研究論文

Roof-top Gardening (RTG) in Capital Cities of Nepal and Japan
Building Resilience to Climate Change

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Background

By 2050, the UN forecasts the world population to reach 9.7 billion; 68% of that population is expected to live in cities and the fastest urbanization is expected to occur in low or middle-income countries. To make our future cities sustainable, there is an urgent need to develop strategies targeted to withstand the effects of climate change, environmental degradation, and high energy demand. Such inter-related problems resulting from rapid urbanization can be addressed by diversifying land-use in urban areas for better productivity. In this report, we focused on rooftop space which is often under-utilized but has much potential to boost productivity. By selecting the capital cities of Nepal and Japan we aim to compare the context and conditions in a developing and a developed country. This comparative approach, is useful to gain new perspectives on building resilience to climate change and can be applied further in other developed or developing countries.

Kathmandu, the capital city of Nepal with 32 wards, spreads across an area of 49.45 km². It is one of the fastest urbanizing cities in Asia. Nepal was among the ten countries most affected by extreme weather events over the 2000–2019 period according to the Global Climate Risk Index (Eckstein et al., 2021). World population review reported that Kathmandu's population reached 1,521,000 in 2022 which is an increase of 3.33% from 2021. Built-up areas in Kathmandu Valley are expected to increase further to 352 km² by 2050, effectively doubling the equivalent 2018 figure (Mesta et al., 2022) which means drastic loss of farmlands and urban greenery. Creation of public parks and open space must be prioritized in Kathmandu also due to the risk from seismic activity (Gautam et al., 2017) which can serve as space for disaster relief. Free open spaces have become so scarce in Kathmandu that even river bank encroachment poses a new problem (Tamrakar & Parajuli, 2019). Supplying food to Kathmandu is often obstructed by natural calamities like floods and landslides that damage road connectivity, resulting in sudden rises in food prices.

On the other hand, Tokyo, the capital city of Japan since 1868, is known as one of the most densely populated cities of the world, and spreads across an area of 2,191 square kilometers. Tokyo has public parks in 82 locations totaling 2,030 hectares which also serve as disaster refuge sites, the significance of which was recognized since the Great Kanto Earthquake of Tokyo in 1923 and as Masuda (2014) mentioned, landscape architecture plays an important role in disaster-prevention, response and social resiliency. In the report by Tran & Murata (2019, 2020), green infrastructure like rooftop gardens in Tokyo, are associated with usage, space affordance as well as image of identity. Kimura et al., (2004) cautions that cultural and social aspects may discourage rooftop gardening in Tokyo as membership to gardening clubs is often required due to difficulty in accessing roof space. According to the world population review, Tokyo's population decreased to almost 14 million in 2021 and the aging of population signals the need for local social engagements like gardening.

By comparing the varying lifestyles, resource availability, cultural aspects and other contrasting urban contexts of these two cities, we can gain further insight to build future cities resilient to climate change and natural hazards.

Differences, similarities and future directions for RTGs in Kathmandu and Tokyo

1. Building architecture: In Kathmandu, RTGs exist on privately owned residential homes, whereas, in Tokyo, they exist mostly on public buildings like mansions, office buildings etc. Privately owned homes in Tokyo usually have slanted tiled roofs, not terrace-style roofs like in Kathmandu where private gardening is possible. Changes in building architecture can provide more roof space in both private and public building structures in these cities.

2. Roof space utilization: In Kathmandu, the basic purpose of RTGs is diverse. Roof space is used for growing edible and ornamental plants, recycling organic kitchen waste, harvesting rainwater, placing water supply poly-tanks, solar water heaters and solar panels to generate electricity. In Tokyo, slanted roofs of private homes are used to place solar panels to generate electricity for sale and home consumption. Edible plants are uncommon on roofs in Tokyo, however, exceptions like the "garlic chive (*Allium tuberosum*) house" built by Terunobu Fujimori, a Japanese architect and architectural historian (Seo, 2019) in Kanagawa prefecture gained much attention. The Ginza Bee Project is another example of harvesting honey from bee boxes placed on rooftops. Otherwise, Tokyo's public buildings are used for car parking or have park-like gardens created for recreational purposes rather than growing edible vegetation. The greenery on roofs reduces the heat island effect and saves energy on air conditioners (Bass & Baskaran, 2003). To further increase and utilize roof space, building design and materials used for rooftop gardens must be reconsidered for heat absorption in both cities, thus categorizing rooftop gardens according to objectives, be it commercial, social, educational, therapeutic or ecological, as mentioned by Nasr et al.（2017）.

3. Economical, ecological and educative: In Kathmandu, restaurants on rooftops have become an example of commercializing the roof space and increasing its real estate value. By extending their seating capacity on rooftops, restaurants grow ornamental plants to attract customers as well as pollinators like birds and bees which enhances the biotope effect as well. If the names and features of plants are displayed (like in a botanical garden), the experience can become educational, too. In Kathmandu, plant names displayed in local languages would gain much public interest because of its linguistically diverse population. In Tokyo, popularity of beer gardens is a seasonal thing. Such beer gardens on roof areas are either temporary or permanent set-ups sometimes adorned only with fake plants if any. To save the cost of maintenance, renting decorative container plants for fixed time periods can become new start-up businesses in both cities.

4. Easing access to gardening space: In Kathmandu, rooftop gardens on private homes are maintained by home-owners themselves or in some cases hired gardeners. Residents who rent rooms located on the lower floors of these homes usually have no access to roof space for gardening purposes (Tuladhar, 2019). In Tokyo, residential mansions keep their roofs locked for security reasons. Home ownership is expensive in cities, so private rooftop gardening is not so common in Tokyo where rooftop gardens on public buildings are maintained by hired professional horticultural service providers. In general, growing edible vegetation on private property is somewhat of a luxury in cities, however the number of RTGs is growing in Kathmandu. Reasons vary, but the majority of gardeners want to avoid buying vegetables with pesticides, save on their grocery bills, and most importantly, be self-sustainable and not be affected by food shortages and inflation. Gardening facilities for the general public must become the next public asset like public libraries that are run on government tax in both cities. Incorporating such gardening facilities in the town-planning strategies would benefit populated cities, and could be encouraged by tax deduction for greenery creators, individuals or enterprises.

5. Facilitating the trend of RTGs: In Kathmandu, formally registered paid membership-based gardening clubs specifically for rooftop gardening do not exist yet, however free online social media groups dedicated to rooftop gardening have become popular platforms for gardener-to-gardener interaction, problem-solving and learning. In Tokyo, free platforms providing advice on gardening are rare, often due to the concept that social media is unsafe, risky or because its aging population are not driven to the internet. Internet-literacy and smart phone ownership alone, can inspire amateur gardeners in core cities, and residents in Kathmandu seem to benefit largely by the use of internet. Kathmandu residents often organize and join trainings and educational programs on RTGs backed by the metropolitan office or non-governmental organizations without having to pay an expensive membership fee or participate in obligatory meetings. They are often introducing new growing methods by posting vid-

eos online. In Tokyo, gardening clubs, societies and organizations run on membership fees and individuals who afford the time and membership join for social interaction rather than for hands-on gardening experience or skill.

6. Need-based green infrastructure: In Tokyo, stable food supply chain, convenient online food delivery systems, busy and long working hours and most importantly living away from family members in one-room apartments, detaches residents from the natural experience of growing food and connecting with nature. The yearning for greenery is proven by the usage of verandas and walls as Tokyo residents grow "green curtains" (Braiterman, 2011) on verandas by growing climbers like ivy, morning glories or vegetables of the cucurbitaceae family like cucumbers, bitter gourds and etc. Known as the "breathing walls" (Koyama et al., 2015) indoor and outdoor vertical walls are covered with ornamental leafy plants in business and residential complexes in Tokyo which is still uncommon in Kathmandu. Perhaps, plant nurseries that are booming in Kathmandu, by extending their professional services to rooftop gardens, verandas and walls, can create further business opportunities greening public buildings like government offices, hospitals, hotels, schools and universities, parking lots and etc. adding value to their services as well as focusing on indigenous species rather than imported exotic species as mentioned by Baral et al.(2005).

Conclusion

In a world where cities are branding themselves based on the level and quality of their green spaces, preservation of a city's unique characteristics of biodiversity and local identity remains the key point, whether it be Kathmandu or Tokyo. In our globalized world today, it has become much easier to share and learn from each other and notice how wonderfully human civilizations of the past developed unique ways to tackle common problems. At a time when climate change affects us all in varying degrees, the key to sustainability lies in understanding that, to solve common problems, simply applying the same solution methods, may or may not work to the same extent every time. Every city is unique in its history, culture and its residents' life-styles. Rooftop gardens and other green infrastructures can bring new changes to urban life-style and cityscape and vice-versa. By comparing the context of developing and developed countries, we could list many unexplored ideas and possibilities in both cities. Further studies are required to find details in green infrastructure building that best fit the city residents' life-style and culture and how it can help them withstand the effects of climate change.

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