# Technological infusion and the change in private, urban green spaces

Kausik Gangopadhyay *, Kulbhushan Balooni [1]

*Indian Institute of Management Kozhikode, IIMK Campus PO, Kozhikode 673570, Kerala, India*

ARTICLE INFO

*Keywords:*
Developing country
Externality
Homegarden
India
Technology

ABSTRACT

Despite the fact that the multifaceted values of urban green spaces in the public and private domain constitute the core of urban sustainability, their importance is not adequately investigated in the context of developing countries. We undertook a survey of homegardens on private properties in Kozhikode, a city located in the state of Kerala, India. Our investigation reveals a substantial loss of private green spaces, defined in terms of the added economic value homegardens provided to households during the last decade. We hypothesise and validate empirically that this loss, over time, is negatively associated with technological infusion at the household level, which we measure by assessing the increase in the number of personal computer(s) possessed by households. We provide an economic framework to discuss the implications of our proposition. We conclude that the nature of positive externalities associated with private, urban green spaces demands policy intervention by the State.



## Introduction

There is a growing realisation that urban green spaces are necessary for creating sustainable urban centres. The contribution of green spaces covered with trees, shrubs and ground vegetation in improving the micro-climatic conditions of urban areas (Avissar, 1996; Givoni, 1991; Miyawaki, 1998; Georgi and Dimitriou, 2010) and other ecosystem services is well documented. Urban green spaces enrich urban communities aesthetically and add recreational avenues for city dwellers (Attwell, 2000; Konijnendijk et al., 2006). Green spaces are also positively associated with greater perceived general health of residents (Maas et al., 2006). Most importantly, green spaces further reinforce the process of carbon sequestration in urban areas to mitigate the effects of climate change (Nowak and Crane, 2002; Jenkins and Riemann, 2003; Escobedo et al., 2010). There is no lack of literature extolling the multifaceted values of urban green space in the context of urban sustainability. In general, green spaces in urban areas fall into two categories based on the nature of ownership – private or public. There are, however, significant external benefits of urban green spaces regardless of ownership.

What needs to be further explored is the likelihood of the loss of urban green spaces due to rapid urbanisation, changing urban lifestyles and culture, and technological advancements, particularly in the context of developing countries like India and China. Thus, there is good reason to undertake research in a variety of relatively unexplored urban landscapes to provide a better understanding of the reality of urban green spaces. The Indian urban landscape context, which is going through a large make-over in the post-economic reform era (1991–), provides this research opportunity. The changing urban landscape and deteriorating urban environment has, now, become an issue of considerable significance to the environmentalists and urban planners in India. The primary challenge is to conserve green spaces and withstand the unprecedented pressure to alter scarce public land resources for expanding public infrastructure, business centres and housing, all of which is gaining momentum due to the twin processes of technological progress and modernisation.

Private green spaces are somewhat undervalued compared to public green spaces, though they both provide vital protection against environmental losses that would happen otherwise. Though India has a long tradition of private green spaces in the form of domestic gardens, backyards, and home gardens, there has been a noticeable change in recent years. Currently, green spaces in urban India are rarer compared to most other Asian countries (Kuchelmeister, 1998). In general, greenery and its conservation once played a central role in the Indian culture. It is well grounded in the philosophical approach of the ancients to nature, which was characterised by subordination, cooperation and participation (Kerr and Swarup, 1997). The ancient religious traditions – within and beyond scriptures – reinforce this view. The question is how much of this ancient culture still exists in modern India, particularly around environmental themes in the urban context? The existence of private green spaces in urban agglomerations presents the opportunity to unravel the genesis of possible change in private green spaces over time and the factors that have influenced that

* Corresponding author. Tel.: +91 495 2809118; fax: +91 495 2803010.
*E-mail addresses:* kausik.gangopadhyay@gmail.com (K. Gangopadhyay), kbalooni@yahoo.com (K. Balooni).
[1] Tel.: +91 495 2809116; fax: +91 495 2803010.

change. We undertake a case analysis of homegardens, a form of private green space with multi-storeyed tropical vegetation in the city of Kozhikode, located in the state of Kerala, India.

'Homegardens' constitute the predominant form of urban and semi-urban private green spaces in Kerala. Homegardens are considered one of the most important multifunctional land use systems in the managed ecosystems of the tropics (Kumar and Nair, 2006). Our survey records the private possession of homegardens by Keralan households along with other demographic and socio-economic variables. This survey reveals a substantial decline in homegardens between 2000 and 2010, measured in terms of economic value added to sample households. In view of this, we attempt to evaluate the role of technological infusion in a household in changing the magnitude of homegardens measured in terms of the added household economic value produced by the homegarden. We employ regression analysis to identify the significance of technological infusion at a household level in reducing the extent of homegardens, measured in terms of their economic value added to the household.

Given the significance of technological infusion in the decline in homegardens, we propose an economic framework to study the relationship between changing resource endowments and management of the landscape within the periphery of the private domain. Even though homegardens are not a public good per se, there are positive externalities associated with them; that is, they benefit the society at large, not just owners. On the other hand, the conservation of green spaces still remains of peripheral interest to the urban governing bodies, which are entrusted with planning, management and administrative affairs in India (Devy et al., 2009). It is in this context that we explore the possible role of the State in mitigating homegarden decline. We also use our economic framework to examine the historical role of the cultural ethos in bridging the gap between the private and the collective assessment of the economic value of homegardens.

## Study area

We provide a case analysis of the city of Kozhikode (formerly Calicut) in the state of Kerala, which is located in peninsular India. Kozhikode, an old coastal city, was chosen due to its location, size, history and cultural backdrop. One of the remarkable features of Kerala, a state bestowed with an abundance of greenery (Forest Survey of India, 2009), is the presence of traditional homegardens in almost every household. Kumar and Nair (2004) point out that the homegardens in Kerala are thought to be at least 4000 years old. This contributes to the high tree cover in Kerala compared to other states in India (Forest Survey of India, 2009). Heritage and culture is very important in Kerala. It has a thriving Ayurveda system (Harilal, 2009), even in the urban centres. (Ayurveda is a system of complementary and alternative medicine. See Chacko (2003) on the efficacy and practice of Ayurveda.) Even though homegardens are centuries-old components of the rural landscape in Kerala, they are also found in small-scale and varied forms in the urban landscape. Despite Kerala's relatively high population density (859 persons/km$^2$ in 2011), attributed to growing urbanisation, the homegardens are still a part of the urban landscape.

Despite its history, there is growing concern over the loss of urban green space in Kerala (our emphasis) that has become more evident since the increase in construction activity from mid-2001 to mid-2004 – the post-economic reform era (the economic reforms in Kerala picked up momentum in 2001 when the state government initiated a number of measures to accelerate economic growth) – resulting in higher growth (6.2%), and by 2003–2004, it became a larger income generating subsector than the manufacturing sector (Jeromi, 2005). There are other environmental (Korakandy, 2000) and societal concerns (Gopikuttan, 1990) arising from the construction boom in Kerala, all of which are particularly relevant for the city of our focus, Kozhikode. Once known as the laidback city of Kerala, Kozhikode is now expanding horizontally and vertically. The history of Kozhikode shows its evolution from a small rural community to a modern city. It now constitutes the third largest urban agglomeration in the state of Kerala. This growth led to a building boom, with the construction of residential apartment buildings and shopping malls in Kozhikode, which was a response to the emergence of a new class of highly demanding consumers looking for quality living space, the demand for space by retailers, and the establishment of two new Information Technology (IT) parks (Sanandakumar, 2008). Evidently, this wave of urbanisation may lead to a decline in green space coverage.

## Survey and methodology

We selected three localities, namely Ashokapuram (1810 households), West Hill (1686 households), and Govindapuram (3615 households), situated within the limits of the Kozhikode Municipal Corporation, which is divided into 75 localities called wards. Our selection of localities was based on their position with respect to Mananchira Square, the centre of Kozhikode city: Ashokapuram is located in the northern part of the city, while West Hill and Govindapuram are located in the north-west and north-east, respectively. Ashokapuram is closest to the city centre, within a distance of 1 km. West Hill is situated near the periphery of the Kozhikode Municipal Corporation. Govindapuram is situated somewhere in between in terms of distance from the city centre.

A sample of 50 households was chosen from each of these three localities. Given the lack of resources, it was not possible to undertake a complete enumeration of all households. Hence, we could not evoke a random sample using a random number generator. However, all efforts were made to choose the sample households from each locality in a non-selective manner. We selected at least one household from each of the small streets in each locality and multiple households from different points on bigger streets. The random nature of our sample is manifested through various descriptive statistics as elaborated in the Results.

We undertook a preliminary survey of five households in each of the three localities to pre-test our structured questionnaire. To negate information bias during the collection process, services of a native and professional field investigator were employed. The structured questionnaire solicited information about each household, including demographic details, economic condition, the details of vegetation in the homegarden, land utilisation pattern divided into two categories (built-up and homegarden area), income accrued from the homegarden, utilisation pattern of homegarden products, and management attributes of the homegarden. The relevant information came from two points in time, the present (2010) and a recollection of the same variables ten years ago (2000).

Based on annual income, we categorised the sample households into three categories: low income, with an annual income of Indian Rupees (INR) 100,000 (approximately US$ 2250; US$ 1 = INR 45 in 2010) or less; middle income, between INR 100,000 to 200,000; and high income, with more than INR 200,000. We observed three kinds of vegetation in the homegardens: 'trees', 'shrubs' and 'climbers'. We included only the cultivated plants in our sample, that is, we excluded weeds. Woody plants more than 2 m high were classified as trees and those woody plants less than 2 m were classified as shrubs. Finally, non-woody plants were classified as climbers. All three kinds of vegetation in homegardens constitute our definition of urban green space. Furthermore, we used the economic value of homegarden products – consumed at the household level and/or sold by the household in the market – obtained from these three

kinds of vegetation as an instrument to measure the inter-temporal change in urban green space in the context of this study.

We present our motivation for using the economic value of homegarden products to measure the change in homegardens. A change in the extent of vegetation may not tell the entire story, as some species are more valuable than others and may also require greater care to maintain them. Therefore, the homegarden change may come from two sources: extrinsically, through a change in the extent of vegetation and intrinsically, through a change in the vegetation pattern that could be traced through a change in economic value for that vegetation. The added economic value takes account of both extrinsic and intrinsic changes.

The research demands a comparison of outcomes and events in two different periods of time for a meaningful evaluation of the trends. At the same time, there is no plausible mechanism to collect past information other than appealing to respondents' memory. This method suffers from the so-called recall bias, which only grows over time. Hence, we restricted our research to a span of ten years for comparison. Moreover, we included a household in our sample only if the household has remained there continuously for the last ten years. These restrictions regarding sample selection and recall bias are likely to consolidate our main findings rather than negate them. We discuss this while describing the empirical findings of our study in the next section.

## Results

### *Sample demography*

We first describe the sample demography (see Table 1), which has direct implications for the results based on our survey of 150 households. A majority (127) of these households are originally from the city of Kozhikode. Nineteen have migrated from the same state and one from a different state in India. This data is missing for three households. A majority of the households (62%) are from various underprivileged parts of society. (The Government of India classifies Indian citizens based on their social and economic condition as Scheduled Caste, Scheduled Tribe, Other Backward Class and the General Category. The first three categories constitute various underprivileged classes.) We notice the rise in the average age for the sample during 2000– 2010, which is consistent with the aging population profile of Kerala (Indian Census, 2011). In Kerala, the female-to-male ratio is 1.084 (1084 females per 1000 males), higher than the national figure of 0.940. In our sample too, a similar trend has been found with the female-to-male ratio standing at 1.169 in 2010.

The members in the sample come from diverse professional backgrounds. There are people employed in various service sectors (20.81%), business people (6.43%), manual labourers (1.06%), professionals (4.91%), housewives (25.04%), unemployed (24.20%), and miscellaneous (17.6%). If we classify based on income, 46.67% households fall in the low-income group; a similar number of households (44%) are in the middle-income group; and relatively few are in the high-income group. The distribution is highly stable over the 10-year time period.

The underlying socio-economic diversity of sample households is illustrative of the random nature of the sample. To some extent, this diversity is attributed to the differences observed regarding household decision making, as shown later.

### *Decline of homegardens*

There is no change in the landholding size for our sample households given our emphasis on choosing households living in the same houses during the last decade. Table 1, however, shows that there is a mild decline in the size of the homegarden for these households, which, on average, constitutes 59.36% of the households' total land, a figure which partially demonstrates the importance of a homegarden for a typical urban dweller in our study area. We find the decrease in the area of homegarden is contingent on household income. On average, the amount of decrease is small (2.43 $m^2$) for the low-income group, of moderate magnitude (14.16 $m^2$) for the middle-income group, and a sharp change (47.35 $m^2$) is noted for the high-income group. Could it be that this change is contingent on the degree of technological infusion? As comparatively well-off households are plausibly more susceptible to technological advances, we may surmise that the reduction in the area of homegarden is attributed to technological advancement and is therefore more prominent among relatively better-off households.

Our analysis reveals a remarkable decline in the magnitude of vegetation in sample homegardens (see Table 1). As described earlier, we measure the change in the magnitude of a homegarden through the change in the economic value of products obtained from that homegarden by the household. After controlling for inflation, this change amounts to a staggering decline of 26.66%. This is partly attributed to the plummeting number (−12.87%) of the principal cash crop, the coconut tree (*Cocos nucifera* L.), in the homegardens in Kerala.

If the sample is a random one, the survey estimates are a good proxy for the population and any conclusion based on the sample carries over to the general population. A valid concern arises regarding whether the general conclusion could be obtained from the sample because the sample suffers from two biases, selection bias and recall bias. On the one hand, we extracted the current information (2010) regarding homegardens from field visits during the survey, and on the other hand, the 2000 information source was extracted through household estimates. In general, it is more probable that a respondent would fail to report some vegetation in 2000 than to over-report it. Therefore, the actual magnitude of decline in homegardens during 2000–2010 is probably even more than what was found in our data. Selection bias occurs in the sample, as we only chose those who were in the same location during 2000–2010. Again, this supports an undervaluing of the true magnitude of decline. Residents often sell their property for construction of high-rise apartments or commercial complexes. In those cases, the loss of greenery is, no doubt, massive. Since we did not select those households deliberately in our sample, our decline estimate is a lower bound. This raises the additional concern that the actual decline in green spaces in the city of Kozhikode is probably more extensive that what is concluded in this study.

### *Technological infusion: analysis in a regression-based framework*

Why are homegardens declining? The decline of homegardens, measured in terms of added economic value, could be attributed to the hypothesis that homegardens are a channel for unskilled labour. Obviously, skilled labour earns more compared to their unskilled counterparts by being employed in technologically advanced sectors. We emphasise here that the words skilled and unskilled are used in a very specific context. The word skill denotes a required level of expertise for a job in the technologically advanced sector. There are skills associated with homegardening, but they are not used in this context. Hence, with the rise in education (skill-level mandatory for the technologically advanced sector), individuals move away from homegarden production, thereby causing a plummet in the economic value added by homegardens. A way to test this hypothesis is to answer the following question: How associated are one's technologically sophisticated skills vis-à-vis the economic value added by her homegarden? If these two attributes

**Table 1**
Average figures for salient features of sample households.[a]

| | Year 2010 | Year 2000 | Change during 2000–2010 |
|---|---|---|---|
| Number of members | 4.43 (1.87) | 4.43 (1.83) | −0.01 (1.66) |
| Age of (adult) household members | 48.71 (9.96) | 36.24 (11.04) | 12.47 (7.43) |
| Years of schooling | 11.86 (2.62) | 11.45 (2.90) | |
| Landholding size (in $m^2$) | 533.78 (423.20) | 533.78 (423.20) | 0 |
| Homegarden size (in $m^2$) | 317.01 (360.08) | 321.68 (364.67) | −1.45 |
| Number of trees, shrubs and climbers in homegardens | 26.08 (20.47) | 29.47 (24.38) | −11.49 |
| Number of trees only | 20.57 (16.99) | 23.16 (20.61) | −12.54 |
| Economic value of homegarden products (consumed and sold at the market, annually) (Indian Rupees)[c] | 2960[b] (2642) | 3058(2763) | −26.66 |
| Number of observations | 150 | 150 | 150 |

[a] Based on a survey in Kozhikode, India; standard deviations are shown in parentheses.
[b] The 2000 and 2010 figures are expressed in terms of respective years' INR values. While calculating the percentage change, we have controlled for inflation during 2000–2010.
[c] US$ 1 = Indian Rupees (INR) 45 in 2010.

are negatively associated, it is indicative that technological infusion is associated with a decline in the economic value of homegardens.

To illustrate the idea further, we employ the following regression framework:

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

where $y_{it}$ is the economic value addition by the homegarden of $i$th household and $x_{it}$ is the vector of socio-economic attributes for the $i$th household in the time period $t$. Moreover, $e_{it}$ represents the regression error. The data are available from the two time periods of 2000 and 2010. We subtract the variables between two time periods. Therefore, we have,

$$D_{y_i} = y_{i,2010} - y_{i,2000} \quad \text{and} \quad D_{x_i} = x_{i,2010} - x_{i,2000}.$$

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

$$D_{y_i} = b \cdot D_{x_i} + u_i \quad (2)$$

Household characteristics that are constant over time, such as caste and landholding size, are factored out of the above equation in this process. We experiment with a few household characteristics, such as average age of the adult household members, number of household members, and the income group to which the household belongs. The dependent variable of change in income group assumes a value of 1 (−1) if a household moves up (down) one place in the income ladder. The dependent variable ($D_{y_i}$) is the change in the economic value added by the homegarden during 2000–2010. This variable is calculated by subtracting the inflation-adjusted economic value of homegarden products in 2000 from that of 2010. Summary statistics for important variables are given in Table 1. In 'Specification I' of the regression (see Table 2), it is found that the number of household members is statistically significant for the economic value addition of the homegarden, as expected.

To further examine our hypothesis of technological infusion being associated with a reduction in the added economic value of homegardens, we formulate the question in the following manner: If skills are rather intangible, how to detect them? Hence, we resort to the usage of technologically sophisticated machinery as an indicator of the possession of technologically sophisticated skills. More specifically, we focus on the number of personal computers. We add the change in the number of computers in a household during 2000–2010 to the list of dependent variables to verify our conjecture on the relationship between technological skill and the added economic value of homegardens. The results are reported in 'Specification II' (Table 2). Clearly, the increase in number of computers is negatively associated (significant at a 5% level) with a growth in homegardens after controlling for income and other demographic characteristics of the household. This is an empirical demonstration of technological infusion being negatively associated with the added economic value of the homegarden at the household level.

It could be said that the possession of personal computers may not have much to do with one's technological skills but, instead, is contingent on the affluence of the household in question. We carry out a placebo analysis by illustrating an example of the possession of colour television(s). Colour televisions are comparable to personal computers in terms of cost in India. However, colour televisions are redundant as far as possession of technological skill is concerned. We supplement our analysis with another regression, shown in 'Specification III' (Table 2), with a change in the number of colour televisions added to the list of independent variables. We do not find this variable to be statistically significant, and it therefore constitutes a stronger argument in favour of our hypothesis that the added economic value of a homegarden is negatively associated with personal computer skills. Therefore, the empirical findings support our hypothesis of a negative relationship between technological infusion at the household level and the added economic value provided by the homegarden of that household.

## Discussion and conclusion

To sum up, our household survey in the city of Kozhikode covers a time horizon from 2000 to 2010 to capture the magnitude of change in homegardens, the dominant form of private green spaces in tropical regions. This study shows a substantial decline in private green spaces, measured in terms of the added economic value of homegardens to their owners. We have identified technological infusion at the household level, measured by the possession of personal computers, as associated with the decline in homegardens. These empirical findings present a striking contrast to the age-old Indian tradition of reverence and conservation of greenery and wooded areas. The relationship between cultural values and homegardens is a recurrent theme in the existing literature (Kimber, 2004; Puri and Nair, 2004; Bhatti, 2006; Galluzzi et al., 2010). These studies demonstrate the fact that homegardens are of major cultural significance not only in India, but elsewhere in the world. However, this state of affairs may not persist in the urban context in India if we extrapolate from the results of this case study.

We would like to emphasise at this point that there are positive externalities generated from the possession of a household homegarden. In terms of added economic value, a homegarden benefits not only the concerned household but also society at large. In fact, the importance of positive externalities of urban green space is embedded in the URGE Team definition (2004): "public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users". (There is no common definition of urban green spaces and the classification of different types of green spaces differs among countries (Baycan-Levent and Nijkamp, 2009)). We find that the definition

**Table 2**
Regression analysis with the change in economic value of homegarden products (2000–2010) as the dependent variable.[a]

| Independent variables | Specifications | | |
|---|---|---|---|
| | (I) | (II) | (III) |
| Change in number of household members | 240.458 (2.29)[b] | 247.432 (2.39) | 243.726 (2.35) |
| Change in average age of adult members | −1.530 (0.07) | −1.715 (0.08) | −1.366 (0.06) |
| Change in income group | −527.882 (0.80) | −901.039 (1.36) | −909.718 (1.37) |
| Change in number of personal computers | - | −819.561 (2.51) | −798.915 (2.43) |
| Change in number of colour televisions | - | - | 265.308 (0.61) |
| $R^2$ | 0.039 | 0.079 | 0.081 |
| Number of observations | 150 | 150 | 150 |

[a] Analysis based on a survey in Kozhikode, India.
[b] Absolute value of the *t*-statistics is noted in the parenthesis.

of urban green space by URGE Team (2004) fits our study context.) In other words, the reduction of homegardens leads to negative externalities. A household would not consider external benefits when making an economic decision regarding homegarden activities; that is, the private benefits of a homegarden would be less than the social benefits of that homegarden. In other words, households do not enjoy the full benefits, e.g., aesthetics, amelioration of microclimate, mitigating noise pollution, that arise from a homegarden. This is a textbook case of externalities causing market failures in the economic context. Therefore, we highlight the fact that the cost of conserving the homegardens falls solely on the shoulders of an owner. The contribution of homegardens to the greater society is largely unnoticed and therefore the cost borne by the owner is disproportionately high compared to the benefits availed by her. On the other hand, the technologically advanced sector offers increasingly higher prices for her technological skills. In other words, if she possesses technological skills, she would prefer to take a job in the technologically advanced sector rather than spending time in her homegarden maximising economic value from homegarden products. The negative association between technological infusion and added economic value of a homegarden for a household is a testament to this reality.

Because homegardens constitute a case of positive externalities by benefiting not only the owners but society as well, economic efficiency demands the State or a collective decision making body to take appropriate measures to conserve urban green spaces in the private domain. We might also presume that in the pre-technological progress era, the cultural ethos was inculcated in the society to make optimal choices regarding the establishment of homegardens. It is entirely possible that the cultural ethos acts as a substitute for the State to internalise these positive externalities generated by homegardens for the individual owners. However, in the wake of technological progress, this cultural ethos may have diminished, leaving state intervention as the only means to internalise the positive externalities.

One way to rectify this problem of positive externalities associated with homegardens is for the State to tax the earnings in the technologically advanced sector to subsidise the conservation of homegardens in the private domain. Incidentally, the provincial government in the study context has come up with a scheme to promote homegardens in urban agglomerations, necessitated by the gradually plummeting economic value provided by homegarden products, specifically coconut, the principal cash crop of this region (Government of Kerala, 2002). The scale of such efforts, nonetheless, may not match the magnitude of the deterioration of the urban landscape, including private green spaces. Because India and other developing countries are becoming increasingly urbanised, the magnitude of this problem will most likely only increase. Therefore, we conclude by suggesting an enhanced role for urban environmental governance for the conservation of private green spaces.

## Acknowledgements

An earlier version of this paper was presented at the Asia-Europe Foundation Workshop on 'Urban management for an urban future', held at the University of Ljubljana, Slovenia during October 15–16, 2010. We are grateful to the workshop participants for their valuable comments as well as University of Ljubljana for providing a travel grant to the corresponding author to participate in this workshop. We thank the Indian Institute of Management, Kozhikode for providing us economic aid (Small Grant Research Project) to undertake this study. Kulbhushan Balooni revised this study while working as a Visiting Senior Research Fellow at Asian Urbanisms Research Cluster, Asia Research Institute in National University Singapore. We thank Jansy Jose for data collection. We duly acknowledge our discussions with B. Mohan Kumar for providing insightful input in preparing the questionnaire regarding homegardens and Duleep Sahadev for providing input on identifying the study sites in the city of Kozhikode. Any errors are the responsibility of the authors alone.

## References

Attwell, K., 2000. Urban land resources and urban planting – case studies from Denmark. Landscape and Urban Planning 52 (2–3), 145–163.
Avissar, R., 1996. Potential effects of vegetation on the urban thermal environment. Atmospheric Environment 30 (3), 437–448.
Bhatti, M., 2006. 'When I'm in the garden I can create my own paradise': homes and gardens in later life. The Sociological Review 54 (2), 318–341.
Baycan-Levent, T., Nijkamp, P., 2009. Planning and management of urban green spaces in Europe: comparative analysis. Journal of Urban Planning and Development 135 (1), 1–12.
Chacko, E., 2003. Culture and therapy: complementary strategies for the treatment of type-2 diabetes in an urban setting in Kerala, India. Social Science & Medicine 56 (5), 1087–1098.
Devy, M.S., Swamy, S., Aravind, N.A., 2009. Reshaping urban green spaces. Economic and Political Weekly 44 (46), 25–27.
Escobedo, F., Varela, S., Zhao, M., Wagner, J.E., Zipperer, W., 2010. Analyzing the efficacy of subtropical urban forests in offsetting carbon emissions from cities. Environmental Science & Policy 13 (5), 362–372.
Forest Survey of India, 2009. India: State of Forest Report 2009. Ministry of Environment & Forests, Government of India, Dehradun.
Galluzzi, G., Eyzaguirre, P., Negri, V., 2010. Home gardens: neglected hotspots of agro-biodiversity and cultural diversity. Biodiversity and Conservation 19 (13), 3635–3654.
Georgi, J.N., Dimitriou, D., 2010. The contribution of urban green spaces to the improvement of environment in cities: case study of Chania, Greece. Building and Environment 45 (6), 1401–1414.
Givoni, B., 1991. Impact of planted areas on urban environmental quality: a review. Atmospheric Environment. Part B. Urban Atmosphere 25 (3), 289–299.
Gopikuttan, G., 1990. House construction boom in Kerala: impact on economy and society. Economic and Political Weekly 25 (37), 2083–2088.
Government of Kerala, 2002. Homestead Farming, Order – G.O.(Rt)668/02/AD, Dated June 27, 2002. Agriculture (Planning) Department, Thiruvanathapuram.
Harilal, M.S., 2009. 'Commercialising traditional medicine': Ayurvedic manufacturing in Kerala. Economic and Political Weekly 44 (16), 44–51.
Indian Census, 2011. Retrieved on September 1, 2011 from http://censusindia.gov.in.
Jenkins, J.C., Riemann, R., 2003. What does nonforest land contribute to the global C balance? In: McRoberts, Re., Reams, G.A., Van Dousen, P.C., Mosor, J.W. (Eds.), Proceedings of 3rd Annual Forest Inventory and Analysis Symposium, 2001

October 17–19; Traverse City, MI. USDA Forest Service. Gen. Tech. Rep. NC-230. U.S. Department of Agriculture, Forest Service, St. Paul, MN, pp. 173–179.
Jeromi, P.D., 2005. Economic reforms in Kerala. Economic and Political Weekly 40 (30), 3267–3277.
Kerr, J.M., Swarup, R., 1997. Natural resource policy and management problems in India. In: Kerr, J.M., Marothia, D.K., Singh, K., Ramasamy, C., Bentley, W.R. (Eds.), Natural Resource Economics: Theory and Application in India. Oxford and IBH Publishing, New Delhi and Calcutta, pp. 3–33.
Kimber, C.T., 2004. Gardens and dwellings: people in vernacular gardens. The Geographical Review 94 (3), 263–283.
Konijnendijk, C.C., Ricard, R.M., Kenney, A., Randrup, T.B., 2006. Defining urban forestry – a comparative perspective of North America and Europe. Urban Forestry & Urban Greening 4 (3–4), 93–103.
Korakandy, R., 2000. State of the environment in Kerala: what price the development model? Economic and Political Weekly 35 (21/22), 1801–1804.
Kuchelmeister, G., 1998. Asia-Pacific forestry sector outlook study: urban forestry in the Asia-Pacific Region – situation and prospects. Working Paper No. APFSOS/WP/44. Forestry Policy and Planning Division, Rome & Regional Office for Asia and the Pacific, Bangkok. Retrieved on May 20, 2011 from http://www.fao.org/docrep/003/x1577e/X1577E00.htm#TopOfPage.
Kumar, B.M., Nair, P.K.R., 2004. The enigma of tropical homegardens. Agroforestry Systems 61, 135–152.
Kumar, B.M., Nair, P.K.R. (Eds.), 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Advances in Agroforestry, vol. 3. Springer, Dordrecht.
Maas, J., Verheij, R.A., Groenewegen, P.P., de Vries, S., Spreeuwenberg, P., 2006. Green space, urbanity, and health: how strong is the relation? Journal of Epidemiology & Community Health 60, 587–592.
Miyawaki, A., 1998. Restoration of urban green environments based on the theories of vegetation ecology. Ecological Engineering 11 (1–4), 157–165.
Nowak, D.J., Crane, D.E., 2002. Carbon storage and sequestration by urban trees in the USA. Environmental Pollution 116, 381–389.
Puri, S., Nair, P.K.R., 2004. Agroforestry research for development in India: 25 years of experiences of a national program. Agroforestry Systems 61–62 (1), 437–452.
Sanandakumar, S., 2008. Building boom in Calicut. The Economic Times, 24 February 2008.
URGE Team, 2004. Making Greener Cities – A Practical Guide, No. 8/2004. URGE – Development of Urban Green Spaces to Improve the Quality of Life in Cities and Urban Regions. UFZ Centre for Environmental Research Leipzig-Halle, Leipzig.