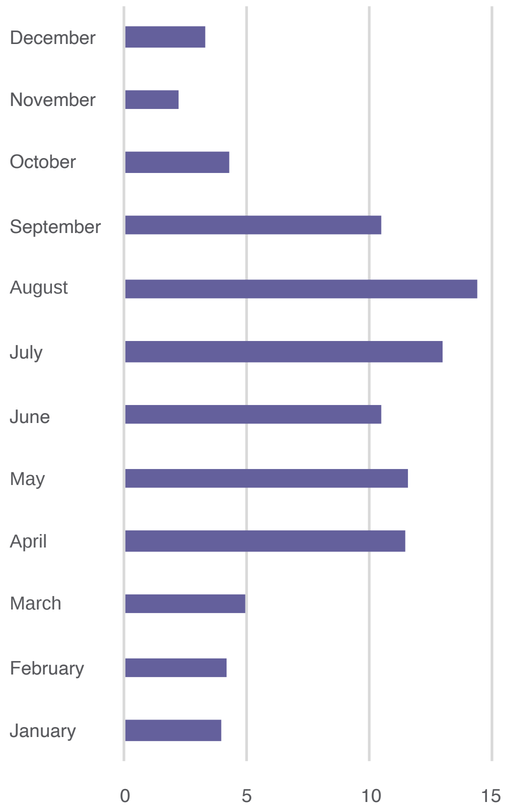


Figure 27: Average Monthly Waste Generated (TPD)

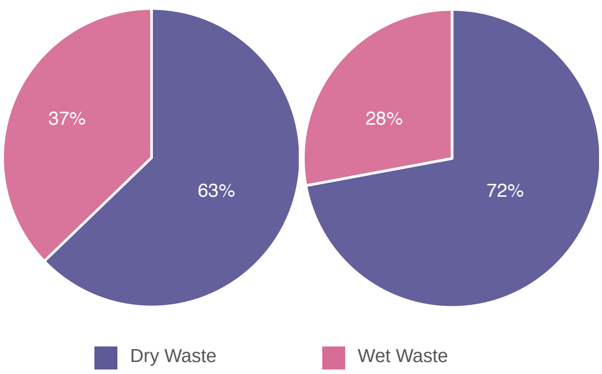


Figure 28: Waste categorisation (a) 2021 (b) 2023

4.5.1 : Waste Minimisation Initiatives

The average daily solid waste generated in Leh is 8.75TPD. However, there is significant variation in the daily averages for summer and winter. The daily waste generated in the summer months is three to five times higher than the daily generation in winter. Even peak waste generated during the summer is much lower than the capacity of the 30TPD waste processing plant, which has operated since 2021.

There has not been any focused effort to minimise the waste generated in Leh. Consequently, the average daily waste generated increased from 7.26TPD in 2021 to 8.41TPD in 2022 and 10.26TPD in 2023. While the current peak consumption is within CPHEEO norms, if current trends continue, leh would exceed the norms of per capita waste generation of 0.6kg.

4.5.2 : Extent Of Dry Waste Recovered And Recycled

The proportion of dry waste as a percentage of the daily waste collected in Leh is high at around 60% (winter) to 75% (summer). The increase in daily average waste generation between 2021 and 2023 (as noted in indicator 4.5.1) is exclusively high due to the increase in solid waste generation. Yet, despite this, Leh can segregate and collect all of its dry waste due to effective door-to-door collection systems. The collected dry waste, particularly the high-value plastics, is sold to private waste management companies, which truck these for processing in the plains. While this might be an effective system, the volume of waste is low, and an increase in dry waste at current rates might necessitate the development of local treatment infrastructure.

4.5.3 : Construction & Demolition (C&D) Waste Management

Leh currently does not have any policy or system in place to handle C&D waste. Although there is no recorded data, the scale of development in Leh over the last decade indicates that the volume of C&D waste generated is very high. This waste is currently being dumped in open/vacant lots, particularly around Ward 12.

4.5.4 : Extent Of Wet Waste Processed

Wet waste constitutes only 30% of the daily waste generated in Leh. The volume of wet waste generated has remained constant over the past three years despite the increase in overall waste generated. A significant portion of the wet waste generated currently (91%) goes towards animal feed, with very little being composted. Leh has made efforts to convert wet waste into manure to help farmers improve the poor quality of Leh's soil. Initial tests have yielded highly positive results with higher crop yields where this manure has been utilised.

4.5.5 : Availability of Scientific landfill and Landfill remediation

The former landfill site in the Bomgard locality in Ward 10 of Leh, whose operations have been closed for the past few years, has been successfully remediated, with the land now being declared fit for alternative uses. Parallely, Leh has also developed a scientific landfill site approximate to the 30 TPD waste processing site at Skampari. Although the site is complete, the final approvals are pending before commencing operations.

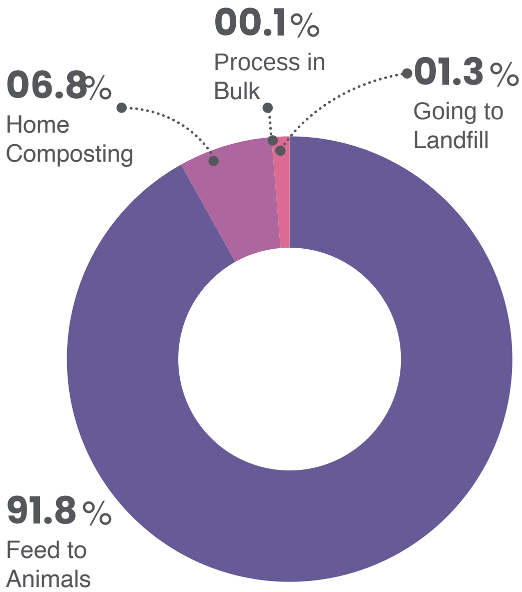
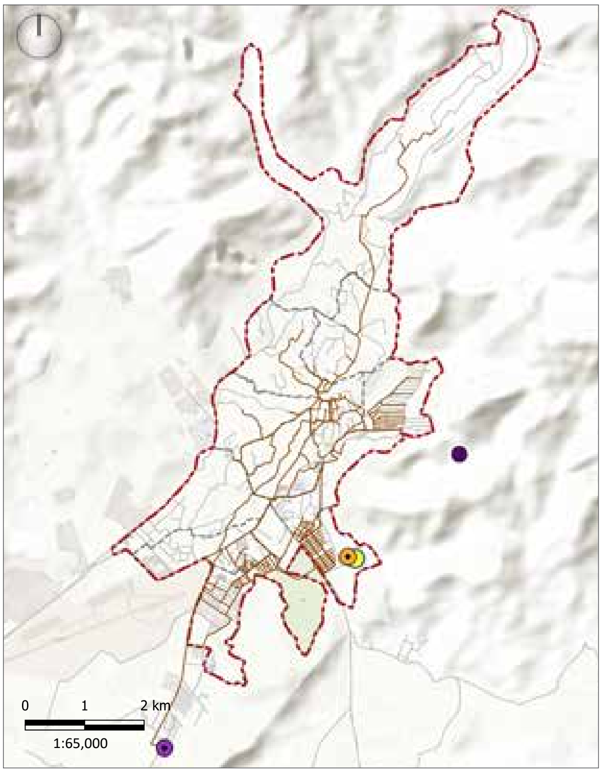


Figure 29: Percentage of processed wet waste



Map 18: Waste Management Infrastructure

Legend

- Fecal Sludge Treatment Plant
- Old Landfill Site
- Leh Municipal Boundary
- Landfill Site
- Sewerage Treatment Plant
- Roads
- Sewerage Network

4.6 Impact of Climate Change

Understanding the impacts of climate change on local weather patterns will be critical to developing strategies for enhancing Leh's resilience against future risks. The Leh CAP employs multi-model climate high-resolution projections for the baseline period (1980-2015), which were validated against the observed climate variables from the local meteorological station in Leh. The temperature projections from the GFDL ESM4 model are found to be in good agreement with the observations; however, no single model investigated in the present study reasonably simulates precipitation, and therefore, a multi-model ensemble is used for precipitation projections.

Two climate scenarios under the Shared Socioeconomic Pathways, defined in the IPCC Sixth Assessment Report on Climate Change in 2021, are considered for this modelling. These scenarios SSP2-4.5 (Middle of the road) and SSP 5-8.5 (Fossil-Fueled Development) are defined as:

SSP 2-4.5	The "Middle of the road" or medium pathway extrapolates the past and current global development into the future. Income trends in different countries are diverging significantly. There is a certain cooperation between states, but it is barely expanded. Global population growth is moderate, leveling off in the second half of the century. Environmental systems are facing a certain degradation. This can be understood as an update to scenario RCP4.5.
SSP 5-8.5	Fossil-fueled Development. Global markets are increasingly integrated, leading to innovations and technological progress. The social and economic development, however, is based on an intensified exploitation of fossil fuel resources with a high percentage of coal and an energy-intensive lifestyle worldwide. The world economy is growing and local environmental problems such as air pollution are being tackled successfully. It can be understood as an update of the CMIP5 scenario RCP8.5, now combined with socioeconomic reasons.

As per the IPCC, the projected temperature changes under the SSP 2 -4.5 scenario is 2.0°C by 2060 and 2.7°C (with an estimated range between 2.1°C – 3.5°C) by 2100, while it is 2.4°C by 2060 and 4.4°C (with an estimated range between 3.3°C – 5.7°C) by 2100 in the SSP 5 - 8.5 scenario. Estimated temperature and precipitation changes in Leh till 2100 have been projected in the following sections.

4.6.1 Temperature

Under the GFDL CM2.1, Leh is projected to witness an average decadal temperature increase of 4.67°C by 2100 under the SSP 5-8.5 scenario and 2.77°C under the SSP 2-4.5 scenario. By 2050, the temperature is expected to increase by 1.38°C and 1.09°C in the two models, respectively. The projected increase in temperature till 2100 is shown in the graphs below. Peak temperatures, however, are projected to go up by 8°C to 10°C during the summer months, while the winter maximums are expected to increase by around 5°C. The winter minimums are also expected to increase by almost 10°C in both scenarios.

The monthly breakdown of the projected temperature increase provides a much more telling picture of the effect on Leh. While the increase in temperature in the early summer months is relatively modest in both the models by 2050 and 2100, the increase across late summer and the winter months is significantly steeper. This is likely to impact the freezing and thawing cycle of the glaciers and hinder their ability to replenish during the winter. A study by Kashmir University predicted that if the average temperature increase in Ladakh exceeds 6°C, the region will likely lose 80% of its glaciers. While in the SSP 2-4.5 scenario, the ~4°C rise in temperature witnessed in late summer and winter is likely to occur by 2050 and then remain steady till 2100, in the SSP 5-8.5 scenario, this is likely to increase steadily to over 7°C by the end of the century.

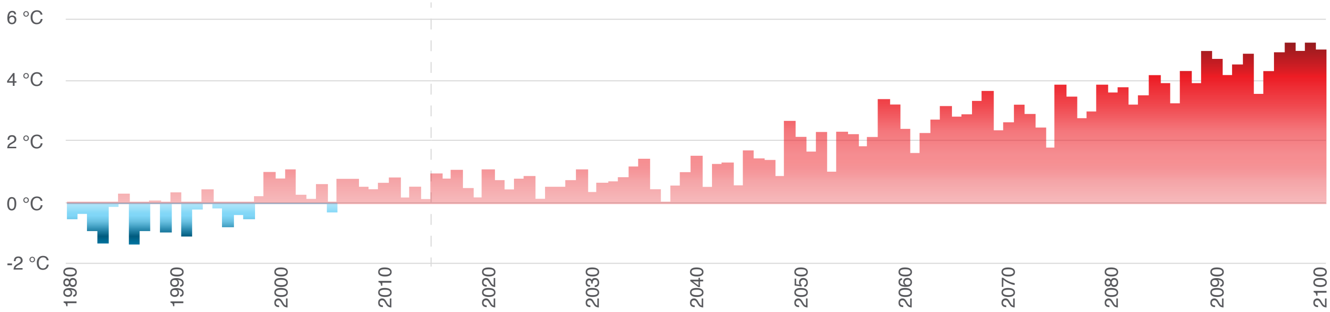


Figure 30: Projected Temperature variation compared to average observed temperature between 1980-2015 SSP 5-8.5

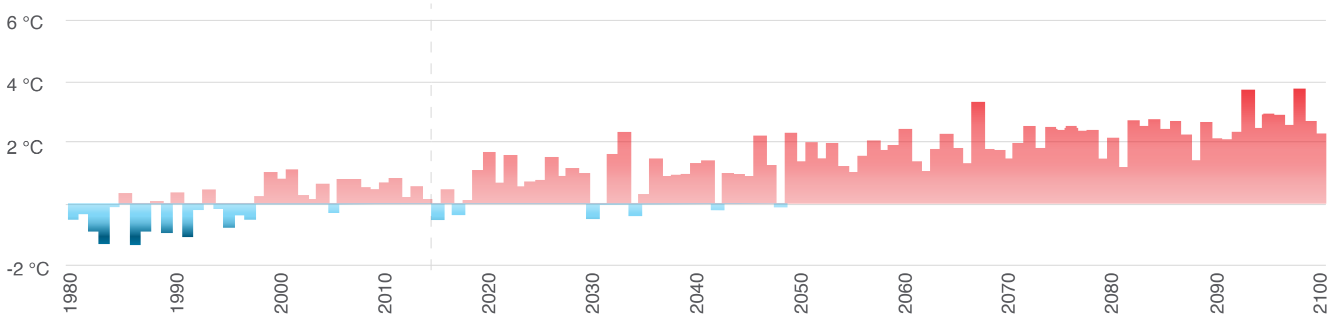


Figure 31: Projected Temperature variation compared to average observed temperature between 1980-2015 SSP 2-4.5

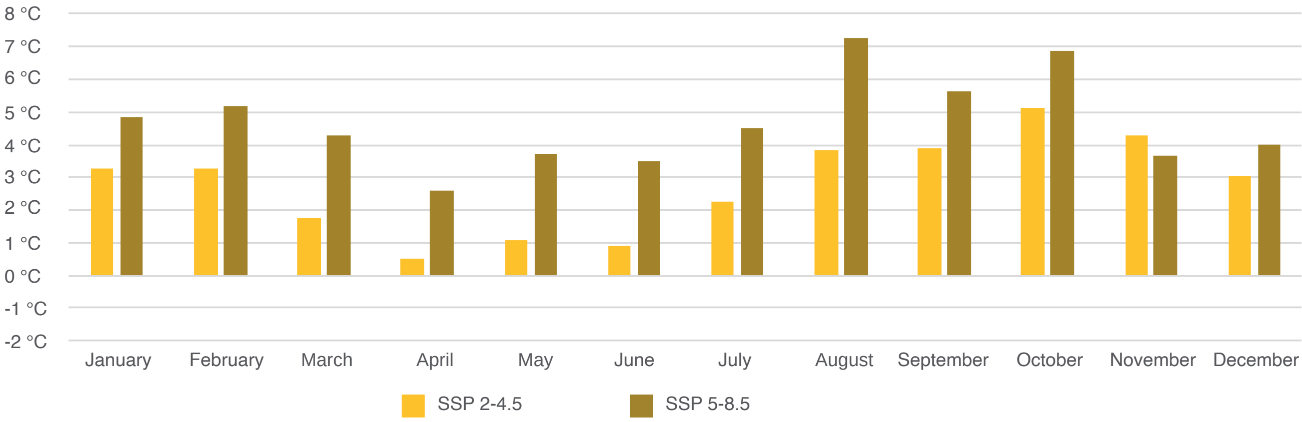


Figure 32: Monthly temperature variation projected in both scenario by 2100

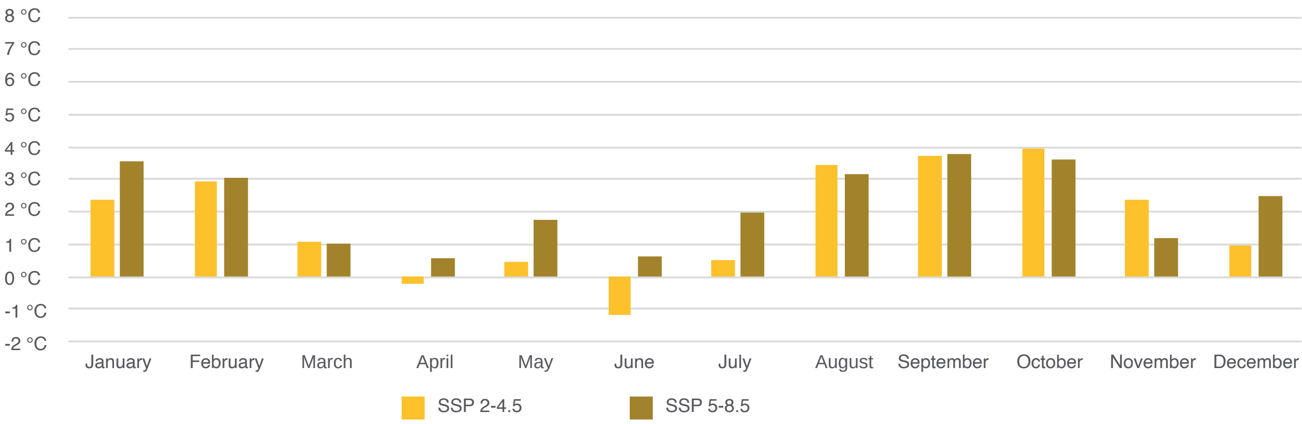


Figure 33: Monthly temperature variation projected in both scenario by 2050

4.6.2 Precipitation

In the SSP 2-4.5 scenario, Leh's precipitation is expected to remain stable with a minor average increase of around 10%, while in the SSP 5-8.5 scenario, the increase is much higher at around 30%. However, this increase in precipitation is expected to occur mostly after 2050, with the annual average precipitation remaining fairly constant at current levels until that point. Similar to the temperature data, however, there are significant variations in the monthly precipitation levels. In both scenarios, there is a decline in the summer precipitation, at least till 2050, while there is a significant increase in the precipitation during the winter months. Since the winter precipitation in Leh will be in the form of snowfall and will not immediately be required for high water consumption activities like agriculture, it could likely increase the water lost due to runoff and reduce the overall water availability in Leh.

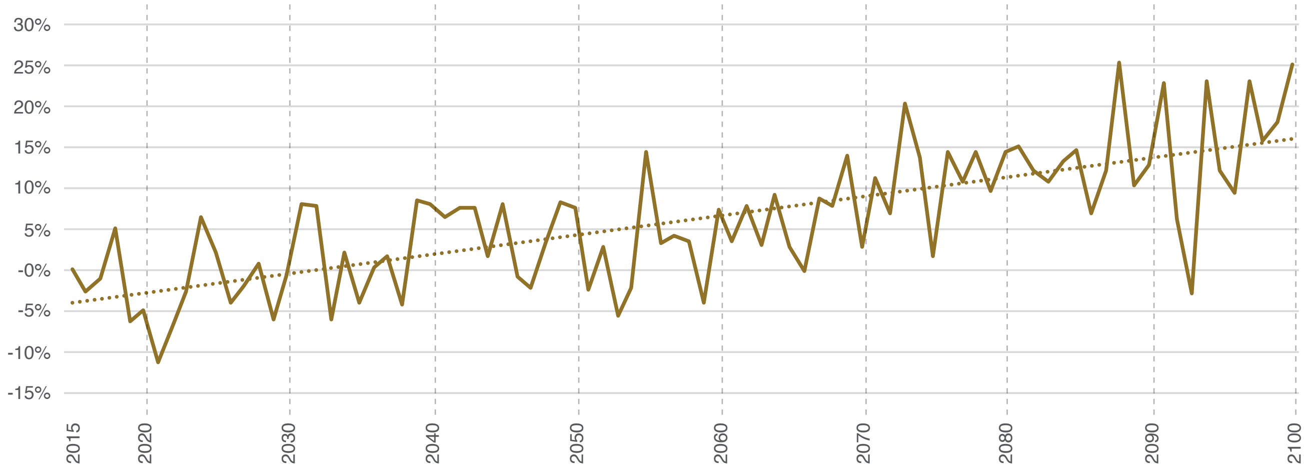


Figure 34: Annual Average variation in precipitation in Leh - SSP 5-8.5

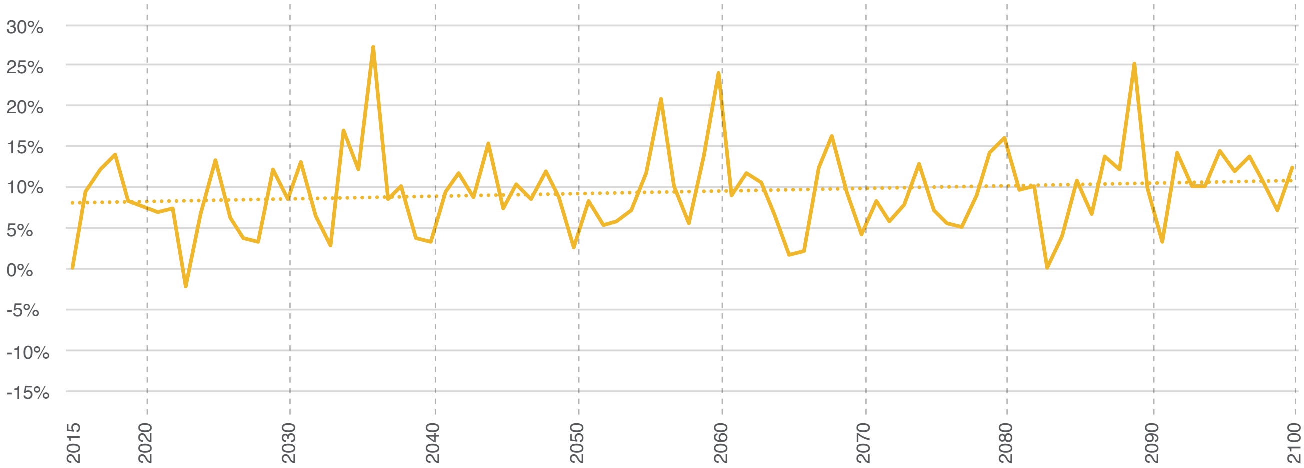


Figure 35: Annual Average variation in precipitation in Leh - SSP 2-4.5

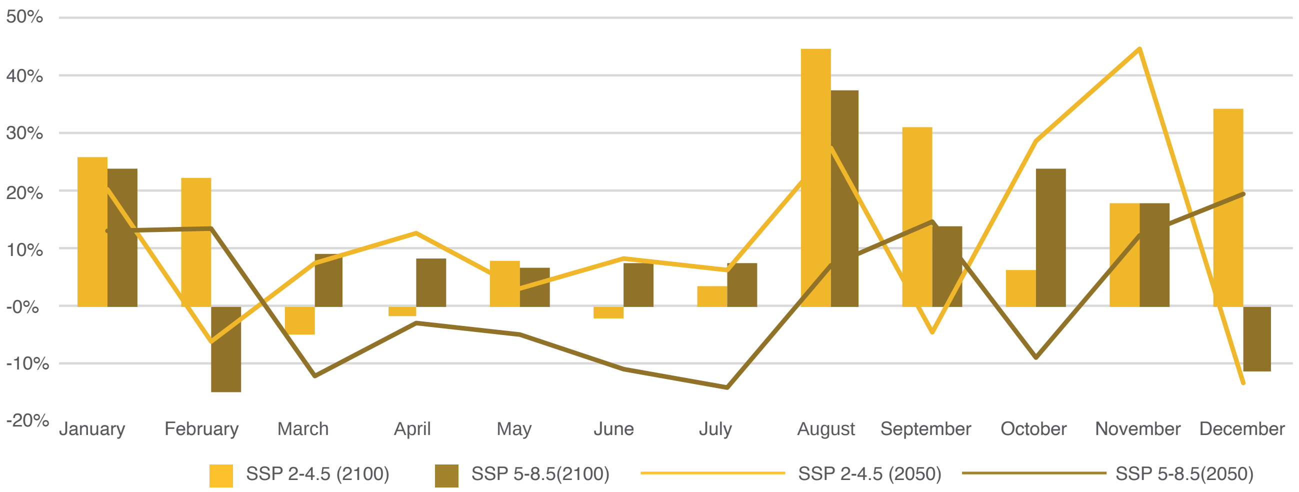


Figure 36: Monthly variations in precipitation

4.7 Summary of GHG Inventory

Based on the analysis in the previous sections, a baseline emission inventory has been developed for the year 2021-22. Leh's total emission for the inventory year is 1,43,884 MTCO2e. This translates to a per capita emission rate of 3.33MTCO2e, much higher than the national average of ~2MTCO2e. This high rate of per capita emissions can be attributed to Leh's large floating and tourist population (compared to the town's size), which are not factored into the per capita calculations. Stationary energy accounts for more than 64% of the emissions from Leh, with diesel used in generators and transmission losses, and other large electricity consumers (commercials, residential, and government) contributing the most to it. The other big component of Leh's emission inventory is transportation emissions, which account for almost 34% of the total and are composed entirely of the emissions from petrol and diesel vehicles. The emissions from waste contribute only 2% of the total emissions, with almost 90% of these emissions coming from wastewater. The low emissions from waste are also a testament to the excellent solid waste management practices of Leh MC.

The GHG emissions for Leh are projected to increase by at least 3.5 times to 4,97,563MTCO2e by the horizon year of the plan(2047). The contribution of Residential usage, transmission losses, usage in government buildings and generator usage is expected to increase. Overall, the contribution of stationary energy is expected to increase to 74%, while the contribution of the transportation and waste sectors is expected to come down to 25% and 1%, respectively. The graphs on the following page highlight these projections and changes.

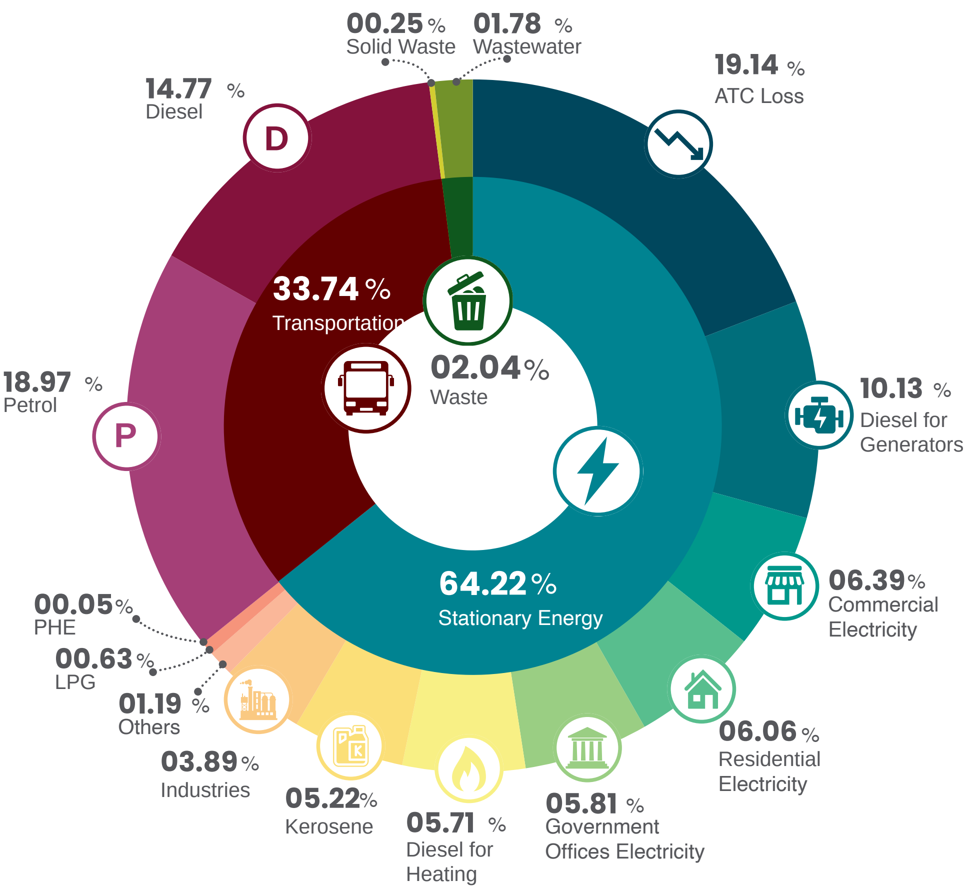


Figure 37: Baseline GHG inventory for Leh - 2022

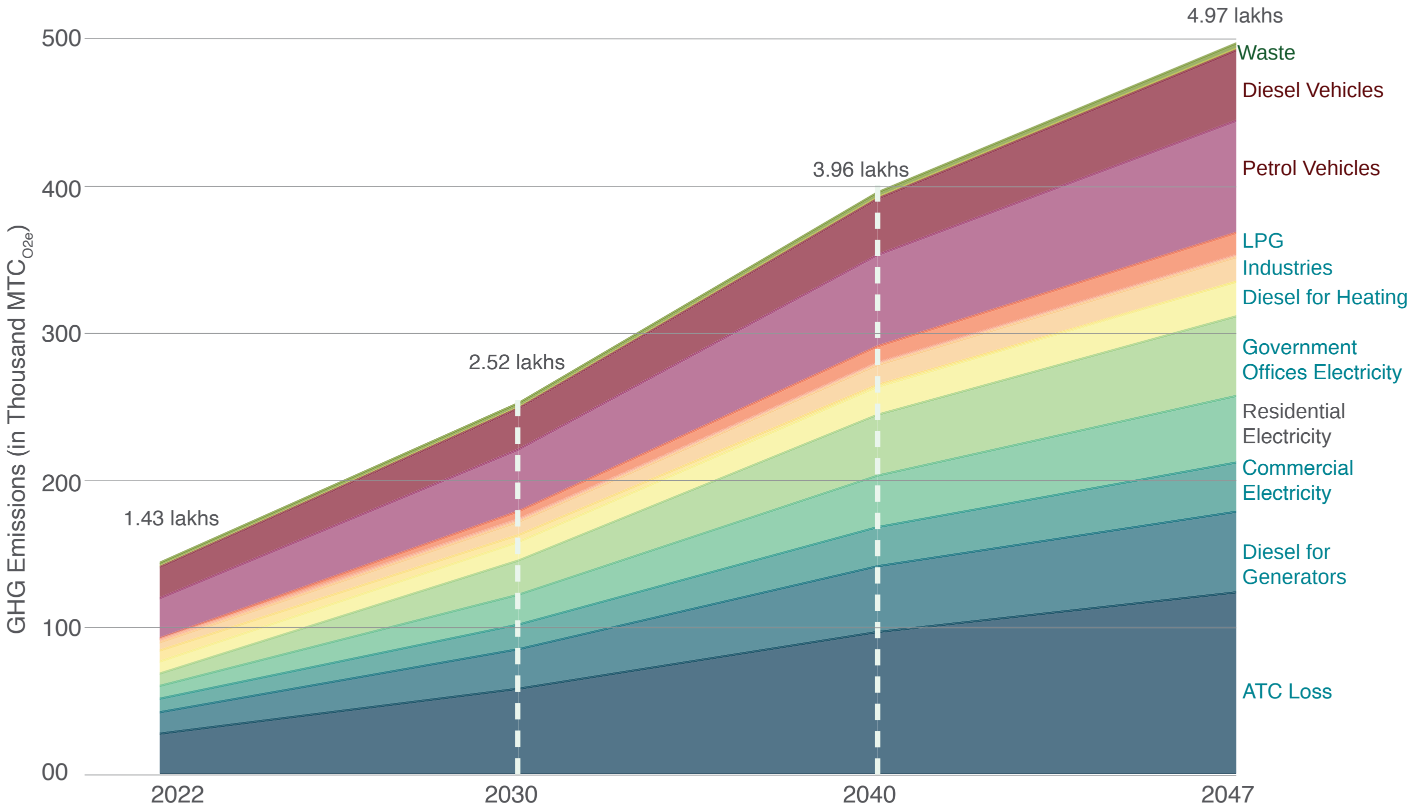


Figure 38: Projected GHG growth in Leh

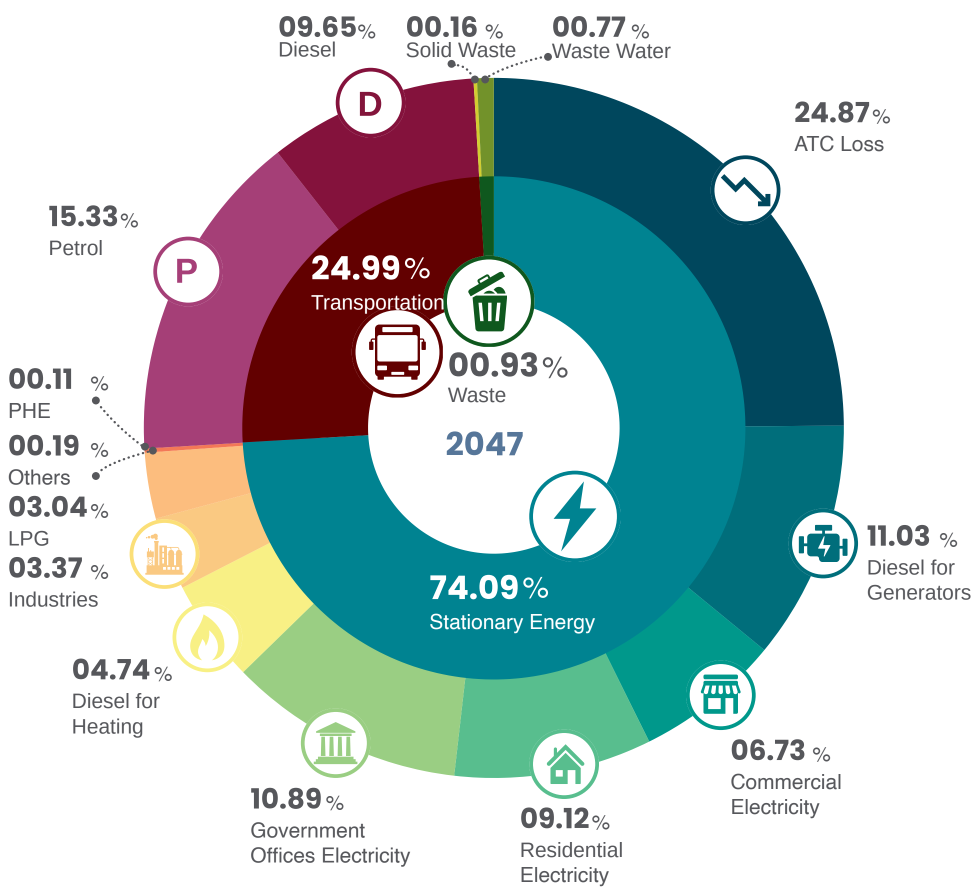


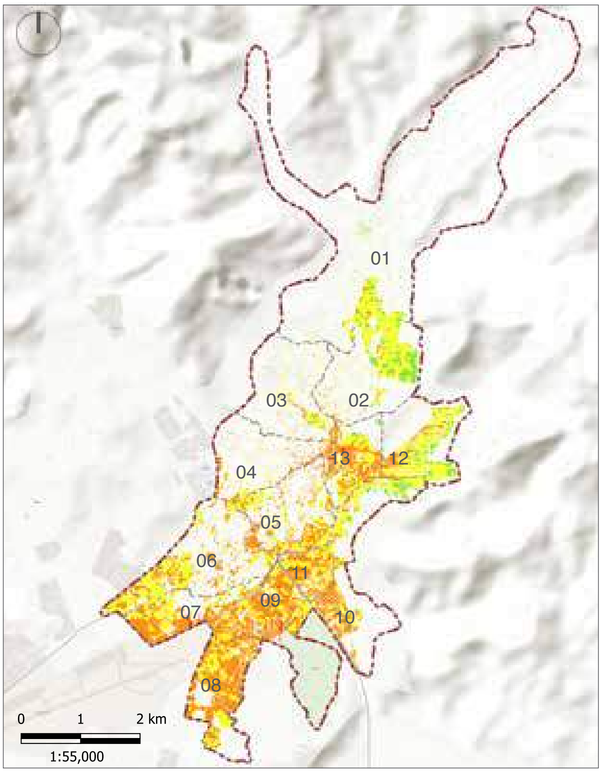
Figure 39: Horizon Year GHG Inventory - 2047

4.8 Summary of Risk Analysis

Based on the insights of the analysis presented in the previous sections, this report looks at the two main climate risks that Leh is likely to face - Urban Floods and Water Scarcity. The risks around flooding stem from the projected increase in rainfall intensity, while the increased water shortage risks stem from the combination of the over-extraction of groundwater and the projected reduction in glaciers due to increased temperatures. The specific risk profile due to these two disasters is as follows:

Flood Risk:

As detailed in Indicators 1.4 and 4.4, a flood risk profile of Leh has been developed using a multi-criteria decision-making process. As per this, 1.86sqkm (42.5%) of developed areas are at high risk of flooding. This area houses a total of 16,052 people which is about 38% of the population of Leh. While more than 58% of the high-risk areas are in Wards 06, 07, and 08, most of the people (>46%) living with high-risk reside in Wards 11 and 13. Wards 05 to 09 house a further 42% of the residents living with similarly high flood risk. Overall, more than 90% (>38,000 people) of the population of Leh



Map 19: Developed Area Under Risk

Legend

- Very Low Flood Risk
- Low Flood Risk
- Medium Flood Risk
- High Flood Risk
- Very High Flood Risk
- Leh Municipal Boundary
- Ward Boundary

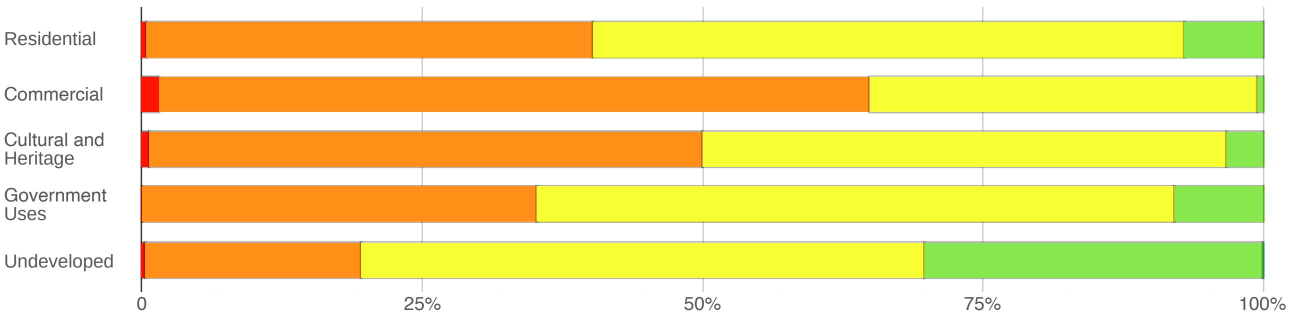


Figure 40: Ward wise Flood Risk Profile

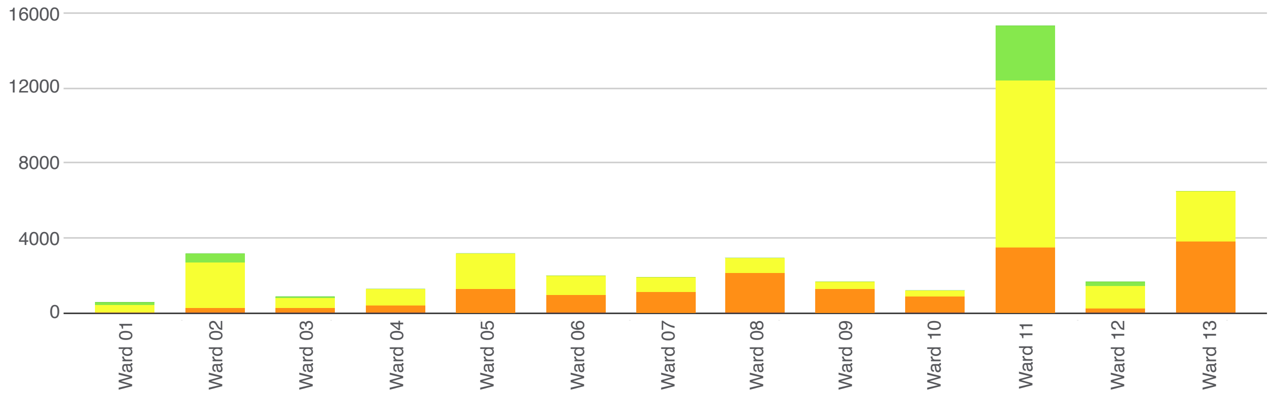
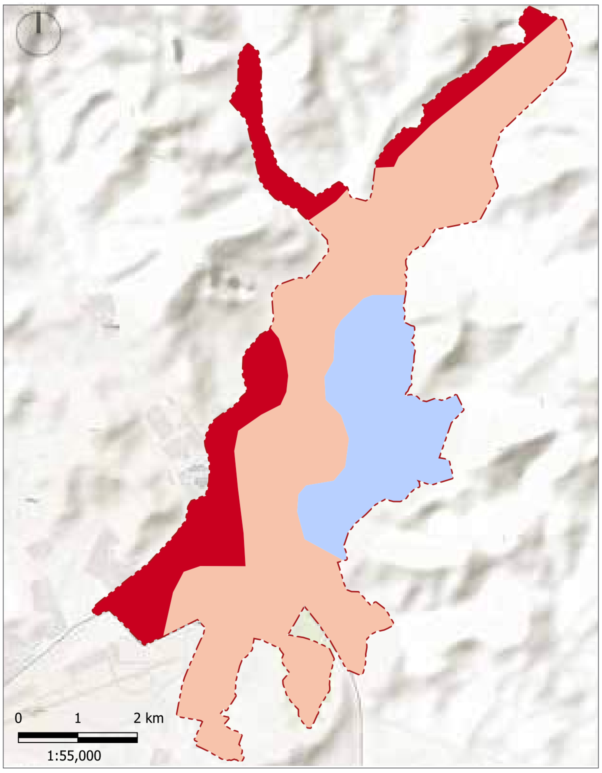


Figure 41: Ward wise Flood Risk Profile



Map 20: Ground Water Level

Source: Water in Liveable Leh, BORDA

Legend

Shallow (<15)

Medium (15-25)

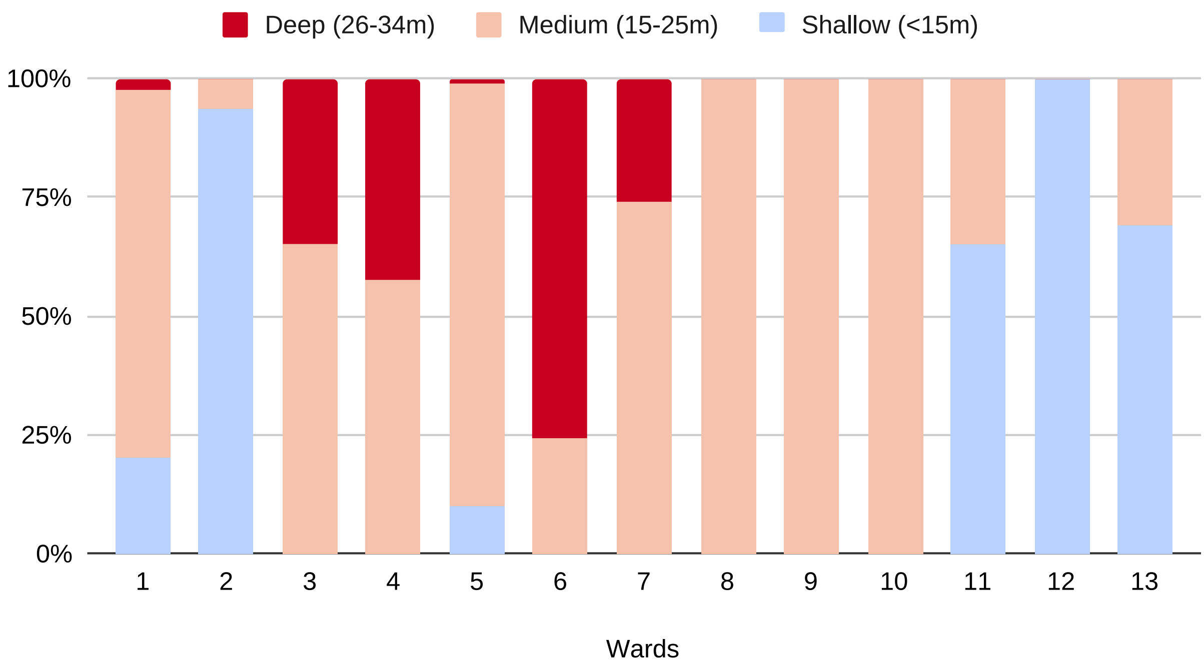
Deep (26-34)

Leh Municipal Boundary

live with flood risk classified over medium. At current rates of urbanisation and population growth, it is projected that by 2047, there will be more than 58,000 people living at similar levels of flood risk.

Water Risk profile.

While water scarcity-related issues are not currently evident, it will likely become Leh's most pressing issue over the next century. Leh depends on groundwater extraction to meet its water needs for all functions, from agriculture to domestic consumption. Leh extracts more than 5.6MLD per day just to meet its domestic demand. The only source of groundwater recharge currently is the snowmelt from the glaciers and the small quantity of rainfall that Leh receives. Mapping of the groundwater table shows that about 7% of the residents of Leh live in regions with low groundwater levels, making their continued dependence on groundwater to meet their daily needs precarious. Further, more than 30% of the low ground water regions are government buildings, while a further 11% are industrial areas.



05 Recommendation

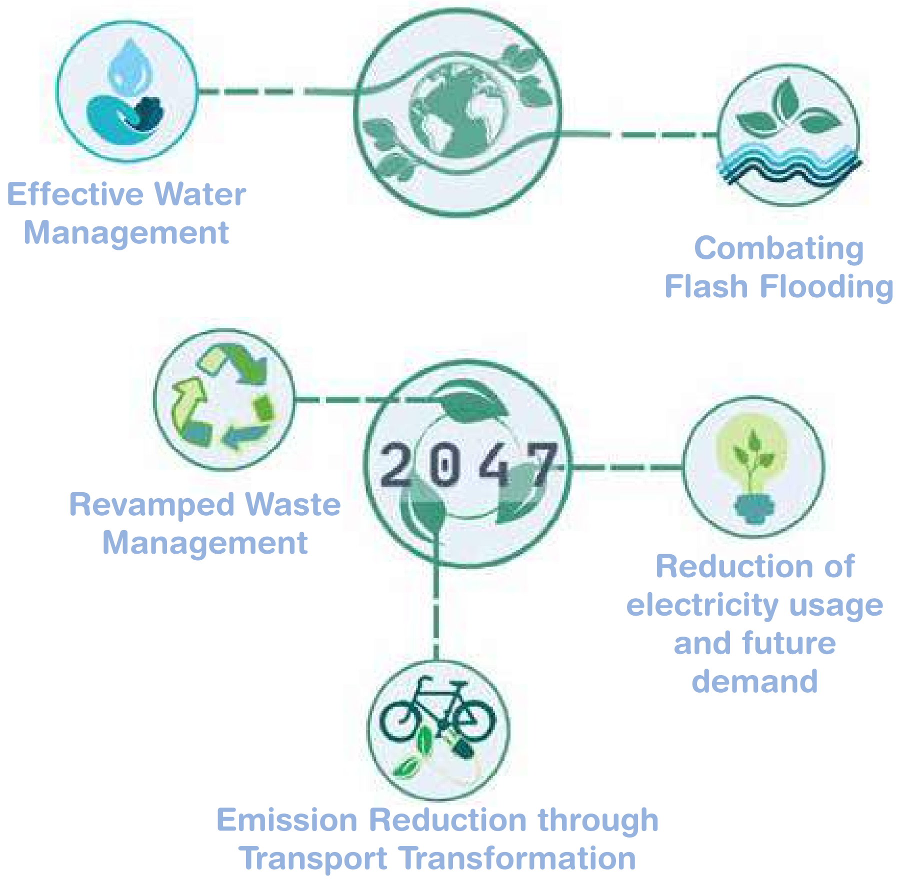

JEANS
INTERNATIONAL

5.1 Vision for the Leh CAP

This climate action plan establishes a dual vision of achieving a climate resilient and net zero Leh by 2047. The dual visions address the two main elements of a climate action plan - Mitigation and Adaptation. This ambitious vision has been set in consultation with the public, the public representatives and the administration. This collective aspiration reflects Leh's determination to stand as a beacon of sustainability, setting an example for communities worldwide. This vision also underscores the region's commitment to cultivating environmental responsibility and resilience within its long-term growth strategy. By embracing this forward-looking vision, Ladakh seeks to preserve its natural splendour and build a balanced, sustainable future for generations to come.

5.2 Thrust Areas

Five thrust areas have been identified through which the vision set out in this Climate Action Plan is proposed to be achieved.



The thrust areas are further divided into 12 objectives and 21 proposals. These proposals are a combination of mitigation and adaptation actions which are either policies, plans or projects.

Thrust Area 01: Effective Water Management

Objectives	Proposal	Objective focus	Proposal type
Reduction of Fresh Water Usage	Developing pricing regime for water supply	Adaptation	Policy
	Integrating Low Flow Fixtures	Mitigation and Adaptation	Plan/Project
	Develop Systems of Wastewater reuse	Mitigation and Adaptation	Plan
Improving Ground-water recharge	Reducing the dependencies of private borewells	Adaptation	Plan
	Improving Ground water recharge	Adaptation	Project
	Spring revival and spring shed management	Adaptation	Plan/Project

Thrust Area 02: Combating Flash Flooding

Objectives	Proposal	Objective focus	Proposal type
Mitigating Mudslides and landslides	Stabilising hill slopes	Adaptation	Plan/Project
Managing Flood Water	Redevelopment of Leh Canal to increase capacity	Adaptation	Project
	Development of storm water drainage capacity	Adaptation	Project
	Limiting urban sprawl and growth in ecologically sensitive and vulnerable land areas (hill slopes, permafrost, waterbody buffers etc)	Adaptation	Plan

Thrust Area 03: Revamped Waste Management

Objectives	Proposal	Objective focus	Proposal type
Augment dry waste management	Reduce dry waste generated by tourist	Mitigation	Policy/Plan
	Develop dry waste processing industry	Mitigation	Policy/Project
Improve management of C&D waste	Implement rules for C&D waste disposal, management and processing	Mitigation	Policy
	Develop a C&D management plant	Mitigation	Policy

Thrust Area 04: Emission Reduction through Transport Transformation

Objectives	Proposal	Objective focus	Proposal type
Reducing dependencies on private mobility	Development of Public transportation infrastructure	Mitigation	Plan
	Development of hop-on hop-off service for tourists	Mitigation	Plan
	Development of NMT infrastructure	Mitigation	Plan/Project
	Implementing restrictions and bans on on-street parking in central Leh	Mitigation	Policy
Transition to Electric vehicles	Development of EV charging infrastructure	Mitigation	Project
	Trial runs of EVs	Mitigation	Policy/Plan
	Increasing EV subsidies for private cars	Mitigation	Policy

Thrust Area 05: Reduction of electricity usage and demand

Objectives	Proposal	Objective focus	Proposal type
Reduce Energy consumption	Reduction of transmission losses	Mitigation	Plan/Project
	Pricing Model to reduce domestic and commercial energy usage	Mitigation	Policy
Implementing Energy efficiency in buildings	Retrofitting government buildings to be energy efficient	Mitigation	Project
	Mandates for the installation of Energy efficient fitting, fixtures and Appliances in commercial buildings being used for hospitality purposes	Mitigation	Policy
	Development planning regulations to ensure longer south facing facades in new developments	Mitigation	Plan
Harnessing the potential of solar energy	Developing Roof Top Solar systems in all buildings	Mitigation	Policy/Project
	Developing Solar Fields to meet energy requirements of Leh	Mitigation	Project
Energy Stabilisation	Developing Pumped hydro systems for energy storage	Mitigation	Project
	Developing potential for generation of green hydrogen for fuel	Mitigation	Policy/Project
	Phasing out of Diesel generators	Mitigation	Policy

5.3 Mitigation Actions

5.3.1 Overview of Actions

The twenty four proposals that address mitigation actions are classified into four main groups - Planned Actions, Usage Reduction Actions, Emission Reduction Actions, and Carbon Sink Actions. Cumulatively, these interventions will help reduce 4,97,619 MTCO2e by the horizon year of 2047. Actions classified as Planned are those the municipality has already begun working on. Usage reduction measures focus on nudging a reduction in the usage of resources among the residents. This would involve measures to reduce electricity and fuel usage, the two highest contributors to emissions in Leh. Electricity use reduction is proposed by incorporating energy efficiency in buildings, telescopic pricing to encourage personal energy use reduction, and IEC measures to encourage resource-efficient individual behaviours tied to Mission LiFE.

Energy use reduction can help mitigate emissions to only certain extents as energy use is integral to economic activities and to ensure quality of life. Hence, even after usage reduction, Leh will still continue to emit 66% of the projected emissions by the horizon year. These emissions can be reduced by switching the energy source from fossil fuels to renewables, which will have low to no emissions. The measures under this include the transition to Electric vehicles and the development of solar potential to meet electricity needs through renewable sources. Four thrust areas focus on measures in this category. The carbon sink measures focus on attenuating the impacts of the residual emissions from sources like LPG and, to some extent, petrol and diesel usage for essential services.

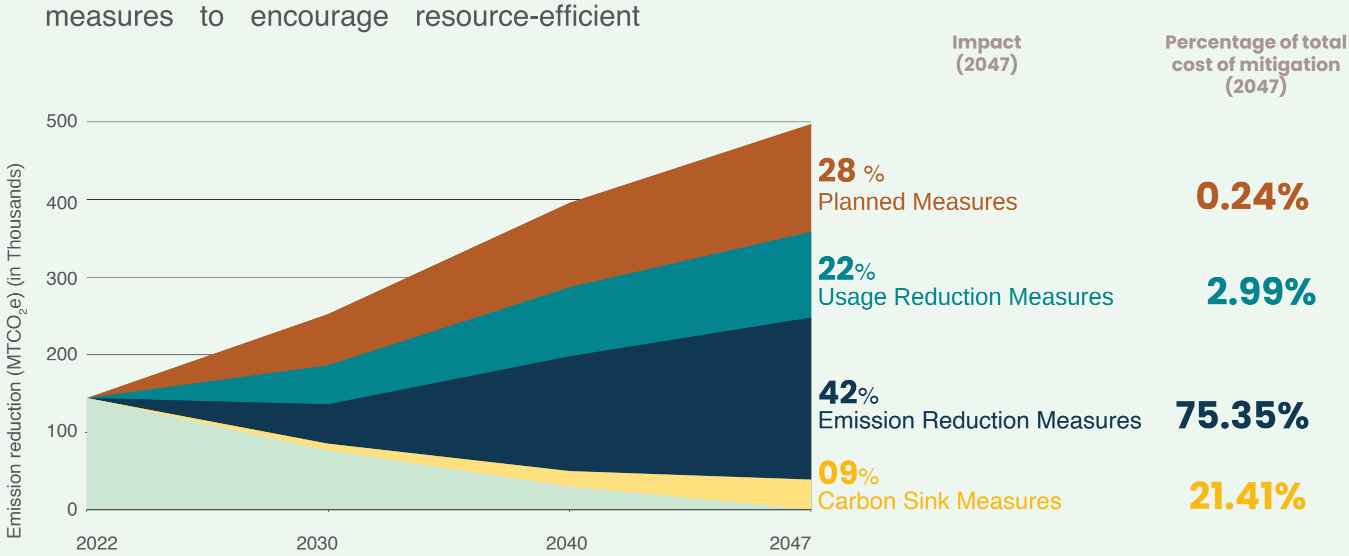


Figure 42: Categorisation of Mitigation Actions under Leh CAP

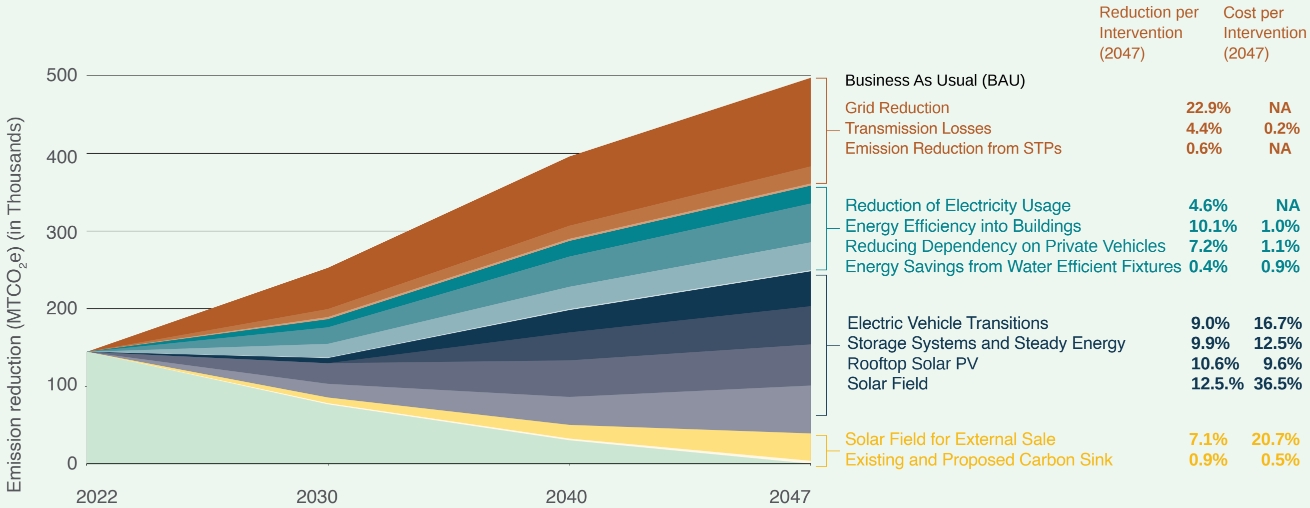


Figure 43: Mitigation actions under Leh CAP

5.3.2 Financial Analysis of Actions*

The total cost of the mitigation actions for leh ₹9,57 Cr. The targetted actions will hence cost the city ₹19,248 per MTCO2e of emission reduced. The administration will need to invest 31% of the proposed costs by 2030, 41% of the costs by 2040, and the final 28% of the costs will need to be invested by 2047. Project costs have been staggered to maximise the investments' efficiency and prevent financial overburden.

An analysis of the financial efficacy of the interventions highlights the staggering difference between the cost-to-impact ratios of usage reduction and emission reduction measures. While the usage reduction measures cost slightly above ₹2000 per MTCO2e removed, the emission reduction measures average upwards of ₹35,000 per MTCO2e removed.

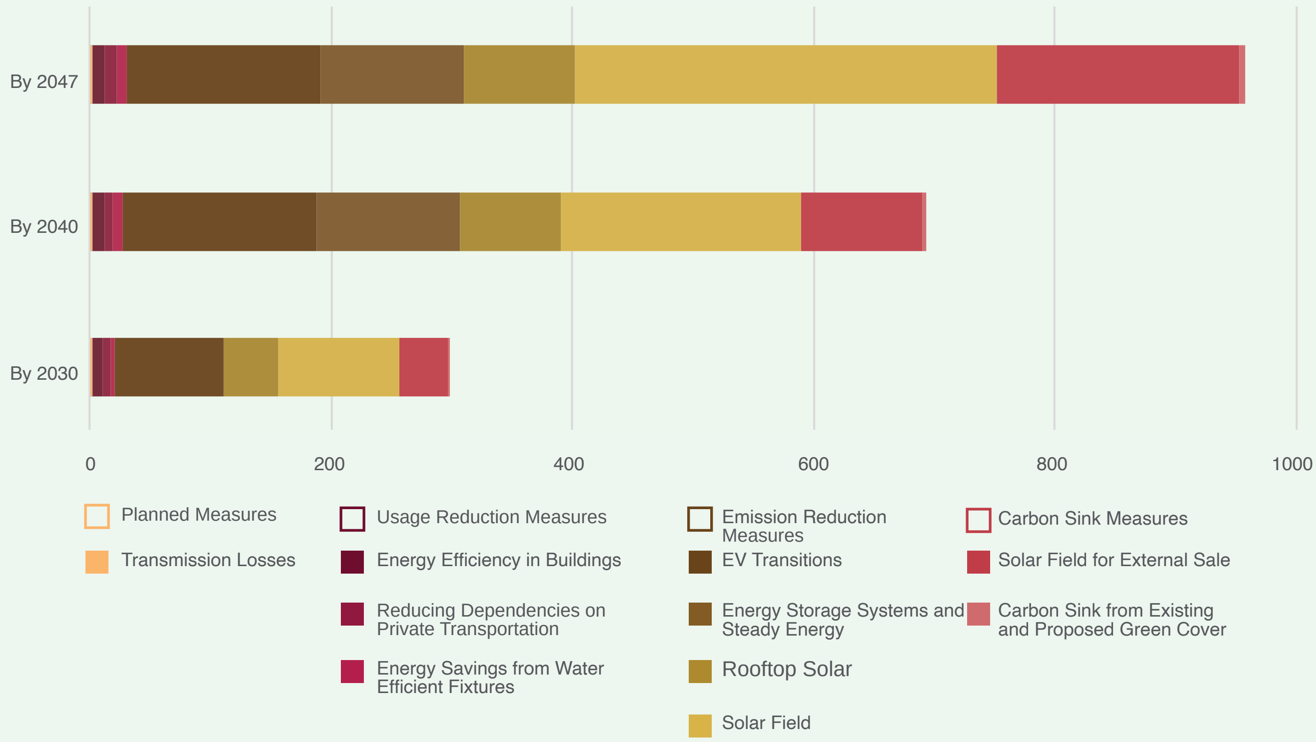


Figure 44: Financial Outlay of Leh CAP

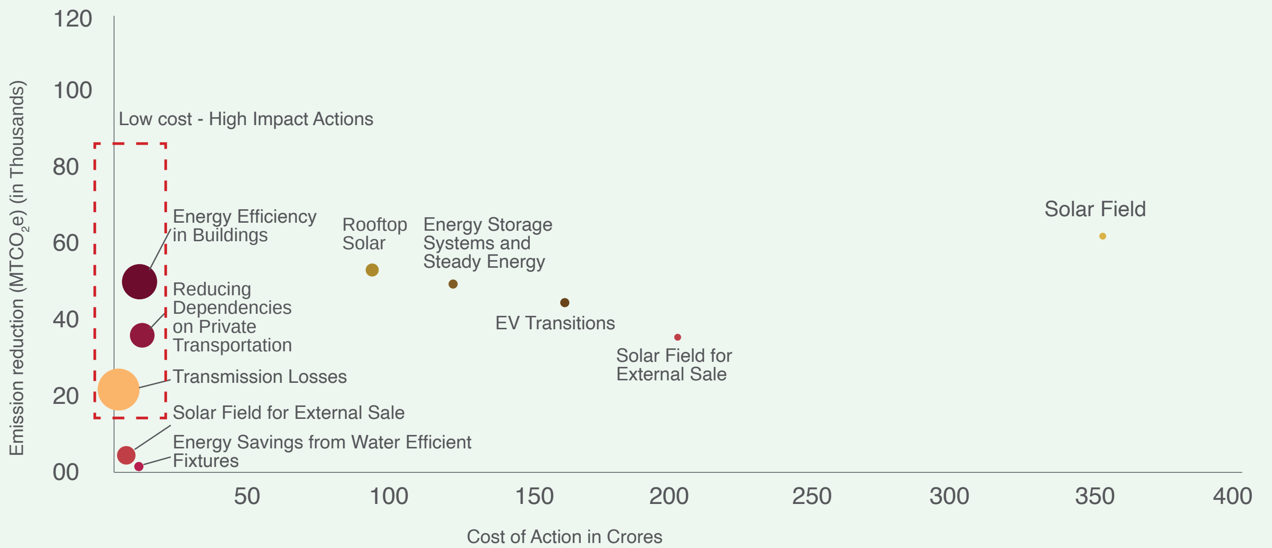
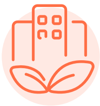
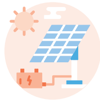


Figure 45: Financial Efficacy of Mitigation Actions

*Tentative Costs Estimated as per 2023 prices. Final costs may vary based on detailed on-ground studies and estimations. Estimations do not include costs of land acquisition

Stationary Energy

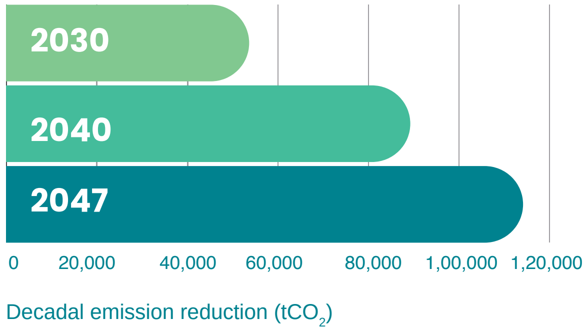
NATIONAL GRID REDUCTION

CSCAF Theme	Indicators	Thrust Area
 Energy and Green Buildings	 Renewable Energy	 Reduction of electricity usage and future demand

Emission Reduction

22.92%
of BAU $MTCO_2e$ reduced

1,14,122
$mtCO_2$ reduced



	2030	2040	2047
Emissions after interventions (Cumulative)	1,99,088	3,06,882	3,83,497
$mtCO_2$ reduced due to interventions (Cumulative)	53,620	89,211	1,14,122
% of Baseline emissions reduced	21.22%	22.52%	22.93%

Intervention M 1: Reducing national grid emission intensity

India has articulated ambitious national objectives for 2030, emphasising the reduction of the national grid emission intensity to 0.000477 MTCO2e/kWh. At the core of this initiative is the development of 500 GW of renewable energy seamlessly integrated into the national grid. This strategic undertaking holds considerable environmental significance, particularly in the locale of Leh, where it is projected to yield a substantial reduction exceeding 22% of emissions.

REDUCTION OF TRANSMISSION LOSSES

Stationary Energy

CSCAF Theme

Energy and Green Buildings

Indicators

Electricity Consumption in the City

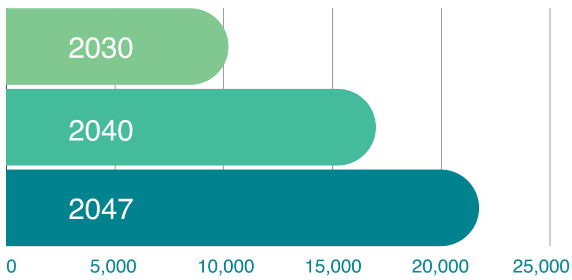
Thrust Area

Reduction of electricity usage and future demand

Emission Reduction

4. 37%
of BAU $MTCO_2e$ reduced

21,732
$mtCO_2$ reduced



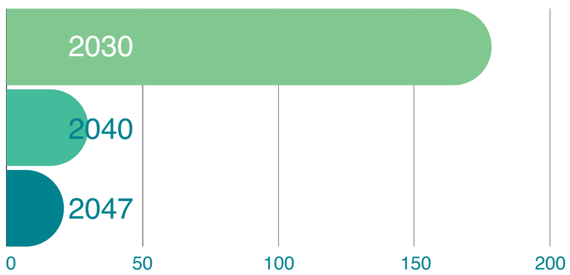
Decadal emission reduction (tCO_2)

Cost of Interventions

₹ 2.29 Cr
Cost of interventions

0.24%
of total cost

₹ 1,057 per tonne of tCO_2 removed



Decadal investment required (in lakhs)

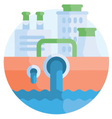
	2030	2040	2047
Emissions after interventions (Cumulative)	1,88,878	3,06,882	3,61,766
$mtCO_2$ reduced due to interventions (Cumulative)	10,210	16,988	21,732
% of Baseline emissions reduced	4.04%	4.29%	4.37%
Cost of Interventions (Cumulative)	₹1.78 Cr	₹2.08 Cr	₹2.29 Cr
Cost per tCO_2 reduced	₹1,748	₹1,228	₹1,057

Waste

REDUCTION of EMISSION FROM STPs

CSCAF Theme | **Indicators** | **Thrust Area**


Water Management


Water Recycle & Reuse

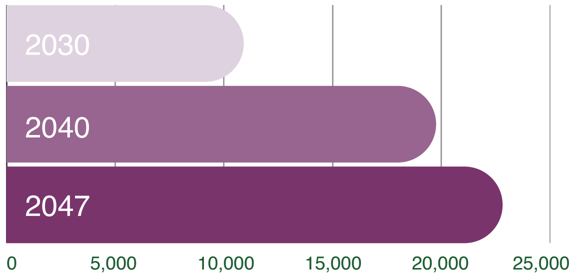

Energy Efficient WasteWater Management System


Revamped Waste Management

Emission Reduction

0.61%
of BAU $MTCO_2e$ reduced

21,732
$mtCO_2$ reduced



Decadal emission reduction (tCO_2)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,86,505	2,87,121	3,58,713
$mtCO_2$ reduced due to interventions (Cumulative)	2,373	2,773	3,053
% of Baseline emissions reduced	0.94%	0.70%	0.61%

Intervention M 2: Smart Metering to reduce electricty losses

Responsible Agency: PDD

Leh grapples with elevated transmission losses, accounting for approximately 45% of the electricity consumed. While some of these losses stem from theft and unmetered connections, inherent inefficiencies exist in the transmission and distribution lines. Addressing this issue necessitates a comprehensive proposal involving the widespread implementation of smart metering for all households and the augmentation of power lines to curtail transmission losses. Within Ladakh's Union Territory (UT), the Revamped Distribution Sector Scheme (RDSS) outlines projects with a Total DPR Cost of Rs. 1172.12 Cr. with Rs 144.60 Cr. allocated for loss reduction endeavours. Additionally, works amounting to Rs 341.47 Cr. are proposed for Modernization/ System Strengthening within the UT of Ladakh. UT Ladakh has set forth a visionary strategy to gradually diminish AT&C losses from 48.17% in the base year 2020-21 to 27.85% by the year 2024-25. These measures are anticipated to yield a reduction of 4.37% in annual CO2 emissions.

Intervention M 3: Development of STP

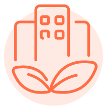
Responsible Agency: IGOOPhey

Leh has a proposal underway to develop an STP outside the municipal limits for a capacity of 13MLD in line with the draft masterplan at a cost of ₹123.61. This project is in its final stages and once completed will help reduce about 0.6% of the baseline GHG emissions.

REDUCE ENERGY USAGE

Stationary Energy

CSCAF Theme



Energy and Green Buildings

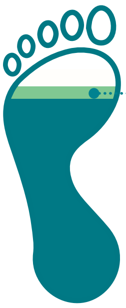
Indicators

Electricity Consumption in the City

Thrust Area

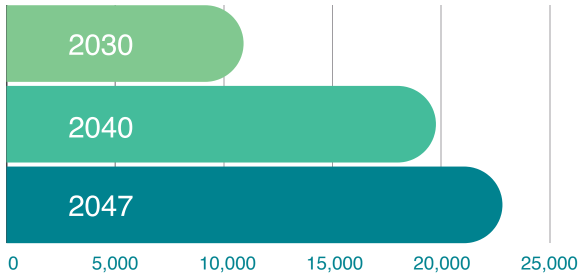
Reduction of electricity usage and future demand

Emission Reduction



4. 59%
of BAU $MTCO_2e$ reduced

22,823
$mtCO_2$ reduced



Decadal emission reduction (tCO_2)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,75,595	2,67,359	3,35,890
$mtCO_2$ reduced due to interventions (Cumulative)	10,910	19,762	22,823
% of Baseline emissions reduced	4.32%	4.99%	4.59%

Intervention M 4: Suggestive pricing model to electricity usage

The per capita electricity consumption is projected to surge from 1,387 kWh in 2022 to 4,191 kWh in 2047, a stark contrast to the national average of 1255 kWh in 2021-22. India is expected to require 2500 kWh per capita to meet various social thresholds. In Leh's energy distribution context, achieving this target equates to approximately 54 kWh per capita for residential use. Introducing telescopic pricing presents a viable strategy to constrain energy consumption to this specified level. The current flat rate prices stand at ₹2.4 per kWh for residential and ₹6.5 per kWh for commercial purposes. This proposed adjustment can enhance state revenue, reduce expenditure on subsidies (which can be diverted to the development of renewables), and provide a reduction of approximately 5% in annual CO2 emissions.

The proposed telescopic pricing regime for electricity in Leh takes a middle-ground approach between the current subsidised model and the unit rate required for 100% cost recovery. The tariff structure is designed to prevent undue financial pressures on the lower-income user (who usually consume less energy) while ensuring that high-energy consumers pay their fair share. Under the proposed structure, users consuming less than 450 units would pay less than they would under the current model, and only consumers utilising more than 1300 units a month (which is very low in the cold climates of Leh) would pay more than the current unsubsidised rates of electricity.

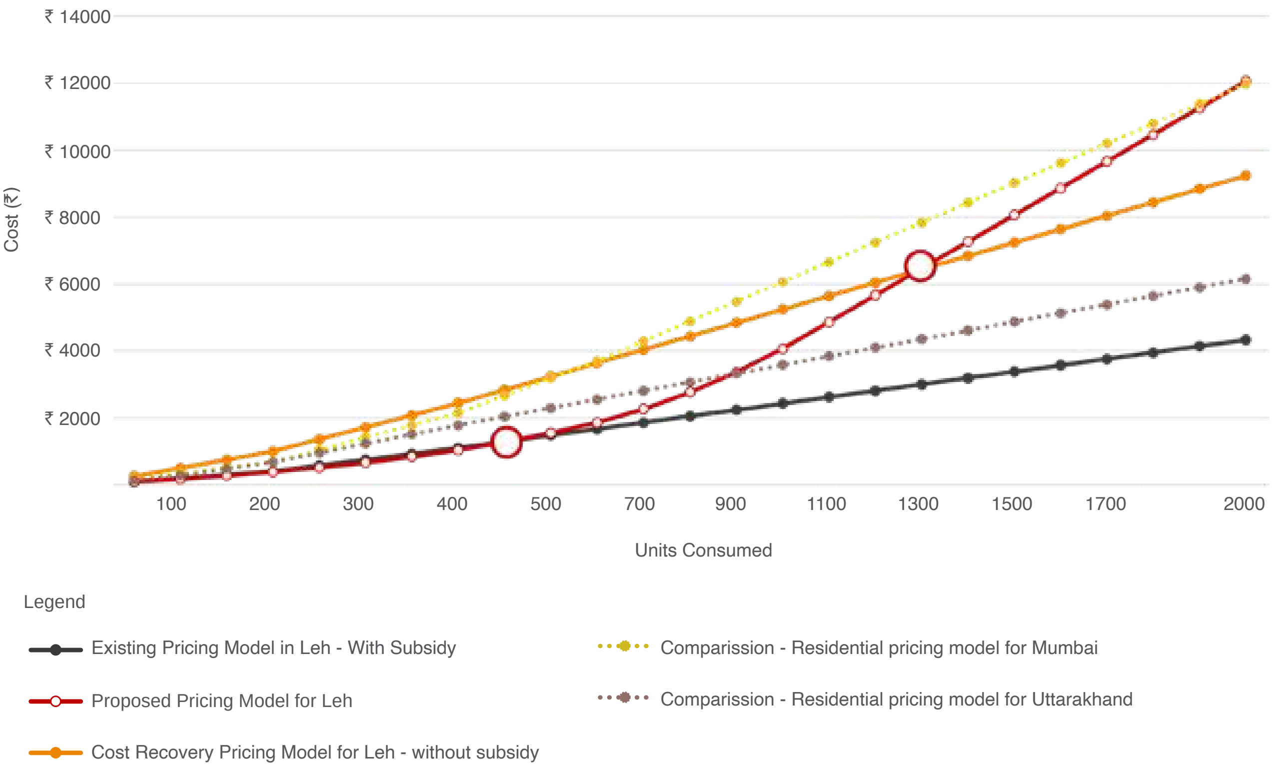
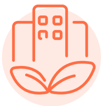


Figure 46: Expected Monthly Trarrif under different Pricing schemes (₹)

IMPLEMENTING ENERGY EFFICIENCY IN BUILDINGS

Stationary Energy

CSCAF Theme



Energy and Green Buildings

Indicators

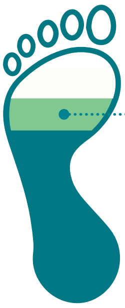
Electricity Consumption in the City

Promotion and Adoption of Green Buildings

Thrust Area

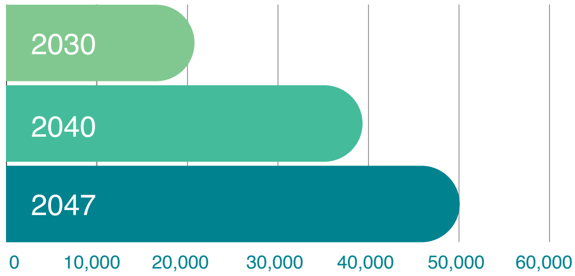
Reduction of electricity usage and future demand

Emission Reduction



10.06%
of BAU $MTCO_2e$ reduced

50,067
$mtCO_2$ reduced



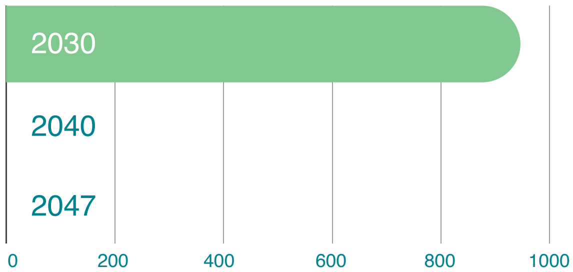
Decadal emission reduction (tCO_2)

Cost of Interventions

0.99%
of total cost

₹ 9.46 Cr
Cost of interventions

₹ 1,890 per tonne of tCO_2 removed



Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,54,822	2,28,026	2,85,823
$mtCO_2$ reduced due to interventions (Cumulative)	20,773	39,333	50,067
% of Baseline emissions reduced	8.22%	9.93%	10.06%
Cost of Interventions (Cumulative)	₹9.46 Cr	₹9.46 Cr	₹9.46 Cr
Cost per tCO_2 reduced	₹4,555	₹2,406	₹1,890

Intervention M 5: Retrofitting government buildings to increase energy efficiency

Responsible Agency: UT Admin, PDD

Government buildings account for 12% of electricity consumption in Leh, with a substantial 80% of this consumption occurring during winter, due to heating loads. The strategic deployment of energy-efficient retrofit solutions within government buildings is poised to reduce energy consumption, thereby mitigating the seasonal disparity between summer and winter consumption patterns. This intervention encompasses the installation of wall and floor insulation, double-glazed units for all windows, hermetically sealed doors and windows, and energy-efficient appliances, including heating systems.

Intervention M 6: Mandates for installing energy efficient fixtures in commercial buildings

Responsible Agency: PDD, Leh MC

In Leh's tourism-dependent economy, hotels and homestays emerged as prominent energy consumers within the commercial sector. While the control over energy consumption in these establishments may not always lie with the operator, proactive measures can still be implemented to curtail energy usage within these buildings. One effective strategy involves incorporating mandates into building bylaws, ensuring that all new commercial structures for hospitality use integrate energy-efficient fittings, fixtures, and appliances. These mandates can be enforced by incorporating energy efficiency audits as a prerequisite for obtaining occupancy and business approval.

Intervention M 7: Purchase-linked subsidies for energy-efficient fixtures and appliances:

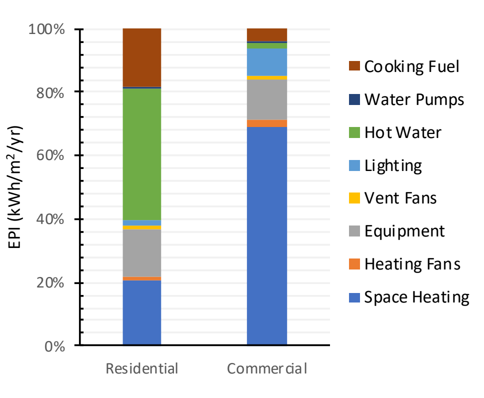
Responsible Agency: UT Admin, PDD

Aligned with the aforementioned strategies, integrating energy efficiency and usage reduction measures within the residential sector is imperative. At the residential scale, fostering the adoption of such technologies necessitates additional incentives in the form of subsidies. These subsidies can be linked to purchases of products like wall and floor insulation, double-glazed units for windows, heat pumps, hermetically sealed doors and windows, and energy-efficient heating systems. While mandates could be implemented to facilitate the integration of these aspects into larger residential developments, it is crucial to exercise prudence and avoid imposing such mandates on smaller residences.

Intervention M 8: Planning regulations to maximise passive solar potential:

Responsible Agency: UT Admin, Leh MC

The potential of passive solar techniques as a cheap means of incorporating energy efficiency within buildings in Leh is immense. However, a large number of buildings, particularly in newer developed areas are unable to tap into this due to the poor orientation of buildings which do not allow them tap the lower winter evening sun or have enough surface area in the predominate sun directions. This is mostly due to the mutual shading provided by neighbouring buildings (in denser settlements) or the poor orientation of the site axis. Planning and building regulations will need to address these issues and will need to ensure that future developments are oriented and spaced to enable all construction to maximise its passive solar potential.



Energy consumption of typical building in Leh

A typical residential and commercial building was modeled using EDGE APP. The figure shows energy consumption for both building types. A single-story residential building for a middle-income group was simulated, covering 145 square meters with three bedrooms for six occupants. The commercial building was a two-story office structure spanning 2,000 square meters, operating six days a week for seven hours each day with 15 holidays annually. The results reveal that residential buildings primarily consume energy for water heating, while commercial buildings mainly use it for space heating.

REDUCTION OF DEPENDENCIES ON PRIVATE TRANSPORT

Transportation

CSCAF Theme

Mobility & Air Quality

Indicators

Availability of Public Transport

Coverage of Non-Motorised Transportion

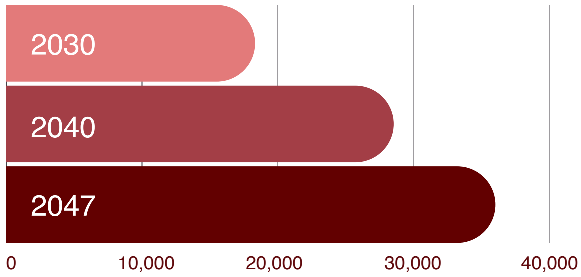
Thrust Area

Emission Reduction through Transport Transformation

Emission Reduction

7.24% of BAU $MTCO_2e$ reduced

36,022 $mtCO_2$ reduced



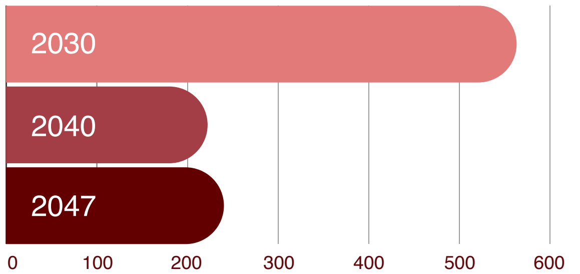
Decadal emission reduction (tCO_2)

₹2,845 per tonne of tCO_2 removed

Cost of Interventions

1.07% of total cost

₹ 10.25 Cr Cost of interventions



Decadal investment required (in lakhs)

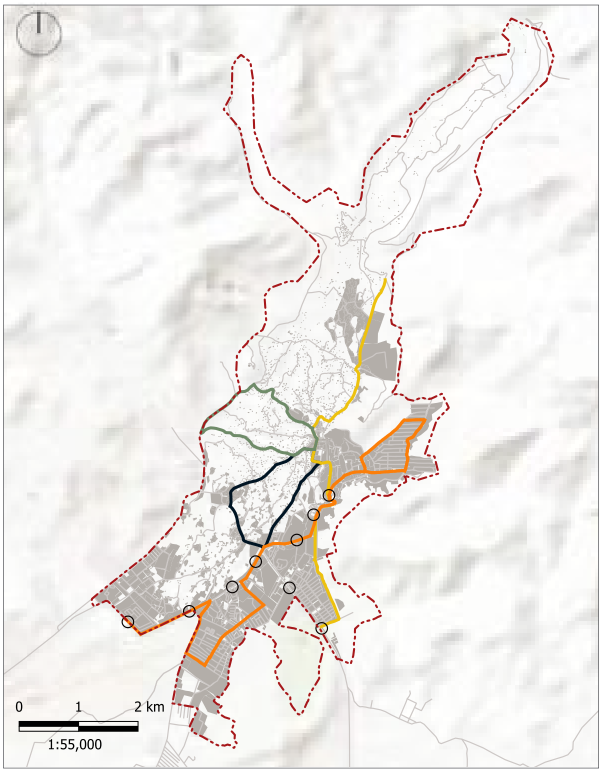
	2030	2040	2047
Emissions after interventions (Cumulative)	1,36,496	1,99,493	2,49,800
$mtCO_2$ reduced due to interventions (Cumulative)	18,326	28,533	36,022
% of Baseline emissions reduced	7.25%	7.20%	7.24%
Cost of Interventions (Cumulative)	₹5.63 Cr	₹7.85Cr	₹10.25 Cr
Cost per tCO_2 reduced	₹3,072	₹2,751	₹2,845

Leh boasts one of India's most elevated car ownership rates, presently standing at 226 per 1000 people (339 when including taxis). Projections based on current vehicular growth trends anticipate a surge in car ownership to 588 per 1000 (729, inclusive of taxis) by the year 2047. This burgeoning ownership is the primary driver behind the anticipated rise in CO2 emissions from fuel consumption. Three key interventions have been proposed to mitigate this trend and foster a reduction in reliance on private transportation.

Intervention M 9: Development of Public Transport Infrastructure:

Responsible Agency: SIDCO, Leh MC, PWD

The inadequacy of public transportation in Leh, as discussed in Section 05, Indicator 3.2, stands out as a primary catalyst for the burgeoning number of private vehicles. While government-operated mini-buses exist, their coverage is limited, serving mainly as transport conduits from Leh to smaller settlements. Notably, only 22.30% of Leh residents have access to this coverage. Given Leh's distinctive characteristics of urban development, which is marked by challenging terrain and narrow roads, the conventional bus network may not be the most efficient mode of public mobility. Consequently, the proposal advocates establishing a shared mobility network, centring on shared e-rickshaws or communal cabs.



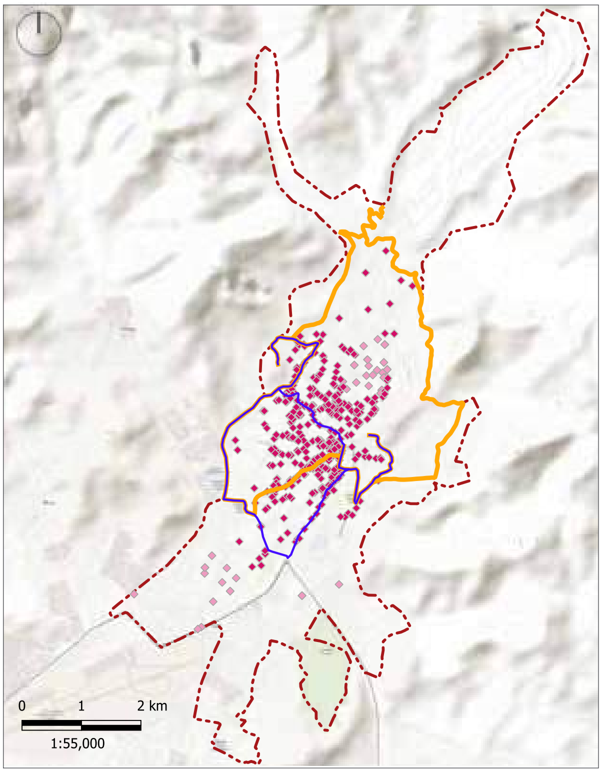
Map 21: Proposed Public Trasnport Routes

Legend

Bus Stops
Roads
Developed Area
Leh Municipal Boundary
Changspa to Leh Market
Airport to Municipal
Chonglansar to Lamdon
Zorawar to Market

Four routes are proposed, strategically connecting the central growth nodes and key destinations like the market, the main bus stand, the airport, etc. The routes are planned in cognisance of the carrying capacity of the roads as well as the movement patterns of the residents of the town. The new network will improve public transportation coverage to more than 90% of the developed area in Leh. The proposal also seeks to improve PTU standards above the service level benchmarks of 0.6 PTU per 1000 people to achieve 0.8 PTU per 1000. This is proposed to accommodate the floating population of Leh.

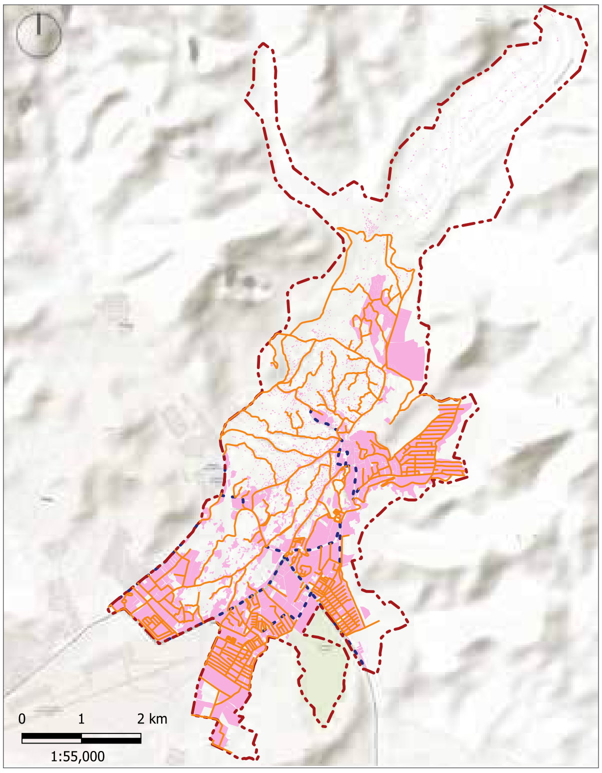
Route No.	Origin	Destination	Route Length (km)
1	Zorawar	Leh Market (loop)	3.86
2	Ward 10	Ward 02	5.69
3	Changspa	Leh Market (loop)	5.69
4	Airport	Ward 12	8.90



Map 22: Proposed Hop-on/Hop-Off Service

Legend

Route 1
Route 2
Hotels
Hotels under 500m buffer of Hop on service
Leh Municipal Boundary



Map 23: Proposed NMT Infrastructure

Legend

Existing Footpath
Proposed NMT
Developed Area
Leh Municipal Boundary

Intervention M 10: Development of Hop-on/Hop-Off Service for Tourists

Responsible Agency: Tourism department, Leh MC, PWD

Another significant contributor to the vehicular congestion on Leh's roads stems from the increased taxi load, primarily associated with tourist influx. The absence of efficient transportation options for tourists navigating various attractions exacerbates this challenge. In response, a hop-on-hop-off service is recommended for Leh town, offering a convenient and cost-effective alternative for tourists while alleviating road congestion. The proposed service comprises two main routes for Leh: a shorter route encompassing the market, palace, and stupa, and a longer route extending up to ward 01. These routes are meticulously designed to cover key tourist locations and ensure widespread access, with the tentative alignment reaching 91% of the hotels in Leh town, all within a 5-minute walking distance.

Intervention M 11: Development of NMT Infrastructure:

Responsible Agency: PWD, Leh MC

A mere 13% of the total road stretch in Leh, equivalent to 17 out of 126 km, currently has Non-Motorized Transport (NMT) infrastructure. Additionally, a considerable number of secondary pedestrian roads remain unmapped. If developed thoughtfully, these pedestrian pathways hold substantial potential to enhance pedestrian mobility significantly. Promoting pedestrianisation is anticipated to result in a marked decrease in car usage, particularly for short-distance journeys. Moreover, most of the hotels are strategically positioned within a 10-minute walking radius from the Leh market. Augmenting walkability in this area alleviates the demand for taxis among tourists, fostering a more sustainable and pedestrian-friendly environment. This proposal recommends the development of a further 109 km of pedestrian infrastructure in Leh city. This development can occur in a phased manner radiating out from the central market area. The development of pedestrian infrastructure should also be accompanied by the development of road safety measures like pelican crossings and streetlights.

Stationary Energy

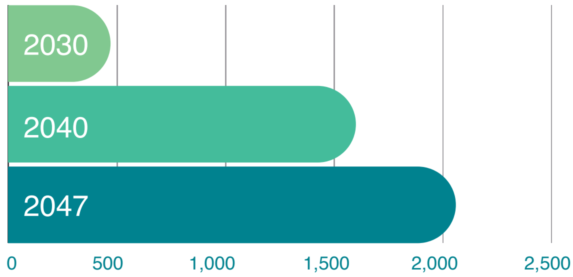
ENERGY SAVING FROM WATER EFFICIENT FIXTURES

CSCAF Theme		Indicators	Thrust Area
Water Management	Water Resources Management	Energy Efficient Water Supply System	Reduction of electricity usage and future demand

Emission Reduction

0.41%
of BAU $MTCO_2e$ reduced

2,059
$mtCO_2$ reduced



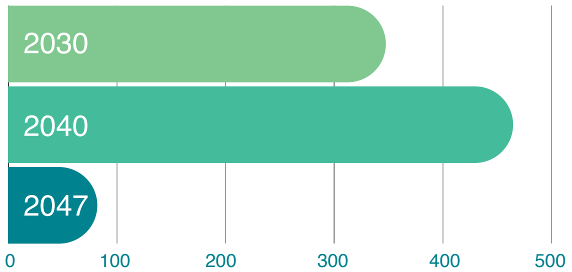
Decadal emission reduction (tCO_2)

Cost of Interventions

₹ 1,890 per tonne of tCO_2 removed

0.93%

₹ 8.94 Cr
Cost of interventions



Decadal investment required (in lakhs)

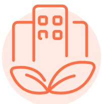
	2030	2040	2047
Emissions after interventions (Cumulative)	1,36,026	1,97,894	2,47,741
$mtCO_2$ reduced due to interventions (Cumulative)	470	1,599	2,059
% of Baseline emissions reduced	0.19%	0.40%	0.41%
Cost of Interventions (Cumulative)	₹3.47 Cr	₹8.12 Cr	₹8.94 Cr
Cost per tCO_2 reduced	₹73,911	₹50,804	₹43,417

RECOMMENDATIONS

TRANSITIONING TO ELECTRIC VEHICLES

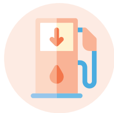
Transportation

CSCAF Theme



Energy and Green Buildings

Indicators

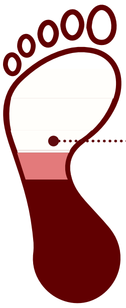


Fossil Fuel Consumption

Thrust Area

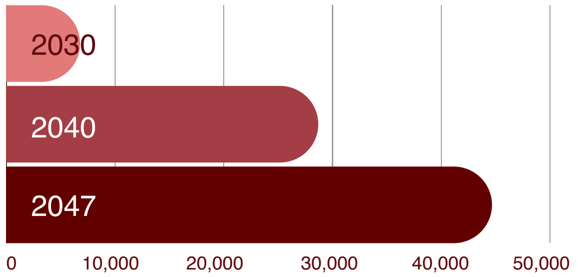
Emission Reduction through Transport Transformation

Emission Reduction



8.97%
of BAU $MTCO_2e$ reduced

44,652
$mtCO_2$ reduced



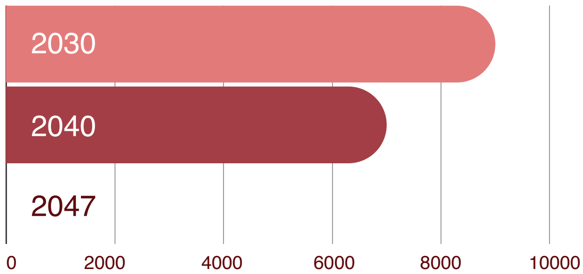
Decadal emission reduction (tCO_2)

₹ 35,833 per tonne of tCO_2 removed

Cost of Interventions

16.70%
of total cost

₹ 160 Cr
Cost of interventions



Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,29,249	1,69,216	2,03,089
$mtCO_2$ reduced due to interventions (Cumulative)	6,777	28,678	44,652
% of Baseline emissions reduced	2.68%	7.24%	8.97%
Cost of Interventions (Cumulative)	₹90 Cr	₹160 Cr	₹160 Cr
Cost per tCO_2 reduced	₹1,32,806	₹55,792	₹35,833

Even with the reduction proposed measures, fossil fuels are anticipated to account for approximately 58% of total emissions after the specified reduction initiatives. Considering the expected surge in emissions, primarily attributed to the burgeoning number of cars, advocating for a transition to Electric Vehicles (EVs) becomes imperative and judicious.

While EVs are not entirely emissions-free, their adoption substantially reduces emissions per kilometre, dropping from 0.15 kg/km to 0.07 kg/km compared to conventional vehicles. Furthermore, over the long term, the residual emissions associated with EVs can be entirely eliminated by transitioning energy generation to renewable sources. By 2047, Leh is projected to have 22,665 private cars (3,533 diesel and 19,132 petrol) and 7,670 taxis (all diesel). Navigating this transition will necessitate distinct approaches for private cars and taxis, ensuring a comprehensive and effective shift toward sustainable transportation.

Taxi drivers and unions express reservations about EVs' performance in Leh's rugged terrains. This, coupled with the absence of a reliable public charging infrastructure, has impeded the transition, even with subsidies outlined in the Ladakh EV policy. Overcoming these obstacles is crucial to realising the financial and environmental benefits of the widespread adoption of electric taxis in the region.

Intervention M 12: Development of EV Charging Infrastructure

Responsible Agency: Leh MC, LREDA

Addressing these challenges necessitates establishing Electric Vehicle (EV) fast charging infrastructure within Leh town and in prominent tourist destinations such as Nubra and Pangong. The proposal outlines the development of 400 rapid public charging stations by 2040, with half of these designated for Leh town and the remaining 200 distributed between Nubra and Pangong. The construction of this infrastructure must take precedence over other administrative measures aimed at promoting EV adoption, as the successful uptake of electric vehicles is contingent upon the accessibility and availability of associated charging facilities. The charging infra can be done with Solar power and the since there is no cost to generation, the power can be supplied free to the early adopters of EV as a further incentive.

Intervention M 13: Conducting Trail Runs of EVs

Responsible Agency: Motor Garages

Despite the Motor Garages department's successful implementation of Electric Vehicle (EV) trials in Leh, the general populace remains hesitant about adopting this technology. A collaborative trial program is proposed to enhance user confidence in EVs, wherein authorities can partner with Taxi unions. This trial initiative could entail the complementary distribution of approximately 10 EVs to the taxi union, allowing them to operate these vehicles for tourist transport. Such a trial not only showcases the benefits of EVs to local taxi drivers but also serves as a tangible demonstration of the technology's advantages, potentially fostering greater acceptance among the broader community. Initial results for the trials have show EVs to be capable of completing distances of more almost 400km (leh to kargil and back) on a single charge.

Benefits of EV transitions for Taxi Drivers

A prospective cab owner in Leh would spend approximately ₹1,09,687 per year on fuel costs for taking a minimum of 5 monthly trips in the Leh-Nubra-Pangong circuit during the peak tourist months. Should this person decide to invest an extra ₹2 lakh in an EV instead of a conventional IC car and take advantage of the free charging facilities the state provides in these three destinations, he would recover the costs in two years. Further, after two years, his yearly income would increase by ₹1,09,687 as compared to if he had invested in an IC car.

Intervention M 14: Increasing EV Subsidies for Private Purchasers

Responsible Agency: RTO

While individuals stand to gain financial benefits from transitioning to Electric Vehicles (EVs), these advantages might not be substantial enough to facilitate the required pace of transition. Subsidies will be imperative to incentivise the adoption of EVs. While the Ladakh EV policy currently offers subsidies of up to ₹2,50,000 for the purchase of electric cars, the policy's target of 127 cars over five years falls significantly short of the numbers necessary for an effective transition to EVs.

There is a compelling need to expand the scope of subsidised vehicles to catalyse a widespread shift. Proposing an annual subsidy for 500 cars over a decade is recommended to attain a critical mass of 25% of vehicles, triggering a large-scale transition. During this period, the maximum subsidy for cars could be reduced to ₹2,00,000, with the remaining cost difference offset through an increase in road tariffs for non-electric cars. This strategic subsidy approach aims to bridge financial gaps and expedite the broader adoption of EVs in the region.

By combining these methods, Leh can fully expect to transition to EVs by 2042-43. The benefits of these proposals extend beyond mere emission reductions. These measures bring about additional secondary advantages, including a reduction in air pollution levels and a consequential decrease in tertiary emissions caused by the trucks engaged in fuel transportation to Leh. Thus, implementing these measures not only addresses environmental concerns but also brings about broader positive impacts on air quality and associated emissions.

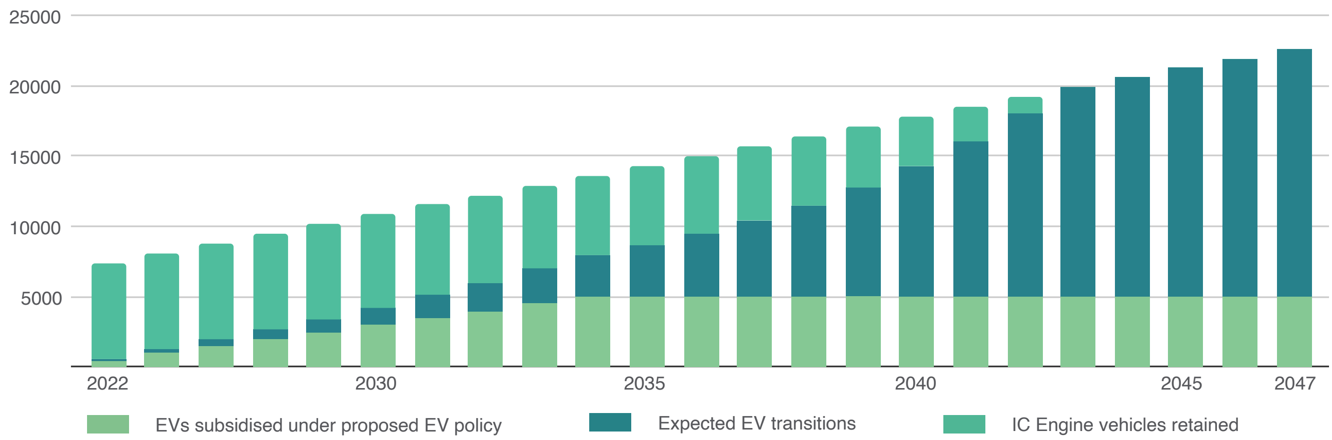


Figure 47: Expected Transitions of Private Cars towards EVs

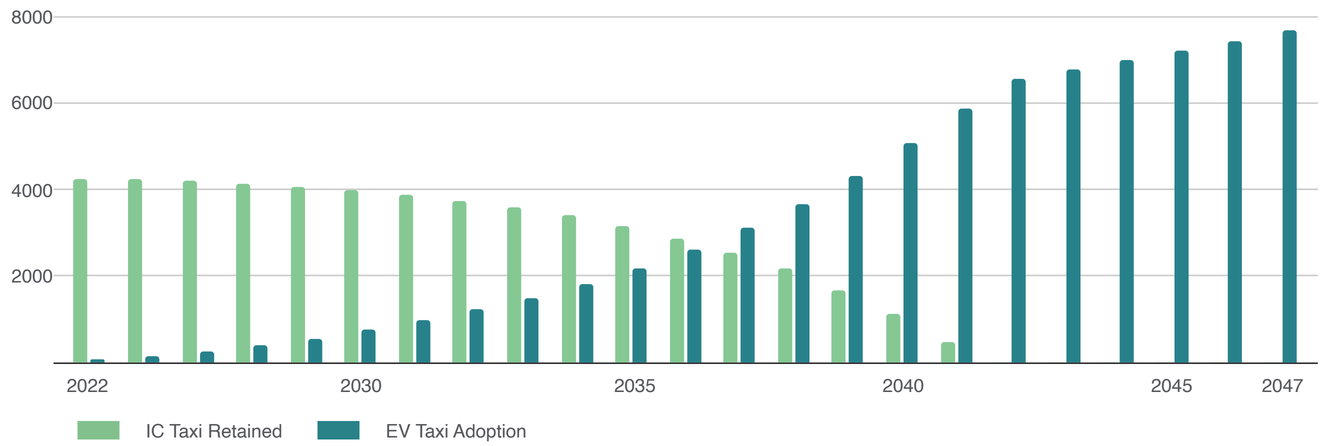


Figure 48: Expected Transitions of Taxis towards EVs

Stationary Energy

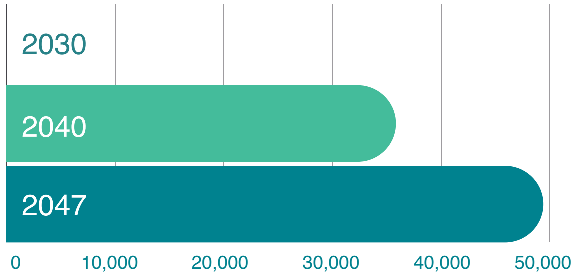
ENERGY STABILISATION AND ENERGY STORAGE

CSCAF Theme	Indicators		Thrust Area
Energy and Green Buildings	Renewable Energy	Fossil Fuel Consumption	Reduction of electricity usage and future demand

Emission Reduction

9.93%
of BAU $MTCO_2e$ reduced

49,392
$mtCO_2$ reduced



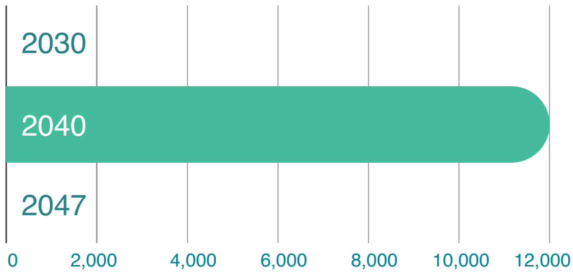
Decadal emission reduction (tCO_2)

Cost of Interventions

₹ 24,295 per tonne of tCO_2 removed

12.53%
of total cost

₹ 120 Cr
Cost of interventions



Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,29,249	1,33,389	1,53,698
$mtCO_2$ reduced due to interventions (Cumulative)	0	35,826	49,392
% of Baseline emissions reduced	0.00%	9.04%	9.93%
Cost of Interventions (Cumulative)	₹0	₹120 Cr	₹120 Cr
Cost per tCO_2 reduced	NA	₹33,495	₹24,295

Frequent power cuts characterise Leh's electric grid, prompting an increasing reliance on diesel generators to compensate for the resultant shortages. The demand for diesel for generator use is projected to escalate to 43% of the total anticipated fuel consumption, a notable increase from the 33% recorded in the inventory year. To address this challenge, the introduction of energy stabilisation measures is imperative to guarantee a consistent and uninterrupted 24x7 electricity supply.

Intervention M 15: Develop Pumped Hydro Systems for water storage

Responsible Agency: PHE, LREDA, PDD, LAHDC, Leh MC

Given the inherent intermittency of Leh's electric grid, the establishment of city-level energy storage systems emerges as a critical imperative. Among the available options, a pumped hydro storage system stands out as the most economically viable and scalable solution. The unique terrain of Leh further accentuates its suitability for the development of such a system, leveraging the region's natural features to enhance efficiency.

A proposed pumped hydro storage system, with a capacity of 12 hours and 100 MW, can meet the energy demands of Leh town. Importantly, the system is designed with flexibility in mind, allowing for an additional 100 MW capacity to be seamlessly integrated should future energy requirements necessitate expansion.

Advantages of Pumped Hydro

Pumped hydro stands out as a notably efficient method of storing electricity, boasting an impressive 80% efficiency, surpassing other alternatives such as batteries with an efficiency range of 60%-70% and hydrogen storage at approximately 75%. Additionally, pumped hydro exhibits the longest operational lifespan among existing storage systems, with a remarkable endurance of around 40 years, in contrast to the comparatively shorter 10-year lifespan of batteries.

The adoption of an effective energy storage system not only enhances the overall efficiency of the energy storage process but also contributes to reducing the costs associated with transitioning to solar energy. Importantly, such systems play a pivotal role in diminishing the reliance on battery storage thereby reducing external dependencies in a remote region like Leh. By leveraging the advantages of pumped hydro, Leh can optimise its energy storage capabilities, ensuring long-term efficiency and cost-effectiveness in its pursuit of sustainable energy solutions

Intervention M 16: Expanding the development of Green Hydrogen systems for energy storage

Responsible Agency: LREDA, PDD, Leh MC, NTPCL

NTPCL is in the early phase of trials of generation and usage of Green Hydrogen Leh. This trail focuses on the generation of Green Hydrogen (utilising solar energy) and the utilisation of the same to power Hydrogen buses. While still in the early phase, the trial shows much promise. The potential of green hydrogen can be expanded beyond this, with hydrogen fuel cells serving as an effective alternative to diesel generators currently used in Leh to supply electricity during a power outage. Hydrogen fuel cells would have much higher capacities to generate electricity. They can even be considered a power source at a neighbourhood scale or for larger users.

While this technology is reasonably well established, its large-scale deployment is still in its infancy. Further, given the untested nature of the technology, particularly in the challenging conditions in India, the potential challenges, issues, and operational hindrances will be hard to ascertain. The administration can, directly or through an industry expert, undertake phased trials of Hydrogen fuel cell technologies as an alternative to diesel generators in Leh.

Intervention M 17: Phasing out Diesel Generators

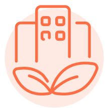
Responsible Agency: Leh MC

The administration can consider implementing a phased ban on diesel generators in conjunction with the above two proposals. Not only do these generators contribute to more than 10% of the inventory year GHG emissions for Leh, but they are also a significant source of pollutants which impact the air quality around settlements where they are used. The ban can, however, only be implemented after implementing the previous two interventions. In the intermediate period, the administration can look at bringing emission standards for diesel generators, which can at least reduce the extent of pollutants.

Stationary Energy

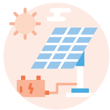
TRANSITION TO RENEWABLE ENERGY- ROOFTOP SOLAR

CSCAF Theme

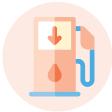


Energy and Green Buildings

Indicators



Renewable Energy

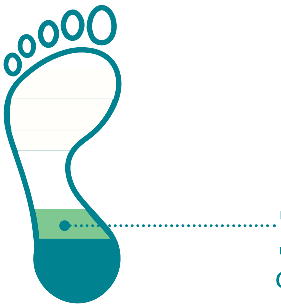


Fossil Fuel Consumption

Thrust Area

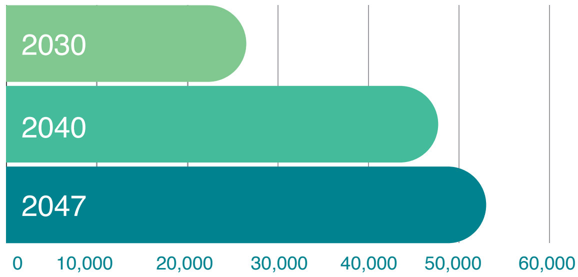
Reduction of electricity usage and future demand

Emission Reduction



10.65% of BAU $MTCO_2e$ reduced

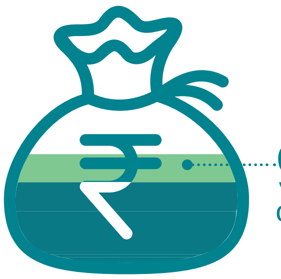
62,039 $mtCO_2$ reduced



Decadal emission reduction (tCO_2)

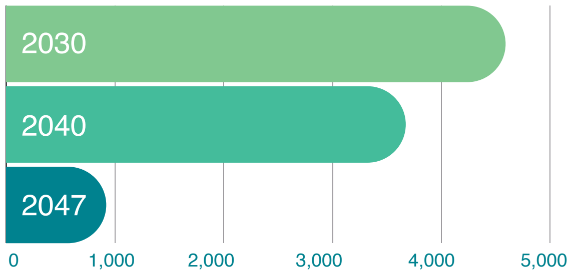
₹17,326 per tonne of tCO_2 removed

Cost of Interventions



9.58% of total cost

₹ 91.8 Cr
Cost of interventions



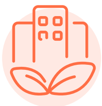
Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	1,02,755	85,700	1,00,709
$mtCO_2$ reduced due to interventions (Cumulative)	26,494	47,689	52,988
% of Baseline emissions reduced	10.48%	12.04%	10.65%
Cost of Interventions (Cumulative)	₹45.9 Cr	₹82.6 Cr	₹91.8 Cr
Cost per tCO_2 reduced	₹17,326	₹17,326	₹17,326

TRANSITION TO RENEWABLE ENERGY– SOLAR FIELD

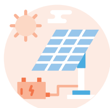
Stationary Energy

CSCAF Theme

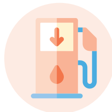


Energy and Green Buildings

Indicators



Renewable Energy

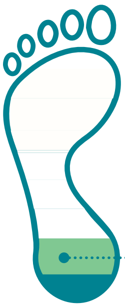


Fossil Fuel Consumption

Thrust Area

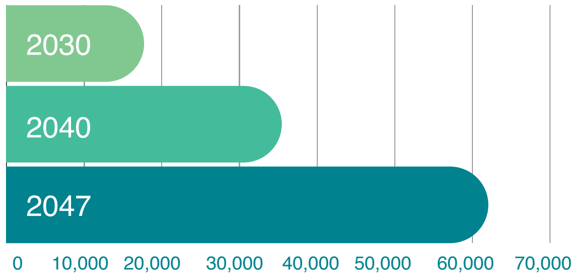
Reduction of electricity usage and future demand

Emission Reduction



12.47% of BAU $MTCO_2e$ reduced

62,039 $mtCO_2$ reduced



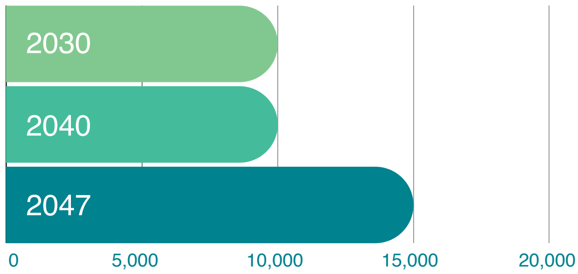
Decadal emission reduction (tCO_2)

₹ 56,416 per tonne of tCO_2 removed

Cost of Interventions

36.54% of total cost

₹ 350 Cr
Cost of interventions



Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	85,030	50,250	38,671
$mtCO_2$ reduced due to interventions (Cumulative)	17,725	35,451	62,039
% of Baseline emissions reduced	7.01%	8.95%	12.47%
Cost of Interventions (Cumulative)	₹100 Cr	₹200 Cr	₹350 Cr
Cost per tCO_2 reduced	₹56,416	₹56,416	₹56,416

Leh holds immense potential for harnessing solar energy. With a solar generation capacity of 1858 kWh per KW installed, the region can capitalise on its abundant solar resources. The advantages of tapping into solar power in Leh extend beyond meeting the region's growing energy demands. Solar power provides a sustainable and clean energy alternative, aligning with global efforts to reduce carbon emissions. The decentralised nature of solar energy production also enhances energy resilience, reducing dependence on external sources. Moreover, solar power facilities contribute to the local economy, fostering job creation and supporting the development of a robust renewable energy sector. By strategically integrating solar fields in the urban peripheries, Leh harnesses its solar potential efficiently and capitalises on solar power's numerous environmental, economic, and social benefits.

Intervention M 18: Expanding scope of subsidies and conduct IEC activites for Rooftop Solar

Responsible Agency: PHE, LREDA, PDD, LAHDC, Leh MC

The dispersed and low-rise nature of development in Leh makes it highly suitable for the large-scale adoption of rooftop solar. Leh currently has a rooftop solar subsidy scheme that provides 17,662 per KW subsidy up to 3KW and a further subsidy of 8831 per KW up to 10 KW for residential uses only. This intervention seeks to increase the subsidy to 18,000 per Kw upto 25KW installed capacity and open the scheme to other building uses with a particular thrust on hotels and homestays. The proposed cost of subsidies, which is expected to come up to ~90 Cr, can be met through a combination of central government funds through the newly launched PM-Surya Ghar Muft Bijli Yojana and the increased revenue generated from the proposed new tariff structure, which can be used to cross-subsidise the adoption of RTS. At optimal levels, Leh can generate 11.1 Cr units of electricity from the rooftop solar system.

The subsidy for RTS systems can be accompanied by an expansion of the IEC (Information, Education and Communication) activities already being carried out by the PDD department.

Intervention M 19: Development of solar fields

Responsible Agency: PHE, LREDA, PDD, LAHDC, Leh MC

To transition towards net zero, leh will need to leverage its excellent solar potential and generate solar power to meet its needs completely. This would entail the development of 70MW of solar power fields to generate the required 13cr units that are expected to be consumed on average per day in Leh by 2047. The development of this field can be done in phases, with the first 20 MW being developed by 2030, the next 20 by 2040 and the final 30 by 2047. This would allow the administration to stagger the extensive financial allocations to achieve this. Further, if the solar fields are developed in conjecture with the pumped hydro systems (M 15), the costs can significantly be reduced as the PHP system would serve as the battery to store the solar power generated, thereby eliminating the need for conventional batteries.

Further, given Leh's difficulty in developing conventional carbon sinks, this Climate Action Plan proposes that Leh become a seller of clean electricity back to the national grid. This can offset the residual emissions, which will be retained after implementing the other actions prescribed by this CAP. To offset this residual emissions, Leh will need to develop a 45MW solar field which can generate approximately 7 Cr units of electricity for sale to the national grid.

DEVELOPMENT OF RENEWABLE ENERGY FOR CARBON TRADING

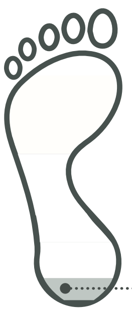
Carbon Sinks

CSCAF Theme: Energy and Green Buildings

Indicators: Renewable Energy

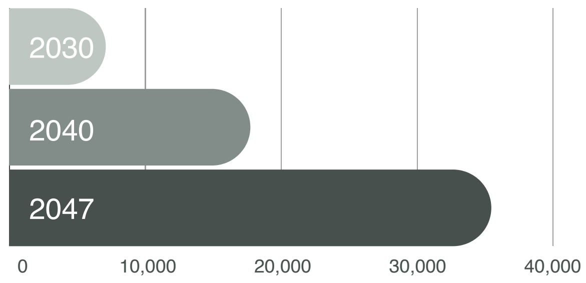
Thrust Area: Reduction of electricity usage and future demand

Emission Reduction



35,451
$mtCO_2$ reduced

7.12%
of BAU $MTCO_2e$ reduced



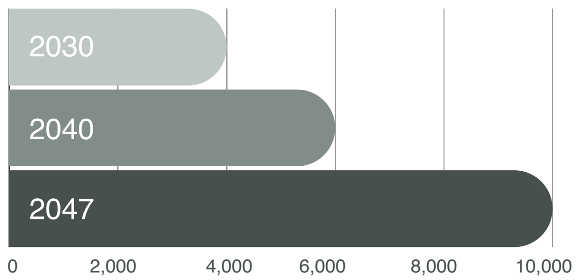
Decadal emission reduction (tCO_2)

Cost of Interventions

20.88%
of total cost

₹ 200 Cr
Cost of interventions

₹ 56,416 per tonne of tCO_2 removed



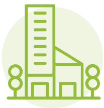
Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	77,940	32,524	3,220
$mtCO_2$ reduced due to interventions (Cumulative)	7,090	17,725	35,451
% of Baseline emissions reduced	2.81%	4.48%	7.12%
Cost of Interventions (Cumulative)	₹40 Cr	₹100 Cr	₹200 Cr
Cost per tCO_2 reduced	₹56,416	₹56,416	₹56,416

Carbon Sink

DEVELOPMENT OF CARBON SINKS

CSCAF Theme



Urban Planning, Green Cover and Biodiversity

Indicators

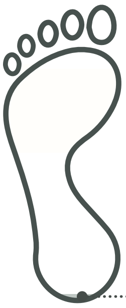
Proportion of Green Cover

Disaster Resilience

Thrust Area

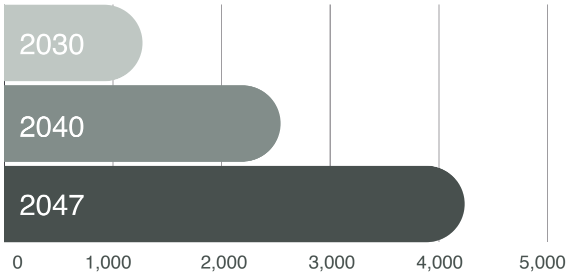
Combating Flash Flooding

Emission Reduction



4,236
$mtCO_2$ reduced

0.85%
of BAU $MTCO_2e$ reduced



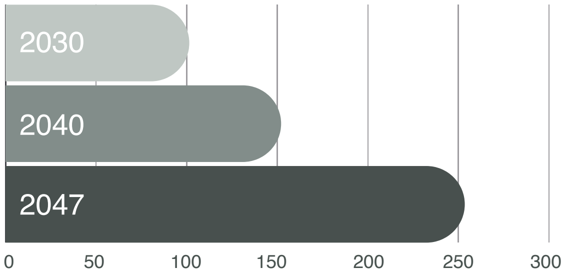
Decadal emission reduction (tCO_2)

₹ 11,971 per tonne of tCO_2 removed

Cost of Interventions

0.53%
of total cost

₹ 5.07 Cr
Cost of interventions



Decadal investment required (in lakhs)

	2030	2040	2047
Emissions after interventions (Cumulative)	76,669	29,983	-1,016
$mtCO_2$ reduced due to interventions (Cumulative)	1,271	2,542	4,236
% of Baseline emissions reduced	0.50%	0.64%	0.85%
Cost of Interventions (Cumulative)	₹1.01 Cr	₹2.53 Cr	₹5.07 Cr
Cost per tCO_2 reduced	₹7,981	₹9,976	₹11,971

Augmenting Waste Management Systems

Waste

In addition to the GHG mitigation measures listed above, Leh will also need to implement the following measures in the waste sector to help it achieve broader sustainability targets. While the waste sector contributes a very small fraction to the GHG emsissions of Leh, mostly because of the excellent wet and dry waste management pracitces of the Leh MC, the areas of Construction and Demolition Waste Management and Dry waste processing fall short. The following interventions have been recommended in this regard. While the scope 01, and 02 emission reduction potential of these measures are minimal, these interventions listed would recuse scope 03 emissions in the waste sector in Leh. Scope 03 is considered for solid waste becase the Leh MC has done a very commendable job in reducing scope 01 and 02 emissions from the sector. However, given the lack of data surrounding the extent of emissions, especially for aspects like embodied energy with respect to C&D waste, the emission reduction potentials of these interventions have not been quantified. Never the less, these measures are critical to the next phase of emission reduction from the waste sector.

Intervention M 20: Reduce dry waste generation

Responsible Agency: Leh MC

The bulk of dry waste is generated during the tourist season, causing a significant surge that often overwhelms existing waste processing facilities. This surge hampers the efficiency and efficacy of dry waste segregation and processing. With the anticipated rise in tourist numbers in Leh, it becomes imperative to decrease the per capita waste generated by tourists to facilitate efficient waste processing. Implementing measures such as bans on single-use plastics, Information, Education, and Communication (IEC) initiatives to educate tourists about minimizing product use, and incentive or disincentive schemes to discourage single-use products can contribute to achieving this goal.

Intervention M 21: Develop dry waste processing industry

Responsible Agency: Leh MC

Leh currently relies on transporting its segregated dry waste to other cities by road for processing. This practice, due to the considerable distance of Leh from major centres, significantly contributes to the town’s scope 3 emissions. As the city continues to grow, this method may become untenable, given the potential prohibitive costs associated with transportation. Additionally, nearly 50% of the processed waste currently ends up in landfills. Consequently, Leh needs to establish a dedicated dry waste processing centre capable of converting dry waste into marketable products. Such an initiative not only presents an opportunity for additional municipal revenue but also contributes to local employment generation.

Intervention M 22: Implement rules for C&D waste disposal, management and processing

Responsible Agency: Leh MC

One area that warrants improvement is the processing and handling of construction and demolition (C&D) waste. The substantial development witnessed by Leh in recent years has led to an increased generation of C&D waste. Leh hence needs a comprehensive C&D waste management policy that would set out the guidelines and responsibilities on managing C&D waste.

Intervention M 23: Develop a C&D waste management plant

Responsible Agency: Leh MC

To address this, Leh could consider establishing an additional C&D waste management centre. Transforming demolition waste back into construction material, with minimal new additions, holds promise. This approach is particularly significant in a region like Leh, where repurposing such materials locally can alleviate the need to transport fresh construction materials from distant regions like Srinagar, thereby reducing construction costs.

5.4 Adaptation Actions

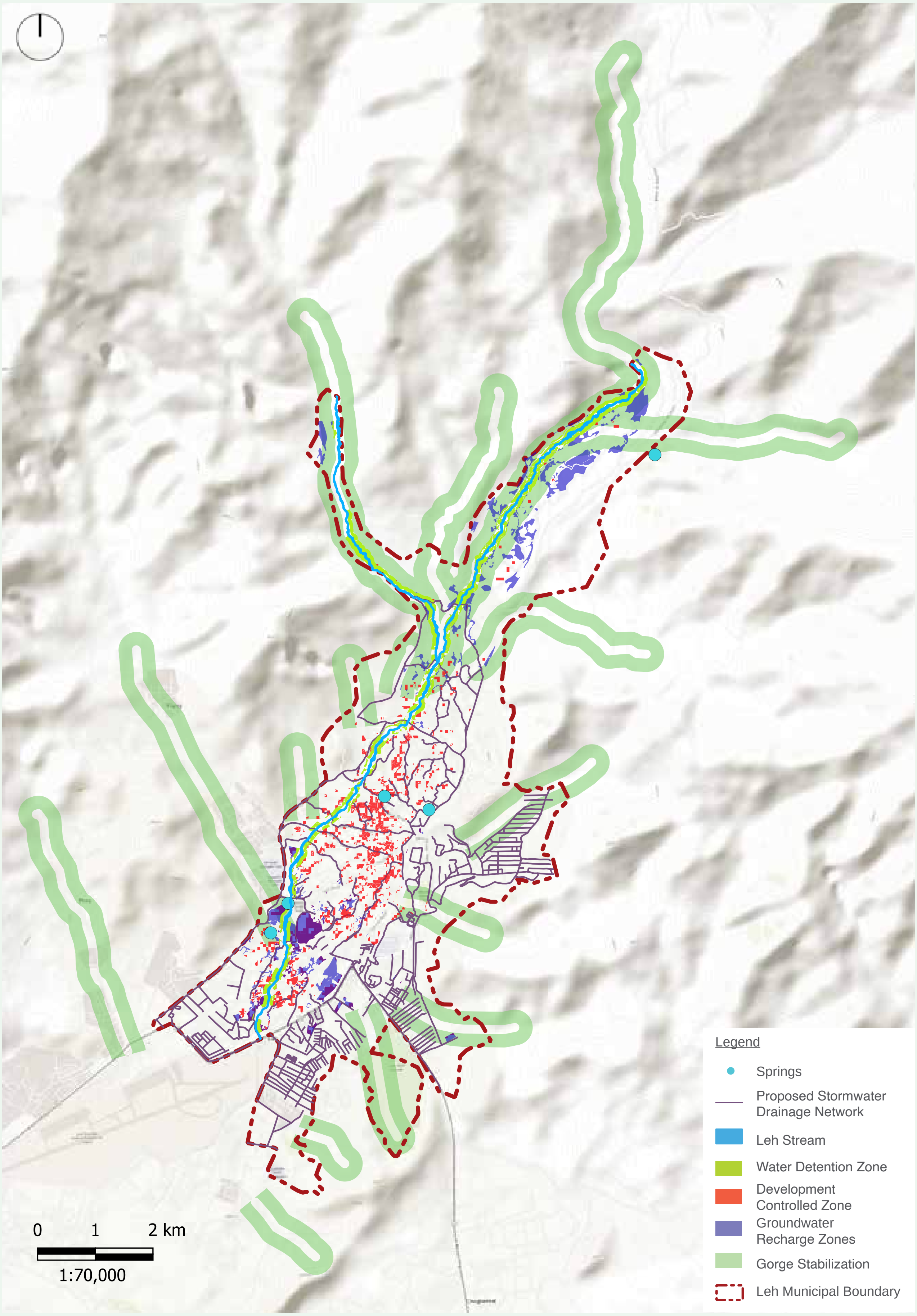
5.4.1 Overview of Actions

Adaptation measures are essential to equip Leh with the tools and strategies needed to confront the consequences of climate change effectively. As underscored in the previous sections, Leh faces significant climate risks in water management and flood resilience. Climate change exacerbates these challenges, necessitating proactive measures to enhance resilience and fortify the community against the evolving impacts of a changing climate. In light of these considerations, adaptation becomes a response to current challenges and a critical investment in building a sustainable and climate-resilient future for Leh.

This Climate Action Plan identifies two thrust areas to address Leh's climate adaptation needs. These are related to Effective Water Management and Combatting Flash Flooding. Four objectives and fourteen actions have been proposed to help Leh adapt to its climate change-related challenges. These actions are a combination of policy, plans and projects devised to help build the resilience of the existing settlements and ensure that future developments have climate resilience built in. A summary of the key actions proposed for this purpose is highlighted in the table below and on the map in the following page.

No.	Action	Extent	Thrust Area	Tentative Cost*
Project Proposals				
1	No Development Area Demarcated (sqkm)	2.45	Combating Flash Flooding	NA
		2.80	Effective Water Management	NA
2	Controlled Development Area Demarcated (sqkm)	6.26	Combating Flash Flooding	NA
		8.17	Effective Water Management	NA
3	Springs Revivals Proposed (nos)	5 / 10	Effective Water Management	₹5 Cr
4	Ground Water Recharge Zones Demarcated (sqkm)	9.8	Effective Water Management	NA
5	Hill Slope Area Stabilised (sqkm)	11.727	Combating Flash Flooding	₹5.07 Cr
6	Storm Water Drainage Developed (km)	84.75	Combating Flash Flooding	₹42.37 Cr
7	Flood Detention Areas Demarcated (sqkm)	0.67	Combating Flash Flooding	NA
Policy Proposals				
8	Pricing Regime for Water Supply		Effective Water Management	NA
9	Mandates for the installation of Low Flow Fixtures in existing and new developments		Effective Water Management	₹8.94 Cr
10	Mandates for Dual piping systems in new commercial and hospitality developments		Effective Water Management	NA
11	Mandates for Borewell usage metering and pricing		Effective Water Management	NA
Plan Proposals				
12	Treated Water Reuse Plan for Leh		Effective Water Management	NA

*Tentative Costs Estimated as per 2023 prices. Final costs may vary based on detailed on-ground studies and estimations. Estimations do not include costs of land acquisition



Map 24: Proposed Adaptation Interventions

Water Management

Reduction of Fresh Water Usage

The water supply in Leh heavily relies on groundwater sources. There is an escalating dependence on groundwater for municipal supply and individual extraction. Compounding the water-related challenges in Leh is the absence of water usage metering, water audits, and a pricing mechanism—all of which contribute to a deficient understanding of water needs and consumption patterns.

Intervention A 1: Developing Pricing Regime for Water:

Leh presently lacks any water pricing structures. While the municipal piped water supply encompasses 56% of the town area, users within this coverage receive no charges for the service, and their connections remain unmetered, leaving water consumption unmeasured. The prevalent use of borewells further complicates the situation, as no

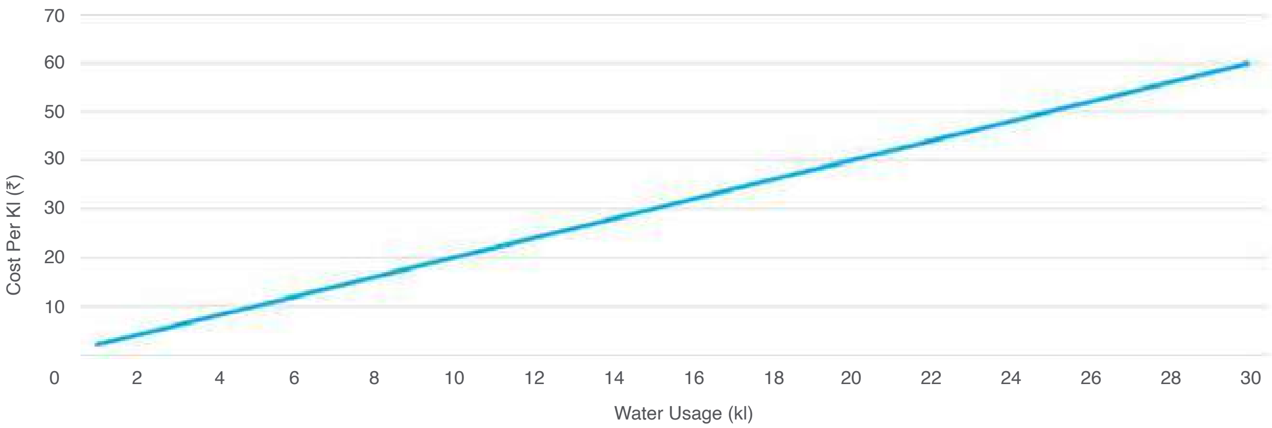


Figure 49: Proposed Water Pricing Structure

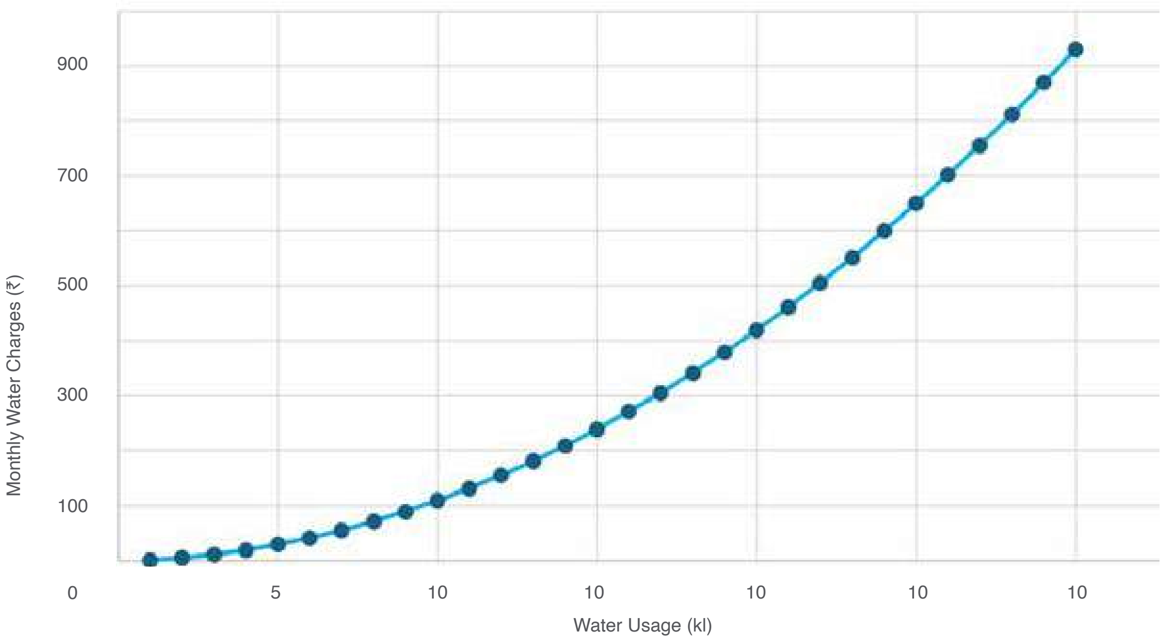


Figure 50: Month Water Charges under New Water Pricing Model

mechanisms exist to quantify and regulate extraction.

The recent decision by the pollution control board to meter borewell connections in commercial properties represents a positive step forward, however, this initiative does not cover legacy borewells. It is crucial to note that the pollution control board needs more authority to impose charges for the extraction or penalise over-extraction.

To effectively control water consumption in Leh, this Climate Action Plan proposes the introduction of a telescopic pricing regime for water consumption in Leh akin to the electricity traffic structure proposed in Intervention M4. A tentative pricing model has been developed with an approximate cost recovery rate of ₹5 crore for the provider to break even. The details of the pricing model are in the table below.

Intervention A 2: Mandating and Subsidising Low-flow Fixture Integration:

The lack of water pricing has led to a culture of water overuse in Leh, especially among the tourists who come during the summer months. While pricing models for water can be an effective tool to reduce usage, adopting low-flow fixtures can add considerable savings to the per capita water consumption. This adoption can happen in the form of mandates for new commercial and hospitality developments and as purchase-linked subsidies for residential users and existing commercial buildings. The additional revenue generated from water metering and pricing can be utilised to provide these subsidies. Integrating these fixtures can reduce freshwater usage by up to 40% without a significant reduction in quality of life metrics and usage behaviours, making it a prudent strategy for promoting sustainable water practices within the community.

Fixture	% Cost proposed to be Subsidized
WC	84%
Pillar (Basin tap)	31%
Bib (Tap)	38%
Sink	26%
Shower	12%

Intervention A 3: Develop Systems of Wastewater reuse:

Leh presently lacks a system for the utilisation of treated used water. Consequently, all treated water is discharged into the Indus River, while freshwater continues to be extracted for various functions. Considering the ongoing expansion of the town's used water treatment capacity from 3 MLD to 10 MLD, it becomes imperative to establish mechanisms to systematically reuse this treated used water, thereby minimising dependence on freshwater resources.

A current administrative proposal outlines the intention to reuse some treated water for landscaping activities within government building complexes. While this represents a positive step in utilising treated water, the scope of its application is limited. Additional avenues include its utilisation for car washes, construction purposes, and any supplementary plantations essential for the slope stabilisation proposal outlined in the subsequent sections to maximise the beneficial reuse of treated water. Leh will need to conduct a detailed water use mapping to understand the extent of water requirement for different functions, which will help identify uses to which this treated water can be put to. One avenue for reuse can be for the plantations required for stabilising the slopes given in the proposal below.

Water Management

Improving Groundwater recharge

Intervention A 4: Implementing borewell metering:

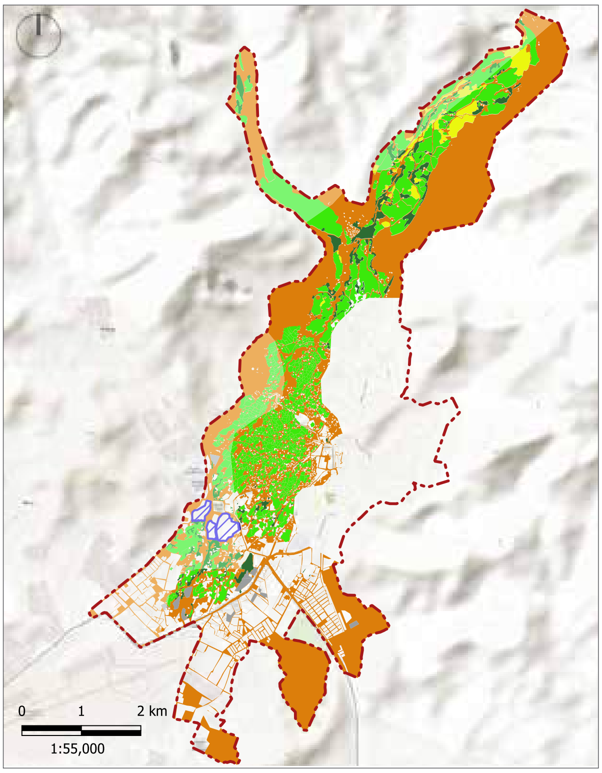
With a substantial number of private borewells in Leh town, the imminent risk of depleting groundwater resources looms large to address this knowledge gap. While the introduction of a metering system for new borewells presents a measure to monitor water extraction, this provision exclusively applies to new borewells in commercial properties, leaving domestic users and legacy borewells unaccounted for. To address this gap, developing a comprehensive borewell metering system within Leh town becomes imperative.

Once consumption and usage are systematically tracked, a cumulative charge for water usage at both household and commercial levels (incorporating both borewell and piped sources) can be implemented at rates elucidated in preceding sections. However, any restrictions imposed on borewell usage must align with the concurrent development of piped water infrastructure in currently uncovered areas and the proposed increase in water supply as outlined in the 24x7 water supply project. This synchronised approach ensures a balanced and sustainable management of water resources in Leh town.

Intervention A 5: Improving Ground water recharge

The extraction of groundwater in Leh through borewells raises concerns about its potential impact on the water table and hydrological systems. Due to a dearth of data, accurately estimating the extent of damage and planning an effective restoration process remains challenging. There is a critical need to commission a robust study. This study would assess the current state of the groundwater table, identify challenges it is facing, and analyse potential areas for water recharge alongside areas requiring extraction.

Based on secondary sources, a tentative mapping of undeveloped land parcels in high ground water potential zones have been identified. These are mainly in Wards 1,3,4,5 and 6. More than 96% of the high groundwater potential zones are currently used for agriculture, while wetlands account for most of the rest. A groundwater recharge system with infiltration sites will need to be developed on these land parcels where stored rainwater or treated used water (if it matches the required quality standards) can be utilised for recharging the groundwater table. Development in these regions will also need to be regulated to ensure that there is no significant reduction in recharge sites.

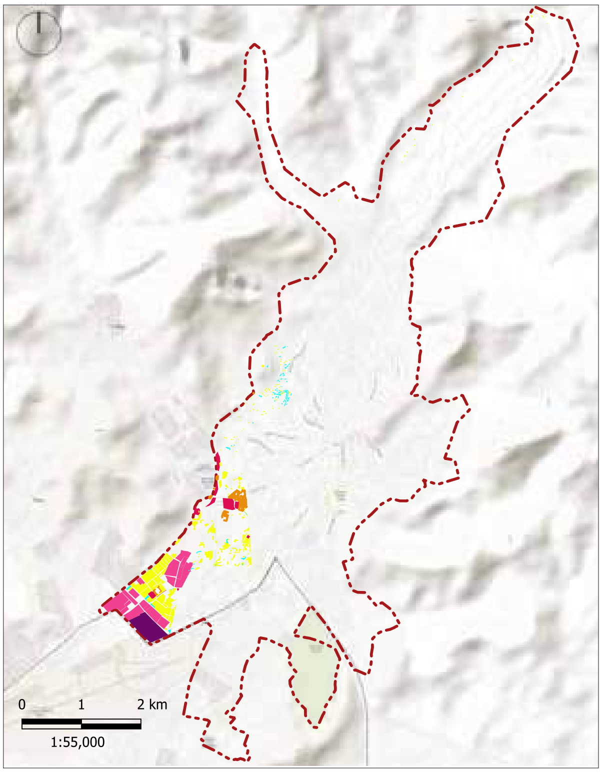


Map 25: Potential Groundwater Recharge Zones

Legend

Leh Municipal Boundary

Groundwater Level	Deep (26-34)	Medium (15-25)
Vacant Land		
Wetland		
Shrub		
Forest		
Agriculture		
Undefined area		



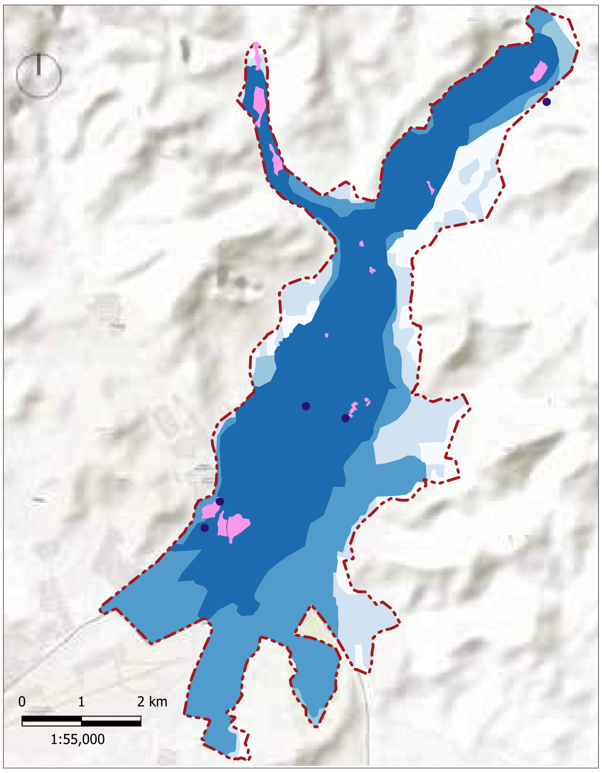
Map 26: Groundwater Extraction Limitation Zones

Legend

Leh Municipal Boundary

Developed Area Under Deep Groundwater Level

Commercial | Defense | Government
Industrial | Residential | Other Classes



Map 27: Springs to be Revived

Source: Water in Liveable Leh, BORDA

Legend

Springs | Wetlands | Leh Municipal Boundary

Groundwater Potential Zones

0.2-4.3 (Very Low) | 4.3-9.3 (Low) | 9.3-16.4 (Medium)
16.4-27.3 (High) | 27.3-46.7 (Very High)

Intervention A 6: Limiting Groundwater extraction

In parallel to enhancing the groundwater recharge, restrictions on the extraction of groundwater will need to be placed in regions where groundwater tables have dropped. These restrictions can either be in the form of outright bans in regions serviced by the municipal water supply network to limits on extractions regulated through the borewell meters. These mandates will however need to be implemented in a phased manner in parallel with the expansion of the water supply network as proposed in the 24x7 water supply plan.

Of the 0.79 sqkm which is proposed to be demarcated for the extraction limits, 42.17% is residential, 30.4% is under government uses and a further 11.56% is industrial land. Currently 6.52% of the population live in these areas and would approximately require 0.33MLD of water. The proposed expansion of the water supply network should prioritize these regions to ensure that the dependencies on borewells is limited.

Intervention A 7: Springshed Management and Spring Revival

The following 10 step proposal can guide spring shed management in Leh and Ladakh. The recommendations have been developed based on the Niti Aayog recommendations on the subject and on the process followed for spring revival under the National Missions for Sustainable Himalayan Ecosystems:

1. ***Systematic Springs Mapping:*** Undertake a systematic mapping of springs across Leh, recognising their potential to contribute up to 20% of mountain water and support vital ecosystem services. Establish a web-enabled database or portal for mapping and tagging springs, encouraging collaboration by involving State government departments, R&D institutions, and NGOs in uploading relevant data.

2. ***Comprehensive Mapping Approach:*** Implement detailed mapping encompassing hydrological, geo-tectonic, morphological, meteorological, land-use, and demographic details. Follow

a selective methodology, integrating current approaches such as the 8-step methodology and incorporating the latest protocols. Apply isotopes to identify the origin of springs and utilise hot-spot analysis to identify vulnerable springs.

3. ***Aquifer Mapping:*** Undertake aquifer mapping, with special attention from CGWB in regions where springs are prominent. Customise aquifer mapping approaches, potentially making the process more participatory.

4. ***Community Involvement and National Registry:*** Involve local communities, NGOs, and State Agencies in the mapping process, ensuring a participatory approach. Establish a national registry for springs to centralise information.

5. ***Reviving Springs:*** Combine scientific knowledge, particularly hydro-geology, with community engagement for a successful spring revival. Focus on the 'aquifer' as the planning unit, integrating watersheds and aquifers for a comprehensive 'spring shed' approach. Implement recharge area protection, including "spring sanctuaries" with measures prohibiting land-use change in recharge areas.

6. ***Engineering Measures and Local Knowledge:*** Implement basic engineering measures coupled with vegetative strategies for spring revival. Identify and incorporate local-level management practices and traditional knowledge in spring-shed management plans.

7. ***Snow Retention and Meltwater Collection:*** Recognize the effectiveness of snow retention and snow meltwater collection for spring recharge in high-altitude regions.

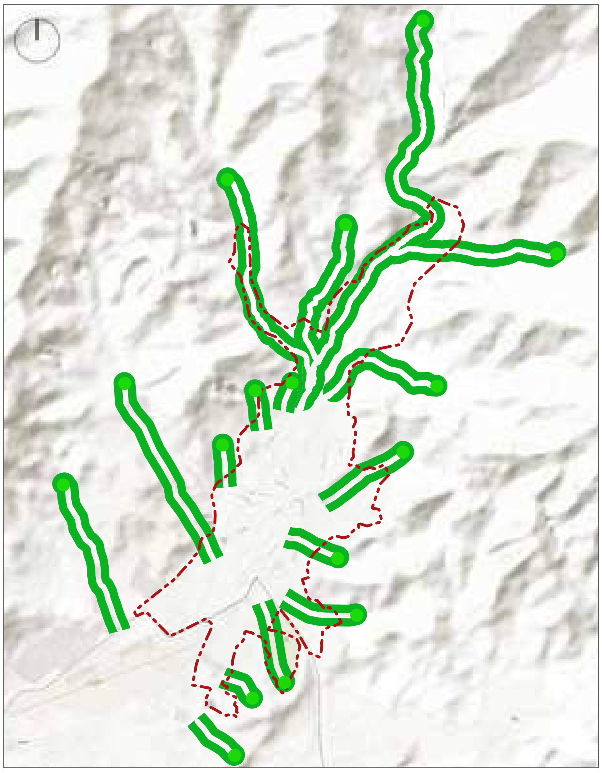
8. ***Demand Management and Livelihood Integration:*** Address the challenge of demand management, emphasising judicious, efficient, and organised water distribution, utilisation, conservation, and management. Link community livelihoods with spring interventions to ensure long-term sustainability, considering the multifaceted benefits of spring revival.

9. ***Development of Adaptive Strategies:*** Develop adaptive strategies, including risk management, as an adaptation measure to climate change impacts. Consider climate change projections and future impacts while identifying and implementing spring shed management activities.

10. R***egular Monitoring:*** Emphasize the importance of regular long-term monitoring of springs, particularly in water-scarce regions in the Himalayas. Collaborate with community organisations to monitor and develop protocols for reporting. Maintain a few permanently monitored springs of distinct typologies in each district to assess the impacts of climate and land-cover change.

Mitigating Mudslides

Combating Flooding



Map 28: Slopes to be Stabilised

Intervention A 8: Stabilisation of Hill Slopes:

Leh town, nestled in a valley surrounded by barren hills, is a product of Ladakh's cold and dry climate. Historically, this topography posed minimal challenges due to limited rainfall. However, the recent surge in high-intensity rains, often triggered by cloud bursts, has elevated the risk of landslides. Identified are 18 gorges encircling Leh town, presenting vulnerabilities to flash flooding (refer to Map 28).

To address this growing concern, it becomes imperative to implement slope stabilisation measures to mitigate the impacts of potential landslides. This comprehensive approach would involve a combination of stabilising elements such as Gabions, terraces, and strategic plantations. A detailed pre-feasibility study is crucial to accurately estimate the specific nature, location, and type of interventions required, effectively minimising landslide risks. While the initial estimate of the project is only around 5Cr, this is only the estimated cost of minimal plantation activities. The overall project costs can only be determined after the completion of feasibility studies.

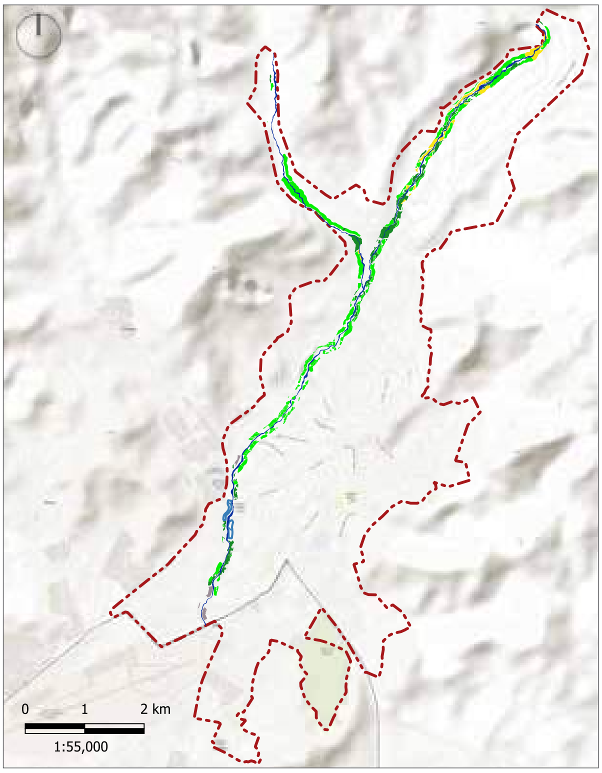
Combating Flooding

Managing Flood Water

Intervention A 9: Redevelopment of Leh Canal to increase holding capacity

The Leh Canal faces encroachments at multiple locations, diminishing its carrying capacity. Consequently, during periods of intense rainfall, such as cloud bursts, the canal overflows lead to flooding in the surrounding areas. The recent increase in high-intensity rainfall has highlighted this, and the projected increase in average rainfall by 2050 and 2100 is only likely to exacerbate this situation. Given that it might be challenging to remove the encroachments and that re-engineering the canal would require extensive studies, the intervention leverages the low-intensity development of Leh and proposes to demarcate flood detention zones along the canal. These empty sites can collect and hold rainwater during high-intensity rains, which can then be gradually released back into the canal in a controlled manner.

These detention ponds would significantly reduce the flow of flood water through the town. If executed properly, they can be developed to capture rainwater for use during the water scarce periods. These ponds, particularly ones at higher altitudes, can also be utilised to form artificial glaciers, a practice prevalent in the Ladakh region since the mid-1980s.



Map 29: Potential Sites for Detention Ponds

Legend

- Leh Stream
- Leh Municipal Boundary

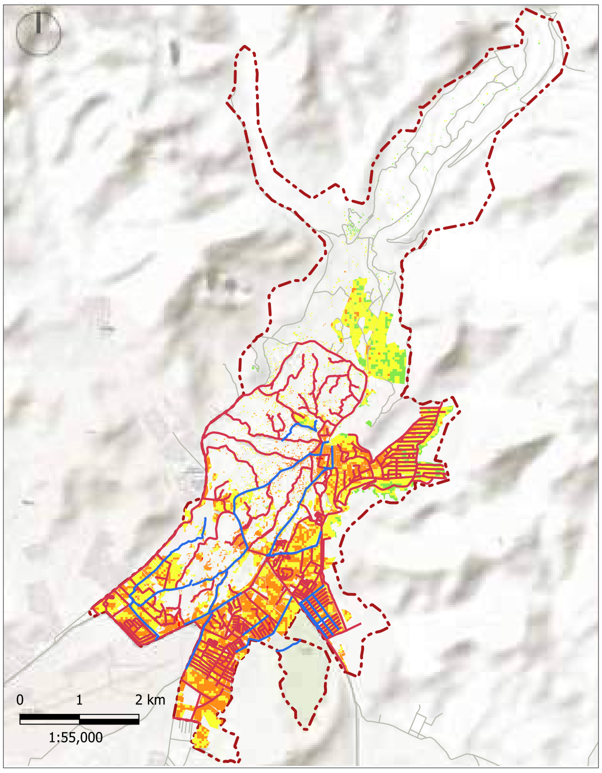
Undeveloped Area Under 50m buffer of Leh Stream

- Agriculture
- Forest
- Shrub
- Vacant
- Wetland

Land Use	Area (in sqkm)
Agriculture	0.405709
Forest	0.164073
Shrub	0.071165
Vacant	0.01722
Wetland	0.019479

Intervention A 10: Development of Storm Water drainage network:

Leh town currently lacks complete comprehensive coverage of stormwater networks. Aligning the flood risk assessment with the existing stormwater network coverage underscores the imperative to establish stormwater networks across Leh, particularly in the high and medium risk regions. The development of stormwater drainage networks is crucial for several reasons. It plays a pivotal role in mitigating the impact of floods by efficiently channelling rainwater, preventing waterlogging, and reducing the risk



Map 30: Proposed Stormwater Drainage Network

Legend

Existing Stormwater Drainage

Proposed Stormwater Drainage

Roads

Leh Municipal Boundary

Developed Area Under Flood Risk

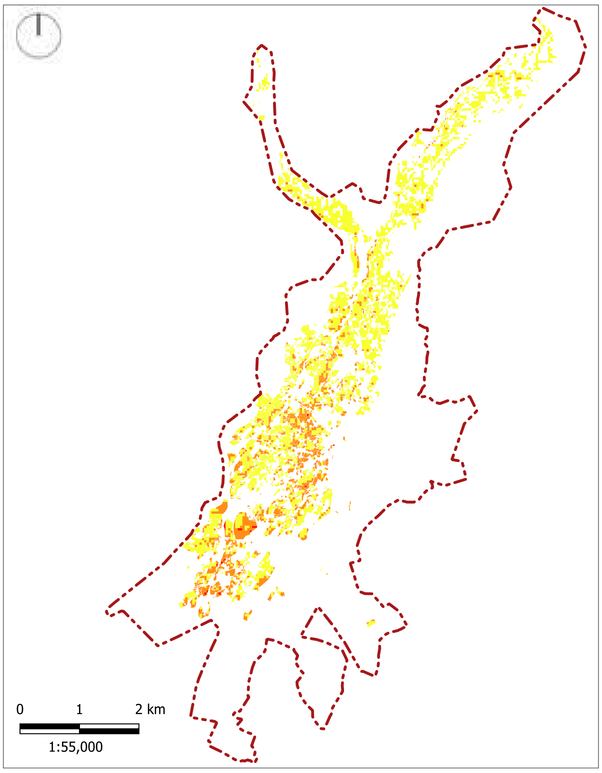
Very Low

Low

Medium

High

Very High



Map 31: Areas with development restrictions

Legend

Leh Municipal Boundary

Developed Area Under Flood Risk

Medium

High

Very High

of flash floods. Additionally, a well-designed stormwater drainage system helps protect infrastructure, preserves the integrity of roads, and safeguards the community's overall resilience against the detrimental effects of heavy rainfall and potential flood events. Cumulatively, this comes up to 84.75km of new stormwater drains, which, at the average cost of ₹50,00,000 per kilometre of pipe, is projected to cost approximately ₹42,37,56,935. The proposed network is divided into two categories based on the priority level shown on the map. This categorisation can be used as the basis for investment prioritisation and phasing.

Intervention A 11: Limiting urban sprawl and growth in ecologically sensitive and vulnerable land areas:

Leh town faces the risk of disaster-related damages arising from cloud bursts and landslides. To effectively adapt to these challenges, it is imperative to demarcate high-risk areas within Leh town as 'no development zones' and medium risk areas as 'controlled development zones'. This strategic demarcation will inform all future development and is essential to prevent the proliferation of settlements in regions prone to disasters. These two zones are selected based on the flood risk analysis.

In addition, the administration could look at a decongession plan in wards 11,13 to minimise the number of people living with flood risk. This plan will also need to include a plan for resettlement of communities, especially vulnerable communities, who currently live in regions of high flood risk.

ANNEXURE I: GHG Methodology

Emission Factors to Estimate Emissions from Various Sources

The emission factors used to estimate the carbon emissions from various sources are listed in Table 1. The Global Warming Potential (GWP) of gases is listed in Table 2.

Table 1 *Emission factors for India 2021-22*

S. No.	Electricity/Fuel	Emission factor	Unit	Emission factor	Unit
1	Electricity	0.815	MTCO2e/MWh	815	MTCO2e/kWh
2	Electricity (including RE)	0.715	MTCO2e/MWh	715	MTCO2e/kWh
3	Petrol	2.20307	MTCO2e/kL	2203.07	MTCO2e/L
4	Diesel	2.62694	MTCO2e/kL	2626.94	MTCO2e/L
5	CNG	0.48066	MTCO2e/kL	480.66	MTCO2e/L
6	LPG	1.51906	MTCO2e/kL	1519.06	MTCO2e/L
7	PNG	0.48066	MTCO2e/kL	480.66	MTCO2e/L

Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

Table 2 *Global Warming Potential of Gases*

S. No.	Name	Formula	GWP
1	Carbon Dioxide	CO2	1
2	Methane	CH4	28
3	Nitrous Oxide	N2O	265
4	Sulphur hexafluoride	SF6	23,500
5	Carbon tetrafluoride	CF4	6,630
6	Hexafluoroethane	C2F6	11,100
7	HFC-23	CHF3	12,400
8	HFC-134a	-	1,300

Source: IPCC 5th Assessment Report

Formulas and Calculations

For most of the emissions sources, GHG emissions are estimated by multiplying activity data by an emission factor associated with the activity being measured as mentioned in Eq. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time. An emission factor is a measure of the mass of GHG emissions relative to a unit of activity.

$$\text{Emissions} = \text{Activity data} \times \text{Emission Factor} \qquad (1)$$

Emissions from consumption of grid-supplied energy within the city boundary

For estimating CO_2 emissions from consumption of grid-supplied energy the data on kilowatt-hours (kWh) of electricity used is multiplied by the emission factor ($MTCO_2e$/kWh) for electricity, which will depend on the technology and type of fuel used to generate the electricity. The emission factors considered for electricity are shown in Table 1.

Emissions from fuel combustion within the city boundary

For estimating CO_2 emissions from fuel combustion, the data on Litres (L) of type of fuel sales (volume of fuel purchased within the city boundary) is multiplied by the respective emission factor ($MTCO_2e$/L) for Petrol, Diesel, CNG, LPG and PNG. The emission factors considered for all fuel type are mentioned in Table 1.

Emissions from in-boundary waste treatment

The IPCC methodology for estimating CH_4 emissions from SWDS is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the waste. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

The equations for estimating the CH_4 generation are given below. As the mathematics are the same for estimating the CH_4 emissions from all waste categories/waste types/materials, no indexing referring to the different categories/waste materials/types is used in the equations below.

First order of decay (FOD) model

- Methane Emissions

The CH_4 emissions from solid waste disposal for a single year can be estimated using Equation 2. CH_4 is generated as a result of degradation of organic material under anaerobic conditions. Part of the CH_4 generated is oxidised in the cover of the SWDS, or can be recovered for energy or flaring. The CH_4 actually emitted from the SWDS will hence be smaller than the amount generated.

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] X\ (1 - OX_T) \quad (2)$$

Where:

CH_4 Emissions = CH_4 emitted in year T, Gg
T = inventory year
x = waste category or type/material
R_T = recovered CH4 in year T, Gg
OX_T = oxidation factor in year T, (fraction)

The CH4 recovered must be subtracted from the amount CH4 generated. Only the fraction of CH4 that is not recovered will be subject to oxidation in the SWDS cover layer.

- Methane Generation

The CH4 potential that is generated throughout the years can be estimated on the basis of the amounts and composition of the waste disposed into SWDS and the waste management practices at the disposal sites. The basis for the calculation is the amount of Decomposable Degradable Organic Carbon (DDOCm) as defined in Equation 3. DDOCm is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS. It is used in the equations and spreadsheet models as DDOCm. The index m is used for mass.

$$DDOC_m = W\ X\ DOC\ X\ DOC_f\ X\ MCF \quad (3)$$

Where:

DDOCm = mass of decomposable DOC deposited, Gg
W = mass of waste deposited, Gg
DOC = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste
DOCf = fraction of DOC that can decompose (fraction)
MCF = CH4 correction factor for aerobic decomposition in the year of deposition (fraction)

CH4 generation potential (Lo) is defined as the product of DDOCm, the CH4 concentration in the gas (F) and the molecular weight ratio of CH4 and C (16/12) as mentioned in Equation 4.

$$L_0 = DDOC_m\ X\ F\ X\ \frac{16}{12} \quad (4)$$

Where:

Lo = CH4 generation potential, Gg CH4
DDOCm = mass of decomposable DOC, Gg
F fraction of CH4 in generated landfill gas (volume fraction)
16/12 molecular weight ratio CH4/C (ratio)

Using DDOCma (DDOCm accumulated in the SWDS) from the spreadsheets, the above equation can be used to calculate the total CH4 generation potential of the waste remaining in the SWDS.

The IPCC Waste Model allows the user to change the default delay of six months to a different value. It is good practice to choose a delay time of between zero and six months. Values outside this range should be supported by evidence.

Emissions from in-boundary wastewater treatment

"Wastewater can be a source of methane (CH4) when treated or disposed of anaerobically. It can also be a source of nitrous oxide (N2O) emissions. Carbon dioxide (CO2) emissions from wastewater are not considered in the IPCC Guidelines because these are of biogenic origin and should not be included in national total emissions. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on-site (uncollected), sewer to a centralized plant (collected) or disposed untreated nearby or via an outfall. Domestic wastewater is defined as wastewater from household water use, while industrial wastewater is from industrial practices only." Source 2006 IPCC Guidelines.

- CH4 emissions from domestic wastewater

$$CH_4\ Emissions = \left[\sum (U_i\ X\ T_{i\ j}\ X\ EF_j)\right](TOW - S) - R \quad (8)$$

Where: CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group i in inventory year

$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

I = income group: rural, urban high income and urban low income

J = each treatment/discharge pathway or system

EF_j = emission factor, kg CH4 / kg BOD

R = amount of CH4 recovered in inventory year, kg CH4/yr

- CH4 emissions factor for each domestic wastewater treatment/discharge pathway or system

The emission factor for a wastewater treatment and discharge pathway and the system is a function of the maximum CH4 producing potential (Bo) and the methane correction factor (MCF) for the wastewater treatment and discharge system, as shown in Equation 9. The Bo is the maximum amount of CH4 that can be produced from a given quantity of organics (as expressed in BOD or COD) in the wastewater. The MCF indicates the extent to which the CH4 producing capacity (Bo) is realised in each type of treatment and discharge pathway and system. Thus, it is an indication of the degree to which the system is anaerobic.

$$EF_j = B_o\ X\ MCF_j \quad (9)$$

Where: EFj = Emission factor, kg CH4/kg BOD

j = Each treatment/discharge pathway or system

Bo = Maximum CH4 producing capacity, kg CH4/kg BOD

MCFj = methane correction factor (fraction)

- Totally organically degradable material in domestic wastewater

The activity data for this source category is the total amount of organically degradable material in wastewater (TOW). This parameter is a function of the human population and BOD generation per person. It is expressed in terms of biochemical oxygen demand (kg BOD/year). The factor I values in Equation 10 expresses the BOD from industries and establishments (e.g., restaurants, butchers or grocery stores) that are co-discharged with domestic wastewater

$$TOW = P \; X \; BOD \; X \; 0.001 \; X \; I \; X365 \qquad (10)$$

Where: TOW = total organics in wastewater in inventory year, kg BOD/yr

P = country population in inventory year, (person)

BOD = country-specific per capita BOD in inventory year, g/person/day

0.001 = conversion from grams BOD to kg BOD

I = correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00)

Carbon Sequestration from Trees and Forests

Carbon sequestration in plant biomass is determined using the above ground biomass (AGB) and below ground biomass (BGB) method. To calculate this, the girth at breast height (GBH) and height of the trees were obtained from scientific literature. The AGB and BGB were then calculated using following formulas:

Basal area (m^2) =	$(GBH)^2/(4\pi)$
Bio-volume (m^3) =	Basal area x Height of the tree
AGB (kg) =	Bio-volume x Wood density (kg/m^3)
BGB (kg) =	AGB x 0.26 (where 0.26 = Root to Shoot ratio)
Total Biomass (TB) in kg/tree =	AGB + BGB
Total Carbon Sequestered (TC) = (in kg/tree)	TB/2

The wood density of the individual tree species is considered from the literature. The CO2 equivalent was calculated using the following formula:

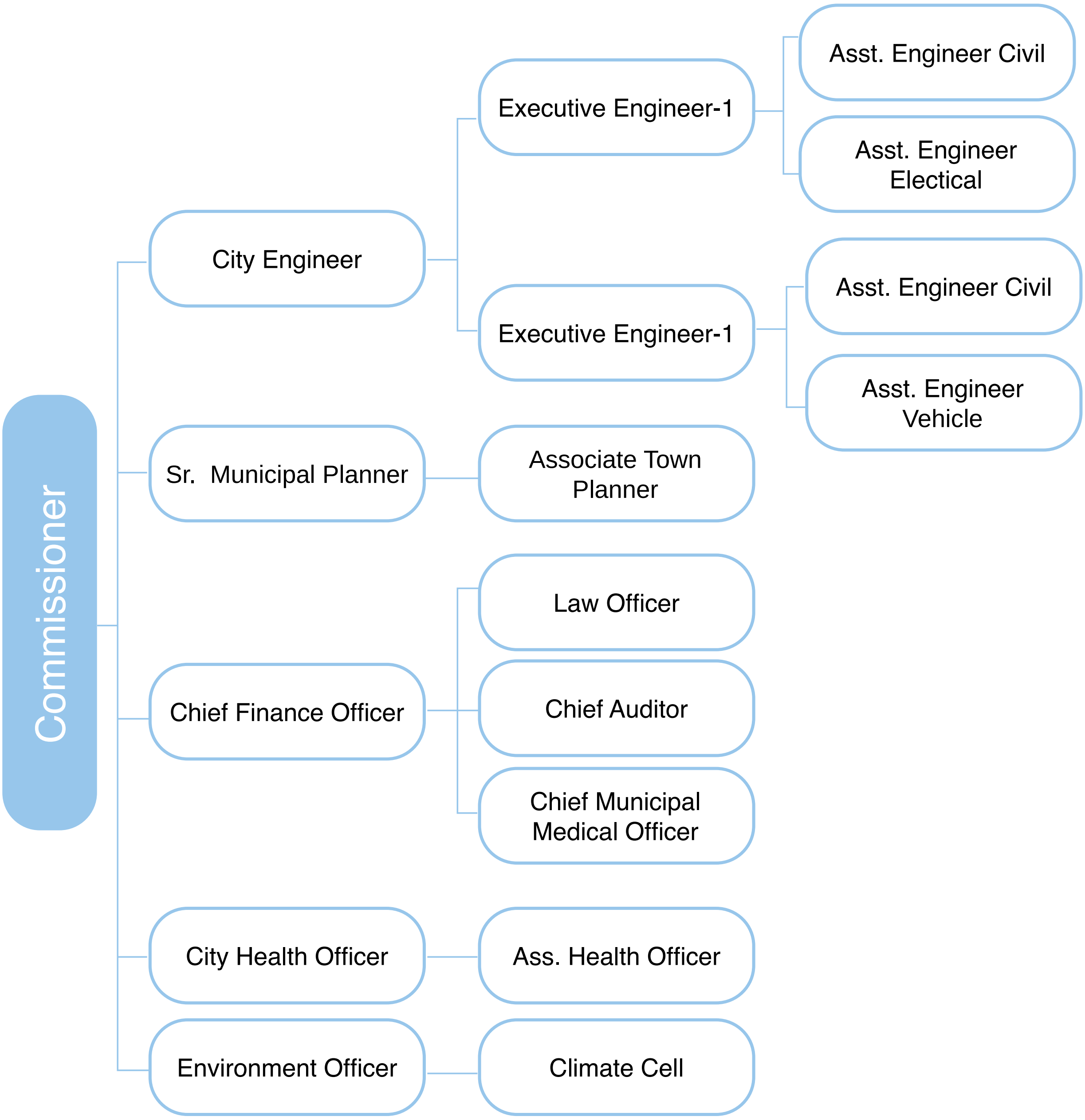
$$CO_{2\text{-eq.}} = (TC \times 44)/12$$

Where, 44 and 12 are the molecular and atomic weight of CO2 and C, respectively.

Carbon sequestration is influenced by both the species and the girth at breast height (GBH) of trees. As plants age, their biomass accumulation increases until they reach death. It is important to note that both above and below ground biomass of plants play a significant role in sequestering terrestrial carbon.

Proposed Governance Structure for Implementation

The existing municipal committee faces capacity limitations in executing the proposed measures outlined in the climate action plan. To address this, there is a pressing need to elevate the committee to a full-fledged municipality, enhancing both its capacity and jurisdiction to effectively implement the outlined strategies. A tentative organizational structure is presented below, aiming to guide the expansion of the municipality and ensure efficient management of key services and departments.



The major coordinator of the structure is the Municipal Commissioner who will be responsible for overseeing all the operations and planning.

For the successful implementation and monitoring evaluation of climate action plan, a Climate Cell has been proposed that would address climate-related challenges and integrate climate considerations in city planning and operations. Its task involves local climate-related data collection and analysis, identification, and mapping of vulnerable groups, risk identification, mitigation and adaptation strategies, formulating policies, and briefing the commissioner of the city for further decision-making. The cell will also report to National Mission Sustainable Habitat (NMSH) and Climate SmartCities Assessment Framework (CSCAF) and oversee the implementation and management of UT to city-level climate-related projects.

Data Collection from City Departments, NGOs and Existing Reports

Data	Departments
Climate	India Meteorological Department (IMD) Leh
Solid waste	Leh Municipal Committee
Electricity	Power Development Department (PDD)
	Ladakh Renewable Energy Development Agency (LREDA)
Water	Public Health Engineering (PHE) Department
Wastewater	Igoo Phey Division Leh
	Irrigation & Flood Control (I&FC)
Transport	Regional Transport Office (RTO)
	Motor Garages Leh
Petrol, Diesel, LPG, other fuels	Indian Oil Corporation Ltd. (IOCL)
	Hindustan Petroleum Corporation Limited (HPCL)
Green cover/ Land cover	Leh Municipal Committee
	Forest Office Ladakh
Disaster	Ladakh Autonomous Hill Development Council (LAHDC)
	Disaster Management Department
Air Quality	Pollution Control Committee (PCC)
City Development	Directorate of Urban Local Bodies (DULB)
	Public Works Department (PWD)
Tourism	Ladakh Tourism Department
	Leh Taxi Union
	Leh Hotel Union
Biodiversity	Forest Department Ladakh
	Govind Ballabh Pant 'National Institute of Himalayan Environment' (NIHE) Leh

ANNEXURE II: Flood Risk Assessment Methodology

In the study, the Analytical Hierarchy Process (AHP) is employed as a key method in the multi-criteria decision-making (MCDM) framework to determine the relative importance of various flood-controlling factors. This approach facilitates the assignment of weights to each factor, aiding in the identification and mapping of flood-prone areas. Weights were assigned based on the local physical characteristics of the study area and insights from previous research. Each factor received a value between 1 and 9, representing its relative importance, with 1 indicating equal importance and 9 indicating extreme importance, allowing for the construction of a pairwise comparison matrix. Following this, a normalized pairwise comparison matrix was generated to compute the weight of each factor. To ensure the validity of the comparisons, a consistency check was conducted using the equations provided. The Consistency Index (CI) was calculated as follows:

$$\mathbf{CI} = (\lambda_{max} - n) / (n-1)$$

where CI is the consistency index, n is the number of factors compared, and λ_{max} is the highest eigenvalue of the matrix. The maximum eigenvalue was then determined. The Consistency Ratio (CR) was calculated using:

$$\mathbf{CR} = CI / RI$$

where CR is the consistency ratio, CI is the consistency index, and RI is the random index, which varies based on the number of factors. A CR value below 0.10 indicates acceptable consistency; values of 0.10 or above suggest inadequate consistency, necessitating a repeat of the comparison process until an acceptable CR is achieved. After reclassifying each flood-controlling factor to a common scale of 1 (very low) to 5 (very high) using GIS software and applying the AHP-derived weights, the spatial layers were integrated using the weighted overlay technique. The flood susceptibility map of the study area was generated using the following equation:

$$\mathbf{FS} = \sum_{i=0}^{n} x_i * w_i$$

where FS represents flood susceptibility, n is the number of decision criteria, x_i is the normalized criterion, and w_i is the corresponding weight. The values of the raster layers were multiplied by their AHP-derived weights, and the results were summed to create the final flood risk assessment map.

ANNEXURE III: Stakeholder Consultation

City Official Consulted

S. No.	Name	Designation	Department
1	Stanzin Rabgais	Executive Officer	Municipal Committee, Leh
2	Rakshit Keemi	Project Manager	WAPCOS Ltd
3	Dr. Ajay Kumar Gupta	Scientist	GBPNIHESD Leh
4	Sarvesh Kr. Singh	Consultant	ECBC Cell TERI, PDD
5	Jigmet Janspal	Reporter	News18 Ladakh
6	Chosying Dorjay	Project Director	LREDA
7	Dr. R K Goyal	Head	CAZRI - Leh
8	Tsering Angchok	Executive Engineer	Igoo Phey Division Leh
9	Gulam Mohl Din	Executive Engineer	Land F.L Div Leh
10	Jigmet Namgyal		LAHDC Leh
11	Dhawan Kumar Rawat	DFO, Leh	Forest Deoartment
12	Tundup Nurbu	Councillor, Phyang	LAHDC Leh
13	Dr Ishay namgyal	President	Municipal Committee, Leh
14	Stanzin Chosphal	EC	LAHDC Leh
15	P. Stanzin Tsepag	Councillor, Upper Leh	LAHDC Leh
16	Tsewang Gurmet		IMD
17	Manish Kumar Gupta	Metacentre Leh	IMD
18	Skalzang Dorje	Executive Engineer	PWD R&B Division, Leh
19	Kunzang Wangmo	District Horticulture Officer	Horticulture Department Leh
20	Ruksana Parveen	District Officer	Ladakh Pollution Control
21	Imzar Ahmed Rana	ARTO, Leh	MVD
22	Aditya Madanpotra, IFS	Director	Pollution Control Committee
23	Ufaq Nazim Dah	Engineer	NHIDCL
24	Ruchi Mathur	PMU Consultant	
25	Tsering Sangdup	Techincal Officer	Electric Division, PDD
26	Phunsok Angmo	PMU Consultant	Tourism
27	Fariha Yousuf	SMM	DUCB
28	Sudhanshu Trivedi	PMU Associate	DULB
29	Mohd. Dy	Soil Conservation Officer	Soil Conservation Department
30	Shahid Salim	Assistant Executive Officer	PHE

NGOs, Business and Religious Association, and Academia Consulted

S. No.	Name	Designation	Department
1	Dr. Skalzang Dorjey	Chairman	Block Development Councillor
2	Kunzes Dolma	Vice Chairperson	SDLF/ Geothermal
3	Dr. Rigzin Chodon	Independent Research Consultant	
4	Anub Tsetan Paljor	Project Assistant Secure	UNDP- Dept. of Wildlife
5	Stanzin Dothon	Researcher & Field Assistant	Little Green World
6	Preeti Chauhan	Founder & MD	Little Green World
7	Nawang Tasi		
8	Tashi Tundup	President	Bikers Association
9	Tsering Angchok	President	
10	Skarma Tsering Dehlex	President	ALHGHA
11	Stanzin Odsal	Urban Planner	LEDEG
12	Tsering Angchuk	Manager	Naropa fellowship
13	Thinles Dorje	President	Tempo Union
14	Stanzin Jordan	Founder	Ladakh Basket
15	Dachen Lamo	Designing & Documental Manager	SRE
16	Tsewang Yangjor	Executive	ALHGHA
17	Dr. Ajaz Hussain	Consultant	Climate Group
18	Faisal Qadir		
19	Nawang Laskit		
20	Tashi Morup	Project Director	LAMO
21	Otsal	Ward Member	MCL
22	Delnaaz Irani	Volunteer	Zero Waste Ladakh
23	Stanzin Tsundus	Co Founder	SRE
24	Sonam Spalzes	Co Founder	SRE
25	Stanzin Namgail	Co Founder	SRE
26	Aparajita Goswami	Founder	Zero Waste Ladakh
27	Dr. Sonam Wangmo	Assistant Professor	University of Ladakh
28	Bhawna Verma	Town Planner / Entrepreneur	
29	Konchok Tashi	Urban Planner	GCOM
30	Rigzin Wangmo Lachic	General Secretary / J.Secretary	ALHGHA / SDFL
31	Lobzang Tsering		ALHGHA

ANNEXURE III: Stakeholder Consultation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Notes:


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