Unlocking the Future of Leh City with Blue-Green Infrastructure and Climate Resilience

Dr. Mahesh Kumar Gaur & Dr. R.K. Goyal

Source: https://www.channelfutures.com/iot/abundant-iot-expands-into-eiot-solutions

Leh City, is located in the pristine environment of the Himalayas, is a place of unparalleled natural beauty and cultural significance. However, like many urban centers around the world, it faces significant challenges in managing its water resources sustainably. Rapid urbanization, climate change, and increasing demand for water pose threats to the fragile ecosystems and the traditional way of life in Leh. Green Cities are concerned with how to design the whole city in a more sustainable, efficient, adaptive and resilient way. Green Cities recognise connections between different sectors and support development strategies that fulfil multiple functions and create multiple benefits for society and urban ecosystems. In the context of urban water resource management,a Blue-Green City calls for the holistic planning and management of water, wastewater and stormwater across the whole city to ensure that populations are resilient to climate change and extreme weather events while ensuring the health of aquatic ecosystems and emerges as a lifeline for our cities. These innovative, nature-based solutions bolster urban water security and create resilient, sustainable, and livable spaces particularly for a resource-starved city like Leh for urban water management.

In water management, Blue-Green Cities advocates for the comprehensive planning and regulation of water, wastewater, and stormwater across the urban landscape. The model seeks to equip cities with the resilience to adapt to climate change and extreme weather occurrences, all while maintaining the vitality of aquatic ecosystems. Blue-Green Cities are at the forefront of urban water management by focusing on sustainable drainage systems, green roofs, and permeable pavements. These strategies go beyond flood control; they contribute to enhanced water quality, improved public health, and greater biodiversity.

Understanding Blue-Green Infrastructure (BGI)

Blue-Green Infrastructure (BGI) is a holistic approach to urban planning and development that seeks to integrate natural water systems and green spaces into urban areas. It refers to a network that provides the "ingredients" for solving urban and climatic challenges by a combination of infrastructure, ecological restoration and urban design to connect people with nature. The urban blue-green space is driven by both human activities and natural disasters, resulting in changes in landscape pattern, process, and function that ultimately lead to landscape ecological health deterioration. The concept of blue-green space was first proposed in 2015 and this strategy combines the benefits of "blue" elements, such as rivers, lakes, and wetlands, with "green" elements, like parks, gardens, and vegetation. Taylor & Hochuli (2017) proposed two definitions of urban blue-green space at macro and micro levels. The macro-level refers broadly to ecological areas in general, including water bodies and vegetated areas, such as forests, coastal areas, cultivated areas, parks, and gardens. The micro-level refers to the open space covered by vegetation, including urban parks, gardens, courtyards, urban forests, and urban farms. In the face of climate change scenario, the Leh City needs to recognize the potential of BGI to enhance water resilience and improve the overall quality of life for its inhabitants. As such, the landscape ecological pattern, process, function, and sustainability are a complex of mutual integration, and organic unity helping to achieve social and economic development.

The Challenges Being Faced by Leh City

The Leh city is facing several challenges today due to rapid urbanization, heavy tourist flow, fast increasing vehicles for transportation, glacial retreatat high altitudes, waste-water generation, haphazard extraction of groundwater, infrastructural development (including the construction of hotels, etc.),land-use changes,and the climate change. The major issues are:

Water Scarcity: dueto sparse population in the Ladakh, earlier water was available in abundance. But rapidly increasing tourist footfalls amid challenges posed by climate change is changing that equation. Historically, the people of Leh depended on surface streams known as "yuras," fed by melted snow, for 90% of their water supply, while the remaining 10% came from natural springs. In the present scenario, 92% of domestic water is sourced from underground reservoirs, with Leh's aquifers contributing to 70% of this supply. Unfortunately, this groundwater is becoming progressively contaminated. As such, there is no initiative or strategy in place to monitor the quality of groundwater, nor is there a concerted effort to prevent its pollution. Further, due to high altitude location, the Leh City has been experiencing extremely low annual precipitation.The region's arid conditions has led to minimal natural water sources, so it is experiencing severe water scarcity. The primary source of water, the Indus River, is primarily dependent on glacial meltwaterfrom the surrounding mountains, which is increasingly unpredictable due to climate change.Peoplein Leh often face water crises as it doesn't snow in the region like it used to be a few decades ago. Climate change and the surge in tourism, combined with modern habits like the use of water for flushing toilets instead of traditional dry toilets, are causing significant disturbances.

The annual precipitation in the area, primarily in the form of snowfall, amounts to less than four inches. However, due to reduced snowfall and warmer summer temperatures, some of the glaciers have disappeared completely, and others are melting at an accelerated rate. Local natural springs across Leh are disappearing due to human development and over exploitation. Khardung La, which was once a sizeable glacier, is now on the brink of extinction (Figure 1). Additionally, the community used to rely heavily on spring and early summer for water supply from the melting snow.

Snowless status of Khardung La (Leh-Ladakh) in August 2023

(Photo courtesy: Dr. Anurag Saxena)

● **Waste-water generation:** Leh City has experienced significant population growth in recent years due to tourism and various economic opportunities. This growth has led to increased wastewater generation from residential areas. As such, the water demandfor domestic purposes (excluding gardening and construction purpose) varies from 8 to 12 MLD (million litres per day)whereas the present water supply is around 4.9 MLD only. As a result, people are forced to extract water from the bore-wells to meet their requirement. As per an estimate, about 8 MPD of wastewater is generated daily by the Leh city. The growth of commercial activities, including markets and shops, has resulted in higher wastewater volumes from business establishments also.So, the inadequate Leh City's inadequate wastewater infrastructure is struggling to keep pace with its rapid development. Many areas lack proper sewerage systems, leading to the discharge of untreated wastewater into nearby water bodies.

● **Flooding:** Paradoxically, Leh City experiences a brief but intense monsoon season, typically from July to September. During this period, heavy rainfall disruptsnatural drainage systems due to rapid urbanization and haphazard, leading to urban flooding.Also, climate change has led to the melting of glaciers in the region. As glacial meltwater accumulates in lakes at higher altitudes, the sudden release of water due to a breach or overflow can trigger destructive glacial lake outburst floods (GLOFs) downstream--

● **Erosion:** Leh's high-altitude desert climate and rugged terrain limit natural vegetation cover. Soil erosion is another pressing concern, primarily due to the sparse-vegetative cover and unplanned development.Sparse plant growth means there are fewer roots to anchor the soil, making it susceptible to erosion. The situation is compounded due to the felling of trees for fuelwood and construction materials reduces the stabilizing effect of forests on soil, leaving it more vulnerable to erosion.Also, unsustainable farming methods and overgrazing can accelerate soil erosion.

● **Climate Change:** Climate change has disrupted traditional rainfall patterns, leading to increased variability and unpredictability in precipitation. The effects of climate change are acutely felt in Leh, with rising temperatures and altered precipitation patterns impacting the volume and timing of glacial meltwater. While the climate change is bigger issue and greenhouse gas (GHG)emission is the major concern. About 50% of GHG emission is from the transport sector. The Himalayan glaciers that feed the region's rivers and lakes are melting at an alarming rate due to rising temperatures. This phenomenon threatens the primary source of freshwater and disrupt traditional water supply patterns in Leh city.

The Blue-Green Infrastructure Solution

Leh City should embrace a forward-thinking approach known as Blue-Green Infrastructure (BGI) to address these pressing issues while creating a more resilient and promoting sustainable urban development.

● **Harvesting of Glacial-melt water:** Leh City has little scope for the rainwater harvesting systems as average annual precipitation is roughly 3 inches (80 mm) and has 25.0 rainy days (6.85% of the time) annually. Rooftop rainwater collection, storage tanks, and filtration systems will have insignificant help to recharge groundwater and provide a valuable source of non-potable water.Every year, huge quantity of glacier melt water flows in the drainage channels that ultimately meets the Indus river. However, capturing of glacial melt water can alleviate the pressure on conventional water sources, replenishthe local groundwater table and improve overall water security. Adopting such practices also offers co-benefits, including reducing pollutant loads in water bodies and contributing to groundwater recharge.

● **Green streets replenishing aquifers:** Green Streets are landscaped streetside planters or swales that capture stormwater runoff and allow it to soak into the ground as soil and vegetation filter pollutants. This replenishes groundwater supplies that feed fresh, cool water to rivers and streams. Green streets protect water quality (by removing up to 90% of pollutants), replenish groundwater supplies, improved air quality, and reduced urban heat island effect.

● **Wetland Restoration:** Recognizing the importance of wetlands of theLeh City, there is aneed to embark on restoration projects of ancient and traditional wetlands. These natural systems used to act as sponges, absorbing excess water during heavy rains and releasing it slowly, thereby, reducing the risk of flooding.

● **Water Management:** Implementing robust water management practices, including the conservation of glacial meltwater, rainwater harvesting, regulating indiscriminate exploitation of groundwater and efficient irrigation techniques, is essential to secure the city's water supply. The Municipal Committee of Leh should closely regulate and monitor domestic water supply and its usage.

● **Disaster Preparedness:** Developing early warning systems for GLOFs and flash floods, as well as conducting regular drills and evacuation plans, wouldhelp minimize the impact of climate-related disasters.

● **Green Roofs and Permeable Pavements:** The city should encourage the construction of green roofs and permeable pavements, which will help reduce stormwater runoff and recharge aquifers. The civil society and the Municipal Committee of Leh can play a proactive role in this direction.

● **Riparian Restoration:** The restoration of riparian zones along the Indus River will help prevent erosion and improve the overall health of the river ecosystem.

● **Renewable Energy:** Transitioning to renewable energy sources, such as solar and wind power, can reduce Leh City's reliance on fossil fuels and decrease greenhouse gas emissions. It is heartening that major steps have already been taken by the concerned agencies including LAREDA.

● **Sustainable Land Use Planning:** Leh City should actively promoting sustainable land use practices, including zoning regulations that will protect natural watercourses and green spaces.

● **Infrastructure Resilience:** Design and construct infrastructure with climate resilience in mind, including flood and earthquake-resistant buildings, elevated roads, and sustainable urban planning.

● **Eco-tourism and Sustainable Development:** There is an urgent need to encourage sustainable tourism practices that minimize environmental impact and ensure the economic benefits of tourism contribute to local resilience efforts.

● **Traditional Knowledge:** Tap into the indigenous knowledge of local communities to adapt traditional practices for modern climate challenges, such as ice stupas and khuls (traditional water channels).

● **Raising Awareness:** Education and awareness campaigns provides information to the residents and tourists alike about climate change, its impacts, and the importance of sustainable practices.

Benefits of Blue-Green Infrastructure

The implementation of Blue-Green Infrastructure (BGI) in Leh city offers a range of benefits that contribute to the city's sustainability, resilience, and overall well-being. Here are some of the key advantages:

● **Water Resilience:** BGI strategies will enhance Leh City's resilience to water scarcity and floods, especially in a region often prone to water scarcity. It would help in ensuring a more reliable water supply and reduced vulnerability to extreme weather events. Rainwater harvesting practices need to be resilient to the colder areas.The restoration of wetlands will provide additional water sources and improve groundwater recharge. Also, by retaining and slowly releasing stormwater, BGI will reduce the risk of flooding during monsoon seasons, protecting both infrastructure and residents.

● **Biodiversity Conservation:** BGI promotes the creation and restoration of green spaces, such as parks and natural wetlands. These areas serve as habitats for local flora and fauna, preserving Leh Town's unique biodiversity.Also, by restoring riparian zones along rivers, BGI supports aquatic life and contributes to maintaining the health of river ecosystems.

● **Enhanced Urban Aesthetics and Improved Livability:** Green roofs, permeable pavements, and urban parks improve the visual appeal of Leh Town, making it a more attractive and livable city. The presence of greenery in urban areas can have a positive impact on residents' mental well-being, providing spaces for relaxation and recreation.

● **Heat Island Mitigation:** Green roofs and urban vegetation help reduce the urban heat island effect by providing shade, cooling the environment, and mitigating the impact of high temperatures during the summer months.

● **Cultural Preservation:** BGI initiatives align with the cultural values and practices of Leh Town. The preservation of traditional water management systems, such as khuls, helps maintain the city's cultural values, heritage and practice while ensuring sustainable water use.

● **Economic Benefits:** BGI can attract eco-tourism and promote sustainable tourism practice, boosting the local economy further while minimizing the environmental impact of tourism.

● **Community Engagement:** The implementation of BGI encourages community participation in environmental conservation and sustainable development, fostering a sense of ownership and responsibility among the citizens.

● **Resilience to Climate Change:** BGI contributes to Leh city's resilience against climate change by mitigating the effects of extreme weather events, such as floods and droughts. It ensures a more stable and reliable water supply in a changing climate.

● **Long-term Cost Savings:** While there may be initial investment in BGI infrastructure, the long-term benefits in this Himalayan city, including reduced maintenance costs, energy savings, and improved public health, would outweigh the initial expenditures.

Conclusion

Leh City's vulnerability to climate change is a stark reminder of the urgent need for global climate action. While it faces significant challenges, proactive adaptation measures can help mitigate the impacts and enhance the city's resilience. As the Leh City is embracing Blue-Green Infrastructure, it will be a testament to its commitment to a sustainable future. By integrating natural water systems and green spaces into urban planning, the city will not only address its immediate water challenges but also fortifying its long-term resilience, sustainability in the face of a changing climate and equitable future. This holistic approach to urban water management will serve as an inspiring example for other Himalayan cities in the country as well for the world seeking to balance urban development with environmental conservation and cultural preservation.

(The authors are Principal Scientists at ICAR-Central Arid Zone Research Institute, Regional Research Station Stakna, Leh-Ladakh)