

Date – January 20, 2021

Project – IUC: Sustainable and innovative cities and region

Sub-project – Baseline study for sustainable tourism in Leh

Deliverable – Final report



Funded by
the European Union

This report was produced with the financial support of the European Union. Its contents are the sole responsibility of IUC India and do not necessarily reflect the views of the European Union.



Acknowledgments



The baseline study for the sustainable tourism project has been commissioned as part of the Leh - Trikala, Farkadona, and Meteora strategic collaboration under the European Union International Urban Cooperation (IUC) - India programme. The study represents the key deliverable of the Urban Cooperation Local Action Plan for sustainable tourism in the city of Leh.

The report has been prepared by Kedar Gharat (Sustainable Tourism Expert, IUC India) and Mohit Ganeriwala (Project Management Expert, IUC India). They are grateful for the support, expertise and insights provided by Mr. Ishey Namgyal, President, Municipal Committee, Leh, Mr. Asikis Konstantinos, Head of Planning Department, Municipality of Farkadona, Greece as well as the IUC India team, including Panagiotis Karamanos, Ashish Verma, Mahesh Harhare and Suhas Pande. The discussions held with these stakeholders and the information provided by them was key to the completion of this study.



Table of contents



1	List of acronyms & abbreviations.....	5
2	List of tables and figures	7
3	Executive summary	9
4	Introduction.....	17
4.1	Assignment background	17
4.2	Leh – district profile.....	17
4.3	Tourism in Leh	19
4.4	Branding of tourism in Leh.....	22
4.5	Greek cities	23
4.6	Tourism in Greek cities	26
5	Main components of sustainable tourism	31
5.1	Sustainable tourism	31
5.2	Main components of sustainable tourism	31
5.3	UNWTO guidelines	34
5.4	UNSECO guidelines	35
5.5	ILO guidelines.....	35
5.6	Conclusion	36
6	Sectors impacted by tourism in Leh	37
6.1	Mobility.....	37
6.2	Solid-waste management	38
6.3	Water supply	43
7	Policies related to tourism.....	46
7.1	National.....	46
7.2	Regional and local	47
7.3	Gaps in policies	47
8	Best practices from Greek cities	48
8.1	Introduction to sustainable practices in the Greek cities	48
8.2	Mobility.....	48
8.3	Solid waste management	52
8.4	Water supply and management.....	54
8.5	Branding of tourism.....	55



9	Best practices from international cities and Leh	58
9.1	Mobility.....	58
9.2	Solid waste management	58
9.3	Water supply and management.....	59
9.4	Branding of tourism.....	60
9.5	Lessons to be learnt from Leh	60
10	Recommendations	62
10.1	Recommendations for sustainable tourism in Leh	62
10.2	Way forward.....	65
11	References	67
12	Annexure 1 - Successful bio-remediation cases in India	70



1 List of acronyms & abbreviations



Abbreviation	Full form
ALHGOA	All Ladakh Hotel and Guest House Owner's Association
ALTOA	All Ladakh Tour Operators Association
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ARTS	Automated road transport system
DIC	District Industries Centre
DPR	Detailed project report
DTA	Domestic tourist arrival
ELV	Electric light vehicle
EU	European Union
FEDHATTA	Federation of Hellenic Associations of Tourist and Travel Agencies
FAME	Faster Adoption and Manufacturing of Hybrid and EV
FSTP	Faecal sludge treatment plant
FTA	Foreign tourist arrival
GCoM	Global Covenant of Mayors
GDP	Gross domestic product
ICT	Information, communication and technology
ILO	International Labour Organization
INR	Indian rupee
IoT	Internet of Things
IUC	International Urban Cooperation
LAHDC	Ladakh Autonomous Hill Development Council
LAP	Local action plan
LeDeg	Ladakh Ecological Development Group
LPCD	Litres per capita daily
LREDA	Ladakh Renewable Energy Development Agency
MLD	Million litres per day
MODI	Mission Organic Development Initiative
NGO	Non-governmental organisation
NTAB	National Tourism Advisory Board



Abbreviation	Full form
PHE	Public health engineering
SLC	Snow leopard conservancy
SWM	Solid waste management
TMB	Transports Metropolitan de Barcelona
TPD	Tonne per day
UIDSMTT	Urban Infrastructure Development Scheme for Small & Medium Town
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNWTO	United Nations World Tourism Organization
UT	Union territory
WAL	Women's Alliance of Ladakh
WWF	World Wildlife Fund
WWTP	Waste water treatment plant



2 List of tables and figures



Table 1: Average water demand of different stakeholders	43
Table 2: Table of references.....	67
Figure 1: Sector-wise issues faced by Leh.....	10
Figure 2: Snapshot of best practices followed by the Greek cities.....	12
Figure 3: Leh district map	18
Figure 4: Tourist arrivals in Leh district from 2011 to 2016	19
Figure 5: Main places of tourist interest.....	21
Figure 6: Trikala city	24
Figure 7: Farkadona city	25
Figure 8: Meteora city	26
Figure 9: Main places of tourist interest.....	28
Figure 10: Components of sustainable tourism	31
Figure 11: UNWTO's data on tourism	35
Figure 12: Components of sustainable tourism	36
Figure 13: Taxis in Leh	38
Figure 14: Garbage truck in Leh	39
Figure 15: Waste dumping ground at Diskit Tsal	40
Figure 16: Newly commissioned waste treatment plant	41
Figure 17: Frozen reservoir in Leh	44
Figure 18: Automated bus in Trikala.....	49
Figure 19: Dedicated cycling lane	51
Figure 20: Elevated road intersection.....	52
Figure 21: Submersible waste storage system.....	53
Figure 22: Smart city control centre.....	54
Figure 23: Kalambaka-Meteora wastewater treatment plant.....	55
Figure 24: Some smart city initiatives in Trikala	55
Figure 25: Christmas city of Trikala	56
Figure 26: Lessons learnt	57
Figure 27: Biomining process at Bhalswa dumpsite.....	70
Figure 28: Trommels at Bhalswa dumping site	71



Figure 29: Before and after images of Kumbakonam dumpsite	72
Figure 30: Biomining process followed at Kumbakonam dumpsite.....	72
Figure 31: Before and after images of Ajith Singh Nagar dumpsite	73



3 Executive summary



This chapter is the executive summary of the baseline study. It provides in brief, the assignment background and objectives of the study, the district profile of Leh, key issues / challenges faced by the city, and a comparative perspective on best practices followed in the Greek cities of Trikala, Farkadona and Meteora for sustainable tourism. It also suggests the way forward for Leh, based on learnings from these international practices.

Assignment background



Preparation of study and problem statement: The baseline study for the sustainable tourism project has been commissioned as part of the Leh - Trikala, Farkadona, and Meteora strategic collaboration under the IUC – India program. The study is the key deliverable of the Urban Cooperation Local Action Plan for sustainable tourism in Leh, focusing on mobility, solid waste management, water supply, and branding. The objective is to provide a set of recommendations to the city of Leh to integrate sustainable measures into tourism related activities, and also share with the Greek cities a set of Indian best practices regarding sustainability.

Strategic cooperation between Leh and Trikala, Farkadona, and Meteora: Leh and the Greek cities signed partnership agreements with IUC-India on 23rd March, 2020 and 20th February, 2020 respectively and later on jointly agreed on the topic of cooperation – i.e., sustainable tourism. The two cities were paired because of their common interests as well as specific features such as size, economic activities etc. IUC-India is supporting the cities through exchange of best practices (e.g., workshops) developments of a baseline report on sustainable tourism for Leh city, etc

Methodology: The baseline study was conceived during the discussion of various stakeholders involved in this strategic collaboration. The study aims to provide a detailed analysis of the existing issues being faced by Leh in four major sectors of mobility, solid waste management and water supply, while also clearly laying out the way forward towards sustainable tourism in the city. The report also looks at the branding initiatives being taken up by Leh to develop the tourism sector. The study is based on: a) secondary research through reports and web links and data shared by the IUC-India team and officials of municipalities of the Greek and Leh cities, web search, case studies on sustainable and smart city solutions in the Greek cities, and b) stakeholder consultations with the officials of the Municipal Committee of Leh, Municipality of Farkadona, and IUC-India.

Introduction



Leh district profile: Leh district is part of the union territory of Ladakh located in the northern most part of India. The district has an area of 45,100 sq km and is situated at an altitude of 2,300 – 5,000 meters above sea level. Leh town situated at 3,250 meters above sea level is one of the highest permanently inhabited towns in the world. The population of Leh district was 133,487 as per the 2011 census and is projected at 152,175 for 2020. Leh has a climate of a cold desert, with November to February experiencing sub-zero temperatures. The economy of Leh depends mainly on agriculture, tourism and trade. The Ladakh Autonomous Hill Development Council (LAHDC) is an autonomous district council that administers the Leh district of Ladakh, India. On the other hand, the Leh Municipal Committee is a grass root level governance structure which aims to look after the area falling under its jurisdiction (13 wards). The committee comes under the Ministry of Housing and Urban Affairs. It plans and utilises funds in various projects, generates income from local sources such as parking fees, rents, and further uses it for public welfare.

Tourism in Leh: Tourism is an important industry in Leh due to creation of employment opportunities (in sectors such as hotels, transport, catering, cottage industry, etc.) as well as income generation on a large scale. Leh opened for tourists in 1974 and since then, has registered an ever increasing influx of both international and

domestic tourists each year, due to its landscape, tradition, culture, and environment. As of 2016, it had 224 hotels and 448 guest houses of different classes registered in the district. Tourism contributes to approximately 50% of Leh's local Gross Domestic Product (GDP). However the benefits of tourism are mostly concentrated in and around Leh town. The main tourism products in Leh district are based on: (a) nature; (b) wildlife; (c) adventure; and (d) religion. The main places of tourist interest are: Pangong Lake, Nubra Valley, Magnetic Hill, Leh Mosque, Leh Palace, Tsomoriri Lake, and Lamayuru Monastery. The main stakeholders associated with the development in Leh are: (a) government agencies; (b) tourists; (c) local businesses (hotels, guest houses, restaurants, tour operators, etc.); (d) industry associations; (e) non-governmental organisations (NGOs); (f) local community; and (g) utilities; and infrastructure providers.

Branding of tourism: Despite lack of tourism branding initiatives and targeted tourism development programs, tourism is one of the major economic activities of the Leh region and contributes 50% to the local GDP. The area has not been able to leverage its geographical advantages to position itself as a preferred destination among domestic / international travellers. Majority of the promotional activities are undertaken by a select number of private sector operators, while an organized region-based branding approach is lacking. Recently, the government has introduced the tourism incentive policy which aims to develop the sector through a focused approach by provisioning incentives for asset creation, expansion, equipment and skill development.

Key issues of sectors impacted by tourism in Leh



The sectors most affected by the large influx of tourists in a short span of time in Leh are: mobility, solid waste management (SWM) and water supply. The tourist population has overburdened the existing infrastructure related to water sourcing and distribution, waste management, transportation and disposal, roads, etc. Further, branding activities to establish Leh as a major tourism destination of India do not seem to be on the forefront of tourism policies. The key issues being faced by these sectors have been summarised in Figure 1 below:

Figure 1: Sector-wise issues faced by Leh



Source: CRISIL analysis

Mobility: There are two ways to reach Leh - by air or road. Given that the nearest railway station (Jammu Tawi) is at a distance of 700 km, rail is not a feasible option. As Leh is a small town, there are no dedicated local bus services, however, there are a number of public and private buses plying for tourist spots in and around it. Further, there are a large number of taxis (either private or those from the Ladakh taxi union) available for local travel. Issues related to mobility in Leh include: (a) increasing number of traffic jams and general road congestion due to large influx of tourists; (b) traffic issues caused by ongoing construction and developmental activities; (c)



heavy snowfall cutting off the two main highways to Leh, leaving travel by air the only option to enter/exit Leh during the winter; (d) freezing of diesel in sub- zero temperatures, and formation of ice on roads, aggravating mobility issues during winter months and e) lack of an efficient public transport system.

Solid Waste Management (SWM): Though Leh has initiated measures such as the ban on polythene bags, the huge influx of tourists has made waste prevention very challenging. As per data received from the Municipal Committee of Leh, the town generates 8-9 tonnes of waste per day in winters and 35-40 tonnes per day in summers. The solid waste comprises 15% organic waste, 15% old and unusable items of daily need, including clothing and blankets, 65% single use plastic and cardboard, and the rest in the form of medical, metal and inert waste. Open dumping has been in practice for the past 25 years at the disposal site in Diksit Tsal, located 1.5 km outside Leh city. The dumping ground does not have boundaries and the site was chosen without considering any environmental and social factors. This legacy dump site apart from being an eye sore has caused serious environmental issues such as leachate and production of landfill gases. Although a waste treatment plant has been recently commissioned, it is not operating at its full capacity and the balance waste is still being dumped at the disposal site. Hence disposal of solid waste and reclamation of the legacy dumpsite are the two key issues being faced by Leh. Further, the local administration has made it mandatory to segregate waste at source but due to apathy and lack of awareness amongst tourist and locals, the practice of waste segregation is not followed properly. Other issues also include improper enforcement of the law on ban on use of single use plastic and reducing the production of waste at source.

Water supply: The water demand in Leh is approximately 5 MLD in summer and approximately 2 MLD in winter. The Department of Public Health Engineering (PHE), the state government utility responsible for supplying drinking water to the residents of the city, currently supplies 4.9 MLD of water during summer. Water is supplied either through piped networks, water tankers or the public stand posts. In terms of sources, Leh gets 60% of its water from borewells (public and private), 30% from the base of Indus river and the remaining 10% from streams/surface water sources. The district being located on the leeward side of the trans-Himalayan region is a cold desert and thus receives very less rainfall (approximately 100 mm every year), leading to scarcity of water. Further, 25% of the water is lost during transportation due to leakages and breakages in the water supply network. The problem of scarcity of water is further aggravated by the huge influx of tourists and their water consumption. Hotel owners prefer to use water intensive flush toilets as they have a better appeal with tourists. During winters, the town experiences sub-zero temperatures which leads to water pipes freezing and bursting, hence water is only supplied through water tankers during these months.

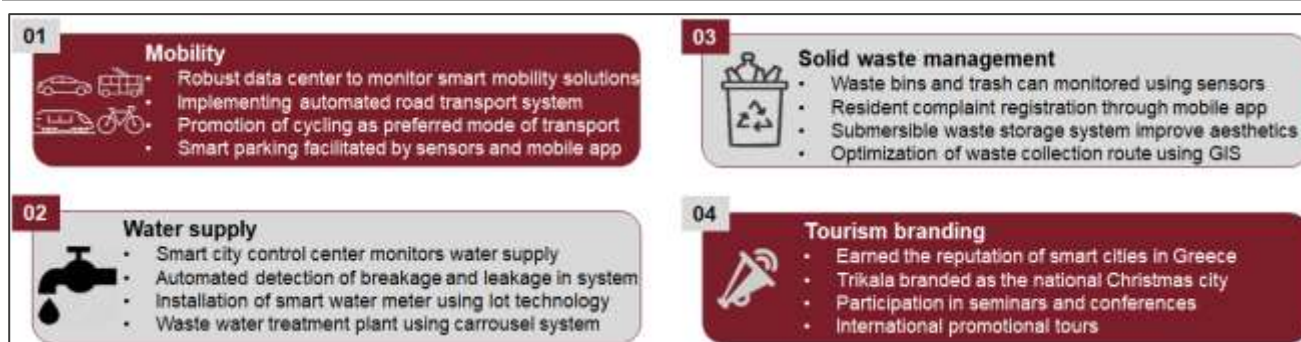
International best practices in sustainable tourism



Leh, under the IUC program, has entered into a strategic collaboration with the Greek cities of Trikala, Farkadona and Meteora. Hence, this study analyses various sustainable and smart city solutions deployed by these cities with the objective of identifying best practices which can be adapted and implemented in Leh. Best practices from the sectors of mobility, solid waste management (SWM), water supply, and tourism branding in the three Greek cities have been summarised in Figure 2:



Figure 2: Snapshot of best practices followed by the Greek cities



Source: CRISIL analysis

Mobility: The three Greek cities have pioneered some innovative urban transport solutions which have also provided a major impetus and boost to tourism in these cities. Some of the smart and sustainable mobility solutions implemented are: i) robust data centre from which all public transport operations are monitored using fleet telematics equipment; ii) impetus to cycling as a sustainable and cheaper way of transport by developing cycling lanes, both inside and outside the main city; iii) smart parking solutions allowing identification, imaging and monitoring of designated parking spaces in the city; iv) increasing usage of clean means of transport such as electric bikes; v) adoption of automated buses allowing creation of a new shared public transport system; vi) smart mobility application to get real time estimates of arrival of city buses, service request for city buses, on-line reservation for public services, etc.

SWM: Solid waste management is quite efficient in the three Greek cities. In Trikala, waste collection bins and trash cans are monitored using sensors at the central waste collection centre. The waste collection centre is notified via these sensors in real time about the level of waste in the bins/trash cans. Also a residents' complaints registration service is now being offered in Trikala through a mobile app and web, which in turn has improved the municipal service for waste collection. The Municipality of Meteora plans to install five submersible waste storage systems. A study has been conducted on the feasibility of this project, which is awaiting approval and the municipality further plans to submit a proposal to the Green Fund (programme to finance businesses in renewable energy, sustainable development and other allied sectors) with regards to the supply of the submersible waste storage system. With this project, the municipality of Meteora aims at an aesthetic result which will also reduce the environmental footprint. The Municipality of Farkadona recently started the implementation of recycling of consumables for information, communication and technology (ICT) equipment (inks, toners, drums, etc.) so that they do not become pollutants in the environment. A cooperation agreement was signed with a company that is active in the field of collection and recycling of waste ICT equipment consumables.

Water supply: Trikala has a smart-city control centre established on the ground floor of its City Hall, to monitor all smart city services. Among other functions, the control centre also monitors the municipal water and sanitation utility through solenoid valves monitoring and regulating system. Additionally smart meters are installed at households and all other establishments enabling consumer notification such as malfunction detection. Farkadona has recently entered into a contract for the supply of smart water metering system, which is a complete solution for the management and control of water meters. The system utilises Internet of Things technology, which allows collection of data from the meters (water measurement) and also control of the valve by a distance (remotely), without the need for human intervention. Further, a contract has been signed for another important project of new technologies that will involve supply and installation of remote control system for optimising the operation and control of leaks in the water supply networks of DEYA Farkadona (water utility company of Farkadona).



Branding of tourism: Trikala achieved smart city status by joining many innovative EU projects. It has implemented many tech-savvy plans including the driverless bus projects, smart water supply systems, energy efficient public lighting systems, etc., and it poses as an ideal test bed for various national and EU initiatives. 'Mill of Elves' in Trikala is the biggest, Christmas theme park in Greece. The water mill, entirely built of stone, was transformed into a Christmas attraction in December 2011. It started as a local celebration and now has evolved into one of the largest theme parks in Greece. In a 10-year period, it has attracted more than 1,000,000 (mainly domestic) visitors annually giving it the title of the 'favourite Christmas city of Greece'. In order to showcase its sustainable practices in various sectors and learn other best practices in sustainability, officials of the Municipality of Farkadona attend several seminars/conferences throughout the European region. Further, in an attempt to promote the tourism sector in Meteora, the Municipality of Meteora recently organised promotion and branding trips to Serbia and Romania. The officials participated in many events, including the Belgrade International Tourism Fair, through which they were able to introduce and promote the tourism sector in Meteora. In Bucharest, promotion was done on two of the most popular local television channels, which televised videos of Meteora. In addition, an interview with the officials of the municipality was also televised, covering the whole range of activities in the Municipality of Meteora.

Recommendations



The study looks at initiatives that have been deployed by the cities of Trikala, Farkadona, and Meteora. Based on the learnings from these cities, Leh may adopt the following best practices for the core sectors of mobility, solid waste management, water supply, and tourism branding.

Mobility: Leh is a remote region and faces several mobility issues, including regional connectivity issues during winters, freezing of fuel due to sub-zero temperatures, and traffic congestions during the summer season on account of huge influx of tourists. The use of diesel vehicles also leads to increased carbon emissions which contribute to rise in temperature levels and further to increased melting of glaciers and ice in and around Leh. The central government has been pushing to create a carbon neutral region around Leh. The city should thus pursue clean energy mobility solutions such as e-vehicles, shared mobility initiatives, etc. Some of the initiatives that can be implemented in Leh include:

- **Introduction of e-vehicles:** Taxi operators should be encouraged to shift to e-vehicles instead of diesel cars as this will drastically reduce carbon emissions especially during the peak summer season. Further, the city can promote shared mobility mechanisms such as e-bikes, e-autos, etc. for movement in the city. Initiatives such as e-bikes also promote healthy living among tourists and residents alike
- **Smart parking initiatives:** During the peak season, the city faces parking issues with public taxis parked at unauthorised / vacant tracts of the land. With the deployment of smart parking systems, the vehicle drivers can be alerted of parking availability and be diverted to available parking slots. These parking stations can further be connected to major tourist places through e-buses / vehicles, which can act as feeder vehicles
- **Promoting non-motorised transport (NMT):** Non-motorised transport such as walking, cycling etc. which will require demarcating vehicle free zones within the city center and other promotional measures to promote NMT in the city. Gol's recent programs in this direction could be referred and adapted as per the needs of the city.

SWM: An efficient and exhaustive SWM cycle is important for the development of any city. Although Leh has been undertaking initiatives such as providing separate bins to households and commercial units for waste segregation and development of solar powered waste treatment plant, the city still faces several challenges across the SWM lifecycle including the management and reclamation of the legacy dumpsite at Diskit Tsal. Recently, Leh has been brought under the ambit of the Smart City Mission. Hence, it could use learnings from the experience of the Greek cities to implement several smart systems and initiatives powered by IoT. Apart



from the smart initiatives, several traditional measures can also be implemented at the city level. Some of the key initiatives that may be undertaken by the city have been provided below:

- Smart central waste collection centre and monitoring: A central waste collection center equipped with sensors could be built in Leh. Smart waste collection bins and trash cans could be monitored in real time using sensors at the waste collection centre and the waste collection center would be notified in real time about the level of waste in bins/ trash cans. The sensors would also help to understand the amount of waste that comes from different areas in the bins, and accordingly, optimise the waste collection. This solution would result in efficiency, cost savings and resource utilisation. The waste collection routes being followed by waste collection vehicles could be monitored in real time through the use of GIS technology, analysed and optimised, thus leading to effective SWM.
- Usage of compost toilets: The lakes in and around Leh are polluted through nitrogen-rich effluent seeping through the ground from all the flush toilets that have been installed to serve tourists. Tourists prefer flush toilets which lead not only to wastage of water but also produce nitrogen rich waste. Compost toilets can therefore be implemented for residents and tourists, which conserve water and do not produce nitrogen rich waste. Ladakhi people are already accustomed to using compost toilets and awareness should be created amongst tourists to follow suit.
- Biomining/ bioremediation of the legacy dumpsite: Although a black hole machine has been set up at the Diskit Tsal legacy dumpsite for incineration of legacy waste, due to its low capacity (one tonne per day) the process of reclamation is proving to be inefficient. The city must employ the biomining/bioremediation process, which is a scientific and highly efficient way of managing and reclaiming a legacy dumpsite. It is the process by which previously dumped waste is dug up after loosening and then processed to recover valuable recyclable scrap while also recovering landfill space. The end product, likely to be soil, is rid of toxic materials and hence becomes reusable. Other major resources extracted from legacy waste are plastic, rubber, metal, textiles, glass, soil, and construction and demolition (C&D) waste.
- Initiatives around reduce, reuse and recycle: The city must promote reduction at source and reuse to enable waste minimisation. This could be implemented by promoting reuse of carry bags, packaging jars, plastic bottles, etc. Since the tourists bring along a lot of plastic waste, the city can also explore promotion of recycling and processing of inorganic waste for other productive uses.
- Awareness campaigns, fines and rewards: The city should regularly conduct awareness campaigns on waste prevention and waste segregation. Apart from this, regular clean up drives must be organised for effective SWM. The municipal corporation must also establish a strict system of fines for non-segregation of waste and use of single use plastics. At the same time, the household or commercial establishments which follow the suggested best practices should be provided commendation letters and rewards at public ceremonies to create more awareness.

Water supply: Leh is an arid region receiving very little rainfall and thereby dependent on other natural sources such as rivers, lakes, springs and ground water. The issue of water supply gets further aggravated during the winter season when the city faces sub-zero temperatures and the water freezes. The city has been heavily dependent on borewells for its water needs; approximately 90% of water is sourced from underground sources while the remaining 10% comes from springs and surface water sources. The average tourist utilises close to four times the water used by a local on a daily basis. This pressure on the water supply requirement is further increased by a huge presence of military establishment and migrant labour population. Leh can explore the following options for solving the problem of water supply and management:

- Smart irrigation systems: Leh has been laying a strong impetus on developing agriculture as an alternative source of income and also meeting the vegetable needs of the population year round. The region is also moving towards organic cultivation with programmes such as greenhouses and Mission Organic



Development Initiative (MODI) being implemented by the government. The city can also explore installing IoT sensors for irrigation systems as these will ensure remote monitoring and prevent any systemic leakages

- Regulation of borewells and smart meters: Due to the large increase in tourist influx there has been an unregulated increase in the number of borewells in the city. The city should implement strict regulations for these borewells and define the quantum of water that can be sourced through them. The borewell can be retrofitted with IoT sensors to monitor the activity and alert city officials in case of misuse. The city should also look at connecting households and commercial units through a piped water supply. These connections could be further linked with smart systems to remotely manage and monitor the supply of water
- Rainwater harvesting and storage of water: Considering that rainfall is scarce in the region and that a dry spell can wreak havoc on the water supply for upcoming months, there is a very strong need for developing water harvesting mechanisms. These could be rainwater harvesting systems, creation of water reservoirs, use of innovative systems such as ice stupas, artificial glaciers,¹ etc. These water harvesting mechanisms will not only be useful for ensuring constant supply of water but can also be used to collect water that flows to lowlands in the winter and be put to use during the summers
- Other initiatives: Apart from the aforementioned activities, the city of Leh could also adopt certain initiatives which can be undertaken on a low budget. The initiatives include artificial groundwater recharge activities, water audit, demand side management of water supply

Branding in tourism: Currently there are minimal interventions in marketing Leh as a tourist spot. Despite this, Leh has seen a tremendous increase in tourists visiting the city each year. Leh has several facets which can be portrayed to attract tourists to the city, including:

- Adventure tourism: Leh offers several adventure activities for locals as well as tourists including mountaineering, trekking, rafting, cycling, motorcycle tours, camping and safaris. Many cities both nationally as well as internationally have managed to successfully create an image for providing adventure tourism. Leh with its ample and wide range of activities can create a targeted campaign to build its image as an adventure tourism city
- Cultural tourism: Leh has a strong Buddhist culture and is home to several monasteries. The initial tourist influx in Leh was based on cultural tourism led by high number of foreign tourists. Although, over the years, the number of tourists visiting Leh on the cultural trail has decreased, the local administration can create travel packages which specifically target the religious spots across the region. Further, homestays can be developed to portray the local Ladhaki lifestyle to the tourists
- Nature and wildlife tourism: Leh, being in the Trans-Himalayan region, has several species of indigenous wildlife, flora and natural spots such as lakes, mountain passes, and trails. This positions Leh as a go-to place for nature and wildlife lovers. The administration, in consultation with local tour organisers and experts, should aim to develop a future plan for nature and wildlife tourism in the region.

Way forward



Having identified various sustainable best practices from the Greek cities of Trikala, Farkadona and Meteora, the following next steps are suggested, which would help in development of sustainable tourism in Leh. The report suggests a three-tiered approach for a structured and successful implementation of various recommendations, as provided in the previous section:

Goal setting: The first step with regard to the recommendations mentioned in the previous section would be to divide them in to short, medium and long-term goals. This would give a broad structure to the whole exercise of

¹ http://www.iwmi.cgiar.org/iwmi-tata/PDFs/iwmi-tata_water_policy_research_highlight-issue_08_2016.pdf



development of sustainable tourism in Leh. Implementation timeline for short term goals would be 0-3 years, for medium term goals 3-7 years, and long term goals, over 7 years. This would also help the local administration in prioritising the recommendations as required.

Conduct feasibility study / detailed project report (DPR): Once the goals are set, the administration should look at undertaking a detailed feasibility study of the priority projects. This can be done by taking assistance from an expert panel of consultants specialising in undertaking DPRs/feasibility studies for tourism sector and other sustainable practices. The DPRs/feasibility will evaluate individual projects on their technical and financial feasibility and also define a project structure best suited to the needs of the local administration.

Secure funding and implement projects: The paucity of funds with the local and regional government can prove to be a major deterrent in implementation of these innovative and sustainable solutions. The process of securing funding for the envisaged projects should be undertaken in conjunction with other steps, as mentioned above. Having an investment attraction programme in place will not only provide chances of attracting potential investors during early stages of project preparation, but also improve the presence of Leh in front of multiple stakeholders by the way of participation in various programmes, activities, seminars, expos, etc. The local government can also turn to the central government to fund its projects through various national programmes such as Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart Cities Mission, and Faster Adoption and Manufacturing of Hybrid and EV (FAME). Another alternative for securing financing support for shortlisted projects could be to explore the public private partnership route and/or approach multilaterals, donor agencies, development banks for securing funding support.



4 Introduction



This chapter describes the assignment background and the objectives of the baseline study. It provides an introduction to the cities of Leh (India), and Trikala, Farkadona and Meteora (Greece). It further sheds light on the state of tourism in each city, types of offerings, popular tourism spots, and the main stakeholders involved in their respective tourism industries.

4.1 Assignment background



Program objectives: The IUC programme's overall objective is to contribute to improved international urban policy diplomacy and increased decentralised cooperation on sustainable urban development and climate change. The programme has two components: a) City/sub-national cooperation on sustainable urban development to strengthen the European Union (EU)-India cooperation among selected city/sub-national governments and between the national level and the EU, on sustainable urban development while contributing to India's Smart Cities Mission, AMRUT and other national and international sustainable urbanisation processes; and b) cooperation on sustainable energy and climate adaptation and mitigation, and access to clean and affordable energy, through building upon the Global Covenant of Mayors (GCoM) initiative in line with existing India-EU commitments.

Baseline study: The baseline study for the sustainable tourism project has been commissioned as part of the Leh – Trikala, Farkadona, and Meteora strategic collaboration under the IUC – India programme. The study is the key deliverable of the Urban Cooperation Local Action Plan for sustainable tourism in Leh, focusing on water supply, solid waste management, mobility, and branding. The objective of this assignment is to provide a set of recommendations to the city of Leh to integrate sustainable measures into tourism related activities, and also share with the Greek cities a set of Indian best practices regarding sustainability.

Strategic cooperation between Leh and Greek Cities: Leh has entered into a strategic collaboration with the Greek cities of Trikala, Farkadona and Meteora, regarding sustainable tourism. The pairing became feasible based on the interest of the cities as well as specific common features such as size, economic activities, etc. IUC-India is supporting the pairing through the exchange of best practices focusing on the formulation of this report on sustainable tourism.

4.2 Leh – district profile



Introduction: Leh district is part of the union territory of Ladakh located in the northern-most part of India. The district, with an area of 45,100 sq km, is the largest in the country² and situated at an altitude of 2,300 - 5,000 m above sea level. The total population of the Leh district was 133,487, as per the 2011 census, of which 59% were male and 41% female. 2020 estimates of population peg the city's population at 152,175.³ Majority of the population is Buddhist (approximately 66%), followed by Hindus (17%), Muslims (14%), and others (approximately 2%). The Leh district is divided into 16 blocks, 116 villages and 93 panchayats as of 2017 (source: Rural Development Department of Leh). The population of Leh city was 30,850 as per the 2011 census.

History: Post partition, Ladakh comprising the areas of the present Leh and Kargil districts, became one of the seven districts of Jammu and Kashmir. In 1979, Ladakh district was divided into two full-fledged districts of Leh and Kargil. Until 2019, Ladakh was a part of the state of Jammu and Kashmir. In August 2019, a Reorganisation Act was passed by Parliament of India, which led to reconstitution of Ladakh as a union territory, separate from

² <https://leh.nic.in/about-district/demography/>

³ <http://www.populationu.com/in/ladakh-population>

the rest of Jammu and Kashmir, which was itself accorded the status of a union territory. Ladakh officially became a union territory on October 31, 2019, retaining the two districts of Leh and Kargil.

Geographical location: The district is situated at a distance of 434 km from Srinagar and 474 km from Manali. The whole district is mountainous with three parallel ranges of Himalayas, viz., the Karakoram, Zaskar and Ladakh. Between these three parallel ranges, the Indus, Shayok and Zaskar rivers flow and majority of the population lives in the valleys of these rivers. Leh town is one of the most remote areas of the union territory of Ladakh and is located in the valley of the Indus river. At an altitude of 3,250 m above sea level, it is one of the highest permanently inhabited towns in the world. Figure 3 provides maps of the Leh district located in Ladakh.

Figure 3: Leh district map



Source: <https://leh.nic.in/about-district/map-of-district/>

Climate: Due to its altitude above the tree line, Ladakh has a climate of a cold desert. In Leh district, November to February are extremely cold with the temperature falling to as low as 1.3° C (max) and -13.4° C (min) in January. The climate starts becoming pleasant from March, with June, July and August recording average maximum temperature of approximately 25° C. The temperature starts dipping again September onwards. Leh is located on the leeward side of the trans-Himalayan region and thus receives only approximately 100 mm of rainfall per year. There is also high annual deviation in terms of rainfall, between 143 mm to only 18 mm. The Himalayas block rain from the south-west monsoon which the rest of India enjoys. Leh receives rain and snowfall only through western disturbances.

Economic activities: As per the economic review of Leh district (2014-15), agriculture is the backbone of the district's economy as it engages over 70% of the work force mostly as cultivators, agricultural labourers and livestock rearers. Keeping livestock, especially sheep, yak, goats and cows, is a major form of pastoral farming. Yaks yield milk, hair, hide, horns, dung and meat; sheep and goats are used for pashm (wool) and meat, while cows are used for milk. However, in recent years, the tourism sector is emerging as another major contributor to the local economy. It generates revenue and creates employment opportunities on a large scale in related sectors such as restaurants, hotels, guest-houses, catering, travel aggregators, taxi drivers, guides, mule porters, retailers, handicrafts, etc. Tourism contributes to approximately 50% of the local GDP, however, its benefits are mostly concentrated in and around Leh town. As of 2017, the number of small scale industries in Leh district registered with the District Industries Centre (DIC) were 13 in sectors, including food, wood and metal products, electricity, etc. There are no large scale industries present in the entire district.



Ladakh Autonomous Hill Development Council (LAHDC): The LAHDC is an autonomous district council that administers the Leh district of Ladakh, India. The LAHDC was constituted as per the LAHDC Act, 1995. The elections for the council were held in August 1995 and the first inaugural meeting for the council held in September. The hill council works with village panchayats in areas such as economic development, education, healthcare, taxation, land-use and local governance, etc. All decisions pertaining to these areas are further reviewed at the LAHDC headquarters in presence of the chief executive councilor and executive councilors. The council is composed of 30 councilors, of which 26 are directly elected and four, nominated. The executive wing of the council is composed of an executive team consisting of a chief executive councilor and four executive councilors.

4.3 Tourism in Leh



Tourism as the main economic activity: Tourism is an important industry in Leh due to its creation of employment opportunities and income generation on a large scale. The tourism industry also provides employment opportunities in related sectors such as hotels, transport, catering services, cottage industries, etc. and plays an important role in shaping the socio-economic profile of Leh. Leh opened for tourists in 1974 and has since registered an ever-increasing influx of both international and national tourists each year, due to its landscape, tradition, culture, environment, etc. Leh also has a lot of potential for adventure tourism. Tourism, therefore, is one of the major contributors to the local economy. There were 224 hotels and 448 guest houses of different classes registered in Leh district as of 2016. As of 2016, Leh district saw 197,693 domestic visitors and 38,005 foreign visitors. Approximately, 226,771 tourists (both foreign and domestic tourists) visited Leh district in 2019, as compared with 264,760 tourists in 2018. Figure 4 provides the influx of tourists (both domestic and international) into Leh from 2011 to 2016.

Figure 4: Tourist arrivals in Leh district from 2011 to 2016



Source: Tourism department – Leh

Major tourism products in Leh district: Leh has a lot to offer to various categories of tourists, from backpackers to families to young adults. The major tourism products that Leh has to offer include: i) Nature tourism - Major attractions include the Nubra valley, Pangong Lake, Tsomoriri Lake, Magnetic Hill, etc.; ii) Wildlife tourism - Leh district has an abundance of distinct and diverse flora and fauna. It has several species of mountain fauna such as Tibetan sheep, snow leopards, yaks, blue sheep, lynx and many others; iii) Adventure tourism - The major attractions for adventure tourism in Leh include mountaineering, trekking, rafting, cycling, motorcycle tours, camping and safaris. Kangyatse and Kangri peaks are popular for mountaineering. The Zaskar and Indus rivers are popular for rafting; iv) Religious tourism - People of various ethnicities and religions inhabit the Leh district, with Buddhists, Tibetans and Muslims forming the major share of inhabitants. Tourist



places of religious interest include the Hemis monastery, Sankar Gompa, Leh monastery, Leh palace museum, Leh mosque, etc. The major festivals in Leh include Gustor, Hemis festival and Matho Nagrang.

Main places of tourist interest: Leh has no dearth of places of tourist interest. Some of the major tourist attractions are highlighted below.

- **Lakes:** Some of Leh's most popular tourist attractions are its many Lakes. These include: i) Pangong Lake, which is situated at a height of 4,350 metres above sea level and is the highest salt water lake in the world. While one-third of the lake is Indian territory, the remaining two-thirds is Chinese territory. The lake extends to a distance of 160 km. The lake came in to the limelight due to the climax of a hit Bollywood movie, Three Idiots, being shot here; ii) Tsomoriri lake, located in the Ruphsu valley at an altitude of 4,000 metres above sea level. This serene lake is surrounded by lofty mountains and is 29 km long and 8 km wide. The lake is located in a calm, beautiful and peaceful region and is the highest altitude lake in India that is entirely in Indian territory.
- **Valleys and hills:** Another category of tourist attractions are the various valleys and hills surrounding the region. These include: i) Nubra valley, which is situated approximately 160 km north of Leh town and is where the Nubra and Shyok rivers meet. The Nubra valley separates the union territory of Ladakh from the Karakoram range. The valley is accessible via the Khardungla road which is the world's highest motorable road at 18,350 feet above sea level. The jagged mountains, stark landscape and high altitude of the Nubra valley attracts both international and national tourists; ii) Magnetic hill, which is located just 30 km from Leh town and is a place that defies gravity. The hill is located on the Leh-Kargil-Srinagar highway in the trans-Himalayan region. To the east of Magnetic hill flows the Sindhu river. A sign near the hill instructs travellers to park their vehicles in a box marked with white paint on the road, known as the Magnetic road. When parked at the instructed spot, the vehicle start moving forward at a speed of 20 km/hr.
- **Monasteries:** Some of the prominent monasteries in the region are: i) The Lamayuru monastery, which is situated 127 km from the town of Leh on the Leh-Srinagar highway. Situated at a height of 3,510 metres above sea level, Lamayuru is known for its monastery and its 'lunar' landscape. The landscape has some incredibly odd geological formations. The Lamayuru monastery is ancient and is built on this lunar landscape which is called the 'moonscape'; ii) The Hemis monastery, which is located 45 km south of the town of Leh on the banks of the Indus river. The monastery is the largest and a richly endowed Ladakhi monastery. It was built in 1630 and has beautiful architecture, adorned on all four sides by colourful prayer flags. Shey, Thiksay and Alchi are some of the other popular monasteries of the region that attract both international and national tourists.
- **Palaces and mosques:** Leh palace is a former royal palace overlooking the town of Leh. The palace, also known as the Lachen Palkar Palace, was built by King Senge Namgyal. The palace has a massive nine-storey stone structure and lies at the base of the Tsemo ridge. The palace was designed in Tibetan style; however, much of the palace is now in a dilapidated condition and very little survives of the interior decorations. Another tourist attraction is the Leh mosque or the Jama Masjid, which is located in Leh town and is the most important mosque in the union territory of Ladakh. The mosque, with its beautiful architecture, was built in 1666-67 AD as per an agreement between the then Ladakh king and the Mughal emperor Aurangzeb. Some of the popular tourist destinations are depicted in Figure 5.



Figure 5: Main places of tourist interest



Leh in winter after snowfall



Pangong lake



Nubra valley



Magnetic hill



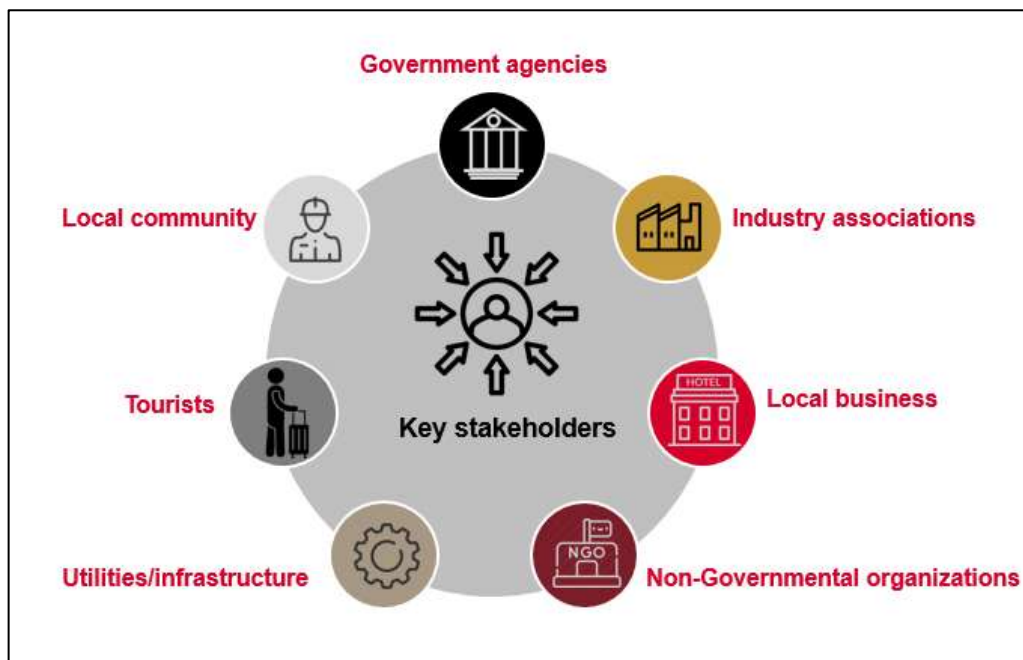
Lamayuru monastery



Leh palace

Source: <https://leh.nic.in/tourist-places/>

Relevant public and private stakeholders: There are a number of key stakeholders which are involved in the tourism industry in Leh. The key stakeholders are highlighted in the figure below.





- **Government agencies:** These include: i) The Ministry of Tourism, Government of India – nodal agency for formulation of national programs and policies related to tourism in addition to development and promotion of tourism in India; ii) Administration of Union Territory of Ladakh - governing authority of the union territory of Ladakh in India and its two districts; and iii) Ladakh Autonomous Hill Development Council - The hill council works with village panchayats in areas such as economic development, education, healthcare, taxation, land-use and local governance etc.
- **Industry associations:** The All Ladakh Tour Operators Association (ALTOA), All Ladakh Hotel and Guest House Owner's Association (ALHGOA), Ladakh Taxi Union (Ladakh Taxi Operator Co-operative), Restaurants Association – Leh, are some of the industry associations as well as important stakeholders of the tourism industry in Leh.
- **Local business:** This group comprises: i) travel operators and aggregators providing tour packages, in addition to airline operators; ii) hotels and guest houses; iii) homestays; iv) restaurants, bars and cafes; v) handicrafts/traditional souvenirs/local jewelry shops; and suppliers of items of daily needs, fruits vegetables, etc.
- **Non-government organisations (NGOs):** NGOs play a vital role in tourism as they point out the imbalances in development in the region, as well as people's perception of that development. NGOs create awareness among the people regarding use or misuse of their resources and assets related to tourism development. Some such NGOs in the region are (a) Students Educational and Cultural Movement of Ladakh (SECMOL), (b) Women's Alliance of Ladakh (WAL), (c) The Mountain Institute, (d) Snow Leopard Conservancy (SLC) (e) Ladakh Ecological Development Group (LeDeg) (f) Group WWF-India and (g) Rural development and You.
- **Utilities and infrastructure:** For the tourism industry to function properly, utilities and infrastructure are required. The power plant such as the Nimoo Bazgo hydroelectric plant, the solar power plant proposed in the Pang region of Leh, and the public health engineering department of Leh supplying water to the residents of Leh are all important stakeholders in the utilities and infrastructure category.
- **Local community:** This stakeholder group is important as the tourist experience and view of a place is largely dependent on this stakeholder group and it largely includes local tour guides, hotel staff, cab drivers and local residents.
- **Tourists:** Tourists are the heart of the tourism industry. Without this stakeholder group, there would not be any tourism industry in Leh in the first place. Approximately 2,26,771 tourists (both foreign and domestic tourists) visited Leh district in 2019, as compared with 2,64,760 tourists in 2018. These consisted of backpackers, adventure seekers, families, young adults, travel influencers, etc.

4.4 Branding of tourism in Leh



Issues pertaining to branding of tourism: Even though tourism is a major activity in the area, Leh region lacks branding itself as a tourist destination. Leh is famous for its strategic importance in Indian military operations rather than a tourist destination. The area has not been able to leverage its geographical advantages to position itself as a preferred destination among local/ international travelers. Most of the promotional activities undertaken for developing tourism in the region have been done by private players such as travel operators, adventure sport companies etc.

Initiatives undertaken: The local administration is now taking cognizance of developing tourism while also implementing sustainable and ecological initiatives in the region. Recently in November 2020, the Directorate of Tourism, Ladakh rolled out its first tourism incentive policy to ensure equitable and sustainable development.



The Honorable Lieutenant Governor of Ladakh, Radha Krishna Mathur, on July 4, 2020⁴, launched Mission Organic Development Initiative (M.O.D.I) of Ladakh and Ladakh Greenhouse Project, aiming to steer Ladakh on a sustainable path. A brief background on these initiatives has been provided below:

- Tourism incentive policy: The investment policy promotes the development of small and sustainable tourism assets as these have low gestation period instead of large hotels and guest hotels. The government will grant 30% capital outright investment subsidy (upto INR 40 lakh) for the fixed assets of new tourism units. The subsidy is also available for expansion of existing units. The policy also establishes the Ladakh Tangible Cultural Heritage Conservation Fund for restoration and conservation of historical sites as Ladakh has a rich collection of historic and heritage sites. The scheme will also promote adventure or recreation tourism by providing up to 20 percent subsidy (upto INR 5 lakh) towards the cost of various identified equipment. The policy also recognizes the need for training of personnel in the tourism industry. The training will assist entrepreneurs in upgrading skills of their employees engaged towards tourism activities.
- Mission Organic Development Initiative (MODI): The program is a special development project with an outlay of INR 500 crore (EUR 59 million) and aims to introduce organic farming into the mainstream agricultural production system. The initiative will be implemented over three phases targeting different blocks of Leh and Kargil. In the first phase, 66 villages of Leh are proposed to be converted into organic villages by the end of financial year 2020, while 85 villages will be certified as organic villages by 2023. The third and final phase will include conversion of 90 villages as organic by 2025. The project will enable farmers to realize 30%- 40% additional income by leveraging organic market demand. The initiative will convert Ladakh into a 100% organic region and provide an impetus towards achieving the target of becoming carbon-neutral.
- Ladakh Greenhouse Project: The project aims to improve the vegetable availability in Ladakh through deep winter greenhouse farming. The project involves use of greenhouses with polycarbonate covering developed by the Defence Institute of High Altitude Research (DIHAR). The project has been allocated a budget of INR 76.44 crore (EUR 9 million) and aims to install 1,676 greenhouses in Leh and Kargil districts over a two-year span. The setup of greenhouses will enable round the year vegetable cultivation and meet the demands of the local citizens
- Solar energy hub of India: As per Government of India reports, Ladakh has a tremendous solar energy generation potential. Realizing this potential, the government is looking to develop 7,500 MW solar energy module in Leh and Kargil and position Ladakh as the solar energy hub of the country. The 5,000 MW solar plant modules will be split across Pang and Hanle with individual capacities of 2,500 MW each. While the project faces several implementation issues such as lack of transmission lines and adverse climate conditions during the construction phase, etc., once the project is commissioned it will cater to energy needs of not only Ladakh but a large portion of northern India
- Marketing initiatives by private players: Leh has seen a major increase in influx of tourists from close to 20,000 tourists per year in the 1970s to close to 280,000 tourists per year in 2017. The tourism focus has moved from cultural / religious tourism to adventure tourism. Several tourists visit Leh each year in summers for long bike rides, visits to monasteries, rafting, rock climbing, etc., while winters are popular for snow treks and another adventure sports. The influx of the tourists has been largely developed through private tour operator initiatives as well as by the shooting of movies in and around Leh

4.5 Greek cities



Trikala: Trikala city is the capital of the Trikala regional unit and is located in northwestern Thessaly in Greece. Trikala is situated on the Lithaios River which is a tributary of the Pineios River. The population of Trikala in

⁴<https://www.reachladakh.com/news/social-news/l-g-mathur-launches-mission-organic-development-initiative-ladakh-greenhouse-project>

2011 was 81,355 while the population of the Trikala regional unit was 131,085, as per the Greek National Statistical Service. Trikala is located 115 metres above sea level. The city has an area of 69 km², while the municipality covers an area of 608 km². The city of Trikala is supposed to be the birthplace of Asclepius, the God of healing. Trikala is built upon the ruins of the ancient city of Trikke, which was an important center in antiquity. The ruins of Asclepion (ancient temple of healing) with its important mosaics as well as the Roman baths can still be found in Trikala. Figure 6 presents a city map of Trikala.

Figure 6: Trikala city



Source: Google Maps, <https://greece-is.com>

Location, climate and economy: Trikala city is the capital of the Trikala regional unit and is located in the fertile plains of Thessaly in central Greece. Trikala is located 331 km northwest of the capital Athens and 215 km southwest of Thessaloniki. The climate of Trikala is warm and temperate with the annual average temperature being around 16°C. July is the warmest (average temperature of 26°C), while January is the coldest (average temperature of 4.7°C) month in Trikala. Winter rainfall in Trikala is much more than in summer. The annual average rainfall in Trikala is 700 mm. The driest month in Trikala is August whereas December receives the highest amount of rainfall. Trikala abounds in natural resources such as fertile agricultural land, water, forests, etc. The economy of Trikala depends mostly on agriculture, with agriculture employment accounting for almost 30% of total employment and contributing 15% to GDP formation. Cotton, maize, sugarbeets, cereals, etc., are the major agricultural crops. Livestock farming of sheep is prevalent in the mountainous regions of Trikala.

Farkadona: Farkadona is a municipality in the regional unit of Trikala and is a part of Thessaly in central Greece. The population of Farkadona town was 2,652 and that of the Farkadona municipality was 13,396, as of 2011. The landscape of the area consists of low mountains with pastures, fertile plains with cultivations, small forests, rivers and archaeological sites. The modern Farkadona municipality covers an area of 370 km² and is a complex of 18 small and medium rural towns and villages following the 'open city' model of urban planning. Farkadona derives its name from the ancient Thessalian town of Pharcadon. The ruins of the town of Pharcadon are still there and are located on a hill near the Klokotos village which is 5 km southwest of the modern town of Farkadona. The modern town of Farkadona was known as Tsioti until 1955. The Farkadona municipality was formed in 2011 by the local government reform by merging the former three municipalities i.e., Oicahlia, Farkadona and Pelinnaioi. The area has some ancient Byzantine monasteries/churches and some ancient bridges, castles, outposts, etc. Figure 7 presents a city map of Farkadona.

Figure 7: Farkadona city



Source: Google maps, <https://farkadona.gr>

Location, climate and economic activities: Farkadona is located halfway between the cities of Trikala to the west and Larissa to the east at a distance of about 30 km from both cities. Farkadona is located near the river Pineios in the Thessalian plains. It is located on the Greek national road 6. Farkadona has a Mediterranean climate. While the summers are hot and dry, winters have a mild temperature. The best time for tourists to visit is from May to October, with a pleasantly warm climate and limited rainfall. The highest average temperature in Farkadona is 31°C in July and the lowest is 8°C in January. The economy of Farkadona is mainly based on agriculture and traditional livestock farming. Other economic activities include trade, commerce, services and some industries.

Meteora: Meteora is famous for its rock formation and is the second largest monastery complex of Greece after Mount Athos. The municipality of Meteora, in central Greece, encompasses the monasteries as well as the city of Kalabaka. Meteora has one of the strangest geological formations in the world and has some amazing clifftop monasteries. Six eastern orthodox monasteries out of the original 24 are still functional and are built in a unique architecture on natural pillars and hill-like rounded boulders that dominate the local area. These monasteries are home to a number of monks and nuns. Meteora is included in the UNSECO World Heritage list and welcomes thousands of tourists every year. The total monastic population of the Meteora monasteries was 56 as of 2015. The monasteries are now tourist attractions. As per scientists, the pillars were formed 60 million years ago during the tertiary period. Also once the area was covered by sea, but a series of tectonic shifts and earth movements caused the sea water to withdraw. The mountains used to be continuously hit by strong winds and waves which along with extreme weather conditions affected their shape. This is the reason why the pillars in Meteora are composed of sandstone and conglomerate. The exact date of the establishment of monasteries is unknown. Figure 8 presents a city map of Meteora.

Figure 8: Meteora city



Source: Google Maps, <https://www.greeka.com/thessaly/meteora/geography/>

Location, climate and economic activities: Meteora is located near the town of Kalambaka at the northwest edge of the Thessaly plain, near the Penios River and the mountains of Pindos in northwestern Greece. Meteora has a Mediterranean continental climate with cold winters and hot summers. At higher elevations it is cooler than that at ground level. Spring season which lasts from March till May gets steadily warmer and temperature increased from 15°C in March to 25°C in May. Summer, which lasts from June to September, is hot and prone to thunderstorms. Temperature during the summer months rises to as high as 32°C in July. Autumn season in October and November witnesses a drop in temperature and lightening of rains. Winter, which lasts from December to February, is wet and cold, often seeing snow, with an average high temperature of 12°C and an average low temperature of 4°C. There are a number of hotels, restaurants, shops and cafes in Kalambaka near Meteora due to the presence of ancient monasteries at Meteora and due to the economic importance of tourism to this town.

4.6 Tourism in Greek cities



Main economic activity: Of the three Greek cities, the economies of Trikala and Farkadona are primarily based on agriculture and stockbreeding with the primary outputs being wine, feta cheese, and sausages. However, in the past decade, Trikala has become an attractive tourist destination and is known as the national Christmas City of Greece, attracting close to 1 million visitors per year. Farkadona on the other hand, has demonstrated remarkable achievements in the sectors of mobility, health, local democracy, etc., and is currently promoting agro-tourism. Meteora on the other hand is one of the major tourist destinations of Greece. Meteora attracts more than 1 million visitors every year on account of its huge rock formations and monasteries situated on top of them. The economy of Meteora is heavily dependent on tourism which is generated due to Meteora rock formations. The rock formations are home to 24 monasteries, of which only 6 are now functioning.

Major tourism products in the three Greek Cities: The major types of tourism in the three cities of Greece (Trikala, Farkadona and Meteora) are: i) Heritage/religious tourism - Tourist places of religious interest include the Monastery of Meteoron, Monastery of the Holy Trinity, Monastery of Varlaam, Monastery of Rousanou, Monastery of St. Nicholas, and Monastery of St. Stephen ii) Cultural tourism - The major tourist attraction of Trikala is the Mill of the Elves which is famous for celebrating Christmas every year. The theme park celebrates the spirit of Christmas, offers many activities and attraction for various age groups, and is absolutely free of cost to all visitors; iii) Adventure tourism - Meteora is also famous for adventure tourism which include rock climbing, canoeing, mountain biking, rafting, horseback riding and many more. Other attractions include guided hike through Meteora's rock forest and multiple trails.



Main places of tourist interest: Trikala, Meteora and Farkadona have no dearth of places of tourist interest. Some of the major tourist attractions are highlighted below.

- **The Mill of the Elves:** It is the largest Christmas theme park in Greece. The theme park hosts a number of artistic events, interactive workshops and many other surprises to cater to different categories of visitors and that too free of charge. Some of the popular attractions include Santa Claus, the princess of the moon, the fairy Halloween, the tree-yard, play Mobil's knights' castle, the elf knowledge workshop, face painting, climbing and mushroom workshops. Not only locals, but also tourists from nearby countries of Bulgaria, Romania, Serbia, Croatia and Italy have been regular visitor to the Mill of the Elves.
- **Meteora monasteries and caves:** The most famous tourist attraction in the entire region of Thessaly are the monasteries sitting at the top of rock formations in Meteora. There are six functional monasteries, which are populated by some monks and nuns. Stairs have been carved out into the rocks for easy accessibility of the tourists. The remaining monasteries are ruined and abandoned and are spread across the area. The area is also famous for hiking and rock/mountain climbing for tourists seeking adventure activities. Apart from the monasteries residing at the top of the rock formations at Meteora, hundreds of caves peeking from the rock faces are major tourist attractions in the area. These are the caves where locals kept their goats and sheep at night, caves where hermit monks went to spend their days in absolute solitude, and caves where unruly monks were jailed for causing trouble and disobeying orders.
- **The Manavika:** A key area for any traveler in Trikala is the Manavika, an area where traders once flogged their wares, it is now full of taverns. Here the tourists can try any of the local specialties such as country sausage, veal liver, pork shank, lamb chops and galotyri, a fresh soft cheese similar to a thick yoghurt. Aside from the eateries, walking through the Manavika, it is worth pausing at the huge mural on Erythros Stavros Road depicting many aspects of life in Trikala: a young boy wearing the jersey of the local team, famous local musicians, taverns, organ grinders, bouzouki players, aristocratic mansions and the newer apartment blocks that are characteristic of Greece's post-war development.
- **Museums and monuments:** Trikala is a town with a rich history and has a slew of monuments bound to excite any history lover such as the Kastro (the castle built by the Byzantine emperor Justin I in the 6th century AD), the clock tower (built by the Ottomans, destroyed in WWII, then rebuilt) the Kursum Mosque (16th century), the riverside Matsopoulos Mill complex (a fantastic industrial monument built in 1884 and the first pasta factory in the country). The old Varousi district lends itself to strolls through the narrow streets amid the traditional houses with their sahinisia – extensions of the first floors of the houses similar to northern European 'erker' bay windows. The decommissioned train wagons by the train station are also utterly charming, resembling those of the legendary Orient Express. Finally the Tsitsanis Museum is worth a visit, dedicated to Vasilis Tsitsanis, one of Greece's most important composers and songwriters who hailed from Trikala and was particularly influential in the field of 'Rebetika' a form of folk music often referred to as the 'Greek blues'. Figure 9 below depicts some of the popular tourist attraction of the three Greek cities.

Figure 9: Main places of tourist interest



Mill of the Elves



Manavika



Tsitsanis Museum



Monastery of Great Meteoron



Monastery of Varlaam



Monastery of Rousanou



Monastery of St. Nicholas



Monastery of St. Stephen

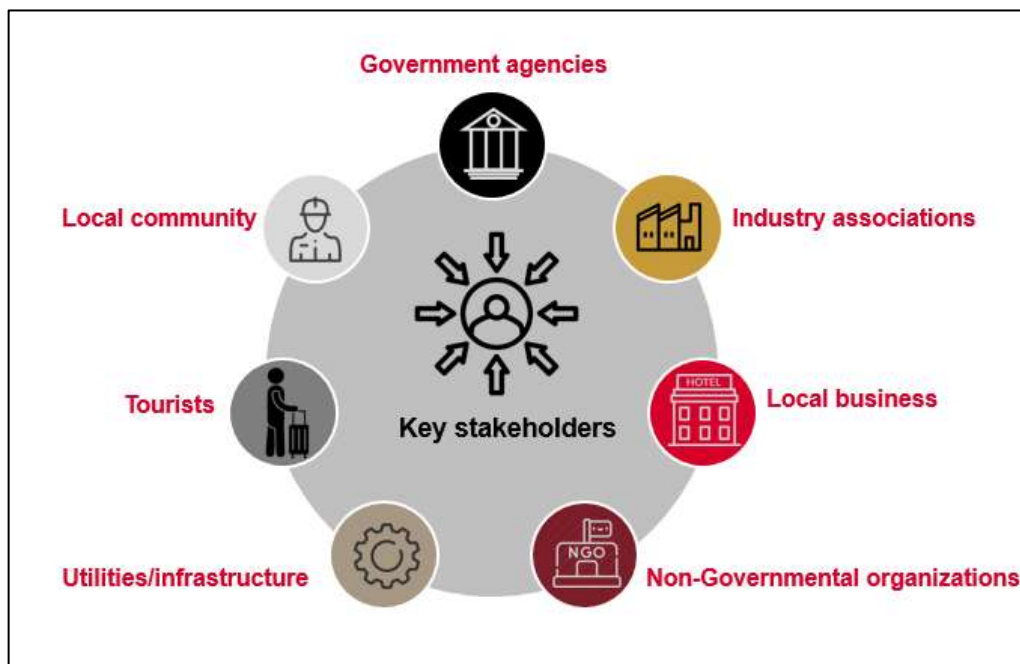


Monastery of the Holy Trinity

Source: <https://www.greece-is.com/5-great-things-about-trikala/>, <https://en.wikipedia.org/wiki/Meteora>

Contribution to local GDP: The three cities in the spotlight, i.e., Trikala, Farkadona and Meteora are part of Thessaly, one of the 13 regions of Greece. Meteora, due to its historic rock formations and monasteries, is the most popular tourist destination of the three cities, followed by Trikala and Farkadona. In 2017, Thessaly accounted for 5.2% (€ 9,437 million) of the national gross domestic product (GDP), ranking third among the 13 Greek regions. The region primarily specialises in the agriculture sector and the share of the primary sector in regional Gross Value Added (GVA) stands at around 12.3%, which is the highest share of all the regions in Greece. Tertiary sectors, combining tourism, retail, wholesale, transportation, etc, contribute 70% to the regional GVA and is also the major employer for the local workforce.

Relevant public and private stakeholders: There are a number of key stakeholders which are involved in the tourism industry in the Greek cities. The key stakeholders are highlighted in the figure below:



- **Government agencies:** These include (a) Ministry of Tourism, Greece - government department in charge of tourism in Greece; (b) Greek National Tourism Organisation - public entity supervised by the Ministry of Tourism. It is the government board which is responsible for the promotion of tourism in Greece. The organization releases advertisement campaigns as a way of promoting tourism in the country; and (c) Municipalities - The Municipalities of Trikala, Farkadona and Meteora are the administrative bodies for their respective cities. Apart from working in different areas such as economic development, education, healthcare, taxation, land-use and local governance, these municipalities are also responsible for implementing various programs and activities in their respective cities.
- **Industry associations:** Federation of Hellenic Associations of Tourist and Travel Agencies (FEDHATTA), is the nationwide representative of the entire travel agency sector in the relevant national, European and international organisation. FEDHATTA, through its member associations, represents approximately 2,500 travel agencies, employing approximately 22,000 people, across Greece.
- **Local business:** This group includes multiple stakeholders such as tourism organisations/aggregators/operators, hotel and guest houses, homestays, restaurants, handicrafts/traditional souvenirs/local jewelry seller, and suppliers. All these stakeholders are either directly or indirectly involved in the tourism value chain. These stakeholders can arguably be titled as one of the most important member of the value chain as they play a key role in forming the opinions and enhancing their experience at various tourist spaces.
- **NGOs:** NGOs play a vital role in tourism as they point out the imbalances in development in the region, as well as people's perception of that development. NGOs create awareness among the people regarding use or misuse of the resources and assets related to tourism development. Some of such NGOs in the region are (a) Deka Trikalon (municipal enterprise for social development), (b) Syn-Eirmos (NGO for social solidarity), (c) Ecological Movement of Environment and Social Intervention of Trikala, etc.
- **Utilities and infrastructure:** For the tourism industry to function properly utilities and infrastructure is required. Power plant such as the Mesochora hydroelectric plant in Trikala; DEYAT, the municipal water supply and sewage company of Trikala; Hellenic Electricity Distribution Network Operator, power distributor are all important stakeholders belonging to the utilities and infrastructure category.



- Local community: This stakeholder group is important as the tourist experience and view of a place is largely dependent on this stakeholder group and it largely includes local tour guides, hotel staff, cab drivers and local residents.
- Tourists: Tourists are the heart of the tourism industry. Without this stakeholder group, there would not be any tourism industry in these Greek cities. As per a report published by OECD, Greece attracted over 33 million tourists in 2018 as compared with over 26 million in 2016.



5 Main components of sustainable tourism

This chapter defines sustainable tourism as per the UNWTO and the ILO. It also reviews the major components of sustainable tourism, as defined by these organisations. These include smart systems, cultural heritage, environment, quality food production, energy, water, waste, mobility, healthcare, green spaces, sewerage and sludge management, government and commerce, etc.

5.1 Sustainable tourism



United Nations World Tourism Organization (UNWTO): The UNWTO describes sustainable tourism as tourism that takes into account all of its current as well as future social, economic and environmental impact, while simultaneously addressing the needs of tourists, visitors, the industry, the environment and the host communities. As per the UNWTO, sustainable tourism should: i) make optimal use of environmental resources that constitute an important element in development of tourism, maintaining essential ecological processes and conserving natural heritage and bio-diversity; ii) respect the socio-cultural authenticity of the host communities, conserve their cultural heritage and values, and also contribute to the inter-cultural understanding and tolerance; and iii) ensure viable and long-term economic operations, providing socio-economic benefits to stakeholders that are fairly distributed. Sustainable tourism ensures stable employment and income earning opportunities and social services to host communities while contributing to poverty alleviation.

International Labor Organization (ILO): The ILO's definition of sustainable tourism is that it is composed of three pillars namely: (1) economic development; (2) social justice; and (3) environmental integrity. Sustainable tourism is committed to enhancement of local prosperity by maximising tourism's contribution to the destination's economic prosperity. Tourism should generate income as well as decent employment for workers without affecting the environment and culture of tourist destinations while ensuring the viability and competitiveness of the destinations and enterprises to enable them to continue to prosper and deliver benefits in the long term.

5.2 Main components of sustainable tourism



The following figure highlights some of the major components that together help in developing sustainable tourism for a region:

Figure 10: Components of sustainable tourism



Source: CRISIL analysis

Water and sanitation: Tourists in many areas contribute to water scarcity and inequity through overexploitation of aquifers, lowering of groundwater tables, appropriation of public water supplies and contamination of fresh



water by salt water and sewage. This leads to resentment among local residents and threatens the sustainability of tourism, which thus damages the economy of the destination. Efficient use of water by hotels, tourists and other stakeholders, coupled with safety measures, waste water management, pollution control and technology incorporation can be the key to conserving water as well as promoting the larger objective of sustainable tourism. Another important aspect of sustainable tourism is proper sewage treatment and sludge management. It should be ensured that all establishments, including hotels and guest houses, are connected to the central sewage system, which ends up at a sewage treatment plant for treatment. Establishments that have septic tanks need to get their tanks de-sludged or cleaned by vacuum trucks to prevent the sewage from polluting the underground water table.

Cultural heritage and quality food production: Sustainable tourism generates income as well as decent employment for the workforce of the tourist destination, without affecting the cultural heritage of the destination. As per the EU definition, sustainable cultural tourism is the integrated management of cultural heritage and tourism activities in conjunction with the local community, creating environmental, social and economic benefits for all stakeholders, to achieve tangible and intangible cultural heritage conservation and sustainable tourism development. Some important stakeholders in the sustainable cultural tourism value chain are tourists (consumers), tourism associations and operators, religious heritage organizations and sites, local and heritage communities, and policy makers. Further, local foods and agricultural produce of a particular tourist destination play an important role in the sustainable tourism experience, as it appeals to the tourists' desire for authenticity within the holiday experience. Local food not only stimulates agricultural activity; it also enhances quality food production, creates job opportunities, encourages entrepreneurship, enhances destination attractiveness, and reinforces destination brand identity. Nearly a third of the tourists' expenditure is on food, which constitutes a considerable portion of a destination's tourism revenue. Therefore, quality food production and the usage of good quality vegetables and other products in restaurants, hotels and guest houses are important factors to be considered for sustainable tourism.

Environment and green spaces: Sustainable tourism is committed to making a low negative impact on the environment of a tourist destination. Green spaces such as parks, botanical and zoological gardens and urban forests not only protect and improve environmental quality standards in cities but also attract residents/inhabitants and tourists alike. Green spaces are important for all types of sustainable tourism such as leisure, cultural, business, congress, meetings, or other tourism forms. The quality of green spaces helps to define the identity of towns and cities which can enhance their attraction for tourism. Green spaces absorb methane, carbon dioxide, carbon monoxide and other harmful gases released through vehicular pollution and other such sources and release oxygen in the environment. To promote sustainable tourism, the municipality of the region should conduct regular cleanliness drives and levy monetary fines on those polluting the environment. The municipality should conduct regular audits at hotels and guest-houses in order to ensure that they are operating as per regulations and are using energy and water within the prescribed limits and are disposing of their waste in a responsible way.

Government and commerce: The role of the government is to formulate and implement required policies, facilitate and spearhead sustainable tourism development in the region. The role of the government is not only to focus on and promote tourism sector as a whole but also focus on other sectors closely linked to tourism, such as water supply, energy, SWM, sludge management and mobility. Destinations wanting to promote sustainable tourism are more likely to be successful when there is effective and supportive local governance. Further, commerce is an important sector, which impacts the tourism industry of a particular tourist destination. Tourism has several economic benefits and opportunities for local businesses, shops, entrepreneurial start-ups, and allow for increased trade of goods and products, which might include but not limited to textiles, clothes, shoes, spices, food items, and/or other specialties native to the region. This further leads to employment opportunities and income generation for the residents as well as local government through taxes and thereby contributes to promoting sustainable tourism.



Smart systems: The smart-city concept has become one of the main driving forces for the transition towards a sustainable economy, low carbon environment and footprint, and urban mobility. Tourism is an important generator of carbon emissions. Sustainable tourism is an important part of the smart-city concept. Within this context, the Internet of Things (IoT) is the key technological point for the development of smart urban environments through the use of aggregated data, integrated in a single decisional platform. The advent of IoT, smart sensors, system-on-chip computing devices and cloud computing is facilitating the design and development of smart services and devices, such as smart-street lightings, smart meters, smart gas stations, smart parking lots and smart and intelligent bus stops. For example, smart and intelligent bus-stops optimize energy consumption as per bus stop occupancy, communicate the occupancy to the incoming buses so that they need not stop at the particular bus stop in case of zero occupancy. The smart bus-stops monitor air-conditioning and lights, automatically report utility breakdowns and measure air pollution around the area. All these smart systems contribute to the concept of smart city and sustainable tourism.

Waste: Tourist destinations generate large amounts of solid waste, particularly during the peak tourist season, which makes its management more complicated. Both hotels and guest houses are identified as some of the largest consumers of durable and non-durable products, resulting in large amounts of waste generated. A typical hotel guest (tourist) can produce 1 kg of waste per day. Additionally, tourists visiting popular tourist spots engage in littering by throwing plastic bottles, wrappers, plastic packaging, and other waste in or nearby rivers, valleys, lakes, other water bodies, streets and other such places. Hence, it is imperative to have a structured solid waste management program in place so as to achieve sustainable tourism for a region. The 3R concept of SWM – that is reduce, reuse and recycle – should be implemented. Waste prevention and waste segregation at source must be emphasized upon, and awareness programs should be organized for both tourists and residents. Appropriate penalties should be levied on both residents and tourists for littering and throwing waste. During disposal and treatment, recyclable fraction of waste should be treated at a recycling plant and the combustible, but non-recyclable fraction of waste should be incinerated in an incinerator. Only the inert and the non-recyclable and non-combustible fraction of waste should be sent to the scientific landfill site.

Mobility: Mobility planning is an integral part of sustainable tourism and territorial planning. Tourist destinations must be integrated with sustainable mobility solutions as it can add value to the travel experience of tourists, therefore promoting sustainable tourism. These may include planning for pedestrian mobility, promoting cycle-tourism and walking trails, developing shared mobility solution (bus/metro train/trams services). Making public transport more attractive to tourists through thematic designing of bus/metro/tram stations and interactive communication with tourists during the journey greatly adds to the holiday experience of tourists. Driverless bus services (automated mobility), usage of electric light vehicles (ELVs) are also some sustainable solutions for mobility. Developing smart bus stops/metro stations providing real time information using IoT and using solar energy not only enhances tourist experience but greatly improves the mobility in the tourist destination.

Healthcare: Tourism is the most important component and element of the economy of a tourist destination. However sustainable tourism seeks a balance between growth, protection, and social and overall well-being. Healthcare is therefore an important component for sustainable tourism. The presence of good public and private hospitals and clinics with learned doctors and sufficient equipment and laboratories at a tourist destination boosts the tourist's confidence while travelling to a particular tourist destination. Apart from this health-tourism is also a part of sustainable tourism wherein individuals travel to a particular destination within the country or overseas for inexpensive and timely medical treatment, which may or may not be available at home. Thus, both healthcare and health tourism are important components of sustainable tourism.



Energy: The achievement of sustainable tourism is the result of focusing on both the tourism sector as well as other sectors closely linked to tourism, such as energy. The adoption and usage of clean energy technologies, in both energy production and savings, electricity usage and usage in tourist-related transport is necessary for sustainable tourism development at the regional and local levels. The particular tourist destination should strive to use renewable energy sources and adopt rational use of energy for sustainable tourism development. Energy-efficient architecture is also one of the key drivers for the success of sustainable urban tourism. Energy-efficient architecture requires application of energy-efficient concepts, elements and systems. Apart from these factors, improving the energy efficiency of hotels, guest-houses and homestays are also important measures to ensure rational use of energy in order to promote sustainable tourism.

5.3 UNWTO guidelines



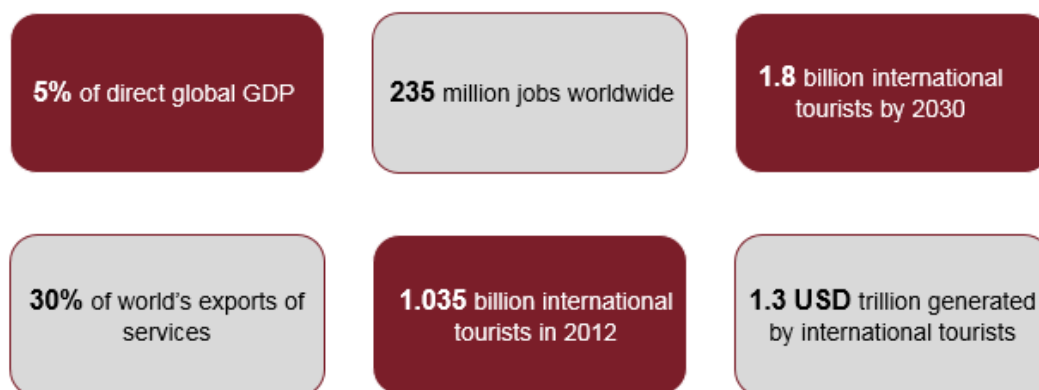
Introduction: Tourism offers young men and women millions of direct entry points into the workforce. Tourism is one of the major sectors in international trade, and is a major income source for many developing countries. It is the only service sector which has recorded surpluses in trade compared with the rest of the world. However, tourism can also be a source of environmental damage and pollution, cause depletion of scarce resources, and pose a threat to the socio-economic culture.

Sustainable tourism as per UNWTO: The UNWTO describes sustainable tourism as tourism that takes complete account of its current as well as future social, economic and environmental impacts, while at the same time addressing the needs of tourists, visitors, the industry, the environment, and the host communities. As per UNWTO sustainable tourism should: i) make optimal use of environmental resources that constitute an important element in development of tourism, maintaining essential ecological processes and conserving natural heritage and biodiversity; ii) respect the socio-cultural authenticity of the host communities, conserve their cultural heritage and values, and also contribute to the inter-cultural understanding and tolerance; iii) ensure viable and long-term economic operations, providing socio-economic benefits to stakeholders that are fairly distributed. Sustainable tourism ensures stable employment and income earning opportunities and social services to host communities while contributing to poverty alleviation.

UNWTO Guidebook: The UNWTO was commissioned to prepare a guidebook on sustainable tourism, as an engine for development, job creation, trade in service sector, and poverty reduction. The guidebook enhances the understanding of tourism in all its dimensions. It also relates to the EU Agenda for change to enable EU services in Brussels and EU delegations in 180 countries as well as other development institutions to include sustainable tourism in their programs. In the guidebook, the UNWTO has ensured maximizing tourism's contribution to development while minimizing its negative impacts, and paying attention to the growth potential of developing countries. The approach of the UNWTO is based on its experience and work with a large number of partner agencies and governments. The results of the guidebook have been tested in six countries namely, Kenya, India, Senegal, Vietnam, Timor-Leste, and Botswana. The guidebook was launched with the EU on June 23, 2013 in Brussels. Figure 11 presents few data points related to tourism, collated by the UNWTO.



Figure 11: UNWTO's data on tourism



Source: <https://www.unwto.org/EU-guidebook-on-sustainable-tourism-for-development>

5.4 UNSECO guidelines



World Heritage and Sustainable Tourism Program: Sustainable planning and management of tourism is the focus of the UNESCO World Heritage and Sustainable Tourism Program. The UNESCO World Heritage and Sustainable Tourism Program represents a new approach based on stakeholder cooperation where planning for heritage management and sustainable tourism is integrated at the destination level, all natural and cultural assets are valued and protected, and sustainable and appropriate tourism is developed. The program creates an international framework for cooperation across sectors to safeguard heritage sites and achieve sustainable economic development.

Mission: The mission of the program is to facilitate the development and management of sustainable tourism at World Heritage sites and properties through capacity building, balanced participation of stakeholders, fostering increased awareness, etc., to protect the properties and sites and their outstanding universal value. At the same time, the mission includes ensuring tourism delivers the benefits for conservation of the properties' sustainable development for local communities as well as present a quality experience to visitors.

Program objectives: The objectives of the UNESCO World Heritage and Sustainable Tourism Program are fivefold: i) integrate principles of sustainable tourism into mechanisms of the World Heritage Convention; ii) strengthen enabling environment by advocating strategies, policies, tools and frameworks that support sustainable tourism as an important vehicle for managing and protecting natural and cultural heritage of outstanding universal value; iii) promote stakeholder engagement in the planning, development and management of sustainable tourism; tourism that follows a destination approach to heritage conservations and focuses on empowering the local communities; iv) ensure capacity building of the heritage stakeholders and provide them the tools to manage tourism efficiently, responsible and sustainably based on the local context and needs; and v) promote quality tourism products and services that encourage responsible behavior among all stakeholders and foster understanding and appreciation of the concept of outstanding universal value and the protection of world heritage.

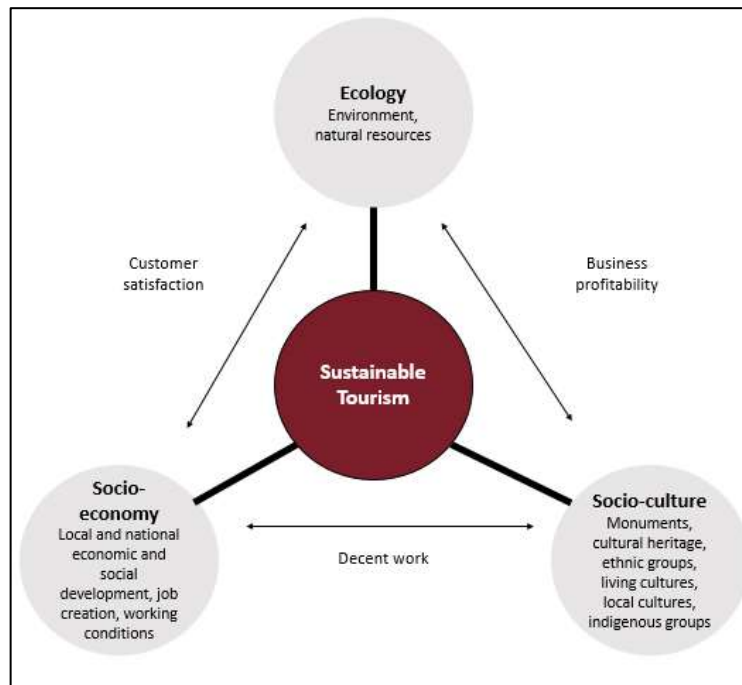
5.5 ILO guidelines



Sustainable tourism: The ILO's definition of sustainable tourism is that it is composed of three pillars: social justice (socio-culture), economic development (socio-economy) and environmental integrity (ecology) as shown in the figure below. Sustainable tourism is committed to enhancement of local prosperity by maximizing the contribution of tourism to the destination's economic prosperity, including the amount of tourist spending retained locally. Sustainable tourism should generate income and decent employment for workers without

affecting the environment, culture and heritage of the tourist destination. Sustainable tourism ensures the viability and competitiveness of destinations to enable them to prosper and deliver benefits in the long term. Sustainable tourism should be distinguished from eco-tourism, which is just a sub-sector of tourism focusing on travel activities that enable environmental protection and social development. Figure 12 depicts the components of sustainable tourism as formulated by the ILO.

Figure 12: Components of sustainable tourism



Source: www.ilo.org

5.6 Conclusion



The definitions of sustainable tourism formulated by the UNWTO, UNESCO and ILO may differ in terms of structure, objectives, pillars, and components. However, they aim to highlight the necessity and importance of adopting sustainable practices while developing tourism in a region. Some of the key takeaways from these international frameworks are: i) need for maintaining established ecological processes and conserving natural biodiversity while promoting tourism; ii) giving adequate respect to the socio-cultural authenticity of the region while contributing to the inter-cultural understanding and tolerance; iii) ensure equitable distribution of socio-economic benefits to the local society; iv) involving relevant stakeholders from the community while planning, developing and sourcing for tourism-related activity; v) capacity building of stakeholders involved in the tourism value chain to implement sustainable practices in their operations and in general adopt a sustainable lifestyle, etc.



6 Sectors impacted by tourism in Leh



As per the relevant discussions with Leh, this chapter focuses on mobility, solid waste management, and water supply which are impacted by the large influx of tourists and tourism activities in the town of Leh. The chapter further explains Leh's overall approach to sustainable tourism.

6.1 Mobility



Reaching Leh: Leh faces several connectivity issues by the virtue of being isolated and facing severe weather changes throughout the year. There are primarily two options to reach Leh – Road and Air. The nearest railway station, Jammu Tawi, being 700 kms from Leh, renders rail as an impractical solution. i) By air – The Leh Kushok Bakula Rimpochee airport is the nearest and the main airport to Leh and is located around 5 km from the main city. There are direct flights to Leh from various cities and states in India. However, due to the inclement weather conditions the flights operate only during the day time ii) By road – Leh is connected to the rest of India through two roads, which are the Leh-Srinagar national highway and the Leh-Manali road. The two roads remain open during only the summer months. During winter, these remain closed for more than seven months, due to the closure of Zoji la, Rohtang la, Baralacha la and the Tanglang la passes. Leh can be reached by road through private vehicles, taxis and also through buses (both private and public). Leh is well-connected through public and private transport buses with both Srinagar and Manali, both of which are well connected with Delhi and Chandigarh; and iii) By rail – The nearest railway station to Leh is Jammu Tawi, located at a distance of approximately 700 km from Leh. The proposed Bilaspur-Manali-Leh railway line is a 498 km long proposed high elevation all weather, broad gauge railway track which will connect Bilaspur in Himachal Pradesh with Leh in Ladakh. On commissioning of this proposed rail line, the connectivity to Leh will be considerably improved.

Mobility in and around Leh: As Leh is a small town, there are no dedicated local bus services. However there are a number of public and private buses for tourist spots in and around Leh such as Pangong lake, Tso Moriri, Nubra valley, Magnetic hill etc. Apart from buses, there are a large number of private cars as well as taxis in and around Leh. There are around 35,000 registered vehicles constituting both private and commercial vehicles. The majority of the registered vehicles are cars followed by trucks and buses. Only few two-wheelers (500) are registered which primarily includes bikes on rent. The taxis are either private (tour operators and rental taxi providers) or belong to the Ladakh taxi union. About 1,500-2,000 taxis (public and private) ply during the tourist season. Taxis are allowed only up to Leh town from other states. Taxis from outside cannot travel on the internal routes in Leh. On average, about 25-30 taxis enter Leh daily from different states. This means that a total of 4,500-5,000 taxis enter Leh during the permissible period of 6 months during the summers. There are dedicated parking spaces for taxis which can accommodate close to 80 taxis at any given point in time. Figure 13 shows some taxis on the outskirts of Leh.

Figure 13: Taxis in Leh



Source: <https://www.ladakhhotelsindia.com/transport.html>

Mobility issues in Leh: There are various issues related to transportation and mobility in Leh which are highlighted below.

- **Large influx of tourists:** Due to the large influx of tourists in the Leh, every year, the number of traffic jams are increasing. The air gets polluted and the entire town gets clogged. More than 1.2 lakhs vehicles come to Leh every year. Also, tourists spend most of their time in Leh town, and seldom explore lesser known parts of the district. This results in the town being highly populated and filled with tourists especially during the tourist season.
- **Developmental activities:** Leh being a tourist town has a lot of developmental activities, such as construction of hotels, sewerage work, and water pipeline work. The ongoing developmental activities in and around Leh also cause traffic issues. Also the developmental work has to be carried out during the peak tourist season because of the unfavourable weather conditions in Ladakh during the winter months. These developmental activities aggravate the traffic and congestion problems in and around Leh.
- **Mobility issues during winter:** Flying is the only option to reach Leh in winter, as the two main highways to Leh are closed during winter months due to the closure of Rohtang la, Zoji la, Baralacha la and the Tanglang la passes. Roads to tourist spots, such as Pangong Lake, Nubra valley, Tso Moriri and Kargil, are kept open and accessible during the winter months. However, in cases of heavy snowfall, the roads maybe closed and it would not be possible to visit such places during snowfall. Additionally, tourists and locals in the high altitude areas of Ladakh face the problem of freezing of diesel in sub-zero temperatures during the winter months. Locals and tourists get stranded and face various hardships as far as mobility is concerned, during the harsh winter months. Additionally, during winter months, there are chances of avalanches and landslides, which either block the roads and highways or cause road accidents.
- **Lack of efficient public transport system:** Leh does not have a well-developed and efficient public transport system. The travel within the city is primarily dependent on shared taxis and public bus transport is not well developed. The bus system for tourist destinations is primarily managed by private players and there is a lack of standardised booking portals for such travel.

6.2 Solid-waste management



Introduction: The mountainous region of Leh faces several challenges in implementing an effective and efficient SWM on account of inadequate methods to handle the solid waste, which has serious cascading effect



on the fragile environment. Also the seasonal influx of tourists aggravates the challenges of SWM due to the fact that an enormous quantity of waste is generated within a short period of time.

Solid-waste generation and segregation: The population of Leh town was 30,870 as per the 2011 census and there are 6,000 households and 3,500 commercial establishments in Leh. Annual waste generation in Leh from all sources is around 4,717 metric tons with a per capita waste generation of 0.41 kg/day. As per the Municipal committee of Leh, waste collected in winters amounts to 8-9 TPD, while that in summer amounts to 35-40 TPD. Of this, 15% constitutes organic waste, 65% plastic, card board, oil containers, etc., 15% old and unusable items of daily needs, such as cloths and blankets, and the remaining is in the form of medical, metal and inert waste. Due to the ecology of high altitude mountains and sub-zero temperature for most parts of the year, the biodegradable waste does not decompose. It mixes with water and deteriorates its quality. The increase in tourism is heavily contributing to the problem of SWM in Leh. Even though there are bins available for segregating waste at source, there is apathy and lack of awareness amongst tourists and locals leading to poor waste management. Additionally, there is lack of appropriate infrastructure, such as limited number of municipal tipper trucks, which collect the waste.

Solid-waste collection and transportation: Apart from door to door collection of solid waste, there are three other types of waste collection points in Leh, namely: i) dumper bins (garbage bins); ii) small dust bins; and iii) open dump sites. There are 15 dumper bins in the Leh town, which can be directly loaded and transported on vehicles, such as a dumper placer equipped with hoisting mechanism. Such dumper bins are located at places where large amount of solid waste is generated, such as hotels, shopping complexes and main market areas. The capacity of the dumper bins is two metric tons. The small dust bins are plastic bins, which are seven in number and are located along the main road in Sanker, Shakynos and Skazagling. The capacity of these bins is 200kg. The third type of waste collection point are open dump sites, which are 40 in number, are illegal and attract dogs and stray animals. The open dump-sites create a lot of nuisance during the peak tourist season. After collecting solid waste from individual households and the central collection points, the waste is transported using 11 municipal tipper trucks to the newly established waste treatment plant. The waste that cannot be treated by the plant (due to capacity limitations) is transported to the dumping ground at Diskit Tsal for disposal. Figure 14 shows a garbage truck employed by Municipal Committee of Leh to collect garbage.

Figure 14: Garbage truck in Leh



Source: <https://www.thethirdpole.net/2018/06/26/photo-essay-tourists-and-trash-at-pangong-lake/>

Solid waste disposal: As of date, Leh does not have a dedicated scientific landfill site. Instead open dumping has been in practice for the past 30 years, which poses several threats to public health and the environment. The waste dumping site is located at Bomb guard in Diskit Tsal just 1.5 km outside of Leh town. No environmental or socio-economic factors were taken into consideration while selection of the dumping ground. Unlike the dumping grounds in the plains, this dumping ground at Bomb guard does not have any boundaries and the waste flies in whichever the direction the wind takes it. Further, this legacy dump site apart from being an eye sore has caused serious environmental issues such as leachate and production of landfill gases. Although a waste treatment plant has been recently commissioned, it is not operating at its full capacity and the balance waste is still being dumped at the disposal site. Hence disposal of solid waste and reclamation of the legacy dumpsite are the two key issues being faced by Leh. Additionally, an engineered landfill site of 83 acre area has been identified at La-ser-mo and the first stage for the construction has been completed. It is a part of the Leh beautification project and Urban Infrastructure Development Scheme for Small & Medium Town (UIDSMTT). Figure 15 depicts the existing waste disposal site at Diskit Tsal.

Figure 15: Waste dumping ground at Diskit Tsal



Source: Dump site and surrounding environment, Leh Town. Source: Field survey 2017

Solid waste treatment: A waste treatment plant with a capacity to treat 30 TPD of waste was commissioned in August 2020. Currently the plant is only processing around 8-10 TPD of waste, which will increase gradually and the plant will start functioning at full capacity by summer of 2021. The plant accepts waste collected by the Municipal Committee of Leh as per its current capacity and the remaining waste is disposed at the local dumping site. The plant runs on a 100 kilowatts peak (Kwp) solar power plant installed by Ladakh Renewable Energy Development Agency (LREDA). The waste treatment plant consists of a glass shredder, high-density polyethylene shredder and bailer machine components, while low-density polyethylene shredder, paper shredder pulp and briquetting machines are yet to be installed at the plant. Figure 16 depicts the newly commissioned waste treatment plant in the city of Leh.

Figure 16: Newly commissioned waste treatment plant



Source: <https://www.reachladakh.com/news/social-news/solid-waste-management-plant-starts-to-process-wastes-in-leh>

Revenue and expenditure towards SWM: The city of Leh deploys 125-130 fulltime and part time workers for the collection of waste in the city. The waste treatment plant is managed and operated by a private contract and the concession period for the same is for 18 months post which the plant will be handed over to the municipal corporation. The city of Leh charges a nominal SWM user fee of INR 12,000 per year from hotels (EUR 141), INR 6,000 per year (EUR 71) from guest houses and whole sellers and INR 1200 per year (EUR 14) from general shops. The city currently does not charge any user fees from households. On the expenditure front, the major expenditure for SWM is on fuel for vehicles (INR 55 lakh per year / EUR 64,706 per year) and salaries of staff (INR 100-120 lakh per year / EUR 117,647 – 141,176 per year). As against the aforementioned expenditure, the city earns only approximately INR 15 lakh (EUR 17,647) of revenue from SWM related user fees thereby facing a deficit which is supported from grants made by the Union Territory administration.

Waste prevention: Waste prevention is the highest priority for SWM in Leh, due to its fragile geo-environmental set-up. To some extent, Leh town has some waste prevention measures such as the ban on single use plastic with full co-operation from the local community. In Leh, most of the products are brought from outside Ladakh. As locals and tourists live more modern and affluent lives, they are moving away from traditional food and practices, thus increasing the usage of packaged products. Therefore huge amounts of packaging waste makes its way into Leh, through packed goods thereby resulting in the generation of large amount of plastics and polythene. It is estimated that an average of 30,000 plastic bottles are dumped at the dumping ground in Leh during the tourist season. The huge influx of tourists in Leh has made waste prevention very challenging and has amplified the waste management problems by a large amount.



New initiatives: The LAHDC has started a pilot project 'Tsangda' with the purpose of waste segregation at primary and secondary levels. As a part of this project, the LAHDC has distributed blue and green colored bins to households and commercial establishments for the purpose of primary waste segregation at source. Those not segregating the waste are levied a monetary penalty by the administration. Door to door collection of segregated waste has been initiated by the administration from around 400 households and commercial establishments. The officers accompany the waste collection vehicles in order to strictly enforce waste segregation. The first pilot secondary segregation center under the project was established at Choglamsar in 2017. At the secondary segregation center, the waste collected by the administration is first segregated into dry and wet waste. The dry waste is then segregated into 15 fractions and is sold to scrap dealers, NGOs and the rural development department, while wet waste is fed to the cattle in nearby villages. Due to extremely cold weather, the administration has also provided heating facilities at the center. During the first year of the project, 65,000 kg waste has been collected from Choglamsar, Nubra, Nimo and Khamtsi, of this, 27,000 kg was sold to scrap dealers and 17,000 kg was reused for making recyclable products like biofuel bricks from the discarded cardboards, egg trays and other agriculture wastes.



Need for managing and reclaiming legacy dumpsite: Legacy dumpsites like the one at Diskit Tsal in Leh have become a ticking time bomb, with all possible associated environment impacts including air, water and soil pollution. The waste at such dumpsites gradually decomposes by a combination of biological, chemical, and physical processes. Two major by-products of this decomposition process which have proven to cause adverse effect to the environment are leachate and landfill gas. While leachate enters various watercourses and get consumed by humans and other lifeforms, landfill gas comprising of carbon dioxide and methane contributes to the greenhouse gases in the environment. Hence, it is imperative that the dumpsite at Diskit Tsal is managed and reclaimed at the earliest. One of the process through which this can be done is known as bioremediation (biomining) of dumpsites. It is the process by which previously dumped waste is dug up after loosening and then processed to recover valuable recyclable scrap while also recovering landfill space. The end product, likely to be soil, is rid of toxic materials and hence becomes reusable. Other major resources extracted from legacy waste are plastic, rubber, metal, textiles, glass, soil, and construction and demolition (C&D) waste. Bioremediation is a three part process:

- **Stabilization:** The dumping site is converted into equal-sized windrows and turned frequently, bio-culture is added and de-odourizer (an odour-controlling agent) sprayed. This phase removes odors, reduces moisture and flies, and eliminates pathogens. The addition of bio-culture speeds up the decomposition of waste to carbon dioxide and water vapour and creates biological heat within it, helping to dry it out and reduce its volume by 35–40 per cent. This process, called bioremediation, dries the waste enough for screening. The waste is considered stabilized when there is no more generation of heat, landfill gas or leachate. A germination test is done by collecting samples from the heap to ensure proper stabilization of the waste.
- **Sorting and segregation:** In this phase, excavated landfill waste that is stabilized is separated to collect soil, stones and combustibles. Series of trommels (mechanical screening machines used to separate materials) and manpower is used to segregate the aggregates and other heavy construction waste and debris
- **Disposal:** In this phase, the non-combustible fractions such as soil and stones are disposed off for further processing into finer aggregates or for earth filling. The combustible fraction is called refuse-derived fuel



(RDF) and is in general sent for co-processing in cement industries. Bioremediation/Biomining is a low-cost solution compared to capping to remove the garbage hills and their lingering ill effects. It achieves permanent near-zero emission of harmful gases (such as methane, hydrogen sulphide and ammonia) and leachate.

Successful cases of bio remediation and land reclamation: India has seen several successful examples of bio remediation and subsequent land reclamation. These initiatives have been undertaken in cities such as Delhi, Kumbakonam (Tamil Nadu), and Ajit Singh Nagar (Vijaywada). The experience of these cities towards bio remediation has been captured in Annexure 1 of the report. The city of Leh can take cognizance of these cases and deploy a program for bio remediation to reclaim the existing solid waste dumpsite.

6.3 Water supply



Introduction: Post 2010, the number of tourists reaching Pangong lake and the union territory of Ladakh as a whole has increased three-fold, increasing from 80,000 in 2010 to over 300,000 in 2018⁵, placing an unprecedented burden on the water supply in Leh district. Since tourism is a water intensive industry it is highly dependent on groundwater resources of the area. Water demand increases manifold during the summer months, due to the large influx of tourists. During the winter months, the pipes freeze, and burst and hence water is supplied through tanker services.

Water demand in Leh: During the summer, water demand in Leh stands at 5 MLD, while that in winter stands at 2 MLD. The Department of Public Health Engineering (PHE), the state government utility responsible for supplying drinking water to the residents of the town, currently supplies 4.9 MLD⁶ of water in summers. Leh is majorly dependent on the ground water resources for its water demand. The following table presents the water demand of different stakeholders in the town of Leh, which includes households, commercial establishments (hotels and shops/offices) and floating population (laborers):

Table 1: Average water demand of different stakeholders

S no	Stakeholder	Number of units	Water demand (liters/day/person)
1	Households	6,000	75
2	Commercial establishments	3,500	Hotels – 100 Offices/shops - 10
3	Floating population	50,000	30

Source: Leh Municipal Committee

Water supply in Leh: The primary source of freshwater in Leh is borewells, which provide water from underground aquifers located at a depth between 55-80m. They can be further categorized as: i) public borewells – which account for 31% water supply; ii) private borewells – accounting for 29% water supply; and iii) borewells installed on the bed of Indus River – accounting for 32% water supply. The remaining 8% water is sourced from springs or other surface water sources. However, 25% of the freshwater is lost during transportation due to breakages and leakages in the piped network. According to a recent study undertaken by an NGO in Leh⁷, more than 70% of the guesthouses and hotels in Leh town had a borewell. There are no water treatment plants in Leh town and the water that is lifted from the river beds is transferred multiple times to water reservoirs where it is chlorinated before being supplied to end user through pipes. There are 16 water reservoirs tanks in the town, of which 8 are operational. These reservoirs have varying capacity in the range of 50,000

⁵ <https://www.livemint.com/news/india/why-are-tourists-staying-away-from-leh-ladakh-this-season-1561433264997.html>

⁶ <https://secureservercdn.net/160.153.138.53/8zq.f50.myftpupload.com/wp-content/uploads/2019/09/Volume-1-Issue-8-2019.pdf>

⁷ <https://secureservercdn.net/160.153.138.53/8zq.f50.myftpupload.com/wp-content/uploads/2019/09/Volume-1-Issue-8-2019.pdf>

litres to 1.5 lakh litres, bringing the total capacity at 6.18 lakh litres. Apart from the piped network, 10 water tankers commissioned by PHE supply 0.5 MLD of water to 2,000 households. Figure 17 depicts a frozen reservoir in the vicinity of Leh.

Figure 17: Frozen reservoir in Leh



Source: <https://www.thethirdpole.net/2017/07/26/ladakh-water-tourism-demands-india/>

Water usage by tourists: As per the data provided by Leh Municipal Committee, the per-capita daily consumption of water of a local resident is 75 litre, while that of tourists is 100 litre. A number of hotels and guest houses are set up every year and some of the big hotels consume as much as 5,000 litre of water in a single day. Almost 75% of the people in Leh and the surrounding areas either run a hotel or guest house from their property. These establishments require continuous supply of water. This water demand is further fueled by the use of water-intensive flush toilets by the hotels and guest houses instead of traditional dry toilets, which used to be prevalent in Leh. Given the inadequate water supply by PHE, the majority of owners of these commercial establishments have installed private borewells at their properties.

Precipitation in Leh: The Union Territory of Ladakh is located on the leeward side of the trans-Himalayan region and is a cold desert and thus receives only approximately 100 mm of rainfall per year. There is also high annual deviation in terms of rainfall that is between 143mm to only 18mm⁸. The Himalayas block rain from the south-west monsoons which the rest of India enjoys. Ladakh receives rain and snowfall only through western disturbances. Also the amount of rainfall is declining each year due to climate change. The less amount of rainfall therefore makes water a precious commodity in the union territory.

Poor wastewater management system: Exploitation of water resources is not the only alarming situation in Leh. With this unmanaged water system, the consumption of water has increased at an increasing rate and with that, the production of wastewater has also increased manifold. Since Leh does not have a centralised

⁸ As per 2007 data provided by Municipal Committee of Leh



wastewater management, all the wastewater (grey and black) is collected in poorly managed soak pits and, at times, septic tanks. Many soak pits do not need to be emptied because of strong leakage and high hydraulic conductivity of the underlying sandy soil resulting in a high exfiltration rate of the wastewater from soak pit/septic tank to underground. This highly inadequate wastewater management system has not only caused environmental contamination of surface and groundwater, but also poses a high risk for human health as the groundwater from the shallow aquifer is used for drinking purposes.

Revenue and expenditure: PHE has not established an efficient water tariff and collection mechanism Leh. Only about 900 households and 120 commercial establishments pay an annual water tariff to the tune of INR 945 (EUR 11) and INR 1,440 (EUR 17), respectively. Since water meters have not been installed at the premises of majority of end users, volumetric pricing is not feasible. The municipal committee plan to roll out a new water tariff system once the entire water network has been refurbished/constructed. As per the information received from the Leh Municipal Committee, water supplied through water tankers (INR 49/kiloliter – EUR 0.6/kiloliter) is approximately 4.5x costlier than that supplied through the piped network (INR 11/kiloliter – EUR 0.13/kiloliter). Further, the annual operating cost of drinking water supply system is INR 1,700 lakh (EUR 2 million) while annual collection only amounts to approximately INR 10 lakh (EUR 11,765), bringing the recovery rate to a meagre 6%.



7 Policies related to tourism



This chapter provides an analysis of the prevailing policy environment concerning tourism activities in Leh, including national, regional and local level policies and regulations.

7.1 National



Introduction: Developing tourism has been a key focus area for the national government over the years. For this, the government has developed several tourism policies and guidelines over the past 40 years, with policies coming out every ten years. The tourism policy currently in effect is from 2015, while the government is in the process of releasing a new tourism policy which is currently in the draft stage.

National Tourism Policy - 2015: The Ministry of Tourism released the National Tourism Policy – 2015 on May 1, 2015, after re-visiting the National Tourism Policy of 2002. This policy aims to boost the country's tourism sector. The objective of the policy is to increase India's share in world tourist arrivals from 0.68% in 2015 to 1% by 2020 and to 2% by 2025 and position tourism as a priority sector on the economic and national agenda. The focus of the policy is on employment generation and community participation in the development of a sustainable tourism industry in India. The policy envisions developing and positioning India as a must-experience and must-revisit destination, integrating aspects of Swachta (cleanliness), Suraksha (safety) and Swagat (welcome). The policy seeks to develop a government-led, private sector-driven and community welfare-oriented framework for tourism development. The policy lays adequate emphasis on skill development across all tourism segments, including setting up a university for tourism and hospitality education and using technology to promote tourism. The National Tourism Advisory Board (NTAB) was proposed to be set up under the chairmanship of the Union Tourism Minister, and assisted by state/union territory tourism ministers. Airways, roadways, waterways and railways will be further developed and tourism infrastructure such as Swadesh Darshan, Pilgrimage Rejuvenation and Spirituality Augmentation Drive (PRASAD), the Buddhist Circuit, etc., will be developed. The policy focuses on the promotion and development of domestic tourism as well as tourism in the North East region as well as in the state of Jammu and Kashmir.

National Tourism Policy - 2020: A new draft National Tourism Policy is being formulated, focusing on employment generation, community participation and tourism development in a sustainable manner. The policy focusses on further development of core infrastructure (airways, waterways, railways and roadways) as well as that of tourism infrastructure. Through the new policy, the government wants to position India as a welcoming, safe, clean, hygienic, and accessible tourist destination. In light of the Covid-19 pandemic, travelers are focusing more on safety, health and hygiene. The policy also proposes to promote standardization and quality assurance in the tourism sector. The new policy also aims to double the foreign tourist arrivals (FTAs), domestic tourist arrivals (DTAs) and foreign exchange earnings for India. The policy proposes to create 20 iconic destinations and 100 smart destinations and set up of Destination Management Organizations (DMOs) in India. Pursuant to the policy, the Ministry of Tourism, in July 2019, identified 17 iconic sites⁹ in 12 clusters. These are Taj Mahal & Fatehpur Sikri (Uttar Pradesh), Ajanta & Ellora (Maharashtra), Humayun's Tomb, Red Fort & Qutub Minar (Delhi), Colva (Goa), Amer Fort (Rajasthan), Somnath & Dholavira (Gujarat), Khajuraho (Madhya Pradesh), Hampi (Karnataka), Mahabalipuram (Tamil Nadu), Kaziranga (Assam), Kumarakom (Kerala) and Mahabodhi Temple (Bihar). The policy intends to connect 75 new tourist destinations with air connectivity and connect ASEAN destinations with India's Buddhist circuit. For strengthening the intelligence system, the policy proposes to set up a national dashboard to provide forecasts to the government and industry which would be helpful to make informed decisions.

⁹ <https://pib.gov.in/newsite/PrintRelease.aspx?relid=192155>



7.2 Regional and local



Regional: Until 2019, Leh-Ladakh was a part of the state of Jammu and Kashmir. In August 2019, a Reorganization Act was passed by the Parliament of India which reconstituted Ladakh as a union territory, separate from the rest of Jammu and Kashmir, which was itself accorded the status of a union territory. Ladakh officially became a union territory on October 31, 2019. Therefore, until 2019, tourism in the Ladakh region was governed by the tourism policies of the state of Jammu and Kashmir. However, after its reconstitution as a separate union territory, Ladakh does not currently have any tourism policy of its own. In September 2019, then Minister of State for Culture and Tourism, Prahlad Singh Patel, had announced the Union Ministry of Tourism would provide full support to the administration of Ladakh to prepare a new tourism policy for Ladakh.

Local eco-tourism policy: In 2017 LAHDC, Leh had adopted an eco-tourism policy framework on tourism for the Leh district in Ladakh. As per this policy, Leh district will be promoted as an eco-tourism destination with a goal of decreasing the negative impact of tourism on the environment. To adopt the policy, a special general council meeting was held in February 2017 under the chairmanship of then Chief Executive Councilor of LAHDC, Leh. After some brainstorming and a fruitful discussion, the resolution was passed. The policy had proposed to impose an environmental fee on all tourists travelling to Ladakh and the revenue generated by this initiative was supposed to be utilized for various projects such as development and maintenance of public convenience facility and sanitation and toilets by the road side, preservation and promotion of Ladakhi culture and heritage, creating awareness on homestays in Ladakh, disposal of garbage, protection of water resources, etc.

7.3 Gaps in policies



Absence of tourism boards: National and regional tourism boards are considered to be marketing agencies for promoting a particular destination and attracting visitors. An additional responsibility includes observing the quality and development of the tourist area for which they are founded. National tourism boards also focus on strengthening the institutional and governance framework in the sector and set the vision for the sector. State tourism boards help in better coordination and implementation of tourism programs. They can further modify and improve national tourism activities and programs tailored to their respective states. The presence of national and state tourism boards in India will help streamline the tourism sector and provide quality and consistent services across the country.

Quality assurance and standardization of tourism: The absence of a robust accreditation and standardization system has led to gaps in the tourism service industry in terms of quality services being provided to tourists. While there are checks and balances to monitor the services being offered by the organized sector, there is no such mechanism in place for the unorganized sector consisting of small-scale service providers and vendors. Having an accreditation and standardization system in the country will promote the quality of services and development of enterprises.

Promoting tourist towns as smart destination: In the wake of the pandemic and even after, the policies need to be more structured and defined in a way that projects India and its tourist destinations as safe, clean, hygienic, and accessible using smart solutions. This would be important since travelers would be looking for places that maintain the utmost level of health and hygiene standards at their premises. This will not only be applicable to restaurants and hotels but places of tourist interests such as monuments, parks, public transport, malls, etc.

Lack of branding initiatives: The region of Ladakh has seen a lack of branding and tourism development initiatives from the government. Recently, post the creation of Ladakh as a union territory, the region has seen introduction of policy for introduction of incentives for tourism development. The local authorities should ensure that this initiative is efficiently and successfully implemented and more such initiatives are undertaken.



8 Best practices from Greek cities

The following chapter analyzes the best practices followed and implemented by the cities of Trikala, Farkadona and Meteora in terms of sustainable tourism. The chapter seeks to identify and explain the smart city concept and how key learnings from the Greek cities can help develop sustainable tourism in Leh.

8.1 Introduction to sustainable practices in the Greek cities



Following is a brief about various sustainable and smart city solutions that have been tested or implemented in the cities of Trikala, Farkadona and Meteora. The next sub-section will give details of the initiatives implemented in the cities in sectors such as mobility, solid waste management, water supply and management, and branding.

Trikala: Trikala is a medium-sized European city, with a history dating back 5,000 years and a population of approximately 81,000 people. Trikala is famous for its culture, heritage, folk music (being the birth place of several Greek musicians), and agriculture, with products like feta cheese, sausages, wine, etc. The city is also famous as a family tourist destination and the thematic park of Elves Mill. Trikala is the flagship Greek smart city with various smart infrastructure and services in town. The city was selected to host one of the first three 5G pilot cases for testing and verifying the potential of 5G wireless technology in Greece. Trikala was chosen as the most suitable candidate for the 5G project since the city had already piloted several successful initiatives such as the self-driving-bus, smart parking, etc., before other Greek cities. As part of the 5G project, the smart lighting network, 5G-enabled smart parking, data collection and analysis, public wireless internet access as well as other conventional commercial solutions were tested with the 5G network.

Farakadona: The Farkadona municipality has 18 medium and small rural towns and villages and follows the 'open city' model of urban planning. Some of the best practices related to water management, waste management and mobility followed in Farkadona are highlighted below. The municipality has implemented the smart city initiative of an intelligent bus stop, which offers high-level services to users of public transport and pedestrians. These intelligent bus stops are more efficient and information rich than traditional ones. Upcoming buses are informed about the number of passengers waiting at a particular stop. If there are no passengers to get on or get off at a particular bus stop, the bus may skip that particular stop. The municipality even received the silver award in the mobility and transportation category at the Best City Awards 2017.

Meteora: Meteora and its monasteries are located close to city of Kalambaka in Greece, near the river Pineos and the Pindus Mountains. Roikos Engineering Consultants SA is a consultancy firm based in Athens specializing in a wide variety of engineering projects. Roikos provided consulting services to build the sewerage network and the Kalambaka-Meteora waste water treatment plant in the region. They were also involved in projects in the Kalambaka-Meteora region such as the traffic management and parking scheme study, master plan and detailed design of open spaces (squares and recreational sites), strategic urban plan for spatial and urban planning and sustainable development for the municipality, development of town hall of the municipality, development of museum of geology, etc.

8.2 Mobility



The three Greek cities are now known for their digital services as well as for their smart mobility solutions. The cities have adopted and pioneered several innovative urban mobility solutions which have had a great positive impact on the lives of local residents as well as that of tourists visiting these cities. Some of these measures include:



Robust data center and mobility app: Trikala has a robust data center because of which it has become easier to build the necessary infrastructure for smart mobility. From the data center, all operations are monitored using fleet telematics equipment. The equipment makes it possible to look at static and dynamic data coming from public transport and from electronic signs located on urban road networks. Further, the Municipality of Trikala launched a free app for the people of Trikala to facilitate easy transportation. Through the app, residents can get a real-time estimate of the arrival of a city bus; send a service request for the city bus (which helps in calculating the demand in advance); access carpooling information and options shared by other riders; and do on-line reservation of existing services such as bike and car rentals.

Automated vehicle project: The CityMobil2 project is a pilot project based on the concept of 'automating mobility'. As the name suggests it is a driverless bus project. The project is highly successful in Trikala and has allowed the creation of a new shared public transport system, which enables mobility from door to door. The vehicles are a part of an Automated Road Transport System (ARTS) and move only in driverless bus lanes. After operating hours the driverless bus lanes of the CityMobil2 project are converted into cycling lanes. Another project by the name of Avint project was an extension of the driverless bus project using fully automated buses and integrating them with the city transport network. This project provides a viable service for the city, interconnecting the University of Trikala with the city center. Further, under this program, two fully automated electric buses were procured from a company, Amani Swiss. Figure 18 depicts the automated bus procured under the project.

Figure 18: Automated bus in Trikala



Source: https://m.facebook.com/etrikala.SA/photos/a.1001954869981359/1001954843314695/?type=3&source=44&ref=page_internal



Cities4people: Rural and peri-urban areas in Trikala are underserved by public transport whereas the grand open market area suffers serious congestion mainly during rush hours. Also there is congestion in the areas around the three bridges over the Litheos River. Cities4people is a pilot project which aims to contribute to re-planning existing public transport systems as well as introduce new mobility solutions mainly in the grand market area of Trikala. Shared mobility is a solution to decrease the number of cars used to commute from the rural and peri-urban areas. Other solutions are the creation of better connections between places, improvement of public transport infrastructure, optimization of parking slots, and establishment of better cycling lanes.

Elviten project: The project is based on the concept of 'Mobility as a service'. Trikala smart city has purchased ten three-wheelers (tricycles) and 10 four-wheelers (quadricycles) from the Swiss company Kyburz. These vehicles are all electric light vehicles (EL-Vs) and have been deployed in the city. The EL-Vs are equipped with an intelligent recording and tracking device which tracks location, speed, delay, and the vehicles' way of moving across the city. Five of the four-wheelers are being used by delivery and courier companies and the rest are used by citizens for the park and rent system.

Smart street lighting: In 2019, the Municipality of Farkadona signed a contract with a company, CICICOM, for the supply, installation and management of smart street lighting system. The system will use the new generation technology of Internet of Things (IoT). This project will be a complete solution for the management and control of street lighting in the municipality. The wireless sensors will use the IoT technology and will have the ability to regulate the operation of the street lights remotely, without the need for human intervention. The municipality will provide adequate training to its staff that will be involved in operating network. The benefits with the installation of this smart system will include greater energy savings, saving of human resources and possibility of timely detection and repair of damage to street lights.

Cycling, walking and car-pooling: Cycling is being actively promoted in the cities. In Trikala, there are cycling lanes of approximately 3.5 km inside the city center and cycling lanes of 5-6 km outside the main city. The city is constantly working on making these bike routes more functional and aesthetic. Recently, a project was approved for remodeling of the bicycle road at Kondili Street which included a number of works such as creating a route for blind people, replacement of existing paving slabs with concrete blocks, inclusion of elevated sections, extension of street lighting, creating new cycle lane, rainwater drainage, etc. In Farkadona, introduction of permanent measures such as pedestrian areas and LED public lighting has created ideal conditions for walking as a preferred means of commuting. All road crossings in the municipality are without traffic lights and priority is always given to pedestrians. Car-pooling is encouraged for daily commute as the two urban centers within the municipality have a distance of 30 km between them. Figure 19 depicts the importance laid on cycling as a preferred means of transport by providing dedicated lanes to cyclists.

Figure 19: Dedicated cycling lane



Source: <https://madeintrikala.gr/en/trikala-zoi-podilato/>

Smart parking: A smart parking management system has been implemented, which allows the identification, imaging and monitoring of designated parking spaces in the city center. As many as 48 specialized sensors have been installed on the streets, with each sensor corresponding to one discreet, delineated parking spot. The sensor provides feedback to the network's controllers by sending appropriate signals when the spot is occupied or unoccupied. Furthermore, residents can be informed in real time about the availability of parking spots in the selected area, both through the parking mobile app for smart phones and through signs that can be installed in central points around the city. Also, traffic control authorities are provided with real-time information about illegal parking instances. The application also offers the option to pay for parking.

Parking for disabled: The Municipality of Trikala implemented an innovative parking system for people with disabilities. The system, after complete implementation, will be available at loading and unloading places, sidewalk ramps for disabled, pedestrian crossings, etc. The parking system presents an innovative process. First, a sensor is placed in the middle of the parking by the municipality which can read the signal emitted by a vehicle's magnetic field. A disabled person is provided with a card which helps the sensor determine if the car belongs to a disabled person. Second, the system simultaneously notifies the central computer of the municipal police using a color-coded system i.e., green – place is empty; blue – occupied by vehicle of a disabled person; and red – illegally occupied by other cars.

Elevated passages and smart traffic light systems: The Municipality of Trikala implemented a simple yet very practical solution for increasing the safety of pedestrians near critical places such as schools by way of constructed elevated passages. This is a modern practice, which without disturbing the movement of traffic, simply reduces their speed, making it easier for the pedestrians to cross roads at the intersections. The places were shortlisted on the basis of experience where accidents had been recorded in the past. Further, electronic equipment (controllers) are installed at the intersections and constantly monitor the operation of traffic lights, report any potential breakdown, provide information about light bulb malfunctions per direction and signage (red – orange – green), and notify the control center online or send a text message to the competent employee. Figure 20 showcases an elevated intersection to slow down the incoming traffic.

Figure 20: Elevated road intersection



Source: <https://trikalacity.gr>

Mobility education: The municipality facilitates provision of mobility education to students besides the conventional seminars or art and play events. The municipality provides methods of experiential learning such as creation of road crossings and traffic police role-playing. Dissemination of sustainable mobility principles through different ways such as leaflets, arts and play events, car-free days, screen spots on intelligent bus-stop, etc., is a common practice. The cities have also prepared an architectural study for the creation of ‘cultural paths’ towards archaeological sites on its territory.

European Mobility Week: As part of the European Mobility Week held from September 16- 22, 2020, the Municipality of Farkadona organized a week of activities taking into account a focal theme. Some of the activities were distribution and promotion of the European Mobility Week posters in public places, schools, etc., thus spreading awareness, conducting a radio dialogue with residents with disability and sharing their experiences in everyday mobility issues, conducting conferences about sustainable mobility, and involving car companies to promote green transportation by allowing them to advertise their own hybrid and green cars. The activities also involved conducting workshops in co-operation with driving schools for safe walking, cycling, skating, and providing complete education of rules of driving. On September 22, a car-free day was organized involving a three-hour closing of the central urban street of Farkadona for motor vehicles.

Open trade center of the Municipality of Meteora: This project includes the installation of smart city systems such as smart parking, smart benches, and provision of free wifi in the open trade center of the Municipality of Meteora; renovation of the public space in the historical, administrative and financial center of Kalambaka; and creation of a single façade, fully compatible with the rock formations of Meteora.

8.3 Solid waste management



Being attractive tourist destinations, the cities of Meteora and Trikala, in particular, see an increase in amount of waste that is generated during the tourist season. However, both the cities along with Farkadona have been

successfully able to come up with innovative practices to deal with the ever-increasing quantum of waste being generated.

Using technology for waste management: Municipal service for waste collection and waste management has improved in Trikala. Waste collection bins and trash cans are being monitored using sensors at the central waste collection centre. The waste collection centre is notified via these sensors in real time about the level of waste in the bins and the trash cans. Additionally a resident's complaints registration service is now being offered through a mobile app and web, which, in turn, has improved the municipal service for waste collection. There is a comprehensive geographic information system (GIS) based on business intelligence in Trikala to facilitate well-informed decision-making for the municipality of Trikala. It includes applications for urban planning data, municipal property, street lighting, etc. As a part of a pilot project, the solid waste collection routes being followed by the waste collection vehicles in Trikala will be monitored, analysed and optimised as part of the GIS project. The goal of this pilot project based on GIS technology is to optimise the route of waste collection vehicles, especially in the commercial centre. Furthermore, 5G services, once implemented in Trikala, are expected to have a far wider coverage of waste collection and citizen engagement for waste bin collection and management.

Submersible waste storage: The Municipality of Meteora plans to commission five submersible waste storage systems. A study has been conducted on the feasibility of this project, which is awaiting approval and the municipality further plans to submit a proposal to the Green Fund with regard to the supply of the submersible waste storage system. With this project, the municipality of Meteora mainly aims at the aesthetic result, which will also reduce the environmental footprint. Figure 21 shows submersible waste storage system.

Figure 21: Submersible waste storage system



Source: <https://www.tameteora.gr/topika/dimos-meteoron/349023/vythizomenoi-kadoi-aporrimmaton-gia-tin-kalampaka/>

Recycling: The Municipality of Farkadona recently started the implementation of recycling of consumables for information, communication and technology (ICT) equipment (inks, toners, drums, etc). A cooperation agreement was signed with a company that is active in the field of collection and recycling of useless ICT equipment consumables. The municipality decided that all the proceeds from this activity will be donated for a charitable purpose.



8.4 Water supply and management



Some of the innovative solutions implemented by the Greek cities for management of water supply have been described below:

Smart city control centre: Trikala has a smart city control centre on the ground floor of the City Hall, to monitor all smart city services. Amongst other functions, the control centre also monitors the municipal water and sanitation utility through a solenoid valve monitoring and regulating system. Additionally, smart meters are installed at households and all other establishments enabling consumer notification such as malfunction detection. Furthermore, the utility provider will also scale up operations with 5G, once implemented, and offer more personalised services such as early warning for network breaks or in-house malfunctions. Figure 22 depicts the smart city control center at the City Hall of Trikala Municipality.

Figure 22: Smart city control centre



Source: <https://egritopress.gr/category/topika-nea/trikala-el/>

Smart metering and other technologies: Farkadona has recently entered into a contract for the supply of smart water metering systems, which is a complete solution for the management and control of water meters. The system uses IoT technology, which allows collection of data from the meters (water measurement) and controls the valve from a distance (remotely), without the need for human intervention. Another project involves supply and installation of a remote control system for optimising the operation and control of leaks in the water supply networks of DEYA Farkadona (water utility company of Farkadona). Adding to sustainable handling of drinking water, DEYA Farkadona will have an excellent technological tool for the remote control and operation of water supply networks, both for optimization of their operations and control of leaks.

Wastewater treatment plant in Meteora: The wastewater treatment plant (WWTP) in the Kalambaka–Meteora region is based on the Carrousel system and designed to service a community of almost 20,000 people in Kalambaka-Meteora region. Carrousel is a leading technology in wastewater treatment and biological nutrient removal. The Carrousel system is based on the general oxidation ditch technology wherein a Carrousel basin is shaped like a race track and has a central longitudinal partition wall. While wastewater circulates around the channel, micro-organisms break down the organic compounds, nitrogen and phosphorus contained in wastewater. It is a patent of the Dutch company DHV Water. Some of the advantages of the Carrousel system are (a) simple operation, (b) low operational costs, (c) flexibility and adaptation to seasonal changes in temperature and organic loading and (d) compliance with the most stringent effluent nutrient requirements. Figure 23 shows the Kalambaka-Meteora WWTP.



Figure 23: Kalambaka-Meteora wastewater treatment plant



Source: <http://www.roikos.gr/en/wp-content/uploads/ROIKOS-EN.pdf>

8.5 Branding of tourism



When it comes to branding, each of the three cities has been able to successfully brand themselves based on their strengths. While Meteora is a UNESCO World Heritage Site and enjoys inherent benefits that come with the title, Trikala and Farkadona have been able to brand themselves as the pioneers of implementing various smart and sustainable solutions in Greece. Further, in the past decade, Trikala has been recognised as the national Christmas city and caters to a huge influx of tourists during the Christmas week.

Smart city: The cities have achieved the reputation of being smart cities by joining many innovative EU projects. They have implemented many tech-savvy plans including the driverless bus projects, smart water supply systems, energy-efficient public lighting systems, smart and disable-friendly parking, smart mobility applications, shared public transport, smart bus stops, etc., and have proven to be an ideal test bed for various national and EU initiatives. Figure 24 depicts some of the initiatives taken by the Municipality of Trikala under its smart city initiative.

Figure 24: Some smart city initiatives in Trikala



Source: <https://cyberparks-project.eu/examples?avt=36&tech=All&typology=42>, <https://www.elviten-project.eu/en/trikala/elviten-in-trikala/>

Christmas City: 'Mill of Elves' in Trikala is the biggest, free-of-charge, Christmas theme park in Greece. The water mill entirely built of stone was transformed into a Christmas attraction in December 2011. It started as a local celebration and has now evolved into one of the largest theme parks in Greece. In the 10 years period, it has achieved to attract more than 1,000,000 (mainly domestic) visitors annually. Figure 25 showcase the Mill of Elves in Trikala during Christmas time.

Figure 25: Christmas city of Trikala



Source: <https://greekcitytimes.com/2019/12/16/trikalas-mill-of-elves-set-to-welcome-over-1-million-visitors/>

Branding and promotion through participation in seminars/conferences: In order to showcase its sustainable practices in various sectors and learn best practices in sustainability, the Greek cities attend a number of events. For example, Municipality of Farkadona representatives recently attended many seminars/conferences. These include:

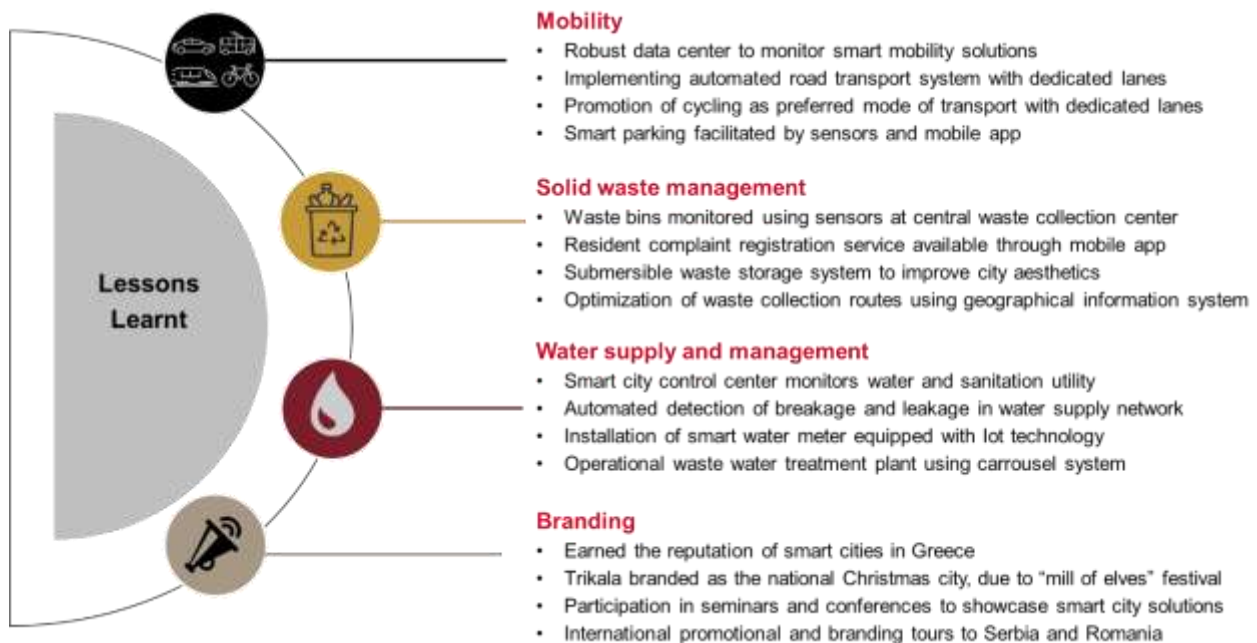
- **EU Green Week 2020:** The Municipality of Farkadona participated in the EU Green Week 2020 for nature and biodiversity. It showed its interest in protecting nature and the environment and took part in two online seminars — 'How healthy is our nature and its state in 2020' and 'Biodiversity in cities and regions after the Coronavirus'.
- **European week of municipalities and regions:** The Municipality of Farkadona participated in the European Week of Municipalities and Regions (EURegionsWeek 2020). The Planning Department of the municipality participated in a series of online workshops with topics particularly important for the planning of development actions and the upcoming developments in the daily life of the citizens.
- **16th Panhellenic conference on healthy cities:** The 16th Panhellenic conference was held online in October 2020, with the theme 'Healthy and resilient cities in times of crisis: The implementation of the 17 goals of sustainable development through the 6 policies of the WHO for the human'. The project consists of 9 partners led by the VIC of Spain. The other partners along with Farkadona are the city of Parnu (Estonia), the city of Falerna (Italy), the city of Anixciai (Lithuania), the municipality of Lule (Portugal), the city of Alfen an den Rhein (Netherlands), the city of Bradford (United Kingdom) and the Maltese Urban Planning Authority. The head of the planning department of the Municipality of Farkadona, participated in a round table where the topic, 'The policy of the European Union, the Greek Network and the members for the 17 goals in the five years 2019-2023' was analysed.

International branding trips: In an attempt to promote the tourism sector in Meteora, the Municipality of Meteora recently organised promotion and branding trips to Serbia and Romania. The officials participated in many events, including the Belgrade International Tourism Fair through which they were able to introduce and promote the tourism sector in Meteora. In Bucharest, two of the most popular local television channels showed

televised videos of Meteora. In addition, an interview with the officials of the municipality was also televised, covering the whole range of activities in the Municipality of Meteora.

Conclusion: The three Greek cities of Trikala, Farkadona and Meteora have implemented some ground-breaking and innovative solutions to tackle various problems in the sector of SWM, mobility and water management. Further, they have been able to successfully brand and promote themselves as smart cities and sustainable tourism destinations. Lessons learnt from the solutions implemented by these cities have been summarized in the figure below:

Figure 26: Lessons learnt



Source: CRISIL analysis



9 Best practices from international cities and Leh



The following chapter analyzes the best practices followed and implemented by the other European cities in terms of sustainable tourism. The chapter seeks to identify and explain these best practices for development of sustainable tourism in Leh. The chapter also explores the best practices followed by Leh which may be explored by the Greek cities. .

9.1 Mobility



Barcelona, the second most populous city of Spain, has been a leader in developing smart solutions for city infrastructure development. The city has used technology to its benefit and introduced several innovative solutions for mobility. Some of these solutions have been highlighted below:

- **Bike borrowing system:** The city has introduced an innovative bicycle borrowing scheme called Bicing for the city residents. Bicycles form a major part of the public transport in the city and thus the city introduced this system wherein the residents can use common bicycles for short journeys of upto thirty minutes. Many of these biking stations are developed near car parkings, parks and metro stations. The use of the shared bicycle helps reduce the number of on-road private vehicles in the city.
- **Orthogonal bus network:** Transports Metropolitan de Barcelona (TMB), the transport system of Barcelona, has integrated a new orthogonal bus network of diagonal, vertical, and horizontal lines. The goal of the system is to ensure that 95% of the travelers have to make only one transfer between any two points in the city. The transit system also utilises hybrid buses with a view to reduce emissions.
- **Driverless metro and integrated fare system:** The city has a more than 30 km long, automated and driverless metro system with 23 stations, which has led to significant improvement in transport services. The city has also introduced an integrated fare system wherein the passenger can obtain free transfer from one public transport to another within a stipulated period of time. The integrated fare system provides the user with flexibility for travel within the city.
- **Smart parking system and bus stops:** The city employs a smart parking system wherein the parking spots are equipped with sensors which provide the user with real-time information on availability of parking spots thus saving time. The smart system also enables the city administration to receive data on parking patterns helping them in traffic management. The bus stops utilise solar panels and feature tablet screens offering a wide range of information to commuters including bus arrival times, tourist tips, tools for navigating the city through public transit.

9.2 Solid waste management



Leh faces a daunting task of managing plastic waste as close to 65% of the total waste generated in the city is in the form of plastic, cardboard etc. Vienna the capital city of Austria has been successful in managing its plastic waste. In Vienna, packaging waste generated from households and businesses is either recycled or incinerated with energy recovery at municipal incinerators. Landfilling is out of question due to landfill ban in Austria. The packaging waste is treated as stipulated below.

- **Sorting of packaging waste:** ARA is a major scheme for packaging and packaging waste in Vienna and in Austria. The ARA scheme was established by private stakeholders of packaging production business and the retail industry to handle management of packaging waste resulting from their day-to-day operations. Sorting of plastic packaging waste collected in the ARA system takes place at sorting plants. Sorting is done



to separate the packaging from other types of waste, and also to sort the packaging into different types of plastics. There are sorting plants with manual sorting and/or automatic sorting (using infrared light to sort out different plastic packaging types). The plastic packaging is sorted in over 20 plastic fractions and a mixed plastic fraction

- Energy recovery through incineration: Under the ARA system of waste collection, after sorting and removal of other types of waste, light weight packaging material is either sent for energy recovery through incineration, or for recycling. The light weight packaging material collected from households as described above is sorted into recyclable and non-recyclable fractions, and the non-recyclable but combustible fraction is sent for energy recovery through incineration, and the energy, thus, recovered is used in public buildings and district heating networks.
- Recycling: The recyclable fraction of light weight packaging as well as PET bottles are recycled. For recycling, the plastic waste is shredded, washed, dried, melted, and then processed into granules, which is used as raw material for manufacturing new products. Plastic packaging needs to be sorted carefully and thoroughly before it can be recycled, as different packaging types have different melting points and do not mix upon melting. Sometimes, it is possible to recycle even unsorted plastic packaging waste; however, it allows manufacturing of only massive products in simple shapes.

9.3 Water supply and management



Murcia, city in south eastern Spain, is a pioneer in night pressure regulation through the installation of continuous monitoring and leak detection sensors. As Leh faces several challenges in water treatment and distribution, it can take cues from the experience of Murcia. The key interventions deployed by Murcia in the water supply and management sector have been highlighted below:

- Deployment of smart sensors: The city's water distribution network has the largest number of smart sensors in the country. These sensors allow the administration to monitor, log and analyse the water flow pressure throughout the entire network on a continuous basis. The system detects any anomalies such as breaks, leaks, abnormal consumption on an instantaneous basis. These systems have enabled Murcia to have one of the highest efficiency rates in Spain.
- Efficient management of water network: The city water network has been divided into small and easy to manage sectors. The city has 188 hydraulic zones and 297 micro sectors which enable a continuous and precise control of water allowing instant detection of leaks, thereby reducing the amount of non-revenue water. The city has reduced the leak detection and repair time to 2.5 days through the zoning and micro sectorisation process. The non-revenue water in the city has reduced to 14% in 2014 as compared to 40% in 1975¹⁰.
- O&M cost recovery: The deployment of the advanced water network has increased efficiency of the water network and savings from reduction of supply network losses. The sale of recovered water has further enabled the city to offset the O&M cost of the water network.
- Water conservation: Murcia aims to maximize conservation of water and it is one of the main goals of the city. The city reuses 10.75% of treated water for agricultural, environmental, and recreational purposes. The remaining 89.25% is discharged to the public waterways. Unused treated water is returned to the river or natural waterways, with the aim of altering natural systems as little as possible.

¹⁰ A report on Water Scarce Cities, Thriving in a Finite World, World Bank



9.4 Branding of tourism



Domestic as well as international tourism is very important for the Dutch economy. In 2018, the country was visited by 18.8 million international visitors and the sector contributed 4.4% to the country's GDP. In the same year the sector employed 679,000 people accounting for 7.2% of the total employment in the country. The Ministry of Economic Affairs and Climate Policy is responsible for tourism at the national level acting as the first point of contact for stakeholders and industry associations. The ministry is also responsible for providing up to 50% of funding to the Netherlands Board of Tourism and Conventions (NBTC) Holland Marketing. The key interventions made by the government to develop tourism in Netherlands are as follows:

- Use of public private partnerships: The NBTC Holland Marketing uses a PPP model to develop and organize marketing programs while fostering a contributory approach to budget management for achieving a shared goal. The stakeholders engaged by the agency include national, provincial and municipal authorities or regional tourist boards, marketing and promotional organisations, and businesses in tourism and related sectors.
- National tourism summit: In 2018, the ministry in association with NBTC Holland Marketing and provinces organized the country's first National Tourism Summit. The goal of the summit was to enhance co-operation between private and public stakeholders involved in tourism. The objective of the summit was to foster a combined approach to enable cities, towns and regions to benefit from growing tourism and share best practices with each other.
- Emphasise short travel distances: Despite short travel distances within the country, international travel visitors do not realise that they can visit different Dutch cities within short times. The administration is making efforts to engage visitors and make them aware of what the country has to offer and how these can be covered within a short period of time.
- Build thematic events each year: The city has developed events centered around different themes each year. For instance 2015 was marketed as the year of Van Gogh, and 2019 was about Rembrandt & the Dutch Golden Age. In 2020, Netherlands celebrated 75 years of freedom and the theme for the year was Europe Remembers. The marketing of themes encourage the spread of visitors throughout the country and also stimulate the development of tourism over a longer term.

9.5 Lessons to be learnt from Leh



Some of the valuable lessons in sustainable tourism that can be learnt from Leh town are highlighted below.

- LAHDC has started a pilot project 'Tsangda'. Under this project, blue and green colored bins have been distributed to households and commercial establishments for the purpose of primary waste segregation at source. Those not segregating the waste are levied a monetary penalty. Door to door collection of segregated waste has been initiated by the administration from around 400 households and commercial establishments. The officers accompany the waste collection vehicles in order to strictly enforce waste segregation. During the first year of the project, 65,000 kg waste has been collected from Choglamsar, Nubra, Nimo and Khamtsi, of this, 27,000 kg was sold to scrap dealers and 17,000 kg was reused for making recyclable products like biofuel bricks from the discarded cardboards, egg trays and other agriculture wastes.
- Green spaces such as parks, botanical and zoological gardens and urban forests not only protect and improve environmental quality standards in cities but also attract residents/inhabitants and tourists alike. The quality of green spaces helps to define the identity of towns and cities which can enhance their attraction for tourism. Green spaces absorb methane, carbon dioxide, carbon monoxide and other harmful gases



released through vehicular pollution and other such sources and release oxygen in the environment. There are several green spaces for recreation, leisure and tourism in and around Leh. Nubra valley, Sand dunes leisure park, Zaskar the virgin valley and Hemis national park are some of the green spaces in and around Leh.

- India's first FSTP on PPP basis which happens to also be the first FSTP in Leh was inaugurated in 2017. The FSTP was built in a record 44 days and provides end to end fecal sludge management services making Leh the first ODF++ (open defecation free) city in India. Under the FSTP system, around 50-60% households have been covered under the sewage system while the rest of them are still connected to septic tanks. The FSTP uses the planted drying bed technology which is robust and flexible under extreme conditions. FSTP plant involves no direct contact with fecal sludge and there is minimal odor during the entire process. The plant involves minimal and simple operations with no skilled labor required, thus minimizing the O&M costs.



10 Recommendations



The following chapter provides a set of recommendations to the town of Leh, to integrate sustainable measures into tourism-related activities such as water supply management, solid waste management, mobility, energy, accommodation, etc.

10.1 Recommendations for sustainable tourism in Leh



Leh has tremendous opportunity to develop tourism in the region. It has seen great interest from both national as well as international tourists in the last few years. The number of tourists visiting the city has increased manifold from 20,000 tourists in the 1970s to 280,000 in 2017. The growth in the number of tourists has largely been organic with limited marketing and branding initiatives being undertaken by the local and regional administration. Thereby, we can safely assume that with a targeted strategy to develop tourism, the city can see tremendous growth and economic gains from the sector. However, it also needs to be noted that Leh is an ecologically sensitive area and the strategy should be developed in a sustainable manner focusing on the elements laid out by organisations such as UNWTO, UNESCO and ILO. In this study, we have looked at initiatives that have been deployed by the cities of Trikala, Farkadona, Meteora and Barcelona. Based on the learnings from these cities, Leh may adopt the following best practices for the core sectors of mobility, solid waste management, water supply, and branding of tourism.

Mobility: Leh is a remote area and faces several mobility issues including regional connectivity during winters, freezing of fuel due to sub-zero temperatures, traffic congestions during the summer season on account of huge influx of tourists, etc. The use of diesel vehicles also leads to increased carbon emissions which contributes to rise in temperature levels and further to increased melting of glaciers and ice in and around Leh. The central government has been pushing to create Leh as a carbon-neutral region. Thus, the city should be pushing towards clean energy mobility solutions such as e-vehicles, shared mobility initiatives, etc. Some of the initiatives that can be implemented in Leh include:

- Introduction of e-vehicles: Taxi operators should be encouraged to shift to e-vehicles instead of diesel cars as this will drastically reduce the carbon emissions especially during the peak summer season. Further, the city can promote shared mobility mechanisms such as e-bikes, e-autos, etc, for movement in the city. Initiatives such as e-bikes also promote healthy living amongst the tourists and the residents.
- Smart parking initiatives: During the peak season, the city faces parking issues and the public taxis are parked in unauthorised / vacant tracts of land. With the deployment of smart parking systems, the vehicle drivers can be alerted to availability of parking and be diverted to available parking slots. These parking stations can further be connected to major tourist places through e-buses / vehicles which can act as feeder vehicles.
- Promoting non-motorised transport (NMT): The city of Leh should explore development of non-motorised transport such as walking, cycling etc. which will require demarcating vehicle free zones within the city center and other promotional measures to promote NMT in the city. Gol's recent programs in this direction could be referred and adapted as per the needs of the city.
- Focus on developing public transport system: Leh does not have a well-developed and efficient public transport system. There are several private players who are operating private vehicles and buses however these are not regulated and thus the services are intermittent and erratic. The local government agency can undertake initiatives towards standardizing the public transport services such as introducing fixed bus routes, fee and timings. Further, an online portal can be developed for facilitating easy advance online seat booking for use by tourists who wish to explore tourist sites in and around Leh.



Solid waste management: An efficient and exhaustive SWM cycle is important for the development of any city. Although Leh has been undertaking initiatives such as providing separate bins to households and commercial units for waste segregation and development of solar-powered waste treatment plant, the city still faces several challenges across the SWM lifecycle including the management and reclamation of the legacy dumpsite at Diskit Tsal. Recently, Leh has been brought under the ambit of the Smart City Mission. The city is learning from the experience of the Greek cities and looking at ways to implement several smart systems and initiatives powered by IoT. Apart from the smart initiatives, several traditional measures can also be implemented at the city level. Some of the key initiatives that may be undertaken by the city have been provided below:

- Smart central waste collection centre and monitoring: A central waste collection centre equipped with sensors could be built in Leh. Smart waste collection bins and trash cans could be monitored in real time using sensors at the waste collection centre and the waste collection centre would be notified in real time about the level of waste in bins/ trash cans. The sensors would also help to understand the amount of waste that comes from different areas in the bins and accordingly optimise the waste collection. This solution would result in efficiency, cost savings and resource utilisation. The waste collection routes used by waste collection vehicles could be monitored in real time through the use of GIS technology, analysed and optimised, thus leading to effective SWM.
- Usage of compost toilets: The lakes in and around Leh are polluted by nitrogen-rich effluents seeping through the ground from all the flush toilets that have been installed to serve tourists. Tourists prefer flush toilets which not only lead to wastage of water but also produce nitrogen-rich waste. Compost toilets which conserve water and do not produce nitrogen-rich waste can, therefore, be installed for residents and tourists. Ladakhi people are already accustomed to using compost toilets and awareness should be created amongst tourists to follow suit.
- Biomining/ bioremediation of the legacy dumpsite: Although a black hole machine has been set up at the Diskit Tsal legacy dumpsite for incineration of legacy waste, due to its low capacity (one tonne per day) the process of reclamation is proving to be inefficient. The city must employ the biomining/bioremediation process, which is a scientific and highly efficient way of managing and reclaiming a legacy dumpsite. It is the process by which previously dumped waste is dug up after loosening and then processed to recover valuable recyclable scrap while also recovering landfill space. The end product, likely to be soil, is rid of toxic materials and hence becomes reusable. Other major resources extracted from legacy waste are plastic, rubber, metal, textiles, glass, soil, and construction and demolition (C&D) waste.
- Initiatives around reduce, reuse and recycle: The city must promote at-source reduction and reuse to enable waste minimisation. This could be implemented by promoting reuse of carry bags, packaging jars, plastic bottles, etc. Since tourists bring along a lot of plastic waste, the city can also explore promotion of recycling and processing of inorganic waste for other productive uses.
- Awareness campaigns, fines and rewards: The city should conduct awareness campaigns on waste prevention and waste segregation on a regular basis. Apart from this, regular clean up drives to be organized for effective SWM. The municipal corporation shall also establish a strict system of fines for non-segregation of waste and use of single-use plastics. At the same time, the household or commercial establishments which follow the suggested best practices such as providing commendation letters, rewards at public ceremonies to create more awareness.

Water supply: Leh is an arid region and receives very little rainfall. It is thereby dependent on other natural sources such as rivers, lakes, springs and groundwater. The issue of water supply gets aggravated further during the winter when the city faces sub-zero temperatures and the water freezes. The city has been heavily dependent on bore wells for its water needs and close to 90% of the water is sourced from underground sources while the remaining 10% comes from springs and surface water sources. The average tourist uses close to four times the water used by a Ladakhi on a daily basis. This pressure on water supply requirement is further



increased by a huge presence of military establishment and migrant labour population. The city of Leh can explore the following options for solving the problem of water supply and management:

- Smart irrigation systems: Leh has been laying a strong impetus on developing agriculture as an alternative source of income and also meeting the vegetable needs of the population all year around. The region is also moving towards organic cultivation with programmes such as greenhouses and MODI being implemented by the government. The city can also explore installing IoT sensors for irrigation systems as these will ensure remote monitoring and prevent any systemic leakages from the system.
- Regulation of bore wells and smart meters: Due to the large increase in tourist influx, there has been an unregulated increase in the number of bore wells in the city. The city should implement strict regulations for these bore wells and define the quantum of water that can be sourced through them. The bore wells can be retrofitted with IoT sensors to monitor the activity and alert city officials in case of misuse. Further, the city should look at connecting households and commercial units through a piped water supply. These connections could be further linked with smart systems to remotely manage and monitor the supply of water.
- Rainwater harvesting and storage of water: Considering that rainfall is scarce in the region and that a dry spell can wreak havoc on water supply for upcoming months, there is a very strong need for developing water harvesting mechanisms. These could be rainwater harvesting systems, creation of water reservoirs, use of innovative systems such as ice stupas, artificial glaciers¹¹, etc. These water harvesting mechanisms will not only be useful for ensuring constant supply of water but can also be used to collect water that streams to lowlands in the winter and be put to use during the summers.

Branding: As mentioned earlier, currently there are minimal interventions in marketing Leh as a tourist spot. Despite this, Leh has seen a tremendous increase in tourists visiting the city every year. Leh has several facets that can be portrayed to attract tourists to the city. These include:

- Adventure tourism: Leh offers several adventure activities for locals as well as tourists including mountaineering, trekking, rafting, cycling, motorcycle tours, camping and safaris. Many cities both nationally as well as internationally have managed to successfully create an image for providing adventure tourism. With its ample and wide range of activities, Leh can create a targeted campaign to promote itself as an adventure tourism city.
- Cultural tourism: Leh has a strong Buddhist culture and is home to several monasteries. The initial tourist influx in Leh was based on cultural tourism led by a high number of foreign tourists. Although the number of tourists visiting Leh on a cultural trail has decreased over the years, the local administration can create travel packages that specifically target the religious spots across the region. Further, homestays can be developed to portray the local Ladakhi lifestyle to tourists.
- Nature and wildlife tourism: Being in the Trans-Himalayan region, Leh has several species of indigenous wildlife, flora and natural spots such as lakes, mountain passes, and treks. This positions Leh as a go-to place for nature and wildlife lovers. The administration, in consultation with local tour organisers and experts, should aim to develop a future plan to promote nature and wildlife tourism in the region.
- Strategic planning and initiatives: The region of Ladakh has seen a lack of branding and tourism development initiatives from the government. Recently, post the creation of Ladakh as a union territory, the region has seen introduction of policy for introduction of incentives for tourism development. The local authorities should ensure that this initiative is efficiently and successfully implemented and more such initiatives are undertaken.

¹¹ http://www.iwmi.cgiar.org/iwmi-tata/PDFs/iwmi-tata_water_policy_research_highlight-issue_08_2016.pdf



Recent initiatives undertaken in Leh for sustainable tourism: The various administrative entities in Leh and Ladakh such as the UT administration, LAHDC and Leh Municipal Committee have launched various initiatives in the area of mobility, solid waste management, and water supply and management. Many of these are under conception stages while planning and feasibility analysis is underway for few projects. Some of these projects have been highlighted below:

- Bioremediation of legacy waste: The administration has decided to undertake the bioremediation of the legacy waste present at the Diksit Tsal dumpsite in order to reclaim the land. A Pune based consultant has been employed for the purpose of preparation of detailed project report. Post the submission of the report and identifying the correct course of action, the process of bioremediation will be started.
- Cycle track: The UT administration has sought the suggestions of the local authorities for constructing a cycling track in Leh in order to give a boost to tourism in the region. The local authorities have already identified a potential area for the development of the cycling track which will be part of the smart cities mission.
- 24*7 water supply: Among the 13 wards in Leh, ward no. 1 is located at the highest elevation. With the help of a local NGO (LEDeG) and the public health and engineering department, the local administration has taken up a pilot project for 24*7 water supply to this ward. The project is expected to be implemented by March'21 and if successful, will be replicated to other wards.
- Tunnel to resolve road closure: There are two approach roads to Leh: one through Manali in Himachal Pradesh and the other via Srinagar in Jammu and Kashmir. Due to heavy snowfall and adverse climate conditions both roads remain closed from the October to March, due to which tourism and other economic activities are heavily affected. The central government has approved the plan for construction of tunnel through the Zoji La Pass which will enable movement of traffic through the Srinagar route even during the winter months. The government has already allocated funds for the project and has further awarded the contract for the construction of tunnel. The timeline for the project has been set at seven years post which Leh would be open to tourists round the year.
- Diesel: Due to extreme climate conditions such as sub-zero temperatures, particularly during the winter months, residents of Leh face the problem of freezing of fuel (diesel). The government has now introduced a diesel variant which can be used in temperatures as low as -30 degree Celsius. This will solve local and regional mobility issues in Leh during the winter months.
- Khardung La tunnel proposal: To the north of Leh lies the highest motor able road in the world which passes through the Khardung La pass. A proposal has been made to the Lieutenant governor of Ladakh for construction of a tunnel from Leh to Khardung La pass so that the water on the other side of the pass can be diverted to Leh. This proposal, if accepted, will solve the major issue of water scarcity in the city of Leh.

10.2 Way forward



Having identified various sustainable best practices from the Greek cities of Trikala, Farkadona and Meteora, we suggest the following next steps/way forward which would help in developing sustainable tourism in Leh. We propose a three-tiered approach for a structured and successful implementation of various recommendations as provided in the previous section:

Goal setting: The first step with regard to the recommendations mentioned in the previous section would be to divide them into short, medium and long-term goals. This would give a broad structure to the whole exercise of development of sustainable tourism in Leh. While the short-term goal will be implemented in a time period of 0-3 years, the timeline for medium-term goals will be 3-7 years, followed by long-term goals with a timeline of more than 7 years. This would also help the local administration in prioritising the recommendations as required.



Conduct feasibility study/ detailed project report: Once the goal setting is in place, the administration should look at undertaking a detailed feasibility study of the priority project. This can be done by taking assistance from an expert panel of consultants specialising in undertaking DPRs/feasibility study for the tourism sector and other sustainable practices. The DPRs/feasibility study will consist of evaluating individual projects on their technical and financial feasibility and define a project structure best suited to the needs of the local administration.

Secure funding and implement projects: The paucity of funds with the local and regional government can prove to be a major deterrent in implementing these innovative and sustainable solutions. The process of securing funding for the envisaged projects should be undertaken in conjunction with other steps, as mentioned above. Having an investment attraction program in place will not only provide chances of attracting potential investors during the early stages of project preparation, but will also improve the presence of Leh in front of multiple stakeholders by way of participation in various programs, activities, seminars, expos, etc. The local government can also turn to the central government to fund its project through various national programmes such as AMRUT (Atal Mission for Rejuvenation and Urban Transformation), Smart Cities Mission, FAME (Faster Adoption and Manufacturing of Hybrid and EV). Another alternative for securing financing support for shortlisted projects could be to explore the public private partnership route and/or approach multilaterals, donor agencies, development banks for securing funding support.



11 References

The chapter lists the documents provided by the IUC, LAHDC, and links to various news articles, publications, policy documents, research papers, company reports, and case studies that were referred to during the preparation of this study.

Table 2: Table of references

Date	Title	Author	Link
Existing reports and studies			
February 2019	Water in Leh: Crisis or Management	Tashi Lundup	https://secureservercdn.net/160.153.138.53/8zq.f50.myftpupload.com/wp-content/uploads/2019/09/Volume-1-Issue-8-2019.pdf
-	EU Guidebook on Sustainable Tourism for Development	-	https://www.unwto.org/EU-guidebook-on-sustainable-tourism-for-development
-	Sustainable tourism	-	http://www.greentourism.eu/en/Post/Name/SustainableTourism
July 20, 2016	List of registered hotels/guest houses in Leh		https://cdn.s3waas.gov.in/s3291597a100aadd814d197af4f4bab3a7/uploads/2018/08/2018081042.pdf
July 21, 2016	List of registered homestays		https://cdn.s3waas.gov.in/s3291597a100aadd814d197af4f4bab3a7/uploads/2018/08/2018081058.pdf
July 21, 2016	List of registered restaurants in Leh		https://cdn.s3waas.gov.in/s3291597a100aadd814d197af4f4bab3a7/uploads/2018/08/2018081037.pdf
-	Transforming urban landscapes of India – Success stories in solid waste management – Swachh Bharat Mission (Urban)	Ministry of Urban and Housing Affairs, Government of India	http://164.100.228.143:8080/sbm/content/writereaddata/SBM%20Coffee%20Table%20Book_Final.pdf
-	Sustainable culture tourism	European Commission	https://europa.eu/cultural-heritage/sites/eych/files/sustainable-cultural-tourism-recommendations_en5097.pdf?token=Ps ePI9T4
May 14-15, 2018	5th European Conference on Sustainable Urban Mobility Plans	Nicola Scanferla	https://www.eltis.org/sites/default/files/d2_scanferla.pdf
-	Hotel, catering and tourism	-	https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/briefingnote/wcms_162197.pdf



Date	Title	Author	Link
-	UNESCO World Heritage and Sustainable Tourism Programme	Peter DeBrine	https://whc.unesco.org/uploads/activities/documents/activity-669-7.pdf
-	UNESCO World Heritage and Sustainable Tourism Programme Online Toolkit	-	http://whc.unesco.org/sustainabletourismtoolkit/sites/default/files/UNESCO%20toolkit%20PDFs%20guide%201C.pdf
-	Case study on Ajit Singh Nagar dumpsite reclamation	-	http://www.zigma.in/comp_proj.html
News articles and other relevant publications			
November 30, 2020	Clean it Right – Dumpsite management in India	CSE India	https://www.cseindia.org/clean-it-right-10487
March 25, 2018	Tourism dilemmas	Karthikeyan Kemalatha	https://scroll.in/article/872942/ladakhs-soaring-popularity-as-a-tourist-paradise-has-left-the-arid-region-water-starved
June 25, 2019	Garbage: It's literally becoming a rising menace in Leh	Zakiya Banoo	https://www.asianage.com/india/all-india/250619/garbage-its-literally-becoming-a-rising-menace-in-leh.html#:~:text=The%20problem%20of%20garbage%20is,leading%20to%20bad%20waste%20management.
September 6, 2015	Sustainable tourism in Ladakh	M Ashraf	https://www.greaterkashmir.com/news/opinion/sustainable-tourism-in-ladakh/
October 19, 2018	Here Is Another Small City Making Big Strides – This Time From Greece	Smartcity	https://www.smartcity.press/trikala-smart-initiatives/
	European Mobility Week		https://mobilityweek.eu/2020-participants/?year=2020&ci=MnXbPYlc
	Smart City Mobility: 7 Major Cities Getting It Right		https://mobility.here.com/learn/smart-city-mobility/smart-city-mobility-7-major-cities-getting-it-right
-	Farkadona	-	https://urbact.eu/farkadona
-	Farkadona	-	http://civitas.eu/city/farkadona
-	Trikala, Greece	-	https://cities4people.eu/pilot-areas/trikala-greece/
-	Leh, India	Editors of Encyclopedia, Britannica	https://www.britannica.com/place/Leh
Official website of stakeholders and government agencies			
-	About LAHDC, Leh district, history and other general data	LAHDC	https://www.leh.nic.in
-	General documents and data	Municipality of Trikala	https://trikalacity.gr/en/
-	General documents and data	Municipality of Farkadona	https://farkadona.gr/



Date	Title	Author	Link
-	General data	Municipality of Meteora	https://dimosmeteoron.com/



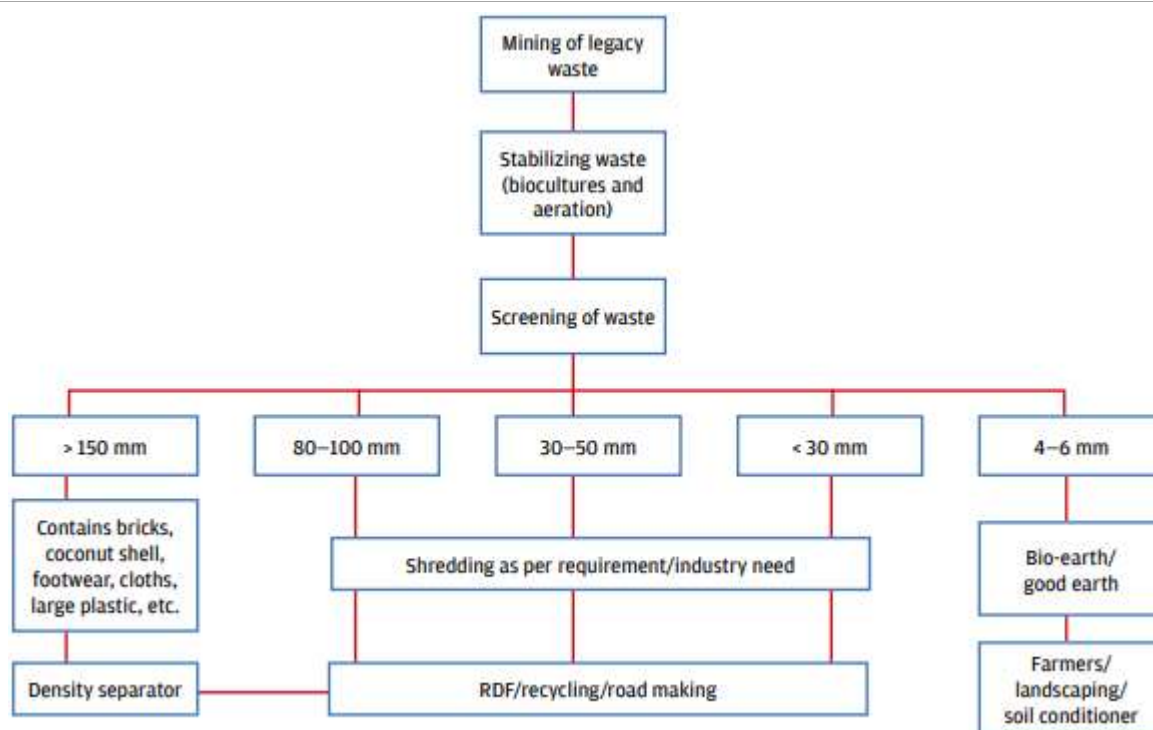
12 Annexure 1 - Successful bio-remediation cases in India



Bhalswa dumpsite in Delhi: The Bhalswa landfill is situated in north-west Delhi and handles dumping of mixed waste of around 2,400 tonnes per day. The dumpsite has been operational since 1994 and reached an estimated height of 62 metres by 2019. The dumpsites stretches in 70 acres (28.3 hectares) with estimated legacy waste of 80 lakh cubic metres above ground level and 8 lakh cubic metres below ground level. The biomining operations started on 1 October 2019. The process is being administered by Delhi Municipal Corporation—North.

- **Equipment and process:** 17 trommels are installed at the Bhalswa dumpsite and 15 trommels are currently processing the legacy waste at the Bhalswa dumpsite (14 trommels of 30 mm screen size and 1 trommel of 6 mm screen size). About 4,200 tonnes of legacy waste is being processed per day. The corporation plans to install more trommels to increase the processing capacity to 5,500 tonnes per day. The following figure highlights the process used for biomining at Bhalswa dumpsite. The following figure showcases the biomining process at Bhalswa dumpsite.

Figure 27: Biomining process at Bhalswa dumpsite



Source: <https://www.cseindia.org/clean-it-right-10487>

- **Waste processed:** As on August 18, 2020 around 661,454 tonnes of legacy waste were processed by biomining. Of this about 85,631 tonnes of inert material has been lifted from Bhalswa and placed at the eco-park site of NTPC at Badarpur and other low-lying areas. About 97,075 tonne of combustible waste or refuse-derived fuel has been sent for co-processing in Jabalpur and the waste-to-energy plant in Bawana. The urban local body had to pay INR 3,240 (EUR 38) per tonne for co-processing the recovered plastic at Jabalpur and INR 1,800 (EUR 21) per tonne for the waste-to-energy plant in Bawana. The biomining process recovered 10,129 tonnes of construction and demolition waste. Legacy waste of about 52,700 sq. m area and 11 metre height from the first mound and about 6,100 sq. m area and 12 metre height from the second

mound have been cleared from the Bhalswa dump. The figure below depicts the trommels installed at the Bhalswa dumpsite for bioremediation of legacy waste.

Figure 28: Trommels at Bhalswa dumping site



Source: <https://www.timesnownews.com/mirror-now/civic-issues/article/taking-out-the-trash-trommel-machines-start-processing-waste-at-ghazipur-bhalswa-and-okhla-landfills/500121>

Kumbakonam dumpsite in Tamil Nadu: Kumbakonam is a special grade municipal town in Tamil Nadu, well known for its farm-based activities. It is also known as the granary of south India. As per the 2011 Census, the city has a population of 1.4 lakh and stretches over 12.5 sq. km. As per the waste projections carried out by the municipality in 2015, based on population density in all the 45 wards, Kumbakonam generated 70 TPD solid waste out of which the biodegradable content was estimated to be 65%. Kumbakonam initiated the first bioremediation site in the country. The estimated quantity of waste in the site is around 3.5 lakh tonnes. The municipality awarded a contract to Zigma Global Environ Solutions Pvt. Ltd in 2015.

- **Biomining and result:** Zigma with its mobile processing unit was able to start its operations in July 2016 and reclaimed the entire 32.5 acres of land. The process was completed in August 2018. In 2017, a 70 TPD processing unit that handles the mixed waste of the city was established on the reclaimed land. In addition, a 5 TPD capacity biogas unit was also commissioned on the same land. No residue was left during the process of bioremediation and the 25-metre-high dumpsite is now completely flat. Around 500 tonnes of refuse-derived fuel (RDF) is left on the site as of now. The RDF, mined from the legacy waste, is sent for co-processing to Dalmia Cement in Dalmiapuram, 70 km from the Kumbakonam. The following pictures represent the before and after scenario at the Kumbakonam dumpsite.

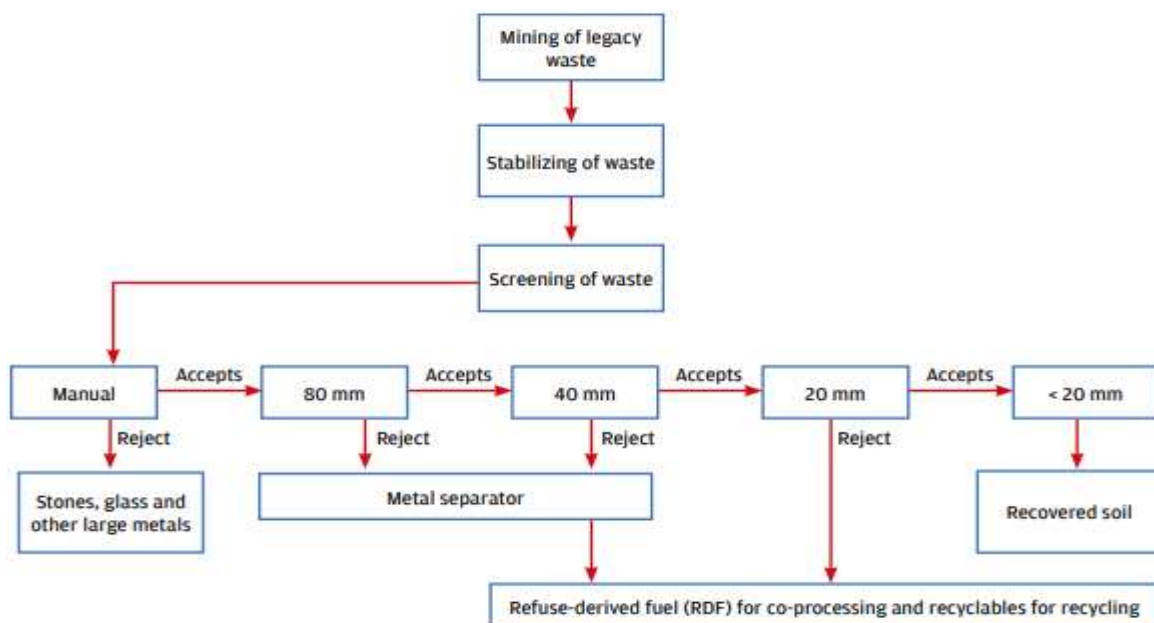
Figure 29: Before and after images of Kumbakonam dumpsite



Source: http://www.zigma.in/comp_proj.html

- Process:** The excavated legacy waste was initially laid in the form of windrows. The legacy waste was then stabilized by adding bio-culture at regular intervals of one week, which catalysed the rate of decomposition of the waste. The decomposition levels were checked every week and soil samples collected for germination testing. The waste, in general, stabilized in 30 days. The stabilized waste was then passed through a series of trommels of various sizes. The rejected materials at each stage were considered as RDF and the accepted materials acted as inputs to the next trommel. Density blowers were used to separate soil from the RDF at each stage of waste passing through the trommel. The final recovered product was soil and was fit for landfilling. The following figures showcase the biomining process followed at Kumbakonam dumpsite.

Figure 30: Biomining process followed at Kumbakonam dumpsite



Source: <https://www.cseindia.org/clean-it-right-10487>

Ajith Singh Nagar dumpsite at Vijaywada: Vijayawada city is a suburb of Andhra Pradesh's state capital Amaravati, and is under the administration of Amravati Metropolitan Region Development Authority. It is a major

trading and business centre of the state and hence is also known as the business capital of Andhra Pradesh. According to the 2011 Census, the city had a population of 15 lakh and is estimated to reach a population of 25 lakh by 2025. The solid waste management of the city is the responsibility of the Vijayawada Municipal Corporation (VMC).

- Waste generated and its composition: In 2015, VMC conducted a qualitative and quantitative assessment of solid waste as per the Central Public Health and Environmental Engineering Organisation (CPHEEO) manual and the waste generation in Vijayawada was estimated to be 550 TPD from all the possible sources. Of the total waste generated, non-biodegradable component was estimated at 57%. Only 16% of the waste was estimated to be inert. Detailed quantitative and qualitative analysis of the physical characteristics of the waste generated showed that about 43% of the total waste generated was biodegradable (including all the sources such as vegetable, mutton, chicken, market waste, waste from residential areas etc.).
- Bioremediation of the legacy dumpsite: In 2018, the municipal corporation started bioremediation of the legacy dumpsite spread across 45 acres. The contract to clear 2.5 lakh tonnes of legacy was awarded to the private company Zigma Global Environ Solutions Pvt. Ltd. The company cleared 2.5 lakh tonnes of waste in nine months and applied for extension of tender to clear the remaining 55,000 tonnes of legacy waste. Of the total waste cleared (over 3 lakh tonnes), 47,212 tonnes was refuse derived fuel (plastic) which was sent to cement companies. The total cost of clearing the legacy waste was around INR 2600 lakh (EUR 3.05 million) and 45 acres of land was reclaimed through the process. Out of the reclaimed land, 5 acres was converted into a construction and demolition waste facility, 2 acres for a plastic waste management facility, 2 acres for a waste to compost processing facility, 5 acres for a farmers produce market and 5 acres for a children's park. The following pictures represent the before and after scenario at the Ajith Singh Nagar dumpsite.

Figure 31: Before and after images of Ajith Singh Nagar dumpsite



Source: http://www.zigma.in/comp_proj.html