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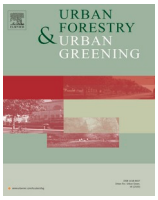

Patterns of urban foraging in Bengaluru city

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ABSTRACT

Urban foraging is widely prevalent globally, and can provide foragers benefits like additional income and nutritional supplements. However, urban foraging is largely understudied and we have little information on types of species foraged, patterns of foraging, socio-economic profile of foragers, and impact of urbanization on foraging. In this study, we aimed to identify patterns of urban foraging in one of the fastest growing cities in the world, Bengaluru in India. Our specific objectives were to identify a) the foragers b) species foraged and foraging sites c) impact of urbanization on foraging and d) the barriers to foraging. We collected our information through semi-structured interviews with residents from four sites selected across a gradient of urbanization. Sixteen per cent of the respondents reported that they foraged, most of who were women (97 %) belonging to socially (90 %) and economically (81 %) disadvantaged groups. Seventy-six species were foraged across the four sites for food (76 %), medicine (26 %), and cultural practices (18 %). Foraging occurred in unused land (32 %), parks (32 %), farmlands (12 %), native villages (12 %), nearby woodlands (9%) and home gardens (3%). We found significant differences in foragers along a gradient of urbanization (chi square = 34.56, $p = 1.5 \times 10^{-7}$, df = 3) with most foragers at the least urbanized site (40 % of the respondents) and least foragers at the most urbanized site (2% of the respondents). Lack of knowledge of foraged species (66 %) and lack of access (55 %) were the biggest barriers to foraging. Our study demonstrates that foraging occurs in a metropolis like Bengaluru with foragers generally belonging to lower socio-economic backgrounds, who are most vulnerable to changes due to urbanization. Redesigning urban environments to create green spaces for forgeable species to flourish, that are made accessible to marginalized communities, is essential for their nutritional and cultural well-being.

1. Introduction

Urban foraging is a ubiquitous practice in most urban centres and has likely existed historically since the growth and establishment of cities (Simons and Maitri, 2006; Shackleton et al., 2017). It can be defined as the harvest of biological materials, which include wild or domesticated species, from formally and informally managed and public or private spaces in cities (Poe et al., 2013; Mclain et al., 2014; Svizzero, 2016). Species can be foraged for personal use or for sale in local markets (Quang and Anh, 2006; Petersen et al., 2012; Farfán-Heredia et al., 2018). They provide additional income to vulnerable communities (Schlesinger et al., 2015), supply household utilitarian goods like building material and firewood (Kaoma and Shackleton, 2015), are used as medicine (Ali and Qaiser, 2009), and enhance livelihoods by promoting traditional crafts like basket making (Hurley et al., 2013). Foraging can help preserve local ethnoecological and ethnobotanical knowledge (Poe et al., 2014; Shackleton et al., 2017); can play a significant role in maintaining good mental health as foragers have reported feeling connected to nature and can strengthen social bonds within the community (McLain et al., 2013; Gopal and Nagendra, 2014). In cities of the Global South, foraging is a complimentary strategy and not the only source of subsistence as seen in cities in Africa (Davenport et al., 2012; Kaoma and Shackleton, 2015), Asia (Cruz-Garcia and Price, 2014; Gopal and Nagendra, 2014) and Latin America (Kujawska and Łuczaj, 2015). Such foraging can act as a safety net during times of distress and uncertainty.

Urban foraging commonly occurs in formal and informal spaces such as forests (Poe et al., 2013; Plieninger et al., 2015), parks (Palliwoda et al., 2017), unused lands (Wehi and Wehi, 2010), avenue trees (Gopal and Nagendra, 2014), municipal commonages (Davenport et al., 2012), and lakes (Unnikrishnan and Nagendra, 2015). Spaces where wild and spontaneous vegetation persist, especially in peri-urban pockets of the city where land has not yet developed, are important sites of collection (Shackleton et al., 2017; Riley et al., 2018). A range of stress tolerant

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native and introduced species of ruderal plants typically occupies these spaces, often neglected by urban planners, and they add to the green cover of the city and support biodiversity (Del Tredici, 2010). However, the pressures of urbanisation often lead to land conversion, making these spaces unavailable for collection (Shackleton et al., 2017). Foraging in urban spaces is often further curtailed as many of the formal and informal spaces, such as streets, parks and private lands, may not be accessible for all urban foragers (Cruz-Garcia and Price, 2014). Privatization and gating of urban commons like lakes and parks as a consequence of gentrification also make green spaces unavailable for collection, excluding people who have traditionally used these spaces for foraging (Nagendra et al., 2012; Unnikrishnan and Nagendra 2014).

A review paper on urban foraging found that the urban poor and residents of peri urban areas are more likely to forage (Shackleton et al., 2017). Foraged foods are rich in micronutrients and can be an inexpensive way of providing food security (Sogbohossou et al., 2015). However, collection is not necessarily limited to the poor, as evidenced by a survey from New England, USA which showed that foraging transcended a range of socioeconomic backgrounds with 17.9 per cent of respondents foraging in the past 12 months and 26.3 per cent foraging in the last five years (Robbins et al., 2008). More than half the population of some South African cities (Tzaneen, Bela Bela, Zeerust) have been recorded to be involved in urban foraging (Kaoma and Shackleton, 2015) and in Surinam, it was reported that 66 % of the urban population used wild medicinal plants (Van Andel and Carvalheiro, 2013).

A range of species are foraged from wild plants, to feral plants, to trees, to fungi. Hurley and Emery (2018) found that 72 % of street trees in New York City were forgeable for edible, medicinal or other uses. Jahnige (2004) recorded 70 plant and 8 fungal species foraged in Baltimore while, as high as 433 plant species and 53 fungal species were foraged in Seattle (Poe et al., 2013). In Kampala, 48 plant species were foraged of which 52 % were for medicinal uses and 48 % for food (Mollee et al., 2017). Seasonality is an important factor in foraging, while some foraging occurs through the year, spring and fall seem to be peak times (Mollee et al., 2017; Jahnige, 2004; Poe et al., 2013).

Urban foraging is prevalent across the globe, however it is overlooked by policy makers in most cities (McPhearson et al., 2016), especially so in Global South cities, where socioeconomic inequity is high (Nagendra et al., 2018). Urban green spaces are largely managed to meet aesthetic, economic and social needs of city dwellers (Bonthoux et al., 2019). In horticultural design, ornamental plants predominate the city landscape, leaving little room for native and spontaneous vegetation (Gopal and Nagendra, 2014). In the Global South cities, foraging may play an especially critical role in the survival and resilience of the urban poor. However, we have little information on urban foraging from these spaces, in particular, on aspects such as the types of species foraged, the socio-economic profile of foragers, and challenges posed by urbanization on foraging. This information is crucial for urban planning and can be used to design cities that can address food connection and security, such as Andernaach the 'Edible City' in Germany (Sartison and Artmann, 2020).

Bengaluru, one of India's largest and fastest growing megacities (Paul et al., 2018), provides a useful context to conduct such research. Research from Bengaluru has shown that residents utilise plants in their gardens and avenue plants for food, medicine or for cultural purposes (Gopal and Nagendra, 2014; Jaganmohan et al., 2012). Majority of the species in slums had multiple uses and were of high economic value, while most tree species in gardens were ornamental (Gopal and Nagendra, 2014; Jaganmohan et al., 2012). This could indicate that urban foraging is more prevalent in slums, especially for food and medicinal purposes, and foraging in urban spaces primarily occurs along avenues lines with trees or if there is access to open spaces. Further, as open spaces and overall species diversity decreases with urbanization (Shackleton et al., 2017), we can expect foraging to also decrease. A systematic study of foraged species, where they are foraged, the ethnography of the people foraging and the impact of urbanisation on foraging, is undocumented. Therefore, in this study we intend to address the following questions

a Who are the people who forage?
b What are the species foraged, where and in which season, and the purpose of foraging?
c How does foraging vary along a gradient of urbanization?
d What are the barriers to foraging?

2. Methods

2.1. Study area

Bengaluru is one of the fastest growing cities in the world with a population of 8.5 million and an expanding boundary (Paul et al., 2018). With a history of human settlement since millennia, the city has been shaped by its ecology and constant interactions between people and nature (Nagendra, 2016). Systematic greening by various Indian and colonial rulers have transformed the landscape from one that was largely open and rocky into India's 'Garden City' with numerous heritage parks, green educational and governmental institutions, sacred spaces and open water bodies (D'Souza and Nagendra, 2011; Nagendra et al., 2012). However, rapid urbanisation and subsequent development has led to a deterioration of such spaces within the city (Sudhira et al., 2007; Nagendra et al., 2012).

In our study we define urbanization as a spatio-temporal process encompassing changes in the environment and society, including built-up areas, livelihoods, connectivity, consumption patterns, and institutions (Haase et al., 2018). The urban is defined as areas where employment is the main source of income and basic needs for food, water and other materials are supplied through import from external ecosystems (Gómez-Baggethun et al., 2013). We selected four localities within the city to establish a gradient of urbanisation (drawing on our extensive prior research on Bengaluru, as documented in Nagendra (2016)). The history of development in Bengaluru was integral while establishing our study sites, along with factors such as the distance from the city centre and the ratio of built-up areas to open spaces (Table 1). Centrally located, Ulsoor (a) is one of the oldest parts of the city, settled prior to the 16th century (12° 58′ 31.97″ N, 77° 37′ 5.49″ E) (Fig. 1). It is the most highly urbanised site in our study, with access to Halasuru Lake nearby. Siddhapura (b) is the next most urbanised site, established in the 19th century, with access to the Lal Bagh botanical gardens, while Banashankari (c), established in the 20th century, has access to a few remnant patches of land and is home to a bustling street market (Fig. 1). Talaghattapura (d) is the least urbanised site in our study. Situated in the southern outskirts of Bengaluru, it predominantly consists of small villages and hamlets and is surrounded by open agricultural fields and forests (Fig. 1).

2.2. Study design

Interviews were conducted at the level of the household. Foragers were defined as any of the respondents who were involved in foraging. Within each site, approximately 50 households within a block of 200 households were selected as the sample for the study. The areas selected within the city were primarily slum areas where we knew foraging

Table 1
Distance from the city centre and the dates of establishment of the study areas in Bengaluru city.

Site	Date of establishment	Distance in km from the city centre
Talaghattapura	Still peri-urban	24
Siddhapura	19th Century	10
Banashankari	20th Century	7
Ulsoor	16th Century	5

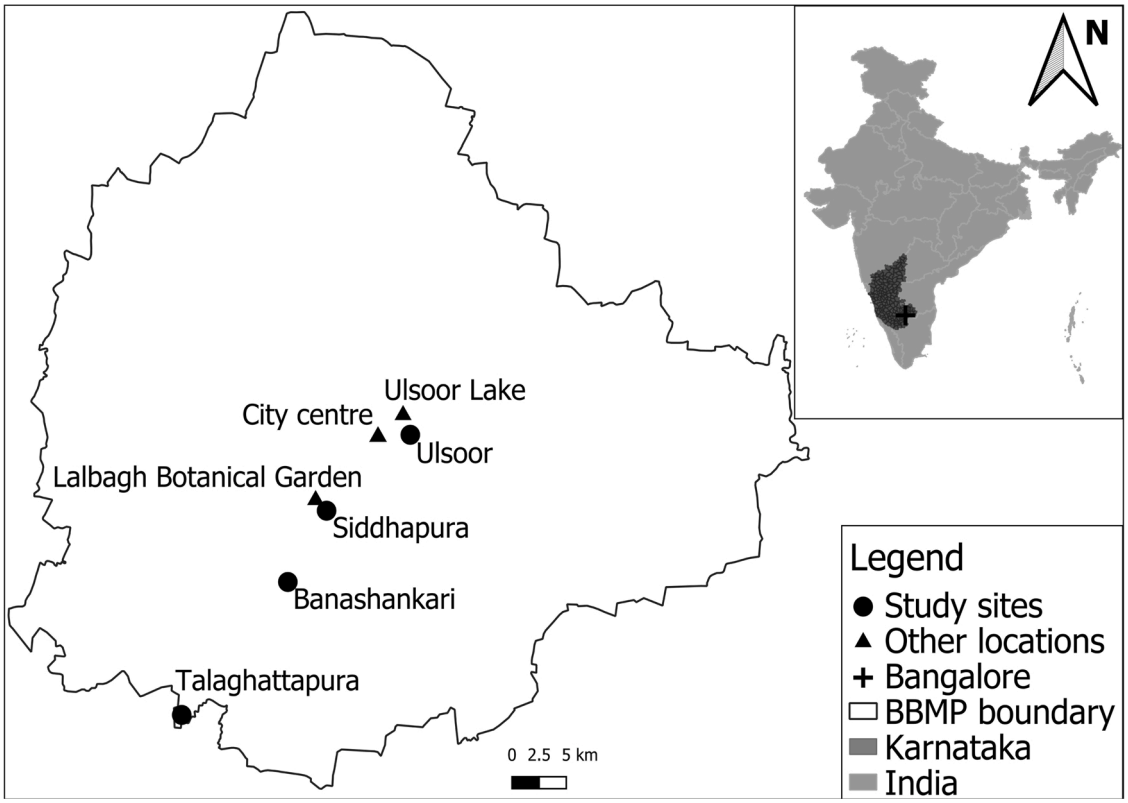

Fig. 1. Four study sites in Bengaluru, selected along a gradient of urbanization.

occurs from previous research (Gopal and Nagendra, 2014). In Bengaluru, as with most cities in the Global South, inequality is very high (Nagendra et al., 2018) and within that context, the areas we selected had similar socio-economic profiles, i.e they were relatively lower in the socio-economic strata. Although, similar within the larger context of Bengaluru, even within these groups, there were differences in caste and class. We chose to omit high-rise apartments and gated communities across all four sites as they were difficult to enter for interviews and it was likely they didn't fall within the socio-economic strata we were interested in. In each block of 200 households, we interviewed every fourth house as a random sample. If the houses were empty or their inhabitants were unwilling to answer, we moved on to the next fourth house. If after interviewing every fourth house we still had not got 50 interviews, we returned to the same area, interviewing every third house.

We interviewed respondents above the age of 18 who were aware of their household consumption patterns. We conducted interviews between late November 2019 to early January 2020, which is the end of the peak collecting season. Interviews were conducted predominantly on weekdays between 14:30 to 17:30 h in Kannada, and where required, in Tamil, Telugu, Hindi and English.

We conducted semi-structured interviews to determine the collection and consumption of foraged species across the sites. We asked questions about whether the respondents foraged and bought foraged species, quantities of the same, sites and time of foraging, and their reasons for not foraging or foraging less. The distinction between commercially cultivated species normally for sale in the markets and foraged species was clearly described to the respondents. We also asked questions about the respondents' local knowledge about foraging and foraged species. Local knowledge was defined as the social and ecological knowledge practices and beliefs embedded in the relationship of local people with nature and each other (IPBES, 2019). People who did not forage sometimes had local knowledge about foraging which was either culturally transmitted or based on their own previous experiences of foraging, but were no longer foragers. We also asked respondents about the species collected, what they were collected for and what parts were utilised, across the sites. The questionnaire is provided in the Appendix A. We identified the species using the data base Flora of India and Digital Flora of Karnataka (IISC).

2.3. Data analysis

Socio-economic categories of foragers were defined according to the Indian government categorization. Other Backward Caste (OBC), Schedule Caste (SC), and Schedule Tribe (ST) are terms used by the Government of India to refer to historically and currently socially disadvantaged groups in Indian society (Ministry of social justice and empowerment, 2020).

All statistical analyses were done using the open source statistical computing software R (R core team, 2018). Pearson's Chi square test was used to test for the difference in foragers and respondents buying foraged species across an urbanization gradient along the four sites.

We asked respondents who did not forage open-ended questions about their reasons for not foraging. We qualitatively analysed the data to identify reasons for not foraging. We calculated the per cent responses under each category and under each study site. Respondents often mentioned more than one reason, and in these cases all the reasons were recorded. Pearson's Chi square test was used to test for differences across the four study sites.

3. Results

3.1. Who are the people who forage?

A total of 202 interviews were conducted across the four sites (Ulsoor = 50, Siddhapura = 50, Banashankari = 52, Talaghatta pura = 50). Most respondents (n = 178, 89 %) were women, as women were more willing to participate in the interviews. When the men were

present in the household or were approached, they directed us toward their wives saying that they knew more about foraging. The average age of the respondents was 44 years. There were 22 households in Ulsoor, 13 in Siddhapura, 16 in Banashankari, and 12 in Talaghattapura unavailable or unwilling to respond, and other households were approached in their place.

Sixteen per cent (32 of 202) of the interviewees reported foraging and 47 % of all the respondents reported buying foraged species. Across all four study sites 97 % of the foragers (people who reported foraging) were women, 81 % belonged to a lower social background, and 90 % belonged to historically and currently disadvantaged communities that the Government of India classifies as Other Background Communities (OBC) and Schedule Caste (SC) groups (Table 2). Consumption of the foraged species occurred at the household level, but women were the primary foragers with women making up 95 % of the foragers in Talaghattapura and all the foragers in Banashankari, Siddhapura, and Ulsoor. Seventy six percent of foragers in Talaghattapura, 85 % in Siddhapura, and 100 % in Banashankari and Ulsoor had a low economic background. All the foragers in Banashankari, Siddhapura, and Ulsoor were from Schedule Caste (SC) and Other Backward Communities (OBC). While 82 % of foragers in Talghattapura were from SC and OBC groups (Table 2).

3.2. Species foraged and uses, foraging seasons and spaces

A total of 76 species were reportedly foraged and bought. Interviewees at Talaghattapura collected the highest number of species (68) followed by those in Siddhapura (39), Banashankari (7) and Ulsoor (3). Residents in Banashankari purchased the highest number of foraged species (37) at local markets, followed by those at Talaghattapura (27), Siddhapura and Ulsoor (20). Herbs were the most colelcted species (n = 36, 47 %), followed by shrubs and trees (n = 13, 17 % each), climbers (n = 12, 16 %), climbing shrubs (n = 2, 3%) and liana (n = 1, 1%). Detailed species list, the part of the species foraged, and their uses at each site is provided in Appendix B. Details of the foraged species bought are provided in Appendix C. Species were foraged for food (76 %), medicine (26 %), for cultural practices (18 %) like ritual bathing, warding off evil spirits, floral offerings, making musical instruments or for household utilitarian purposes. Thirty-seven species (49 %) were collected only for food, 9 species (12 %) only for medicinal purposes, and 7 species (12 %) only for cultural purposes. Fifteen species (20 %) were collected for food and medicinal purposes, 4 species (5%) for medicinal and cultural purposes, and 3 species (4%) for both food and cultural purposes. Only one species was collected for all three purposes. Leaves, stem, roots, tubers, flowers, fruits and seeds of the plants were collected. Of these, leaves (76 %) and fruits (27 %) were the parts that were most extensively collected (Appendix B).

Most collection (60 %) occurred from June to September (monsoon), 23 % from October to December (post-monsoon and winter) and 17 % of foragers foraged throughout the year.

The most common foraging sites in Bengaluru were unused land and parks (32 %), followed by farmlands (12 %), native villages (12 %), nearby forests (9%) and their gardens (3%) (Fig. 2).

3.3. Foraging along a gradient of urbanization

There were significant differences in reported foraging across the four sites (chi square = 34.56, $p = 1.5 \times 10^{-7}$, df = 3), with the number of foragers decreasing with urbanization. Talaghattapura had the highest number of foragers (40 % of the respondents), followed by Siddhapura (26 %), Banashankari (4%) and Ulsoor had the lowest number of foragers (2%) (Fig. 3).

There were no significant differences in respondents who bought foraged species across the four sites.

3.4. Barriers to foraging

Some respondents who did not forage said that they would like to forage (41.6 %), but were unable to. A total of seven reasons were mentioned for not foraging. The most cited reason for not collecting wild plants were a lack of knowledge regarding collection and use of foraged species (66 %) followed by lack of access to spaces to collect them (55 %), they were not interested in collecting (46 %), and health concerns

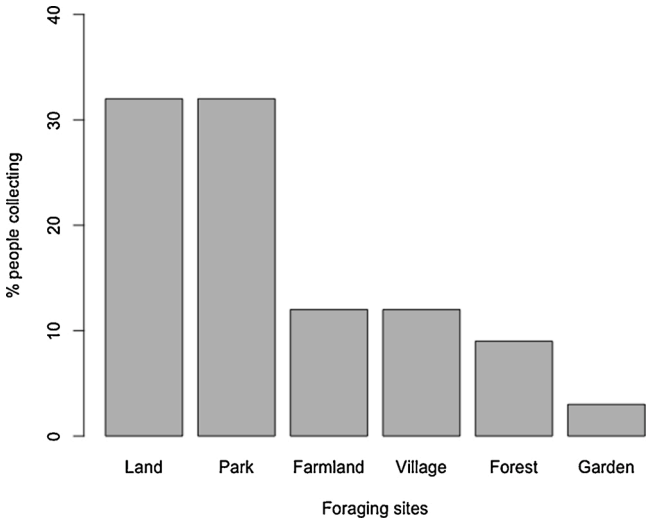

Fig. 2. Percentage of people using foraging sites for all four study sites in Bengaluru.

Table 2
Socio-economic characteristics of foragers across all four sites in Bengaluru. OBC = Other Backward Communities, SC = Schedule Caste, ST = Schedule Tribe (classification categories according to the Indian government).

Variable		Talghattapura (N = 50)		Banashankari (N = 52)		Siddhapura (N = 50)		Ulsoor (N = 50)	
		Foragers (N = 19)	Total	Foragers (N = 2)	Total	Foragers (N = 11)	Total	Foragers (N = 1)	Total
Gender	**Female**	18	47	2	45	11	48	1	38
	Male	1	3	0	7	0	2	0	12
Economic background	**Low**	16	42	2	37	9	30	1	12
	Middle	2	7	0	12	1	18	0	28
	High	1	1	0	1	1	2	0	9
Social background	**OBC**	9	25	2	34	1	19	1	19
	SC	6	13	0	5	10	22	0	5
	General	0	1	0	5	0	7	0	9
	ST	2	5	0	1	0	0	0	0
	Hindu (uncategorised)	1	4	0	0	0	1	0	3
	Muslim	1	2	0	7	0	0	0	11
	Christian	0	0	0	0	0	1	0	3

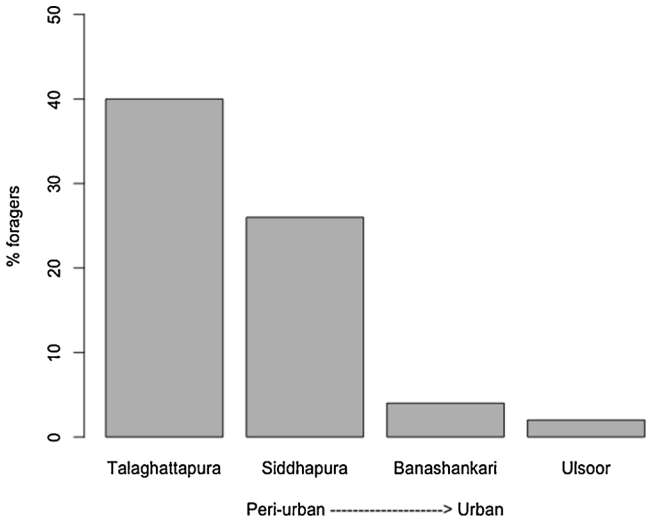

Fig. 3. Percentage of respondents who reported foraging across four sites in Bengaluru. Talaghattapura, the least urbanized settlement had the most foragers, while Ulsoor, the most urbanized had the least foragers.

(28 %). The least cited reasons were that they had no time to collect (13 %), previous negative experiences (9%), and beliefs that prevented collection (4%) (Table 3). There were significant differences in lack of knowledge (chi-squared = 44.7, df = 3, p = 1.1×10^{-9}), lack of access (chi-squared = 13.6, df = 3, p-value = 0.003), and lack of interest (chi-squared = 15.13, df = 3, p-value = 0.0017) that acted as barriers across the four sites. Lack of knowledge and lack of interest, were the biggest barriers in the most urbanized sites, Ulsoor (78 % and 57 % respectively) and Banashankari (80 % and 48 % respectively). Lack of access was the biggest barrier in the least urbanized sites, Talaghattapura (68 %) and Siddhapura (84 %).

4. Discussion

Our study showed that foraging occurs in Bengaluru with 16 % of our respondent reporting that they foraged. Our study was focused on socially and economically disadvantage areas in Bengaluru and if it were to include all strata of society, it is likely that reported foraging might be lower. This was lesser than foraging reported from other cities in the Global South, such as 68 % from South Africa and 47 % from Uganda (Mollee et al., 2017; Garekae and Shackleton, 2020b). However, 47 % of the respondents reported buying foraged species, and 42 % of the respondents reported that they would like to forage, indicating that the demand for foraged species in Bengaluru was similar to other cities in the Global South.

Trends from across the world show that seasonality is an important factor in foraging as foraged species are seasonal (Nordeide et al., 1996; Poe et al., 2013). The peak foraging season in Bengaluru was during the monsoon (June to September). Several studies also report similar findings, where foraging is highest during the monsoon period due to greater availability (Nordeide et al., 1996; Mertz et al., 2001; Garekae and Shackleton, 2020b).

Our study focused on areas we knew foraging occurs from previous research (Gopal and Nagendra, 2014). In Bengaluru, these areas mostly considered to belong to a lower socio-economic background. However, even within these regions there were variations in class and caste. The foragers were predominantly female, belonging to socially and economically disadvantaged groups. This pattern is reflected from other studies on urban foraging from the Global South, that people with lower incomes are most likely to forage to complement their diets and for additional income (Shackleton et al., 2017). Including the more affluent regions in the city is unlikely to change these patterns as from previous research in these spaces, most of the more affluent households utilized nature for cultural purposes such as aesthetics (Jaganmohan et al., 2012).

Foraged species were mainly collected for food, which play an important role in increasing the dietary diversity of urban dwellers (Garekae and Shackleton, 2020a). Several of these species collected are multi-functional, and supplement the nutritional and medicinal requirements of the consumers. Weedy herbs were the most commonly collected. Weedy greens that grow with crops and in unused lands are an important part of the diet in South India (Kumar and Shiddamallayya, 2014a, 2014b). Respondents mentioned that these plants are seasonal and grow spontaneously.

Earlier studies showed that foragers in Bengaluru collected raw plant material from commonages like lakebeds and from trees growing in their slums/localities (Nagendra and Gopal, 2010; Gopal and Nagendra, 2014). Close-by unused lands and parks were the areas most frequented for foraging. Parks were a popular site to forage for fruits, berries, mushrooms and greens in metropolitan cities as was also seen in studies from other parts of the world like Berlin and Seattle (Hurley and Emery, 2018; Landor-Yamagata et al., 2018). Fragmented open lands in urban areas are also sites of collection in New Zealand (Wehi and Wehi, 2010), where proximity of the foraging area plays a key role.

Studies from Africa and the USA show that foragers living close to the periphery of the city tend to forage more than those living in the more urbanised parts of the city (Schlesinger et al., 2015; Mollee et al., 2017; Garekae and Shackleton, 2020b). Similar trends were observed in our study. Residents of Talaghattapura, our least urbanised site, had the highest number of foragers. Access to fragmented pieces of unused land, nearby forested area and the distance from the nearby market could be the reasons behind this observed trend. Fewer foragers were reported from Ulsoor and Banashankari.

Rapidly shrinking access to public spaces seems to be the major barriers preventing the urban residents from utilizing the green spaces for foraging (Nagendra et al., 2012; Kujawska and Łuczaj, 2015). This was reflected in the responses, where respondents cited lack of access to open spaces as the second biggest barrier to foraging. In per-urban areas, lack of access was cited as the biggest barrier to foraging, while in the most urbanized areas, lack of knowledge and lack of interest were cited as the biggest barriers. It is likely that foraging has recently decreased in the peri-urban areas as built-up areas in these regions have increased with the expansion of the city, therefore lack of access to previously accessible sites was the biggest reason. In contrast, it is likely that foraging has not been prevalent for a long time in the most urbanized sites probably due to a lack of open, unmonitored spaces where people can forage. This could have lead to a decrease in the knowledge of wild plants and a lack of interest, making them the biggest barriers to foraging. Local knowledge about the ecosystem is created and nurtured through the relationship that people have with nature and each other (IPBES, 2019). With decrease in foraging, the local knowledge in the system also gets eroded (McDaniel and Alley, 2005).

While there was a significant difference in foraging across the four sites, there was no significant difference in buying foraged species across the four sites. This indicates that there is a market and demand for foraged species in Bengaluru, and it is likely that the species are being foraged from the peri-urban areas. In other urban areas wild weedy plants have been commoditised and are easily available in local markets (Ladio and Molares, 2013). Studies from Africa report that urban residents also have access to local markets that sell wild foods and do not have to gather them (Sneyd, 2013). Time constraints and the price of substitutes also control the consumption of wild plants in countries like Thailand, increasing pressure on the neighbouring rural areas (Cruz-Garcia and Price, 2014). Further research needs to be conducted into the markets for foraged species and the supply and demand networks fuelling these markets in Bengaluru.

In many cities, urban foragers are considered a nuisance and collecting activities are not welcome by policy makers (Shackleton et al.,

Table 3
Seven reasons for not collecting foraged species across the four study sites and sample statements from interviews illustrating these reasons.

Reasons for not collecting	Sample statements	Total Percent response (%) (N = 166)	Talaghattapura (N = 30)	Siddhapura (N = 37)	Banashankari (N = 50)	Ulsoor (N = 49)	Pearson's Chi-Square test
Lack of knowledge	*"My mother in law used to collect, I am not very good at identifying them." "Species that I am familiar with do not grow here" I am a Mason I do not know anything about foraged species. We buy everything we need from the market there we do not have to collect anything." "Our family is not used to eating collected plants. I don't know how to cook it." "I have never heard of the plants you mentioned so I believe that our family does not use any of these." "There is no place to collect here. People who sell it tend to mix plants that are not edible. I do not prefer buying also"*	66 %	47 %	49 %	80 %	78 %	chi-squared = 44.72, df = 3, p = 1.06×10^{-9} *
Lack of access	*I used to collect species growing near of parks and in open areas 8 years ago. There aren't any open spaces to collect anymore." "I am concerned about the places from which the species sold are collected. It would be nicer if we had some place to collect by ourselves."*	55 %	68 %	84 %	38 %	55 %	chi-squared = 13.6, df = 3, p-value = 0.003*
Not interested	*"I prefer species that grow in Ragi fields and I do not collect them from open spaces." "We don't collect often because we grow the vegetables we need." "We have never used them."*	46 %	32 %	32 %	48 %	57 %	chi-squared = 15.13, df = 3, p-value = 0.0017*
Health concerns	*"I do not use any foraged species because consuming some of them will cause diseases like jaundice." "Open spaces are very dirty and the plants growing in these spaces are also very dirty." "People use open spaces as a toilet and the species that grow there should not be used."*	28 %	46 %	54 %	20 %	16 %	chi-squared = 10.052, df = 3, p-value = 0.018
No time to collect	*"We are busy and there is absolutely no time for such activities. We buy whatever is available in the supermarket"*	13 %	24 %	24 %	2%	2%	chi-squared = 17.3, df = 3, p-value = 0.0006*
Negative experiences	*"I do not buy any because they taste bitter."*	9%	11 %	14 %		6%	ch-squared = 5.1, df = 3, p-value = 0.16
Beliefs	*"We do not collect or buy any green leafy vegetables because it aggravates wheezing."*	4%	0%	0%	10 %	4%	ch-squared = 9.5, df = 3, p-value = 0.02

2017). At the same time, the idea of "Edible Cities" is emerging, suggesting that sustainable cities are those where the availability of forageable species is high, thereby localising food production in the city (Sartison and Artmann, 2020). For instance Havana has become an outstanding example of a sustainable city supported by urban agriculture (Anguelovski, 2013). In the Edible District of Friedrichshain in Germany, edible native species were integrated into the urban landscape, which has improved the biodiversity of the city while providing food for the residents (Hajzeri and Kwadwo, 2019). Research of the kind we have conducted shows the importance of redesigning urban green spaces to create spaces for wild plants and spontaneous weedy vegetation to flourish, moving away from the current emphasis on ornamental plants and landscaping. Such an approach can help restore the frayed connections between people and nature in urban settings, and improve mental and physical health of urban foragers. By providing nutritional supplementation and fulfilling traditional cultural needs, it can significantly improve the quality of life of marginalised urban residents, especially women, and members of social disadvantaged groups, who are often important repositories of traditional knowledge but whose insight and knowledge is rarely taken into consideration by planners.

5. Conclusion

We demonstrate that foraging is prevalent in metropolises like Bengaluru. The foragers generally belong to lower social and economic backgrounds, are largely women, and are most vulnerable to land use changes, gentrification and pollution due to urbanization. Loss of knowledge and lack of access to sites with forageable resources were the constraints to foraging. Providing the required access to spaces to support continued foraging is important for wellbeing of marginalized communities, and to help promote the transfer of knowledge of wild plant foraging and use from these communities to other urban residents. Future research needs to focus on understanding the ecology of the spaces that are providing these services, to identify the plant traits and characteristics of foraged plants, and monitor the changes in vegetation due to urbanisation to promote more informed policy.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Name:
Contact info (in case you want to go back)
Age
Gender
Occupation/ employment types/ sources of income
Annual household income
Where are you from? How long have you been living here?
What is your religion and caste?
(Religion/caste)
Do you collect any wild plants?
If yes, why do you collect them?
Where do you collect them from?
If no, why do you not collect them?
Would you like to collect them?
If yes, what is preventing you from collecting them?
If no, why not?
Do you forage for edible or medicinal wild plants?

Yes
- Where?
- What do you forage for and when?
- Where did you learn this skill from?have you passed it down or shared with others?
- How often do you forage and how much?
- How has the change in land use altered the species abundance and distribution?
- Are these wild plants better? Are you aware of any medicinal or cultural benefits of the plants you collect?
- Does foraging have any economic benefits in your household?
- Since there is a demand for edible greens do you collect to sell these products?(if yes, does it add to your family income.if no, why?)

No
- Why?
- Do you have the skills required and the access to spaces?
- Did you forage in the past?
- Would you like to forage?
- If you have skills have you passed it down to others?
- If you were foraging in the past,what are the substitute? How has this impacted the daily expenditure of your family?

Knowledge of wild plants
When do you collect the plants?
Why do you collect them at this time?
When is a good time for collecting the plants?
Why is this time good?
When does it flower?
When does it fruit?
How do you know about this information?

Appendix B

The species of plant collected in each site, the habit of the species, the parts collected and their uses are given for each of the four sites surveyed.

Appendix C

The species of plant bought in each site, the habit of the species, the

Serial number	Scientific name	Local name	Habit	Parts used	Use	Surveyed sites			
						Talaghatapura	Banashankari	Siddhapura	Ulsoor
1	Acalypha indica L.	Kuppegida	Herb	Leaves	Food, Medicine	×	×	✓	×
2	Alternanthera pungens Kunth	Mullu honagone	Herb	Leaves	Food	✓	×	×	×
3	Alternanthera sessilis (L.) R. Br. ex DC.	Honagone soppu	Herb	Leaves	Food, Medicine	✓	✓	✓	✓
4	Alternanthera trigyna L	Honagone soppu	Herb	Leaves	Food	✓	×	✓	×
5	Amaranthus spinosus L.	Harive,mullu harive	Herb	Leaves	Food	✓	×	×	×
6	Amaranthus tricolor L.	Chikka harive soppu	Herb	Leaves	Food	✓	×	✓	×
7	Amaranthus viridis L.	Chelakeerae/kilkeere soppu	Herb	Leaves	Food	✓	×	✓	×
8	Andrographis paniculata (Burm.f.) Nees	Nelabevu	Herb	Leaves	Medicine	✓	×	×	×
9	Boerhavia diffusa L.	Aadukudkun soppu,Punarnava	Herb	Leaves	Food, Medicine	✓	×	✓	×
10	Celosia argentea var. argentea	Anne soppu	Herb	Leaves	Food, Medicine, Cultural	✓	×	✓	×
11	Centella asiatica (L.) Urb	Ondelaga soppu,Brahmi soppu,Illikivi soppu	Herb	Leaves	Food	✓	×	✓	✓
12	Chenopodium giganteum D.Don	Naati chakota	Herb	Leaves	Food	✓	×	×	×
13	Cleome monophylla L.	Kolikalu soppu	Herb	Leaves	Food	×	×	✓	×
14	Commelina benghalensis L	Kanne soppu	Herb	Leaves	Food	✓	×	✓	×
15	Cyanotis cristata (L.) D.Don	Kanne soppu	Herb	Leaves	Food	✓	×	✓	×
16	Digera muricata (L.) Mart.	Kancali soppu,Arkberike soppu	Herb	Leaves	Food	✓	×	×	×
17	Eclipta prostrata (L.) L.	Gargesoppu,Bhirngaraja	Herb	Leaves, Flowers	Food, Medicine	×	×	✓	×
18	Euphorbia heterophylla L.	Halsoppu,Beedi soppu	Herb	Leaves	Food	×	×	✓	×
19	Euphorbia hirta L	Halsoppu,Akke gida	Herb	Leaves	Food	×	×	✓	×
20	Glossocardia bosvallia (L.f.) DC	Kadu sabsige soppu	Herb	Leaves	Food	×	×	✓	×
21	Leucas aspera (Willd.) Link	Thumbe soppu	Herb	Leaves	Food,Cultural, Medicine	✓	✓	✓	×
22	Lycopersicon esculentum Mill	Tomato	Herb	Fruits	Food	✓	×	✓	×
23	Mimosa pudica L.	Muttidare muni	Herb	Leaves	Food,Cultural	✓	×	✓	×
24	Ocimum tenuiflorum L.	Tulsi	Herb	Leaves	Cultural, Medicine	✓	×	×	×
25	Oxalis corniculata L.	Hulisoppu	Herb	Leaves	Food	✓	✓	✓	✓
26	Oxalis latifolia Kunth	Dodda hulisoppu	Herb	Leaves	Food	✓	✓	✓	×
27	Phyllanthus amarus Schumach. & Thonn.	Nela nelli kai,Jaundice soppu	Herb	Leaves	Food	✓	×	✓	×
28	Phyllanthus fraternus G.L.Webster	Nela nelli kai,Jaundice soppu	Herb	Leaves	Food	✓	×	✓	×
29	Plectranthus amboinicus (Lour.) Spreng.	Doddapathre	Herb	Leaves	Food,Medicine	✓	✓	✓	×
30	Portulaca oleracea L.Doddagoni soppu, Goli soppu		Herb	Leaves,Flowers	Food	✓	×	✓	×
31	Senna tora (L.) Roxb.	Thagache,Thangadi	Herb	Leaves	Food	×	×	✓	×
32	Solanum americanum Mill.	Kashi soppu,Ganike soppu	Herb	Leaves,Fruit	Food,Medicine	✓	×	✓	×
33	Solanum viarum Dunal	Nati Badanekai	Herb	Leaves	Food	✓	×	×	×
34	Sonchus oleraceus L.	Halmulangi soppu	Herb	Leaves	Food	✓	×	✓	×
35	Trianthema portulacastrum L.	Gonni soppu	Herb	Leaves	Food	✓	×	✓	×
36	Tribulus terrestris L.	Anne neggele mullu, Mullu soppu	Herb	Leaves	Food	✓	×	✓	×
37	Argemone mexicana L.	Daturi gida	Shrub	Root	Medicine	✓	×	✓	×
38	Bambusa bambos (L.) Voss	Bidiru kalale	Shrub	Stem	Food	✓	×	×	×
39	Barleria mysorensis B.Heyne ex Roth		Shrub	Leaves	Cultural	✓	×	×	×
40	Calotropis gigantea (L.) Dryand.	Ekkada gida	Shrub	Leaves, flowers	Cultural	✓	×	✓	×
41	Chenopodium giganteum D.Don	Naati chakota	Shrub	Leaves	Food	✓	×	×	×
42	Dodonaea viscosa Jacq.	Bandaru,Andru soppu	Shrub	Leaves	Medicine	✓	×	×	×
43	Helicteres isora L.	Edamuri gida	Shrub	Flowers, Fruits	Cultural	✓	×	×	×
44	Lantana camara L.	Cheddi	Shrub	Leaves	Medicine	✓	×	×	×
45	Ocimum basilicum L.	Kamakastoori, Kagarle	Shrub	Leaves	Cultural	✓	×	×	×
46	Senna occidentalis (L.)Link	Kola thagache	Shrub	Leaves,Flowers, Seeds	Medicine, Cultural	✓	×	×	×
47	Sida acuta Burm.f.	Kaddi gida	Shrub	Whole plant	Cultural	✓	×	×	×
48	Solanum erianthum D. Don	Chowgdangi soppu	Shrub	Leaves	Medicine	✓	×	×	×
49	Solanum rudepannum Dunal	Sundekkayi	Shrub	Fruit	Food	✓	×	×	×
50	Basella alba L.	Basale,Bachale	Climber	Leaves	Food	✓	×	✓	×
51	Coccinia grandis (L.) Voigt	Thondesoppu	Climber	Leaves	Food	✓	×	✓	×
52	Cardiospermum halicacabum L.	Budde gida	Climber	Leaves	Food				

(*continued on next page*)

(*continued*)

53	Cocculus hirsutus (L.) W.Theob.	Jagadisoppu,Dagadiballi	Climber	Leaves	Food, Medicine	✓	×	×	×
54	Cucurbita maxima Duchesne	Kumbla soppu, Kumbla kai	Climber	Leaves,fruit	Food	✓	×	×	×
55	Dioscorea esculenta (Lour.) Burkill	Mullu genasu	Climber	Root	Food	✓	×	×	×
56	Ipomoea batatas (L.) Lam.	Genasu	Climber	Root	Food	✓	×	×	×
57	Ipomoea staphylina Roemer & Schultes	Ugniumboo	Climber	Flowers	Flowers	✓	×	×	×
58	Lagenaria siceraria (Molina) Standl.	Huchsorekai,Kaadusorekai	Climber	Fruit	Cultural	✓	×	×	×
59	Luffa sp.	Thuppadeerekai	Climber	Fruit	Food	✓	×	×	×
60	Momordica charantia L.	Hagalakai	Climber	Fruit	Food	✓	×	×	×
61	Tylophora indica (Burm. f.) Merr	Adumutadaballi	Climber	Leaves	Medicine	✓	×	×	×
62	Passiflora foetida L.		Climbing shrub	Fruit	Food	✓	×	×	×
63	Ziziphus oenopolia (L.) Mill	Choorihannu	Climbing shrub	Fruit	Food	✓	×	×	×
64	Acacia caesia (L.) Willd	Seegesoppu	Liana	Leaves	Food	✓	×	×	×
65	Alangium salviifolium (L.f.) Wangerin	Ankole mara	Tree	Leaves, Fruit	Food, Cultural	✓	×	×	×
66	Azadirachta indica A.Juss.	Bevina mara	Tree	Leaves	Medicine, Cultural	✓	✓	✓	×
67	Euphorbia tirucalli L.	Halgalli,Kalli mara	Tree	Leaves, Stem	Cultural	✓	×	×	×
68	Limonia acidissima Groff.	Belada mara	Tree	Fruit	Food	✓	×	×	×
69	Moringa oleifera Lam.	Nuggekai	Tree	Leaves, Fruit	Food	✓	×	✓	×
70	Phyllanthus acidus (L.) Skeels	Kir nellikai	Tree	Fruit	Food	✓	×	×	×
71	Phyllanthus emblica L.	Bettada nellikai	Tree	Fruit	Food, Medicine	✓	×	×	×
72	Pithecellobium dulce (Roxb.) Benth.	Kaduhunase	Tree	Fruit	Food	✓	×	×	×
73	Psidium guajava L.	Chepehannu,Seebehannu	Tree	Leaves, Fruit	Food	✓	×	×	×
74	Senna surattensis (Burm.f.)	Adavi thangadi	Tree	Leaves, Flowers	Medicine, Cultural	×	×	×	
75	Sesbania grandiflora (L.) Pers.	Agase	Tree	Leaves, Flowers	Food	✓	×	×	×
76	Tamarindus indica L	Hunase soppu	Tree	Leaves, Fruit	Food	✓	×	✓	×

						Plant species bought			
Serial number	Scientific name	Local name	Habit	Parts used	Uses	Talghattapura	Banashankari	Siddhapura	Ulsoor
1	Alternanthera sessilis (L.) R. Br. ex DC.	Honagone soppu	Herb	Leaves	Food, Medicine	✓	✓	✓	✓
2	Amaranthus tricolor L.	Chikka harive soppu	Herb	Leaves	Food	✓	✓	✓	✓
3	Amaranthus viridis L.	Chelakeerae/kilkeere soppu	Herb	Leaves	Food	✓	✓	✓	×
4	Celosia argentea var. argentea	Anne soppu	Herb	Leaves	Food, Medicine, Cultural	✓	✓	✓	×
5	Centella asiatica (L.) Urb	Ondelaga soppu,Brahmi soppu,Illikivi soppu	Herb	Leaves	Food	✓	✓	✓	✓
6	Chenopodium giganteum D.Don	Naati chakota	Herb	Leaves	Food	✓	✓	×	×
7	Commelina benghalensis L	Kanne soppu	Herb	Leaves	Food	✓	✓	✓	×
8	Cyanotis cristata (L.) D.Don	Kanne soppu	Herb	Leaves	Food	✓	✓	×	×
9	Digera muricata (L.) Mart.	Kancali soppu,Arkberike soppu	Herb	Leaves	Food	✓	✓	×	×
10	Eclipta prostrata (L.) L.	Gargesoppu,Bhirngaraja	Herb	Leaves,Flowers	Food, Medicine	×	✓	×	×
11	Ocimum tenuiflorum L.	Tulsi	Herb	Leaves	Cultural, Medicine	✓	✓	✓	✓
12	Oxalis corniculata L.	Hulisoppu	Herb	Leaves	Food	×	✓	✓	×
13	Oxalis latifolia Kunth	Dodda hulisoppu	Herb	Leaves	Food	×	✓	✓	×
14	Portulaca oleracea L.Doddagoni soppu, Goli soppu		Herb	Leaves,Flowers	Food	✓	✓	✓	✓
15	Senna tora (L.) Roxb.	Thagache,Thangadi	Herb	Leaves	Food	×	✓	×	×
16	Solanum americanum Mill.	Kashi soppu,Ganike soppu	Herb	Leaves,Fruit	Food	✓	✓	✓	✓
18	Trianthema portulacastrum L.	Gonni soppu	Herb	Leaves	Food	✓	✓	✓	×
19	Calotropis gigantea (L.) Dryand.	Ekkada gida	Shrub	Leaves,flowers	Cultural	×	✓	×	✓
20	Ocimum basilicum L.	Kamakastoori, Kagarle	Shrub	Leaves	Cultural	×	✓	×	×
21	Solanum rudepannum Dunal	Sundekkayi	Shrub	Fruit	Food	✓	✓	✓	×
22	Basella alba L.	Basale,Bachale	Climber	Leaves	Food	✓	✓	✓	✓
23	Cardiospermum halicacabum L.	Budde gida	Climber	Leaves	Food	✓	✓	×	✓
24	Coccinia grandis (L.) Voigt	Thondesoppu	Climber	Leaves	Food	×	✓	×	×
25	Cucurbita maxima Duchesne	Kumbla soppu, Kumbla kai	Climber	Leaves,Fruit	Food	✓	✓	×	×
26	Ipomoea staphylina Roemer & Schultes	Ugniumboo	Climber	Flowers	Cultural	×	✓	×	×

(*continued on next page*)

(*continued*)

27	Momordica charantia L.	Hagalakai	Climber	Fruit	Food	✓	✓	✓	✓	✓
28	Azadirachta indica A.Juss.	Bevina mara	Tree	Leaves	Medicine Cultural	✓	✓	✓	✓	✓
29	Delonix elata (L.) Gamble	Vayunarayani soppu	Tree	Leaves	Food	×	✓	×	×	×
30	Limonia acidissima Groff.	Belada mara	Tree	Fruit	Food	✓	✓	×	×	×
31	Moringa oleifera Lam.	Nuggekai	Tree	Leaves,Fruit	Food	✓	✓	✓	✓	✓
32	Phyllanthus acidus (L.) Skeels	Kir nellikai	Tree	Fruit	Food	✓	✓	×	×	×
33	Phyllanthus emblica L.	Bettada nellikai	Tree	Fruit	Food	✓	✓	×	×	✓
34	Sesbania grandiflora (L.) Pers	Agase soppu	Tree	Leaves,Flowers	Food	✓	✓	✓	✓	✓

parts collected and their uses are given for each of the four sites surveyed.

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