Environment Pollution and Climate Change

Jayasinghe C, et al., Environ Pollut Climate Change 2022, 6:9

Research Article Open Acces

An Assessment of the Function of Residential Green Spaces in a Residential Zone of Galle City, Sri Lanka

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ABSTRACT

Urban green spaces are considered as a key solution to problems associated with increasing urbanization, such as pollution and urban heat island effects. The green spaces of cities include both public and private green spaces, which although different, can both provide positive benefits for residents. Gardens on private residential lots represent a substantial proportion of green spaces in low-density cities with extensive suburban areas. This paper investigates the environmental, social and economic functions of residential gardens in a primary residential zone of Galle City, Sri Lanka. 280 housing units were surveyed to collect the data for multiple regression analysis and develop models to illustrate the functions of residential gardens. The model value was substituted and the Ŷ value taken for every housing unit. These data were entered into the Geographic Information System (GIS) platform, taking one house as a unit of analysis. Findings from our qualitative research showed that only 8 percent of the residential gardens were functioning well in environmental, social and economic terms while 24 percent of the residential gardens were functioning at a moderate level. 59 percent of the residential gardens were functioning poorly (at a low level) and the remaining 9 percent of residential gardens were not functioning at all. These results suggest that overall; gardens on private residential plots are not functioning well in Galle City. The implications of such findings for policy planners is that residential Green spaces, which have the potential to provide a wide range of functions, can play a significant role in benefiting the urban environment and its populace. Therefore, it is clear there is an urgent need to promote the use of residential green spaces positively by implementing sustainable action plans.evelop and implement effective wastewater management plan.

Keywords: Functions of green spaces; Private garden; Residential garden; Urban green spaces; Urbanization

Introduction

According to a UN projection, the world's urban population will increase by 2.5 Billion people by 2050, and urbanization will be faster in Asia and Africa than in any other parts of the world. Accordingly, their urban populations will increase by 64% and 56% respectively, by 2050. This indicates that the dramatic urbanization phenomenon will continue.

A significant feature of third world urbanization is the concentration of urban populations in and around the mega cities. Due to the high demand for residential properties, the population is unevenly scattered near the urban edges of the metropolitan areas. This sort of uncontrolled growth has had a strong negative impact on urban green space and obviously this requires immediate attention. Green spaces and urban trees will become increasingly important in developing countries, especially in Asia, because the rate of urbanization is greatest in the bigger cities of Asia.

Green spaces of cities include both public and private green plots, which although slightly different in nature, can both provide positive benefits for residents. Gardens on private residential plots represent a substantial proportion of the green spaces in low-density cities with sprawling suburban areas. Residential Green spaces by providing a wide range of functions and serving many purposes can play a significant role in benefiting the urban environment and its populace. These benefits can be categorized according to their social, environmental, and economic aspects. Although residential gardens are probably the most common type of green space prevalent in cities, not many studies have been undertaken to assess their various functions.

Therefore, the main purpose of this paper is to evaluate the multifarious functions of residential green space in an urbanized city of Sri Lanka.

Materials and Methods

Research objectives

a) Identifying the Environmental, Social and Economic function of residential green spaces.

b) Developing models to illustrate the functions of residential green spaces.

c) Assessing the Environmental, Social, Economic and overall influence of residential green spaces.

Literature review

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Citation: Jayasinghe C, GPTS Hemakumara, P Hewage. (2022) An Assessment of the Function of Residential Green Spaces in a Residential Zone of Galle City, Sri Lanka. Environ Pollut Climate Change.6:300

Received: 23-March-2020, Manuscript No. EPCC-22-001-Pre Qc 22; **Editor assigned:** 03-August-2022, PreQC No. EPCC-22-001-Pre Qc 22 (PQ); **Reviewed:** 17-August-2022, QC No. EPCC-22-001-Pre Qc 22; Revised: 22-August-2022, Manuscript No. EPCC-22-001-Pre Qc 22 (R); **Published:** 29-August-2022, **DOI:** 10.4172/2573-458X.1000300

Urban Green space

Even though the definition of green space has been argued about for a long time, a universally accepted definition is yet to materialize. The European Commission (2013) defined green space as a strategically planned network of high quality natural and partly built-up areas replete with many environmental features, designed and managed to deliver a wide range of ecosystem services and protect biodiversity, in both rural and urban settings. Jim and Chen (2003) defined urban green spaces as vegetated areas found in urban environments that could be described as semi-natural areas, such as parks, forest patches, open spaces, residential gardens and long rows of trees lining one or both sides of a roadway.

Urban residential gardens

Definition of residential garden as "the area adjoining a private dwelling, whether it is owned or rented" means that it is not accessible to the general public. Residents' autonomy over the garden is a key feature of private gardens, although householders may give the design and maintenance responsibilities to other parties such as landscape architects, professional gardeners or caretakers. Private gardens vary in form, function and size.

Private yards are important because they provide city residents with immediate access to urban green space. However, they also play a significant role in contributing to overall vegetation cover in cities, as residential areas account for more than 50% of all available green space in many cities.

Functions of green spaces

Urban green areas fulfill many functions in the urban context that benefit people's quality of life. Most of the studies on urban green areas focus mainly on one benefit or related specific benefits, including the following: a) environmental benefits such as climate moderating potential in the form of cooling by providing shade and moisture, noise reduction and filtration of airborne pollutants by passage through foliage and the promotion of biodiversity; b) social benefits such as supporting social interaction and integration as well as providing mental and physical health benefits; c) economic benefits such as enhanced real estate prices because of green spaces in the vicinity.

Therefore, the functions of green spaces can be classified under three main headings as Environmental, Social and Economic.

Environmental functions

These functions improve ecologic conditions and help reduce pollution. Urban green areas enhance the quality of life of urban communities with ecosystem services ranging from maintenance of biodiversity to the regulation of urban climate. Plants improve air circulation, provide shade and transfer a lot of moisture into the air by way of evaporation from the leaves. This provides a cooling effect by helping to lower air temperatures. A study conducted in Chicago has shown that increasing tree cover in the urban setting by 10% may reduce the total energy required for heating and cooling by 5 to 10%. In addition to that, research has shown that on average, 85% of the air pollution in a green area can be filtered out.

Urban green areas can function as sanctuaries that promote the reproduction of both plant and small animal species besides contributing to the conservation of plants, and the maintenance of soil and water quality. A functional network of green areas is essential for the maintenance of ecological conditions needed for a sustainable urban landscape.

Social functions

Social functions include health and well-being, which can receive a boost through the recreational value of green spaces, which can also provide a relaxing setting. The positive influence of green spaces on people is important for everyday enjoyment, work productivity and general mental health. A recent study in Sweden showed that the more time people spend outdoors in urban green areas, the less they are affected by stress. In a psychological study, patients in hospital whose rooms faced a green area recovered 10% faster and needed 50% less potent pain relieving medication as compared to patients whose rooms were facing the wall of a building.

Urban green areas may also influence social capital by providing a meeting place for users to develop and maintain neighborly social ties. The social interaction enhances the personal and social communication skills of users. The presence of green vegetation and the formation of neighborhood social ties in urban areas can significantly contribute to residents' sense of safety and adjustment. Furthermore, urban green spaces provide a good meeting place for local residents where they can engage in various social interactions.

Economic functions

The benefits of UGS can be calculated in economic terms; e.g. by avoiding the cost of establishing more rainwater retention basins, by reduced energy consumption, and through reduced healthcare costs due to a reduction in air-pollution and an increase in outdoor activity. Increased property values for homes overlooking or close to green spaces are a well-documented example of direct economic benefits as witnessed in various countries. House prices with a forest view are 4.9% higher in Finland and 8% higher with a park view in the Netherlands.

These functions have been summarized as being applicable to the social, environmental and economic domains as shown in (Table 1)

Present a conceptual framework to facilitate the development of an inclusive model for the assessment of green space. The framework focuses on the environmental, social and economic purposes of green spaces and provides indicators to establish a model for assessing the functions of green spaces. Indicators reduce the complexity of data, simplify interpretation and assessment. Therefore, indicators can be used to highlight key information concerning the green space functions. Thirty indicators have been identified and the proposed variables or indicators are both qualitative and quantitative in nature (Tables 2-4).

The various functions performed by urban green spaces clearly show that they have a complex and multidimensional structure, and contain important features that contribute to the overall quality of urban life.

Results and Discussion

Research method and materials

Study area: The City of Galle, Capital of the Southern Province is a famous and highly populated city that is developing rapidly. Galle Municipal Council area covers an extent of 1742.4 hectares and consists of 15 wards. According to the proposed zoning plan (2008-2025) of the Urban Development Authority, eight primary residential zones have been demarcated within the Galle MC. The best residential zone, which has 280 housing units was selected for the study purpose.

Green Space Functions	Benefits of Urban Green Spaces
Social Functions	Provide a place for quiet contemplation and reflection, for relaxation, informal recreation, peace, space and appreciation of nature. – Provide opportunities to improve mental health and physical fitness and take part in a wide range of outdoor sports and activity. – Provide safe areas to meet, talk, play and associate freely with friends and even strangers; with other families and between generations. – Provide cultural links with a city's past, giving a sense of place and identity. – Provide opportunities for community events, voluntary activities and charitable fund raising by serving as a good venue. – Provide an educational resource, which is in fact, an outdoor classroom, stimulating ideas on art, design, the environment and natural science.
Environmental Functions	– Provide habitats for wildlife, aiding biodiversity. – Help to stabilize urban temperatures and humidity. – Absorb pollutants in air and ground water. – Provide opportunities for the recycling of organic materials. – Improve storm water runoff and reduce drainage infrastructure. – Provide a sense of the seasons and act as a link between the natural world and the urban environment.
Economic Functions	– Produce agricultural and horticultural crops. – Promote physical and mental health of people and reduce the cost of social medical payment. – Alleviate environmental problems and curtail environmental spending. – Provide job opportunities for managing and maintaining green space. – Add value to the surrounding properties, both commercial and residential, consequently increasing tax yield to maintain public services. – Contribute by attracting tourists. – Encourage employment and inward investment in an area. – Push forward urban regeneration and neighborhood renewal. – Boost the local economy by enabling the holding of special events.

Table 1: Functions of urban green space

Environmental functions	Indicators	References
Climatic and microclimatic modifications	Urban Heat Island effect mitigation	Regulation of solar radiation (Armson et al., 2012; Akbari et al., 2001)
	Temperature moderation through evapotranspiration and shading	Lowering air temperature through evapotranspiration (Heidt & Neef, 2008)
	Wind speed modification	Wind breaking (Duryea et al., 1996)
Air quality improvement	Pollutant removal; Reducing emissions	Pollutant removal; Reducing emissions
Pollutant removal; Reducing emissions	Direct carbon sequestration and storage; avoiding greenhouse gas emissions through cooling	Direct carbon storage and Sequestration (CNT 2010; Nowak & Crane, 2002) Controlling carbon dioxide emissions by cooling effect (CNT 2010; Akbari, 2002)
Reduced energy use for heating and cooling	Direct carbon sequestration and storage; avoiding greenhouse gas emissions through cooling Shading by trees; covering buildings with green roof and green walls	(Akbari & Taha, 1992)
Hydrological regulation	Water flow control and flood reduction; regulation of water quality; water purification	Regulation of water quality Problems (Sanders, 1986) Increased rainwater retention and flooding CNT 2010; Xiao et al., 2000)
Improved soil quality and Erosion prevention	(e.g. soil fertility; soil stabilization)	(McKinney, 2006)

Waste decomposition and nutrient cycling		(Astbury & Rogers, 2004)
(Astbury & Rogers, 2004)		(CNT 2010)
Biodiversity protection and enhancement	Communities; species; genetic resources; habitats	Promoting conservation (Adams, 1994) Harboring wildlife (Dunster, 1998)

Table 2: Environmental functions of green space

Social functions	Indicators	References
Improving physical well-being	Physical outdoor activity; healthy food; healthy environment	(Schipperijn et al., 2013)
Improving social well-being	Improving social well-being	(Peschardt et al., 2012)
Improving mental well-being	Reduced depression and anxiety; recovery from stress; attention restoration; positive emotions	Reduction of mental fatigue (Arnberger & Eder, 2012)
Opportunities for recreation, tourism and social interaction	Community livability	(Gobster & Westphal, 2004)
Food production	Urban agriculture; kitchen gardens; edible crop landscape and community garden	(Clark & Nicholas, 2013)
Provision of outdoor sites for education and research		(McDonnell et al., 1997)
Reduction of crimes and fear of crime	Comfort; amenity and safety	(Kuo & Sullivan, 2001)
(Kuo & Sullivan, 2001)	(Kuo & Sullivan, 2001)	(McKinney, 2006)

Table 3: Social functions of green space

Economic functions	Indicators	References
Increased property values	Social	(Donovan & Butry, 2010)
Increased property values		(Akbari & Taha, 1992)
Healthcare cost savings		(Akbari & Taha, 1992)
Economic benefits of provision services	Raw materials; timber; food products; biofuels; medicinal products; fresh water, etc.	(Akbari & Taha, 1992)
(Akbari & Taha, 1992)		(CNT 2010; Scott et al., 1998)
Value of avoided energy consumption	Reduced demands for cooling and heating	(CNT 2010; Akbari & Taha, 1992)
Greater local economic activity	Tourism, recreation, cultural activities or other income generating activity	(Wolf, 2004; McPherson & Simpson, 2002)

Table 4: Economic functions of green space

Dependent Variable	Independent variables (Environmental)	Unit of analysis
Green coverage	Biodiversity protection	No. of species in the garden
	Air quality improvement	Pm
	Temperature amelioration	Temperature °F/C
	Reduced energy use for cooling	Average Cost incurred for cooling per month (Rs.)

Table 5: Selected variables to analyze the Environmental functions of residential greenery

Selected variables for the study

According to the findings of the literature review, the following variables were selected by considering their measurability level for the study purposes. Show the selected variables and their respective unit of analysis.

Research methodology

The dependent variable is the percentage of land area used as residential garden out of the total land area that is available for use as a garden. There are nine independent variables in all. The collected data were analyzed by using IBM SPSS Statistics 25. Then four separate models were developed to illustrate the function of residential gardens. Relationship between the dependent and independent variables is shown in (Figure 1).

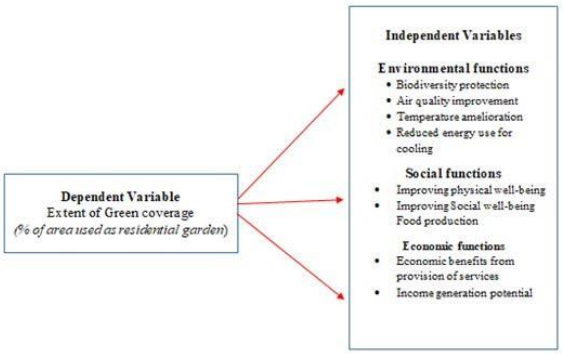

Figure 1: Relationship between dependent variables and independent variables

Analysis and Discussion

280 housing units were surveyed to collect the data needed for multiple regression analysis and to develop four separate models to illustrate the environmental, social, economic and overall functions of residential gardens. Collected data were entered into the illustration models and the Ŷ value was calculated for every housing unit. Then these data were entered into the Geographic Information System (GIS) platform, taking each house as a unit of analysis to assess the Environmental, Social, Economic and Overall functions of residential green spaces.

Model A - Environmental function of residential green spaces

The model was created based on the selected four variables as P values of all variables were less than 0.05 and t values of all variables were greater than 1.96. Therefore, the models to illustrate the environmental functions were developed as follows:

Extent of the green area (Environmental Functions) = 79.799 + 1.165 (NOS) - 1.061 (AT) - 0.167 (DPA) - 0.030 (ACFC)

According to (figure 2), the residential garden lots shown in dark green color are highly functional. It means only 10% of the residential gardens are environmentally functional. Gray color residential gardens shown in figure 2 are not environmentally functional because the value taken from these housing units are below zero. 52.85% of the gardens on residential lots are poorly functional while 27.5% are moderately functional shows the level of functioning ability as a percentage.

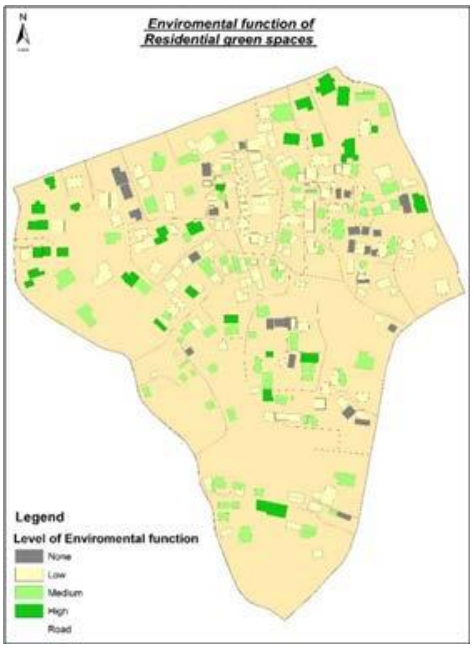

Figure 2: Environmental function of residential green space

Model B - Social function of residential green space

This model is created based on the selected seven factors under the social function of residential greenery as P values of all variables except UGTEWF and UGTPS are less than 0.05 and t values of all variables except UGTEWF and UGTPS are greater than 1.96. Therefore, the model to illustrate the social function is developed as follows:

Extent of the green area (Social Functions) = 9.334 + 1.562 (NOTFV) + 8.677 (UGFRT) + 10.840 (UGTMF) + 10.704 (UGFSF) + 4.286 (UGFES)

According to (figure 3), the residential green spaces of the housing units shown in red color are socially functioning well. It means 12.85% of the residential gardens are socially functioning. Gray color housing units are functioning poorly because the value taken from these housing units are below 0. According to 59% of the residential gardens are not socially functioning well. These residents are not getting any social benefits from their residential gardens.

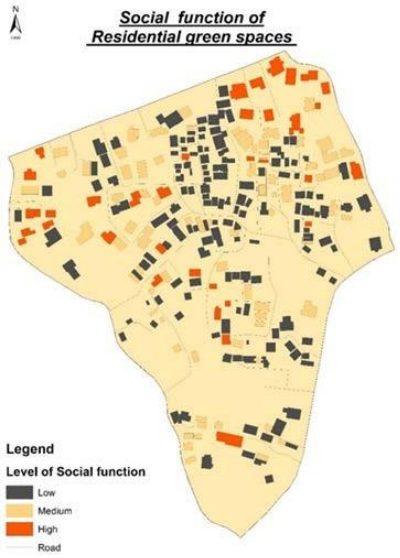

Figure 3: Social function of residential green space

Model C - Economic functions of residential gardens

This model is created based on the selected five factors under the economic function of residential greenery as

According to (figure 4), the residential gardens of housing units shown in red color are economically functioning well. It means 12.85% of residential gardens are economically functioning. Black housing units are poorly functioning because the values taken from these housing units are below 0. According to, 59% of residential gardens are not functioning well economically. The residents are not deriving any economic benefits from their home gardens.

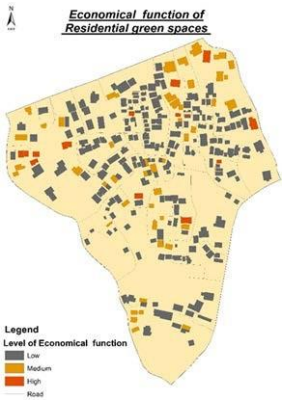

Figure 4: Economic functions of residential green space

When comparing the analyzed data, 50% of the gardens on residential lots are environmentally, economically and socially functioning at a low level. (Figure 5) shows the percentage of residential gardens that are functioning at a low level under each category.

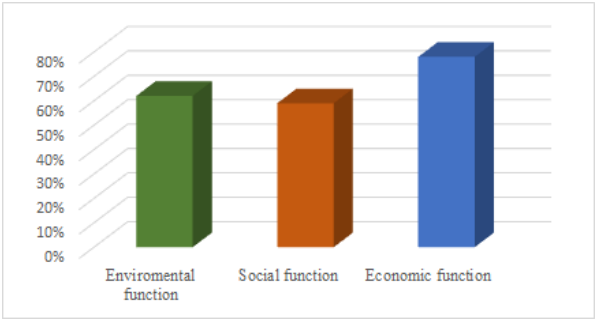

Figure 5: Percentage of residential gardens that are functioning at a low level

Model D - Overall function of Residential green space

This model is created based on all the selected factors under the environmental, social and economic functions of residential greenery the overall function of residential green space is shown in (figure 6).

According to figure 6, the residential green spaces of housing units shown in dark green color are functioning well. It means that 8.9% of the residential gardens are environmentally, socially and economically functioning well. Gray color housing units are functioning at a low level because the values taken from these housing units are below 0. According to, 7.8% of residential gardens are not functioning well. 24% of housing units are moderately functioning and 59% of residential gardens are poorly (i.e. low) functioning.

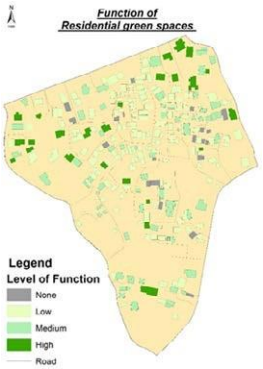

Figure 6: Overall function of residential green space

Conclusion

Residential Green spaces provide a wide range of functions that can play a significant role in benefiting the urban environment and its populace. The gardens also have considerable environmental, social and economic values for many people.

The results of our survey indicate that nearly 9% of residential gardens are well functioning in the selected residential zone but 59% of these home gardens are low functioning. 8% of the residential gardens are not functioning at all. We found that a wide range of functions is performed by residential gardens but the level of functioning varied according to the category. 78% of gardens on residential plots were economically low functioning, 59% of gardens were socially low functioning, and 52% were environmentally low functioning in the selected residential zone.

Cultivation of homegrown fruits and vegetables could be a benefit of having a garden but 78% of respondents were not getting any economic benefits from their gardens. Residential gardening can also provide considerable socio-economic benefits, such as space for socializing, rest and recreation, while substantially increasing property values. According to the analysis, only 36% of householders receive any social benefits from their garden.

Vegetation around the home can provide a variety of important ecosystem services to the people, such as Ecological Benefits, Pollution Control, Biodiversity and Nature Conservation. These benefits can reduce the energy requirements for air conditioning and lower the peak demand for energy, thereby reducing consumer costs in residential homes. The physical presence of vegetation around the home can also provide benefits of noise reduction by buffering residential areas from urban noise pollution, and enhancing privacy by blocking the views from neighboring properties. Further, flood mitigation is another benefit because carefully designed vegetative systems will reduce flood discharge by allowing greater levels of infiltration and recharge without requiring any physical intervention. However, only 10% of the respondents were receiving the environmental benefits in the study area.

It is believed that homes with a greater amount of vegetation surrounding them will provide a greater amount of environmental, social and economic service benefits to the residents. Our results show that only 8% respondents are receiving all those services from their residential yards. This result highlights the fact that the functions of residential green spaces are at a low level in the selected residential zone.

All of the above evidence shows that residential green spaces can fulfill many functions in the urban context that will benefit people's quality of life. They can contribute to environmental, social, economic, recreational, cultural, aesthetic, and commercial developments in urban communities.

There is therefore, a broad consensus about the importance and value of residential green spaces in urban communities, so that there is a trend towards transforming urban areas into more sustainable eco-friendly places in the 21st century.

Acknowledgment

None

Conflict of Interest

None

References

1. Akbari H, Pomerantz M, Taha H (2001) Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. Sol Ener 70 (3): 295-310.
2. Armson D, Stringer P, Ennos AR (2012) The effect of tree shade and grass on surface and globe temperatures in an urban area. Urb Forest Urb Green 11(3): 245-255.
3. Arnberger A, Eder R (2012) Exploring coping behaviours of Sunday and work day visitors due to dense use conditions in an

urban forest. Urb Forest Urb Green 11 (4), 439-449.

4. Astbury B, Rogers P (2004) Evaluation of the stronger families and communities strategy: Gilles Plains community garden case study, RMIT Univer Collabor Instit Research.
5. Heidt V, Neef M (2008) Benefits of urban green space for improving urban climate. Eco, plan, manage urb forest: Internat perspect, Springer: New York 23(4): 84-96.
6. Duryea ML, Blakeslee GM, Hubbard WG, Vasquez RA (1996) Wind and trees: A survey of homeowners after hurricane Andrew. J Arboricul 22 (1): 44-50. [GoogleScholar]
7. CNT (2010) Integrating valuation methods to recognize green infrastructure's multiple benefits. Center Neighbor Tech 11(3): 245-255.
8. Nowak DJ, Crane DE (2002) Carbon storage and sequestration by urban trees in the USA. Environ Pollu 116 (3): 381-389.
9. Sanders RA (1986) Urban vegetation impacts on the hydrology of Dayton, Ohio. Urb Eco 9(3): 361-376.
10. Xiao Q, McPherson EG, Ustin SL, Grismer ME, Simpson JR (2000) Winter rainfall interception by two mature open-grown trees in Davis, California. Hydro Proc 14(4): 763-784. [GoogleScholar]
11. McKinney ML (2006) Urbanization as a major cause of biotic homogenization. Bio Conserv 127 (3):247-260.
12. Schipperijn J, Bentsen P, Troelsen J, Toftager M, Stigsdotter UK (2013) Associations between physical activity and characteristics of urban green space. Urb Forest Urb Green 12(1):109-116.
13. Peschardt KK, Schipperijn J, Stigsdotter UK (2012) Use of small public urban green spaces (SPUGS). Urb Forest Urb Green 11(3): 235-244.
14. Gobster PH, Westphal LM (2004) The human dimensions of urban greenways: Planning for recreation and related experiences. Landscape Urb Plan 68(2-3): 147-165.
15. Clark KH, Nicholas KA (2013) Introducing urban food forestry: A multifunctional approach to increase food security and provide ecosystem services. Landscape Eco 28(9): 1649-1669.
16. McDonnell MJ, Pickett STA, Groffman P, Bohlen P, Pouyat RV, et al. (1997). Ecosystem processes along an urban-to-rural gradient. Urb Eco 1(1): 21-36.
17. McPherson EG, Simpson JR (2002) A comparison of municipal forest benefits and costs in Modesto and Santa Monica, California, USA. Urb Forest & Urb Green 1(2): 61-74.
18. Kuo FE, Sullivan WC (2001) Aggression and violence in the inner city: Effects of environment via mental fatigue. Environ Behavior 33(4): 543.
19. Donovan GH, Butry DT (2010) Trees in the city: Valuing street trees in Portland, Oregon. Landscape Urb Plan 94(2): 77-83.