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Research Paper

Governance for private green spaces in a growing Indian city

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HIGHLIGHTS

- We found an overall decline in floristic elements of homegardens.
- For low-income households, value of homegarden products has decreased by one-third.
- Despite decline, homegardens are still an active source of livelihood.
- Floristic structure of small landholders' homegardens has tilted toward food items.
- We give suggestions to create possible mechanisms to manage and conserve homegardens.

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ABSTRACT

Urban green spaces are relatively scarce in developing countries, and such countries face challenges related to urban sustainability in view of rapid urbanization in the post-economicliberalization era. Although private green spaces constitute the core of urban sustainability, they have received far less attention compared to urban green spaces under the public domain. We studied the change in the homegardens (a form of private green space with multistoried vegetation that abounds in the tropical regions) in the city of Kozhikode, Kerala, India. We assessed the dynamics of homegardens from 2000 to 2010 based on household socio-economic characteristics. The study reveals a decline of 11.5% in the cultivated plants in homegardens, reflecting the loss of urban sustainability. The floristic structure of small landholdings has tilted toward food items—an indication of contribution of homegardens in complementing livelihood sustainability. After examining existing and possible policy mechanisms, we propose local community participation under the auspices of decentralized governance, which has now evolved as a major policy tool to achieve environmental sustainability in developing countries, for promotion and conservation of private green spaces.

1. Introduction

Trees and forests in the urban and peri-urban environment in developing countries and transitional economies are rarely taken into account at policy and decision-making fora (Merzthal, Mecklenburg, & Gauthier, 2009). However, policy interventions at various administrative levels to promote and conserve these resources in urban areas—urban green spaces in urban studies parlance—are crucial to realize urban sustainability. In fact, the social demand for urban green spaces is increasing as a result of rapid urbanization (Choumert & Salanie, 2008), and hence, maintaining the quantity and quality of urban green spaces is a pressing global challenge (Fuller & Gaston, 2009). This challenge is especially relevant for a highly populated and rapidly growing economy, such as India's, which is characterized by rapid urbanization rates and fewer green spaces compared to European and even many other Asian countries (Kuchelmeister, 1998).

The contribution of green spaces covered with trees, shrubs and ground vegetation to improving the urban micro-climate and other ecosystem services is well documented (Georgi & Dimitriou, 2010; Givoni, 1991; Miyawaki, 1998). Urban green spaces also enrich urban communities esthetically, add to recreational opportunities (Attwell, 2000; Konijnendijk, Ricard, Kenney, & Randrup, 2006), and may offer health benefits for residents (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006). Studies also show that urban green spaces contribute to economic benefits (Konijnendijk et al., 2006; Smardon, 1988). Green spaces further reinforce the process of carbon sequestration in urban areas and may help mitigate the adverse effects of climate change (Escobedo, Varela, Zhao, Wagner, & Zipperer, 2010; Liu & Li, 2011). Sustainable development calls for a convergence of economic development,

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social equity and environmental protection (Drexhage & Murphy, 2010). The above studies indicate that urban green spaces contribute immensely to urban sustainability. The term 'urban sustainability' in our study context implies that urban green spaces provide social, ecological and economic benefits which contribute to the increase in liveability, equity and sustainability in cities (Cilliers, 2010).

Many previous studies have documented the multifaceted non-marketable and marketable values of urban green spaces in an urban sustainability context. We, however, found that urban centers in developed countries constitute the context of most of these studies. The few studies on developing countries cover a relatively small, selected segment of the urban landscapes, such as Bangalore (Gowda & Sridhara, 2008; Nagendra & Gopal, 2010; Sudha & Ravindranath, 2000) and Chennai (Sundaram, 2011) in India, Bangkok in Thailand (Thaiutsa, Puangchit, Kjelgren, & Arunpraparuta, 2008), Beijing (Xu, Duan, Sun, & Sun, 2011) and Kunming (Wei & Lin-sen, 2007) in China, Bujumdura in Burundi (Bigirimana, Bogaert, de Cannière, Bigendako, & Parmentier, 2012), Mombasa in Kenya (Kithiia & Lyth, 2011), Leon in Nicaragua (Gonzalez-Garcia & Sal, 2008). This skewed spatial distribution of studies on urban green spaces is indicative of the sparse policy and program initiatives to promote them. In any case, there is a clear need to evaluate the potential of a variety of urban landscapes in developing countries, which are relatively unexplored, to better understand the reality in these countries. The Indian urban landscape context, which is experiencing substantial changes in the post-economic reform era since 1991, provides this research opportunity.

In general, green spaces in urban areas fall into two categories based on ownership: private green spaces (viz., private or domestic gardens, backyards, and homegardens) and public green spaces (viz., public gardens, national parks, sanctuaries, forest reserves). Although many studies focus on public green spaces, relatively fewer studies (see, for example, Barbosa et al., 2007; Colding, Lundberg, & Folke, 2006; Gonzalez-Garcia & Sal, 2008; Grove et al., 2006; Lubbe, Siebert, & Cilliers, 2010; Troy, Grove, O'Neil-Dunne, Pickett, & Cadenasso, 2007) center on private green spaces. The few studies on private green spaces mostly focus on the multi-dimensional social characteristics of households and their implications on vegetation (Grove et al., 2006), opportunities for greening and vegetation patterns using high resolution spatial data (Troy et al., 2007), the distribution of and benefits from access to private garden spaces (Barbosa et al., 2007) and co-management designs in urban landscapes including private gardens (Colding et al., 2006). However, as noted before, these few studies are largely in the context of developed countries. Based on literature review, Lubbe et al. (2010) highlights the lack of urban ecological research in developing countries and state that the findings on private green spaces from developed and developing countries do not always correspond.

To our knowledge, there is no literature describing the various characteristics and condition of private green spaces in urban areas from India. "Homegardens", multistoried vegetation structures comprising trees, shrubs and climbers that provide multiple utilities, however, constitute the predominant form of private urban and peri-urban green spaces in most parts of India. The term homegarden has become more prevalent in the discourse on sustainable land use practices especially in the rural environment. Homegardens are considered one of the most important multifunctional land use systems in the managed ecosystems of the tropics and often intended for fulfilling subsistence needs (Kumar & Nair, 2006). Although some authors employed the term 'domestic garden' to define private green spaces in urban areas (Bigirimana et al., 2012; Loram, Tratalos, Warren, & Gaston, 2007; Lubbe et al., 2010; Smith, Thompson, Hodgson, Warren, & Gaston, 2006), we have purposely used the term 'homegardens' that generally connote private green spaces in rural areas (Kumar & Nair, 2006; Rugalema, Okting'Ati, & Johnsen, 1994). With the "emergence of homegardening as a practice outside their traditional habitat into urban and commercial settings" (Nair & Kumar, 2006, p. 2), we feel that this is justifiable.

We articulate one emerging concern in the post-economic reform era in India. It is a challenge to keep hold of green spaces, in both the private and public domain. This is primarily because there is unprecedented pressure to alter the scarce land resources for expanding infrastructure, business centers and housing, particularly in urban centers with high population density. It can be hypothesized that the incentive for urban dwellers to alter their private landholding in a way that substitutes green spaces for built-up area is increasing as such development is economically more beneficial to them. In general, greenery and its conservation, which once played a central role in the Indian culture (Kerr & Swarup, 1997), may be undergoing a perceptible change in recent years. In short, the consequences of rapid urbanization for green spaces are unclear in India, as in most developing countries.

We assessed the dynamics of private green spaces and evaluated them vis-à-vis multi-dimensional socio-economic characteristics of the households from 2000 to 2010. We undertook a household sample survey in the city of Kozhikode located in the state of Kerala in India. We asked: (i) What are the characteristics of cultivated plants in homegardens? How great is the diversity when we divide our sample of homegardens into subgroups by income and landholding? (ii) What are the changes that have taken place with respect to homegardens from 2000 to 2010? What is the relation between the change in the structure of homegardens and the profile of a household?

2. Study context

The study was conducted in the city of Kozhikode (erstwhile Calicut; 11°15′ N; 75°49′ E) in the state of Kerala. Kerala has a tropical climate, and therefore has extensive vegetation cover (Forest Survey of India, 2011); homegardens are a pervasive land use system in the state. There are about 5.4 million small homegardens, mostly less than 0.5 ha, in Kerala (KSLUB, 1995). In a typical homegarden, there are intimate, multistory combinations of various trees and crops, sometimes in association with domestic animals (Kumar & Nair, 2004), and they combine ecological and socioeconomic sustainability (Peyre, Guidal, Wiersum, & Bongers, 2006). The tropical homegardens of Kerala are one of the oldest forms of managed land-use systems, and they are considered to epitomize sustainability (Kumar & Nair, 2004).

Although homegardens are millennia-old components of the rural landscape in Kerala (Kumar & Nair, 2004), they are also found in the urban landscape in small-scale and varied forms. The presence of homegardens in urban areas can be attributed to the historical evolution of Kerala as a rural–urban continuum (Oommen, 2007). Despite Kerala's relatively high population density (859 persons/km^2 in 2011) and growing urbanization, homegardens still exist in urban areas. The growing urbanization in Kerala is evident; the state's urban population increased by 84% between 2001 and 2011, whereas the urban population of the entire nation increased only by 12% during the same period (Census of India, 2001, 2011). There is also a concern about the recent drop (24 km^2) in Kerala's forest cover (Forest Survey of India, 2011). Homegardens, which are important constituents of trees outside forests in Kerala, may help to improve the tree cover in the state if they are promoted.

Kozhikode city, the focus of our study, evolved gradually over more than a hundred and fifty years from a small rural community to its present status as a modern city. Kozhikode became a

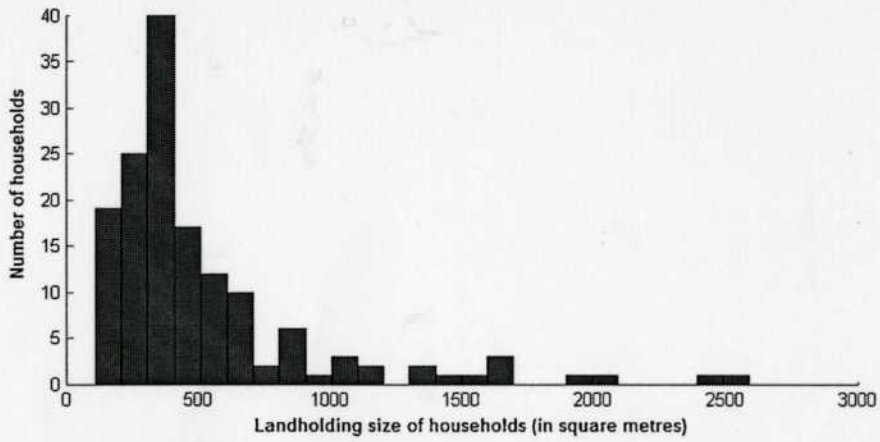

Fig. 1. Histogram of landholding size of sample households ($N = 148$)[a] in Kozhikode, Kerala. [a]Information on landholding size is missing for two households.

municipality in 1866 and over the years, Kozhikode has expanded both in terms of geographical area (Kozhikode District Administration, 2013) and population (Census of India, 2011). The Kozhikode Urban Agglomeration, with a population of more than 2 million, ranks 19th among the urban agglomerations of India (ibid.). Hence, we can postulate that Kozhikode is largely representative of an expanding Indian urban agglomeration with pan-tropical relevance, given its location in the hot and humid tropical zone.

Kozhikode city is located along the seashore. Kozhikode has lowlands and midlands dotted with small hills and a network of canals, estuaries and wetlands. The city experiences a mean annual precipitation of 3084 mm and annual mean daily minimum and maximum temperature of 24.1 °C and 31.1 °C, respectively (IMD, undated), which are conducive for growing an array of crops.

3. Survey and methods

From the various localities of Kozhikode under the Kozhikode Municipal Corporation (which is divided into 75 wards), we selected three localities for this study: Ashokapuram (Ward no. 63), Govindapuram (Ward nos. 28 and 30) and West Hill (Ward no. 72). The selection was based on the distance of these localities from Mananchira Square, the center of Kozhikode and the principal hub of economic activity. Ashokapuram is located approximately 750 m to the north of Mananchira Square; Govindapuram is situated 2.5 km to the north-east of Mananchira Square; and West Hill is located 4.5 km to the north-west of Mananchira Square. Ashokapuram and West Hill have approximately 1700 households each, whereas Govindapuram has approximately 3600 households. There is no significant difference among these three localities in terms of aggregate socioeconomic indicators, which is in contrast to the studies conducted in other developing countries (e.g., Bernholt, Kehlenbeck, Gebauer, & Buerkert, 2009; Lubbe et al., 2010). Sample households in Ashokapuram, being close to the center of Kozhikode, have marginally higher incomes and marginally lower landholding sizes compared to sample households in West Hill and Govindapuram. A sample of 50 households was chosen from each of these three localities. We selected the households in a randomized manner. In our sample, we included only those households who have stayed in the same house continuously for the past ten years. This condition was adopted to analyze the temporal changes in homegardens during 2000–2010. We conducted a preliminary survey with five households in each locality to pre-test the structured questionnaire. To negate information bias during the collection process, we employed the services of a native and professional field investigator.

The eldest available person of a particular sample household was interviewed. Using these interviews, we collected manifold information about each household, including the demographic details concerning the household, economic conditions of the household, land utilization pattern of the homegardens, income from the homegardens, utilization of the homegarden produce, and aspects relating to homegarden management. Information regarding plants in the homegardens was recorded by the field investigator on the basis of actual observation. Data pertaining to the present period of time (2010) were gathered, in addition to a recollection of the same variables as they were ten years ago (2000). The research interest demanded a comparison of outcomes and events from two different periods of time for a meaningful evaluation of the trends over time. Nevertheless, there was no other way to collect past information other than relying upon the recollections of respondents. A cursory look may suggest the possibility of a recall bias, a potential limitation of our study and a point which has been discussed in Section 4.

We classified the cultivated plants (i.e., we excluded the weeds) into three categories: trees (woody plants more than 2 m in height), shrubs (woody plants less than 2 m in height), and herbaceous crops. The plants were further divided into seven utilization categories: multipurpose plants, timber, fruit, vegetable, spice, medicine and other (including ornamental plants). These categorizations, which were based on use, were employed to analyze the structure of homegardens. The multipurpose plants category includes plant species that provide various outputs, such as timber, fuel wood, fruit, nuts, medicine and fodder. We measured the diversity of the plants using the Shannon index (Shannon, 1948).

Our assessment of private green spaces was founded upon the change in monetary benefits derived from this space and/or quality of this space in terms of decline in vegetation characteristics. We calculated the monetary value of homegarden products, consumed at the household level and/or sold by the household in the market, from all three categories of vegetation. While comparing the temporal changes (2000 vs. 2010) in the monetary value of a homegarden, we adjusted for inflation. To be precise, the change in monetary value was calculated by subtracting the inflation adjusted monetary value of homegarden products in 2000 from the monetary value of homegarden products in 2010. Furthermore, while calculating this monetary value, we considered marketable homegarden products and excluded any non-marketable homegarden ecosystem services, as these are beyond the scope of our study. The data were analyzed by sub-dividing the sampled households into three categories based on the size of landholdings (small, medium and large, see Table 2) and annual income levels (low, medium and

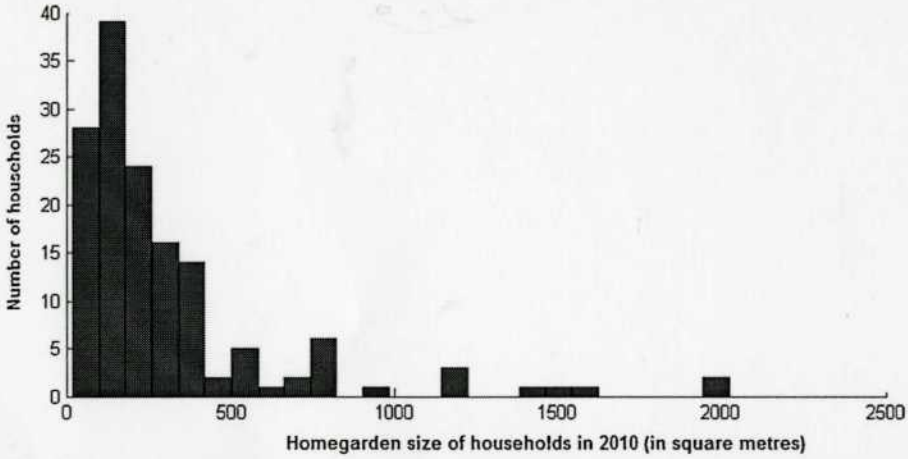

Fig. 2. Histogram of homegarden size of sample households ($N = 148$)[a] in Kozhikode, Kerala. [a]Information on homegarden size is missing for two households.

high, see Table 3). The frequency distribution of landholdings and homegardens in 2010 is shown in Figs. 1 and 2, respectively.

We specifically collected information on garden size for each sample household. We gathered data from the sample households on the weekly hours spent on five homegarden activities: pruning plants, making trenches around trees, using fertilizers, using household organic waste and maintaining the homegardens. We also queried the reasons for change in the number of plants in the homegardens in the sample households. For the statistical tools, we used regression (ordinary least squares) and descriptive statistics.

We employed a regression framework, in which homegarden activities are contingent on household characteristics. The equation is as follows:

$$y_{it} = b \cdot x_{it} + e_{it} \quad (1)$$

where y_{it} is the amount of homegarden activity and x_{it} is the vector of household characteristics for the ith household at the time period t. Moreover, e_{it} represents the error term in the regression. Data are available for 2000 and 2010. We calculate the differences in the variables between the two time periods. Therefore, we have:

$$Dy_i = y_{i,2010} - y_{i,2000} \quad \text{and} \quad Dx_i = x_{i,2010} - x_{i,2000}$$

Eq. (1) gives rise to the following equation:

(2) $Dy_i = b \cdot Dx_i + u_i$

The household characteristics which are constant over time, such as religion and location of the house, are canceled out in this process. We experimented with a few household characteristics as independent variables, such as number of household members, average age of adult members, income group to which the household belongs, number of female members, number of household members aged over 50 years and average years of education. Therefore, Dx_i represents the change in monetary value for each independent variable during 2000–2010. For example, the change in number of household members measures the difference in the number of members in a particular household between 2010 and 2000. The independent variable change in income assumes a value of 1 (−1) if a household moves up (down) one place in the income ladder. The dependent variable (Dy_i) is the change in the monetary value of the homegarden from 2000 to 2010.

4. Results: changing urban homegarden scenario

4.1. An overall perspective

We confirmed the loss of quality of homegardens through our survey in terms of the number of plants and monetary value of the homegarden products consumed and sold, from 2000 to 2010. Table 1 shows that the total number of trees, shrubs and climbers declined by 11.49% during this period. The decrease in total number of trees was 12.54%. These changes reflect the homegarden dynamics of the study location. Although there was only a marginal shrinkage (1.45%) in the average size of gardens (Table 1), the monetary value of the homegarden products consumed and sold has plummeted by more than 26%. The contribution of homegardens to urban households' food consumption has also declined. For instance, the mean proportion of homegarden contributions toward food expenses decreased from 7.29% in 2000 to 5.52% in 2010.

Coconut (*Cocos nucifera* L.), a multipurpose tree and essentially a cash crop, was the dominant plant component of the sampled homegardens (Table 1). With regard to changes in species preference of the households over time, there has been no change in the composition of homegardens over the past ten years. The top six plant species were the same in both 2000 and 2010, and their relative proportions were similar; however, their absolute numbers plummeted considerably between 2000 and 2010. Further, with regard to the use category, the homegardens of Kozhikode have remained somewhat stable from 2000 to 2010.

The species composition of the urban, private green spaces in Kozhikode also underwent some modest transformations. Two plant species, pathimuham (*Caesalpinia sappan* L.) and water melon (*Citrullus lanatus* (Thunb.) Mansf.), were absent from the entire sample. However, two plant species, bamboo (*Bambusa* spp.) and sugarcane (*Saccharum officinarum* L.), were added to the sample in 2010. The Shannon index (Table 1) implies that there is marginal movement toward a more diverse species structure.

Above findings raise a question about the robustness of the temporal comparisons in light of the possibility of recall bias, given that the magnitude of this bias increases over time. Hence, we confined the scope of this study to a span of ten years. It is more likely that a respondent would fail to report some vegetation in 2000 than to over-report it. Therefore, the true magnitude of the decline in homegardens from 2000 to 2010 is possibly larger than that has been reported. Furthermore, our sample constitutes only those households that include residents who lived in the same place from 2000 to 2010. If the sample had been completely random, the survey estimates would have been representative of the general population. Given our sample selection criterion, our results are likely to underestimate the true magnitude of the decline rather than inflate it (because of Kerala's booming construction sector in the post-economic liberalization era (Jeromi, 2005)). It is not uncommon for households to sell off their property to allow for the

Table 1
A comparative picture (2000 and 2010) of sample homegardens ($N = 150$) in Kozhikode, Kerala.

	2000	2010	Change (%)
Number of plant species	63	63	0
Total number of plants	4420	3912	−11.49
Number of tree species	34	34	0
Total number of trees	3490	3101	−12.54
Average landholding (in m^2)	533.78	533.78	0
Average size of homegarden (in m^2)	321.32	316.87	−1.45
Top plant species in numbers			
Coconut (*Cocos nucifera* L.)	1313 (29.71)[a]	1144 (29.24)[a]	−12.87
Plantain (*Musa* spp.)	851 (19.25)	695 (17.76)	−18.33
Areca nut (*Areca catechu* L.)	601 (13.60)	574 (14.67)	−4.49
Mango (*Mangifera indica* L.)	200 (4.52)	173 (4.42)	−13.50
Amaranth (*Amaranthus viridis* L.)	196 (4.43)	169 (4.32)	−13.78
Jackfruit (*Artocarpus heterophyllus* Lamk.)	132 (2.99)	119 (3.04)	−9.85
Shannon index (plants)	2.53	2.57	–
Shannon index (trees)	1.86	1.92	–
Use categories of plants			
Multipurpose[b]	2302 (52.08)[a]	2063 (52.74)[a]	−10.38
Timber	22 (0.50)	22 (0.56)	0.00
Fruit	1027(23.24)	871(22.26)	−15.19
Vegetable	807 (18.26)	683 (17.46)	−15.37
Spice	137 (3.10)	136 (3.48)	−0.73
Medicine	49 (1.11)	50 (1.28)	2.04
Others	76 (1.72)	87 (2.22)	14.47
Monetary value of homegarden products consumed and sold in market annually	3058 (in 2000 INR)	2960 (in 2010 INR)[c]	−26.66
Annual food expenditure	40,618 (in 2000 INR)	53,597 (in 2010 INR)	–
Mean proportion of contribution of homegarden toward food expenses (in %)	7.29	5.52	–

[a] Figures in the parenthesis indicate proportion of plants.
[b] Multipurpose category includes plant species providing various uses, such as timber, fuelwood, fruit, nut, medicine and fodder.
[c] US$ 1 = 45 Indian Rupees (INR) in 2010.

construction of high-rise apartments or commercial complexes. In such cases, the loss of private green space is expected to be far more than that in our sample of households. Because of our exclusion of such households from the sample, our estimate of the decline in homegardens, in fact, constitute a lower bound for the general population.

4.2. Landholding size and income level analysis

Temporal comparisons indicate that the percentage of decline in the number of plants during 2000–2010 was relatively higher for the small landholdings (Table 2) and that the lowest was for the large landholdings. Because of our sample selection criterion,

Table 2
Change in sample homegardens ($N = 148$)[a] by landholding size[b] in Kozhikode, Kerala.

	2000			2010		
	Small	Medium	Large	Small	Medium	Large
Number of households	39	71	38	39	71	38
Total number of plants	663	1736	1924	549	1516	1750
Change in number of plants during 2000–2010 (%)	–	–	–	−17.19	−12.67	−9.04
Shannon index	2.57	2.62	2.31	2.72	2.67	2.30
Total number of trees	507	1318	1566	393	1159	1451
Change in number of trees during 2000–2010 (%)	–	–	–	−22.49	−12.06	−7.34
Shannon index (trees)	1.95	1.93	1.70	2.10	1.99	1.74
Monetary value of homegarden products (INR in the respective years)[c]	1816	2550	5238	1420	2342	5637
Change in monetary value during 2000–2010 (%)	–	–	–	−40.76	−30.42	−18.48
Homegarden contribution to food expenses (average %)	6.82	7.17	12.96	3.34	4.94	10.44
Use categories (%)						
Multipurpose trees (coconut + areca nut)	51.73 (41.48)	49.25 (39.75)	54.63 (46.99)	42.81 (32.60)	50.07 (40.44)	57.88 (50.57)
Timber	0.45	0.58	0.45	0.55	0.66	0.49
Fruit	19.76	22.98	24.59	22.77	22.03	22.31
Vegetable	23.98	18.89	15.83	27.69	17.61	14.29
Spice	2.41	3.40	3.07	4.19	3.30	3.41
Medicine	0.90	1.50	0.84	1.09	1.78	0.92
Others	0.75	3.40	0.59	0.91	4.55	0.70

[a] Information on landholding size is missing for two households.
[b] In Kerala, lands are typically measured in a unit called cent, which is equal to 40 m^2. In view of the predominance of the relatively small-sized holdings in the study area, holdings less than or equal to 283.28 m^2 (less than or equal to 7 cents) were labeled small, those between 283.28 m^2 and 566.56 m^2 (between 7 and 14 cents) were labeled medium, and those more than 566.56 m^2 (more than 14 cents) were labeled large.
[c] US$ 1 = 45 Indian Rupees (INR) in 2010.

Table 3
Change in sample homegardens ($N = 150$) by income category[a] in Kozhikode, Kerala.

	2000			2010		
	Low income	Medium income	High income	Low income	Medium income	High income
Number of households	70	66	14	70	66	14
Total number of plants	1749	2284	387	1583	1987	342
Change in number of plants during 2000–2010 (%)	–	–	–	−9.49	−13.00	−11.63
Shannon index	2.55	2.41	2.55	2.59	2.45	2.53
Total number of trees	1345	1842	288	1218	1603	265
Change in number of trees during 2000–2010 (%)	–	–	–	−9.44	−12.98	−7.99
Shannon index (trees)	1.91	1.77	1.81	1.95	1.83	1.88
Monetary value of homegarden products (INR in the respective years)[b]	2899	3262	2882	2665	3254	3043
Change in monetary value during 2000–2010 (%)	–	–	–	−30.35	−24.43	−20.02
Homegarden contribution to food expenses (average %)	10.06	7.71	5.61	6.39	5.88	4.58
Use categories (%)						
Multipurpose	54.03	50.96	49.87	52.37	53.04	52.63
Timber	0.51	0.48	0.52	0.57	0.55	0.58
Fruit	18.87	26.97	20.93	20.03	24.31	20.76
Vegetable	22.18	15.85	14.73	21.86	15.10	10.82
Spice	2.63	3.15	4.91	2.78	3.77	4.97
Medicine	0.80	1.36	1.03	0.88	1.61	1.17
Others	0.97	1.23	8.01	1.52	1.61	9.06

[a] For annual income, low refers to a household income of 100,000 INR or less in 2010 or 60,000 INR in 2000; middle indicates an annual household income of 100,000–200,000 INR in 2010 or 60,000–100,000 INR in 2000. An annual income of more than 200,000 INR in 2010 (more than 100,000 INR in 2000) is considered part of the high income group.
[b] US$ 1 = 45 Indian Rupees (INR) in 2010.

the landholding size of sampled households remained the same between 2000 and 2010. There is, perhaps, an economy of scale in maintaining the homegardens. This economy of scale is exemplified by the fact that the relative proportion of multipurpose plants, specifically coconut and areca nut (*Areca catechu* L.), increased in the larger landholdings and declined among the smaller landholdings. Diversity of plant species, however, did not show any perceptible variations among the large landholdings over time, as opposed to the small landholdings, where diversity increased. The most perceptible difference between three groups of landholding size is that the medium landholdings had more plants in the other category which also includes ornamental plants.

With regard to income variations, almost half (70 out of 150) of the sample households fell in the low-income group, and a relatively a small proportion (14 out of 150) of households fell in the high-income group during 2010 (Table 3). The distribution of households into the income groups in 2000 was quite similar to the distribution in 2010. Households rarely changed from one income group to another one during 2000–2010. Given the static nature of income groups, we treated the income groups as separate strata. The most noticeable change occurred in the low-income group, in which the monetary value of homegarden products declined, on average, by almost one-third during the time period under study.

Table 4
Average landholding and homegarden size by income category of sample households ($N = 148$)[a] in Kozhikode, Kerala.

	Average landholding size (m^2)	Average homegarden size (m^2)	
		2000	2010
Low	452	259 (57.30)[b]	256 (56.64)[b]
Medium	597	380 (63.65)	366 (61.31)
High	646	383 (59.29)	383 (59.29)

[a] Information on landholding size is missing for two households.
[b] Figures in the parenthesis indicate proportion of homegarden size to the landholding size in percentage terms.

The low-income group used a higher proportion of homegarden products for food. This group is the largest segment of the population, and it has suffered most in terms of declining homegardens, as the contribution of homegardens toward food expenses diminished most prominently in this group (Table 3). A household's possession of land and its income were weakly correlated (Table 4). Only the medium-income group showed a relatively larger change in homegarden size among the sampled gardens. Implicit in this result is the fact that the change in number of plants in homegardens from 2000 to 2010 was also the most pronounced for this income group.

4.3. Reasons for the decline of the homegarden

The salient reasons for the decline of homegardens, in terms of number of plants, include health problems of household members (23 responses out of 145), inadequate availability of labor to maintain the homegarden (19), a decline in homegarden size (19) and a decrease in household size (14). Health problems could be attributed to the aging of the adult members of the household; the state of Kerala has relatively high proportion of aged population compared to the national scenario (Kerala State Planning Board, 2010). The decrease in the supply of labor for the homegarden has emerged as another prominent reason for the decline of homegardens. The pertinent question is who provides the labor to manage homegardens? The most plausible answer is household labor, particularly females' involvement in the production process, which not only ensures a lowering of production costs but also satisfies a wide range of domestic needs more economically and effortlessly than local labor markets (Kumar & Nair, 2004). A related possibility is that homegardens provide a channel for unskilled household labor. With the rise in education (skill-level), households are moving away from this avenue of production, and we therefore observe a decline in homegarden activities (Gangopadhyay & Balooni, 2012).

In this context, we employed the regression framework as elaborated in Section 3, in which homegarden activities are contingent

Table 5
Regression analysis with change in monetary value of sample homegarden products during 2000–2010 (as dependent variable) in Kozhikode, Kerala.

Independent variables	Specifications[a]				
	(I)	(II)	(III)	(IV)	(V)
Change in number of household members	240.46 (2.29)[b]	227.46 (2.16)	196.70 (1.20)	238.13 (2.21)	169.82 (1.01)
Change in average age of adult members	−1.53 (0.07)	−7.86 (0.33)	−0.36 (0.02)	−0.99 (0.04)	−5.53 (0.23)
Change in income group	−527.88 (0.80)	−639.57 (0.97)	−536.94 (0.81)	−518.80 (0.78)	−635.26 (0.96)
Change in number of female members	–	–	85.53 (0.35)	–	103.47 (0.42)
Change in number of members aged over 50	–	306.91 (1.36)	–	–	312.78 (1.38)
Change in average years of schooling	–	–	–	10.86 (0.11)	20.81 (0.22)
R^2	0.04	0.05	0.04	0.05	0.05
Number of observations	150	150	150	150	150

[a] The specifications (I–V) consider different sets of independent variables listed in the leftmost column.
[b] Absolute of the *t*-statistics is noted in the parenthesis.

on household characteristics. In Specification I of the regression (Table 5), the number of household members is statistically significant with respect to promotion of the homegarden. More specifically, an additional member in a household adds 240.46 Indian Rupees (INR) in terms of monetary value to the concerned household. All other independent variables, such as the number of female members in the household, average number of adult members, number of senior citizens and average years of education are found to be statistically insignificant in explaining the change in the monetary value of homegardens (Specification II–Specification V, Table 5).

With respect to the inputs for upkeep of homegardens, the overall picture is somewhat static. Noticeably, the use of fertilizers as an input is on the decline (9.1–5.7%) among the small landholdings. Fertilizers are increasingly being replaced by organic waste generated at the household level (89.2–92.3% of the small landholdings). As expected, the weekly hours increased with an increase in landholding size and income level. This increase occurred because a larger landholding implies a larger homegarden size (Table 4) and a greater income implies the same.

5. Discussion

5.1. Multi-functionality and urban sustainability

While our analysis explicitly demonstrates an overall decline in the cultivated species in homegardens in Kozhikode from 2000 to 2010, a related issue concerns homegardens' changing roles in the context of urban sustainability. In general, the vegetation composition in the homegardens reflects human intentions. For example, the types of products households want to obtain for both domestic consumption and trade in the market is critical to the management of homegardens. Food and nutritional security are clearly important issues in the minds of traditional homegardeners (Bernholt et al., 2009; Kumar & Nair, 2004). For our sample of households, the monetary value of the homegarden products plummeted, on average, by almost one-third. In the present economic context of growing food inflation (Nair & Eapen, 2012), particularly among food items, the loss of any source of livelihood is a concern worth considering as highlighted by Lubbe et al. (2010).

Households, however, may alter the floristic structure and management of the homegardens to meet any contingency. Accordingly, we noticed that the floristic composition of small landholdings (Table 2) has tilted toward basic food items, such as vegetables, spices and fruits. This finding is in tune with that of Bigirimana et al. (2012) and Lubbe et al. (2010) who show that poorer communities cultivate relatively more utilitarian species in their domestic gardens compared to their richer counterparts. In our study, the change in floristic composition may be indicative of the efficiency of homegardens in complementing livelihood sustainability. Studies in the rural context in developing countries show that homegardens with diverse products available year-round contribute to food security during lean seasons (Kumar & Nair, 2004). In addition to sustenance, some of the products, such as fruits, nuts, spices and wood fuel are also important as sources of income for the homegardeners. Lower floristic diversity in the large gardens, relative to the small ones (Table 2), could be interpreted as an indication of increasing commercialization of larger homegardens; this pattern has also been observed in homegardens in other tropical regions with homegardens (e.g., Indonesia: Abdoellah, Takeuchi, Perikesit, & Hadikusumah, 2001; Niger: Bernholt et al., 2009). This observation gains importance with the increasing proportion of two cash crops, coconut and areca nut, in large homegardens (Table 2).

Our data clearly highlight that diversified production (Table 1) and monetary value (in other words, income generation in perpetuity), despite the 20–30% decline in the monetary value of the products from the sampled homegardens between 2000 and 2010 (Table 3), are intrinsic features of the homegardens in Kozhikode, as they are elsewhere (Kumar & Nair, 2004). The diversified range of products available from the homegardens (63 cultivated species: Table 1) and increased monetary value of outputs (e.g., better quality of produce when few or no chemical inputs are used) enhances food diversity and nutritional security (e.g., better availability of fruits and vegetables, which reduces the occurrence of nutritional disorders). The multitude of tree species (34 with a Shannon index between 1.86 and 1.92; Table 1) in the homegardens also provide a variety of materials for buildings, furniture, fuels, food and medicines.

One of the findings of our study is no perceptible change in the diversity of the cultivated plant species over time among households with relatively large landholding, whereas the diversity increased in case of small landholdings. We did not come across any study in a developing country context that looks into this inter-temporal change in diversity of plant species cultivated in the private green spaces in the urban areas. There are studies that compare diversity of cultivated plant species among various income groups but at a particular point in time (Bigirimana et al., 2012; Lubbe et al., 2010). Lubbe et al. (2010) shows such diversity increases among the relatively wealthier socio-economic classes. We highlight the need for more inter-temporal studies on multi-functionality of the private green spaces in the urban areas in a developing country context.

5.2. Challenges and the way forward

It is a fact that large-scale urban development projects have been replacing agricultural fields and woodlands in urban and peri-urban areas (Guillerme et al., 2011) and many products originally derived from green spaces are being replaced with modern equivalents, which presumably diminishes the need for maintaining homegardens. Despite this, there are still private green spaces that have

survived the rapid urbanization, as in the case of homegardens in Kozhikode. However, our study reveals such vestiges of private green spaces are vulnerable to rapid urbanization and the homegardens of Kozhikode experienced a loss of 11.5% in the cultivated plants during the first decade of this century. The pertinent issue therefore concerns the creation of a possible mechanism to manage and conserve private green spaces in urban areas.

Since private green spaces provide similar environmental services as the public green spaces (where substantial non-priced benefits of green spaces are externalized), we highlight the role of economic incentives for an individual to manage and conserve private green spaces. The State may provide economic incentives in the form of subsidies, which, though theoretically possible, is difficult to implement in a developing country such as India, where urban land prices are skyrocketing (Chakravorty, 2013). Various legislative measures such as those that restrict indiscriminate felling and the destruction of trees (Guillerme et al., 2011), also may be ineffective for conserving homegardens because of the high transaction cost of monitoring and implementing these measures. Therefore, a participatory approach aimed not only at maintaining tree cover but also preserving the floristic structure and diversity of the private green spaces may be appropriate. This is particularly relevant when decentralized governance based on participatory approach has emerged as a major policy tool during the last two decades to achieve environmental sustainability in Kerala. This participatory approach implies encouraging homegarden owners and other local stewards of private green spaces to take up the cause of private green spaces in their self-interest and the societal interest at large (Colding et al., 2006). This approach also holds potential in promoting livelihood security for urban dwellers.

A case in point is the Kerala-wide intensive campaign for promoting organic farming (Government of Kerala, 2008). This policy document targets promotion of organic farming by establishing organic kitchen gardens and organic orchards mainly in the rural households. It would be achieved through participatory approach by way of formation of compact area groups, viz., household groups, clubs, self-help groups and cooperatives. This policy initiative is being emulated in the urban context too as evident in case of Kozhikode Municipal Corporation which recently launched a 'Thousand Kitchen Garden Project' by involving local resident associations and neighborhood groups (Kattakayam, 2010). This, then, calls for policy interventions by the state or local bodies and urban planners in developing countries which are increasingly dependent upon citizens' participation in this area of governance. Such an approach may be able to reverse the process of 'urban homegarden decline' in our study area and those other similarly situated cities in the developing countries.

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